GWOU ADMINISTRATIVE RECORD
SECTION TITLE:
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DOE/GJ/79491-936

Record of Decision for Final Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site

Draft

September 2003

U.S. Department of Energy
Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

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September 2003

prepared by

U.S. Department of Energy, Grand Junction Office, Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri

DECLARATION STATEMENT

Site Name and Location

Weldon Spring Chemical Plant
Groundwater Operable Unit
St. Charles County, Missouri
CERCLIS Identification Number: MO3210090004

Statement of Basis and Purpose

This Record of Decision (ROD) announces the selection of monitored natural attenuation (MNA) coupled with institutional controls (ICs) and contingencies as the final remedial action for the groundwater operable unit (GWOU) of the U.S. Department of Energy's (DOE's) Weldon Spring Site in St. Charles County, Missouri. This action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. National Environmental Policy Act (NEPA) issues related to the Chemical Plant have also been addressed and have been integrated into the CERCLA decision-making process for the GWOU to the extent practicable, in accordance with DOE's policy on NEPA.

As the MNA process is used in the GWOU, it is predicted to remediate all of the contaminants of concern (COCs) in groundwater at the Chemical Plant Area. The selection of MNA is based on the Administrative Record (AR) for the GWOU. Major documents in the AR include the (1) Remedial Investigation/Feasibility Study (RI/FS) Work Plan, (2) RI and Baseline Risk Assessment (BRA) Reports, (3) Feasibility Study (FS) Report and Supplemental Feasibility Study, (4) Supporting Evaluation Report, and (5) Proposed Plan (PP). Public comments received during the review period for the Proposed Plan were considered in the development of this ROD. Responses to significant public comments are provided in the Responsiveness Summary.

[Insert statement from the State of Missouri here.]

Assessment of the Site

The response action announced in this ROD is necessary to protect the public health or welfare of the environment from actual or threatened releases of hazardous substances from this site that were not addressed under previous response actions.

Description of the Selected Final Remedy

The selected final remedy for the GWOU is MNA coupled with ICs and contingencies. MNA involves the collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations. Dilution and dispersion are the primary natural processes identified that are reducing all contaminant concentrations in groundwater at the

Chemical Plant. The GWOU is the second of two operable units established for the Chemical Plant of the Weldon Spring Site. The first operable unit, the Chemical Plant Operable Unit, accomplished the treatment of sludges, excavation of soil, dismantling of buildings, and removal of other source materials located at the Chemical Plant proper. The ROD for that operable unit was signed on September 28, 1993, and the remediation was completed in 1998.

The selected remedy is the final remedy for the GWOU. This final ROD establishes necessary ICs and contingencies, as appropriate, and defines monitoring requirements for MNA.

The ROD Data Certification Checklist on the following page lists the locations within this ROD where the reader can find key information supporting the selected remedy.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with applicable or relevant and appropriate requirements (ARARs) to the extent practicable and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site.

Review of this selected remedy will be included in the five-year review process conducted for the Weldon Spring Site as required by CERCLA. Five-year reviews are developed in consultation with the U.S. Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR). These reviews are made available to the public.

____ ______________________

Manager of Policy and Site Transition Date
Office of Legacy Management
U.S. Department of Energy
Lead Agency

____ ______________________

Superfund Division Director Date
U.S. Environmental Protection Agency Region VII
Support Agency

Groundwater Operable Unit ROD Data Certification Checklist

The following information is included in this ROD. Additional information can be found in the Administrative Record for this operable unit of the Weldon Spring Site.

Site Data
Contaminants of concern (COCs) and their concentrations.
Baseline risk represented by the contaminants.
Cleanup levels established and the basis for the levels.
Methods of addressing how source materials constitute principal threats.
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the Baseline Risk Assessment and ROD.
Potential land and groundwater use that will be available at the site as a result of the selected remedy.
Estimated capital, annual operations and maintenance (O&M), and total present net-worth costs.
Key factor(s) that led to selecting the remedy.

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FIGURES (Cont.)

NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

GENERAL

AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CSR	*Code of State Regulation*
DA	U.S. Department of the Army
DHSS	Missouri Department of Health and Senior Services
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	federal facility agreement
FHHS	Francis Howell High School
FS	feasibility study
GWOU	groundwater operable unit
IC	institutional control
ICO	in-situ chemical oxidation
IROD	Interim Record of Decision
LOAEL	lowest observed adverse effect level
LTS&MP	Long-Term Surveillance and Maintenance Plan
MCL	maximum contaminant level
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MDOH	Missouri Department of Health
MoDOT	Missouri Department of Transportation
MNA	monitored natural attenuation
MOA	memorandum of agreement
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
NOAEL	no observed adverse effect level
O&M	operations and maintenance
PP	Proposed Plan
RA	remedial action
RAO	remedial action objective
RBC	risk-based concentration
RD	remedial design
RfD	reference dose

GENERAL (CONT.)

RI	remedial investigation
ROD	Record of Decision
RPD	relative percent difference
UCL95	upper confidence limit at 95%
WSTA	Weldon Spring Training Area

CHEMICALS

1,3-DNB	1,3-dinitrobenzene
DNT	dinitrotoluene
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
NB	nitrobenzene
TCE	trichloroethylene
TNT	trinitrotoluene
2,4,6-TNT	2,4,6-trinitrotoluene

UNITS OF MEASURE

cm	centimeter(s)
cm^2	square centimeter(s)
d	day(s)
ft	foot (feet)
gal	gallon
h	hour(s)
ha	hectare(s)
kg	kilogram(s)
km	kilometer(s)
L	liter(s)
m	meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mL	milliliter(s)
pCi	picocurie(s)
yr	year(s)
µg	microgram(s)

RECORD OF DECISION FOR FINAL REMEDIAL ACTION FOR THE GROUNDWATER OPERABLE UNIT AT THE CHEMICAL PLANT AREA OF THE WELDON SPRING SITE

1 SITE NAME, LOCATION, AND DESCRIPTION

Name and Location: Weldon Spring Site
St. Charles County, Missouri

U.S. Environmental Protection Agency (EPA) CERCLIS Database ID: MO3210090004

Lead Agency: U.S. Department of Energy (DOE)

Site Type: Federal Facility – Former Uranium Processing Plant

Site Description Abstract: The groundwater operable unit (GWOU) underlies the 88-ha (217-acre) Chemical Plant, located at DOE's Weldon Spring Site in St. Charles County, Missouri, about 48 km (30 mi) west of St. Louis. The operable unit contains contaminants resulting from uranium processing and trinitrotoluene (TNT) production. Burgermeister Spring, which is hydrologically connected to the Chemical Plant groundwater, is in the August A. Busch Memorial Conservation Area outside the site.

2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Weldon Spring Site consists of two noncontiguous areas: the Chemical Plant and the Quarry. Both properties are located in St. Charles County, Missouri, about 48 km (30 mi) west of St. Louis (Figure 2.1). The 88-ha (217-acre) Chemical Plant lies within the boundaries of the former Ordnance Works (Figure 2.2).

The sources of contamination at the Chemical Plant from uranium processes are those shown in the original layout of the Chemical Plant (Figure 2.3). Previous contamination of nitroaromatic compounds originated from TNT process lines. These consisted of approximately 40 buildings, four waste retention ponds (referred to as Raffinate Pits), two ponds (Ash Pond and Frog Pond), and two former dumps (north and south). Remediation of these source areas has been completed. Burgermeister Spring, which is hydrologically connected to the Chemical Plant groundwater, is in the August A. Busch Memorial Conservation Area.

The Chemical Plant was used for TNT production from 1941 to 1945 and later as a uranium-processing facility from 1957 to 1966. The Quarry was used to dispose of uranium and thorium residues (drummed and uncontained), radioactively contaminated building rubble and process equipment, and TNT and dinitrotoluene (DNT) residues from cleanup of the former Ordnance Works.

