URANIUM MILL TAILINGS REMEDIAL ACTION PROJECT 1994 ENVIRONMENTAL REPORT

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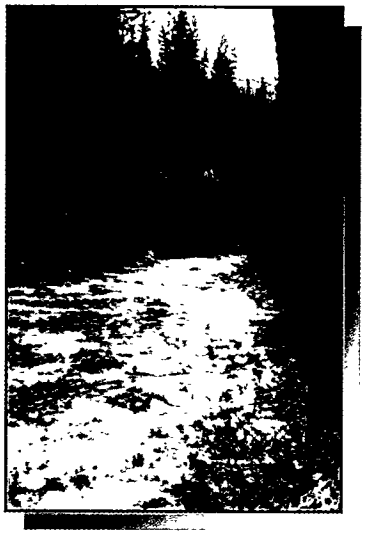

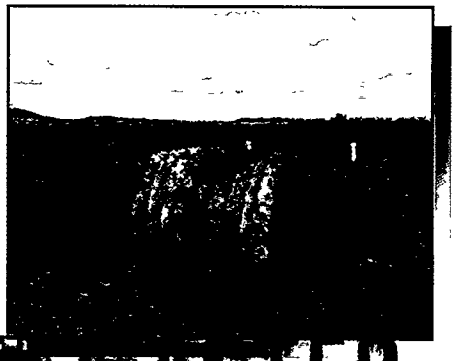

DISCLAIMER

UMTRA PROJECT

URANIUM MILL TAILINGS REMEDIAL ACTION PROJECT 1994 ENVIRONMENTAL REPORT

Prepared for

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ENVIRONMENTAL PROGRAM OVERVIEW

This annual report documents the Uranium Mill Tailings Remedial Action (UMTRA) Project environmental monitoring and protection program. The UMTRA Project routinely monitors radiation, radioactive residual materials, and hazardous constituents at associated former uranium tailings processing sites and disposal sites.

At the end of 1994, surface remedial action was complete at 14 of the 24 designated UMTRA Project processing sites: Canonsburg, Pennsylvania; Durango, Colorado; Grand Junction, Colorado; Green River, Utah; Lakeview, Oregon; Lowman, Idaho; Mexican Hat, Utah; Riverton, Wyoming; Salt Lake City, Utah; Falls City, Texas; Shiprock, New Mexico; Spook, Wyoming; Tuba City, Arizona; and Monument Valley, Arizona. Surface remedial action was ongoing at 5 sites: Ambrosia Lake, New Mexico; Naturita, Colorado; Gunnison, Colorado; and Rifle, Colorado (2 sites). Remedial action has not begun at the 5 remaining UMTRA Project sites that are in the planning stage: Belfield and Bowman, North Dakota; Maybell, Colorado; and Slick Rock, Colorado (2 sites). The ground water compliance phase of the UMTRA Project started in 1991.

The UMTRA Project Environmental Protection Implementation Plan, as required by U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program,* identifies the elements of the UMTRA Project environmental protection program detailed in compliance and monitoring plans and guidance documents. The UMTRA Project Office implements all environmental protection programs required by DOE Order 5400.1, including a waste minimization and pollution prevention awareness program, a ground water protection management program, and an environmental monitoring program. Implementation of these programs ensures that UMTRA Project activities are in compliance with all radiological and nonradiological environmental requirements and are performed in a safe and environmentally sound manner. The UMTRA Project Office continually evaluates compliance with environmental regulations and UMTRA Project requirements by conducting internal appraisals at Project sites to review records and work practices.

Because the UMTRA Project sites are in different stages of remedial action, the breadth of the UMTRA environmental protection program differs from site to site. In general, sites actively undergoing surface remedial action have the most comprehensive environmental programs for sampling media. At sites where surface remedial action is complete and at sites where remedial action has not yet begun, the environmental program consists primarily of surface water and ground water monitoring to support site characterization, baseline risk assessments, or disposal site performance assessments.

COMPLIANCE SUMMARY

In accordance with DOE policy, the UMTRA Project complies with all applicable federal and state environmental requirements. In 1994, activities at UMTRA sites complied with all applicable regulations, including those pertaining to hazardous material management, underground storage tanks, air emissions, surface water discharges, community-right-to-know notifications, plans for spill prevention control and countermeasures, and environmental impact analyses. Chapter 2 of this report contains a complete summary of compliance issues and activities. Chapters 5 through 14 give more detailed, site-specific information on compliance issues and activities.

ENVIRONMENTAL MONITORING SUMMARY

The UMTRA Project Office has developed an environmental monitoring plan that describes the types of environmental monitoring activities that will be conducted at UMTRA sites. To assess the conditions of concern at each site, this plan is implemented through a series of site-specific monitoring plans. Environmental monitoring was conducted at UMTRA sites during 1994 for airborne radionuclides and fugitive dust, environmental penetrating gamma radiation, and radiological and nonradiological contaminants in surface water and ground water. Chapter 3 of this report contains general environmental monitoring information and details on the monitoring methodologies applied at UMTRA sites.

The most comprehensive monitoring programs (which covered air, surface water, and ground water) were conducted at active sites where surface remedial action occurred in 1994. At nonactive sites where surface remedial action has not yet begun or is complete, the program typically consists of surface and ground water monitoring. The environmental monitoring program at each UMTRA site is discussed in detail in the site-specific sections (Chapters 5 through 14) of this report.

Airborne Radioactivity

Air monitoring for radon-222 gas and for thorium-230 airborne radioactive particulates was conducted at all UMTRA sites undergoing surface remedial action. Air particulate and radon gas sampling stations were established adjacent to these active sites and in nearby residential areas. Air monitoring was continuous from 1 month before the start of remedial action to 1 month following completion of the radon barrier on a disposal cell.

The annual average thorium-230 concentrations for all UMTRA sites undergoing remediation were below the DOE limits established in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.* Background levels of radon-222, at some UMTRA sites, may be higher, on the average, then those found eslewhere in the U.S. This is due to the natural abundance of uranium in the areas immediately surrounding some UMTRA sites and radon contributions from open uranium mine air vents and from active uranium mill tailings sites adjacent to UMTRA radon monitoring stations. These factors are unrelated to the UMTRA Project.

Fugitive Dust

Fugitive dust emissions (total suspended particulates) are of concern only at active sites. In most cases, active sites are not required to monitor specifically for fugitive dust emissions; usually, dust suppression programs are all that is required. However, total suspended particulates monitoring was required and conducted at the Rifle, Colorado, processing site in accordance with site-specific state permits. Total suspended particulates monitoring was also conducted at the Gunnison, Colorado, site although the monitoring was not required by state of Colorado air permits. However, the Gunnison site is conducting modified total suspended particulates monitoring as per an agreement with the Colorado Department of Public Health and Environment-Air Pollution Control Division (CDPHE-APCD). Air sampling stations were installed around the site boundaries at both the Rifle and Gunnison sites.

In 1994, an agreement with the CDPHE-APCD and the UMTRA Project provided that all total suspended particulates exceedances which were demonstrated to be caused by off-site activities, would only require telephonic notification and be reported in each individual total suspended particulates Quarterly Report rather than an individual report for each total suspended particulate exceedance caused by off-site activities.

In 1994, the total suspended 24-hour particulate threshold limit value of 150 micrograms per cubic meter ($\mu g/m^3$) established by the state of Colorado and adopted from the U.S. Environmental Protection Agency (EPA), was exceeded six times at only one UMTRA site, in Colorado. All exceedances were the result of off-site activities not related to the UMTRA Project.

The annual geometric mean of 60 $\mu g/m^3$ was not exceeded. The state issued no violations or citations. There were no exceedances of the annual guidelines in 1994 or in the first quarter of 1995.

Environmental Penetrating Gamma Radiation

Environmental dosimetry monitoring for penetrating gamma radiation was conducted at all UMTRA sites undergoing surface remediation. A monitoring network at these sites measured the external penetrating gamma radiation dose to the public. The sampling locations and schedules used to monitor environmental penetrating gamma radiation were used to monitor airborne radioactivity.

The annual gamma radiation/dose levels for all sites monitored were below the DOE guideline of 100 millirem above background established in DOE Order 5400.5.

Surface Water

The surface water monitoring program is designed to monitor 1) compliance with discharge permits, 2) the effects of construction activities on surface water bodies adjacent to active sites, and 3) the impact of ground water contamination on surface water quality.

Surface water discharged from UMTRA Project sites is monitored using methods and frequencies identified in federal and state discharge permits. The issuing agencies determine which constituents will be monitored and their acceptable release limits. During 1994, only one site in Colorado discharged surface water, in accordance with the state waste water discharge permit.

Samples were collected from surface water bodies at active sites to assess the potential environmental impacts of site remedial action activities and discharges to local sewer systems. Taken quarterly and after storm events, these samples were analyzed for thorium-230 and radium-226. Wherever possible, samples were taken from upstream and downstream locations as well as from standing water bodies. Monitoring results from these sites showed concentrations of these radionuclides in surface waters were less than the derived concentration guide values in DOE Order 5400.5.

The impact of ground water contamination on surface water quality was assessed at 14 UMTRA sites in 1994. Samples were analyzed for radiological and nonradiological constituents identified in the EPA ground water standards for UMTRA Project sites. Site-specific constituents of concern were identified, based on previous site characterization information and historical records on the uranium processing methods used at the sites. This round of surface water sampling generally coincided with the site ground water sampling. Ground water contamination at most UMTRA sites did not influence surface water quality in 1994.

Ground Water

Ground water was monitored at 24 UMTRA sites in 1994 to observe changes in ground water quality before, during, and after surface remedial action and to support UMTRA Ground Water Program baseline risk assessments. At five of these sites, ground water monitoring also supported assessments of disposal site performance and determined compliance with ground water protection standards. Ground water samples were analyzed for major ions and the hazardous constituents listed in the EPA ground water protection standards and indicator parameters. The ground water data were used to identify the extent of contamination of hazardous constituents and indicator parameters. Constituent concentrations were compared with background levels and EPA maximum concentration limits.

Quality Assurance

Quality assurance in the UMTRA Project environmental monitoring program is consistent with DOE Order 5700.6C, *Quality Assurance*, and includes the applicable portions of the 11 quality assurance elements identified in DOE Order 5400.1. Trained personnel implement environmental monitoring and compliance activities and follow formal sampling, chain-of-custody, analysis, and data validation procedures. Instruments are routinely calibrated with National Institute of Standards and Technology reference materials. Vendors and laboratories are

certified and accredited where necessary, and are audited for compliance with program requirements. These measures ensure consistent quality throughout the UMTRA Project environmental monitoring program. Chapter 4 of this report presents details of the UMTRA Project quality assurance program.

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FOREWORD

From 1943 to 1970, most uranium ore mining in the United States was conducted by private companies under contract to the U.S. Atomic Energy Commission. The uranium ore was used in national defense research, weapons development, and the emerging nuclear industry. After fulfilling their contracts, many of the uranium mills closed, leaving large quantities of waste (such as uranium mill tailings and abandoned mill buildings) at the mill sites. At some sites, no effort was made to prevent the spread of mill tailings by wind and water erosion or to prevent their use in local construction projects. As a result, uranium mill tailings were spread beyond the mill site boundaries into areas referred to as vicinity properties.

In the 1960s and 1970s, direct gamma radiation, radon gas, and radon gas decay products at the abandoned mill sites were determined to be potential health hazards. In 1972, concern for the potential long-term adverse health effects of uranium mill tailings used in construction projects led Congress to pass legislation authorizing the cleanup of structures contaminated with uranium mill tailings in Grand Junction, Colorado. Continued public concern about other abandoned uranium mill sites led to engineering and radiological studies to identify other mill sites in need of cleanup. As a result, Congress passed Public Law 95-604, the *Uranium Mill Tailings Radiation Control Act* on November 8, 1978 (42 USC §7901 *et seq.*). This act led the U.S. Department of Energy (DOE) to establish the Uranium Mill Tailings Remedial Action (UMTRA) Project to manage the cleanup and disposal of mill tailings at 24 designated inactive mill sites.

The DOE is committed to conducting UMTRA Project operations in an environmentally sound manner to protect human health and the environment. To achieve this goal, UMTRA Project activities must be consistent with the requirements of DOE Order 5400.1, *General Environmental Protection Program*. UMTRA Project activities also must follow all applicable federal, state, tribal, and local environmental protection laws and regulations, executive orders, and DOE policies. Accordingly, the DOE and its contractors have implemented an ongoing environmental monitoring program required by DOE Order 5400.1 at the 24 UMTRA Project sites to demonstrate adherence to these requirements.

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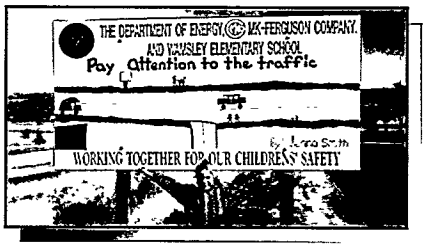
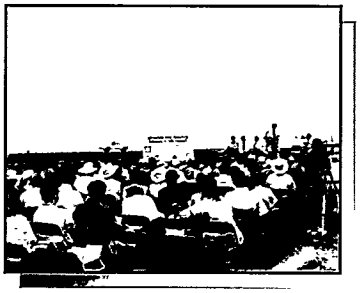
LIST OF ACRONYMS AND ABBREVIATIONS

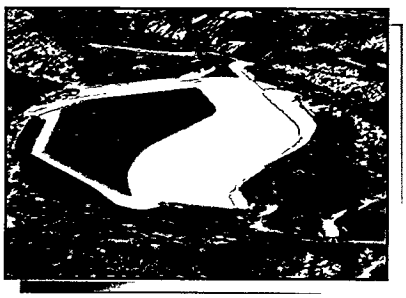
Acronym	Definition
ac	acres
CAA	Clean Air Act
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-To-Know Act
°F	degrees Fahrenheit
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FM-1344	Farm-to-Market Road 1344
ft	feet
HMTA	Hazardous Materials Transportation Act
ICRP	International Commission on Radiological Protection
$\mu g/m^3$	micrograms per cubic meter
µCi/mL	microcuries per milliliter
mg/L	milligram per liter
mi	miles
mrem	millirems
MSL	mean sea level
mSv	millisieverts
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^2s	picocuries per square meter per second
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SIP	stabilized in place
SOS	stabilized on-site
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers

UMTRA PROJECT

CHAPTER 1
INTRODUCTION







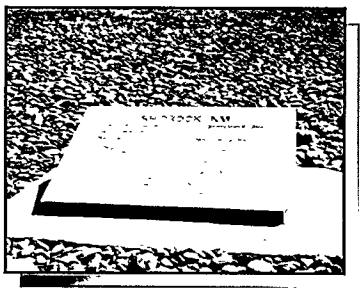


Figure 1-1
UMTRA Project Site Location Map

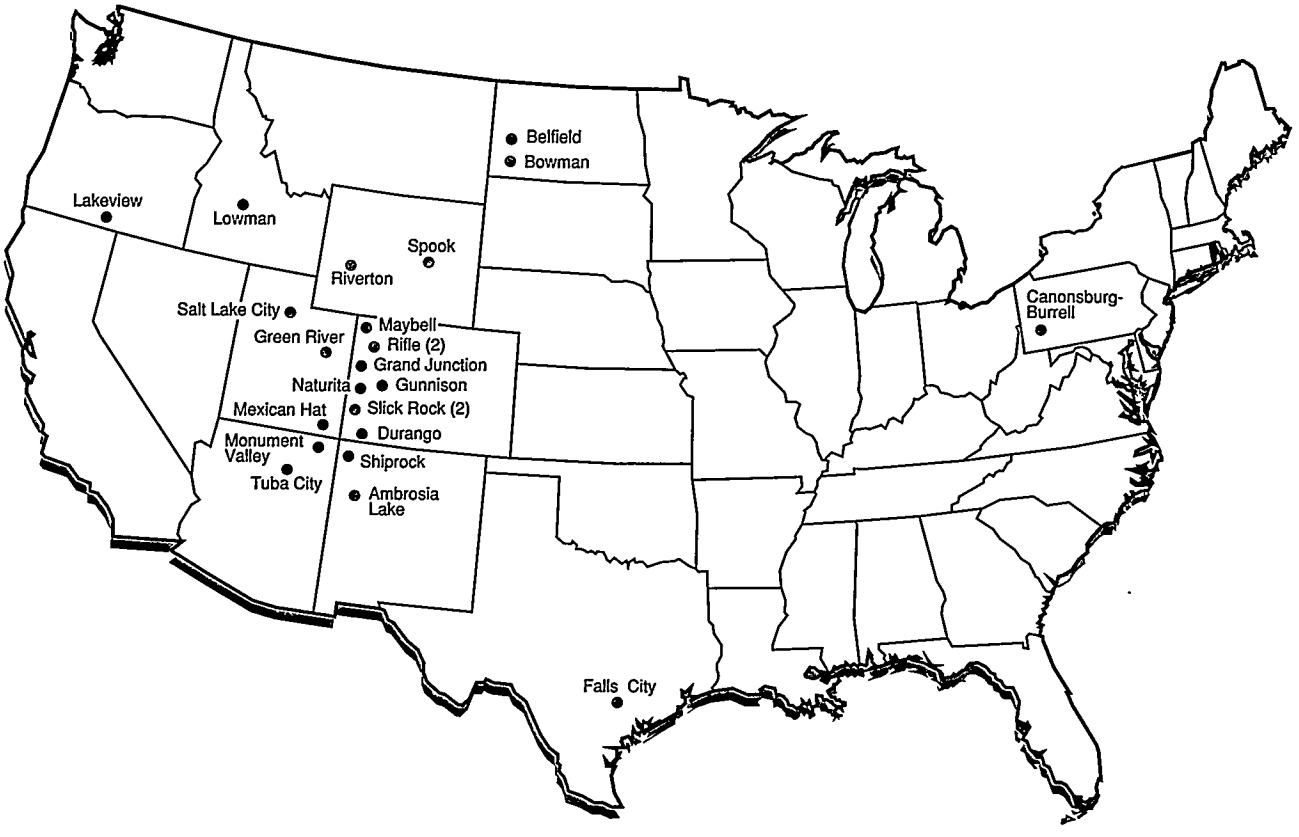


Table 1-1 Status of remediation activities—UMTRA Surface Project sites (1994)

Remediation complete — 14 sites	
Canonsburg-Burrell, Pennsylvania	Mexican Hat, Utah
Durango, Colorado	Monument Valley, Arizona
Falls City, Texas	Riverton, Wyoming
Grand Junction, Colorado[a]	Salt Lake City, Utah
Green River, Utah	Shiprock, New Mexico
Lakeview, Oregon	Spook, Wyoming
Lowman, Idaho	Tuba City, Arizona
Remediation under way — 5 sites	
Ambrosia Lake, New Mexico	Naturita, Colorado
Gunnison, Colorado	Rifle, Colorado (2 sites)
Remediation planned — 5 sites	
Belfield, North Dakota	Maybell, Colorado
Bowman, North Dakota	Slick Rock, Colorado (2 sites)

[a]Cheney disposal cell remains open to receive vicinity property material.

for conducting the Ground Water Project and assesses the potential programmatic impacts of conducting the Ground Water Project, thus providing a method for determining site-specific ground water compliance strategies. Site-specific NEPA documents, such as environmental assessments, will be derived from the programmatic environmental impact statement.

Additional information may be obtained through the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque Operations Office, Albuquerque, New Mexico, or by calling the following toll free numbers: 1-800-523-6495 (outside New Mexico) or 1-800-423-2539 (inside New Mexico).

ENVIRONMENTAL MONITORING PROGRAM

Because radioactive and hazardous constituents occur at UMTRA Project sites, federal and state environmental protection requirements apply to all UMTRA sites. UMTRA Project personnel continually monitor and investigate the effects of these constituents on the environment. The UMTRA Project environmental monitoring program is basic to this effort.

Like any other complex program or investigation, the environmental monitoring program was developed after careful consideration of many components. For example, radioactive and nonradioactive hazardous materials present at the former processing sites may be released to the

environment by air and liquid discharges. The monitoring program follows the anticipated movement of those materials through air, surface water, and ground water pathways and measures the amount of radioactive and nonradioactive material leaving the sites and entering the surrounding environment.

Focusing on results, the environmental monitoring program also includes the following activities:

- Evaluates the impact of site activities (past and present) on the environment.
- Measures progress in correcting problems from past site activities and in implementing improved environmental management practices.
- Identifies significant and meaningful trends in monitoring results.
- Prepares an annual report on the sampling conducted each year to demonstrate that the sites comply with DOE, EPA, state, tribal, and local requirements (i.e., this report).
- Addresses exposure pathways and contaminants that could result in unacceptable risk to the public or the environment.

UMTRA REGULATORY ARENA

Pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*), the DOE administers the UMTRA Project following U.S. Nuclear Regulatory Commission (NRC)- and EPA-promulgated regulations for remediating residual radioactive materials and associated ground water contamination and for subsequent long-term care of disposal sites. This chapter gives an overview of those UMTRA-specific regulations and the DOE environmental protection guidelines applicable to the UMTRA Project. Other environmental regulations that apply to the UMTRA Project are discussed in Chapter 2.

U.S. Environmental Protection Agency Standards

In 1983, the EPA published environmental protection standards for residual radioactive materials at designated processing sites (40 CFR Part 192). The UMTRCA defines residual radioactive materials as uranium mill tailings and other processing site wastes determined by the DOE to be radioactive. The EPA standard is divided into three subparts that affect the UMTRA Project. Subpart A identifies standards for controlling residual radioactive materials at designated processing and disposal sites. Subpart B identifies standards for cleaning up land and buildings contaminated with processing site residual radioactive materials. Subpart C provides guidance for implementing the provisions of Subparts A and B. Subpart C also establishes the criteria the implementing agencies follow when they

apply supplemental standards. The implementing agencies are the DOE, NRC, and affected states and Indian tribes.

In 1985, the U.S. Court of Appeals for the Tenth Circuit set aside portions of the EPA standards (40 CFR §192.20(a)(2) and (3)) related to ground water protection and required the EPA to replace them. The EPA issued new ground water standards that became effective 10 February 1995 (60 FR 2854 (1995)).

These are the primary objectives of the human health and environmental protection standards: isolating and stabilizing residual radioactive materials to prevent misuse by people and dispersal by natural forces; controlling radon emissions; remediating contaminated ground water; and protecting ground water resources from the adverse effects of potential contaminant migration.

U.S. Nuclear Regulatory Commission Standards

The NRC has established licensing requirements for UMTRA Project disposal sites in 10 CFR §40.27, *General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites.* The NRC general license provides the mechanism for licensing residual radioactive materials for each UMTRA Project disposal site as the NRC accepts each site-specific long-term surveillance plan. Long-term care includes monitoring and maintenance necessary to protect public health and safety.

U.S. Department of Energy Orders

DOE Order 5400.1, *General Environmental Protection Program,* established environmental protection program requirements for DOE operations, including the UMTRA Project, to ensure compliance with applicable federal, state, and local environmental protection laws, regulations, and executive orders. The DOE has also established requirements to protect the public and the environment from radiological hazards in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.* These and all other applicable requirements are routinely incorporated into UMTRA Project activities.

PARTICIPATION BY FEDERAL AGENCIES, STATES, AND INDIAN TRIBES

The responsibility for fulfilling the UMTRCA legislative mandate is divided primarily between the DOE, NRC, EPA, and the affected states and Indian tribes. Their roles are described below.

U.S. Department of Energy

As the lead agency carrying out the UMTRCA mandate, the DOE is responsible for overall management of the UMTRA Project. The DOE is responsible for making all programmatic decisions and for reviewing and supervising the work of DOE contractors. The DOE coordinates its activities with the affected state, tribal, and local governments and with the NRC and other federal agencies.

Within the DOE, the Assistant Secretary for Environmental Management at DOE Headquarters oversees administration of the UMTRA Project. The DOE Albuquerque Operations Office is the responsible field organization. The Environmental Restoration Division in Albuquerque, New Mexico, manages UMTRA Project daily operations.

U.S. Nuclear Regulatory Commission

UMTRCA designates the NRC as the federal regulatory oversight agency for the UMTRA Project, with the following responsibilities for the UMTRA Surface and Ground Water Projects:

- Ensure that DOE's selection of remedial action will meet EPA standards.
- Ensure that remedial action was completed as designed.
- License completed disposal sites.
- Sign the cooperative agreements.

The NRC provides technical and regulatory review of UMTRA Project decision and planning documents, including remedial action plans, completion reports, long-term surveillance plans, and certification reports. The NRC must concur with those documents before it will license a site, pursuant to a memorandum of understanding between DOE and NRC. In addition, the NRC provides concurrence on all supplemental standards applications for vicinity properties.

U.S. Environmental Protection Agency

As amended by UMTRCA, the Atomic Energy Act of 1954 (42 USC §2011 *et seq.*) requires the EPA to set general standards for protecting public health, safety, and the environment (including air and ground water) from radiological hazards (e.g., uranium and radon) and nonradiological hazards (e.g., nitrate, molybdenum, and arsenic) associated with residual radioactive materials. In establishing these standards (40 CFR Part 192), the EPA considered the potential risk to public health, safety, and the environment; the environmental and economic costs of applying the standards; and other appropriate factors.

States and Indian Tribes

The UMTRCA requires the affected states to participate fully in surface remediation of designated processing sites. The affected Indian tribes are consulted when remedial action is planned on tribal lands. The roles of the states and Indian tribes in the UMTRA Project are defined through cooperative agreements. Those agreements establish the funding, real estate actions, and technical review requirements needed to conduct remedial action. Each state provides 10 percent of the surface remedial action costs for each of its sites and, if necessary, acquires title to the processing or disposal sites. When remedial action is complete, where applicable, states are required to

transfer ownership of the disposal sites to the federal government for long-term custodial care. Indian tribes share none of the remedial action costs. Custody of disposal sites on Indian lands will be transferred to the DOE through a long-term custodial agreement to allow the DOE to conduct surveillance and monitoring activities at the sites.

State and tribal participation in the UMTRA Ground Water Project includes state and tribal review and comment on major technical documents and concurrence on remedial action plans. The existing cooperative agreements are mechanisms for state and tribal participation in the UMTRA Ground Water Project, but the agreements may need modification to incorporate issues specific to ground water activities. In addition, the states and tribes will assist in implementing appropriate institutional controls during ground water remediation where they are deemed necessary.

UMTRA PROJECT PUBLIC PARTICIPATION PROGRAM

The UMTRCA requires public involvement in remedial action planning. The Secretary of Energy must hold public meetings in states that contain processing sites, vicinity properties, or disposal sites. However, public participation in the UMTRA Project is not limited to the mechanisms formally required by law. The public is involved in informational meetings, workshops, local citizen task forces, and advisory groups.

The UMTRA Project Public Affairs Plan (DOE, 1994a) describes the procedures and methods of informing the public about all aspects of the UMTRA Project to encourage informed UMTRA Project participation from the public and government officials. Information is disseminated to federal, state, and local officials; the media; special interest groups; and all other interested parties.

1994 UMTRA PROJECT ACCOMPLISHMENTS

During the 1994 reporting period, the following milestones were achieved:

- Completed phase I of the remedial action, building demolition and hazardous materials abatement, at Naturita.
- Completed the removal of contaminated materials at the Old Rifle processing site.
- Completed construction of disposal cell at Mexican Hat with collocated materials from Monument Valley and Mexican Hat, including vicinity properties.
- Installed ground water elevation data recorders in new and existing wells at Falls City, Grand Junction, Gunnison, Riverton, and Rifle sites.

- Completed relocation of all contaminated materials from the Grand Junction processing site to the disposal site.

- Relocated all contaminated materials from the processing site at Gunnison to the disposal site.

- Completed disposal cell and remedial action activities at the Falls City site, including vicinity properties. Radon levels on the site have been reduced from 16 picocuries per liter (pCi/L) to the present level of 1 pCi/L.

- Completed placement of contaminated materials into the disposal cell at the Ambrosia Lake, New Mexico, site.

- The DOE Office of Environmental Management approved the UMTRA Ground Water Project draft programmatic environmental impact statement.

- Achieved NRC and state of Colorado concurrence on the Grand Junction remedial action plan.

- Completed the final environmental assessments for Naturita, Maybell, and Slick Rock, Colorado.

- Completed the Implementation Plan for the Ground Water Project programmatic environmental impact statement.

- Completed final remedial action plans for Maybell and Naturita, Colorado, sites.

- Burrell, Pennsylvania, site licensed by the NRC.

- Prevented discharge of potentially contaminated water at all sites with efficient wastewater use for on-site dust control.

- Implemented an effective waste minimization program and recycling program to reduce Project-generated waste material by recycling paper, oil, antifreeze, batteries, and some metal materials. In addition, hazardous products/materials were eliminated or substituted with nonhazardous materials, accomplishing operations without producing hazardous waste.

- Revised the UMTRA Project Ground Water Protection Management Program Plan (DOE, 1994b).

- Issued the UMTRA Project Waste Minimization and Pollution Prevention Awareness Program Plan (DOE, 1994c).

- Revised the UMTRA Project Environmental Protection Implementation Plan (DOE, 1994d).

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DOE (U.S. Department of Energy), 1994d. *Uranium Mill Tailings Remedial Action Project Environmental Protection Implementation Plan,* DOE/AL/62350-79, Rev. 1, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material,* U.S. Nuclear Regulatory Commission.

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings,* U.S. Environmental Protection Agency.

DOE Orders

Order 5400.1, *General Environmental Protection Program,* November 9, 1988, U.S. Department of Energy, Washington, D.C.

Order 5400.5, *Radiation Protection of the Public and the Environment,* U.S. Department of Energy, Washington, D.C.

Federal Register

60 FR 2854, *Ground Water Standards for Remedial Action at Inactive Uranium Processing Sites;* Final Rule, U.S. Environmental Protection Agency, 11 January 1995.

United States Code

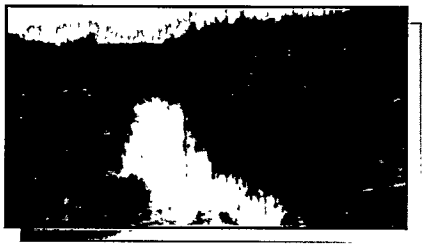
42 USC §2011 *et seq., Atomic Energy Act.*

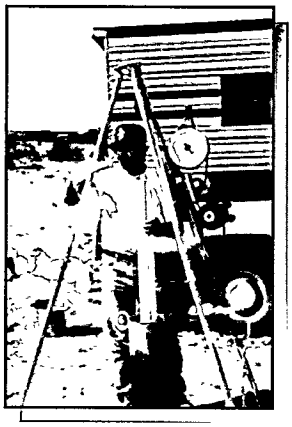
42 USC §4321 *et seq., National Environmental Policy Act.*

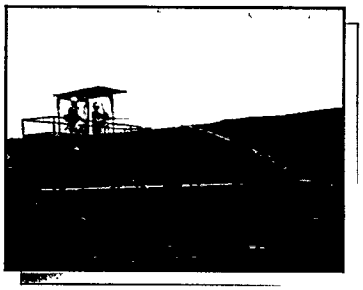
42 USC §7901 *et seq., Uranium Mill Tailings Radiation Control Act.*

UMTRA PROJECT

CHAPTER 2
ENVIRONMENTAL COMPLIANCE SUMMARY

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

The UMTRA Project must follow the environmental protection requirements established by the agencies that govern activities at the 24 UMTRA Project sites. These requirements fall into three general categories:

- Requirements imposed by federal statutes and regulations.
- Site-specific requirements imposed through agreements with regulatory, state, and local agencies and Indian tribes.
- Requirements imposed by DOE Orders and directives.

Activities on the UMTRA sites must follow regulations for hazardous materials management and transportation, underground storage tank removal, discharge to surface water, ground water protection, airborne emissions, community right-to-know notifications, and spill prevention control and countermeasures.

COMPLIANCE SUMMARY

This chapter summarizes the statutes and regulations applicable to the 24 UMTRA Project sites.

Uranium Mill Tailings Radiation Control Act

The UMTRCA of 1978 (42 USC §7901 *et seq.*) requires the DOE to remediate designated processing sites in accordance with EPA standards for cleanup and disposal of residual radioactive materials prescribed in 40 CFR Part 192. The UMTRCA also requires the DOE to care for the permanent disposal sites in accordance with NRC general license requirements in 10 CFR Part 40.

In 1994, surface remedial action consisted of excavating residual radioactive materials and placing those materials in engineered disposal cells at five UMTRA sites in accordance with remedial action plans. To assess disposal cell performance, point-of-compliance ground water monitoring was conducted at five completed disposal sites in accordance with the long-term surveillance plans developed to meet 10 CFR Part 40 licensing requirements. The UMTRA Project meets 40 CFR Part 192 cleanup and disposal standards and obtains the concurrence of all appropriate implementing agencies. Ground water remediation activities were not conducted in 1994.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) requires notification of, response to, and cleanup of unpermitted hazardous substance releases of specified reportable quantities. Releases of residual radioactive materials from UMTRA processing sites are specifically excluded from regulation under CERCLA, and no UMTRA sites are on the National Priorities List. All 1994 UMTRA Project activities met CERCLA requirements. No spills of hazardous substances exceeded reportable quantities during 1994 at any UMTRA site.

Emergency Planning and Community Right-To-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 (42 USC §11001) provides for the notification of state and local emergency planning entities of facility inventories of hazardous substances and environmental releases of those substances. In 1994, inventories of hazardous substances that exceed EPCRA threshold planning quantities were submitted to appropriate state and local authorities for seven active UMTRA sites in Arizona, Colorado, New Mexico, and Utah. No UMTRA sites had unpermitted releases of hazardous substances that exceeded reportable quantities in 1994.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 USC §6901 *et seq.*) mandates a comprehensive program to regulate and manage hazardous waste (including underground storage tanks) from generation to disposal. During 1994, the UMTRA Project was active in Arizona, Colorado, New Mexico, Texas, and Utah. Depending on location, either a state agency or the EPA enforced RCRA compliance. Residual radioactive material regulated under 40 CFR Part 192 is not subject to RCRA hazardous waste regulations. The UMTRA Project rarely generates RCRA wastes, and none were generated in 1994.

RCRA Subtitle I regulates underground tanks that contain RCRA-regulated substances. The EPA has delegated full regulatory authority to each state; state regulations must be at least as stringent as those of the EPA. In 1994, one underground storage tank was discovered at an active site in New Mexico. The underground storage tank was subsequently removed and properly disposed of.

The UMTRA Project requires all chemical products used on the site to be consumed in the remediation process, reused, or recycled to minimize waste generation. Qualified local vendors are contracted to recycle most bulk products such as oil, fuels, antifreeze, solvents, greases, and batteries on a scheduled basis. Site procedures encourage the complete use of chemicals and the use of nonhazardous chemicals in the place of hazardous ones. These waste minimization and pollution prevention activities reduce the generation of hazardous wastes at UMTRA sites.

Clean Water Act

The Clean Water Act (CWA) (33 USC §1251 *et seq.*) sets requirements to protect, maintain, and restore the chemical, physical, and biological integrity of the nation's water. The CWA established the National Pollutant Discharge Elimination System (NPDES), which requires permits for all point-source effluent and storm water discharges to water sources. In 1994, the UMTRA Project complied with all specific state, federal, and tribal regulations implementing the CWA at UMTRA sites.

All UMTRA sites undergoing surface remediation were required to comply with NPDES requirements. In 1994, active sites in New Mexico, Colorado, Texas, Utah, and Arizona did not release water

under NPDES permits. At active sites, waste water is used on-site for dust control or evaporated in lined retention ponds, minimizing the need to discharge surface waters. One inactive UMTRA site in Colorado discharged surface water, in compliance with NPDES permit limits, in October 1994.

Site-specific spill prevention control and countermeasures plans address requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. Lined earthen berms that meet spill prevention control and countermeasures requirements have been constructed around all aboveground storage tanks and oil drum storage areas at all active UMTRA Project sites as required; these secondary containment systems are designed to control spills adequately. In 1994, spill prevention control and countermeasures plans, including procedures for berm inspection, spill detection, emergency spill response, and spill cleanup, were implemented for active fuel and oil storage areas. No significant spills occurred in 1994.

At UMTRA sites undergoing remediation, sanitary waste is disposed of in holding tanks, septic systems, or through local sewer systems. Holding tanks are emptied at least yearly, or as needed. Temporary portable toilets are available at all active UMTRA sites; waste from these facilities is disposed of in accordance with state and local requirements.

National Environmental Policy Act

The NEPA of 1969 (42 USC §4321 *et seq.*) requires federal agencies to prepare a detailed statement identifying and analyzing the potential environmental impacts of proposed actions that could significantly affect the quality of the human environment.

NEPA-related documents (environmental impact statements and environmental assessments) that analyze the site-specific impacts of proposed surface remediation are complete for 18 of the sites and are being developed for the remaining 6 sites. These environmental assessments were completed in 1994 and were awaiting final DOE approval at the end of 1994.

Because the UMTRA Ground Water Project is considered a new federal action, the DOE has determined that additional NEPA documentation is needed to address the potential impacts of complying with EPA standards. A ground water programmatic environmental impact statement has been prepared to provide a framework for the Ground Water Project. The implementation plan for the programmatic environmental impact statement was finalized in 1994. DOE Headquarters comments were received and the document was revised. The document is in DOE Headquarters awaiting final approval to publish the draft for public review and comment.

Environmental monitoring and the preparation of mitigation plans are typically part of site-specific NEPA documents prepared on the UMTRA Project. As part of the NEPA process, activities such as surveys for threatened and endangered species and cultural resources, assessments of wetlands and floodplains, or plans for environmental mitigative action may be needed.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (42 USC §300f *et seq.*) is an environmental statute intended to protect drinking water resources. Primary drinking water standards promulgated under the SDWA apply to water at the tap as delivered by public or private supply systems.

The UMTRA Project does not own or operate a drinking water supply system at any site. Local, publicly owned water works supply potable water, when possible. Bottled drinking water is purchased from local vendors for use at remote locations. Also, proper well construction techniques help prevent ground water contamination in an effort to protect drinking water resources.

Endangered Species Act

The Endangered Species Act (16 USC §1531 *et seq.*) prohibits federal agencies from taking any action that would jeopardize the existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat.

The DOE contacts the appropriate regional U.S. Fish and Wildlife Service office and state wildlife resources agencies as early as possible in project planning. When the DOE receives the U.S. Fish and Wildlife Service list of threatened and endangered species in the general area of concern, the DOE determines the status of those species at each site and prepares a site-specific biological assessment. The status of a species may be determined from published information or may require a site-specific survey. The DOE's biological assessment, the U.S. Fish and Wildlife Service biological opinion of the assessment, and all agreed-upon mitigation documentation become part of the site-specific NEPA documentation.

During 1994, field surveys were performed for threatened and endangered species at four UMTRA sites as part of the Endangered Species Act compliance process.

Executive Order 11988; *Floodplain Management*

Executive Order 11988, *Floodplain Management*, instructs federal agencies to consider the effects of proposed actions on floodplains, avoid adverse impacts associated with the occupancy and modification of floodplains to the extent possible, and avoid direct or indirect support of floodplain development when there is a practical alternative.

Remedial action at some UMTRA sites involves removing tailings-contaminated soil and/or vegetation from floodplains. In accordance with 10 CFR Part 1022, the DOE prepared floodplain assessments for

three Colorado sites and incorporated them into the site-specific draft environmental assessments being prepared under NEPA.

Executive Order 11990, *Protection of Wetlands*

Executive Order 11990, *Protection of Wetlands*, requires federal agencies to determine whether a wetland may be affected by remedial action, assess the impacts on such areas, and consider alternative action. The intent of this Executive Order is to protect wetlands and minimize the adverse effects of development in or around wetlands. Project-related impacts are also addressed in a U.S. Army Corps of Engineers (USACE) Section 404 Permit, if USACE-regulated wetlands are present.

Remedial action at UMTRA sites occasionally involves removing tailings, contaminated soil, and/or vegetation from wetlands. The DOE addresses impacts to wetlands in a wetlands assessment consistent with the requirements of 10 CFR Part 1022. This assessment describes the wetland, the predicted impacts, alternative courses of action, and mitigation measures. In 1994, Slick Rock, Maybell, and Naturita sites underwent wetlands assessments.

The USACE is consulted when an UMTRA site includes wetlands. Typically, a USACE biologist visits the site to verify the presence and extent of regulated wetlands. The application for a Section 404 Permit includes boundary information, projected Project plans, the projected impact of those plans on the wetland, and proposed mitigation plans. A wetlands mitigation plan was prepared for and implemented at a Colorado site in 1994.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) (16 USC §470 *et seq.*) requires a federal agency to consider the effects of its proposed actions on properties listed or eligible for listing on the National Register of Historic Places. Potential impacts on prehistoric, historic, and other cultural resources are addressed in site-specific environmental assessments and environmental impact statements.

The DOE consults with federal land management agencies, local Indian tribes, and appropriate state historic preservation officers concerning specific compliance requirements and cultural resource preservation planning. Consultation with the Advisory Council on Historic Preservation may also be required in some cases and often includes appropriate local historical organizations and interested individuals or groups.

Clean Air Act

The Clean Air Act (CAA) (42 USC §7401 *et seq.*) requires facilities that release airborne toxic and nuisance materials to obtain permits. A tribal, state, or federal agency enforces CAA compliance, as appropriate.

All UMTRA Project sites undergoing surface remediation in 1994 applied for air quality permits before construction began. CAA activities on the Project ranged from complying with state requirements for controlling visible fugitive dust to extensively monitoring total suspended particulates at sites in Colorado. (Individual site compliance is described in site-specific chapters.) No citations were issued at any UMTRA Project site during 1994, and all audits show the fugitive dust emissions program was in compliance with the CAA.

National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations governing radionuclide emissions are delineated in 40 CFR Part 61. The UMTRA Project is programmatically exempt from the DOE monitoring requirements of Subparts H and Q of 40 CFR Part 61. Subpart T of 40 CFR Part 61 regulates disposal of uranium mill tailings at UMTRA Project sites, limiting radon emissions to 20 picocuries per square meter per second (pCi/m^2s) and require monitoring when a disposal cell is completed to demonstrate compliance. Radon flux monitoring was conducted at two UMTRA sites in New Mexico and Utah in 1994. Both sites tested were in compliance with the NESHAP's radon emission standard.

Hazardous Materials Transportation Act

Enforced by the U.S. Department of Transportation (DOT), the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*) is the major transportation-related statute affecting the DOE. The HMTA improves regulatory and enforcement authority and protects the public from risk to life and property when hazardous materials are transported.

Uranium mill tailings with a total specific activity exceeding 2000 picocuries per gram (pCi/g) are classified as radioactive (i.e., hazardous) material. The HMTA regulates transport of these tailings and radiological samples (exceeding 2000 pCi/g). The HMTA also regulates calibration standards for testing equipment.

In 1994, the DOE acquired a renewal to its DOT exemption (E-10594) for the UMTRA Project to transport tailings at or above 2000 pCi/g in bulk shipments. The exemption grants the use of special placards for haul trucks, shipping documentation, and training to address the tailings hazards. All activities for which DOT Exemption E-10594 did not apply were carried out under applicable DOT regulations.

In 1994, all active UMTRA sites that transported tailings under DOT Exemption E-10594 conducted training in mill tailings radiation hazards and emergency shipping procedures prescribed by the exemption.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 USC §136 *et seq.*) requires registration of all pesticides, restricts use of certain pesticides, and regulates application, disposal, and transportation of pesticides. Pesticide use at UMTRA sites is minimal, and no unusual events associated with FIFRA compliance occurred in 1994.

State Regulatory Requirements

UMTRA Project sites comply with all appropriate state, county, and city regulatory requirements. In the compliance section for each site, this document details the regulatory requirements unique to individual states and sites.

Granted States Regulatory Authority

Many federal environmental acts (CAA, CWA, RCRA) enacted by Congress give regulatory authority to individual states for enforcement so long as individual state compliance programs meet or exceed the corresponding federal requirements.

State-Specific Requirements

Each state has a regulatory agency or division with the authority to enforce the CAA. The state of Colorado requires permits for facilities (including UMTRA sites) that release airborne toxic and nuisance materials such as fugitive dust.

Site facilities or activities that may affect surface or ground water supplies (e.g., underground storage tanks, monitoring wells, abandoned wells, fuel storage tanks, septic systems and holding tanks for sanitary wastes, and surface water discharges) fall under the regulatory authority of the state agencies/divisions. In most cases, as regulatory authorities under the CWA, individual states may issue permits for surface water discharge.

Special Permits-Requirements

Local agencies (city/county) or state departments administer UMTRA site activities such as land use, haul road construction, highway access, and noise control. Tribes are consulted, if required.

DOE ENVIRONMENTAL AUDITS

The DOE Office of Environmental Audit performed an environmental management audit of the UMTRA Project in October-November 1992. This audit assessed the adequacy of the UMTRA Project's environmental programs and management organization in ensuring environmental protection and compliance with federal, state, and DOE requirements. Although the audit resulted in 18 findings, the audit team concluded that the UMTRA Project has made good progress in developing and implementing environmental programs. The action plan for this audit was submitted in July 1993 (DOE, 1993). The UMTRA Project follows the action plan, and all corrective actions are expected to be complete in 1995.

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

SITE COMPLIANCE STATUS

The significant site-specific compliance-related issues for 1994 are discussed below.

Monument Valley, Arizona

With surface remedial action completed at the Monument Valley site, the UMTRA Project met 40 CFR Part 192 cleanup standards. The subsequent site completion report is being prepared.

Durango, Colorado

The site discharged surface water in October of 1994. This discharge was a result of the accumulation of water from the completed disposal cell toe drain. The water was treated to remove residual radioactive material. The release criteria for the surface water was well below discharge limits established in the state permit.

Grand Junction, Colorado

Pretreated wastewater was discharged from the Grand Junction processing site to the city sewer system in accordance with a city discharge permit.

Rifle, Colorado

The Rifle processing sites recorded total suspended particulate readings higher than the permit threshold limit of 150 micrograms per cubic meter ($\mu g/m^3$) on the following dates: 17 May, 20 May, 10 June, 16 June, 7 November, and 1 December. All exceedances were a result of off-site activities not related to the UMTRA Project. The annual geometric mean of 60 $\mu g/m^3$ was not exceeded. No violations were issued for this site.

Ambrosia Lake, New Mexico

NESHAP monitoring was conducted in 1994. The site is in compliance with the 40 CFR 61, subpart T, radon emission standard of 20 pCi/m^2s.

During March 1994, one underground storage tank was discovered. The tank did not contain any RCRA-regulation hazardous water and was subsequently removed, and properly disposed of in the disposal cell.

With the placement of all residual radioactive material in the disposal cell completed at the Ambrosia Lake site, the UMTRA Project met 40 CFR Part 192 surface cleanup standards. The site completion report is being prepared.

Falls City, Texas

With surface remedial action completed at the Falls City site, the UMTRA Project met 40 CFR Part 192 cleanup and disposal standards. The subsequent site completion report is currently under preparation.

Mexican Hat, Utah

NESHAP monitoring was conducted in 1994. The site is in compliance with the 40 CFR 61, Subpart T, radon emission standard of 20 pCi/m^2s.

With surface remedial action completed at the Mexican Hat site, the UMTRA Project met 40 CFR Part 192 cleanup and disposal standards. The subsequent site completion report is being prepared.

REFERENCES

DOE (U.S. Department of Energy), 1993. *Uranium Mill Tailings Remedial Action Project Environmental Line Management Audit Action Plan*, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material*, U.S. Nuclear Regulatory Commission.

10 CFR Part 1022, *Compliance with Floodplains/Wetlands Environmental Review Requirements*, U.S. Department of Energy.

40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*, U.S. Environmental Protection Agency.

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

Executive Orders

Executive Order 11988, *Floodplain Management*, Office of the President, Washington, D.C.

Executive Order 11990, *Protection of Wetlands*, Office of the President, Washington, D.C.

United States Code

7 USC §136 *et seq., Federal Insecticide, Fungicide, and Rodenticide Act.*

16 USC §1531 *et seq., Endangered Species Act of 1973.*

16 USC §470 *et seq., National Historic Preservation Act.*

33 USC §1251 *et seq., Clean Water Act.*

42 USC §300f *et seq., Safe Drinking Water Act.*

42 USC §4321 *et seq., National Environmental Policy Act.*

42 USC §6901 *et seq., Resource Conservation and Recovery Act.*

42 USC §7401 *et seq., Clean Air Act.*

42 USC §7901 *et seq., Uranium Mill Tailings Radiation Control Act of 1978.*

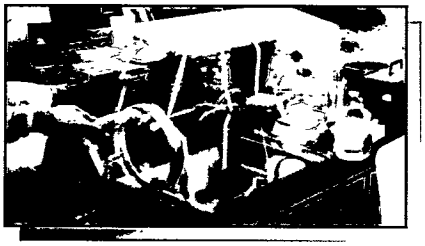
42 USC §9601 *et seq., Comprehensive Environmental Response, Compensation, and Liability Act.*

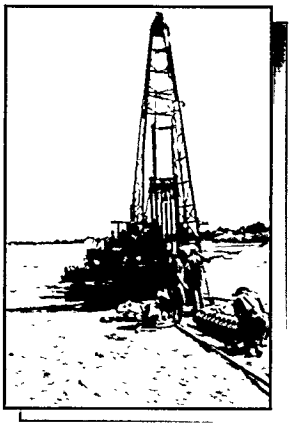
42 USC §11001 *et seq., Emergency Planning and Community Right-To-Know Act.*

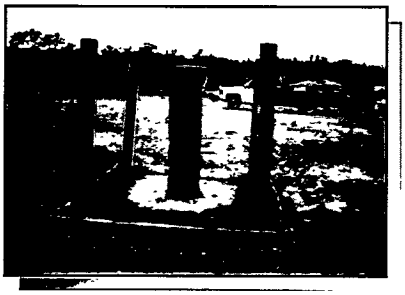
49 USC §1801 *et seq., Hazardous Materials Transportation Act.*

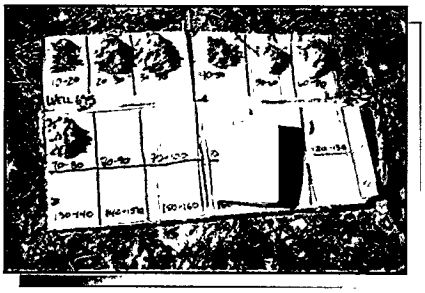
UMTRA PROJECT

CHAPTER 3
ENVIRONMENTAL MONITORING METHODOLOGIES









CHAPTER 3 — ENVIRONMENTAL PATHWAYS, RADIATION FUNDAMENTALS, AND ENVIRONMENTAL MONITORING METHODOLOGIES

INTRODUCTION

This chapter addresses general aspects of environmental pathways, regulatory standards and guidelines, radiation fundamentals, units of measure, and sources of background radiation and exposure. Information on these basic concepts will aid in understanding this report.

ENVIRONMENTAL PATHWAYS TO HUMANS

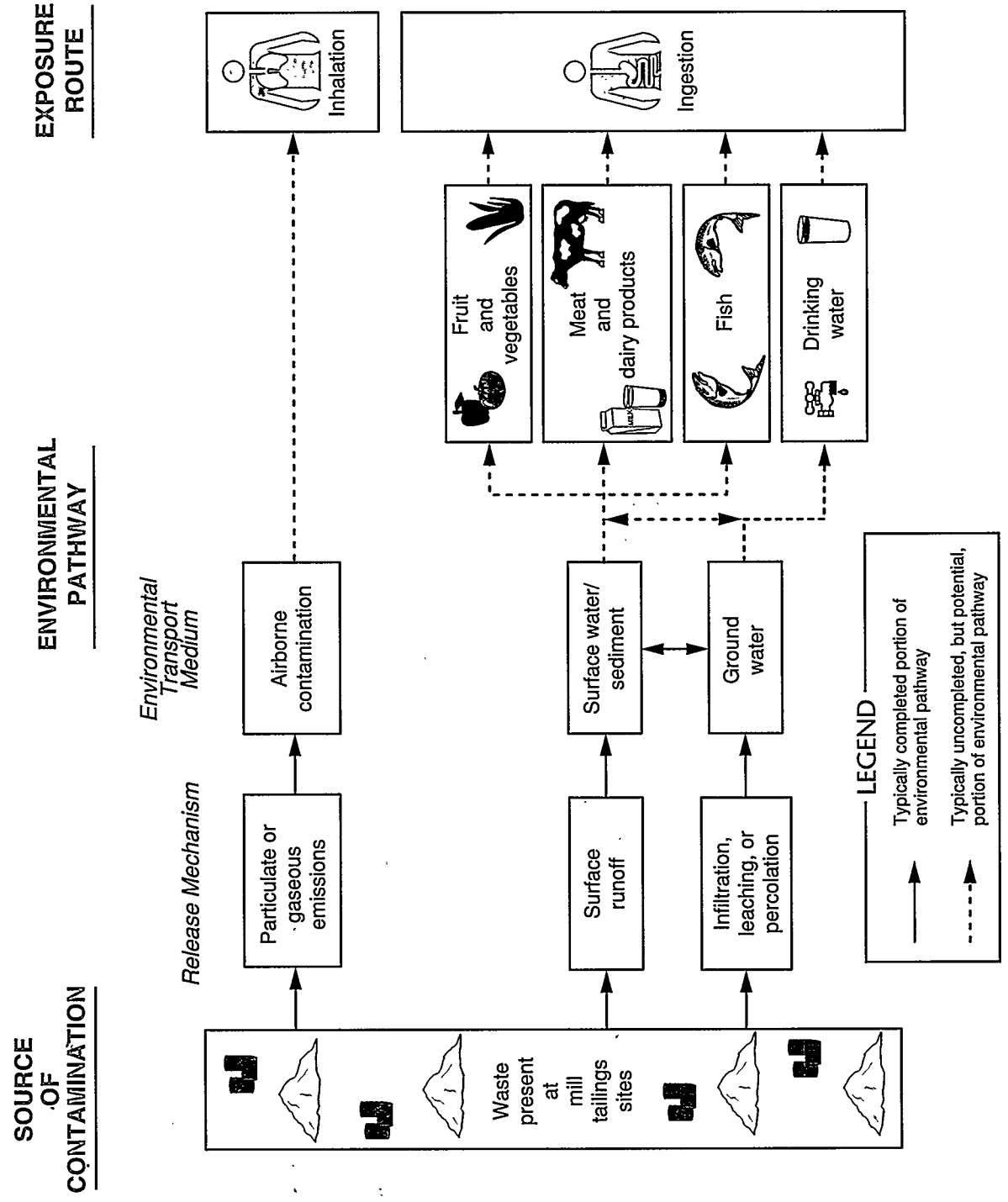
The sampling results in this report represent the efforts of Project scientists and engineers to determine the interaction between site-related contaminants and the environment. The UMTRA Environmental Monitoring Program focuses on sampling environmental pathways to assess the effectiveness of remedial actions and determine the potential for excess risk to human health and the environment. An environmental pathway generally is a contaminant's route of migration, or transport, after its release into the environment. These environmental pathways typically include air and water. For example, during past operations of mill tailing sites, winds dispersed tailings materials (a source of radiological and chemical contamination) at the surface. Also, percolation of rainwater through tailings released water-soluble contaminants to ground water, and runoff from precipitation released waterborne contaminants and contaminated sediments to surface water bodies. Furthermore, local residents removed mill tailings at some UMTRA sites for use as fill or for other purposes.

Figure 3-1 illustrates some general aspects of environmental pathways; the figure is intended to be informational and not representative of a specific UMTRA site. An actual contaminant pathway, as shown in *Figure 3-1*, can be very complex. Both radioactive and chemical contaminants may be transported through the same pathways.

Uranium mill tailings, or residual radioactive materials, are the major radioactive contaminant at UMTRA sites. The uranium milling process extracts approximately 90 percent of the uranium from the ore, leaving approximately 10 percent in the mill tailings. Because the milling process removes only the uranium from the ore, the tailings contain original concentrations of other radionuclides in the uranium decay chain, such as thorium-230, radium-226, and radon-222 and its decay products.

Chemicals such as nitric acid and sulfuric acid were used in the uranium leaching process, thus introducing a source of nonradiological contamination at UMTRA sites. Other contaminants include metals (such as molybdenum, arsenic, and selenium), which were contained in the uranium ore. Thus, mill tailings are contaminated with radioactive materials, metals, and chemicals used in the process of removing uranium from the ore.

Figure 3-1
Schematic Presentation of the UMTRA Project Environmental Pathways



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Air Pathway

Contaminants in the air pathway may include airborne fugitive dust, radionuclide particulates, and radon gas carried from UMTRA sites during active surface remediation. The form and chemical makeup of contaminants influence their dispersion into the environment. For example, fine particles and gases may be inhaled while larger, heavier particles tend to settle on vegetation or soil. Chemical properties determine whether a contaminant will dissolve in water, be absorbed by plants and animals, or accumulate in sediment and soil.

Direct gamma radiation is considered part of the air pathway. During radioactive decay, gamma rays often are released with alpha and beta radiation. Unlike alpha and beta radiation, which release energy in the form of particles, gamma radiation is electromagnetic energy. It has no mass and can travel long distances. Therefore, gamma radiation is monitored on and off the site at all UMTRA sites undergoing active remediation.

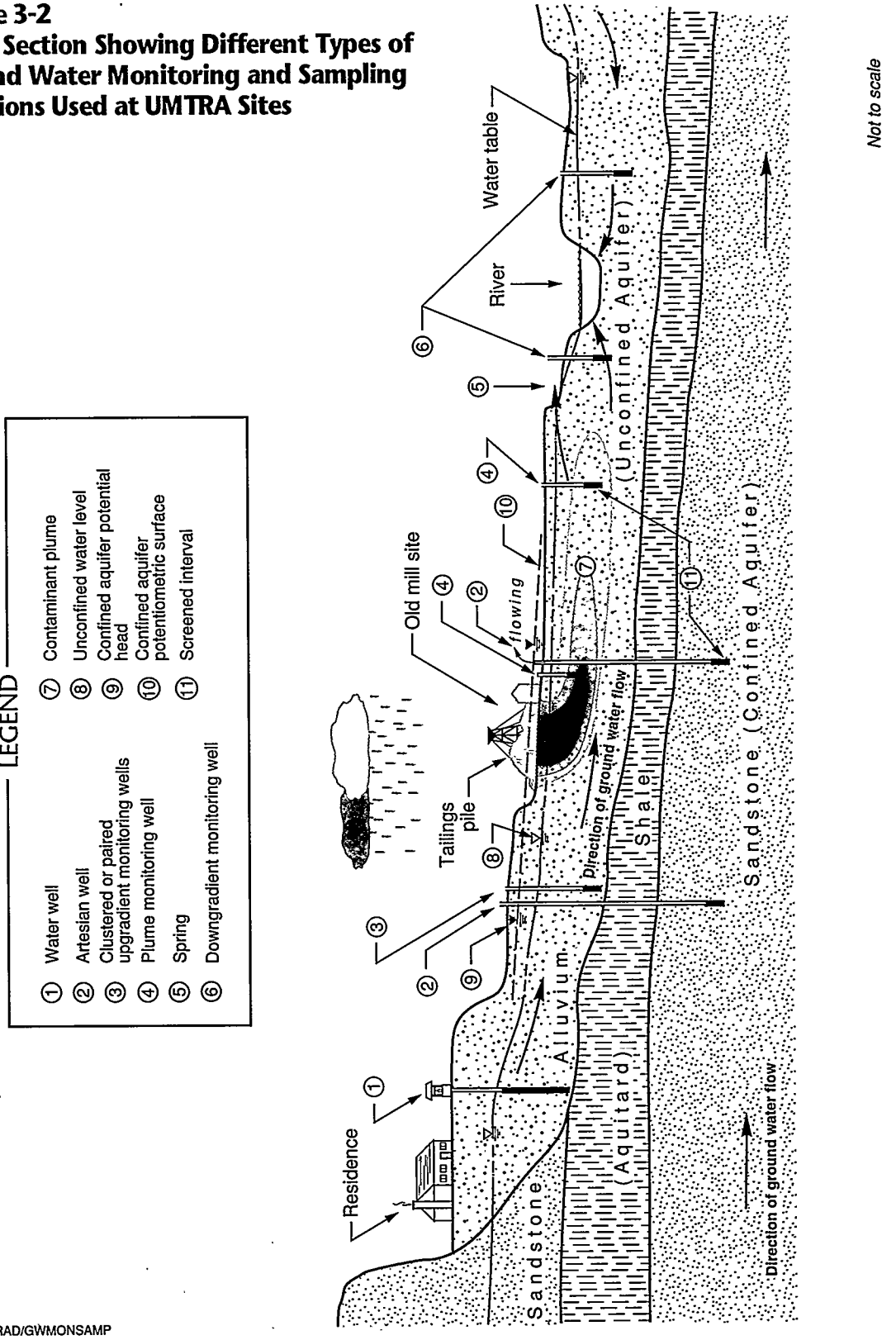
The air pathway is monitored by measuring the concentration of contaminants at the point of release. This provides information on the amount of contaminant released and its behavior in the environment. Off-site concentrations also are measured to assess any potential impacts to the public and the environment. The UMTRA Project operates on-site and off-site air and gamma monitoring stations 24 hours a day, 7 days a week, at all sites undergoing active surface remediation.

Water Pathway

The water pathway includes all releases of waterborne contaminants. Typical water pathways at UMTRA sites include ground water, surface water, and uncontrolled stormwater runoff. Ground water is an important component of the water pathway because it may provide the water source for area homes, farms, and ranches. Extensive sampling of wells on the site and in the surrounding area provides aquifer information. The wells sampled may include livestock wells, DOE monitoring wells, and privately owned wells used for drinking water. By sampling the aquifer in many locations and at varying depths, Project personnel can determine the extent of any contamination.

Draining of placement fluids and leaching of contaminants from tailings has contaminated the ground water at many former mill sites. Leaching occurs when precipitation, or water from some other source, percolates through tailings material removing water-soluble components. Contaminant-laden seepage from tailings material generally flows downward above the water table and then laterally upon reaching ground water (*Figure 3-2*). Contaminants become diluted when mixed with ground water, and concentrations in ground water diminish downgradient of the site. Chemical and biochemical reactions and/or the local ground water flow velocity may influence the

Figure 3-2
Cross Section Showing Different Types of Ground Water Monitoring and Sampling Locations Used at UMTRA Sites



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migration of contaminants, depending on the chemical, biological, and physical properties of the contaminants; the ambient ground water; and the geological materials encountered by seepage and contaminated ground water. For example, uranium may combine with carbonate to form a stable compound in solution with ground water. However in the absence of carbonate, uranium may bond with iron-rich minerals, thereby reducing the amount of uranium detected in ground water samples. Conversely, nitrate, derived from using nitric acid or ammonia during milling, generally is unaffected by geological materials and is transported at about the same flow velocity as ground water. However, biological activity may reduce nitrate concentrations under certain conditions.

In the subsurface, rocks and soil serve either as aquifers or aquitards (confining units). Aquifers are permeable formations that readily transmit water in sufficient quantity for economic use via a well or spring. Sand and gravel deposits, sandstone, weathered limestone, and fractured rocks (such as granite or marble) are common aquifer materials. Aquifers present at or near the land surface contain unconfined water, (i.e., they contain a free water surface that rises and falls in response to differences in recharge and discharge, and the water in the aquifer is contained at atmospheric pressure).

Confined aquifers are bounded above and below by low-permeability aquitards. The water level in a well completed in a confined aquifer rises within the well casing above the elevation of the top of the aquifer (an artesian well) and may even exceed the elevation of the land surface (a flowing artesian well). Confined aquifers are less likely to become contaminated by mill tailings-related constituents due to the presence of the overlying confining unit (***Figure 3-2***).

Aquitards are low-permeability formations that do not readily transmit water in sufficient quantity to be economically beneficial. Geologic materials that typically function as aquitards include shale, silt, and clay rich formations. Aquitards limit the downward flow of ground water from unconfined aquifers and the upward flow of ground water from confined aquifers (***Figure 3-2***). Frequently an upward hydraulic gradient is present from an underlying confined aquifer to the unconfined aquifer, thereby limiting the potential for downward flow of shallow contaminated ground water.

Figure 3-2 a profiles a hypothetical setting wherein previous milling operations resulted in ground water contamination. Ground water wells specifically designed for monitoring ground water chemistry and water levels are used extensively at ground water contamination sites to characterize the interaction of site hydrogeology and contaminants.

Water wells used by rural residents and local communities as a drinking water source typically are sampled to obtain background ground water quality conditions when located upgradient of contamination or to determine possible contaminant impacts when located downgradient of the contamination source. Springs (locations where ground water naturally discharges to the land surface), rivers, lakes, creeks, and ponds are other locations where sampling may determine the relationship between ground water contamination and nearby hydrologic features. Clusters or pairs of monitor wells sometimes determine variations in contaminant distribution with depth and depth characteristics of hydrogeologic units in the site vicinity. Within an aquifer containing contamination, monitor wells typically are installed upgradient of the contamination source, within the contamination zone, and downgradient of the contamination zone to obtain the spatial distribution of contaminants. By routinely sampling these locations (usually semiannually or annually), trends in contaminant concentrations can be obtained.

The arrangement of monitor wells, selection of other sample location types, the contaminants of concern, and the frequency of sample collection and analysis are determined on a site-specific basis. Factors affecting the ground water monitoring strategy for a site include: the quality of available information on site contamination, the complexity of the ground water environment, potential risks to human health and the environment, the relative stage of completion of remedial action, applicable regulatory requirements, and the need for information to facilitate remedial action decision-making.

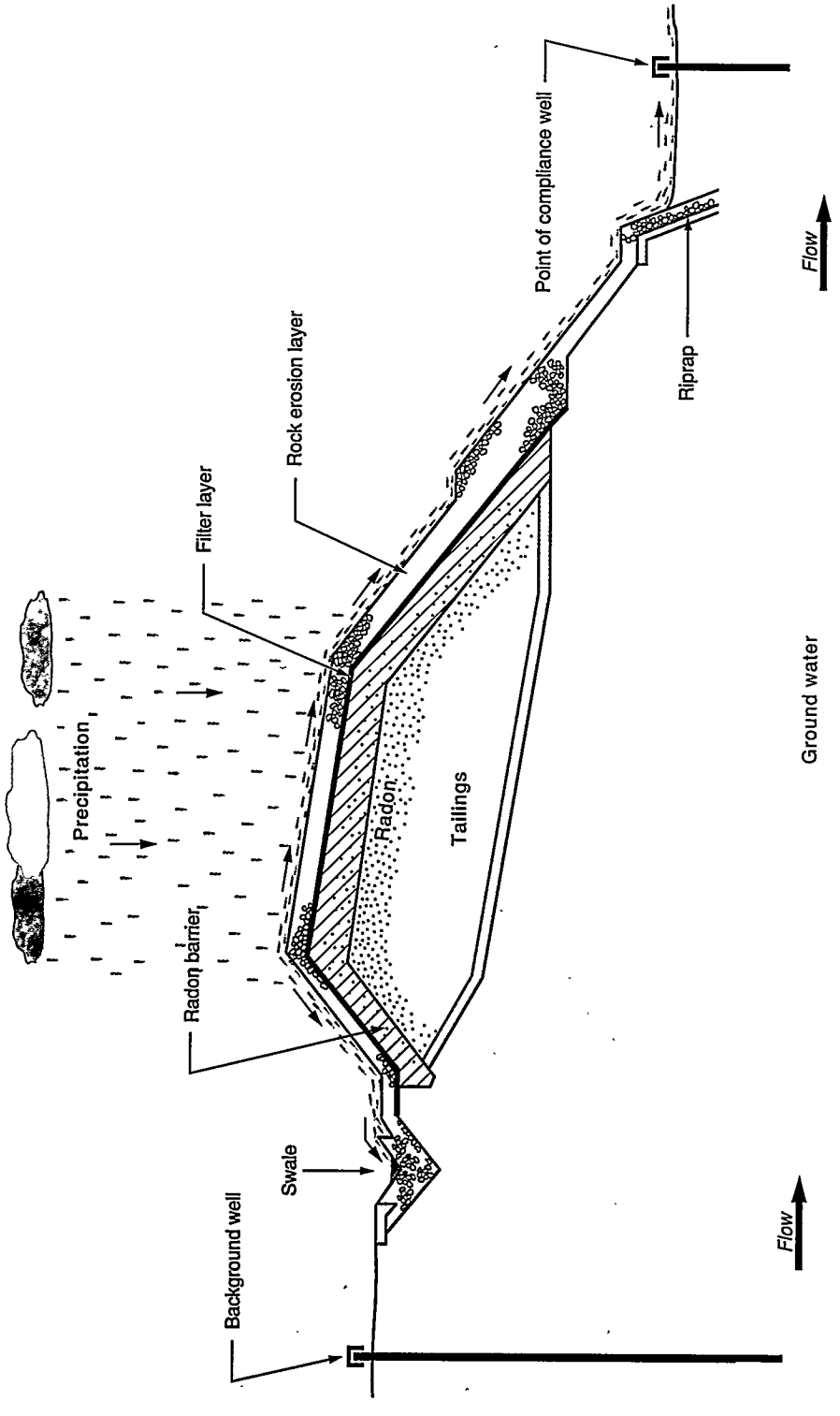
Disposal Cell Design

Under the surface project, engineering controls protect human health by isolating tailings from the environment. Engineering controls usually take the form of a disposal cell designed to stabilize wastes effectively for 200 to 1000 years. One key to effective waste containment over the long term is hydrologic isolation by means of a thick low-permeability cover (***Figure 3-3***). A thick low-permeability cover retards erosional threats from large storms or anomalously wet years and discourages infiltration by promoting precipitation runoff. Furthermore, this low-permeability cover retards radon gas emissions (***Figure 3-3***). This design has been proven effective in meeting EPA NESHAP standards.

Disposal Site Selection

The DOE's mill tailings are stabilized in place (SIP), stabilized on-site (SOS), or stabilized by relocating to an alternative site. The final location and configuration affects the final disposal cell design. Each type of stabilization can vary, from aboveground disposal to different degrees of below-grade disposal.

Figure 3-3
Cross Section of a Typical UMTRA Project Disposal Cell



ASER95/RAD/TYPX-SEC

The disposal site selection process considers a site's geological stability and its impact on disposal cell design, including the seismotectonic and geomorphic setting of the site. The expected magnitude of hydrologic impacts greatly influences the type of stabilization used at UMTRA Project sites. Impacts from watershed runoff, flooding from nearby streams, surface water quality impacts, aquifer parameters, depth to ground water, direction of ground water flow, and potential impacts of tailings seepage on ground water quality (including compliance with EPA ground water standards) can necessitate relocation of the pile within the site boundaries or to an alternative site. For SIP or SOS options, greater restrictions apply with regard to improving surface water drainage conditions.