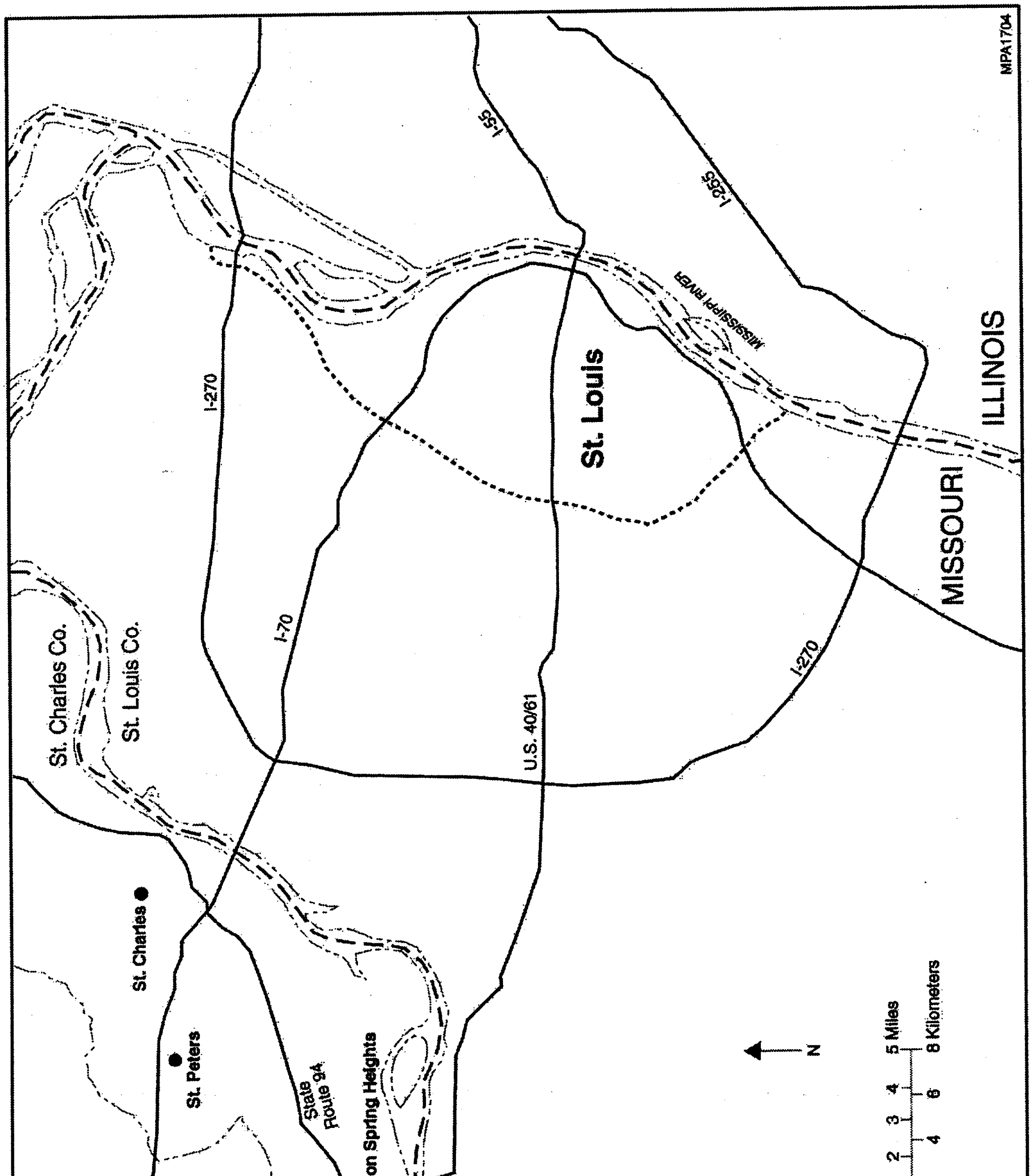


FIGURE 2.1 Location of the Weldon Spring Site

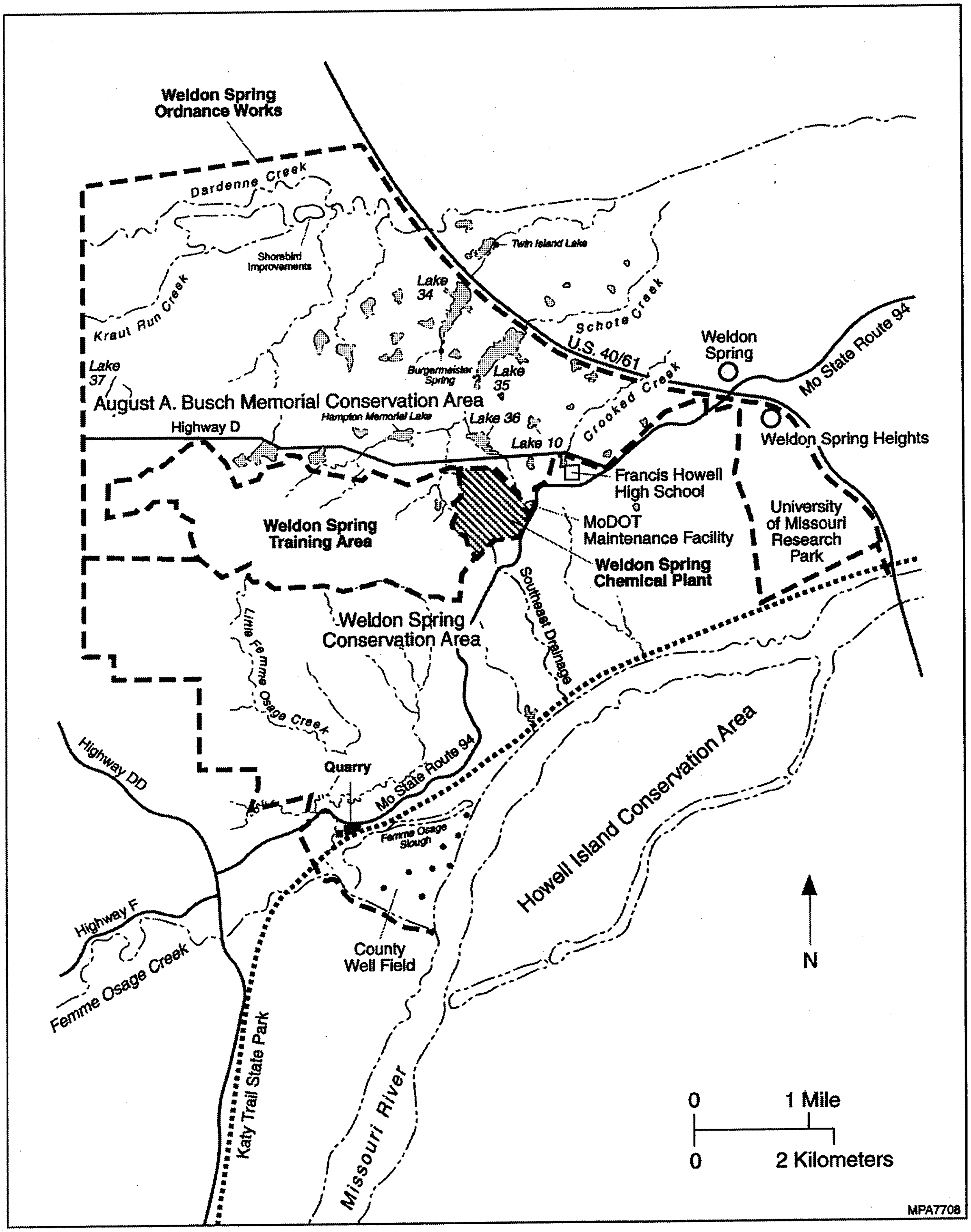


FIGURE 2.2 Map of the Chemical Plant Area and Immediate Vicinity

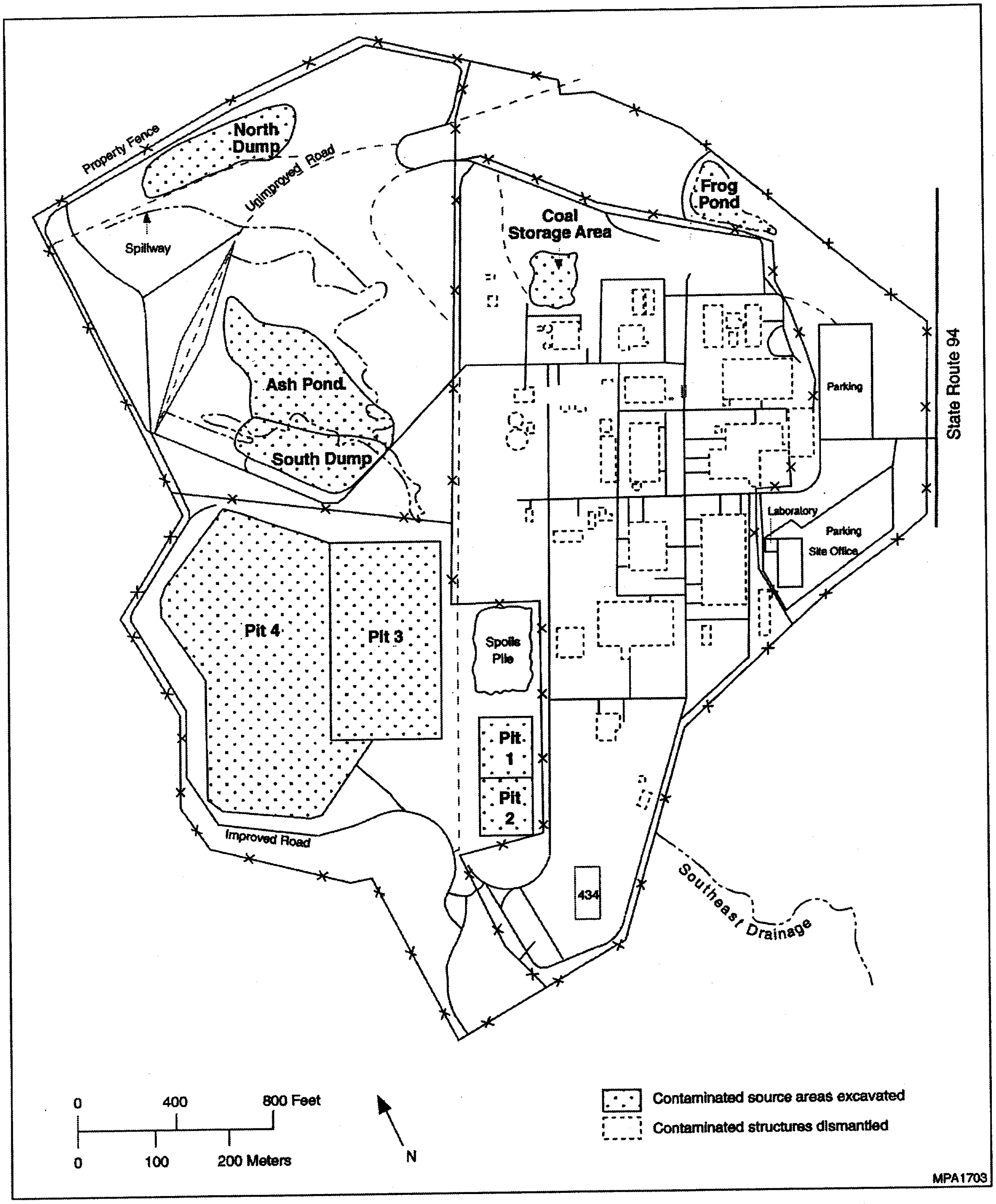


FIGURE 2.3 Original Layout of the Chemical Plant

In 1986, the EPA and DOE entered into a federal facility agreement (FFA) (EPA 1992b). The EPA listed the Quarry on the National Priorities List (NPL) in 1987. The Chemical Plant was added in 1989. The FFA was amended in 1992 and complies with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The amended FFA includes agreements to ensure that the environmental impacts associated with past and present activities at the Weldon Spring Site are thoroughly investigated and that appropriate remedial action is taken, as necessary, to protect public health and the environment. This FFA also facilitates the exchange of information among the EPA, DOE, and the State of Missouri and contains procedures for resolving disputes, assigning penalties for nonconformance, and ensuring public participation in the remedial action decision-making process.

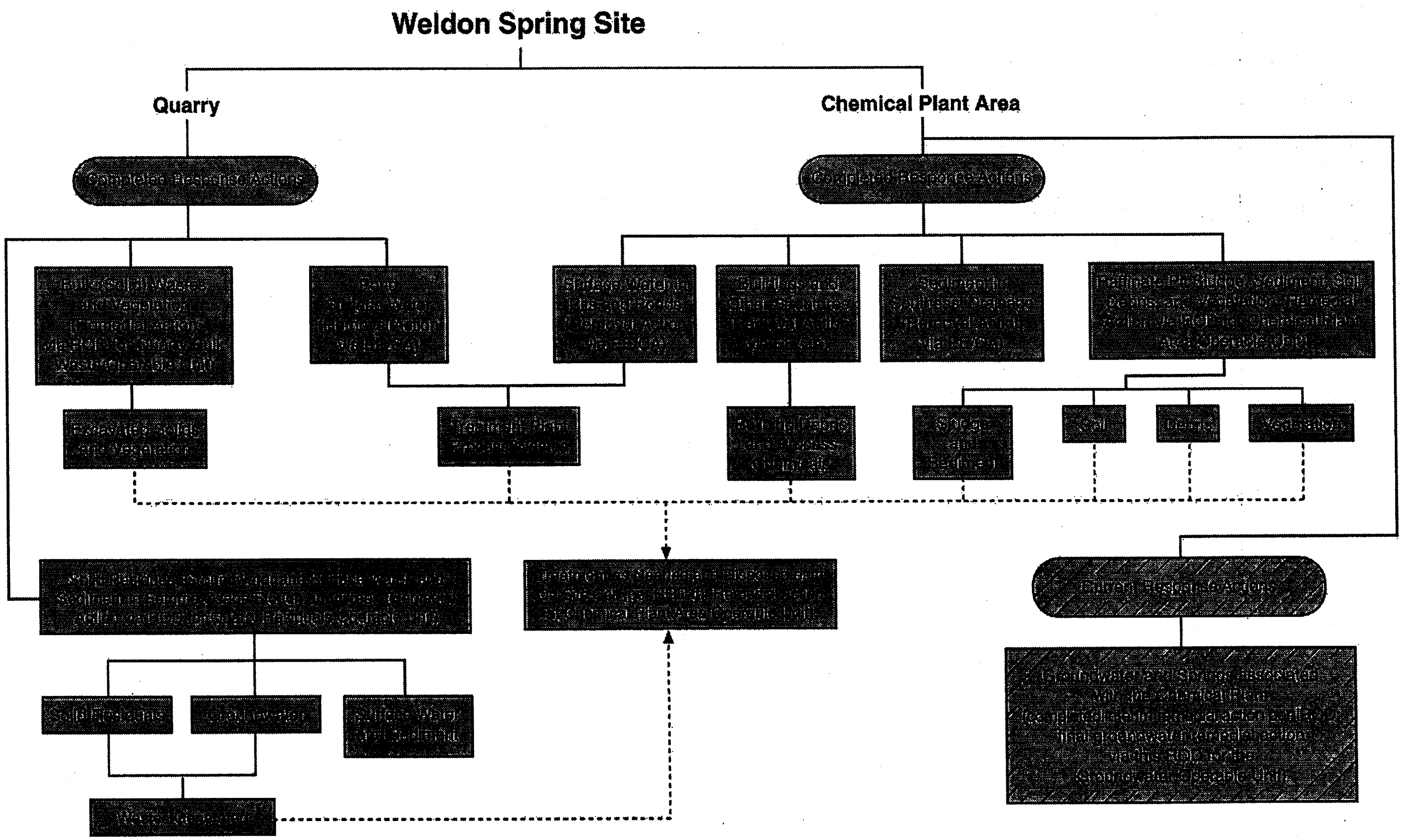
In 2000, DOE published an Interim Record of Decision (IROD) for the remediation of trichloroethylene (TCE). The remedial action announced in that IROD was in-situ chemical oxidation (ICO). This present Record of Decision (ROD) for remediation of the GWOU includes remediation of TCE by using a method that differs from the remedy selected in the 2000 IROD.

3 COMMUNITY PARTICIPATION

The Proposed Plan (PP) and its supporting documentation (remedial investigation/feasibility study [RI/FS] and other related reports) for the GWOU were made available to the public in August 2003. These reports can be found in the Administrative Record (AR) located at the site. The notice of availability of the PP was published August 3, 2003, in the *St. Louis Post-Dispatch* and the *St. Charles County Journal*. A public comment period was held from August 4 to September 3, 2003. A public meeting was held on August 13, 2003, to present the PP. At the meeting, DOE provided an overview of the preferred alternative and explained the process that led to its selection. Representatives from the Missouri Department of Natural Resources (MDNR), Missouri Department of Conservation (MDC), and EPA expressed the positions of their respective agencies regarding the proposal. Comments from several members of the public who attended the meeting were also received. A transcript of the meeting is available in the AR. Responses to comments received at the meeting and to timely comments received during the comment period are provided in the Responsiveness Summary, which is presented as a separate report but is considered a part of this ROD.

4 SCOPE AND ROLE OF THE OPERABLE UNIT

This selected remedy for the GWOU constitutes the final CERCLA remedial action of the four-part phased cleanup process implemented at the Weldon Spring Site (Figure 4.1). The first three operable units were the (1) Quarry Bulk Waste Operable Unit, composed of contaminated bulk waste at the Quarry; (2) Chemical Plant Operable Unit, composed of contaminated soil and structures located at the Chemical Plant (including the construction of the on-site disposal cell); and (3) Quarry Residuals Operable Unit, composed of the remaining or residual contamination at the Quarry area (including contaminated groundwater).



Note: The boxes represent contaminated media addressed by the project's cleanup actions for the chemical plant and the quarry; they are connected by solid lines to the appropriate phase of site cleanup. Dashed lines identify wastes generated as a result of the completed response actions and that were treated and disposed of in the on-site cell at the chemical plant. Boxes with cross-hatching constitute contaminated media that are being addressed as part of the GWOU and this ROD. The GWOU is the final of four operable units for the Weldon Spring site.

FIGURE 4.1 Remediation Components for the Weldon Spring Site

This ROD will be followed by a remedial design/remedial action (RD/RA) Work Plan. This final GWOU ROD will reflect the change to the remedy stipulated in the IROD for TCE, which was ICO. That is, the remedy stipulated in this ROD serves as the final remedy for all contaminants of concern (COCs) for the GWOU, including the TCE that remained after implementation of the IROD. The site Long-Term Surveillance and Maintenance Plan (LTS&MP) (DOE 2003a) will incorporate long-term (monitoring) activities stipulated in this final ROD and the RD/RA Work Plan.

5 SITE CHARACTERISTICS

5.1 CONTAMINATION UNDER CURRENT GROUNDWATER AND SPRINGWATER CONDITIONS

The current monitoring program consists of 86 wells (including 5 wells that monitor the performance of the Chemical Plant disposal cell) and 5 springs. (Approximately 60 additional monitoring wells that had also been constructed and sampled since 1987 were abandoned.) The current network of wells and current network of springs monitored at the Chemical Plant area are shown in Figure 5.1 and 5.2, respectively. The COCs in groundwater are TCE, nitrate, uranium, and nitroaromatic compounds. The nitroaromatic compounds of concern include 2,4-DNT, 2,6-DNT, 2,4,6-TNT, 1,3-dinitrobenzene (1,3-DNB), and nitrobenzene (NB).