Public sentiment is considered when selecting a disposal site location. In some cases, SOS met all of the technical disposal site selection criteria, but the public preferred an alternative site. While this option may be considered, implementation is dependent on locating a suitable alternative site and associated cost benefits.

Point of Compliance Monitor Wells

To ensure compliance with EPA ground water standards, point of compliance monitoring wells are established at the hydraulical downgradient edge of the disposal cell (***Figure 3-3***). Selecting the point of compliance location demonstrates early detection of any hazardous constituents released into the ground water zone.

Background monitoring wells are established upgradient from the disposal cell, although wells sufficiently downgradient or crossgradient may be used (***Figure 3-3***).

ENVIRONMENTAL STANDARDS AND GUIDELINES

As part of data analysis, Project personnel compare the data with established standards and guidelines. These standards and guidelines have been developed by numerous national and international scientific and government groups, including the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), the EPA, and the DOE.

These groups studied the effects of radioactive and nonradioactive materials as they move through many environmental pathways toward people. From this information, standards and guidelines were established to ensure protection of people in the surrounding area and the environment.

DOE Orders are standards that the DOE adopts upon the recommendation of highly qualified groups of experts (such as the ICRP). Once published as a DOE Order, those recommendations become limits that DOE facilities must meet. For example, DOE

Order 5400.5, *Radiation Protection of the Public and the Environment*, defines the guidelines for public exposure to radiation, based upon recommendations of the ICRP. Almost all countries with nuclear programs have adopted the ICRP-recommended guidelines, which provide a scientific basis for radiological protection and the selection of dose limits. Once the DOE publishes a standard in a DOE Order, each DOE site must meet the limits established in that Order.

DOE Order 5400.5 also establishes guidelines for concentrations of radionuclides in air emissions and in liquid effluent. These concentrations, called derived concentration guidelines, are initial screening levels that enable Project personnel to review and interpret emissions and effluent data.

The EPA has established ground water protection cleanup standards to prevent and correct ground water contamination at DOE UMTRA Project sites. These standards, promulgated in 40 CFR Part 192, are referred to as maximum concentration limits, (*Table 3-1*). UMTRA Project personnel compare ground water monitoring data with the established standards to assess regulatory compliance and to support site characterization, ground water compliance strategies, and remedial action strategies.

In cases where ground water protection standards have not been established, ground water data may be compared with naturally occurring background concentrations at a given UMTRA site or may be compared with the secondary drinking water standards promulgated in 40 CFR Part 143.3. Although the UMTRA Project is not required to comply with secondary drinking water standards as cleanup criteria, the standards are sometimes used in data comparison studies as reference criteria or benchmark indicators.

RADIATION FUNDAMENTALS

Radioactivity and Radiation

There are many kinds of radiation. Sound is a familiar form of radiation, and various types of electromagnetic radiation, such as radio and television transmission signals, are all around us. Suntans result from ultraviolet radiation, and infrared radiation is a form of heat energy.

But when people hear the word radiation, they often think of nuclear weapons, nuclear power, and radioactivity. The energy in this kind of radiation can cause changes in atoms, creating the electrically charged atoms we call ions. Radiation that produces ions is called ionizing radiation. Life evolved in an environment filled with ionizing radiation, but unlike heat and light, this radiation is undetectable to our senses.

Table 3-1 EPA maximum concentration limits for ground water protection

Constituent concentration	Maximum[a]
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Endrin	0.0002
Lead	0.05
Lindane	0.004
Mercury	0.002
Methoxychlor	0.1
Selenium	0.01
Silver	0.05
Toxaphene	0.005
Nitrate (as N)	10.0
Molybdenum	0.1
Combined radium-226 and radium-228	5 pCi/L
Combined uranium-234 and uranium-238	30 pCi/L
Gross alpha-particle activity (excluding radon and uranium)	15 pCi/L
2,4-Dichlorophenoxyacetic acid	0.1
2,4,5-Trichlorophenoxypropionic acid	0.01

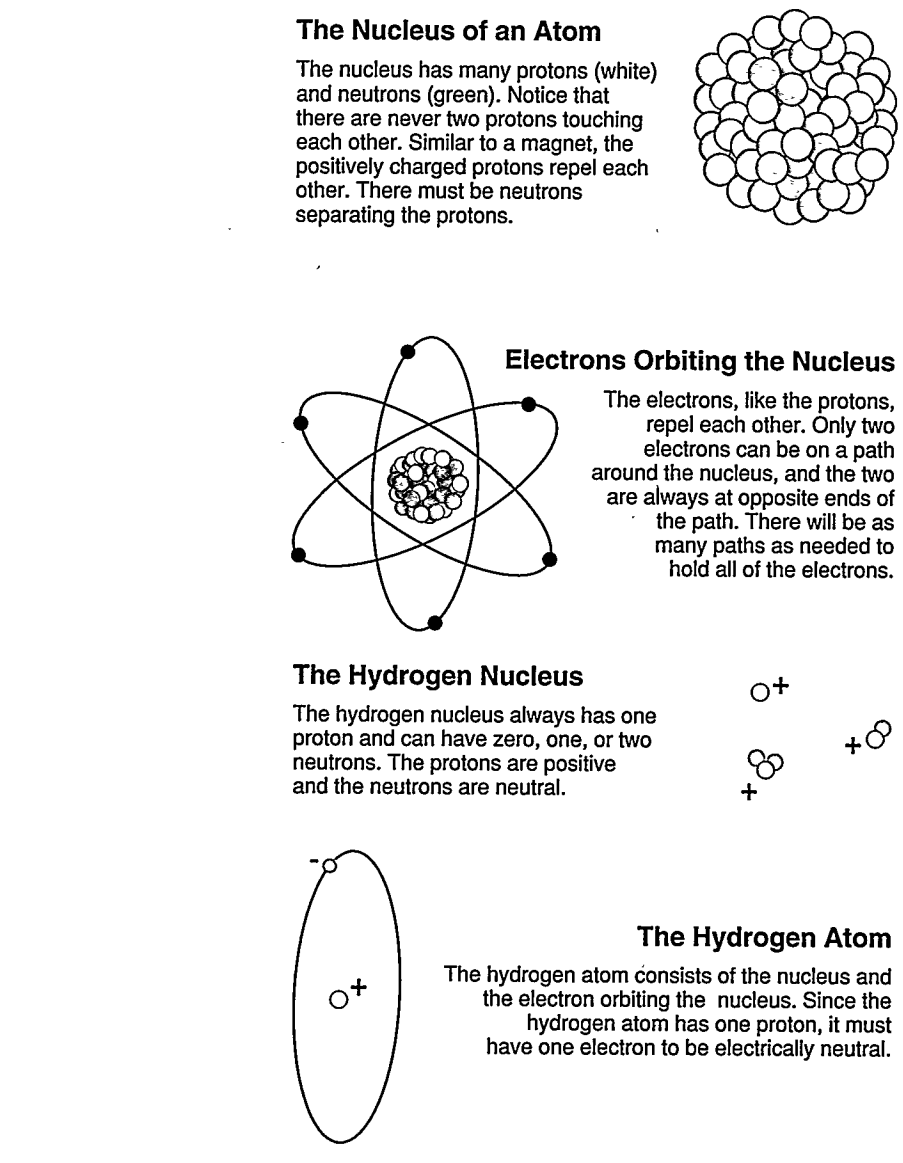
[a]Milligrams per liter, unless stated otherwise.

Special instruments allow us to detect and measure radiation. A familiar example is the Geiger counter, which produces audible clicks that get faster as the radiation intensity increases.

Ionizing Radiation

The forces in ionizing radiation are revealed upon examining the atom (***Figure 3-4***). A single human hair is a million times thicker than an atom. But small as it is, an atom is made up of even smaller particles. Particles called protons have a positive charge, while electrons have an equal negative charge. A third particle, called a neutron, has no charge. At the center of a helium atom (a good example because of its simple structure) is a nucleus formed by two protons and two neutrons. Two electrons orbit this nucleus. The balance of positive and negative charges, equal in strength, makes the atom neutral.

Figure 3-4
Structure of the Atom



ASER95/RAD/STRUCTRATOM

The number of protons in the nucleus determines the atom's element. Everything in our world and the universe beyond is made up of atoms-atoms that form a family of more than 90 different elements. All atoms of a given element have the same number of protons, but the number of neutrons can vary. Atoms with the same number of protons in their nuclei, but with varying numbers of neutrons, are called isotopes. Nearly all the elements have two or more isotopes.

Radioisotopes

Most atoms are stable isotopes; the balance of protons and neutrons is such that these atoms never change. But some isotopes are unstable, such as uranium-238, a primary component of uranium ore. To achieve stability, these atoms release energy from the nucleus in the form of alpha, beta, or gamma radiation. Unstable atoms that emit this radiation are called radioactive isotopes or radioisotopes. They also are known as radionuclides.

Since radioisotopes are unstable, they continue to release energy until they finally become stable and, therefore, nonradioactive. This process is called radioactive decay. Radioisotopes that have completed this radioactive decay process are called decay products. The decay product may also be unstable and emit further radiation. For example, radium-226, a component of mill tailings, decays to radon-222, which subsequently decays through another series of short-lived decay products This chain continues until a stable isotope is produced. This decay happens quickly with some radioisotopes, but others take a very long time. In the case of uranium-238, when the process has finally ended after a long series of decay products and billions of years, the uranium atoms will be transformed into lead (***Table 3-2***).

Half-life

The term half-life refers to the time it takes for half the radioactive atoms of a certain type to decay. For example, the half-life of radon-222 is about 4 days. Given a certain quantity of radon, only half the radioactive atoms will remain unchanged after that length of time. After another 4 days, only half of that number will remain, and so forth until nearly all the atoms have decayed.

Alpha Particles

Alpha particles consist of two protons and two neutrons, which makes them relatively large. They have a positive charge. Because they are charged, alpha particles interact with other atoms by scattering off other charged particles, thus losing their energy. Moreover, because of their large size, alpha particles do not travel very far when emitted (1 to 8 centimeters in air). They are unable to penetrate any solid material, such as paper or skin, to any significant depth (***Figure 3-5***).

However, when alpha particles are released inside the body, they deposit all their energy in a very small volume and can damage soft internal tissues. Uranium decays by emitting alpha particles. If uranium particles were inhaled or swallowed, the emitted alpha particles could damage internal tissue. At a typical UMTRA site, the radionuclides that decay by emitting alpha particles include uranium-238, thorium-230, radium-226, and radon-222.

Beta Particles

Beta particles are electrons that carry a negative electrical charge. They are much smaller than alpha particles and travel at nearly the speed of

Table 3-2 Nuclides of the uranium decay chain

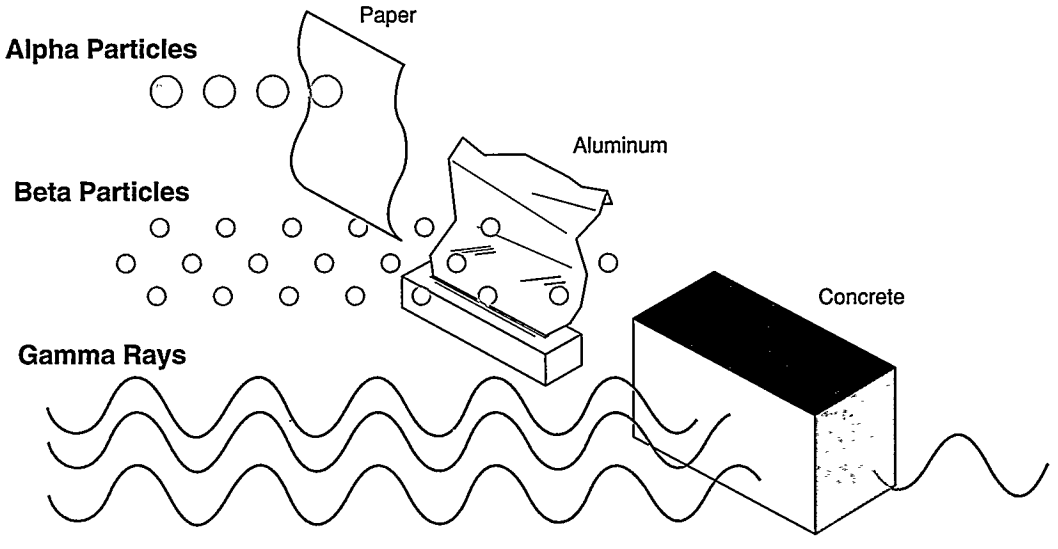
Isotope	Half-life	Radiation
Uranium-238	4,500,000,000 years	alpha
Thorium-234	24 days	beta, gamma
Protactinium-234m	1.2 minutes	beta, gamma
Uranium-234	250,000 years	alpha, gamma
Thorium-230	80,000 years	alpha, gamma
Radium-226	1,622 years	alpha, gamma
Radon-222	3.8 days	alpha
Polonium-218	3.05 minutes	alpha
Lead-214	26.8 minutes	beta, gamma
Astatine-218	2.0 seconds	alpha
Bismuth-214	19.7 minutes	beta, gamma
Polonium-214	0.000164 second	alpha, gamma
Thallium-210	1.3 minutes	beta, gamma
Lead-210	22 years	beta, gamma
Bismuth-210	5.0 days	beta
Polonium-210	138 days	alpha, gamma
Thallium-206	4.2 minutes	beta
Lead-206	stable	none

light; thus, they can travel approximately 6 to 12 feet (ft) in air and may penetrate solid materials. Beta particles may be attenuated by a thin piece of metal. Beta particles interact with other atoms in ways similar to alpha particles, but because they are smaller, faster, and have less charge, beta particles cause less concentrated damage when interacting with tissue. Thorium-234, a decay product of uranium-238, emits beta particles.

Gamma Rays

Gamma rays are electromagnetic energy that behave as though they were particles. These gamma rays emit photons. They are similar to visible light, but have a much higher energy. Compared to x-rays, a type of high-energy electromagnetic radiation that can damage the body with excessive exposure, gamma rays are generally more energetic. They can travel long distances and penetrate skin and internal body organs. Depending on their energy, gamma rays also can penetrate solid materials like concrete or steel. Gamma rays often are released during radioactive decay along with alpha and beta particles. Lead-214

Figure 3-5
Types of Ionizing Radiation



ASER95/RAD/IONRAD

and bismuth-214 are gamma-emitting radioisotopes belonging to the radon decay chain typical of mill tailings at UMTRA sites.

UNITS OF MEASUREMENT

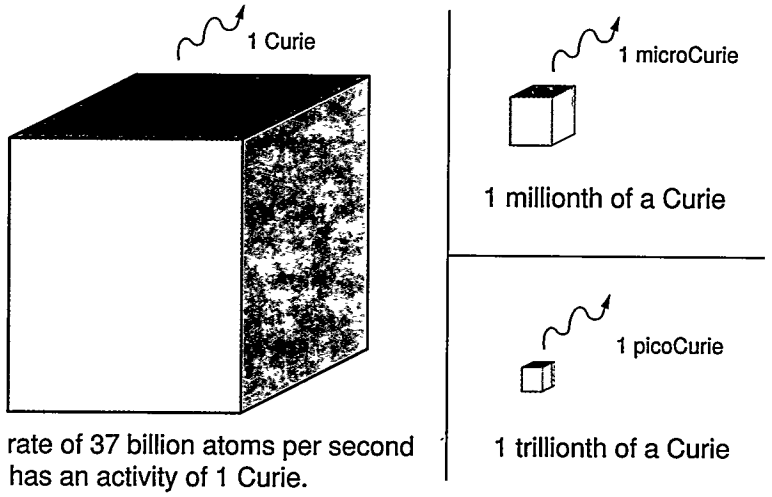
Scientists have developed methods to measure radiation levels and chemical constituents. Data are presented in units of measure specific to the matrix or constituent of concern.

Radiological

The curie is the basic unit used to describe the amount of radioactivity present. One curie is equivalent to 37 billion disintegrations per second; a curie also can be the specific quantity of a given radionuclide that decays at a rate of 37 billion disintegrations per second. ***Figure 3-6*** shows the curie and its relationship to the microcurie (μCi), which is one-millionth of a curie, and the picocurie (pCi), which is one-trillionth of a curie. Radioactive concentrations are expressed in fractions of curies per unit mass or volume.

Two commonly used units of measure quantify levels of radioactivity and radiation exposure in this report: microcuries per milliliter (abbreviated as μCi/mL) and millirem (or mrem). For example, radiological air particulate and radon gas data are reported in microcuries per milliliter.

Figure 3-6
Comparison of Disintegration Rate



Not to Scale

ASER95/RAD/DISINTEGR

Environmental gamma radiation measurements are reported numerically in units of radiation equivalent man (or rem). Rem is a term that relates ionizing radiation and its resultant biological effect or risk. Exposure data in this report use the unit mrem per year, which is equal to one-thousandth of a rem. A dose of 1 mrem has a biological effect roughly similar to the dose received in 1 day's exposure to natural background radiation.

Nonradiological

Surface and ground water results are usually reported in units of mass per units of volume. The term mass concentration expresses the mass of a certain contaminant (or solute) as it is contained in water (or solution). In this report, the mass concentration measured in surface water and ground water is presented in milligrams per liter (or mg/L). One milligram of solution is equivalent to one part per million, which is consistent with EPA ground water protection standards. These standards are included in all data tables listing surface water and ground water analyses results.

BACKGROUND RADIATION EXPOSURE

In everyday life, people are exposed to radiation from a variety of sources, both naturally occurring (or background) and man-made. Everyday radiation comes from such decay processes as the decay of radioactive elements in the earth's crust; the steady stream of high-energy particles from space, called cosmic radiation; radioactive isotopes that

occur naturally in the human body, like potassium-40; medical procedures; the production of man-made phosphate fertilizers (phosphates and uranium are found together in nature); or even just the operation of such household items as televisions and smoke detectors. In the United States, a person's average annual exposure to background radiation is 360 mrem. The DOE guidelines (as well as others) apply to exposures individuals receive by primary or secondary pathways and to radiation from background sources and medical procedures.

Radon

As shown in ***Figure 3-7***, radon is the biggest contributor to background radiation. At an average of 200 mrem per year, naturally occurring radon accounts for more than half of the background dose in the United States.

Background sources of radon

Radon is a radioactive gas that occurs naturally as uranium decays in soil. Trace amounts of uranium can be found in soils virtually everywhere on earth, and radon gas is always present in outdoor air. The U.S. annual average background concentration for radon gas is 0.4 to 0.7 pCi/L. However, background radon concentrations around UMTRA Project sites may be higher, on the average, due to the continued presence of uranium ore in these areas.

In addition to the radon found naturally in the environment, uranium mill tailings piles at UMTRA Project sites contain radium, which decays to radon. In compliance with the requirements of DOE Order 5400.5, the UMTRA Project environmental monitoring program has monitored radon levels at each site during active remediation. The DOE monitors all releases applicable to site-specific activities and assesses radiation exposure to the public.

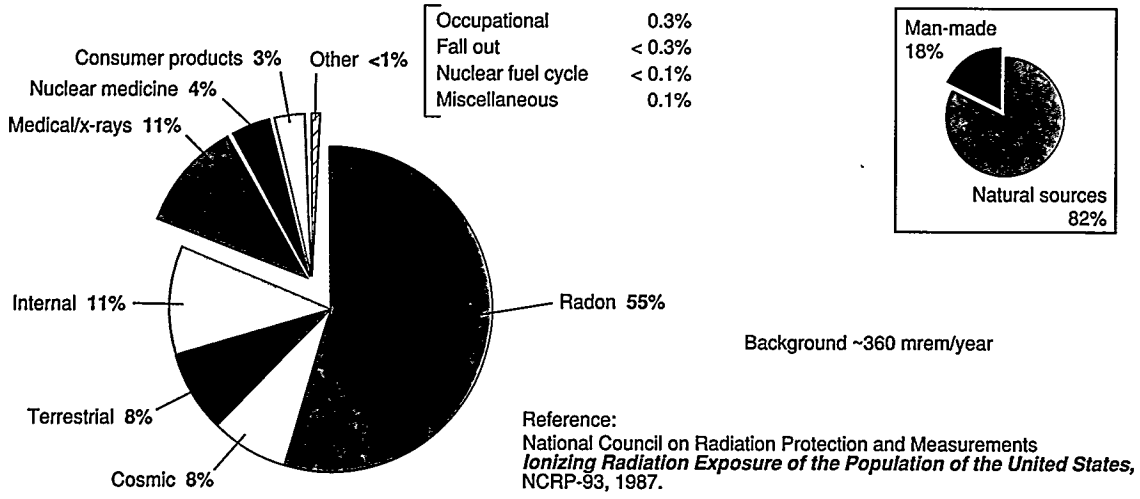
Annual Dose Assessment

In general, the background radiation dose will vary in different parts of the country. For example, a person living in the Cincinnati area for 1 year would receive an exposure of approximately 110 mrem compared with a person living in Denver, who would receive approximately 125 mrem. This difference partly can be attributed to soil composition and distance above sea level. Other factors are various, including the type of building materials people use in their homes. ***Figure 3-8*** shows the annual dose received from living in a brick or concrete house is about twice that received from living in a wood-frame house. To illustrate the sources of background radiation further, the figure shows an exposure of approximately 4 mrem from a round-trip flight from Cincinnati to London (or its equivalent).

INTRODUCTION

The following discussion addresses specific aspects of environmental monitoring methodologies used on the UMTRA Project. This section presents monitoring methodologies for air particulate, radon, surface water, ground water, and ecological sampling.

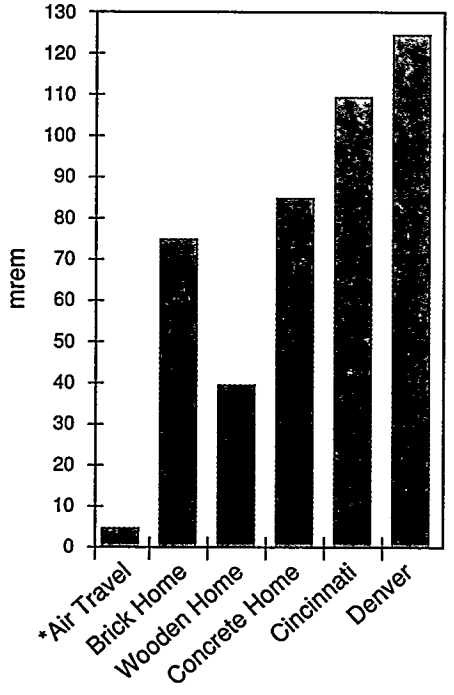
Figure 3-7
Exposure to Background Radiation



Reference:
National Council on Radiation Protection and Measurements
Ionizing Radiation Exposure of the Population of the United States,
NCRP-93, 1987.

ASER95/RAD/EXPOTORAD

Figure 3-8
Breakdown of Average U.S. Radiation Exposures



* 1 mrem for each 4,030 km (2,500 miles)

ASER95/RAD/BREAKDOWN

The UMTRA Project follows specific standard operating procedures for monitoring well installation; sample preservation and transportation; chain of custody; sample analysis; quality assurance; analytical data management and validation; air monitoring; and surface water, ground water, sediment, and soil sampling. These procedures are reviewed annually and updated to reflect changes in industry standards, best management practices, state and local protocols, and DOE or applicable EPA guidance. These procedures were developed specifically for the UMTRA Project and are consistent or compatible with applicable EPA regulations, American Public Health Association Standards, similar DOE programs, and relevant industry standards.

AIR PARTICULATE MONITORING

The UMTRA Project monitors the air for any pollutants carried from sites as particulate distribution in the environment. The primary sources of these air pollutants are fugitive dust and radionuclide particulates from construction, remediation activities, and wind erosion.

Releases of nonradiological and radiological airborne materials are monitored throughout the remedial action at the UMTRA Project sites. Radiological air monitoring demonstrates the effectiveness of remedial action (by comparing airborne radioactivity levels before and after remedial action) and provides the public information regarding radioactive concentrations in the surrounding environment. To ensure radioactive airborne particulate concentrations well below regulatory limits, monitoring results are compared with the derived concentration guidelines in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

Nonradiological Air Particulate Monitoring

When required by state regulations, total suspended particulate samples are collected to monitor nonradiological airborne particulate concentrations. Sampling locations and frequencies must follow site-specific protocols developed in accordance with state guidelines and UMTRA Project standard operating procedures.

Calibrated, high-flow air sampling pumps and glass-fiber filters collect air particulate samples. The sample filters are sent to a contract laboratory and analyzed in accordance with the laboratory's standard operating procedures, which meet or exceed industry standards. In addition to total suspended particulates, the filters are analyzed for lead, arsenic, and vanadium constituents, the most common contaminants resulting from former processing activities.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at UMTRA Project sites follows a comprehensive sampling strategy. Sampling locations for the monitoring stations are based on wind direction, population

distribution, and the availability of electrical power for the sampling pumps. Calibrated, low-flow air sampling pumps and glass-fiber filter sampling media collect air particulate samples pursuant to UMTRA Project standard operating procedures. Sampling is continuous, starting 1 month before remedial action and ending 1 month after placement of the radon barrier. Individual samples are accumulated for 3 to 4 days.

Sampling results are compared with the derived concentration guidelines in DOE Order 5400.5 to determine whether environmental concentrations are below or above guidelines, which do not include naturally occurring radionuclide (background) concentrations. The concentration guideline is 500×10^{-16} μCi/mL above background for thorium-230. Thorium-230 was chosen because it is the most restrictive of the alpha radiation concentration guidelines and is an abundant component of uranium mill tailings. In 1994, the minimum detectable activity for this sampling method was well below the concentration guideline for Class Y thorium-230.

After collection, sample filters are stored for 5 to 10 days to allow the decay of short-lived radionuclides (radon daughters). The sample filters are analyzed on the site for gross alpha activity in accordance with UMTRA Project standard operating procedures. Because on-site analytical capabilities are limited to gross alpha concentrations in air, the thorium-230 concentration is determined by multiplying the gross alpha concentration by a conversion factor. This conversion factor is a conservative ratio of the radiochemical laboratory thorium-230 concentrations to the laboratory gross alpha concentrations.

RADON MONITORING

Real-time radon gas monitors and passive radon gas monitors determine radon concentrations at the UMTRA Project sites.

Real-Time (Active) Radon Gas Monitoring

A real-time (active) radon gas monitor is a filtered air monitor that continuously measures radon gas concentrations with a zinc sulfide radon detection system. A microprocessor controls the monitor and provides printed 1- and 24-hour averages.

Radon sampling locations are selected based on wind direction, population distribution, and the availability of electrical power for the monitors. The radon gas monitors operate continuously, starting 1 month before remedial action and ending 1 month after the radon barrier is placed on the disposal cell. The radon gas monitor provides hourly and daily average radon concentrations. Radon sampling follows UMTRA Project standard operating procedures and the manufacturer's operating instructions.

The daily average radon concentrations determine a weekly average concentration. The weekly concentration is compared with the radon-222 derived concentration guideline in DOE Order 5400.5 to determine if environmental concentrations differ from 3×10^{-9} μCi/mL. The guideline value does not include naturally occurring radon or background concentrations.

Passive Radon Gas Monitoring

When a passive radon detector is exposed to radon, alpha particles from radon decay products interact with a small piece of plastic polymer film, producing microscopic tracks in the film. At the laboratory, a chemical etching process enhances these tracks. The tracks are counted under a microscope and the radon concentration is determined by calibrating the relationship between radon concentration and track density.

Radon is monitored with passive (alpha-track) detectors, following UMTRA Project standard operating procedures and the manufacturer's operating instructions. Sampling locations are based on wind direction and population distribution. During 1994, three passive radon detectors at each monitoring station were exposed for periods of approximately 3 months throughout the year. The number of passive radon detectors deployed at each sampling location and the sampling frequencies were selected to detect anomalies and reduce the overall uncertainty in the measurement. After the passive radon detectors were retrieved from the field, they were packaged and promptly sent to an approved contract laboratory for analysis.

The 3-month radon concentrations were compared with the 3×10^{-9} μCi/mL radon-222 guideline action level in DOE Order 5400.5. This guideline does not include naturally occurring radon or background concentrations.

EXTERNAL GAMMA RADIATION DOSE MONITORING

Lithium fluoride thermoluminescent dosimeters monitor gamma radiation levels. The monitoring network will indicate the effects of moving radioactive tailings materials by measuring ambient radiation levels at the site. Lithium fluoride thermoluminescent dosimeters are used for environmental monitoring on the Project due to their linear energy response to gamma radiation and their closeness to human tissue in atomic composition, and because the dose does not fade significantly over 3-month periods. The thermoluminescent dosimeters are placed in the field for 3 months and then analyzed to determine the doses at those locations. Sampling station locations are selected based on wind direction, the need for perimeter monitoring locations, and the locations of nearby residents.

Thermoluminescent dosimeters use small crystals to measure the cumulative radiation dose for the exposure period. Each environmental thermoluminescent dosimeter consists of five lithium fluoride crystals packaged in a rugged plastic container to protect the crystals from the environment. Each dosimeter simulates human tissue. This simulation measures the penetrating gamma dose to humans in the area. Because neither alpha nor beta radiation can penetrate the thermoluminescent dosimeter package, the dosimeter measures the dose equivalent from gamma radiation only. After exposure, the dosimeters are appropriately packaged and sent to a Project-approved contract laboratory for analysis.

The 3-month environmental gamma radiation data are compared with the DOE Order 5400.5 guideline of 100 millirems (mrem) per year, which does not include naturally occurring background radiation.

SURFACE WATER MONITORING

Surface water monitoring at UMTRA sites undergoing surface remediation assesses compliance with NPDES permit requirements for discharge water and radionuclide guidelines for water defined in DOE Order 5400.5. Surface water samples also are collected for site hydrogeologic studies to investigate the potential for environmental impacts due to the interaction of contaminated ground water and surface water. UMTRA guidelines for surface water are based on a contaminant's most soluble chemical form. This approach assumes that soluble chemical forms have a higher potential than insoluble chemical forms to become ingestive routes of exposure.

Discharge Water

The UMTRA Project monitors surface water discharges from the sites, when applicable, to ensure compliance with NPDES permits. Samples are collected before scheduled water discharges from retention ponds and/or water treatment facilities. Effluent discharge surface water samples also are collected from established site and vicinity sampling points to determine whether construction activities meet NPDES permit requirements.

All samples are collected, packaged, and shipped pursuant to UMTRA Project standard operating procedures. The samples are analyzed for radiological and nonradiological constituents by a Project-approved contract laboratory in accordance with the laboratory's standard operating procedures.

Surface Water Assessments

Surface water samples routinely are collected upstream and downstream from a site to assess the potential environmental impact of remedial action activities. The samples are analyzed for total concentrations of radium-226 and thorium-230.

Surface water samples also are collected upstream, downstream, and adjacent to the site to establish baseline surface water quality for hydrological assessments and to evaluate the potential for contaminated runoff and ground water to affect surface water quality. Surface samples from rivers and streams sometimes are collected at the low-water stage to maximize the potential of detecting adverse impacts from contaminated ground water. The samples are analyzed for radiological and nonradiological constituents.

All samples are collected, packaged, and shipped pursuant to Project standard operating procedures. A Project-approved contract laboratory performs all analyses in accordance with the laboratory's standard operating procedures. The results are compared with the appropriate EPA standards and DOE guidelines for surface water assessments and regulatory compliance.

GROUND WATER MONITORING

Ground water monitoring at UMTRA Project sites supports site characterization, development of ground water compliance strategies and remedial action strategies, and evaluation of remedial action effectiveness. Ground water monitoring results are used for site baseline risk assessments, site characterization, compliance with ground water cleanup standards, disposal site compliance, and evaluation of the magnitude and extent of ground water contamination among other purposes. The UMTRA ground water sampling program is conducted in accordance with Project standard operating procedures that comply with applicable DOE guidance and industry standards.

Site Characterization

Site characterization of ground water is performed to provide physical and chemical data for disposal cell design; to assess the potential for discharge to surface water; to determine the presence and movement of ground water, the nature and extent of ground water contamination, and background ground water quality; and to predict any potential effects of surface remedial actions on ground water. These data typically are collected from ground water monitoring wells before, during, and after surface remediation.

Each site's ground water monitoring program begins during site characterization and continues through surface remediation and ground water restoration. The ground water monitoring program for disposal cells (included in the formal, long-term surveillance plan after construction) is complete. Sampling frequency is determined by site-specific factors such as ground water flow rate, seasonal variations in ground water quality and quantity, and potential risks to human health and the environment. Ground water samples are analyzed for physical and chemical parameters determined on a site-specific basis.

Ground Water Protection

The DOE has proposed a site-specific strategy for ground water protection at each UMTRA disposal site. These strategies must meet EPA ground water protection standards (40 CFR Part 192) that stipulate the following criteria at each site:

- All contaminants must be identified.
- A list of concentration limits for those contaminants must be proposed.
- A point of compliance must be established.

At the Canonsburg, Shiprock, and Salt Lake City sites, the disposal cell design was based on 1985 standards. The design has proven to be protective of ground water; therefore, no specific written ground water protection strategy is required.

The list of hazardous constituents is based on the residual radioactive material composition and the process chemicals still in the tailings. Proposed concentration limits are based on each constituent's background concentration, regulated maximum concentration limit, or alternate concentration limit, or on supplemental standards. The disposal cell point of compliance is that portion of the uppermost aquifer immediately downgradient of the disposal cell. Point of compliance monitoring wells are installed as close to the disposal cell as is practical to provide access for monitoring ground water quality.

Additional ground water monitoring is required to characterize the uranium processing sites further during the UMTRA Ground Water Project. During this project, the DOE must demonstrate the adequacy of proposed ground water cleanup actions at the processing sites to bring ground water quality into compliance with 40 CFR Part 192, Subpart B.

Baseline Risk Assessments

Ground water monitoring also supports the development of site-specific baseline risk assessments, which examine the potential effects of ground water contamination on public health and the environment at the former processing sites.

ECOLOGICAL ASSESSMENT

Ecological assessments provide site-specific ecological data and information at UMTRA Project sites. These data are collected in enough detail to perform an impact assessment, if necessary. Information collected for the ecological assessment identifies areas that may need study during or after the baseline risk assessment.

Upland Vegetation

Upland vegetation sampling is qualitative or quantitative, depending on site-specific factors. A qualitative description of the vegetation, including major plant communities and common plants within each community type, often is adequate to support impact assessments and mitigation monitoring requirements.

Quantitative vegetation analysis typically occurs in areas that could be directly or indirectly disturbed during surface remedial activities. The types of data collected may include vegetation density, percent of vegetation cover, species importance values, number of acres of each plant community type, and a plant community map. The level of detail for such quantitative studies varies from site to site, depending on the sensitivity of the plant communities affected and/or whether sensitive wildlife species occur in these plant community types.

Wetland Vegetation

Wetlands boundaries are delineated based on specific criteria and following the methods established in the *Corps of Engineers Wetlands Delineation Manual* (USACE, 1987). The UMTRA Project uses this manual in all wetland evaluations. The wetlands are mapped according to plant community type; plant species composition and use by wildlife are determined. The U.S. Army Corps of Engineers field-checks wetland delineations when appropriate.

Nonthreatened and Nonendangered Wildlife

The presence of wildlife at the UMTRA Project sites is described qualitatively or quantitatively, depending on site-specific factors. At sites with little or no disturbance, wildlife is described qualitatively. This level of characterization notes common wildlife species in the area, including game species. At sites with greater land disturbance and/or sites where important species such as game may be disturbed, more detailed data may be required. The level of detail for collecting quantitative wildlife data is determined on a site-by-site basis. A qualified biologist conducts any required surveys.