5.1.1 TCE

The maximum contaminant level (MCL) for TCE is 5 µg/L. TCE contamination exceeding that limit is found primarily within the Chemical Plant boundary (in the vicinity of the former Raffinate Pits) extending just beyond the DOE boundary onto the adjacent Army site. Contamination is primarily limited to the weathered portion of the shallow aquifer. The source of TCE contamination was drums discarded in Raffinate Pit 4, which were removed as part of the Chemical Plant Operable Unit. Since 1996, decreasing trends have been observed. Data collected in 2002 showed TCE concentrations ranging from 1.6 to 580 µg/L, with the maximum reported for MW-4029 (a monitoring well located within the Chemical Plant boundary near the Raffinate Pits). Concentrations of TCE (lower than the MCL) have been detected only in one spring, SP 6303, at approximately 1 µg/L.

During 2001, the pilot-phase ICO process was performed as described in the IROD (DOE 2000). The ICO appears to have achieved only temporary reduction of TCE within the area of influence (approximately 100 ft [30 m] from the injection point). Dispersion of the oxidant favored a downgradient direction toward a preferential flow feature (paleochannel), and uniform distribution was not achieved. The latest data, collected in 2003 at some locations where TCE

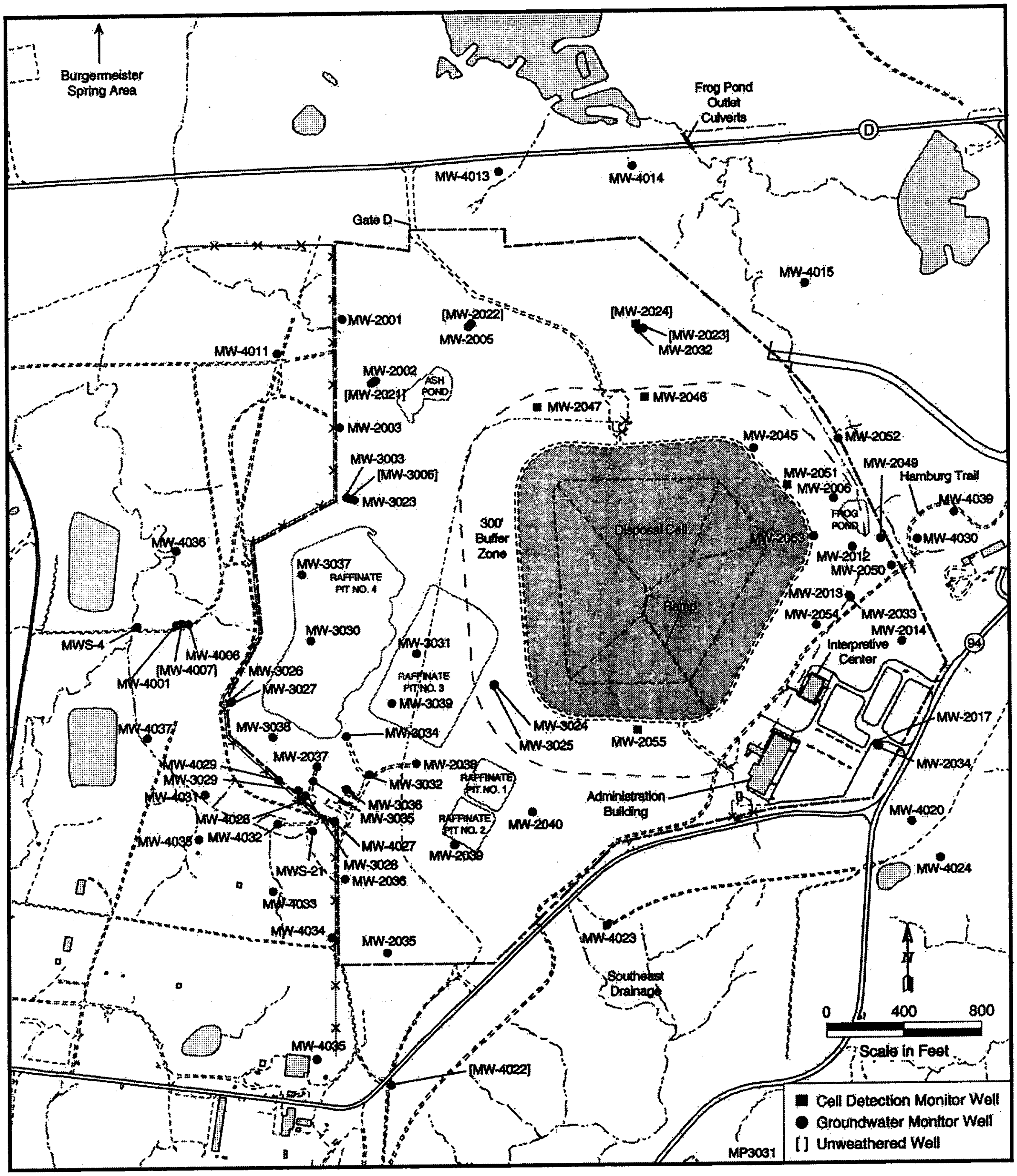


FIGURE 5.1 Locations of Wells in the Chemical Plant Area

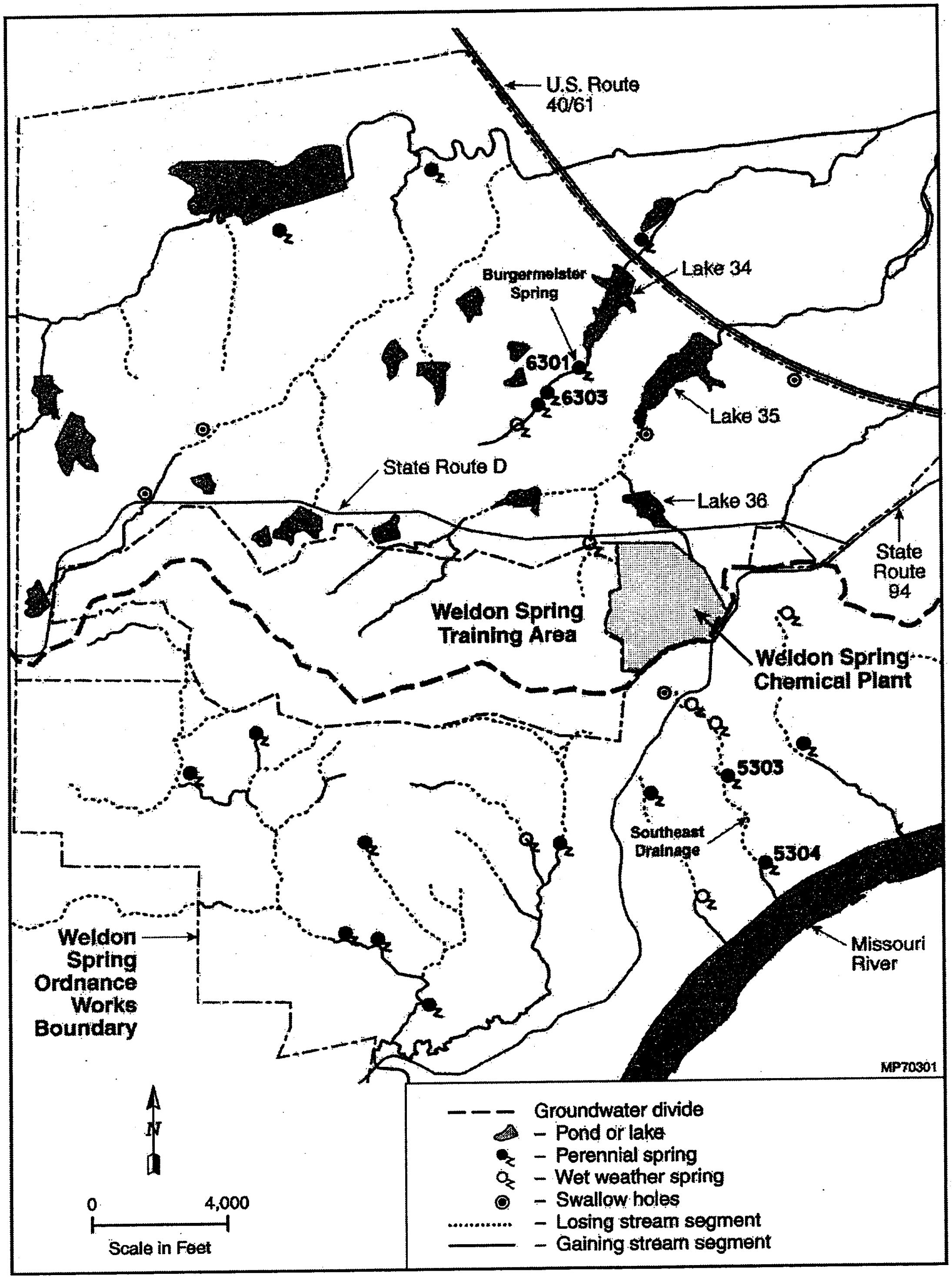


FIGURE 5.2 Locations of Springs and Drainage Areas in the Chemical Plant Area

was treated and reduced to nondetectable levels, show that concentrations have returned to near pretreatment concentrations. This result was considered possible and was probably caused by recontamination from the TCE that is in other nearby portions of the groundwater because it was not reduced by the pilot-phase ICO. It is noteworthy that the original source of TCE contamination, which was drums discarded in Raffinate Pit 4, was removed during the remedial action for the Chemical Plant Operable Unit.

5.1.2 Nitrate

The MCL for nitrate is 10 mg/L. The highest concentrations of nitrate have been measured in the vicinity of the Raffinate Pits and Ash Pond, which are historical sources of this contaminant. Nitrates are mobile in the shallow aquifer system. Data for 2002 show nitrate concentrations ranging from 0.4 to 826 mg/L, with the maximum reported for MW-4029. Nitrate concentrations that exceed the MCL are observed at locations within the DOE Chemical Plant boundary, locations on MDC property, and locations within the adjacent U.S. Department of the Army (DA) site. Remediation activities in the raffinate pit area and Ash Pond in 1998 resulted in slight increases in contaminant concentrations in several of the nearby wells. This effect was considered a possibility because of the large-scale soil excavation that occurred during remediation of the Chemical Plant. It is anticipated to be only temporary. The majority of the wells exhibit stationary trends, with a few beginning to show downward trends.

Nitrate concentrations at Burgermeister Spring vary with changes in flow rate but are generally lower than concentrations measured in groundwater. Lower concentrations occur during high flow rates because of dilution. Data for 2002 indicate nitrate concentrations ranging from 0.94 to 11 mg/L. Nitrate results from Burgermeister Spring (1999 through 2002) show a downward trend during high flow and a stationary trend during base (low) flow. A nitrate concentration of 1.9 mg/L was also detected at SP-5304 in 2002.

5.1.3 Uranium

The MCL for uranium is 30 µg/L (or 20 pCi/L, based on the isotopic ratio determined for the Weldon Spring Site). Uranium concentrations exceeding the MCL are located within the Chemical Plant boundary and at several springs located on MDC property. The Raffinate Pits were the historical source of uranium in groundwater as it entered the aquifer via infiltration through the overburden. Contamination is primarily limited to the weathered portion of the shallow aquifer. Adsorption of uranium onto the overburden limited its extent in groundwater. Data on uranium concentrations collected in 2002 showed ranges of 0.1 to 60 pCi/L, and concentrations in only two wells exceeded the MCL. MW-3024 had 60 pCi/L, and MW-3030 had 57 pCi/L. Both wells are located within the Chemical Plant boundary. Because of the relatively low concentrations, downward trends are not expected to be clearly obvious until several more years of groundwater data are collected.

Uranium has been detected at Burgermeister Spring (SP-6301) and at the Southeast Drainage (SP-5304). In 2002, uranium ranged from 8.6 to 100 pCi/L and from 9.4 pCi/L to

103 pCi/L at the two springs, respectively. Uranium concentrations measured at Burgermeister Spring are generally higher than those measured in groundwater at the Chemical Plant. Base flow concentrations have shown a downward trend at Burgermeister Spring since 1999 and have also shown a stationary trend under high-flow conditions.

5.1.4 Nitroaromatic Compounds

State of Missouri water quality standards for 2,4-DNT, 1,3-DNB, and NB are 0.11 μg/L, 1.0 μg/L, and 17 μg/L, respectively. There are no federal standards for the nitroaromatic compounds of concern in groundwater at the Chemical Plant. Nitroaromatic compounds occur in groundwater in the northeastern and southwestern portions of the site where TNT production lines were located both on the Chemical Plant site and the adjacent DA site. Contamination occurs predominantly in the weathered portion of the shallow aquifer. In 2002, maximum concentrations of 1,600 μg/L for 2,4-DNT, 1,300 μg/L for 2,6-DNT, 290 μg/L for 2,4,6-TNT, 1.7 μg/L for 1,3-DNB, and 69 μg/L for NB were detected. These maximums were reported for one particular well, MW-2012. Starting in 1999, increasing trends were observed from this monitoring well near the Frog Pond area located within the Chemical Plant boundary. They are most likely due to excavation of TNT-impacted soil in this area or due to excavation of the nearby waste lagoon for the adjacent Weldon Spring Ordnance Works site by the DA. The increase in concentrations is expected to be temporary, since the sources of nitroaromatic contamination have been removed and water quality should improve over time. Nitroaromatic compound contamination at the remainder of the site is significantly lower. Of the nitroaromatic compounds sampled for at Burgermeister Spring in 2002, only 2,6-DNT was detected, at an average concentration of 0.12 μg/L. At the Southeast Drainage, 2,4,6-TNT and 2,6-DNT were detected at average concentrations of 26 μg/L and 0.12 μg/L, respectively.

5.2 SITE HYDROGEOLOGY

Two major geologic units are present beneath the Chemical Plant area: unconsolidated surface materials and underlying limestone bedrock. Unconsolidated surface materials as much as 18 m (60 ft) thick are clay-rich and mostly of glacial origin. The uppermost bedrock unit in the area, the Burlington-Keokuk Limestone, has been separated into two zones with different physical characteristics: a weathered zone underlain by an unweathered zone. The weathered zone ranges in thickness from 3 to 17 m (10 to 55 ft) and consists of highly fractured limestone with solution voids and enlarged fractures. Fracturing in the bedrock is predominantly horizontal. Solution features are common in the weathered portion of the Burlington-Keokuk Limestone and range from pinpoint vugs to small zones of core loss, typically less than 1.5 m (5 ft) (DOE 1992); however, these features are generally clay filled. The unweathered zone has less fracturing and weathering than the weathered zone.