Threatened and Endangered Species

The consideration of threatened and endangered species and other species of concern must be consistent with the requirements of the Endangered Species Act of 1973 (16 USC §1531 *et seq.*). Informal consultation with the U.S. Fish and Wildlife Service will determine whether threatened or endangered species occur at a given site. A biological assessment is prepared if a proposed action could affect a threatened or endangered species. The U.S. Fish and Wildlife Service responds to this assessment with a biological opinion. That opinion may agree with the biological assessment findings, suggest additional studies, or require additional mitigation measures. Field studies to assess the status of a particular species are conducted consistently with required and/or scientifically accepted methods. A biologist familiar with the species under consideration conducts all surveys.

REFERENCES

USACE (U.S. Army Corps of Engineers), 1987. *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, prepared by the Environmental Laboratory, Vicksburg, Mississippi, for the Department of the Army, Washington, D.C.

Code of Federal Regulations

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

DOE Orders

Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

United States Code

16 USC §1531 *et seq.*, *Endangered Species Act of 1973.*

UMTRA PROJECT

CHAPTER 4
QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Accurate data are essential to all environmental sampling and analysis programs. The DOE developed the *UMTRA Project Office Quality Assurance Program Plan* (DOE, 1994) and the UMTRA Project *Environmental Monitoring Plan* (DOE, 1992) to establish quality assurance policies and guidelines for all environmental monitoring activities on the UMTRA Project. The quality assurance program is based on DOE Order 5700.6C, *Quality Assurance,* or applicable sections of 10 CFR 830.120. These plans are supported by standard operating procedures and other documents that specify how environmental sampling and analysis will be conducted. Following these standard operating procedures ensures consistency between programs and ensures the use of EPA, DOE, or industry-approved practices for conducting environmental sampling and analysis. Quality assurance protocols provide the guidelines needed to monitor the performance of these standard operating procedures in a controlled and consistent manner.

DATA QUALITY OBJECTIVES

The data quality objective process begins before samples are collected. This process provides a means for decision makers and the technical team to define the level of quality needed. Regulatory, quality assurance, and technical requirements and objectives are identified and sampling and analysis plans are completed prior to sample collection to ensure effective use of Project resources.

REMEDIAL ACTION CONTRACTOR QUALITY ASSURANCE

The Remedial Action Contractor supports the DOE UMTRA Project by managing surface remedial action at UMTRA Project sites. The Remedial Action Contractor Quality Assurance Department oversees and implements environmental monitoring for environmental gamma radiation, airborne radionuclides, waterborne radionuclides, and fugitive dust. Environmental sampling starts 1 month before the beginning of remediation and ends 1 month after the first layer of the radon barrier is placed on the disposal cell. This schedule does not apply to fugitive dust monitoring, which is conducted only during initial remedial action activities.

The site health physics manager implements the radiological environmental monitoring quality assurance program. Trained, qualified health physics personnel perform environmental radiological monitoring in accordance with site-specific health physics monitoring plans and applicable procedures. The site industrial hygienist directs nonradiological environmental monitoring. Groups comprised of DOE representatives and contractors periodically audit the Remedial Action Contractor environmental monitoring program.

Environmental Gamma Radiation

Environmental gamma radiation is monitored with environmental thermoluminescent dosimeters. Site-specific health physics monitoring plans determine the locations of the dosimeters.

A vendor approved by the Remedial Action Contractor Quality Assurance Department provides environmental thermoluminescent dosimeters. The vendor is accredited under the National Voluntary Laboratory Accreditation Program; both the Remedial Action Contractor and the vendor are accredited under the DOE Laboratory Accreditation Program for personnel dosimetry systems. The vendor calibrates the dosimeters using a National Institute of Standards and Technology (NIST)-certified cesium-137 standard.

Vendor analysis reports are sent to the site health physics manager and the Remedial Action Contractor Albuquerque Project Office. Anomalous data are identified and investigated during the review process. The monitoring data are then summarized and incorporated into this report.

Real-Time (Active) Radon Monitoring

On-site radon gas monitors operate continuously, recording an hourly average and a 24-hour average radon concentration. Site-specific health physics monitoring plans determine the locations of the monitors.

A DOE-approved vendor calibrates radon gas monitors, annually and after any repairs, using a NIST-traceable liquid radium-226 standard. Monthly instrument background measurements are used to track potential radon progeny buildup and/or potential radioactive particulate contamination during remedial action activities. These background measurements are a function of the instrumentation only and are not indicative of the ambient radon background concentration for any given site. To conduct the instrument background measurement, the radon gas monitor operates in a closed-loop configuration with an activated charcoal cartridge in the loop. A routine check log maintains functional information for each monitor. The site health physics manager reviews these logs.

When monthly average radon concentrations are compared to time and graphed, the graph reveals trends; trend analysis reveals instrument problems or significant changes in the radon concentrations.

Passive Radon Monitoring

Radon is also monitored with passive radon detectors. The passive radon detectors are placed beside radon gas monitors and at additional locations indicated in the site-specific health physics monitoring plans. An approved vendor provides the passive radon detectors.

Each quarter, passive radon detectors are placed around the site. The exposed detectors are shipped to the vendor in a foil pouch to protect the sensitive material from inadvertent exposure. Two detectors remain in their foil pouches for the entire quarter as quality control detectors.

Radioactive Airborne Particulate Monitoring

Radioactive airborne particulate concentrations are monitored by collecting particulate samples with a calibrated air sampling pump and then counting the samples for gross alpha radiation at the on-site laboratory. Site-specific health physics monitoring plans determine the locations of air particulate monitoring stations.

When in use, the on-site counting systems are calibrated daily when in use with a NIST-traceable thorium-230 standard. Background checks and minimum detectable activity calculations are performed daily when the system is in use.

The EPA certifies vendors every 3 years, after extensive quality assurance audits of their analysis procedures and operations. Subcontract laboratories are enrolled in the EPA laboratory intercomparison studies program, conducted by the EPA Environmental Monitoring Systems Laboratory. Those laboratories participate in the DOE Laboratory Quality Assurance Program conducted by the DOE Environmental Measurements Laboratory.

Periodically, a composite of each station's air particulate samples is sent to a subcontract laboratory for gross alpha, radium-226, and thorium-230 analysis. Each set of radiological analyses is accompanied by 10-percent duplicate splits, 1-percent known standards, and 1-percent blanks. The acceptance criterion for the standards and blanks is 10 percent of the known values. Efficiencies and yields for all radionuclides analyzed are obtained using NIST-traceable standard.

At the Remedial Action Contractor Albuquerque Project Office, the data are reviewed and discrepancies are resolved. A computer program checks for math errors. Data are graphed monthly and forwarded to the sites. The Remedial Action Contractor Albuquerque Project Office health physics personnel and the site health physics manager review the graphs for trends. At the end of the year, the data are summarized and incorporated into this report.

Surface Water Radionuclide Monitoring

Radionuclides in surface water are monitored by collecting quarterly surface water samples, pursuant to Project standard operating procedures, from natural water courses in the site vicinity and sending them to an approved vendor for analysis. The monitoring determines whether remedial action activities are releasing radionuclides into nearby surface water. Surface water samples also are collected during storms at locations where water could run off the site. The water samples are analyzed for thorium-230 and radium-226. The site health physics manager designates routine and storm runoff water sampling locations.

A subcontract laboratory conducts analyses for the Remedial Action Contractor surface water sampling program. Internally, each data set is accompanied by 10-percent duplicate splits, or a minimum of one duplicate per data set. In addition, 1-percent blanks and known standards, or a minimum of one blank and one standard per data set, are required. The acceptance criterion for the standards and blanks is 10 percent of the known values. The subcontract laboratory participates in the EPA Region VIII certification program for radiochemical analysis in water and was certified in 1993 to analyze for radium-226 under SDWA (42 USC §300f *et seq.*). Efficiencies and yields for all radionuclides analyzed are obtained from NIST-traceable standard reference material. Analysis reports are sent to the site and the Remedial Action Contractor Albuquerque Project Office.

At the Remedial Action Contractor Albuquerque Project Office, water sample results are reviewed and discrepancies resolved. The data are summarized at the end of the year and incorporated into this report.

Water Discharge Monitoring

Radionuclides in surface water are monitored by collecting surface water samples from water discharge points in the site vicinity and sending them to an approved vendor for analysis. Monitoring determines whether construction activities meet NPDES permit requirements. Engineering or safety personnel collect the samples before water discharge. Samples and chain-of-custody documentation are sent to the approved vendor for analysis. Chemical analysis also follows specific city permit requirements, as needed. All samples are collected pursuant to Project standard operating procedures.

The subcontract laboratory conducts the analysis for the Remedial Action Contractor discharge water sampling program and provides sample containers and preservatives. The laboratory participates in the EPA Region VIII certification program for radiochemical analysis in water. Efficiencies and yields for all analytes are obtained using NIST-traceable or other verifiable sources.

Laboratory Cross-Check Radiological Data

The Remedial Action Contractor site laboratories do not participate in the EPA and DOE laboratory intercomparison programs because the programs do not routinely analyze the same matrixes and/or analyte samples as the site laboratories. The vendor laboratory participated in the EPA program several times during 1994; except for natural uranium in the April tests, all results were within the appropriate control limits (***Tables 4-1 through 4-3***). The vendor laboratory participated in the DOE intercomparison programs in July 1994 and January 1995. ***Tables 4-4, 4-5, and 4-6*** provide the results of the DOE Laboratory Quality Assurance Program.

Table 4-1 Water evaluation intercomparison study

Date	Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
February	U-Nat	10.1	4.9	15.3	9.64	8.10	0.00
February	Radium-226	19.9	14.7	25.1	19.39	19.27	1.62
February	Radium-228	14.7	8.3	21.1	14.09	13.60	0.70
January	Gross alpha	15.0	6.3	23.7	13.75	12.33	0.58
January	Gross beta	62.2	44.7	79.3	56.14	54.7	1.53
June	Radium-226	15.0	11.0	19.0	14.95	18.40	2.17
June	Radium-228	15.4	8.6	22.2	15.39	15.57	1.42
June	U-Nat	52.6	43.4	61.8	51.08	48.30	0.02
July	Gross alpha	32.0	18.1	45.9	29.74	31.00	4.36
July	Gross beta	10.0	1.3	18.7	14.91	12.00	1.00

Note: Results of analyses by EPA Environmental Monitoring Systems Laboratory. Results reported in (E-9) microcuries per milliliter.

U-Nat – Uranium in natural isotopic abundance

Table 4-2 Air filter evaluation intercomparison study

Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
Gross alpha	35.0	19.4	50.6	36.89	40.33	2.08
Gross beta	56.0	38.7	73.3	59.08	63.33	1.53

Note: Results of analyses by EPA Environmental Monitoring Systems Laboratory. Results reported in (E-6) microcuries per filter.

Table 4-3 Water performance evaluation intercomparison study

Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
Gross alpha	86.0	47.8	124.2	84.40	69.00	7.21
Radium-226	20.0	14.8	25.2	19.72	18.67	2.25
Radium-228	20.1	11.4	28.8	20.07	20.77	1.25
U-Nat	25.0	19.8	30.2	24.39	18.97	0.12

Note: Results of analyses by EPA Environmental Monitoring Systems Laboratory. Results reported in (E-9) microcuries per milliliter.

U-Nat – Uranium in natural isotopic abundance

Table 4-4 Soil evaluation intercomparison study, quality assurance program

Date	Isotope	Reported value	EML value	Reported/EML
January 1994	U-Nat	.027 ± .054	.053	0.51 ± 0.02
July 1994	U-Nat	1.61 ± .13	1.47	1.10 ± 0.18
January 1995	U-Nat	1.62 ± 0.0	1.81	0.90 ± 0.04

Note: Results of analyses by DOE Environmental Measurements Laboratory. Results reported in picocuries per gram.

EML – Environmental Measurements Laboratory
U-Nat – Uranium in natural isotopic abundance

Table 4-5 Air evaluation intercomparison study, quality assurance program

Date	Isotope	Reported value	EML value	Reported/EML
January 1994	U-Nat	15.2 ± 0.0	14.6	1.04 ± 0.05
July 1994	U-Nat	1.11 ± 0.1	1.08	1.02 ± 0.10
January 1995	U-Nat	0.64 ± 0.0	0.62	1.02 ± 0.04

Note: Results of analyses by DOE Environmental Measurements Laboratory. Results reported in (E-5) microcuries per filter.

EML – Environmental Measurements Laboratory
U-Nat – Uranium in natural isotopic abundance

Table 4-6 Water evaluation intercomparison study, quality assurance program

Date	Isotope	Reported value	EML value	Reported/EML
January 1994	U-234	2.70 ± 0.03	2.87	0.94 ± 0.05
	U-238	2.70 ± 0.03	2.92	0.93 ± 0.03
	U-Nat	0.225 ± 0.0	0.228	0.99 ± 0.04
July 1994	U-234	1.37 ± 0.14	1.41	0.98 ± 0.11
	U-238	1.34 ± 0.14	1.43	0.94 ± 0.11
	U-Nat	2.68 ± 0.24	2.84	0.94 ± 0.10
January 1995	U-234	2.97 ± 1.08	3.00	0.99 ± 0.36
	U-238	2.70 ± 1.08	3.00	0.90 ± 0.36
	U-Nat	0.081 ± 0.001	0.089	0.91 ± 0.02
	U-Nat	0.079 ± 0.0	0.089	0.89 ± 0.02

Note: Results of analyses by DOE Environmental Measurements Laboratory. Results reported in (E-8) microcuries per milliliter, except for U-Nat in the Jan. 1995 test, which is reported in micrograms per milliliter.

U-Nat – Uranium in natural isotopic abundance

TECHNICAL ASSISTANCE CONTRACTOR QUALITY ASSURANCE

The Technical Assistance Contractor supports the DOE UMTRA Project through technical services, planning, and strategy development. The Technical Assistance Contractor has a separate Quality Assurance department that oversees implementation of the quality assurance protocols for environmental monitoring. Systems audits are conducted for all aspects of Technical Assistance Contractor environmental monitoring activities, and corrective action plans are developed and implemented when deficiencies are identified.

Technical Assistance Contractor Monitoring Methodologies

The UMTRA Project Technical Assistance Contractor has specified or established standard operating procedures or statements of work for the following activities:

- Installing and developing monitoring wells.
- Sampling surface and ground water, sediments, and soil.
- Preserving and transporting samples.
- Conducting field analyses.
- Maintaining proper chain-of-custody control.
- Performing laboratory analyses.
- Adhering to quality assurance protocols.
- Validating and managing analytical data.

All routine work is conducted in accordance with these standard operating procedures and statements of work, which are reviewed annually and updated (as appropriate) to reflect changes in industry standards, best management practices, and DOE or EPA guidance.

Sampling Procedures

Water samples are collected from monitor wells, domestic wells, and surface locations according to the standard operating procedures developed by the UMTRA Project Technical Assistance Contractor. These Technical Assistance Contractor standard operating procedures for sampling are the same as or compatible with DOE Hazardous Waste Remedial Action Program (DOE, 1990a), EPA, and other industry standard procedures.

Analytical Methods

All UMTRA Project Technical Assistance Contractor subcontract laboratories are required to perform analyses using EPA Contract Laboratory Program statement of work methods, EPA SW-846 analytical methods, American Public Health Association analytical methods, and other approved procedures, all of which are adapted to the specific laboratory environment and maintained as controlled documents.

Technical Assistance Contractor analytical chemists have chosen analytical methods, quality control criteria, and quality assurance protocols from EPA, DOE, American Public Health Association, and other guidance documents for analytical chemistry to meet the needs of

the UMTRA Project cost effectively. For example, Technical Assistance Contractor subcontract laboratories are required to maintain the full range of supporting documentation required by the EPA Contract Laboratory Program for Level D quality data. However, the laboratories need only provide the minimum documentation required for Level C data validation in routine deliverables. This means that Technical Assistance Contractor analytical costs are reduced because laboratory staff members need not reproduce and deliver several hundred additional pages for each report. This practice also significantly reduces Technical Assistance Contractor data reviewer costs.

Analytical Quality Control

Analyses performed by the subcontract laboratories consist of concentration or activity determinations for test parameters in water and soil samples. The type and frequency of quality control analyses are specified in the EPA Contract Laboratory Program Statement of Work. Although the specifications in the EPA Contract Laboratory Program Statement of Work are not regulatory requirements for the UMTRA Project, they are used because they reflect what have become standard industry practices in environmental analysis. Not all of the analytes of interest to the UMTRA Project are addressed in the Contract Laboratory Program Statement of Work; even so, the Contract Laboratory Program quality control practices have been extended to UMTRA Project analytes as a best management practice, where possible.

Analytical Quality Assurance

The UMTRA Project Technical Assistance Contractor follows a rigorous subcontract analytical laboratory selection process that includes technical proposal evaluations, analysis of prequalification samples, and prequalification systems audits. After subcontract awards, laboratories must submit to annual systems audits and analyze quarterly performance evaluation samples prepared specifically for the UMTRA Project Technical Assistance Contractor.

In addition, Technical Assistance Contractor data management procedures require semiannual data package assessments be conducted at each subcontract laboratory. These on-site validation activities perform two functions. They ensure that the complete analysis documentation needed for technical and legal defense of the data is maintained at the laboratory, and they provide a vehicle for verification of contract compliance.

To comply with the DOE specifications for analytical data acquisition (DOE, 1990b), each subcontract analytical laboratory is also required to submit a monthly progress report to Technical Assistance Contractor data management for review. These reports describe changes in key staff members, quality assurance practices, analytical procedures, and instrumentation.

Analytical Data Validation

For subcontract laboratory data validation, UMTRA Project Technical Assistance Contractor guidelines conform to or exceed the Level C data quality objectives set forth by DOE for analytical data (DOE, 1990b). The precision and accuracy criteria specified for Level C data validation are used in the validation process for most general inorganic analyses. However, those quality control practices are not applicable to all UMTRA Project analytes. Specific data validation procedures covering all UMTRA analytes are given in the Technical Assistance Contractor data validation standard operating procedure.

In addition to meeting the DOE Hazardous Waste Remedial Action Program quality control requirements, Technical Assistance Contractor data management verifies unbroken chain-of-sample custody as well as conformance with UMTRA Technical Assistance Contractor sampling procedures and EPA specified holding times. Analytical results are stored in the UMTRA Project Technical Assistance Contractor computer database, the Software Program for Environmental Analysis and Reporting. As an additional validation tool, a program within the Software Program for Environmental Analysis and Reporting compares new data with historical data to identify potential anomalies.

Interlaboratory Performance Evaluation Programs

UMTRA Project subcontract analytical laboratories are contractually required to participate in EPA- and DOE-sponsored performance evaluation sample programs. Data from those programs are reported quarterly to Technical Assistance Contractor data management. Technical Assistance Contractor data management staff reviews the data and any associated corrective actions, together with the UMTRA Project Technical Assistance Contractor quarterly performance evaluation sample results, daily quality control sample results, and information included in the monthly progress reports, to determine the overall proficiency of subcontract laboratories. Technical Assistance Contractor data management staff then requests additional corrective action reports, or takes other action to facilitate the correction of deficiencies, as appropriate.

In conformance with DOE Order 5400.1, subcontract laboratories performing radiochemical analyses are required to participate in and report results for the DOE Environmental Measurements Laboratory intercomparison program. In addition, radiochemistry labs supporting the Technical Assistance Contractor must participate in and report results for the EPA Environmental Monitoring Systems Laboratory intercomparison program.

Subcontract laboratories performing general inorganic analyses in support of Technical Assistance Contractor activities must participate in and report results for the EPA water supply and water pollution studies. All those intercomparison studies are briefly described below.

The EPA water supply and water pollution studies address a wide range of analytes including metals, nutrients, total organic carbon, organic compounds and anions, including cyanide.

The EPA Environmental Monitoring Systems Laboratory intercomparison studies primarily address natural radionuclides and gross alpha and beta emission in water samples.

The DOE Environmental Measurements Laboratory intercomparison studies primarily address fission products and gross alpha and beta emission in a variety of matrices, including plant and animal tissue.

The Technical Assistance Contractor quarterly performance evaluation program is the only performance evaluation program available to the Technical Assistance Contractor that covers all 49 parameters routinely measured in Technical Assistance Contractor samples. These performance evaluation samples are prepared and verified by chemists at the Rust Geotech analytical chemistry laboratory, located on the Grand Junction Projects Office compound. The matrix for Technical Assistance Contractor performance evaluation program samples is water, since the vast majority of all samples analyzed in support of Technical Assistance Contractor activities have a water matrix.

Performance Evaluation Program Results

Since a very large body of data is acquired for the performance evaluation programs discussed above, and since the Technical Assistance Contractor quarterly performance evaluation program is the only one that addresses all parameters routinely measured in Technical Assistance Contractor samples, the scope of the results summary that follows is limited to the quarterly Technical Assistance Contractor performance evaluation program. The results discussed in this section are those submitted to Technical Assistance Contractor data management in the first quarter of 1995.

The data acceptance intervals for the Technical Assistance Contractor performance evaluation program are calculated to yield narrower acceptance ranges than are typically associated with the other performance evaluation programs. This practice allows Technical Assistance Contractor data management staff members to identify deficiencies quickly and to minimize the amount of data potentially affected.

Corrective action reports may be requested for any of the following reasons:

- Large analytical error.
- Systematic bias indicated by both results when two performance evaluation samples are submitted.

- False negative result reported.
- Parameter outside the acceptance interval in two consecutive rounds.
- Parameter outside the acceptance interval in more than one performance evaluation program.
- Monthly progress reports describing a change in a problem area.
- Deficiency in a problem area, also indicated by daily quality control sample results.

Technical Assistance Contractor subcontract analytical laboratories may be suspended from participation in the chemical analysis program for a variety of reasons, including poor performance in one or more of the performance evaluation programs. *Table 4-7* on the following page summarizes the results of the quarterly performance evaluation program.

Twelve analytical results were outside the acceptance range specified by the Technical Assistance Contractor. Of these, six were only marginally outside the acceptance range, and six resulted in requests for corrective action. No laboratories were suspended due to poor performance.

The first quarter performance evaluation results are very good. The performance evaluation sample program results, together with the other quality assessment factors, indicate that the Technical Assistance Contractor subcontract analytical laboratories are providing accurate and high quality data.

Table 4-7 Results summary for the Technical Assistance Contractor quarterly performance evaluation program

Parameter	Number of labs reporting	Results outside acceptance interval
Aluminum	4	0
Ammonium	4	0
Antimony	4	0
Arsenic	4	0
Barium	4	0
Beryllium	4	0
Boron	4	0
Bromide	4	2
Cadmium	4	0
Calcium	4	0
Chloride	4	2
Chromium	4	0
Cobalt	4	0
Copper	4	0
Cyanide	4	1
Fluoride	4	0
Gross alpha	4	0
Gross beta	4	0
Iron	4	0
Lead	4	0
Lead-210	4	0
Magnesium	4	0
Manganese	4	0
Mercury	4	0
Molybdenum	4	0
Nickel	4	0
Nitrate	4	0
Phosphate	4	1
Polonium-210	4	1
Potassium	4	0
Radium-226	4	0
Radium-228	4	1
Selenium	4	0
Silica	4	2
Silver	4	0
Sodium	4	0
Strontium	4	0
Sulfate	4	0
Sulfide	4	1
Thallium	4	0
Thorium-230	4	0
Tin	4	1
Total dissolved solids	4	0
Total kjeldahl nitrogen	4	0
Total organic carbon/ dissolved organic carbon	4	0
Uranium	7	0
Vanadium	4	0
Zinc	4	0
	Total results submitted 195	**Total outside of acceptance interval** 12

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DOE (U.S. Department of Energy), 1994. *UMTRA Project Office Quality Assurance Program Plan*, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 1992. *UMTRA Project Environmental Monitoring Plan*, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 1990a. *Hazardous Waste Remedial Actions Program, Quality Control Requirements for Field Methods*, DOE/HWP-69/R1, prepared by HAZWRAP Support Contractor Office and the K-25 Plant, Oak Ridge, Tennessee, for the U.S. Department of Energy.

DOE (U.S. Department of Energy), 1990b. *Hazardous Waste Remedial Actions Program, Requirements for Quality Control of Analytical Data*, DOE/HWP-65/R1, prepared by the HAZWRAP Support Contractor Office and the K-25 Plant, Oak Ridge, Tennessee, for the U.S. Department of Energy.

DOE Orders

Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy, Washington, D.C.

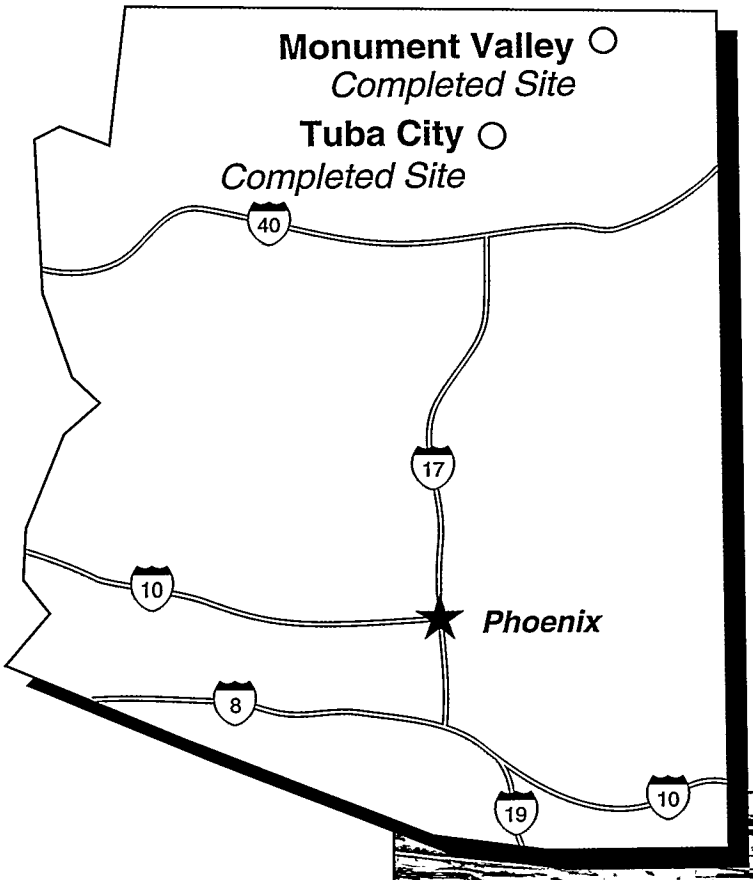
Order 5700.6C, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

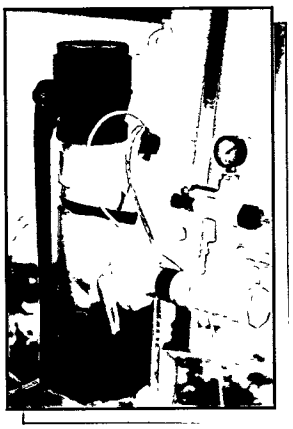
United States Code

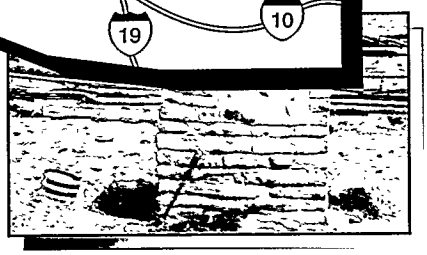
42 USC §300f *et seq., Safe Drinking Water Act.*

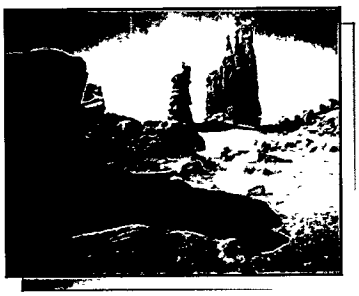
UMTRA PROJECT

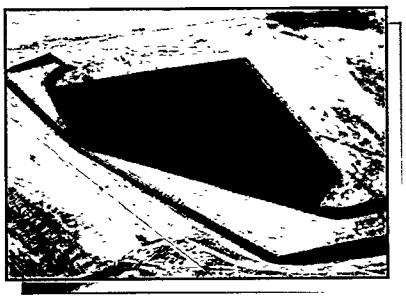
Chapter 5
Arizona Sites

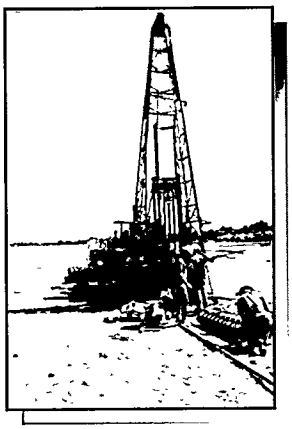












SITE DESCRIPTION AND LOCATION

The Monument Valley UMTRA Project site is on the Navajo Nation reservation in a remote area within Cane Valley in northeastern Arizona's Apache County (*Figure 5-1*). Accessed by Indian Route 6440, the site is 17 mi south of the Mexican Hat UMTRA Project disposal site and about 4 mi south of the Arizona-Utah border.

The communities closest to the Monument Valley site are Dinnehotso, Arizona (about 6 mi south), and Mexican Hat and Halchita, Utah (approximately 17-20 mi north). The closest towns are Blanding, Utah, approximately 40 mi northeast of Mexican Hat, and Kayenta, Arizona, approximately 30 mi southwest of the Monument Valley site.

The site area is remote and relatively undeveloped, with no public housing or community services such as schools, sewage systems, or health care facilities. Employment in this area is related primarily to coal, oil, and gas exploration and development. An accurate population estimate for the site and surrounding area is unavailable; however, it is probable that no more than 25 people live within 2 mi of the Monument Valley site.

The climate in the Monument Valley area is arid with large ranges in daily and seasonal temperatures. Winters are cold, with minimum temperatures below freezing prevailing from November through March; summers are hot, with temperatures as high as 100 degrees Fahrenheit (°F). Annual precipitation averages about 6 inches per year. July through October typically receive slightly more precipitation than other periods due to seasonal thunderstorm activity in the Colorado Plateau region. Snowfall is normally light.

The weather station nearest the site is at Mexican Hat, Utah. The Monument Valley site, south of Mexican Hat, can be expected to have a similar climate. However, since it is at a higher elevation, the Monument Valley site may have slightly lower temperatures and slightly greater precipitation than Mexican Hat.

Average wind speeds have been recorded at 9.2 mi per hour at Blanding, Utah, approximately 40 air miles northeast of Mexican Hat. The distribution of windblown tailings at the Monument Valley site indicates the wind blows predominantly from the southwest; however, the wind rose shows no predominant direction (*Figure 5-2*).

SITE HISTORY AND OWNERSHIP

From 1942 to 1945, the Vanadium Corporation of America mined for vanadium under a lease from the Navajo Tribal Council. Uranium mining began in 1948. High-grade ores were shipped to a mill in Durango, Colorado, while the low-grade ores were either bypassed by selective mining or stockpiled in waste dumps.

In 1955, a mechanical upgrader mill was installed at the site to concentrate the lower-grade ores before shipment. Ore slimes

Figure 5-1
Monument Valley Site Location

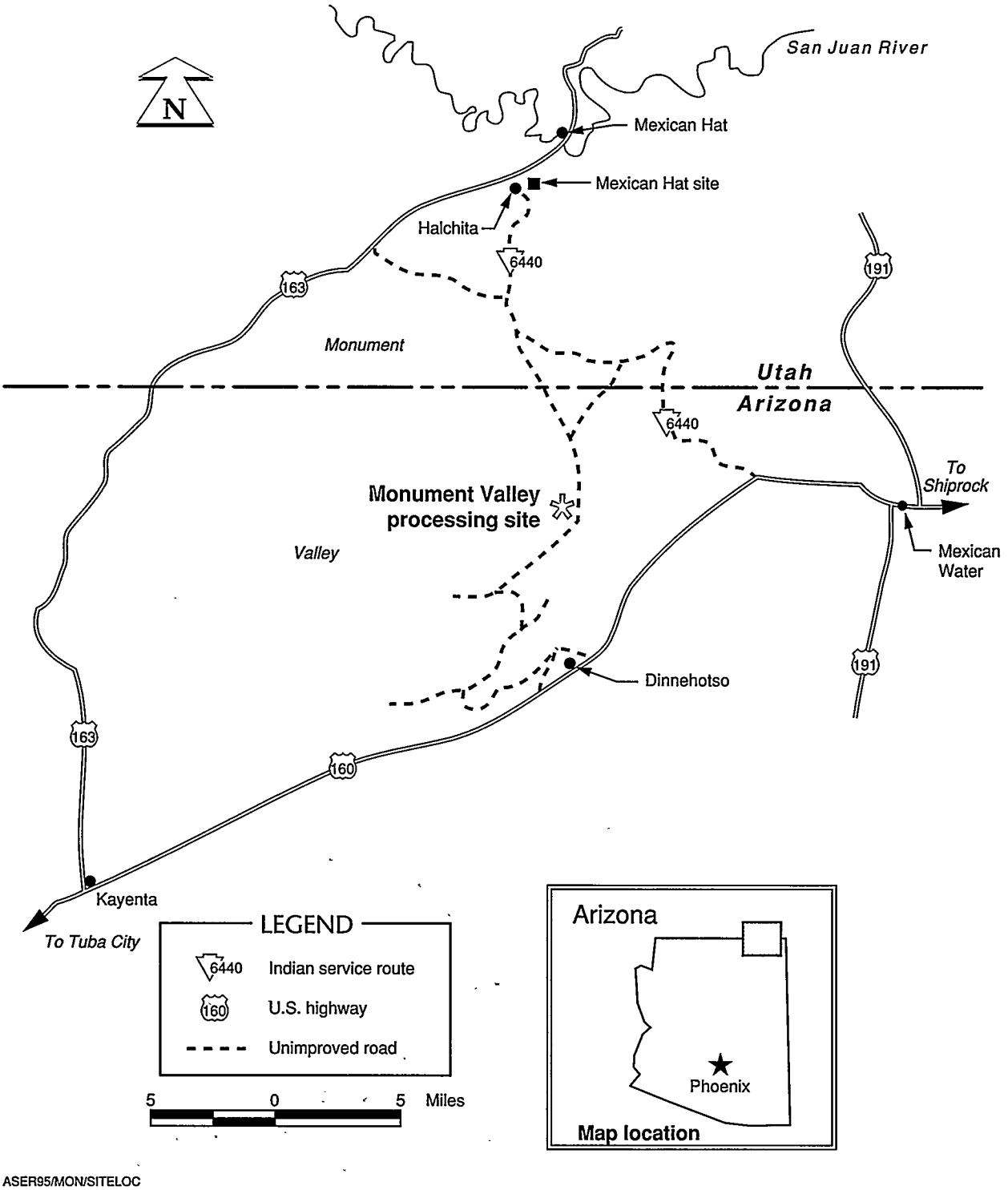


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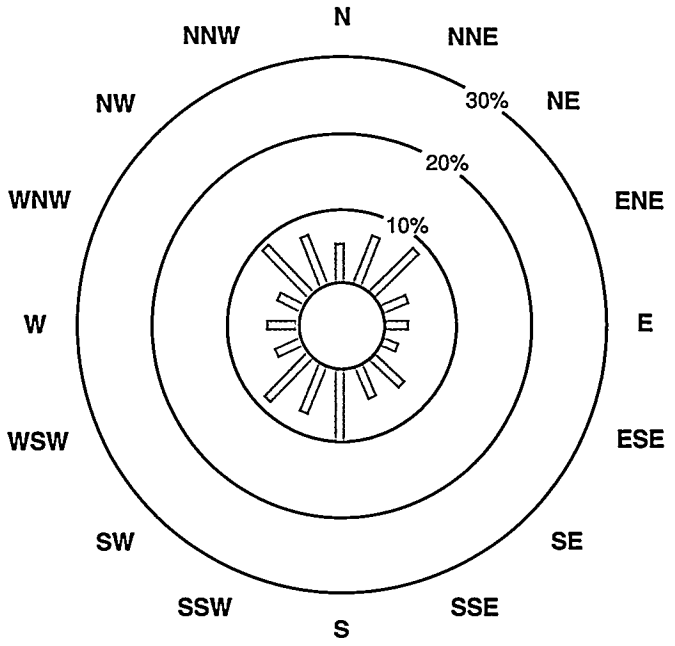
Figure 5-2
Wind Rose



Ref: Blanding, Utah.
Cumulative data 1977-1978.

ASER95/MON/WINDMON

recovered from the upgrader were shipped to other locations. A batch leach plant was constructed at the site in 1964 to upgrade the sand tailings rejected from the mechanical upgrader; the plant operated for 3 years. The uranium/vanadium product generated by this batch leach concentrator was sent to the Shiprock mill for processing. The bulk of the tailings from this plant were placed in a tailings pile east of the Monument Valley mill.

In 1966 and 1967, Vanadium Corporation of America experimented with heap-leaching low-grade ores from mine dumps, producing an acidic, oxidizing leachate. Subsequently, Foote Minerals Corporation operated the plant until 1968, when the mill buildings were dismantled and control of the site and the tailings reverted to the Navajo Nation.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Monument Valley site is designed to meet the EPA standards established in 40 CFR Part 192 for areas being excavated. Remedial action involves cleanup of the abandoned mill site and relocation of the residual radioactive materials to the Mexican Hat disposal cell (*Figure 5-1*). The relocation of 780,000 cubic yards of residual radioactive materials began in 1992 and was completed in January 1994.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Monument Valley, Arizona, complies with federal and tribal environmental regulations. Remedial action activities, and the associated environmental impacts, are continuously evaluated to ensure they meet applicable regulatory requirements. In 1994, Monument Valley site activities were in compliance with all applicable environmental regulations. Activities at the Monument Valley site included reporting certain quantities of hazardous materials used or stored at the site, spill prevention control and countermeasures, and adherence to transportation and local regulations and permits.

Uranium Mill Tailings Radiation Control Act

Radiation surveys were performed at the Monument Valley site to confirm compliance with UMTRCA (42 USC §7901 *et seq.*) soil cleanup standards.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*), the Monument Valley site complies with emergency planning and community right-to-know requirements. These requirements include notifying the appropriate authorities of inventories and spills of hazardous substances. In 1994, the site met the requirements of EPCRA, Section 311, because a site inventory had been developed for all materials stored on-site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, other automotive maintenance fluids, and uranium mill tailings, and was submitted to the State Emergency Response Commission, the local emergency planning committee, and the fire department on 1 March 1994. No materials were released into the environment that fall under EPCRA reporting requirements in 1994.

National Environmental Policy Act

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Monument Valley UMTRA site.

Clean Water Act

Because potential water discharges from the site would eventually flow into the San Juan River, Region IX of the federal EPA has regulatory authority for activities associated with the NPDES and storm water.

National Pollutant Discharge Elimination System

During 1994, the Monument Valley site had no wastewater discharges.

A general storm water permit was submitted to the federal EPA in 1993. There were no storm water releases at the Monument Valley site in 1994.

Spill Prevention Control and Countermeasures Plan

Earthen berms were designed and constructed around existing aboveground storage tanks and around oil drum storage areas. These secondary containment systems are designed to control spills. In addition, plans for berm inspection, spill detection, emergency spill response, and spill cleanup were developed for fuel and oil storage areas. The storage area was dismantled in 1994 and all tanks were properly drained of contents and drummed materials removed. During 1994, the site had no reportable spills.

Septic/Holding Tanks

During 1993, septic systems were constructed at the Monument Valley site following requirements of the Navajo Office of Environmental Health, which has regulatory jurisdiction. In 1994, the septic systems were removed in accordance with applicable regulations.

Clean Air Act

The federal EPA determined that the Monument Valley site is not a major source of contamination. Because the major pollutant at the site is fugitive emissions from nonpoint sources, the Monument Valley site does not require an EPA permit. However, off-site visible fugitive dust emissions were strictly controlled, as required by the Navajo Nation EPA.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Public scoping meetings for the programmatic environmental impact statement were held in 1993, and the preparation of the draft programmatic environmental impact statement took place in 1994. The draft programmatic environmental impact statement is in DOE Headquarters in Washington, D.C., awaiting final approval to be published for public review. Public hearings regarding the draft programmatic environmental impact statement will be held in 1995 and will include locations in the vicinity of the Monument Valley site.

Hazardous Materials Transportation Act

All materials transported in 1994 from the Monument Valley site to the Mexican Hat disposal site were in full compliance with all applicable requirements of the HMTA (49 USC §1801 *et seq.*) and DOT exemption E-10594.

Environmental Compliance Permits

Table 5.1 lists all active permits that apply to environmental activities and under which the Monument Valley site operated during 1994. The Monument Valley site complied with all permits.

The Monument Valley site is under the jurisdiction of the Navajo Nation EPA and Region IX of the federal EPA.

Table 5-1 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number
NPDES permits (EPA)				
Process site storm water (general)	10/93	Pending	Pending	a
BIA borrow permit (general fill)	09/90	Pending	Pending	b
BIA revocable use permit for trailer site	11/88	Pending	Pending	b

[a]Application accepted as storm water by the federal EPA Region IX. Submitted to establish legality.
[b]Permit from agency is overdue.

BIA – Bureau of Indian Affairs

ENVIRONMENTAL MONITORING

The DOE implemented a detailed environmental monitoring program at the Monument Valley site in 1994, which included determining environmental gamma-dose equivalent and contaminant concentrations in air, surface water, and ground water. This program monitored the amount of radioactive material and nonradiological hazardous constituents released into the environment, demonstrated compliance with the applicable guidelines, and indicated the efficiency of environmental protection measures.

Air Monitoring

Nonradiological Air Particulate Monitoring

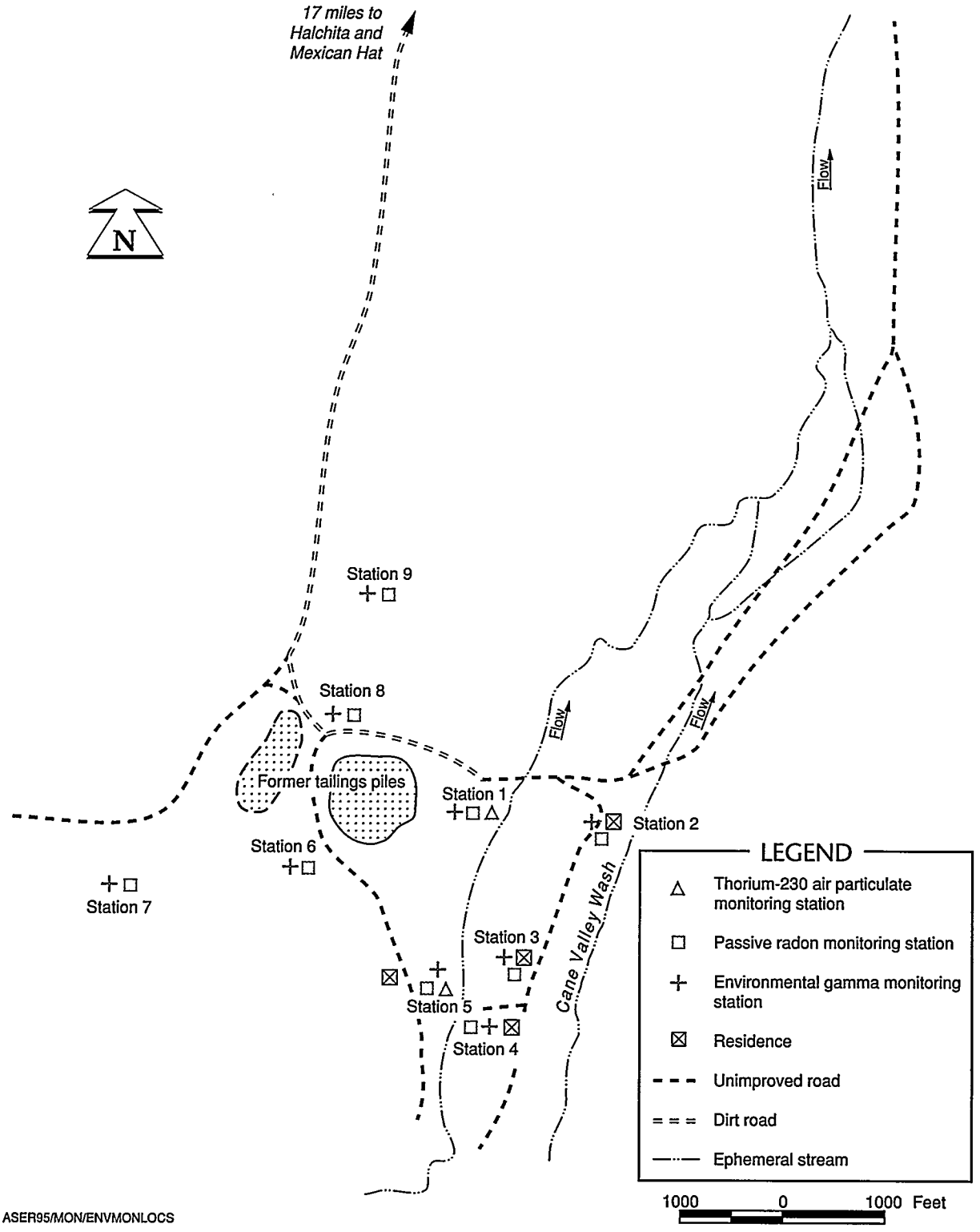
Because the major pollutant at the site was fugitive dust emissions from nonpoint sources, a federal EPA permit was not needed and total suspended particulate monitoring was not conducted; however, off-site visible fugitive dust emissions were strictly controlled.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Monument Valley site was conducted at Stations 1 and 5 (***Figure 5-3***). Background measurements were not taken because airborne radioactivity levels at the site were very low. Monitoring was discontinued 24 January 1994 for Station 1 and 27 January 1994 for Station 5, 1 month after remedial action was completed at the Monument Valley site. The average thorium-230 concentrations for Stations 1 and 5 were 38×10^{-16} and 22×10^{-16} μCi/mL, respectively. Those concentrations were estimated from gross alpha measurements.

All measurements were well below the DOE thorium-230 annual average guideline of 500×10^{-16} μCi/mL above background, indicating radioactive particulate releases from remedial action were not significant.

Figure 5-3
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site



Radon Monitoring

Real-Time (Active) Radon Monitoring. Because radioactivity in the tailings was low in concentration, and because the Monument Valley site is in a very remote area, real-time radon monitoring was not required in 1994. However, passive environmental radon monitoring was conducted at the site.

Passive Radon Monitoring. Nine stations were established around the Monument Valley site, five of them near residences. Background monitoring was conducted at Station 9 (***Figure 5-3***). Monitoring was discontinued at the end of March since remedial action was completed earlier in the calendar quarter.

All measurements (***Table 5-2***) fell below the DOE guideline of 3.0×10^{-9} µCi/mL above background.

Table 5-2 Passive (alpha-track) radon concentration (10^{-9} µCi/mL)

Location	Quarter 1
1	0.8
2	0.7
3	0.7
4	0.6
5	1.0
6	1.2
7	1.9
8	1.1
9	1.0

Air Monitoring Conclusions

No releases from the site occurred during 1994. All measured concentrations of thorium-230 particulate and radon-222 were lower than the applicable guidelines.

Environmental Gamma Radiation Monitoring

In 1994, a network of nine thermoluminescent dosimeters measured exposure to penetrating gamma radiation in the environment around the Monument Valley site. Background dose was measured at Station 9, approximately 1.5 mi north of the site. Four dosimeters were placed around the site boundary at Stations 1, 6, 7, and 8 (***Figure 5-3***). The remaining five dosimeters were placed near residences. Monitoring was discontinued at the end of March since remedial action was completed earlier in the calendar quarter.

None of the dose equivalents measured (***Table 5-3***) would lead to an annual average greater than the DOE guideline of 100 mrem per year above background.

Table 5-3 Environmental gamma dose equivalent (mrem)[a]

Location	Quarter 1
1	38.0 ± 19.6
2	32.0 ± 7.5
3	33.2 ± 5.9
4	38.0 ± 5.5
5	35.3 ± 5.3
6	34.4 ± 6.1
7	53.0 ± 11.7
8	34.6 ± 17.9
9	27.8 ± 12.7

[a]All errors reported as 2 standard deviations. Insufficient data for annual dose equivalent.

Environmental Gamma Radiation Monitoring Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guideline, indicating no releases to the environment during 1994.

Surface Water Monitoring

Surface water features in the vicinity of the Monument Valley UMTRA site consist of Cane Valley Wash, several small drainage channels leading into the wash, and areas of ponded water locally referred to as the frog ponds. Cane Valley Wash is east of the tailings piles and flows from south to north. The frog ponds are east of the tailings piles and have been excavated into the wash.

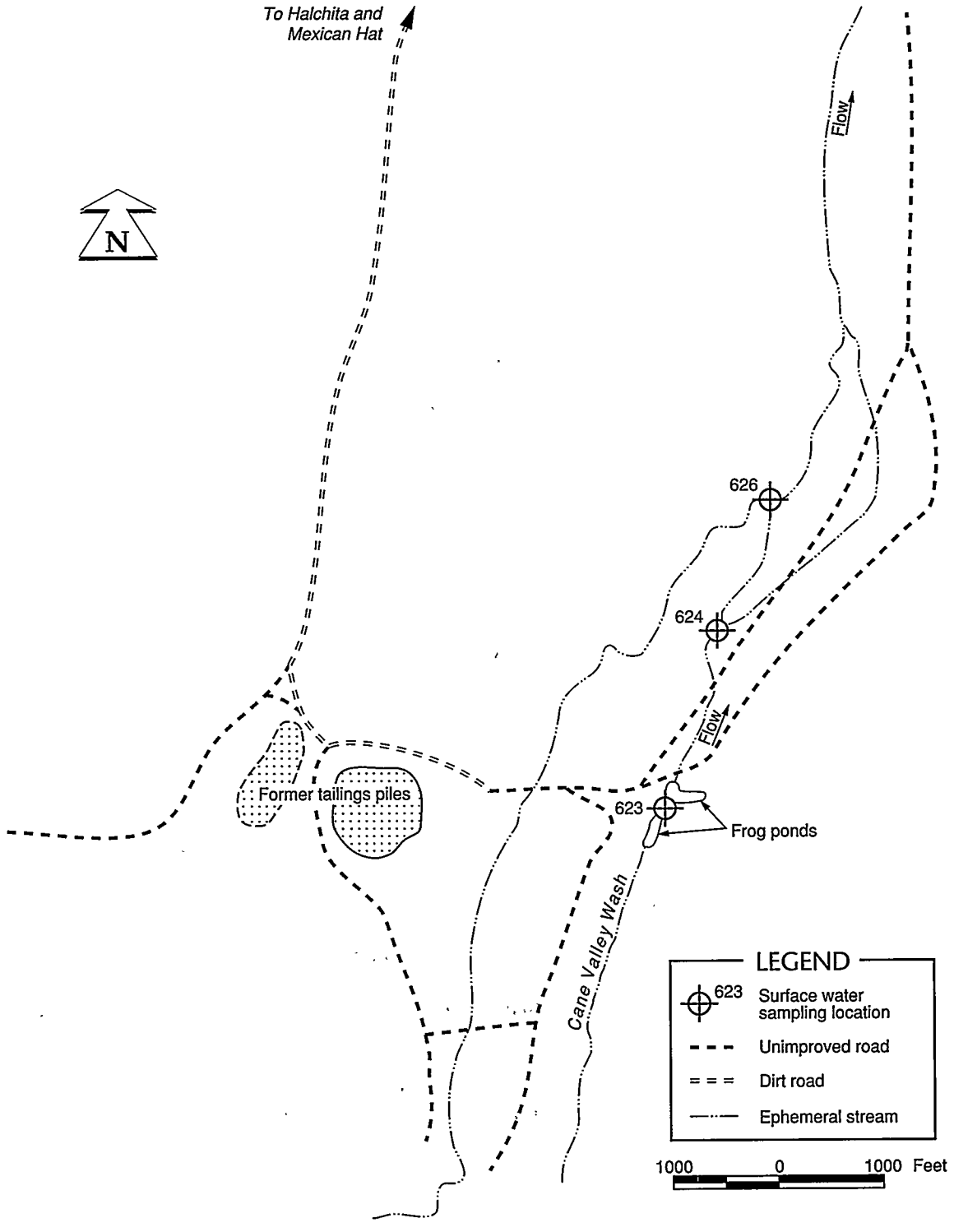
Figure 5-4 shows the wash, frog ponds, and surface water sampling locations. Surface water in the site area is not usually present during prolonged dry periods, except in the frog ponds.

Surface water samples were taken at the following locations in April/May and December of 1994:

- 623 - The southernmost frog pond.
- 624 - A small area of ponded water within Cane Valley Wash.
- 626 - A small pond in Cane Valley Wash. This location could not be sampled in December because no water was present.

Analyses at each location included nitrate, a primary contaminant indicator. Nitrate was chosen as an indicator parameter because it is a by-product of the milling operation and has low concentrations in uncontaminated water.

Figure 5-4
Surface Water Sampling Locations, Processing Site



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Surface Water Results and Conclusions

Analytical results for the 1994 sampling events show that the concentrations of nitrate are below the laboratory detection limit (1 milligram per liter [mg/L]) and the maximum concentration limit (44 mg/L). This indicates that surface water at the locations sampled has not been impacted by former mill operations.

Ground Water Monitoring

Ground water was sampled in April/May and December of 1994. ***Figure 5-5*** shows the location of monitoring wells and a hand-dug, shallow monitoring station for the Alluvium Aquifer, designated as location 627.

The area of the Monument Valley UMTRA Project site contains three water-bearing zones (aquifers). From shallowest to deepest, they are called the Alluvium, the Shinarump Conglomerate member of the Chinle Formation, and the De Chelly Sandstone member of the Cutler Formation. Ground water within each aquifer flows northeast. ***Figure 5-6*** shows flow direction in the Alluvium Aquifer. The extent of the contaminant plume and the length of time the mill was in operation show that ground water flows at a rate of approximately 150 feet (ft) per year.

Ground water samples were analyzed for several constituents, including nitrate, the primary indicator of ground water contamination. Nitrate is a good indicator of ground water contamination because it is a by-product of mill operations, travels at about the same rate as ground water flow, and concentrations are usually low in uncontaminated ground water.

The wells are divided into three categories (upgradient, downgradient, and crossgradient) that reflect well locations relative to the former mill and tailings piles (the source of contamination) and to the direction of ground water flow.

Ground Water Results

Table 5-4 summarizes ground water results for 1994. Ground water sample results for 1994 indicate that nitrate concentration exceeded the maximum concentration limit of 44 mg/L in four wells for the April/May sampling event and two wells for December.

Figure 5-7 shows the extent of nitrate contamination in the Alluvium Aquifer, which has the largest contaminant plume based on April/May sampling. Limited nitrate contamination also occurs in the Shinarump and De Chelly aquifers, but the plumes are smaller.

Wells 606 and 655 contain the largest measured concentrations of nitrate in ground water and are near the contaminant source (the former mill and tailings pile). These wells show relatively consistent nitrate concentrations over time (***Figure 5-8***). Well 653 is at the downgradient extent of contamination. Over time, increasing contaminant concentrations at well 653 indicate the progress of plume

Figure 5-5
Ground Water Sampling Locations in the Alluvium, Shinarump, and De Chelly Aquifers, Processing Site

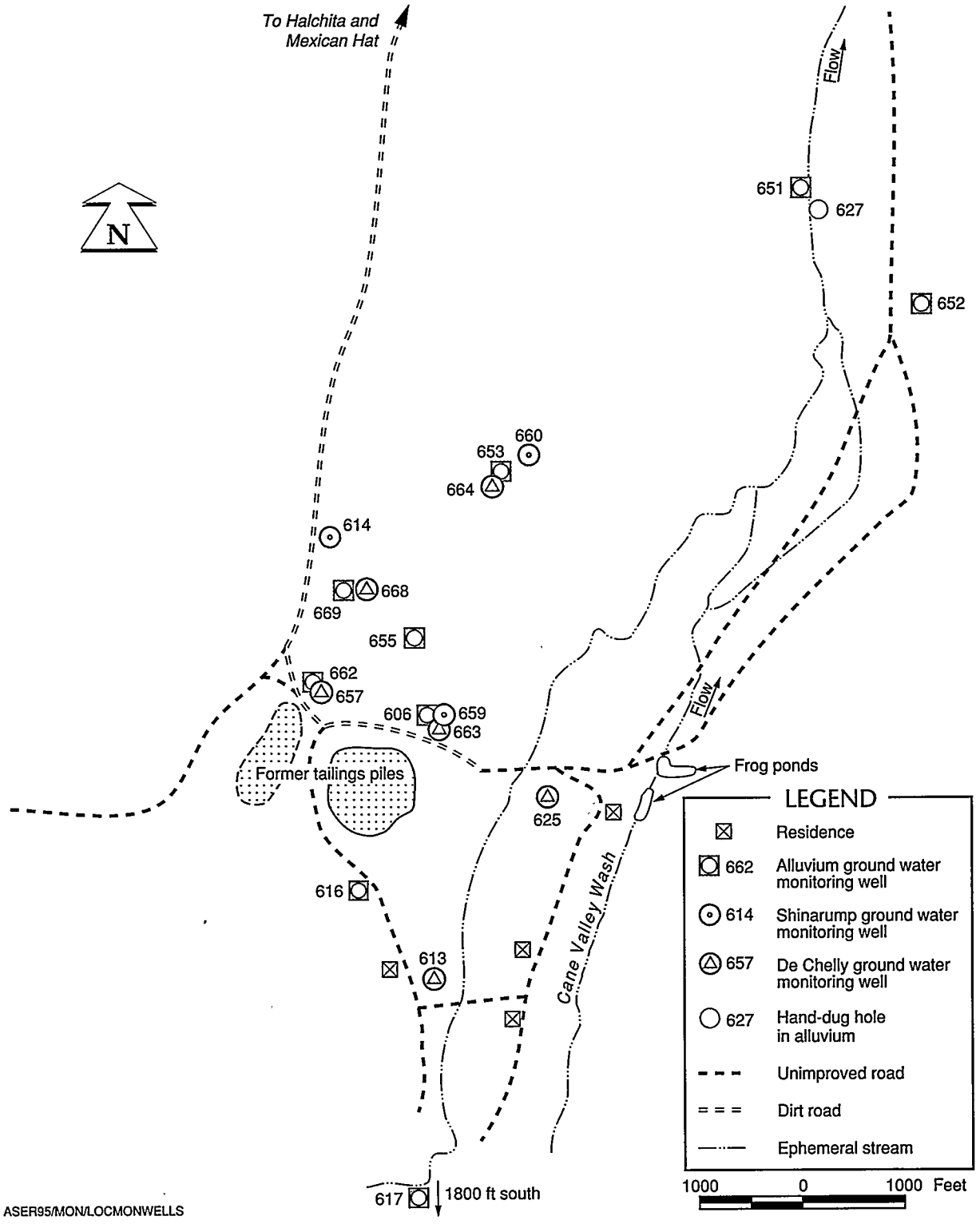

Figure 5-6
Ground Water Table Contours for the Alluvium Aquifer

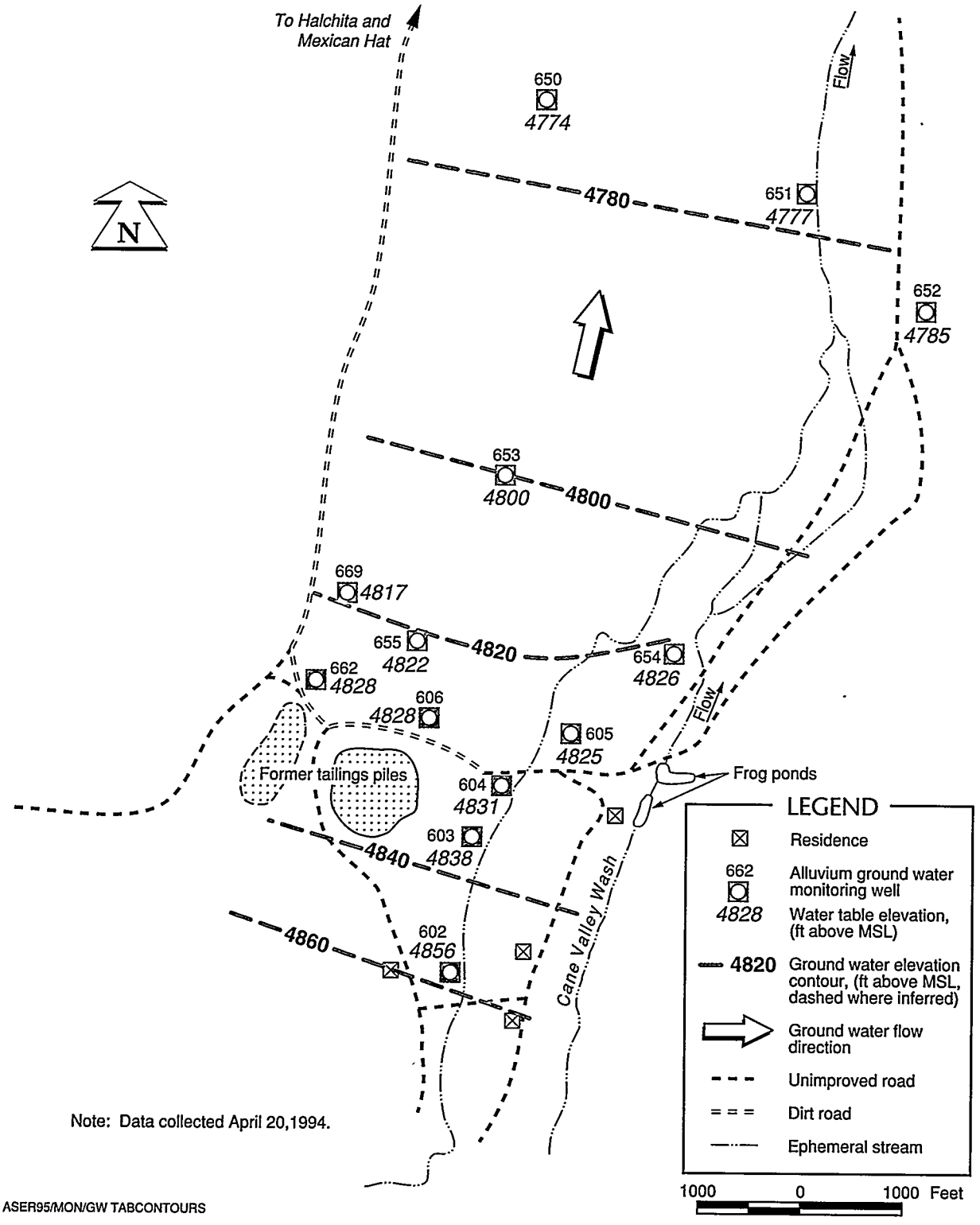

Table 5-4 Nitrate concentrations in ground water

Monitoring well location	Nitrate concentrations[a] (mg/L) April/May	December	Relative location	Water-bearing zone
606	1,180	1,360	Downgradient	Alluvium
613[b]	3	2.7	Upgradient	DeChelly
614[b]	X	23	Downgradient	Shinarump
616[b]	7	X	Upgradient	Alluvium
617[b]	29	36	Upgradient	Alluvium
625[b]	<1	<1	Crossgradient	DeChelly
627	<1	4.4	Downgradient	Alluvium
651	1	1	Downgradient	Alluvium
652	X	21	Downgradient	Alluvium
653	85	88	Downgradient	Alluvium
655	574	X	Downgradient	Alluvium
657	19	20	Downgradient	DeChelly
659	2	<1	Downgradient	Shinarump
660	<1	<1	Downgradient	Shinarump
662	74	X	Downgradient	Alluvium
663	<1	2	Downgradient	DeChelly
664	<1	<1	Downgradient	DeChelly
668	1	X	Downgradient	DeChelly
669	28	X	Downgradient	Alluvium

[a]Maximum concentration limit for nitrate is 44 mg/L.
[b]Domestic use wells.

mg/L – milligrams per liter.
< – less than.
X – no sample taken.

migration downgradient from the contaminant source. Well 651 (downgradient) is far enough away from the area of contaminated ground water that it shows no contamination (***Figure 5-9***). The lack of any trend at this location demonstrates the relatively consistent quality of ground water outside the contaminated area.

Ground Water Conclusions

Ground water in the vicinity of the site is affected by the former milling operations. The contaminated ground water in the Alluvium Aquifer moves northeast at a rate of approximately 100 ft per year.

Results from wells on the leading edge of the contamination (downgradient from the site) show a gradual increase in concentrations. This increase demonstrates the slow migration of the plume. Sampling results also show that nitrate exceeds maximum concentration limits within the most concentrated portion of the contaminated ground water. Domestic wells are unaffected by ground water contaminated by the former mill.

Figure 5-7
Nitrate Concentrations in the Alluvium Aquifer

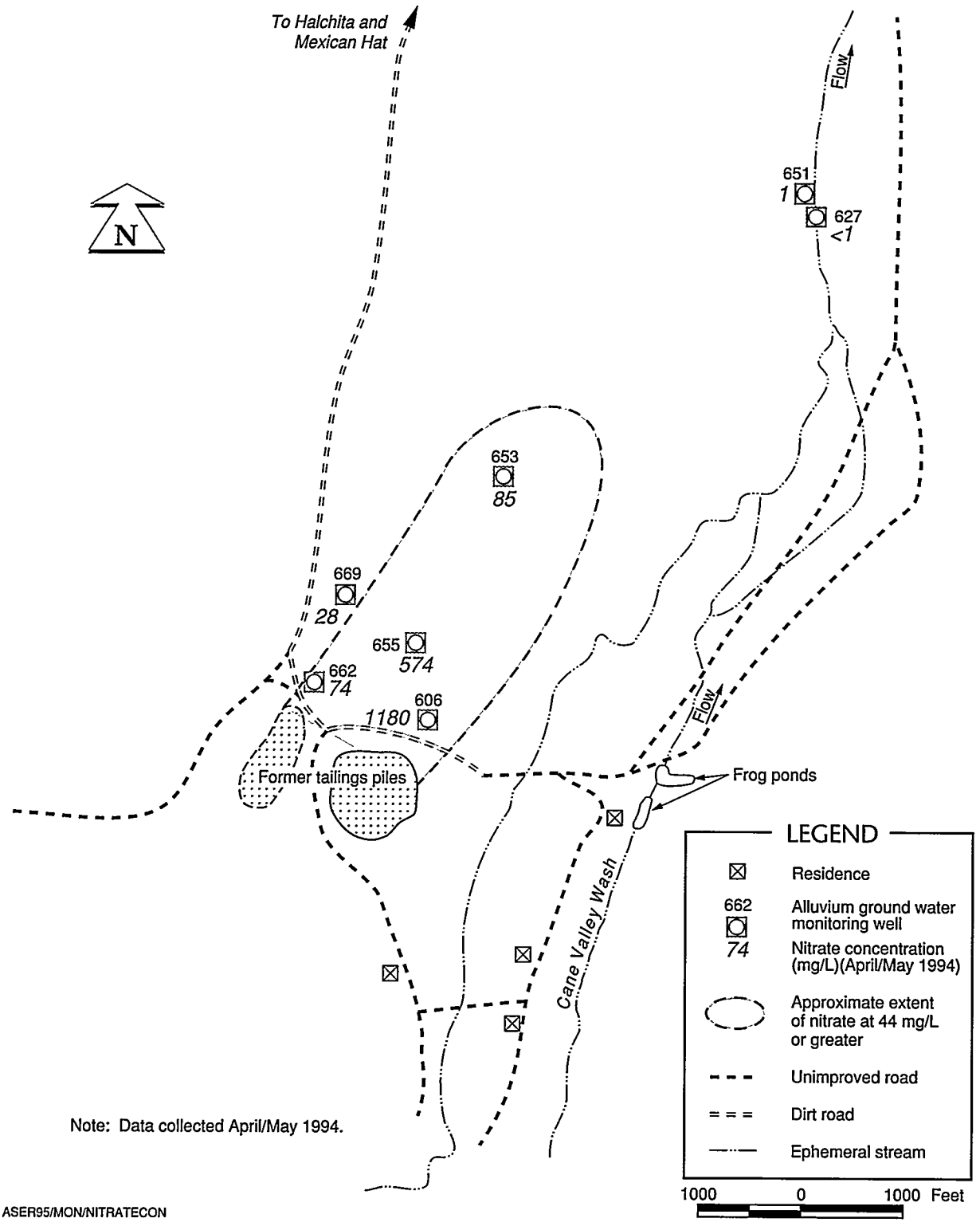

Figure 5-8
Nitrate Concentrations Over Time, Alluvium Ground Water Monitoring Wells Near Contaminant Source

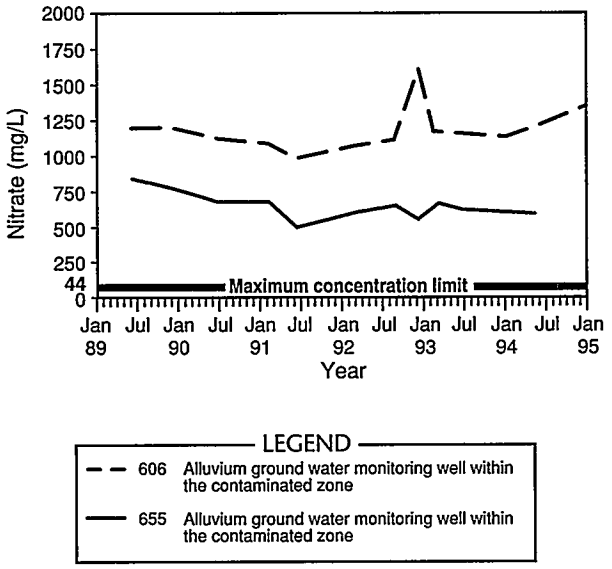

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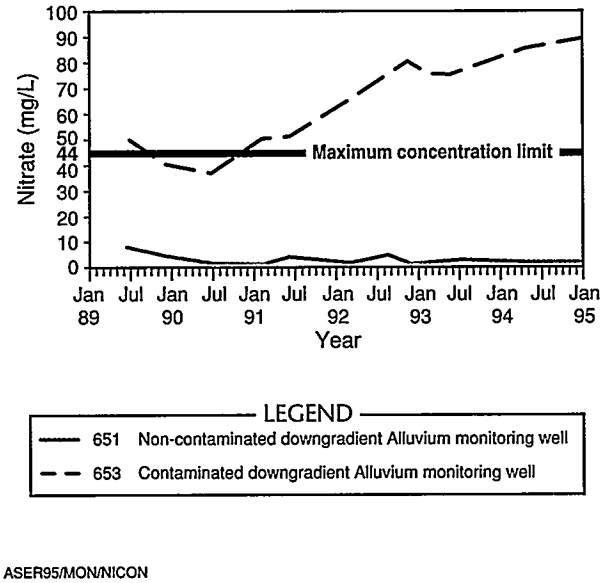
Figure 5-9
Nitrate Concentrations Over Time, Alluvium Ground Water Monitoring Wells, Downgradient From Contaminant Source



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SITE DESCRIPTION AND LOCATION

The Tuba City UMTRA Project site lies at an elevation of approximately 5100 ft above mean sea level (MSL) on alluvial and windblown deposits of the Southern Kaibito Plateau. The site is on a gently sloping terrace approximately 6000 ft northwest of Moenkopi Wash, an intermittent stream that drains west-southwest into the Little Colorado River. Surface drainage is to the southeast, toward Moenkopi Wash. The terrain north and west of the site is gently rolling, with active and partially stabilized windblown sand deposits and occasional outcrops of Navajo Sandstone. To the east and south, erosion has dissected the terrain along the flank of Moenkopi Wash. Although mostly covered by dune deposits, the Navajo Sandstone appears to be close to the surface throughout the area.