Three regional bedrock aquifers are present in the vicinity of the Chemical Plant area: a shallow unconfined aquifer (although it may be locally confined), a middle confined aquifer, and a deep confined aquifer. Characterization data indicate that the shallow unconfined aquifer has been affected by former activities at the Chemical Plant area; therefore, it is the groundwater system of primary interest for this ROD. The aquifer consists of the Burlington-Keokuk Limestone, the Fern Glen Formation (both limestone units), and the overburden to the north of the Chemical Plant.

An east-west trending groundwater divide results in two distinct flow systems in the Chemical Plant area. Presently, this divide is located along the southern boundary of the Chemical Plant property. Previously, the divide had been situated beneath the raffinate pit area because of extensive recharge from the pits; these pits have since been removed. At the Chemical Plant area, shallow groundwater north of the divide flows to the north and into a karst conduit system that discharges at Burgermeister Spring (Figure 5.1). Transport through this conduit can be very rapid as demonstrated by subsurface dye trace studies performed at the Chemical Plant site in 1995 and 1998 (DOE and DA 1997b). Water discharged at Burgermeister Spring then mixes with other surface water and with ponded water in Lake 34. Any dissolved contaminants in the discharged groundwater are then subject to extensive dilution and, for some, physical and chemical degradation. Because most of the shallow groundwater beneath the Chemical Plant area discharges to the surface in the vicinity of Burgermeister Spring, the spring defines the northernmost extent of direct groundwater transport from the site and provides an ideal location for monitoring endpoint contaminant concentrations.

Groundwater south of the divide at the Chemical Plant area flows south to southeast toward the Missouri River, primarily through the Southeast Drainage. This represents only a small portion of the Chemical Plant, and currently no groundwater contamination attributable to the Chemical Plant site has impacts south of the divide. Therefore, at present, there is no groundwater component to the contamination present in the downgradient springs. Historically, contaminated groundwater from Raffinate Pits 1 and 2 flowed into the Southeast Drainage. This drainage was also used as a discharge point for effluent from the Chemical Plant operations, and because this drainage has losing stream segments in its upper reaches, mixing between groundwater and surface water occurred. Springs in the Southeast Drainage are ideal locations for monitoring.

The shallow groundwater system beneath the Chemical Plant area is hydrogeologically complex and characterized by fractures, conduits, paleochannels, and dissolution or weathering features. Because of these features, the aquifer exhibits highly heterogeneous and anisotropic values in hydraulic conductivity and transmissivity from place to place. Pump tests performed in July 1998 and the field test performed in 2001 to determine the effects of groundwater withdrawal and injection on the aquifer further demonstrated the variability of the aquifer and the low unsustainable yields of groundwater (MK-Ferguson and Jacobs Engineering Group 1998).

6 CURRENT AND FUTURE LAND AND RESOURCE USES

Current and potential future land use and groundwater and springwater use are described in this section to provide the basis for the exposure assumptions presented in subsequent sections of this ROD.

6.1 CURRENT LAND USE

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 (MK-Ferguson Company and Jacobs Engineering Group 2001). Francis Howell High School (FHHS) is about 1 km (0.6 mi) northeast of the site along Missouri State Route 94 and is occupied regularly by about 1,700 faculty, staff members, and students.

The Missouri Highway and Transportation Department (MoDOT) Weldon Spring maintenance facility, located adjacent to the north side of the Chemical Plant, employs about 10 workers. The Army Reserve Training Area to the west of the site is visited periodically by Army trainees and law enforcement personnel (MK-Ferguson Company and Jacobs Engineering Group 2001). 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 site are operated by the MDC and employ about 50 people. Two residences are located on the MDC property north of the Chemical Plant.

6.2 FUTURE LAND USE

At the Chemical Plant, the 24-ha (60-acre) disposal cell facility, including the 300-ft (91-m) buffer, will remain under the custody of DOE. As currently planned, only three buildings will remain within the Chemical Plant proper after project completion and site closure. The administration building would be made available for use by a local organization. The access control building contains the DOE maintenance equipment storage area and the Weldon Spring Site interpretive center. The center is a place where members of the public can obtain information about the site. A small water treatment enclosure will be located over the leachate sump.

The adjacent Weldon Spring Training Area (WSTA) will continue to be used by the DA for field training. The MDC will continue to maintain the remaining surrounding areas for recreational use.

6.3 CURRENT GROUNDWATER AND SPRINGWATER USE

The shallow bedrock aquifer beneath the boundary of the Chemical Plant property and the adjacent DA and MDC properties are not currently used for drinking water or for irrigation. However, on the basis of EPA guidance for groundwater classification (EPA 1986), site groundwater could be classified as potentially usable from a water quality standpoint. That is, according to the EPA, a potential source of groundwater is one capable of yielding at least 150 gal/d to a well or spring, which is sufficient for the needs of a family. Also, a drinking water source must have a total dissolved solids concentration of less than 10,000 mg/L that can be supplied without treatment.

No active private wells are located within 1 mi (1.6 km) of the Chemical Plant. One well, which is used for irrigation at the Missouri Research Park, is located within 2 mi (3.2 km), but it is cross gradient of the site and therefore should not be affected by the site. No active domestic wells are known to be within the Chemical Plant area, the adjacent Ordnance Works area, or in the Busch Conservation area (Vogel 2003). The closest privately owned domestic water wells from the site are located 2.1 mi (3.4 km) to the north-northeast. These wells are estimated to be 70 to 91 m (325 to 350 ft) below the ground surface. Although these wells produce water that includes groundwater from the shallow aquifer, the potential for impact from contaminated groundwater originating from the Chemical Plant site is low. Groundwater field studies have supported that the preferential flow direction for groundwater from the site is to the northwest toward Burgermeister Spring and the 6300 Drainage (DOE and DA 1997b). If active wells were present between the site and this drainage, the likelihood for impact would be high.

The Missouri Department of Health and Senior Services (DHSS), which was at that time called the Missouri Department of Health (MDOH), initiated a sampling program of private drinking water wells surrounding the Weldon Spring Site in 1982. The number of wells was expanded over time in an effort to fully investigate the area around the Chemical Plant and the former Army Ordnance Works area. When a well is no longer used for consumption, it is removed from the sampling program. In 2003, the DHSS will sample several wells within approximately 6 mi (9.7 km) of the Chemical Plant area. Historically, wells closer to the site were sampled quarterly, and those in outlying areas were sampled annually. Presently, wells are sampled on a semiannual or annual basis. Sampling results indicate background levels of those parameters analyzed, including radiological parameters (Basko 2003). The only impacted wells identified were at Twin Island Lakes (Dardenne Lakes) located northeast of the Chemical Plant and Ordnance Works area, where elevated nitroaromatic compounds were detected. This impact is not due to the DOE Weldon Spring Site and was investigated by the DA as part of its Ordnance Works CERCLA site. More extensive sampling performed by the DA determined that elevated levels of nitroaromatic compounds were present only in the samples from the Twin Island Lakes wells.

6.4 POTENTIAL FUTURE GROUNDWATER AND SPRINGWATER USE

A municipal water supply is currently available to serve the household needs of the area communities. Thus, for the foreseeable future, it is unlikely that the impacted groundwater beneath the Chemical Plant would be used for household purposes. In addition, the impacted, shallow portion of the aquifer is characterized by low yield. The deeper, unaffected, higher-yielding aquifers would more likely serve as a groundwater source in the unlikely event that groundwater use would ever occur. Despite the unlikelihood of the impacted groundwater actually ever being used for household purposes, in accordance with EPA guidelines and for the purpose of making this remedial action determination, this shallow groundwater is categorized as a potentially usable resource.

Access to springwater will remain similar to access under current conditions, consistent with recreational land use.

7 SUMMARY OF SITE RISKS

The baseline risk assessment (BRA) (DOE and DA 1997a) prepared for the Chemical Plant area provides an estimate of the potential human health and ecological risk that would be posed by the site if no remedial action was taken. Information on current and future land use and resource (groundwater and springwater) use was used to develop the use assumptions that were incorporated in the risk assessment. Section 6 presents information regarding current and future land and resource use for the Chemical Plant Area and its vicinity. Section 7.1 summarizes the human health risk assessment and results. Section 7.2 summarizes the ecological risk assessment that was performed for the GWOU.

7.1 HUMAN HEALTH RISK ASSESSMENT

As part of the RI/FS, potential risks to human health and the environment from groundwater and springwater contamination were evaluated by using standard EPA methods. The conclusion is that site groundwater and springwater contamination levels are acceptable for the recreational visitor scenario but not for the resident scenario.

7.1.1 Identification of Contaminants of Concern

The COCs identified in groundwater underlying the Chemical Plant are TCE, nitrate, uranium, and nitroaromatic compounds (2,4-DNT, 2,6-DNT, 2,4,6-TNT, 1,3-DNB, and NB). The COCs identified in springwater are the same as those for groundwater, except for TCE. Table 7.1 presents a summary of these COCs and their associated concentrations.

7.1.2 Exposure Assessment

Risk scenarios were developed on the basis of current and likely future land uses. Foreseeable future land use at the Chemical Plant and surrounding area is likely to be recreational, which is the same as current land use. Therefore, potential exposure is only through access to springwater.

The Army reservists scenario, which accounts for reservists who train at the adjacent Army training area, was not evaluated because the reservists do not have access to any active springs within the training area. Also, the exposure assumptions (e.g., frequency and duration) for the recreational visitor scenario would account for the instances when these reservists would access the springs outside the training area while on personal time.

TABLE 7.1 Summary of Contaminants of Concern and Exposure Point Concentrations

COC	Exposure Point Concentration (UCL95)[a]
When exposure point is direct contact with groundwater	
TCE	2–3,800 µg/L
Nitrate	0.005–900 mg/L
Uranium	0.22–60 pCi/L
2,4-DNT	0.026–5 µg/L
2,6-DNT	0.023–5 µg/L
2,4,6-TNT	0.044–29 µg/L
1,3-DNB	0.27–0.86 µg/L
NB	0.042–0.062 µg/L
When exposure point is direct contact with springwater[b]	
Uranium	0.33–120 pCi/L
Nitrate	0.14–18 mg/L
2,4-DNT	0.04–0.21 µg/L
2,6-DNT	0.048–2 µg/L
2,4,6-TNT	0.02–120 µg/L

a The ranges presented indicate the minimum and maximum upper confidence limit at 95% (UCL95) of the wells or springs evaluated in the BRA (DOE and DA 1997a).

b 1,3-DNB and NB were not detected in the Springs for the BRA evaluation.

The assessment presented in the BRA (DOE and DA 1997a) also provided risk estimates for a hypothetical future resident scenario that assumes access to groundwater contaminants. For the hypothetical resident scenario, the assessment assumed ingestion of groundwater from a well for 350 days a year for 30 years; the resident would drink 2 L each day.

For the recreational visitor scenario, the assessment assumed conservatively that the recreational visitor would visit the area 20 times a year for 30 years for 4 hours on each visit and that each time, the visitor would ingest a cupful of springwater. Table 7.2 tabulates key exposure assumptions and intake parameters used in the evaluations.

TABLE 7.2 Exposure Scenario Assumptions and Intake Parameters

Intake Parameter	Current or Future Recreational Visitor	Future Resident
Exposure time (h/event)	4	0.16[b]
Exposure frequency (no. of events/yr)	20	350
Exposure duration (yr)	30	30
Body weight (kg)	70	70 (4)[c]
Spring water ingestion rate (mL/event)	400	NA[d]
Groundwater ingestion rate (L/event)	NA	2 (0.64)[c]
Inhalation rate (m^3/h) (showering scenario for TCE only)	NA	0.83
Surface area (cm^2)	4,200[e]	20,000[f]
Permeability coefficient (cm/h)		
Default	1×10^{-3}	1×10^{-3}
TCE	NA	1.6×10^{-2}

[a] Assumptions and intake parameters are consistent with recommendations by the EPA (1995b, 1992a).

[b] Assumed length of time per day for showering.

[c] Exposure assumptions in parentheses are for an infant ingesting groundwater. These parameters were used to calculate intakes and hazard quotients for nitrates in groundwater because of the greater sensitivity of infants to the toxic effects of this contaminant.

[d] NA = not applicable.

[e] Surface area consists of the arms, hands, and lower legs (EPA 1992a).

[f] Surface area is the whole body (EPA 1992a).

7.1.3 Toxicity Assessment

The assessment of radiological human health risks in the BRA was limited to carcinogenic effects. This approach is consistent with EPA guidance, which notes that cancer risk is generally the limiting effect for radionuclides and suggests that radiation carcinogenesis be used as the sole basis for assessing radiation-related human health risks (EPA 1989). The method used to calculate carcinogenic risks for the radionuclides of concern is similar to existing methods used to calculate chemical carcinogens; both use an age-averaged lifetime excess cancer incidence per unit intake. To support this evaluation, the EPA has developed cancer incidence factors per unit intake that are synonymous with the slope factors developed for chemical carcinogens.

The following slope factors were used in this assessment: 4.4×10^{-11}/pCi for uranium-234, 4.5×10^{-11}/pCi for uranium-235, and 6.2×10^{-11}/pCi for uranium-238+D

(EPA 1995a). The "+D" designation indicates that the risks from associated short-lived decay products (i.e., with radioactive half-lives that are less than or equal to 6 months) are also included. Only ingestion slope factors were used because inhalation and external radiation are not pathways of concern for the receptors being assessed. The activity-weighted average of these slope factors for isotopic conditions present in site groundwater (5.3×10^{-11}/pCi) was used in conjunction with the total concentration of uranium (in pCi/L) to estimate the radiological risk.