The site is 6 mi east of Tuba City (***Figure 5-10***) in Coconino County (population 96,591), Arizona. The 1990 populations of Tuba City/Moenkopi Village and the Tuba City Division were 924 and 27,436, respectively.

The Tuba City site is arid. Very light precipitation, warm summers, cool winters, and occasionally strong, seasonal winds are characteristic of the area.

Due to the high elevation and low humidity at Tuba City, large daily temperature variations are typical. Normal daily highs range from 45 °F in January to 95 °F in July. Normal daily lows range from 19 °F in January to 61 °F in July.

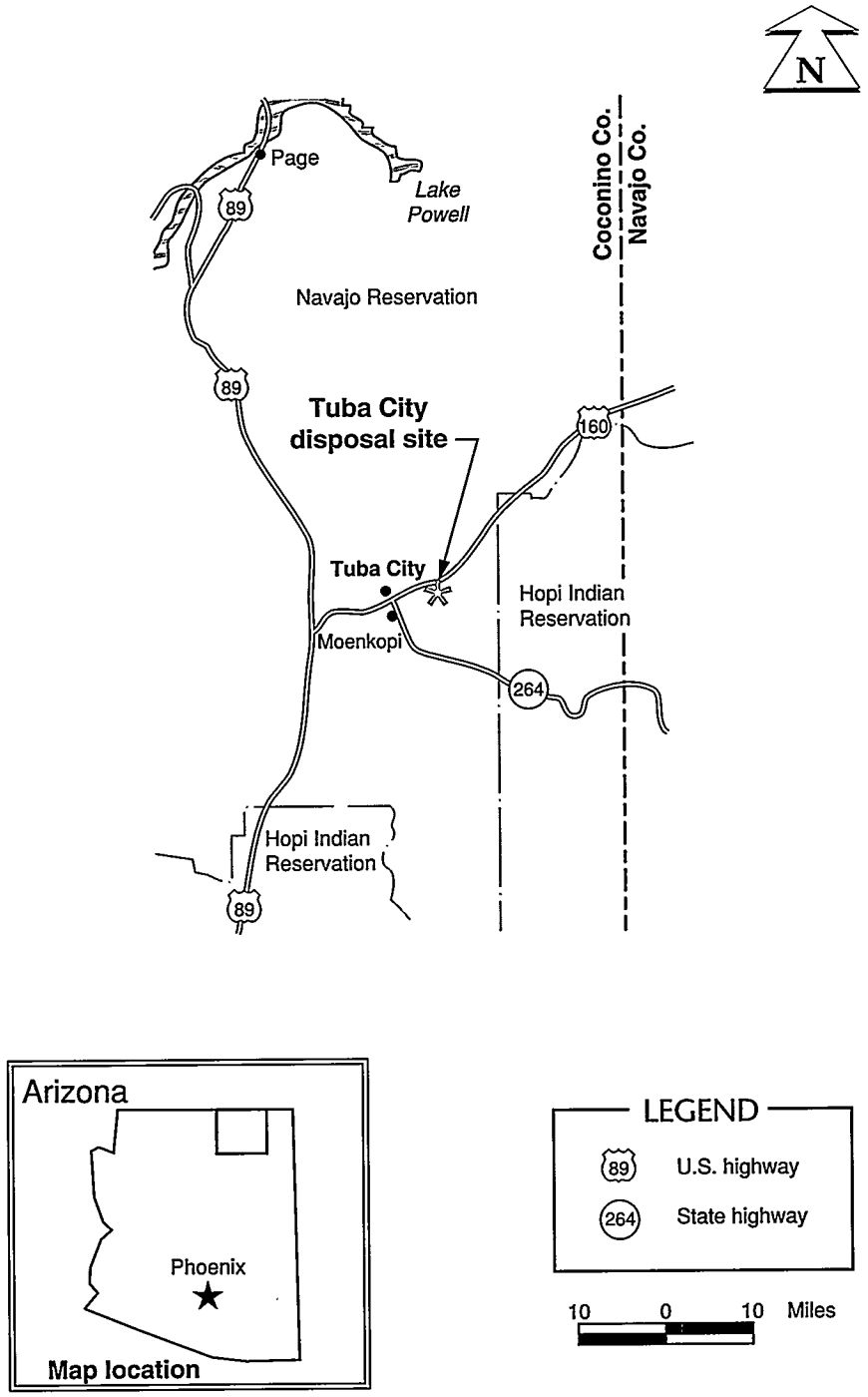
The average annual precipitation at Tuba City from 1941 to 1970 was approximately 6 inches. The greatest monthly rainfall occurs in August, the peak of the late summer thunderstorm season. The driest month is June.

No wind data are available for the Tuba City area; however, sand dune formation in the area indicates that the wind comes predominantly from the southwest.

SITE HISTORY AND OWNERSHIP

Rare Metals Corporation of America operated the uranium mill at the Tuba City site from 1956 to 1962. In 1962, Rare Metals merged with the El Paso Natural Gas Company, which ran the mill until 1966. About 800,000 tons of ore were processed in the 10 years of milling. The mill was designed to process uranium ores using a sulfuric acid leaching, sand-slime separation, and resin-in-pulp ion exchange recovery system. In 1962, however, a high lime content ore became the primary feed source, and the mill was modified to use a carbonate leach process. Processing chemicals included iron metal, lime, ammonia gas, magnesia, tertiary amine, sulfuric and nitric acids, and kerosene. The tailings were placed as slurry in three contiguous piles at the site.

Figure 5-10
Tuba City Site Location



ASER95/TUB/SITELOC

The DOE entered into cooperative agreements with the Navajo Nation and the Hopi Tribe to perform surface remedial action at the Tuba City site. The title to the residual radioactive material now located in the disposal cell will transfer to DOE from the tribes when the tribes receive the final Tuba City completion report. A long-term custodial care agreement between the DOE and the tribes is under development.

SITE CHARACTERIZATION AND CLEANUP

Remedial action to stabilize the tailings in place began in 1988. Relocated tailings from the adjacent subpiles, windblown and waterborne deposits, and other contaminated materials (including demolished buildings) were placed in the engineered disposal cell. Remedial action was completed in April 1990, with a total of 1,400,000 cubic yards of contaminated materials stabilized in the disposal cell. The cell covers 50 acres (ac) of the 145-ac disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Tuba City site complete, the remaining surface-related compliance actions include NRC licensing under the provisions of 10 CFR Part 40. This licensing procedure arranges for long-term surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring.

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are analyzed to evaluate the ground water contamination resulting from processing site activities. In addition, sample results are evaluated for compliance with EPA ground water standards (40 CFR 192).

National Environmental Policy Act

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Tuba City UMTRA site.

ENVIRONMENTAL MONITORING

At the Tuba City site, the DOE conducts an environmental monitoring program for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Tuba City site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA Project environmental monitoring program in 1994.

No surface water or sediment samples were collected at the Tuba City in 1994.

Ground Water Monitoring

Ground water beneath the Tuba City site occurs within the Navajo Sandstone and Kayenta Formation. Collectively, these two formations form a single hydrologic unit called the N-Aquifer. Saturated alluvium associated with Moenkopi Wash provides water to wells and springs along the wash.

The ground water monitoring network consists of 14 wells completed in the Navajo Sandstone portion of the N-Aquifer (***Figure 5-11***). Background ground water quality was established using data from monitoring wells 901, 910, and 917. The extent and magnitude of ground water contamination related to site activities was established using data from monitoring wells 903, 906, 908, 909, and 912. Downgradient ground water quality was established using data from monitoring wells 904, 913, 914, 915, 920, and 921.

Ground water elevations were measured and samples were collected from 8 wells in May 1994 and from 14 wells in late August 1994. ***Figure 5-11*** shows the potentiometric surface for the Navajo Sandstone wells in August 1994. The next water quality sampling round is scheduled for 1 April 1995.

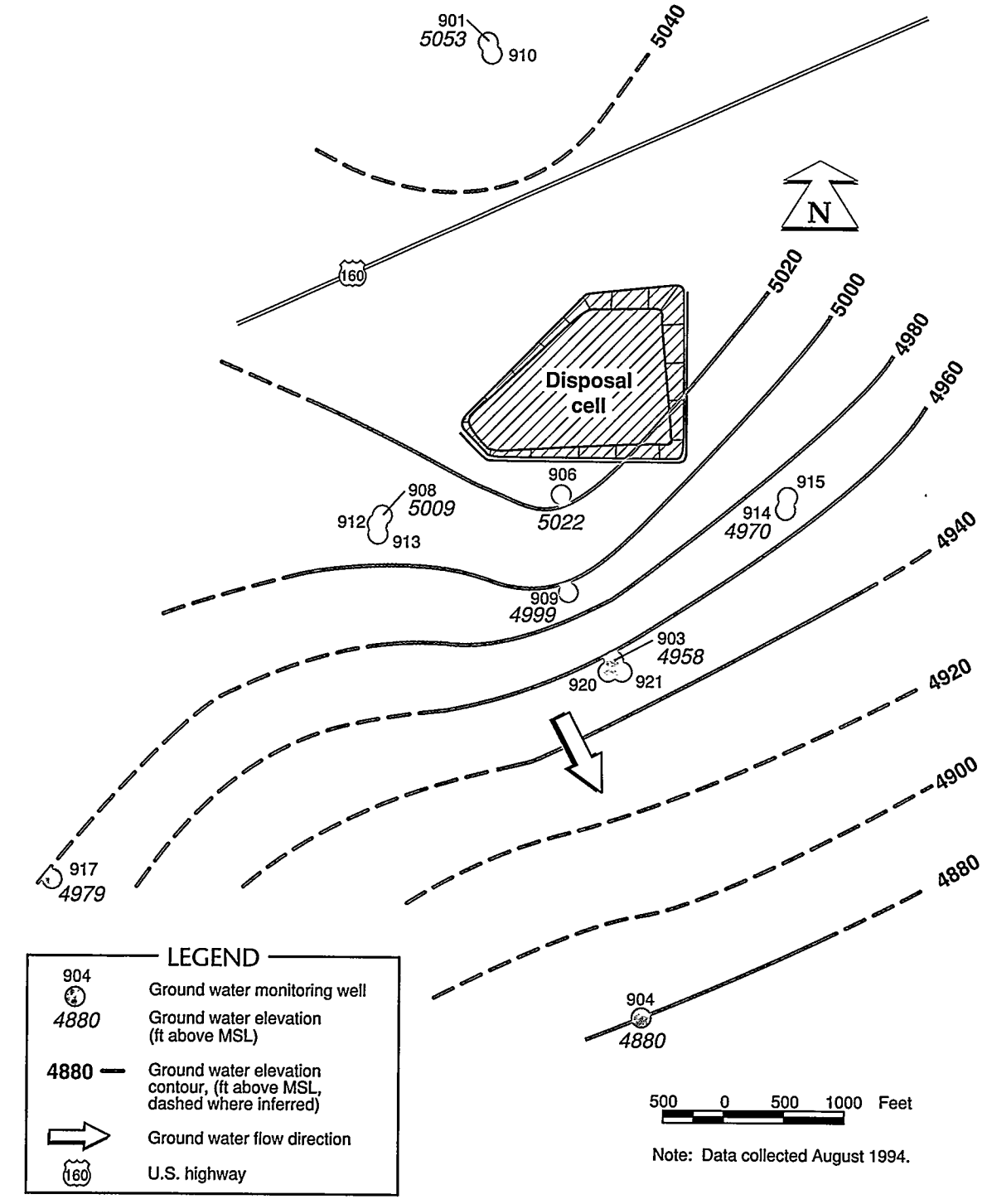
The parameters that were analyzed reflect the hazardous constituents in ground water related to uranium processing activities at this site. Chloride, sulfate, total dissolved solids, and uranium are the four major contaminants chosen as indicator parameters. These indicator parameters are contaminants, derived from the processing activities and tailings piles, that have migrated into ground water in the uppermost aquifer during the past 35 years.

Ground Water Results

Results from the 1994 sampling rounds showed that ground water concentrations of molybdenum, selenium, and uranium exceeded maximum concentration limits in the Navajo Sandstone portion of the N-Aquifer beneath the site. Ground water quality data for a background monitoring well, a monitoring well screened in the plume, and a monitoring well downgradient of the plume are presented in ***Table 5-5***. The extent of total dissolved solids in the ground water is indicative of other contamination related to uranium processing and tailings disposal at the site. The levels of total dissolved solids at the site are shown in ***Figure 5-12***. ***Figure 5-13*** shows trends in total dissolved solids concentration in ground water for the years 1985 to 1994.

Figure 5-14 shows ground water level trends near the disposal cell. The rise in total dissolved solids and water levels in well 906 closest to the disposal cell probably results from the release of water from the wet tailings in the cell due to tailings consolidation and normal drainage of tailing pore fluids.

Figure 5-11
Ground Water Monitoring Well Locations and Potentiometric Surface of Navajo Sandstone, Disposal Site



ASER95/TUB/POTENTIO

Table 5-5 Ground water quality results

Indicator parameter[a]	Guideline	Monitoring well location 901 (background)	906 (contaminated area)	904 (downgradient)
Chloride	250[b]	11	410	95
Molybdenum	0.1[c]	<0.01	0.51	<0.01
Total Dissolved Solids	500[b]	180	7000	400
Selenium	0.01[c]	<0.005	0.16	0.006
Sulfate	250[b]	18	2700	76
Uranium	0.044[c]	0.003	1.36	0.003

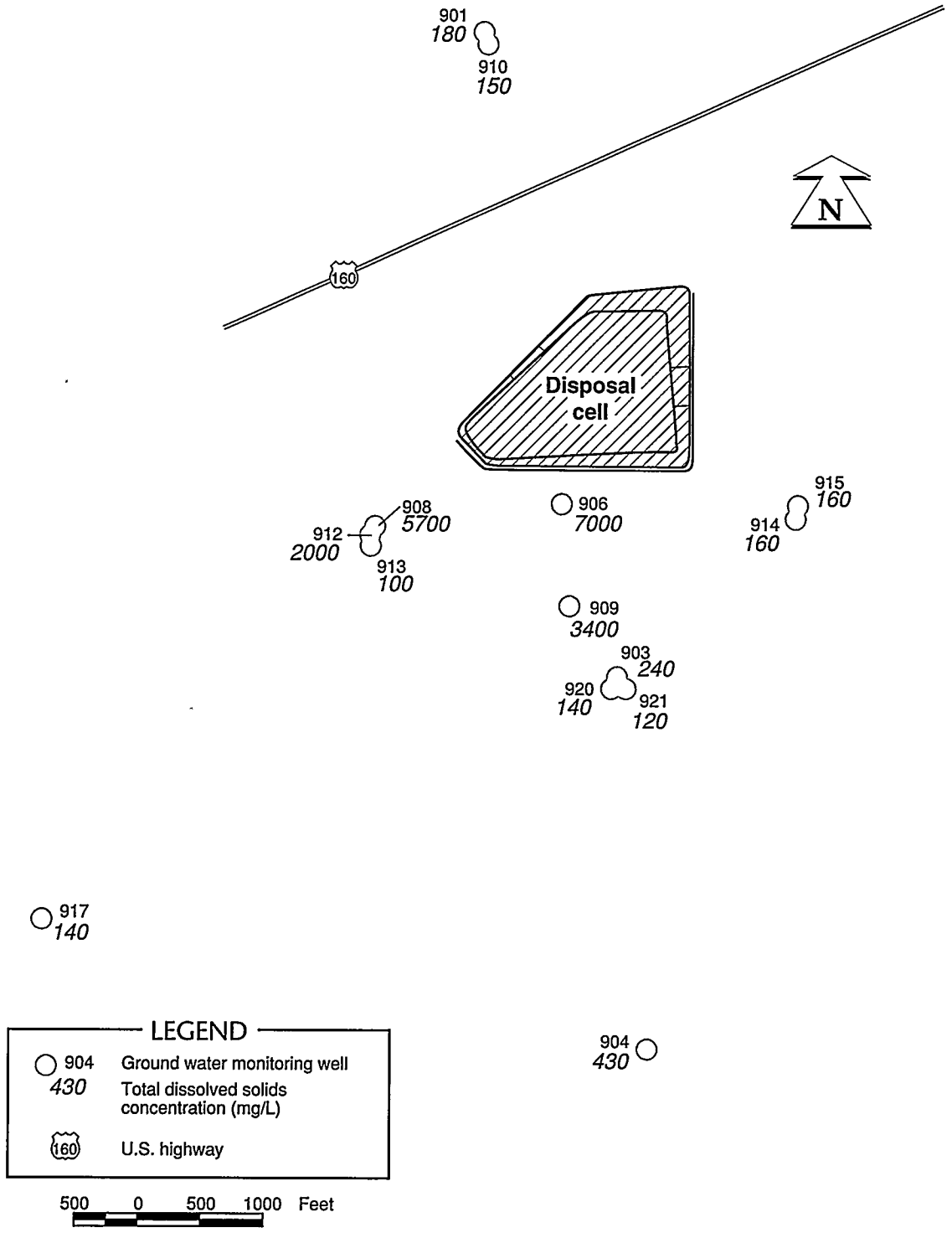
[a]Ground water samples were collected August 1994. Results are reported in milligrams per liter.
[b]Secondary Drinking Water Standard.
[c]Maximum concentration limit.

< indicates actual level is less than the detection limit (number shown).

Ground Water Conclusions

Ground water near the Tuba City disposal cell has been contaminated as a result of the former uranium processing activities. Ground water quality conditions immediately downgradient of the disposal cell (in the vicinity of monitoring well 906) show a significant increase in chloride, sulfate, total dissolved solids, and uranium concentrations. This trend is caused by the release of tailings pore fluids (transient drainage) into the aquifer. The continued transient drainage of contaminated water from the disposal cell is expected to last for the next several years. However, the concentrations pose no risk to public health and the environment at this time because ground water is not being used for domestic or industrial purposes.

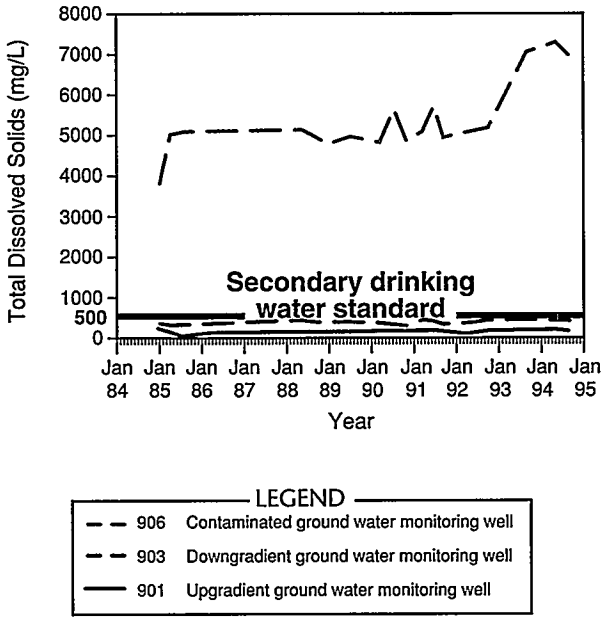
Figure 5-12
Total Dissolved Solids in Ground Water, Disposal Site



ASER95/TUB/TDSCONTAM

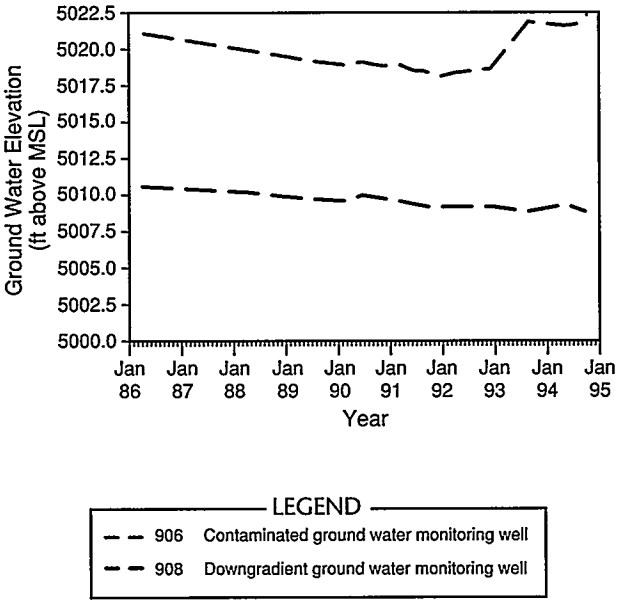
Note: Data collected August 1994.

Figure 5-13
Total Dissolved Solids in Ground Water Over Time, Disposal Site



ASER95/TUB/TDS

Figure 5-14
Trends in Ground Water Levels Over Time, Disposal Site



ASER95/TUB/GWELEV

REFERENCES

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material*, U.S. Nuclear Regulatory Commission.

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

United States Code

42 USC §4321 *et seq., National Environmental Policy Act.*

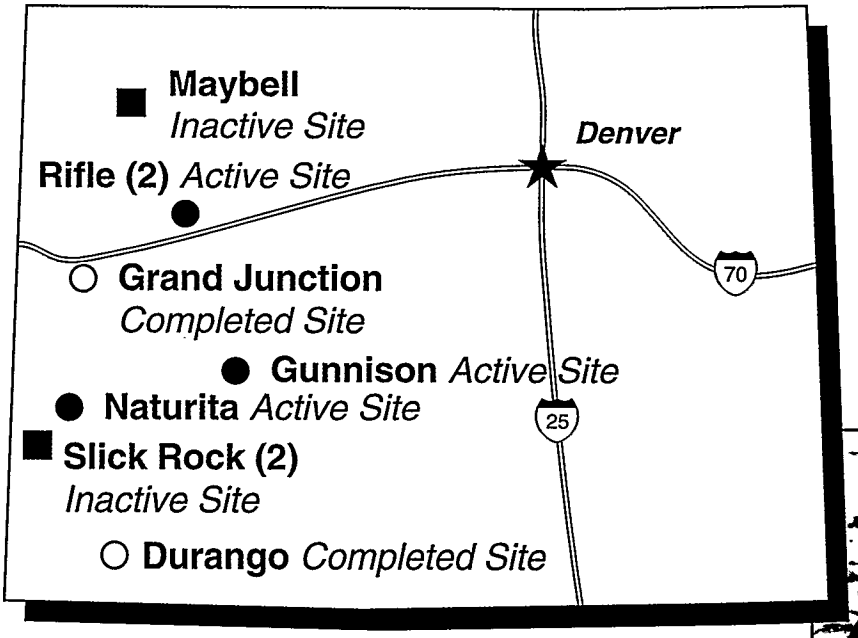
42 USC §7901 *et seq., Uranium Mill Tailings Radiation Control Act of 1978.*

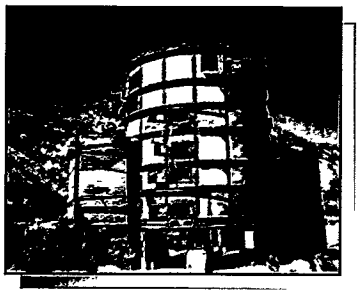
42 USC §11001 *et seq., Emergency Planning and Community Right-to-Know Act.*

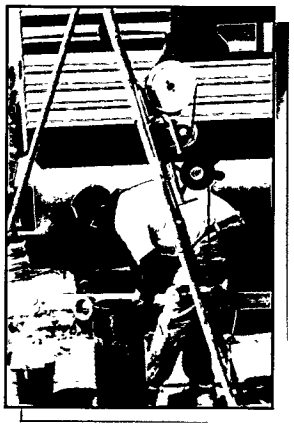
49 USC §1801 *et seq., Hazardous Materials Transportation Act.*

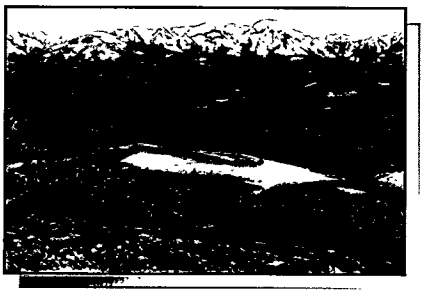
UMTRA PROJECT

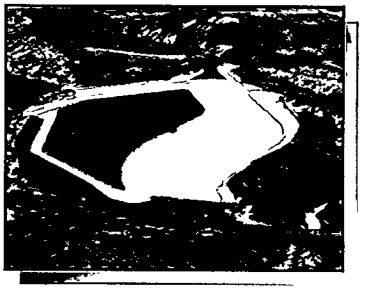
Chapter 6
Colorado Sites











COLORADO SITES

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at the Durango, Grand Junction, Gunnison, Maybell, Naturita, Slick Rock, and Rifle, Colorado, sites during 1994. There are two UMTRA Project sites at both Rifle and Slick Rock, making a total of nine UMTRA sites in the state of Colorado.

Numerous documents describe the environmental and construction details of surface remediation at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Durango

The Durango site is in La Plata County in southwestern Colorado. Site remediation was completed in May 1991. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Grand Junction

The Grand Junction site is in Mesa County in northwestern Colorado. The tailings haul from the processing site to the disposal cell is complete. The disposal cell is still open to receive residual radioactive material from Grand Junction vicinity properties. During 1994, air was monitored for thorium-230 particulates and radon-222. Environmental gamma radiation monitoring was conducted as well. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Gunnison

The Gunnison site is in Gunnison County in western Colorado. The site is undergoing remedial action. During 1994, air was monitored for total suspended particulates, thorium-230 particulates, and radon-222. Environmental gamma radiation monitoring was conducted as well. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Maybell

The Maybell site is in Moffat County in northwestern Colorado. Site remedial action is scheduled to begin in 1995. Because remediation at the Maybell site is in the planning stage, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Naturita

The Naturita site is in Montrose County in western Colorado. Site demolition began during the summer of 1994. During 1994, air was monitored for thorium-230 particulates and radon-222. Environmental gamma radiation monitoring was conducted as well. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Rifle

The two Rifle sites are in Garfield County in northwestern Colorado. The New Rifle site is undergoing remedial action. Tailings cleanup and haul at the Old Rifle site have been completed. During 1994, air was monitored for total suspended particulates, thorium-230 particulates, and radon-222. Environmental gamma radiation monitoring was conducted at the New and Old Rifle sites. In addition, surface water and ground water were monitored for radiological and nonradiological constituents at both the New and Old Rifle sites. Only the constituents defined as indicator parameters for these sites are discussed here.

Slick Rock

The two Slick Rock sites are in San Miguel County in southwestern Colorado. Site remedial action is scheduled to begin in the Spring of 1995. Because remediation at the Slick Rock site is in the planning stage, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

SITE DESCRIPTION AND LOCATION

The Durango UMTRA Project site includes the former processing site (the former mill/tailings pile site and raffinate pond area) and the Bodo Canyon disposal site.

The mill/tailings site and raffinate pond area are on the west bank of the Animas River, immediately southwest of the intersection of U.S. Highways 160 and 550, southwest of Durango in La Plata County, Colorado. The disposal site is approximately 1.5 mi farther southwest, in a mountain valley near Bodo Canyon (*Figure 6-1*). The mill/tailings site encompasses approximately 40 ac on a bedrock-supported river terrace between Smelter Mountain to the west, the Animas River to the east, and Lightner Creek to the north.

The northern edge of the raffinate pond area, which covers approximately 17 ac of the river terrace, is approximately 2000 ft south of the southern end of the mill/tailings site. The two areas are geologically and hydrologically separated. The Animas River borders the northeastern half of the site, and U.S. Highway 160/550 runs along the southeastern half. A small, intermittent creek (South Creek) forms the southern boundary of the raffinate pond area.

The Bodo Canyon disposal cell is in a southwest-to-northeast trending valley. The valley is bordered on both its northern and southern flanks by bedrock-supported ridges. Eastward-flowing arroyos to the north and south of the two flanking ridges are dry during much of the year. The 1990 census reported a county population of 32,284. The population of the city of Durango was 12,430 (DOC, 1990).

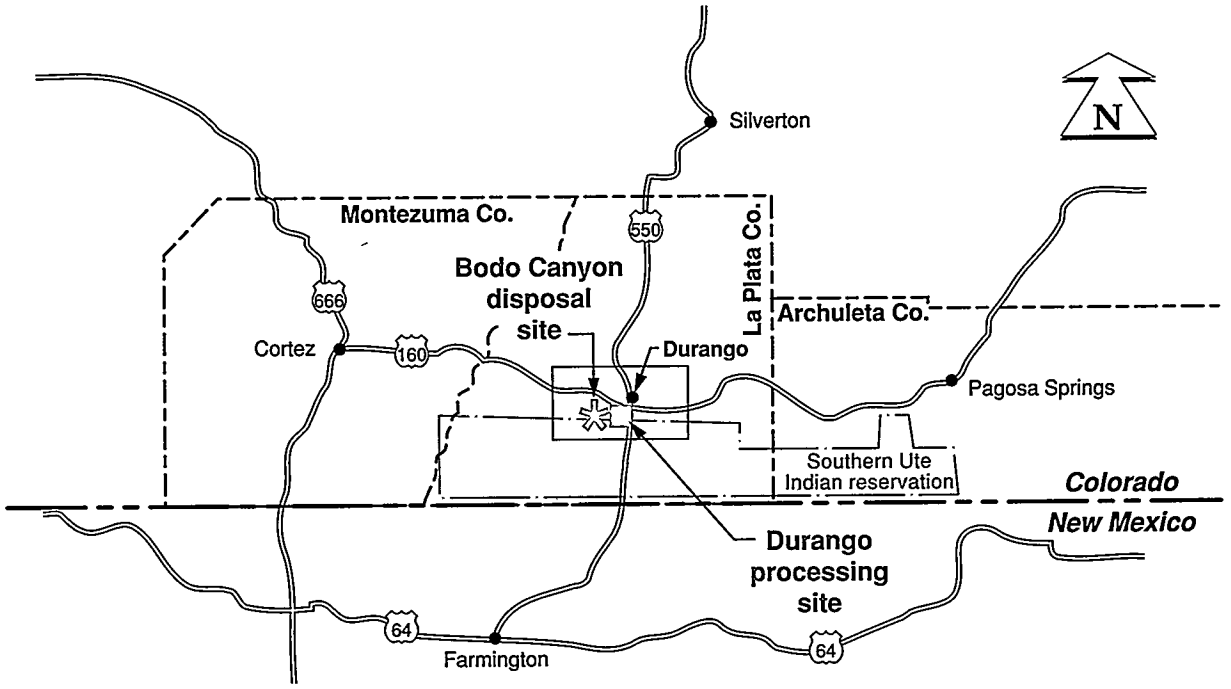
Southwestern Colorado is climatically classified as a midlatitude steppe characterized by warm summers, cool springs and autumns, and moderately cold winters. The average annual temperature recorded at the National Weather Service Station in Durango is 46.8 °F. Temperatures usually reach or exceed 90 °F about 18 days each year, and are below 0 °F about 10 days each year. Annual average precipitation is about 18 inches.

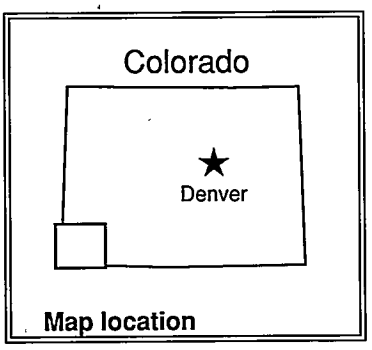
SITE HISTORY AND OWNERSHIP

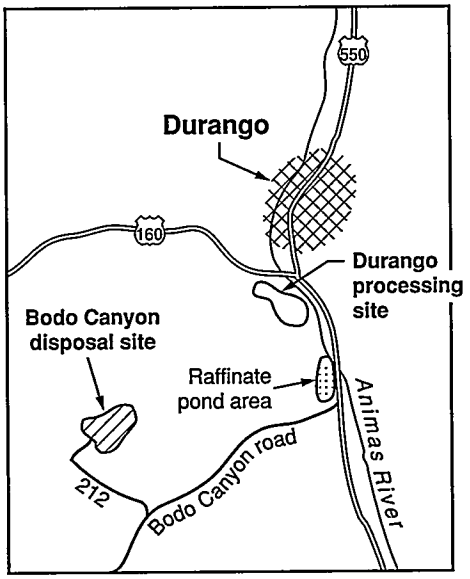
A lead smelter located near the south end of the mill/tailings site operated from 1880 to 1930. There is still slag from the smelter operation in the southeast corner of the site along the Animas River.

In 1942, U.S. Vanadium Corporation leased the property and constructed a uranium processing mill on the site. The mill operated until 1946, when the mill was shut down. In 1949, Vanadium Corporation of America leased and subsequently purchased the processing site. The Vanadium Corporation of America operated the mill and sold uranium to the U.S. Atomic Energy Commission until March 1963, when the mill shut down permanently. Ranchers Exploration and Development Corporation purchased the mill in 1977.

Figure 6-1
Durango Processing and Disposal Site Locations, La Plata County







NOT TO SCALE

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Hecla Mining Company acquired Ranchers Exploration and Development Corporation in July 1984.

Between 1942 and 1963, the uranium mill processed approximately 1.6 million tons of ore. From 1942 to 1959, the ore was salt-roasted, using sodium chloride, then quenched in sodium carbonate. The tailings were acid-leached with sulfuric acid and oxidizers. The acid-leach liquor was treated by solvent extraction, using kerosene and amines to recover vanadium and uranium. The principal wastes from the process included vanadium precipitation liquor, raffinate from the organic solvent extraction process, overflow from alkaline leach tanks, iron and aluminum sludge, and acid leach tails. Tailings were disposed of in two piles northwest of the mill. Until 1959, waste liquors were discharged directly into the Animas River or Lightner Creek without treatment.

After 1959, raffinate from the solvent extraction process flowed into a series of ditches and a system of 10 ponds at the raffinate pond area south of the mill site. The ponds were designed to dispose of the raffinate through evaporation and seepage, with no direct discharge to the river.

The Bodo Canyon disposal site was used as pasture land and managed by the U.S. Department of the Interior, Bureau of Land Management. No mining, milling, or other industrial activities occurred in the valley before the disposal cell was established. The disposal site was deeded to the state of Colorado. Prior to licensing the state of Colorado will transfer the site to the federal government.

SITE CHARACTERIZATION AND CLEANUP

In March 1987, DOE initiated remedial action to relocate the tailing piles and the contaminated soils from the mill/tailings site and raffinate pond area to the Bodo Canyon disposal site. Relocation was completed in May 1991.

Residual radioactive materials, including tailings, subpile soils, surficial materials from the mill yard, windblown materials, soils from vicinity properties, soil from the raffinate pond area, contaminated building foundations, the lead smelter stack, rubble, and debris were removed and buried at the disposal site. In the disposal cell, materials with relatively low concentrations of radium-226 were placed on top of materials with higher concentrations. This design provides additional shielding from both gamma radiation and radon.

After the residual radioactive material was removed from the Durango site, the site was backfilled with approximately 230,000 cubic yards of uncontaminated soil, contoured for drainage, and reseeded with native vegetation. The haul road between the processing site and the disposal site was scanned during and after remedial action to ensure it had not

become contaminated. River bank areas susceptible to erosion were lined with riprap (rock).

Supplemental standards were applied to three areas at the processing site (40 CFR Part 192): two locations along the banks of the Animas River (where removing the tailings would cause more environmental harm than leaving them in place), and one location on the face of Smelter Mountain. Safety concerns associated with removing the small area of tailings on Smelter Mountain outweighed the health risks associated with leaving the material in place.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Durango site complete, the remaining surface-related compliance issues are NRC licensing (10 CFR Part 40) and continued surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring. Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected and analyzed to evaluate ground water contamination from the former uranium processing activities.

Clean Water Act

The Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division, has regulatory authority over all CWA activities in Colorado (33 USC §1251 *et seq.*). In October 1994, drainage collected from the disposal cell was treated and discharged into the arroyo north of the disposal cell, in accordance with waste water discharge permit CO-0041548. An analysis of the treated water was conducted prior to release. The analytical results indicated all water released from the site was well below the applicable release criteria established by the state permit.

National Environmental Policy Act

In compliance with the NEPA (42 USC §4321 *et seq.*) a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Durango UMTRA site.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for contaminants in surface water and ground water at the Durango site. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Durango site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

Additionally, no surface water and sediment samples were collected in 1994.

Ground Water Monitoring

Processing Site

The Durango processing site consists of the former mill tailings area and the former raffinate ponds area (***Figure 6-2***). Ground water at the former mill tailings area moves toward the Animas River as a thin (less than 5-ft-thick) layer through the alluvium on top of the nearly impermeable Mancos Shale. The low permeability of the shale limits downward ground water movement. At the former raffinate ponds area, ground water moves toward the Animas River through the alluvium and the relatively permeable underlying sandstone.

Water levels were measured and ground water samples were collected in June and October/November 1994. In June, samples were collected from the following sources:

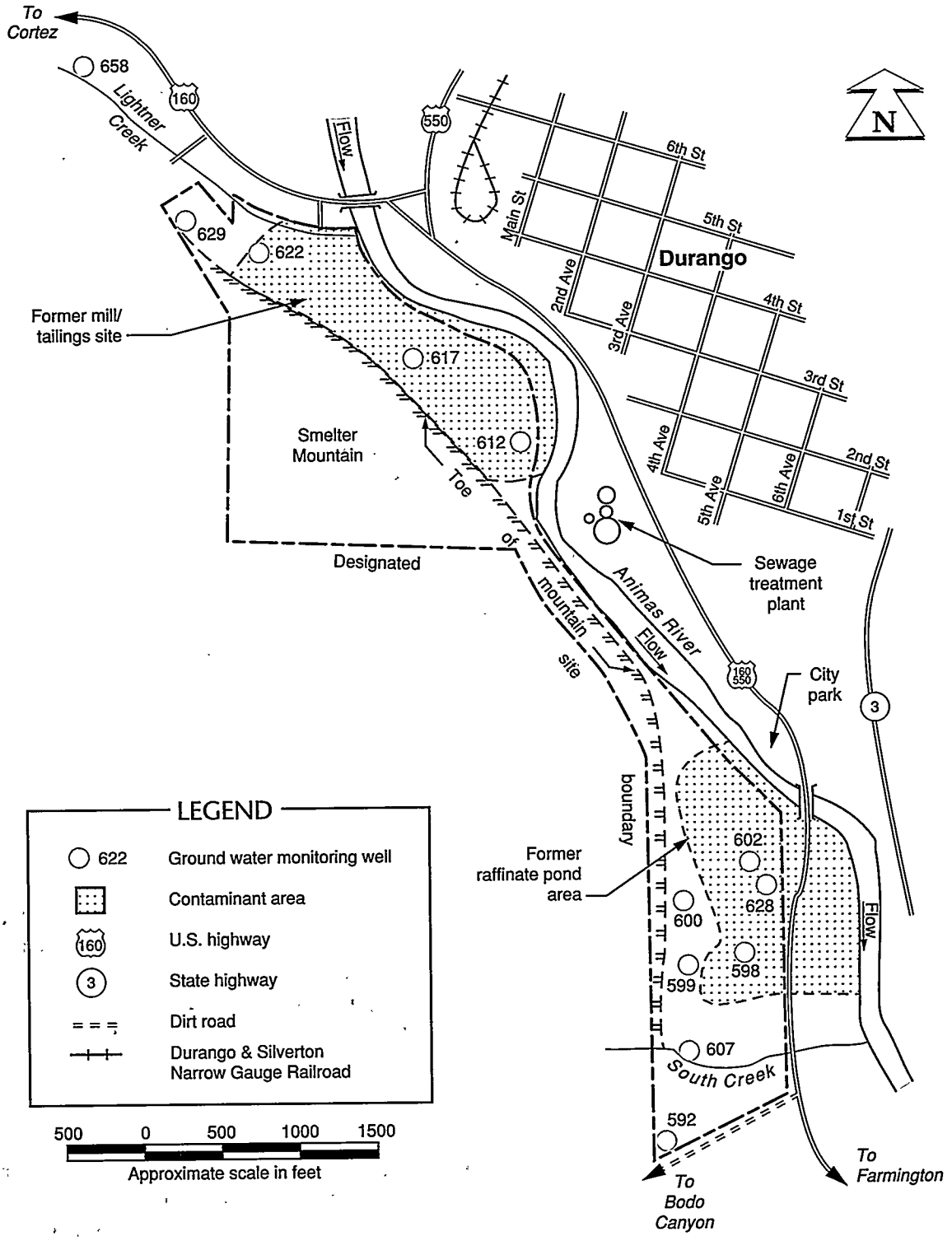
- Wells 629 and 658 (background).
- Wells 602, 628, 612, 617, and 622 (downgradient from contaminant sources at former tailings pile and raffinate ponds area). See ***Figure 6-2***.
- Bureau of Reclamation wells 598, 599, and 600.
- Well 607 (at western edge of raffinate ponds area).

The Bureau of Reclamation supplied water quality data and supporting quality control information for their wells in the raffinate ponds area. Those wells are represented in the DOE database as monitoring wells 592 through 600, with well 592 representing background quality. The data are for the period from June 1993 to April 1994.

In October, ground water samples were collected from the same wells, with the exception of well 658, an irrigation well that was shut for the winter. Data from the June 1994 and the 1993 sampling rounds confirmed the reliability of the Bureau of Reclamation samples, and no additional sampling was necessary at those wells. To assess the areal distribution of contaminants at the mill tailings area and to compare the present water quality to that reported in wells abandoned during surface remediation, one round of samples was collected in October from piezometers 630, 631, 633, 634, and 635. The piezometer provided a wider coverage of the site (***Figure 6-2***) and can be compared to older wells.

Monitoring wells and piezometers were used to measure ground water elevations. Surface water elevations in Lightner Creek and the Animas River were measured to evaluate ground water and surface water

Figure 6-2
Ground Water Monitoring Well Locations, Processing Site



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interactions. Qualitative aquifer tests were performed by conducting short pumping and recovery tests in wells 602, 612, and 617, as well as piezometers 630, 631, and 633. Changes in water levels were also recorded during sampling. The ground water flow pattern at the tailing site in June 1994 is shown in ***Figure 6-3***. Representative ground water contours at the raffinate pond area are shown in ***Figure 6-4***.

Ground Water Results. The ground water samples from the processing site were analyzed for the following parameters: alkalinity, arsenic, cadmium, calcium, chloride, iron, magnesium, manganese, molybdenum, nitrate, potassium, selenium, silica, sodium, sulfate, total dissolved solids, uranium, vanadium, zinc, lead-210, polonium-210, radium-226, radium-228, pH, reduction-oxidation potential, turbidity, dissolved oxygen, and specific conductance. Total dissolved solids, chloride, sulfate, and uranium are considered indicator parameters of ground water contamination caused by the former uranium milling operations. ***Table 6-1*** gives the water quality data on these four indicator parameters from background and upgradient wells (592, 607, 629, and 658) and plume wells (598, 617, and 628).

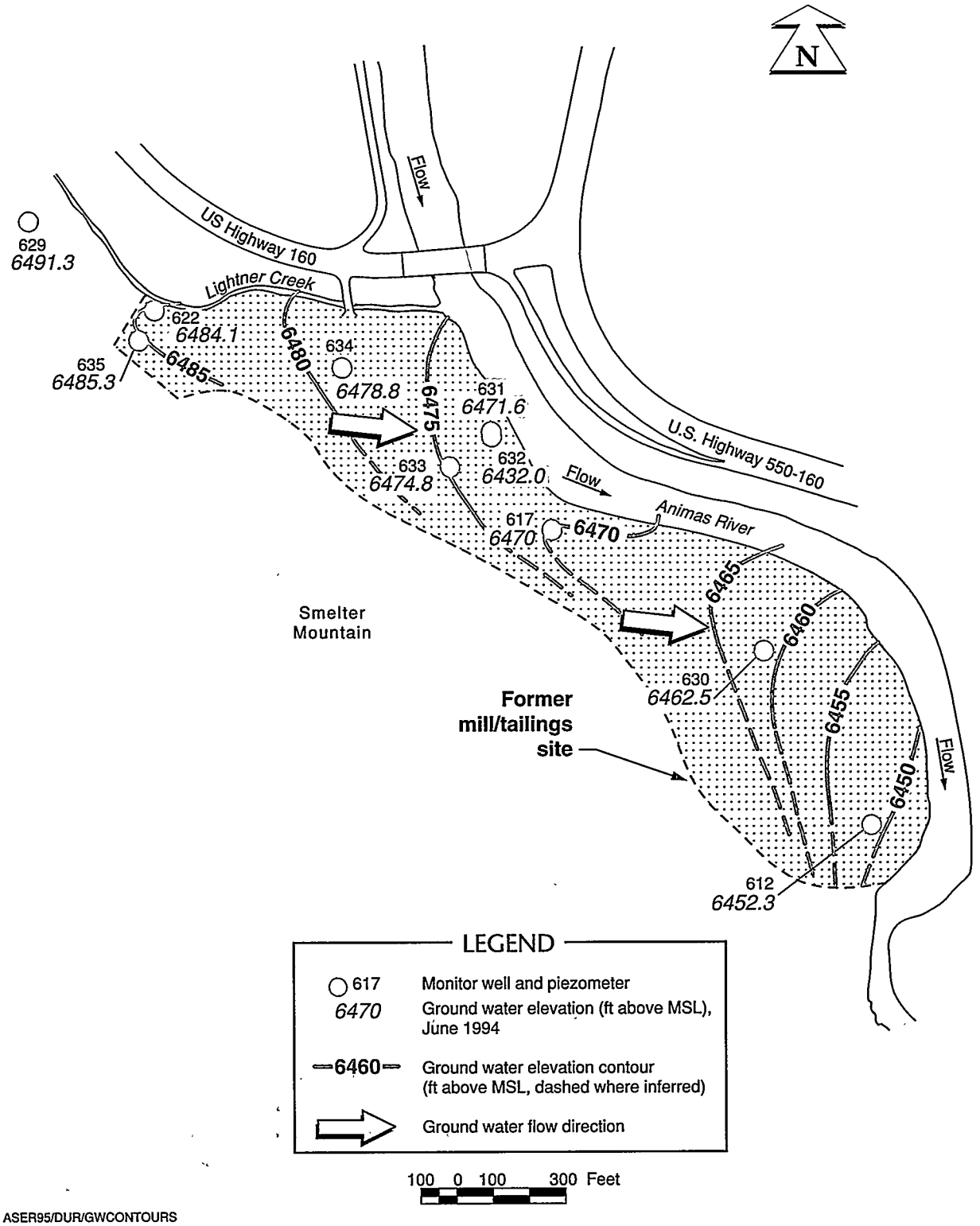
Ground Water Conclusions. Ground water contours and their relationship to the surface water in Lightner Creek and the Animas River are shown in ***Figures 6-3 and 6-4***. The flow pattern indicates that water from Lightner Creek and the Animas River moves into the northern portion of the mill tailings area and discharges back into the Animas River along the southern part of that area. Ground water moving beneath the site along the base of Smelter Mountain joins this flow.

Ground water beneath the raffinate pond area discharges into the Animas River. The Animas River is incised into the bedrock along this stretch of the river and does not recharge the aquifer.

Ground water samples collected in previous years from the wells downgradient of the sources of contamination at the processing site show the ground water is contaminated by the former uranium milling activities. Hydrogeologic information on the aquifer characteristics, however, indicates that the amount of ground water discharging to the Animas River is relatively small compared to the flow in the river.

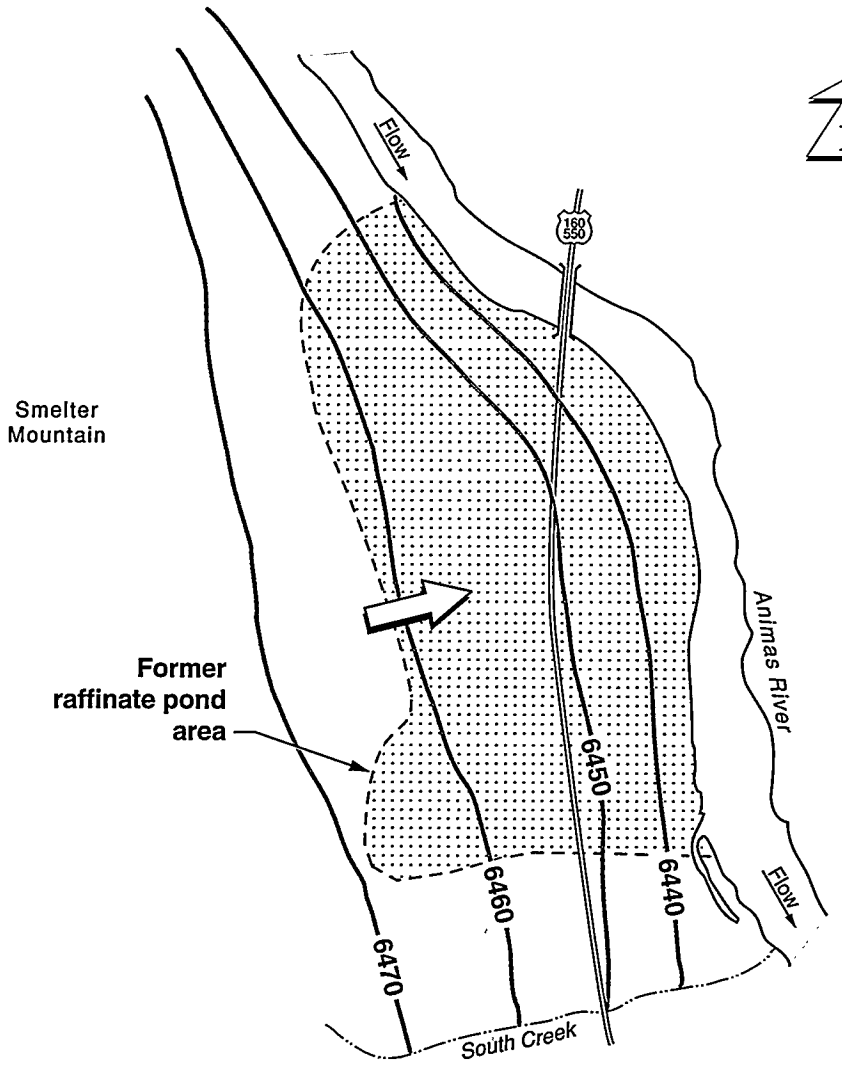
Analytical data also show constituent concentrations at the former mill tailings site remain fairly constant, although the plume does appear to be migrating downgradient to the south. Sulfate and uranium concentration levels have decreased over time at the raffinate pond area, which suggests that ground water moving beneath the site and *in situ* reactions between the aquifer and the ground water are removing these contaminants from the ground water (***Figures 6-5 and 6-6***).

Figure 6-3
Ground Water Table of the Mill Tailings Area, Disposal Cell



ASER95/DUR/GWCONTOURS

Figure 6-4
Ground Water Table Contours of the Raffinate Pond Area, Processing Site



Note: This figure represents conditions before surface remediation began as determined by U.S. Bureau of Reclamation, April 1990.

LEGEND

—6440— Ground water elevation contour (ft above MSL)

Ground water flow direction

Ephemeral stream

160
550
U.S. highway

200 0 200 400 600

Approximate scale in feet

ASER95/DUR/GWCONTOURMAP

Table 6-1 Ground water quality results, processing site

Indicator parameter	Guideline	Mill tailings area			Raffinate ponds area			
		629 background	658 background	617 downgradient	592 background	607 upgradient	602 downgradient	628 downgradient
TDS	500[a]	3,500	NA	4,060	1,700	1,265	12,660	14,600
Chloride	250[a]	24	8	68	66	36	1,750	486
Sulfate	250[a]	1,860	83	2,200	680	534	5,690	8,030
Uranium	0.044[b]	0.002	0.002	0.29	<0.005	0.003	0.050	0.55

[a]Secondary drinking water standards.
[b]Maximum concentration limit.

Notes: 1. All data in milligrams per liter.
2. Well 592 sample collected in April 1994. All other samples collected in June 1994.
3. NA not analyzed.

Disposal Site

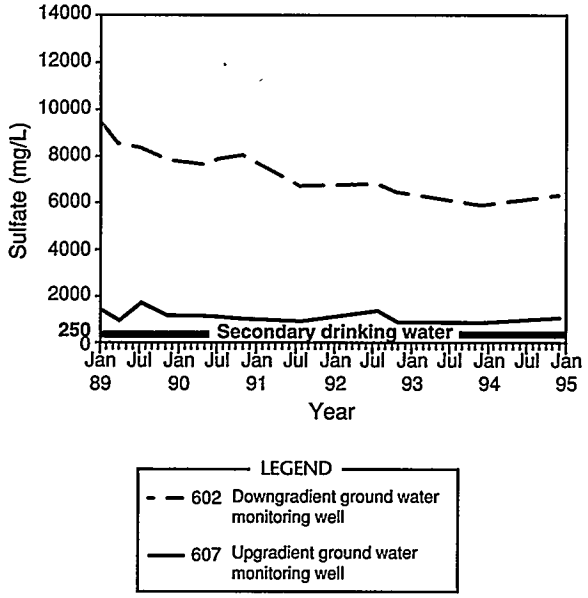
Ground water in the alluvium beneath the disposal cell moves northeast; in the sedimentary rocks underlying the alluvium, ground water moves southeast and northeast. Before the disposal cell was constructed, the Bodo Canyon site was used only as pasture. Therefore, all the monitoring wells originally were background wells.

Monitoring wells were sampled in June and October 1994 to determine whether changes in ground water quality indicate the movement of contaminants from the disposal cell. Ground water elevations were also measured before sampling to monitor how well the cell cover reduces seepage into the ground water.

In June 1994, ground water samples were collected from upgradient alluvial monitoring well 623 and upgradient bedrock wells 605 and 625 (***Figure 6-7***). Samples were also collected from downgradient alluvial wells 606, 608, 618, and 620, and downgradient bedrock monitoring wells 607, 612, 616, and 621. Wells 605, 607, 612, and 621 are proposed point-of-compliance wells. In October, samples were collected from all three wells except 606 and 625.

Ground Water Results. These samples were analyzed for the following parameters: alkalinity, arsenic, cadmium, calcium, chloride, cobalt, iron, lead, magnesium, manganese, molybdenum, nitrate, potassium, selenium, silica, sodium, sulfate, total dissolved solids, uranium, vanadium, zinc, gross alpha, gross beta, radium-226, radium-228, pH, reduction-oxidation potential, turbidity, dissolved oxygen, specific conductance and temperature. Total dissolved solids, sulfate, and uranium are considered indicator parameters of ground water contamination. ***Table 6-2*** lists the water quality data on these three parameters from upgradient well 623 in the alluvium and point-of-compliance well 605 in the bedrock, and downgradient well 608 in the alluvium and point-of-compliance wells 607, 612, and 621 in the bedrock for the November 1993 sampling event.

Figure 6-5
Sulfate Concentrations Over Time,
Raffinate Pond Area, Processing Site



ASER95/DUR/SULOTRAFF

Figure 6-6
Uranium Concentrations Over Time,
Raffinate Pond Area, Processing Site

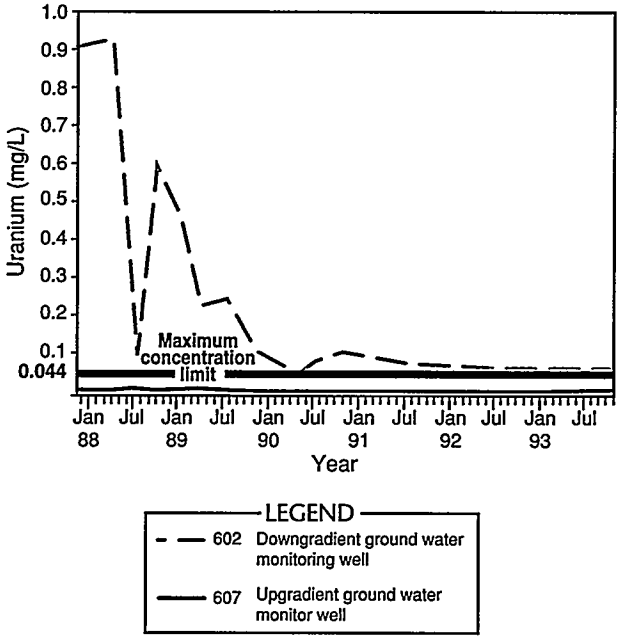


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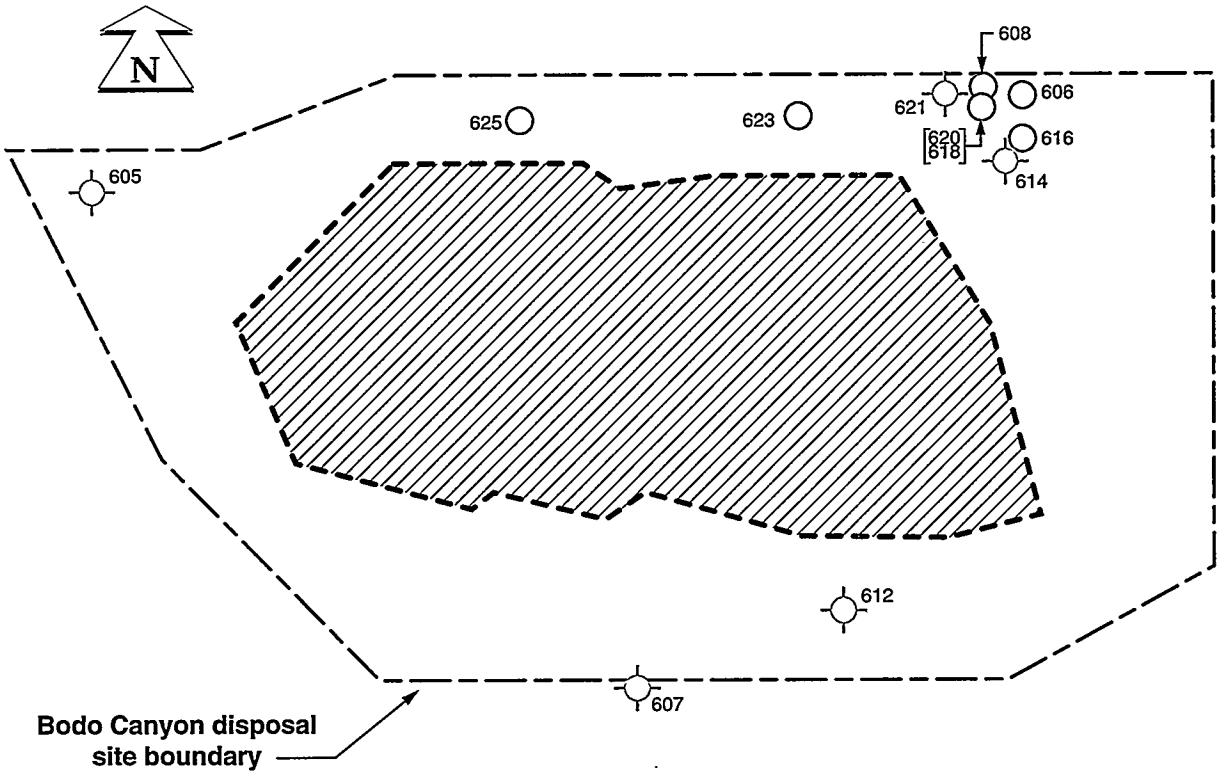
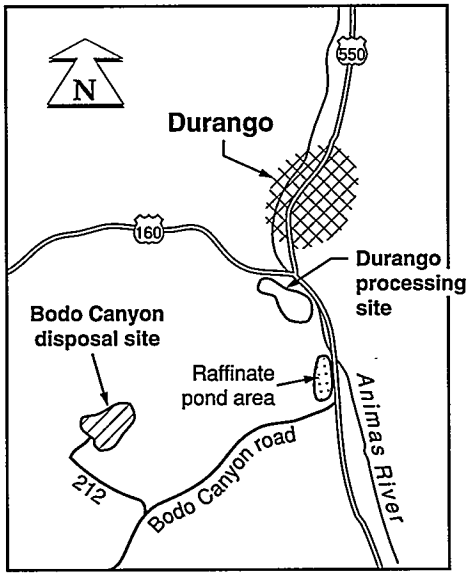
Figure 6-7
Ground Water Monitoring Well Locations, Disposal Cell





LEGEND

625 ○	DOE ground water monitoring well
612 -⊕-	Proposed point-of-compliance well
[620] [618]	Nested pair of ground water monitoring wells
- - - -	Approximate outline of disposal cell
550	U.S. highway

200 0 200 400
Approximate scale in feet

ASER95/DUR/LOCSMONWELLS

Table 6-2 Ground water quality results, disposal cell

Indicator parameter	Guideline	Monitoring location: Alluvium 623 (upgradient)	Alluvium 608 (downgradient)	Bedrock 605 (upgradient)	Bedrock 607 (downgradient)	Bedrock 612 (downgradient)	Bedrock 621 (downgradient)
Total dissolved solids	500[a]	2510	1750	1900	3550	2750	5590
Chloride	250[a]	23	25	25	25	29.4	9
Sulfate	250[a]	1340	882	786	2000	750	3670
Uranium	0.044[b]	<0.002	0.004	<0.001	<0.002	0.002	<0.005

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: 1. October 1994 sampling event. Concentrations are reported in milligrams per liter.

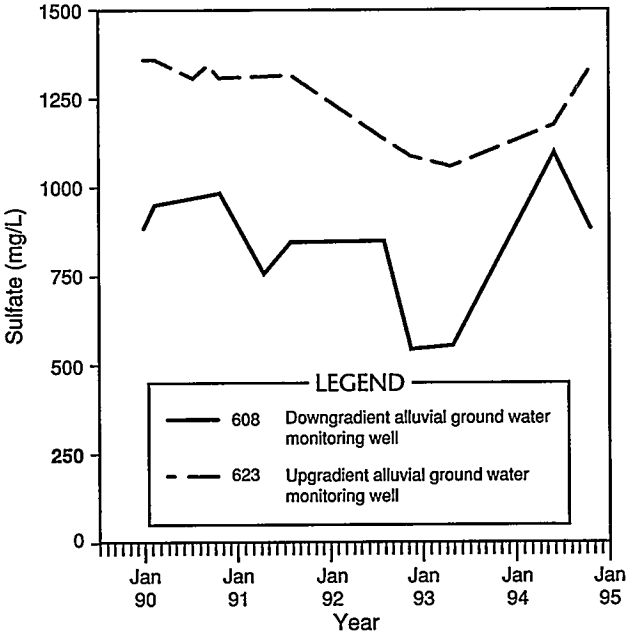
< indicates actual is less than the detection limit (number shown).

Historic trends in concentration versus time for sulfate and uranium in the upgradient and downgradient alluvial and bedrock wells (***Figures 6-8 and 6-9***) show that concentrations do not increase downgradient of the disposal cell.

Ground water elevations from upgradient and downgradient alluvial wells 623 and 608, respectively, are plotted in ***Figure 6-10***. Although these water level measurements in upgradient and downgradient alluvial wells do not indicate lowered water levels in the disposal cell, they may indicate that the magnitude of the water level fluctuations in downgradient wells has been reduced since the disposal cell was constructed.

Ground Water Conclusions. The samples collected in 1994 confirm earlier findings: no trends indicating increasing contamination from the disposal cell have been detected.

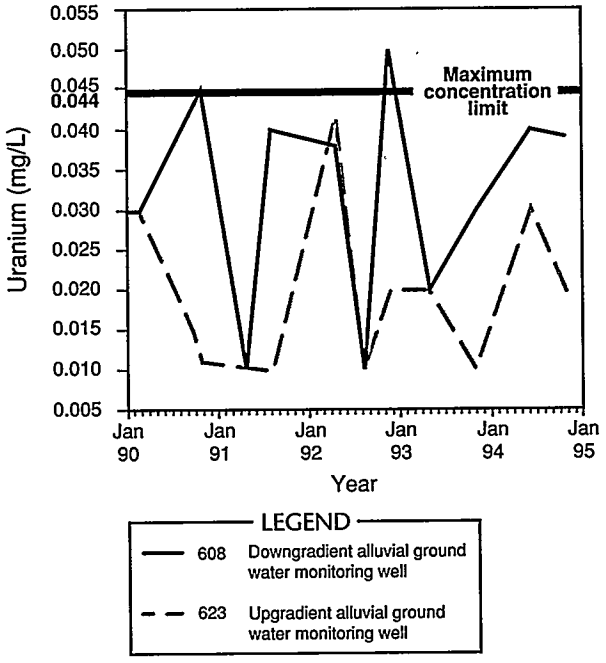
Figure 6-8
Sulfate Concentrations Over Time, Alluvial Wells, Disposal Site



Note: Secondary drinking water standard = 250.

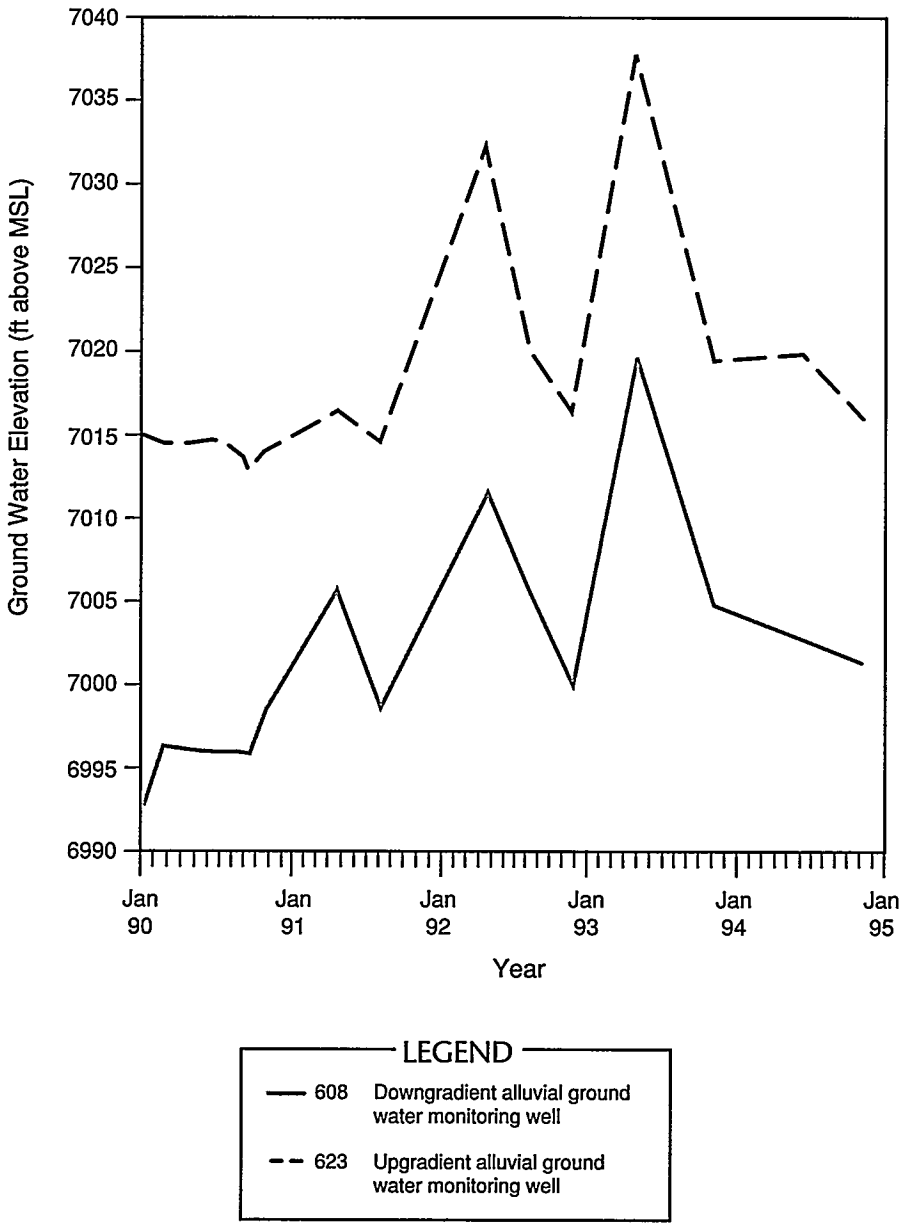
ASER95/DUR/SULOTDIS

Figure 6-9
Uranium Concentrations Over Time, Alluvial Wells, Disposal Site



ASER95/DUR/URNOTDIS

Figure 6-10
Ground Water Elevations, Alluvial Wells, Disposal Site



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SITE DESCRIPTION AND LOCATION

The Grand Junction UMTRA Project processing site is in Mesa County, Colorado, immediately south and east of Grand Junction city limits (a portion of the site is within city limits). The site lies in the floodplain along the north side of the Colorado River, about 0.75 mi upstream from the confluence of the Colorado and Gunnison Rivers (*Figure 6-11*). The site is in the Grand Valley, a major structural feature on the northeastern flank of the Uncompahgre Uplift.

The Cheney disposal cell is approximately 18 mi south of Grand Junction, 2 mi due east of State Highway 50. The site sits on terraced deposits below the Grand Mesa, approximately 6 mi due east of the Gunnison River (*Figure 6-11*).

The 1990 populations of Mesa County and Grand Junction were 93,145 and 29,034, respectively (DOC, 1990).

Summer days with maximum temperatures near 90 °F and minimum temperatures near 60 °F are common. Monthly average temperatures range from 26.6 °F in January to 78.7 °F in July. Summer rains occur mainly as scattered intense showers from thunderstorms that develop over the nearby mountains. Winter snows are fairly frequent; however, they are mostly light and the snow melts quickly.

The average annual precipitation for Grand Junction is 8.4 inches. Snowfall at Grand Junction averages 26.5 inches.

The prevailing winds are from the east-southeast and average 8 mi per hour (*Figure 6-12*). The distribution is constant throughout the year because of the dominant, valley-induced upslope and downslope flows.