The EPA has derived toxicity values for the chemical contaminants of human health concern and assigned reference doses (RfDs) to measure the noncarcinogenic effects of chemicals. The chronic RfD is defined as "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime" (EPA 1989). To derive an RfD value (expressed in mg/kg-d), the EPA reviews all toxicity studies available for a given substance and a given route of exposure, determines a "no observed adverse effect level" (NOAEL) or a "lowest observed adverse effect level" (LOAEL) from the study most relevant to humans (the critical study), and applies uncertainty factors to these values. The RfD can be compared with estimated exposure levels to evaluate the potential for deleterious effects. Current available RfD values are specific to either the inhalation or ingestion route of exposure because the toxic mechanism and dose required for toxicity to occur can differ for these routes of exposure. For the BRA, only ingestion RfDs were used because ingestion was determined to be the pathway of concern for the receptors being assessed. Oral RfDs are available for uranium, nitrate, 1,3-DNB, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, and NB.

The short-term toxicity of nitrate was assessed by using infant exposure parameters as well as adult exposure parameters to calculate hazard indices. The use of infant exposure parameters resulted in a calculated hazard index of 1 for a well with a nitrate concentration of 10 mg/L.

Carcinogenic risks from exposure to known and potential carcinogens are evaluated separately from noncarcinogenic risks because, hypothetically, any exposure to a carcinogen increases the risk of cancer by a finite amount. Therefore, the risk from exposure to a carcinogen at a given level can be derived, but an exposure level at which no carcinogenic effect is likely to occur (as for noncarcinogenic endpoints) cannot be defined. The EPA has defined two toxicity values for evaluating the potential carcinogenic effects of a given substance: the weight-of-evidence classification and the slope factor. For substances that have weight-of-evidence classifications of A (human carcinogen), B1 or B2 (probable human carcinogens), and sometimes C (possible human carcinogens), the EPA has calculated slope factors on the basis of data from dose-response studies. The slope factor is defined as a "plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime" (EPA 1989).

Tables 7.3 and 7.4 summarize the chemical noncarcinogenic toxicity and carcinogenic risk information relevant to the COCs in groundwater and springwater at the Chemical Plant.

TABLE 7.3 Toxicity Values for COCs Related to Ingestion of Groundwater and Springwater: Potential Systemic Effects

				RfD		
Parameter	Chronic RfD (mg/kg-d)	Level of Confidence	Critical Effect	Basis	Source[a]	Uncertainty Factor (UF)[b]
Uranium	0.003	Medium	Weight loss; moderate kidney activity	Oral, rabbit	IRIS	1,000
Nitrate-N	1.6	High	Methemoglobinemia	Oral, human	IRIS	1
1,3-DNB	0.0001	Low	Increased splenic weight	Oral, rat	IRIS	3,000
2,4,6-TNT	0.0005	Medium	Liver effects	Oral, dog	IRIS	1,000
2,4-DNT	0.002	High	Neurotoxicity; bilary tract hyperblasia; Heinz bodies	Oral, dog	IRIS	100
2,6-DNT	0.001	NA[c]	Neurotoxicity; bilary tract hyperblasia; Heinz bodies	Oral	HEAST	100
Nitrobenzene	0.0005	Low	Hematological, adrenal, renal, and hepatic lesions	Inhalation, rat and mouse	IRIS	10,000

[a] Source: *Integrated Risk Information System* (EPA 1997), except as indicated.

[b] The NOAEL or LOAEL dose from the critical study can be obtained by multiplying the chronic RfD by the uncertainty factor.

[c] NA = not applicable.

TABLE 7.4 Toxicity Values for COCs Related to Ingestion of Groundwater and Springwater: Potential Carcinogenic Effects

Parameter	Slope Factor $(mg/kg\text{-}d)^{-1}$	Weight-of-Evidence Classification	Type of Cancer	Slope Factor	
				Basis	Source[a]
2,4,6-TNT	0.03	C: possible human carcinogen	Urinary bladder; transitional cell papilloma; transitional squamous carcinoma	Diet, rat	IRIS
2,4-DNT	0.68	B2: probable human carcinogen	Liver, mammary gland; adenocarcinomas/carcinomas	Water, rat	IRIS
2,6-DNT	0.68	B2: probable human carcinogen	Liver, mammary gland; adenocarcinomas/carcinomas	Water, rat	IRIS
TCE	0.011[b]	B2: probable human carcinogen	Liver	NA[c]	-[d]

[a] Source: *Integrated Risk Information System* (EPA 1997), except as indicated.

[b] TCE slope factor for the inhalation pathway is 0.006 (EPA 1996).

[c] NA = not applicable.

[d] Not available through IRIS.

7.1.4 Risk Characterization

Tables 7.5 and 7.6 present summaries of the risk results presented in the BRA (DOE and DA 1997a). The risk estimates indicated that the recreational visitor ingesting springwater from each of the contaminated springs was not at increased risk for cancer or systemic toxicity from site contaminants. The risk of developing cancer (from the combined effects of radiation and chemicals) was estimated to range from greater than 1 in 1 billion to 2 in 1 million.

The risk estimates for the hypothetical resident scenario, however, indicate three things. First, in several wells near the Raffinate Pits area, TCE concentrations could result in a risk of greater than 1 chance in 10,000. Second, in wells near the Frog Pond area, 2,4-DNT and 2,6-DNT contamination could result in a risk of greater than 1 chance in 10,000 (current concentrations are higher and result in a risk of 1 chance in 1,000). Third, in wells near the Raffinate Pits area, uranium concentrations could result in a risk greater than 1 chance in 100,000. The EPA compares these risk results to a risk range of 1 in 1 million to 1 in 10,000 (EPA 1990). For known or suspected carcinogens, the EPA has determined that acceptable exposure levels present an excess lifetime cancer risk to an individual of between 1×10^{-4} and 1×10^{-6} (from 1 in 10,000 to 1 in 1 million).

The hazard indices estimated for a recreational visitor at the springs ranged from less than 0.001 to 0.2. For the hypothetical resident scenario, nitrate concentrations at several groundwater locations and at Burgermeister Spring would result in a hazard index greater than 1. The EPA has defined a hazard index of greater than 1 as indicating possible adverse noncarcinogenic health effects.

The risk calculations indicate that the site contamination levels are acceptable for a recreational visitor but not for a resident. In addition, groundwater concentrations for TCE, nitrate, uranium, and some of the nitroaromatic compounds exceed federal or state drinking water standards or MCLs. Therefore, restrictions on the residential use of groundwater will be necessary to protect human health until a time when contaminant concentrations will have decreased to levels equivalent to or below the MCLs.

7.2 ECOLOGICAL RISK ASSESSMENT

The results of the ecological assessment indicate that contaminant concentrations in springwater and sediment pose little or no risk to ecological resources in the area and that remediation is not needed from an ecological perspective (DOE and DA 1997a). Biotic surveys of macroinvertebrates, fish, and amphibians that inhabit the Burgermeister Spring drainage indicated no evidence of adverse effects. The spring was determined to contain generally good aquatic habitat, and the species present are typical of those found in similar habitats throughout the Midwest. Under low-flow conditions, as commonly occur in the summer, the stream drainage below the spring becomes intermittent, and portions of the habitat become dry. Surveys of amphibians found a community typical of similar habitats in the Midwest. Fish tissue analyses revealed relatively low levels of contaminant bioconcentrations, all below levels of concern.

TABLE 7.5 Risk Characterization Summary: Noncarcinogens

Receptor population: Recreational visitor
Receptor age: Adult[a]
Scenario time frame: Current and future

Exposure Medium	COC	Critical Effect	Noncarcinogenic Hazard Quotient[b] Ingestion	Dermal	Total for Both Pathways
Springwater	Uranium	Kidney toxicity	<0.0001–0.01	<0.0001–0.0002	<0.00001–0.01
	Nitrate	Methemoglobinemia	<0.0001–0.002	<0.00001–<0.00004	<0.0001–0.002
	2,4-DNT	Neurotoxicity	<0.00001–0.00002	<0.00001–<0.00001	<0.00001–<0.00002
	2,6-DNT	Neurotoxicity	<0.00001–0.0003	<0.00001–<0.00001	<0.00001–<0.0003
	2,4,6-TNT	Liver effects	<0.0001–0.04	<0.0001–0.0008	<0.0001–<0.04
Total receptor hazard index					<0.0001–0.052

Receptor population: Resident (hypothetical)
Receptor age: Adult[a]
Scenario time frame: Future

Exposure Medium	COC	Critical Effect	Noncarcinogenic Hazard Quotient for Ingestion[c]
Groundwater	TCE	Liver	-[d]
	Uranium	Kidney toxicity	0.0014–0.82
	Nitrate	Methemoglobinemia	0.0044–15
	2,4-DNT	Neurotoxicity	<0.001–0.068
	2,6-DNT	Neurotoxicity	<0.001–0.30
	2,4,6-TNT	Liver effects	<0.002–1.6
	1,3-DNB	Increased splenic weight	0.24
	NB	Hematological, adrenal, renal, hepatic lesions	0.002–0.003
Total receptor hazard index			0.011–36

a Because the toxic effect of nitrate is primarily of concern for infants, nitrate was also evaluated for infant exposure. The hazard quotient for nitrate was about 5.6 times higher for infant exposure than for adult exposure.

b Range represents the minimum and maximum noncarcinogenic hazard quotient from the springs evaluated.

c Range represents the minimum and maximum noncarcinogenic hazard quotient from the wells evaluated.

d TCE was not evaluated as a noncarcinogen.

TABLE 7.6 Risk Characterization Summary: Carcinogens

Receptor population: Recreational visitor
Receptor age: Adult
Scenario time frame: Current and future

Exposure Medium	COC	Weight-of-Evidence Classification	Carcinogenic Risk[a] Ingestion	Carcinogenic Risk[a] Dermal	Carcinogenic Risk[a] Total for Both Pathways
Springwater	Uranium[b]	Carcinogenic	4×10^{-9} to 2×10^{-6}	4×10^{-11} to 2×10^{-8}	4×10^{-9} to 2×10^{-6}
	Nitrate[c]	-	-	-	-
	2,4-DNT	B2: probable human carcinogen	2×10^{-9} to 1×10^{-7}	4×10^{-11} to 2×10^{-10}	2×10^{-9} to 1×10^{-7}
	2,6-DNT	B2: probable human carcinogen	2×10^{-4} to 9×10^{-8}	5×10^{-11} to 2×10^{-9}	2×10^{-9} to 9×10^{-8}
	2,4,6-TNT	C: probable human carcinogen	4×10^{-11} to 2×10^{-7}	9×10^{-13} to 5×10^{-9}	4×10^{-11} to 2×10^{-7}
Total receptor risk					8×10^{-9} to 2×10^{-6}

Receptor population: Resident (hypothetical)
Receptor age: Adult[d]
Scenario time frame: Future

Exposure Medium	COC	Weight-of-Evidence Classification	Carcinogenic Risk from Ingestion[a]
Groundwater	TCE	B2: probable human carcinogen	1×10^{-7} to 7×10^{-4} [d]
	Uranium[b]	Carcinogen	1×10^{-7} to 7×10^{-5}
	Nitrate[c]	-	-
	2,4-DNT[e]	B2: probable human carcinogen	2×10^{-7} to 4×10^{-5}
	2,6-DNT[e]	B2: probable human carcinogen	2×10^{-7} to 9×10^{-5}
	2,4,6-TNT[e]	C: possible human carcinogen	2×10^{-8} to 1×10^{-5}
	1,3-DNB[c]	-	-
	NB[c]	-	-
Total receptor risk			6×10^{-7} to 9×10^{-4}

[a] Range represents minimum and maximum carcinogenic risk from the springs or wells evaluated.

[b] Uranium is assessed for its carcinogenic effects as a radionuclide.

[c] Although nitrate, 1,3-DNB, and NB are COCs, they are not classified as carcinogens.

[d] The risk presented for TCE also includes the risk from inhalation through showering.

[e] The total risk from nitroaromatic compounds is approximately 1.4×10^{-4} (sum of the three compounds). Current concentrations of nitroaromatic compounds are higher than those evaluated for the BRA, resulting in a risk of approximately 1×10^{-3}.

8 REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) for the GWOU are to (1) protect human health and the environment by attaining applicable or relevant and appropriate requirements (ARARs) and achieving risk-based concentrations (RBCs) and (2) ensure that land use remains consistent with groundwater and springwater use restrictions.

For the groundwater COCs, the following ARARs and RBCs have been identified: (1) 5 µg/L for TCE, based on the federal MCL for drinking water; (2) 10 mg/L for nitrate, based on the federal MCL for drinking water; (3) 20 pCi/L for uranium, based on the recently promulgated federal MCL of 30 µg/L (the conversion to 20 pCi/L takes into account the isotopic ratios of uranium established for the Weldon Spring Site); (4) 0.11 µg/L for 2,4-DNT, 1.0 µg/L for 1,3-DNB, and 17 µg/L for NB, as chemical-specific ARARs based on State of Missouri water quality standards; and (5) 0.13 to 13 µg/L for 2,6-DNT and 2.8 to 280 µg/L for 2,4,6-TNT, as the RBC ranges based on concentrations of each of the contaminants equivalent to a risk range of 1 in 1 million to 1 in 10,000.

9 DESCRIPTION OF REMEDIAL ALTERNATIVES

In selecting a remedy, the three alternatives described below were evaluated. Conventional and innovative techniques for groundwater removal and treatment were considered as remedies, but extensive field testing conducted in 1998, 2001, and 2002 demonstrated that they were ineffective (DOE 2003b). First, the site hydrogeology presents significant implementability problems for pump-and-treat methods; full-scale implementation cannot be effectively done. Moreover, although ICO was locally effective in treating TCE, the site hydrogeology makes full-scale application impractical (DOE 2003b). These active treatment alternatives were thus not retained for further evaluation because they are not implementable on a large scale, perform no better than the passive alternatives at reducing the contaminants, and do nothing to limit the need for institutional controls (ICs). However, ICO has been retained as a contingency component of Alternative 3 because of its potential for providing localized treatment of TCE. Sections 9.1 through 9.3 describe the remedy component for each alternative and the common elements and distinguishing features of each alternative.

9.1 ALTERNATIVE 1: NO FURTHER ACTION

The no further action alternative is evaluated as a baseline for comparison with the other alternatives. No action would be taken under this alternative, and ICs would not be provided. However, the existing network of monitoring wells would be abandoned, constituting a one-time cost that would be incurred.

The estimated capital cost for Alternative 1 is $520,000, and the estimated total present net-worth cost is $520,000.

9.2 ALTERNATIVE 2: LONG-TERM MONITORING WITH INSTITUTIONAL CONTROLS

Long-term groundwater monitoring would be conducted via an optimized network developed from the existing monitoring well network. Restrictions on groundwater use would be imposed to ensure that contaminated groundwater was not used for drinking purposes and was not impacted by other activities such as pumping. Long-term groundwater monitoring would be performed to ensure that use restrictions remained appropriate over time. Use restrictions would be imposed through ICs. These ICs would remain in place as long as contaminant concentrations exceeded drinking water levels or MCLs. Nonattainment of drinking water standards would be addressed through technical impracticability waivers. As required under CERCLA, periodic reviews would be conducted no less than every 5 years to ensure that the remedy remained protective.

Use restrictions would apply to the area covering the impacted groundwater, including an appropriate hydraulic buffer. DOE would monitor groundwater use by establishing a long-term surveillance program. For the land DOE controls (Chemical Plant property), DOE would place a notation on the federal acquisition land records. Restrictions within this notation would accrue to succeeding owners of the land. Similar restrictions would be placed on DA property, which would be further supported with a memorandum of agreement (MOA) between DOE and DA. DOE would obtain formal agreements with the state, as applicable, for the surrounding areas (e.g., agreements with MDC, MDNR, or MoDOT). These ICs would be indefinite-term licenses, easements, or permits, as applicable.

The estimated capital cost for Alternative 2 is $450,000; the estimated annual operations and maintenance (O&M) cost is $160,000; and the estimated total present net-worth cost is $2,700,000.

9.3 ALTERNATIVE 3: MONITORED NATURAL ATTENUATION (MNA) WITH INSTITUTIONAL CONTROLS AND CONTINGENCIES

Long-term groundwater monitoring would be conducted via an optimized network. Dilution and dispersion are the primary natural processes acting to reduce all contaminant concentrations in groundwater at the Chemical Plant area over time. Conditions do not appear to be favorable for biological processes degrading the TCE, nitroaromatic compounds, nitrates, or uranium. The source removal actions performed according to the Chemical Plant ROD (DOE 1993) ensure that there will be no further contaminant contribution to the groundwater. As a result, groundwater contaminant concentrations are expected to decrease with time. This alternative differs from Alternative 2 in that attenuation performance measures would be established and in that the monitoring objectives would be designed to include verification that these measures would be met. This alternative also would include contingency measures to be undertaken in the event attenuation did not perform as expected.

On the basis of predictive calculations, it is anticipated that groundwater contaminant concentrations will attenuate to levels consistent with drinking water standards or MCLs in approximately 100 years. Monitoring would be performed to verify decreases in contaminant concentrations at wells and discharge points (at springs) over time. Trigger concentrations would be incorporated into the monitoring strategy so that pre-established contingency actions could be taken, as necessary. ICO would be retained as a contingency component for Alternative 3 because of its potential to provide localized treatment of TCE.

As part of Alternative 3, ICs would also be required to provide protection of human health and the environment because of the approximately 100 years that it would take to approach MCLs or ARARs. The ICs would be the same as those described for Alternative 2. Similarly, routine inspections for indications of groundwater use would be performed to ensure use restrictions were being adhered to.

The estimated capital cost for Alternative 3 is $540,000; the estimated annual O&M cost is $340,000; and the estimated total present net-worth cost is $5,400,000.

10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All of the alternatives except the no further action alternative would provide adequate protection of human health and the environment because they include components for eliminating, reducing, or controlling exposure to the contaminated media. All alternatives except the no further action alternative include ICs to restrict groundwater use during the remedial action period until protective levels or ARARs are met.

10.2 COMPLIANCE WITH ARARS

The principal ARARs for the impacted groundwater are the drinking water standards known as MCLs under the Safe Drinking Water Act and Missouri water quality standards. MCLs have been regulated for a number of common organic and inorganic contaminants. These levels regulate the concentrations of contaminants in public drinking water supplies and are considered relevant and appropriate for groundwater aquifers that have the potential for use as drinking water. Implementation of either Alternative 1 or 2 would not allow these standards to be met and would not include any mechanism for establishing compliance with these standards. If Alternative 2 was selected as the remedy, technical impracticability waivers would be sought. Under Alternative 3, attainment of ARARs would be a condition of adequate performance, and it is estimated that the ARARs would be met in a period of approximately 100 years. Alternative 3 would rely on verification of natural attenuation processes to attain ARARs.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

It is thought that Alternative 3 would be more effective and permanent over the long term than Alternative 2 because it has the objective of meeting health-based standards. Alternative 3 also has more rigorous monitoring objectives than Alternative 2; therefore, it would probably result in a greater understanding of fate and transport.

10.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME OF CONTAMINANTS THROUGH TREATMENT

None of the three alternatives would reduce toxicity, mobility, or volume by means of treatment, since treatment is not a component of any of the three alternatives. Active treatment alternatives have been thoroughly investigated and discarded as being ineffective.

10.5 SHORT-TERM EFFECTIVENESS

Alternatives 2 and 3 would be comparatively effective over the near term. Potential short-term impacts associated with monitoring, implementation of ICs, and abandonment of wells are expected to be low, with less than one case of occupational injury and no occupational fatalities expected during construction or abandonment of wells.

10.6 IMPLEMENTABILITY

From a construction standpoint, both Alternatives 2 and 3 would be implementable by using conventional methods for monitoring contamination and constructing wells. The more rigorous monitoring objectives of Alternative 3 would make its design somewhat more difficult to develop than the design for Alternative 2, but not substantially so. The establishment of ICs would present some administrative challenges, but these are considered surmountable, given that current land use and groundwater use are not affected by needed restrictions and that impacted lands are owned by the federal or state governments. In any event, the challenges would be the same for each alternative.

10.7 COST

Alternative 3 has the highest capital, annual, and total present net-worth costs of the three alternatives. As a disclaimer, the information for the cost estimates is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the AR or a relative percent difference (RPD) amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50% to –30% of the actual project cost.

10.8 STATE ACCEPTANCE

(Text will be inserted to reflect the MDNR's position consistent with that shown in the Declaration Statement.)

10.9 COMMUNITY ACCEPTANCE

The local St. Charles community generally supported the remedy selected. However, objections were raised by members of the public in surrounding communities (e.g., St. Louis County). Additional issues that were beyond the scope of the proposed action (e.g., worker safety) were also raised by members of these communities.

11 PRINCIPAL THREAT WASTES

The National Contingency Plan (NCP) emphasizes treatment of principal threats posed by source materials at CERCLA sites. See NCP Section 300.430(a)(1)(ii)(A). Since contaminated groundwater is usually not considered a source material, this is not applicable to the GWOU.

12 SELECTED FINAL REMEDY

12.1 SUMMARY OF THE RATIONALE FOR THE SELECTED REMEDY

The selected remedy for the remaining groundwater contamination at the Chemical Plant is MNA, with ICs being used to restrict groundwater use during the restoration period. Contingency activities have been identified in case natural attenuation does not happen as predicted. This remedy provides the best balance of trade-offs among the alternatives that were evaluated against the balancing criteria.

Calculations performed to estimate the amount of time (in years) that will be required for the natural occurrences of dilution and dispersion to reduce contaminant concentrations to levels equivalent to chemical-specific ARARs indicate time frames of approximately 100 years (DOE 2003b).

12.2 DESCRIPTION OF THE SELECTED REMEDY

This section provides the basis for the designs of the two main components of the selected remedy. Section 12.2.1 discusses the plans for the identification, preparation, implementation, and enforcement of the ICs needed on DOE, MDC, MoDOT, and DA property. Section 12.2.2 presents the design basis for the monitoring strategy for each of the groundwater COCs at the Chemical Plant area. The details addressing performance monitoring for TCE, nitrate, uranium, and the nitroaromatic compounds are presented in Tables 12.1 through 12.4. DOE, the EPA, and the MDNR will be conducting further discussions on the details presented before final designs are incorporated in the RD/RA Work Plan.

12.2.1 Institutional Controls

For the IC component of the selected remedy, instruments or mechanisms that are appropriate with regard to land ownership and that are considered to be implementable, reliable, and enforceable were considered. The affected land area would involve federally owned and state-owned properties. To restrict groundwater and springwater use effectively, restrictions on groundwater use would be implemented within the Chemical Plant boundary that is under the jurisdictional control of DOE, while restrictions on groundwater and springwater use would be implemented at the MDC, MDNR, MoDOT, and DA properties surrounding the Chemical Plant. The IC area extends to Burgermeister Spring to the north and includes the Southeast Drainage to the south. A hydraulic buffer zone of 305 m (1,000 ft) to preclude well placement (which could alter the flow path of contaminated groundwater) would also be included in the IC area from the site to the Burgermeister Spring (see Figure 12.1).

For the Chemical Plant property, a notation would be placed on the federal acquisition land records, with specified restrictions to accrue to succeeding owners of the land. Restrictions would prohibit the construction of a residential dwelling or facility for human occupancy. Except for giving DOE access to the groundwater for sampling and investigative purposes, the notation would prohibit access to groundwater for use. These restrictions would be for an indefinite term. If the land was conveyed to another party, notice of the restrictions or prohibitions would be placed within the conveyance document. Enforcement of these ICs would be accomplished under CERCLA and could include litigation in federal courts for compliance.

For properties in the area surrounding but outside the Chemical Plant (e.g., those owned by MDC, MDNR, MoDOT, or DA), indefinite-term licenses, easements, and permits, as applicable, are being considered. These instruments would specify groundwater and springwater access restrictions for the current owners or users of the land. These instruments would also give DOE continued access to monitor and analyze the groundwater for a period of time to be defined.

Routine (annual) inspections would be conducted to look for indications of groundwater and springwater use that were inconsistent with the specified restrictions. On an annual basis, affected landowners would also be contacted to ensure that they were aware of the restrictions imposed. The inspections would ensure that use would continue to be in compliance with the terms of the IC instruments being used. These long-term activities would be incorporated into the site LTS&MP (DOE 2003a).

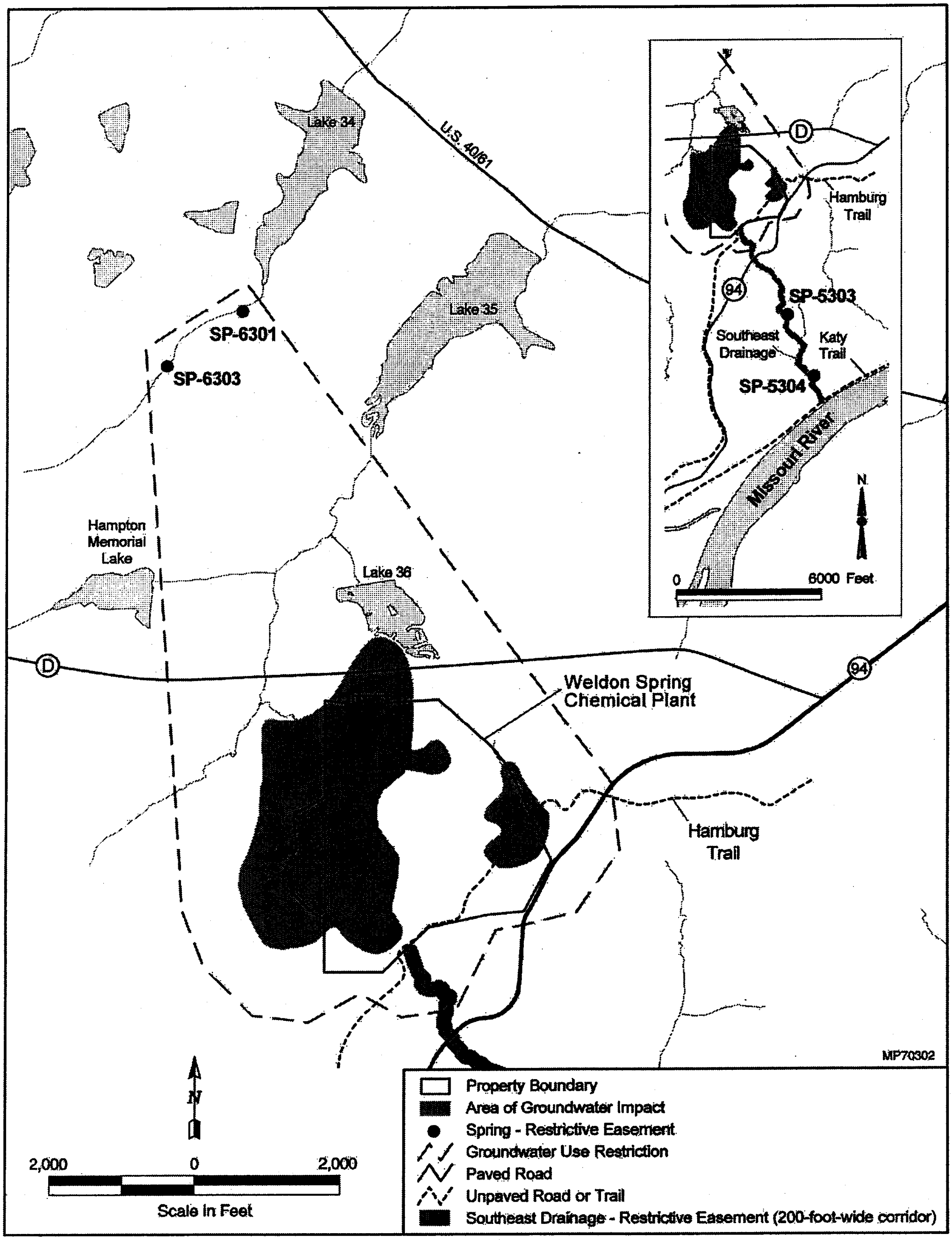


FIGURE 12.1 Locations of Institutional Controls at the Chemical Plant Area

12.2.2 Basis for Performance Monitoring Strategy

The objectives of the performance monitoring effort for the selected remedy are to (1) perform upgradient monitoring, (2) verify that natural attenuation is occurring as predicted, (3) ensure that the contaminant plumes are expanding or migrating only as predicted, (4) monitor the unweathered or deeper portion of the shallow aquifer to make sure that contamination does not go any deeper than it currently is, (5) demonstrate that contaminant concentrations at the springs are protective on the basis of its current recreational use, and (6) demonstrate hydrologic stability.

The prediction is that the contaminant plumes will continue to disperse and become more diluted with natural recharge from rainwater. Since the various sources of contamination have been removed as a result of the remedial action for the Chemical Plant Operable Unit, groundwater quality should continue to improve. The overall area of contamination should not become significantly larger than it currently is. The IC boundary shown in Figure 12.1 takes into account any increase in size due to dispersion. The contamination should not go any deeper than it already has (on the basis of site knowledge indicating that the preferential flow of shallow groundwater is predominantly horizontal and toward Burgermeister Spring). The potential risk to the recreational visitor should remain very low.

Within the proposed network for MNA, selected locations have been assigned specific trigger concentrations that invoke specified contingency responses, ranging from an increase in sampling frequency, to a reevaluation of predicted MNA time frames, to a reevaluation of ICs. Sampling of fish from Lakes 34 through 36 would also be conducted, and samples would be analyzed for uranium. For TCE, the contingencies include localized treatment of TCE by using ICO.

The performance monitoring would have the following objectives (1 through 6).

- Objectives 1 and 6 are similar in that they are to monitor upgradient locations and water levels, respectively, in order to detect potential changes in groundwater flow patterns.
- Objective 2 is to verify that natural attenuation is occurring as predicted. This objective will be met by using existing wells at or near the highest concentrations of contaminants and trending the data over time. In this way, the worst contaminant locations will be scrutinized. A downward trend is anticipated to emerge following the post-excavation stabilization/baseline period.
- Objective 3 is to ensure that contaminant plumes are expanding or migrating only as predicted. This objective is the one for which it is most difficult to establish a monitoring approach, because "dispersion" is a key component of the MNA remedy. Contaminants are expected to continue to disperse within known flow pathways associated with bedrock lows (paleochannels) in the upper Burlington-Keokuk Limestone and become diluted with less

contaminated water and with infiltrating rainwater. This process is more complicated if several contaminant plumes overlap. This objective will be met by measuring various downgradient locations near the leading edge of the plume (as defined by the MCL contour) that are either not yet impacted or marginally impacted below the MCL. Increases in some of these locations would be expected as the plumes expand as predicted, but trigger levels will be set to evaluate any upward trends and to compare these potential increases to overall decreases in the center of the plume.

- Objective 4 is to assure that any further vertical migration is detected. Since the conceptual model of groundwater flow has established that more than 80% of the flow in the shallow aquifer is horizontal and that the sources (contaminated soils, sludges, and drummed waste) have been remediated, the prediction is that little or no additional vertical migration will occur. This will be determined by utilizing existing wells screened and influenced by the unweathered zone and by drilling two additional unweathered wells to monitor for possible downward migration in areas where recent data are not available. Data from wells previously abandoned during remedial action activities demonstrate the low probability of vertical migration. New well locations will be selected along the known flow pathways of the plume; however, the wells will be drilled slightly downgradient to reduce the possibility of opening a vertical pathway into the unweathered unit through the areas of highest contamination. Downgradient locations are also preferred because the established ratio of horizontal cracks to vertical cracks is greater than 20 to 1.

- Objective 5 is to monitor for the contaminants at the only points of exposure: the springs. Current contaminant concentrations at these locations are protective of human health and the environment, given current recreational land use. For one COC (uranium), the springs periodically show higher concentrations than does the groundwater. This objective will be met by confirming that there is continual improvement in the water quality at these locations; high-flow and low-flow conditions will be evaluated separately.

Appropriate trigger concentrations are associated with each of these objectives. They comprise a tiered approach for actions to be taken when an unexpected upward trend in the data occurs. The initial trigger will be a statistically significant increase in contaminant concentration above the baseline condition. This will be a concentration that is not necessarily of concern but is rather an early warning of an upward trend. The reaction will be to take confirmatory samples to assure that laboratory error or temporal fluctuation has not occurred. If the confirmatory sample confirms the original data point, sampling frequency will be increased to determine if the event represents a sustained upward trend. If that is the case, sampling frequency will be increased at other nearby locations. If other locations are also affected above the baseline condition, then the frequency of sampling will continue to be increased in order to gather as much information as possible. If a second, higher concentration is reached, then a second-tier response will be initiated. This response will include the addition of other existing monitoring locations, reevaluation of the MNA time frames that form the basis for the remedy, and reevaluation of the adequacy of the ICs. The response to trigger levels at Objective 3 wells will be moderated on the basis of trends at the center of the plume (i.e., sustaining a trigger level at an Objective 3 location will require a more vigorous response if the trends in the center of the plume [Objective 2 wells] are also upward). Likewise, a less vigorous response will be appropriate if the center of the plume is dissipating as predicted. For TCE only, an active contingency remedy will be among the possibilities for a response to sustained higher TCE concentrations.

The specific monitoring locations and the specific trigger concentrations will be defined in the RD/RA Work Plan that implements this ROD. Figure 12.2 depicts a generic concept of the approach for establishing monitoring locations to meet the stated objectives. Figure 12.3 indicates the locations of the wells that are being considered for the MNA network. Tables 12.1 through 12.4 show the criteria for selecting these locations, potential monitoring locations, and trigger concentrations for each of the objectives for the various COCs.

13 STATUTORY DETERMINATIONS

In accordance with the statutory requirements of Section 121 of CERCLA, as amended, the remedial actions selected shall:

- Be protective of human health and the environment,
- Comply with ARARs to the extent practicable,
- Be cost effective, and
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

The selected remedy is discussed below in relation to how it fulfills the requirements. In addition, the preference cited in CERCLA Section 121 for treatment as a principal element is discussed.

13.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy will be protective of human health and the environment under current conditions, because the contaminated groundwater is not used as a drinking water source. Although the contaminated groundwater is not a likely source of drinking water in the future, it is considered a potentially usable source.

In addition, because source removal has been accomplished under the Chemical Plant ROD (DOE 1993), no new migration of contaminants to the groundwater system should occur.

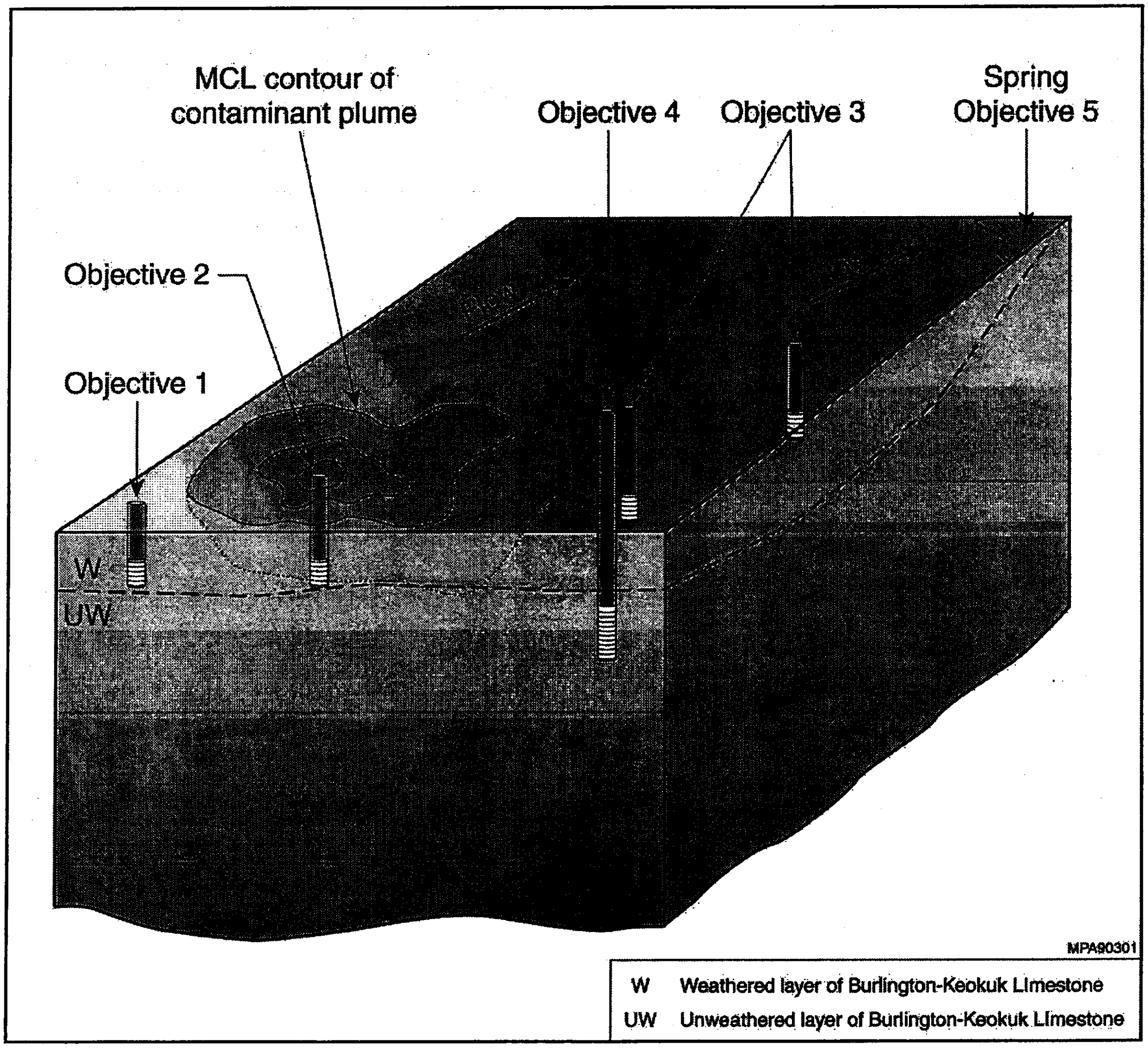


FIGURE 12.2 Conceptual MNA Network

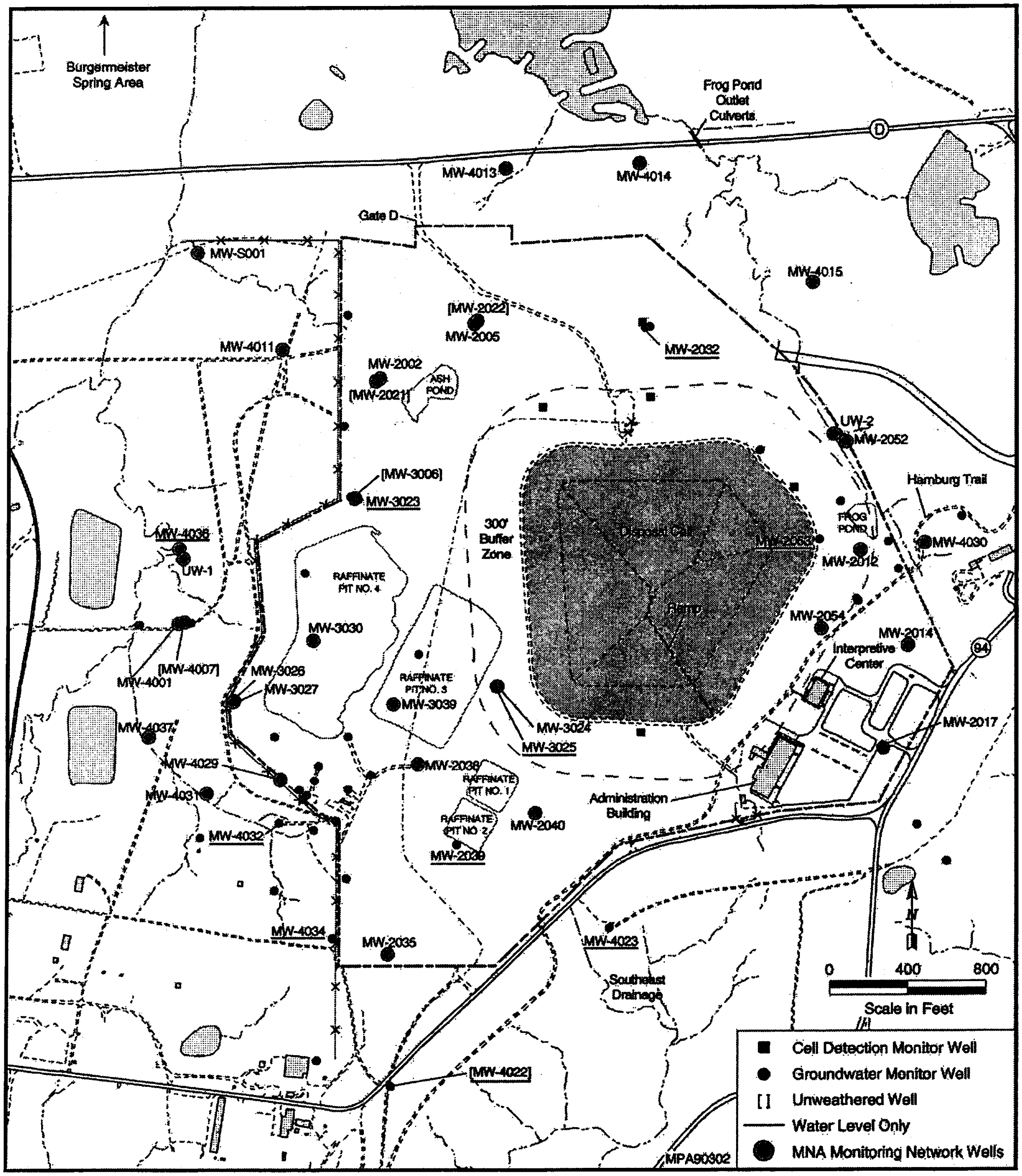


FIGURE 12.3 Locations of Wells Included in the MNA Network

TABLE 12.1 Design Basis for MNA Network for TCE

TCE Objective	Criterion for Location	Potential Monitoring Location	Trigger Concentration (µg/L)	Contingency Action
1	At least 200 ft upgradient from the edge of the plume	MW-2035	Tier 1: >3 Tier 2: >10	Tier 1: Increase sampling Tier 2: Reevaluate groundwater flow
2	Axis along flow path through center of the plume(s) as defined by MW-3030 or MW-4029	MW-2038/ 3030/3039/ 4001/4029/ 4031/4037	Tier 1: Above baseline Tier 2: >1000	Tier 1: Increase sampling Tier 2: Invoke ICO[a]
3	At least 1200 ft downgradient from center of the plume in weathered portion of the aquifer	MW-S001	Tier 1: >3 Tier 2: >3 but <75 Tier 3: >75	Tiers 1 and 2: Increase sampling Tier 3: Invoke ICO[a]
4	At least 400 ft downgradient from center of the plume in unweathered portion of the aquifer	MW-3006/ 3026/4007	Tier 1: >3 Tier 2: >10	Tier 1: Increase sampling Tier 2: Invoke ICO[a]
5	Springs	SP-6301/ 6303	Tier 1: >3 Tier 2: >5	Tier 1: Increase sampling Tier 2: Invoke ICO[a]
6	Throughout the site	MW-2039/ 3025/3023/ 2032/2053/ 4022/4023/ 4032/4034	Tier 1: Rise or fall in water table Tier 2: Change in flow direction	Tier 1: Reevaluate well network with regard to screened intervals Tier 2: Reevaluate flow model and ICs

[a] Localized ICO will not be invoked as a contingency remedy if the center of the plume has dissipated to less than 300 µg/L. Localized ICO may also not be invoked (after consultation with the EPA and MDNR) if the center of the plume is at or below the predicted concentration.

TABLE 12.2 Design Basis for MNA Network for Nitrate

Nitrate Objective	Criterion for Location	Potential Monitoring Location	Trigger Concentration (mg/L)	Contingency Action
1	At least 200 ft upgradient from the edge of the plume	MW-2035	Tier 1: Above baseline Tier 2: >100	Tier 1: Increase sampling Tier 2: Reevaluate flow model and ICs
2	Axis along flow path through center of the plume(s) as defined by MW-2038, MW-3023, or MW-4029	MW-2038/ 2040/3030/ 4001/4029/ 2002/2005/ 4011/4013/ 3036	Tier 1: Above baseline Tier 2: 1500 or when the three highest concentrations within plume are >1000	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
3	At least 1200 ft downgradient from center of the plume in weathered portion of the aquifer	MW-S001	Tier 1: Above baseline Tier 2: >500	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
4	At least 400 ft downgradient from center of the plume in unweathered portion of the aquifer	MW-3026, UW-1	Tier 1: Above baseline Tier 2: >500	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
5	Springs	SP-6301/ 6303	Tier 1: Above baseline Tier 2: >100	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
6	Throughout the site	MW-2039/ 3025/3023/ 2032/2053/ 4022/4023/ 4032/4034	Tier 1: Rise or fall in water table Tier 2: Change in flow direction	Tier 1: Reevaluate well network with regard to screened intervals Tier 2: Reevaluate flow model and ICs

TABLE 12.3 Design Basis for MNA Network for Uranium

Uranium Objective	Criterion for Location	Potential Monitoring Location	Trigger Concentration (pCi/L)	Contingency Action
1	At least 200 ft upgradient from the edge of the plume	MW-2035	Tier 1: >20 Tier 2: >100	Tier 1: Increase sampling Tier 2: Reevaluate flow model and ICs
2	Axis along flow path through center of the plume(s) as defined by MW-3024 or MW-3030	MW-3024/ 3030/4036	Tier 1: Above baseline and >20 Tier 2: >300	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
3	At least 1200 ft downgradient from center of the plume in weathered portion of the aquifer	MW-S001	Tier 1: Above baseline and >20 Tier 2: >100	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
4	At least 400 ft downgradient from center of the plume in unweathered portion of the aquifer	MW-4007	Tier 1: Above baseline and >20 Tier 2: >100	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
5	Springs	SP-6301/ 6303/5303/ 5304	Tier 1: Above baseline and >20 Tier 2: >300	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
6	Throughout the site	MW-2039/ 3025/3023/ 2032/2053/ 4022/4023/ 4032/4034	Tier 1: Rise or fall in water table Tier 2: Change in flow direction	Tier 1: Reevaluate well network with regard to screened intervals Tier 2: Reevaluate flow model and ICs

TABLE 12.4 Design Basis for MNA Network for 2,4-DNT

2,4-DNT Objective	Criterion for Location	Potential Monitoring Location	Trigger Concentration (µg/L)	Contingency Action
1	At least 200 ft upgradient from the edge of the plume	MW-2017/ 2035	Tier 1: >0.11 Tier 2: Sustained at >0.11	Tier 1: Increase sampling Tier 2: Reevaluate flow model and ICs
2	Axis along flow path through center of the plume(s) as defined by MW-2012, MW-3030, and MWS-21	East Plume MW-2012/ 2014/2052/ 2054/4030 West Plume MW-3030/ 4029/2002/ 3003/4013	East Plume Tier 1: Above baseline Tier 2: >400[a] West Plume Tier 1: Above baseline Tier 2: >100	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
3	At least 1200 ft downgradient from center of the plume in weathered portion of the aquifer	East Plume MW-4014/ 4015 West Plume MW-S001/ 4001	Tier 1: >0.25 Tier 2: Sustained at >0.25	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
4	At least 400 ft downgradient from center of the plume in unweathered portion of the aquifer	East Plume UW-2 West Plume MW-2021/ 3006/4007	Tier 1: >0.25 Tier 2: Sustained at >0.25	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
5	Springs	SP-6301/ 6303	Tier 1: >0.25 Tier 2: Sustained at >0.25	Tier 1: Increase sampling Tier 2: Recalculate MNA time frames
6	Throughout the site	MW-2039/ 3025/3023/ 2032/2053/ 4022/4023/ 4032/4034	Tier 1: Rise or fall in water table Tier 2: Change in flow direction	Tier 1: Reevaluate well network with regard to screened intervals Tier 2: Reevaluate flow model and ICs

[a] Concentrations in MW-2012 presently exceed 400 µg/L. A trigger concentration of 200 µg/L will be applied until concentrations decrease below 400 µg/L.

13.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As required by Section 121(d)(4) of CERCLA, the selected remedy will comply with all ARARs (chemical-specific and action-specific) to the extent practicable.

13.2.1 Chemical-Specific ARARs

Chemical-specific ARARs set concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or COCs. The MCL for TCE of 5 μg/L, the MCL for nitrate of 10 mg/L, the MCL for uranium of 20 pCi/L, and the Missouri water quality standard of 0.11 μg/L for 2,4-DNT, 1.0 μg/L for 1,3-DNB, and 17 μg/L for NB are chemical-specific ARARs. Current concentrations in groundwater at the Chemical Plant Area exceed these ARARs.

13.2.2 Action-Specific ARARs

Action-specific ARARs are standards that restrict or control specific remedial activities related to the management of hazardous substances or pollutants for a variety of media. These requirements are triggered by a particular activity, not by specific chemicals or the location of the activity. Several action-specific ARARs may exist for any specific action. These action-specific ARARs do not in themselves determine the appropriate remedial alternative; instead, they indicate performance levels to be achieved for the activities performed under the selected remedy. On-site actions must comply with all substantive provisions of an ARAR but do not need to comply with related administrative and procedural requirements (e.g., filing reports or obtaining a permit). The term "on-site" includes the areal extent of contamination and of all suitable areas in very close proximity to the contamination that is necessary to implement the response action. No permit applications will be necessary for any on-site activities. The selected remedy will comply with all pertinent action-specific ARARs, which are listed in Appendix A of the FS (DOE and DA 1998). Missouri requirements for well construction (10 CSR 23-4.050; CSR is *Code of State Regulation*) will be an ARAR for any newly installed wells or for the plugging of wells under the selected remedy.

13.3 COST EFFECTIVENESS

The selected remedy will be cost-effective because it provides overall protection of human health and the environment at a reasonable cost.

13.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site.

13.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy does not include treatment as a principal element. However, contingency activities for TCE include localized in-place treatment, as necessary.

13.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The selected remedy results in an irreversible and irretrievable commitment of resources (groundwater and springwater) at the Chemical Plant area.

13.7 SIGNIFICANT CHANGES

The selected remedy is the same as the preferred alternative in the PP presented to the public for review and comment. Details on the design of the monitoring network that were originally presented in the Supporting Evaluation Report (DOE 1993b) were incorporated into this ROD and are presented in Section 12.

14 REFERENCES

Basko, R., 2003, e-mail from Basko (Missouri Department of Health and Senior Services, St. Louis, MO) to R. Cato (Weldon Spring Site Remedial Action Project, St. Charles, MO), May 22.

DOE, 1992, *Remedial Investigation for the Chemical Plant Area of the Weldon Spring Site,* DOE/EIS-0185D (DOE/OR/21548-074, Vol. I), prepared by MK-Ferguson Company and Jacobs Engineering Group, Inc., Weldon Spring, MO, for U.S. Department of Energy, Oak Ridge Field Office, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, Nov.

DOE, 1993, *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site,* DOE/OR/21548-376, U.S. Department of Energy, Oak Ridge Field Office, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, Sept.

DOE, 2000, *Interim Record of Decision for Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site,* DOE/OR/21548-798, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN, Sept.

DOE, 2003a, *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site,* GJO-2002-342-TAC, Draft, U.S. Department of Energy, Grand Junction Office, Grand Junction, CO, May.

DOE, 2003b, *Proposed Plan for Final Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site, Weldon Spring, Missouri,* DOE/GJ/79491-932, prepared by Argonne National Laboratory, Argonne, IL, for U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, June.

DOE and DA, 1997a, *Baseline Risk Assessment for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring, Missouri,* DOE/OR/21548-568, prepared by Argonne National Laboratory, Argonne, IL, for U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of the Army, Corps of Engineers, Kansas City District, Kansas City, MO, July.

DOE and DA, 1997b, *Remedial Investigation for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring Site, Weldon Spring, Missouri,* DOE/OR/21548-571, prepared by MK-Ferguson Company and Jacobs Engineering Group, Inc., Weldon Spring, MO, and Argonne National Laboratory, Argonne, IL, for U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of the Army, Corps of Engineers, Kansas City District, Kansas City, MO, July. (see p. 5-10 for TCE and p. D-9 for 2,6-DNT)

DOE and DA, 1998, *Feasibility Study for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring, Missouri,* DOE/OR/21548-569, prepared by Argonne National Laboratory, Argonne, IL, for U.S. Department Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of the Army, Corps of Engineers, Kansas City District, Kansas City, MO, Dec.

EPA, 1986, *Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy,* Final Draft, U.S. Environmental Protection Agency, Washington, DC.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)*, EPA/5401/1-89/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1990, "National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule (40 CFR Part 300)," *Federal Register* 55(46):8666-8865, U.S. Environmental Protection Agency, March 8.

EPA, 1992a, *Dermal Exposure Assessment: Principles and Applications,* EPA/600/8-91-011B, Interim Report, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Jan.

EPA, 1992b, *First Amended Federal Facilities Agreement*, Docket No. CERCLA-VII-85-F-0057, prepared for U.S. Department of Energy Weldon Spring Site, St. Charles, MO, Jan.

EPA, 1995a, *Health Effects Assessment Summary Tables, FY-1995 Annual*, EPA/540/R-95-036, Office of Solid Waste and Emergency Response, May.

EPA, 1995b, *Exposure Factors Handbook*, EPA/600/P-95/002A (PB95-252532), U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, June.

EPA, 1996, *Risk Assessment Issue Paper for: Carcinogenicity Information for Trichloroethylene (TCE) (CASRN 79-01-6)*, Attachment III by U.S. Environmental Protection Agency to facsimile transmittal from Superfund Technical Support Center (Cincinnati, OH) to H. Hartmann (Argonne National Laboratory, Argonne, IL), Oct. 17.

EPA, 1997, *Integrated Risk Information System*, database, U.S. Environmental Protection Agency, accessed Feb. 1997.

MK-Ferguson Company and Jacobs Engineering Group, 1998, *Completion Report for the Pilot Pumping Test for the Groundwater Operable Unit at the Weldon Spring Site,* DOE/OR/21548-757, prepared for U.S. Department of Energy, Oak Ridge Operations Office, Weldon Spring Site Remedial Action Project, St. Charles, MO, Oct.

MK-Ferguson and Jacobs Engineering Group, 2001, *Weldon Spring Site Environmental Report for Calendar Year 2000, Rev. 0,* DOE/OR/21548-886, prepared for U.S. Department of Energy, Oak Ridge Operations Office, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, July.

Vogel, J., 2003, e-mail from Vogel (Missouri Department of Conservation, St. Charles, MO) to P. Thompson (U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, MO), Apr. 3.