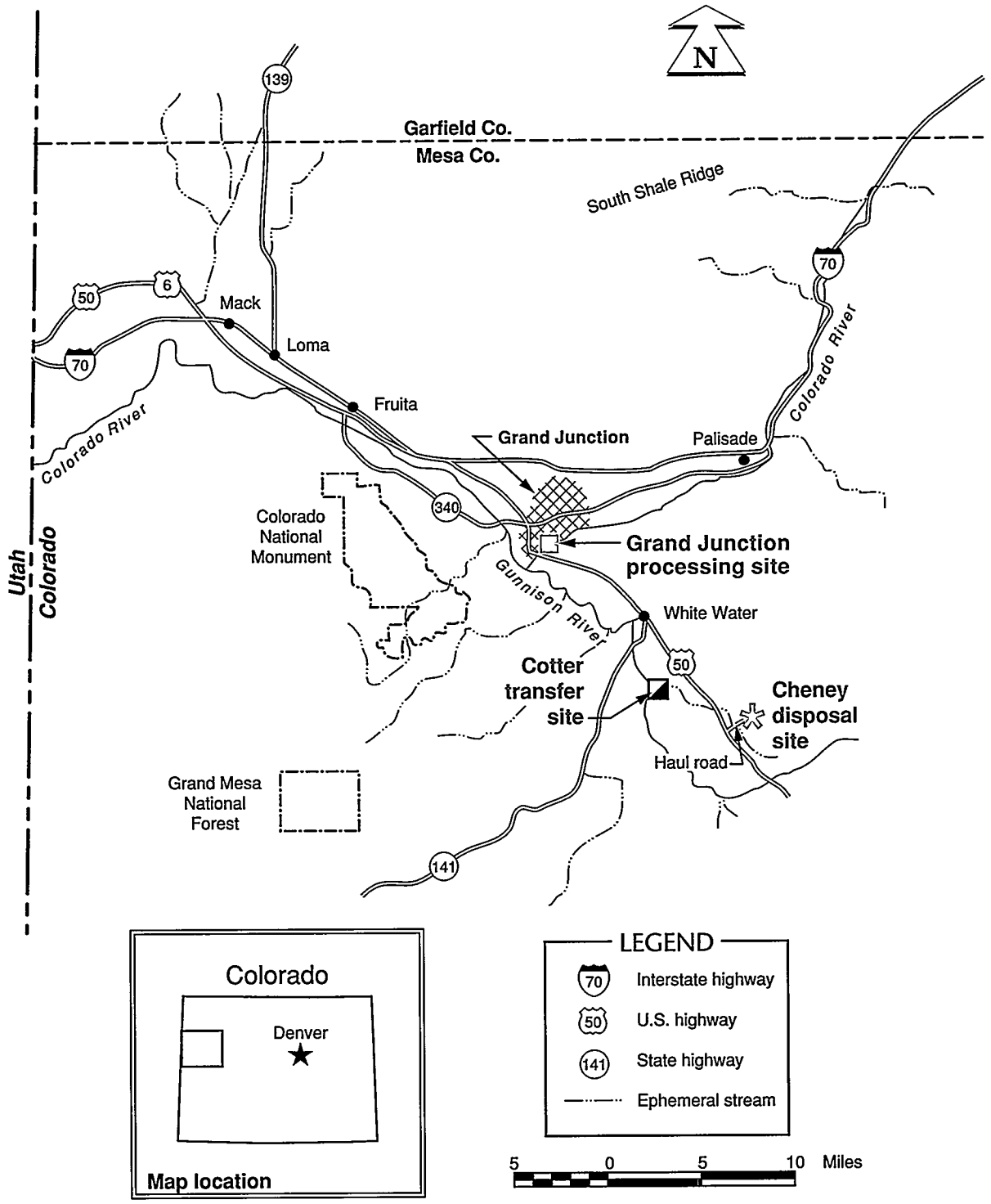
SITE HISTORY AND OWNERSHIP

The Climax Uranium Company opened the mill in Grand Junction in 1951. It was designed and built for uranium production, with by-product vanadium production. The mill's processing capacity was 330 tons of ore per day in 1951, which increased to 500 tons per day in 1955. A solvent-extraction circuit was added in 1956. The mill process involved ore neutralization, sand/slime separation, and treatments for sand and slime. An acid-leaching and solvent extraction process recovered uranium from the sand. The slimes were salt-roasted, then water-leached to remove vanadium, and finally acid-leached with a solvent-extraction step to extract uranium and the remaining vanadium.

In 1960, the Climax Uranium Company was incorporated into American Metals Climax, Inc., which operated the mill until February 1970.

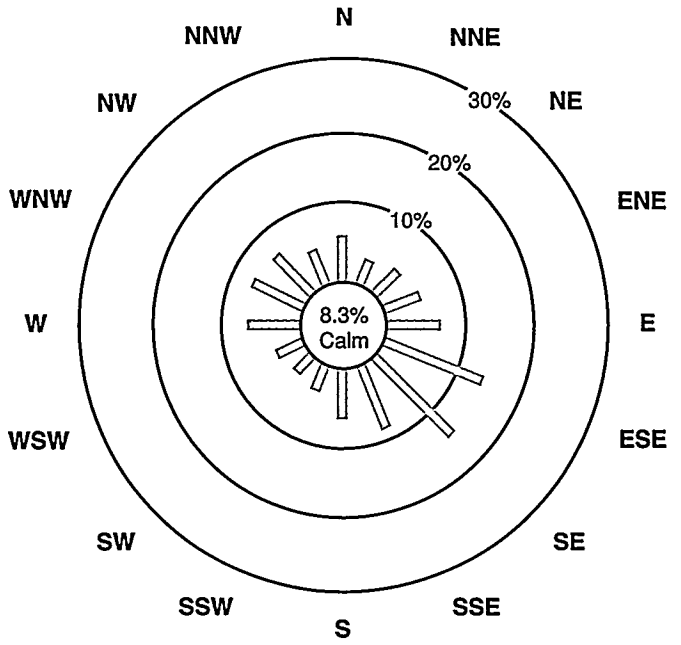
Approximately 4.6 million dry tons of tailings were produced at the Grand Junction mill. Climax released approximately 500,000 cubic

Figure 6-11
Grand Junction Site Location



ASER95/GRJ/SITELOC

Figure 6-12
Wind Rose



Ref: Grand Junction Airport.
Cumulative data 1948 through 1956.

ASER95/GRJ/WINDGRJ

yards of tailings to private individuals and contractors for use as construction fill material from 1951 to 1966.

The mill was dismantled and the tailings pile was stabilized from late 1970 to early 1971. Contaminated materials remediated from vicinity properties in the Grand Junction area were stored in the evaporation ponds east of the tailings pile.

The state of Colorado owns the Grand Junction site. The DOE owns the Cheney disposal site.

SITE CHARACTERIZATION AND CLEANUP

Remedial action for the Grand Junction site entailed excavating all residual radioactive materials from the site. The materials were transported by train to the Cotter transfer site near Whitewater, a community 10 mi southeast of Grand Junction. At the Cotter transfer site, the tailings containers were transferred from the train to trucks. Trucks transported the tailings containers on a specially constructed haul road to the Cheney disposal site. Train transport activities at the Grand Junction mill tailings site were completed in September 1993. Since then all residual radioactive material has been transported by truck.

Phase I remedial action, which involved fencing, constructing retention ponds, and preparing the wastewater treatment plant foundation at the process site, was completed in 1989.

Phase II construction began in 1990 and included constructing the disposal cell and assembling the wastewater treatment plant. Tailings movement started in the spring of 1991. Remedial action at the Grand Junction processing site was completed in 1994.

At the Cheney site, the residual radioactive materials were placed in a single disposal cell. Frost barrier bedding material, a radon barrier, and rock layers on the sideslopes protect the pile from erosion. Residual radioactive materials from remediation of vicinity properties continue to be relocated to the Cheney disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Grand Junction complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure that they meet applicable regulatory requirements. In 1994, Grand Junction site environmental compliance activities included reporting quantities of hazardous materials used or stored at the site, monitoring wastewater discharges, spill prevention control and countermeasures planning, and adherence to transportation regulations, local regulations, and permits.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*), the Grand Junction site must comply with emergency planning and community right-to-know requirements. These requirements include notifications for threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

In 1994, the site was inventoried for all on-site stored materials in excess either of 10,000 pounds or of the threshold planning quantities for hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. It was submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Clean Water Act

The CDPHE, Water Quality Control Division, has regulatory authority over all CWA (42 USC §1251 *et seq.*) activities in Colorado.

National Pollutant Discharge Elimination System

Under the Colorado Discharge Permit System, the CDPHE issues wastewater and storm water permits to the Grand Junction site. Wastewater discharge permits were issued for the retention basins at the processing site and the disposal site. The disposal site wastewater permit (No. CO-0042391) is expected to be inactive in 1995. The disposal site storm water permit (No. COR-30192) has been extended to 1997. The three discharge points, or outfalls, for effluent water identified in the processing site wastewater permit (No. CO-0042536)

were inactivated in 1994. A report was sent to the CDPHE to terminate this permit in the spring of 1994.

All effluent generated at the processing site was treated by a wastewater treatment plant and was discharged to the city sewer system under permit No. 017, issued by the city of Grand Junction. During 1994, wastewater was discharged routinely into this local treatment facility. No other wastewater discharges occurred at the processing site or the disposal site. Discharge parameters were not exceeded in 1994.

Spill Prevention Control and Countermeasures Plan

In 1990, the earthen berms were designed and constructed around existing aboveground storage tanks and around drum storage areas at Grand Junction. These secondary containment systems provided adequate spill control. In addition, plans for berm inspection, spill detection, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas. The storage area at the processing site was dismantled in 1994, and the tanks were drained of contents and drummed materials removed. During 1994, no reportable spills occurred at the site.

Septic/Holding Tanks

The processing site used a septic tank and portable lavatories for sanitary sewage. These were removed in 1994. A septic tank at the disposal site holds gray water from sanitary facilities.

Clean Air Act

Total Suspended Particulates

The CDPHE, Air Pollution Control Division, has the regulatory authority to enforce CAA requirements. The state has adopted federal standards for total suspended particulate, including a 24-hour limit of 150 $\mu g/m^3$ and an annual limit of 60 $\mu g/m^3$ geometric mean. Because remediation at the Grand Junction processing site is complete, total suspended particulate monitoring was not required in 1994.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Grand Junction UMTRA site.

Hazardous Materials Transportation Act

Residual radioactive materials transported to the Cheney disposal site are subject to the requirements of the HMTA (49 USC §1801 *et seq.*). In 1994, approximately 430,000 cubic yards of residual radioactive materials were hauled from the processing site in compliance with all requirements of DOT exemption E-10594.

Environmental Permits

The Grand Junction site obtained and operated under all required permits in 1994. *Table 6-3* lists all permits active in 1994. Noncompliance notices were not issued in 1994.

Table 6-3 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permits (U.S. Army Corps of Engineers)					
Process site	07/88	10/88	01/89	9978	12/95
Kannah Creek[a]	12/89	11/89	02/90	9978	12/95
Colorado Discharge Permit System					
Process site wastewater[b]	04/89	12/89	05/90	CO-0042536	02/95
Disposal site wastewater	04/89	Final received	03/91	CO-0042391	12/95
Process site storm water (general)	09/92	Final received	10/92	COR-30263	06/97
Disposal site storm water (general)	09/92	Final received	08/92	COR-30192	06/97
Cotter site storm water (general)	09/92	Final received	10/92	COR-30262	06/97
Air emission notices					
Process site[h]	08/88	10/90	07/93	88ME250	NA
Disposal site	08/88	10/90	07/93	88ME247	NA
Disposal site screening plant[c]	07/91	09/91	NA	91ME598	NA
Surface water rights - Cheney[d]	08/88	Final received	12/88	92CW144	04/99
County floodplain (Mesa County)					
Process site[e]	07/88	Final received	09/88	F2-88	11/94
Floodplain permit repository (city of Grand Junction)[f]	07/88	Final received	03/90	13-90	NA
Ground water discharge permit (city of Grand Junction)[g]	05/91	Final received	05/91	017	05/95
Conditional use permits					
Mesa County truck/train	01/88	Final received	03/89	MCM88-30	04/94
Amendment for Cheney vicinity property	05/93	Final received	08/93	88-30(D)	09/96
Amendment for Grand Junction Project Office and Cheney	05/94	Final received	7/94	88-30(E)	NA

[a]Two included as amendment to permit number 9978.
[b]Inactive notice from CDPHE 11/07/94.
[c]Letter requesting termination sent to CDPHE 11/18/93.
[d]Was 88CW97, given conditional status.
[e]Expiration date extended.
[f]Issued to DOE Idaho, then MK-Ferguson; stays with property.
[g]Wastewater discharge to city sewage. Termination request to city 01/25/94.
[h]Termination request to CDPHE 05/17/94.

NA – Not applicable; permit is pending.

ENVIRONMENTAL MONITORING

The DOE conducted a detailed environmental monitoring program at the Grand Junction site in 1994, which included determining environmental gamma-dose equivalent and contaminant concentrations in air, surface water, and ground water. This program monitored the quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrated compliance with the applicable guidelines, and indicated the efficiency of environmental protection measures.

Air Monitoring

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the processing site was conducted at Stations 2 and 7, which were collocated with active radon gas monitoring stations (***Figure 6-13***). Stations 20, 25, and 28 (***Figure 6-14***) monitored the Cheney Reservoir disposal site. Because the Cotter Transfer site is now nonoperational, no radiological air particulate monitoring was conducted during 1994.

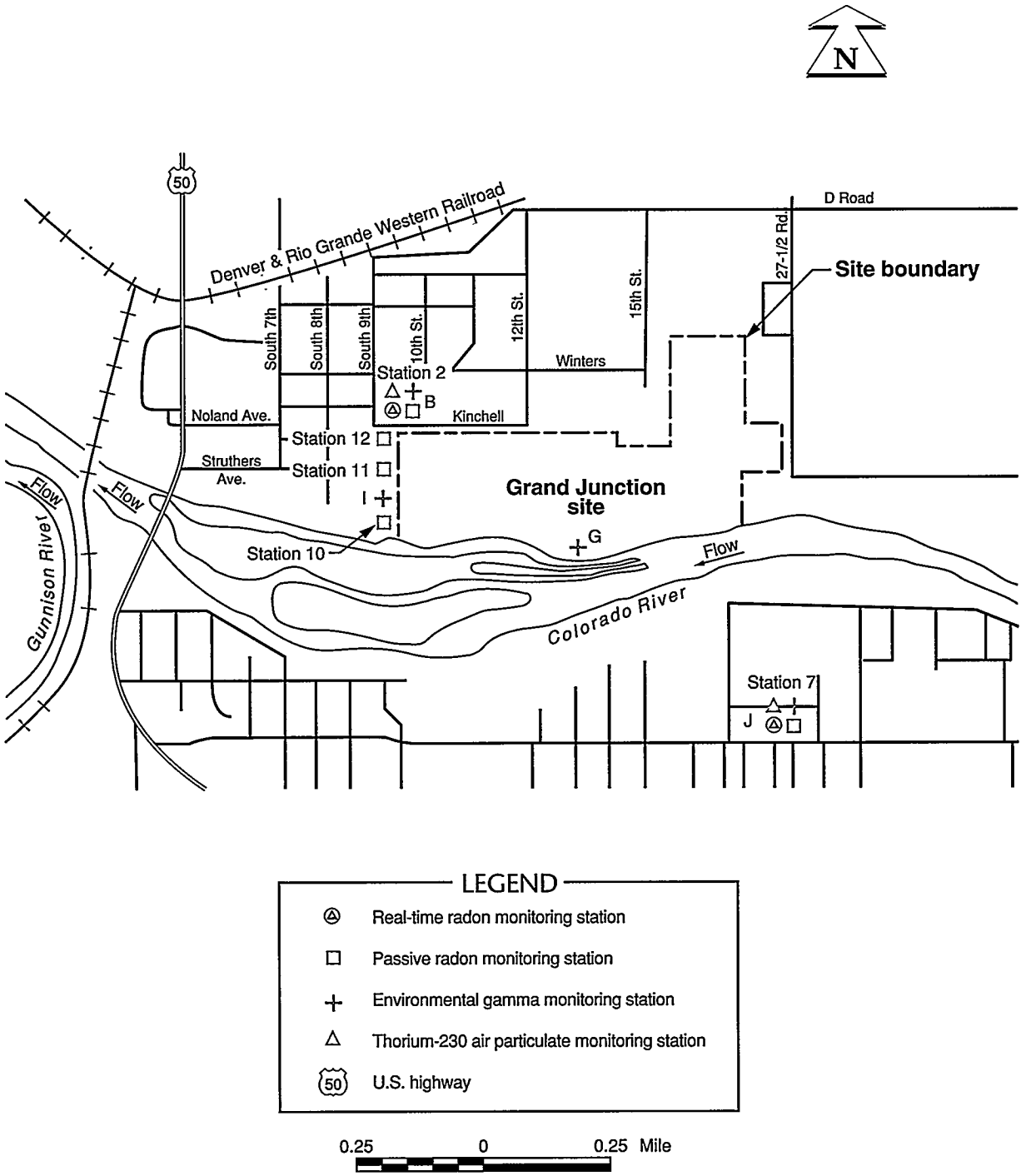
For Station 2, the concentration of thorium-230 at the processing site, estimated from gross alpha measurements, was 157 x 10^{-16} µCi/mL. Monitoring at Station 2 was discontinued on 8 February 1994, 1 month after remedial action was completed at the processing site. The background concentration of 63 x 10^{-16} µCi/mL was measured at Station 7. ***Table 6-4*** summarizes the thorium-230 concentrations estimated from gross alpha measurements for the stations at the disposal site. Monitoring began at Station 28 at the disposal site on 6 May 1994, when monitoring was discontinued at Station 25. Due to the extremely low estimated thorium-230 concentrations, no background monitoring was performed after 1 April 1994 when Station 7 was shut down. The estimated thorium-230 concentrations at all stations were well below the DOE thorium-230 average annual guideline of 500 x 10^{-16} µCi/mL above background.

Radon Monitoring

Real-Time Radon Monitoring. ***Figures 6-13 and 6-14*** show the locations of real-time radon monitoring stations. Stations 2 and 7 at the processing site and Station 20 at the disposal site provided real-time monitoring during 1994. Background radon concentrations were measured at Station 7, located 3 mi upwind (south) of the site (***Figure 6-13***).

Table 6-5 presents the quarterly average radon concentrations for all locations at the Grand Junction site for 1994. Monitoring at Station 2 was discontinued on 5 February 1994, 1 month after remedial action was completed at the processing site. Due to the low measured concentrations of radon background monitoring at Station 7 was discontinued on 2 April 1994. The annual average background radon concentration measured at Station 20 was much lower than the DOE guideline of 3 x 10^{-9} µCi/mL above background.

Figure 6-13
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site



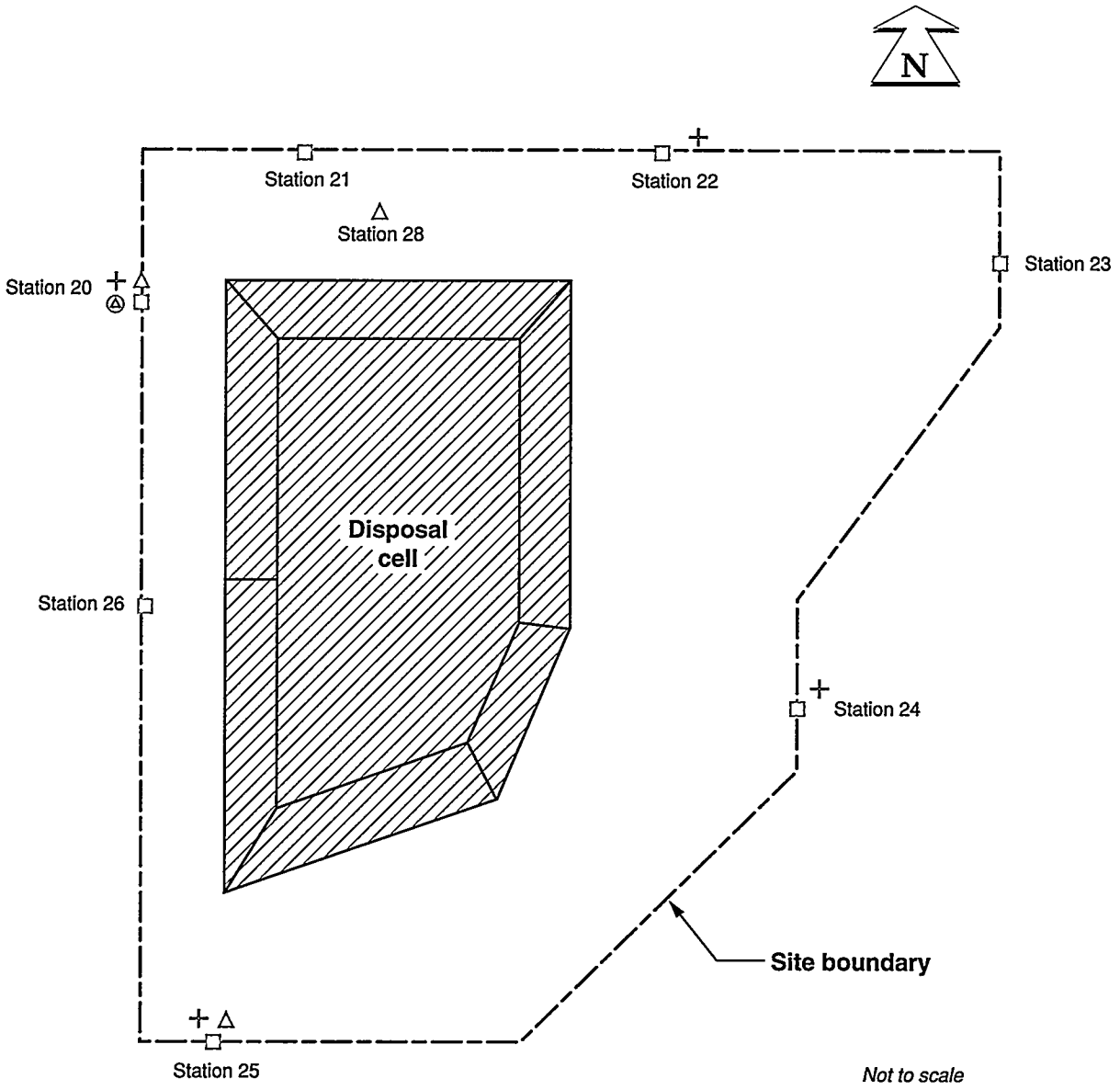
LEGEND

- Real-time radon monitoring station
- Passive radon monitoring station
- Environmental gamma monitoring station
- Thorium-230 air particulate monitoring station
- U.S. highway

0.25 0 0.25 Mile

ASER95/GRJ/ENVMONLOCS

Figure 6-14
Environmental Air and Gamma Radiation Monitoring Stations, Cheney Disposal Site



LEGEND

- Real-time radon monitoring station
- Passive radon monitoring station
- Environmental gamma monitoring station
- Thorium-230 air particulate monitoring station

ASER95/GRJ/DISSIFAC

Table 6-4 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} µCi/mL) Grand Junction disposal site

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average
20	60	25	10	6	25 (12)
25	59	26	X	X	a
28	X	26	8	9	13 (6)

[a]Insufficient data for annual average.

Notes: 1. Station 25 discontinued 05/06/94.
2. Station 28 started 05/06/94.

( ) indicate 10^{-8} picograms per millimeter.
X – no sample taken.

Table 6-5 Real-time radon concentration (10^{-9} µCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
2	1.13[a]	X	X	X	X
7	0.55[b]	X	X	X	X
20	0.81	0.62	0.75	0.86	0.76

[a]Station 2 discontinued 02/05/94.
[b]Station 7 discontinued 04/02/94.

X – no sample taken.

Passive Radon Monitoring. Twelve stations around the processing and disposal site perimeters monitor passive radon (Stations 2, 7, 10, 11, and 12 at the processing site, and Stations 20 through 26 at the disposal site). Background monitoring was performed again at Station 7, upwind of the site. ***Figures 6-13 and 6-14*** show locations of passive radon detectors at the processing site and Cheney Reservoir disposal site, respectively.

Table 6-6 presents the passive radon monitoring results for stations at the Grand Junction site. Monitoring was discontinued at the processing site stations (Stations 2, 7, 10, 11, and 12) on 1 April 1994, at the end of the quarter in which remedial action at the processing site was completed. All average annual radon concentrations measured at the disposal site were much lower than the DOE guideline.

Table 6-6 Passive (alpha-track) radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual average
2	0.7	X	X	X	X
7	0.5[a]	X	X	X	X
10	0.5	X	X	X	X
11	0.9	X	X	X	X
12	0.8	X	X	X	X
20	0.5[b]	0.8	1.0	1.1	0.9
21	0.5[b]	1.1[c]	1.2	1.3	1.1
22	0.4	1.2	1.1	1.3	1.0
23	0.5[a]	0.7	0.8	1.0	0.8
24	<0.3	0.6	0.9	0.9	0.8
25	0.4[a]	0.6	0.9	1.1	0.8
26	1.3	0.6	1.0	1.3	1.0

[a]1 detector was less than the detectable limit, the remaining detectors were averaged.
[b]2 detectors were less than the detectable limit, the result is based on remaining detector.
[c]1 detector was lost, the remaining detectors were averaged.

< indicates all detectors were less than the detectable limit; the detection limit is reported.

X – no sample taken.

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulates and radon-222 were less than the applicable guidelines. No significant releases occurred from the site during 1994.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters was used to measure exposure from environmental gamma radiation in the environment around the Grand Junction site. Monitors were placed around the site perimeter as well as in key locations in the city of Grand Junction.

Eight dosimetry monitoring stations were active in 1994. The processing site was monitored by three environmental dosimeters (Stations 2B, G, and I) on the site boundary (***Figure 6-13***). Background dose is measured at Station 7J, 3 mi south and upwind of the processing site. Four environmental dosimeters (Stations 20, 22, 24, and 25) were placed on the Cheney Reservoir disposal site boundary (***Figure 6-14***).

Monitoring at the processing site (Stations 2B, G, and I) and at the background location (Station 7J) was discontinued on 1 April 1994, at the end of the quarter in which remedial action at the processing site was completed. ***Tables 6-7 and 6-8*** present the results of the environmental dosimetry monitoring the Grand Junction site for 1994.

Table 6-7 Environmental gamma dose equivalent[a] (mrem) Grand Junction processing site

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
2B	31.6 ± 8.3	c	c	c	d
7J	20.8 ± 7.8	c	c	c	d
G	b	c	c	c	d
I	38.8 ± 6.2	c	c	c	d

[a]All errors reported as 2 standard deviations.
[b]Lost dosimeter.
[c]Monitoring was discontinued at the processing site for these quarters.
[d]Insufficient data for annual dose equivalent.

Table 6-8 Environmental gamma dose equivalent[a] (mrem) Grand Junction disposal site

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
20	32.4 ± 7.7	35.0 ± 5.8	29.2 ± 5.5	34.2 ± 11.3	130.8 ± 15.8 (1.308 ± 0.158)
22	32.4 ± 12.7	31.2 ± 3.3	29.2 ± 3.6	38.4 ± 2.7	131.2 ± 13.9 (1.312 ± 0.139)
24	27.8 ± 7.1	25.2 ± 6.4	17.8 ± 9.8	37.8 ± 7.8	108.6 ± 15.8 (1.086 ± 0.158)
25	27.0 ± 8.4	26.0 ± 4.2	28.2 ± 7.3	36.6 ± 7.3	117.8 ± 14.0 (1.178 ± 0.140)

[a]All errors reported as 2 standard deviations.

( ) indicate millisieverts (mSv).

None of the measured dose equivalents exceeded the DOE guideline of 100 mrem above background.

Environmental Gamma Radiation Monitoring Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guidelines, indicating no significant releases to the environment.

Surface Water Monitoring

Surface water was monitored for radiological contaminants to assess potential environmental impacts remedial action site activities. Surface water monitoring was performed during the first quarter of 1994; downstream results were indistinguishable from upstream results, indicating no significant releases to the environment during 1994 (***Table 6-9***). All samples were below DOE guidelines for surface water.

No sediment samples were collected from the Grand Junction processing site and vicinity or the Cheney disposal site during 1994. A series of ponds have been constructed by the USACE between the north channel of the Colorado River and the Grand Junction processing site (***Figure 6-15***) to provide wetlands habitat and flood control. In addition, the city of Grand Junction has proposed a botanical garden and construction of a pond west of the former processing site. To assess the response to wetlands development of the hydrologic system near the site, a staff gauge has been placed in the north channel of the Colorado River at the I-50 bridge; staff gauges have also been placed in two of the on-site ponds. Surface water quality and surface water elevations will be monitored at these locations during 1995.

Ground Water Monitoring

Processing Site

At the Grand Junction processing site, ground water occurs in alluvial sand and gravel associated with the Colorado River. The saturated thickness of the alluvial aquifer ranges from about 16 ft near the northeastern portion of the site to about 10 ft in the southern portion of the site near the Colorado River. The alluvial aquifer is not currently used for any known purpose in the vicinity of the processing site.

Ground water is monitored during remediation of the Grand Junction processing site to assess the effects of remedial activities on ground water flow and ground water quality. In 1994, samples were collected from the processing site monitoring locations shown in ***Figure 6-15***. Ground water occurs under unconfined conditions in the alluvium and generally flows south and southwest toward the Colorado River (***Figure 6-16***).

Ground water elevations were measured and samples were collected during one sampling round in June 1994. All wells currently monitored at the processing site (***Figure 6-15***) are screened in the alluvium. These include two monitoring wells (745 and 746) to collect background ground water quality data and four monitoring wells (590, 736, 740, and 742) to collect crossgradient and downgradient ground water quality data. Static ground water elevations were measured in the six sampled monitoring wells.

During 1994, three wells (1000, 1001, and 1002) were installed on the processing site (***Figure 6-15***) in order to collect water levels and water

Table 6-9 Surface water concentrations (10^{-9} μCi/mL)[a]

Location	Radionuclide	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	Guideline
Colorado River Upstream (01)	^{226}Ra	0.2 ± 0.2	b	b	b	c	100
	^{230}Th	0.1 ± 0.6	b	b	b	c	300
Colorado River Downstream (02)	^{226}Ra	0.2 ± 0.2	b	b	b	c	100
	^{230}Th	0.0 ± 0.5	b	b	b	c	300

[a]All errors reported as 2 standard deviations.
[b]Monitoring was discontinued for these quarters.
[c]Insufficient data for annual average.

quality data. This information will be used to assess potential ground water restoration options. Water level data are being obtained in the new wells and background well 746 through the use of continuous water level recorders.

Ground water in the alluvium (uppermost aquifer) is affected by uranium processing activities. The contamination extends approximately 3300 ft downgradient from the site (*Figure 6-17*). Uranium is sampled and analyzed to measure the extent of the contamination because it is the most prevalent and mobile hazardous constituent that exceeds the maximum concentration limit. To evaluate the need for ground water remediation, ground water quality data are compared to background levels and the maximum concentration limits.

Ground Water Results

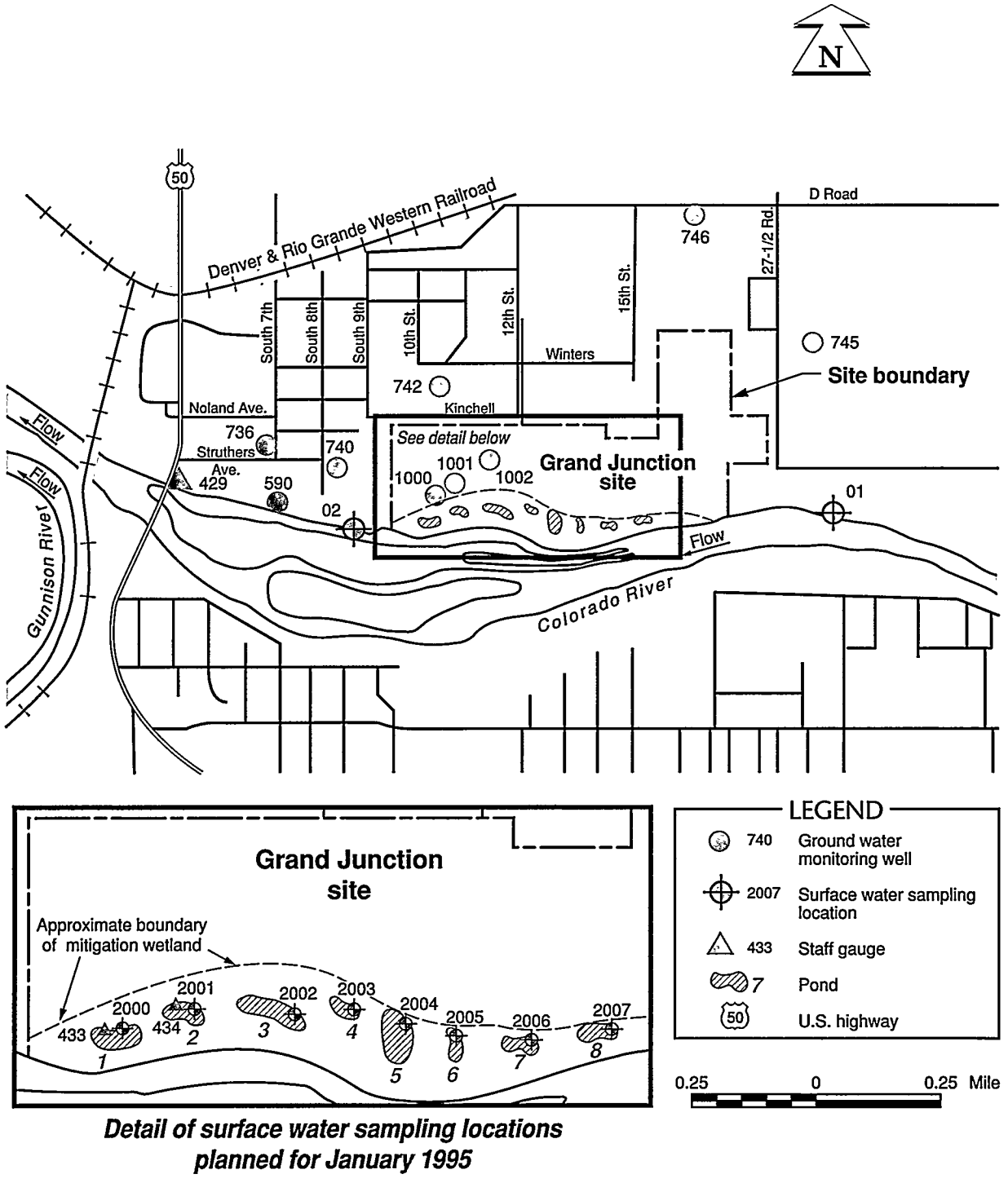
Water samples were analyzed for the following parameters: ammonium, gross alpha, molybdenum, nitrate, radium-226 and radium-228, selenium, strontium, sulfate, uranium, and total dissolved solids. *Table 6-10* lists the results of 1994 ground water analyses for indicator parameters calcium, magnesium, and uranium at the processing site.

Figure 6-18 illustrates uranium concentration variations in background, contaminated, and downgradient ground water. The fluctuating uranium concentrations in on-site and downgradient well 740 indicates a slight increase in uranium concentration since 1989. This apparent increase may be due to a combination of seasonal and contaminant migration-related factors. Contaminants within ground water near the former Grand Junction processing site are moving downgradient toward the Colorado River, which may be the ultimate point of discharge for local ground water.

Ground Water Conclusions

Ground water elevation data show ground water flow direction and gradient remained relatively stable during 1994.

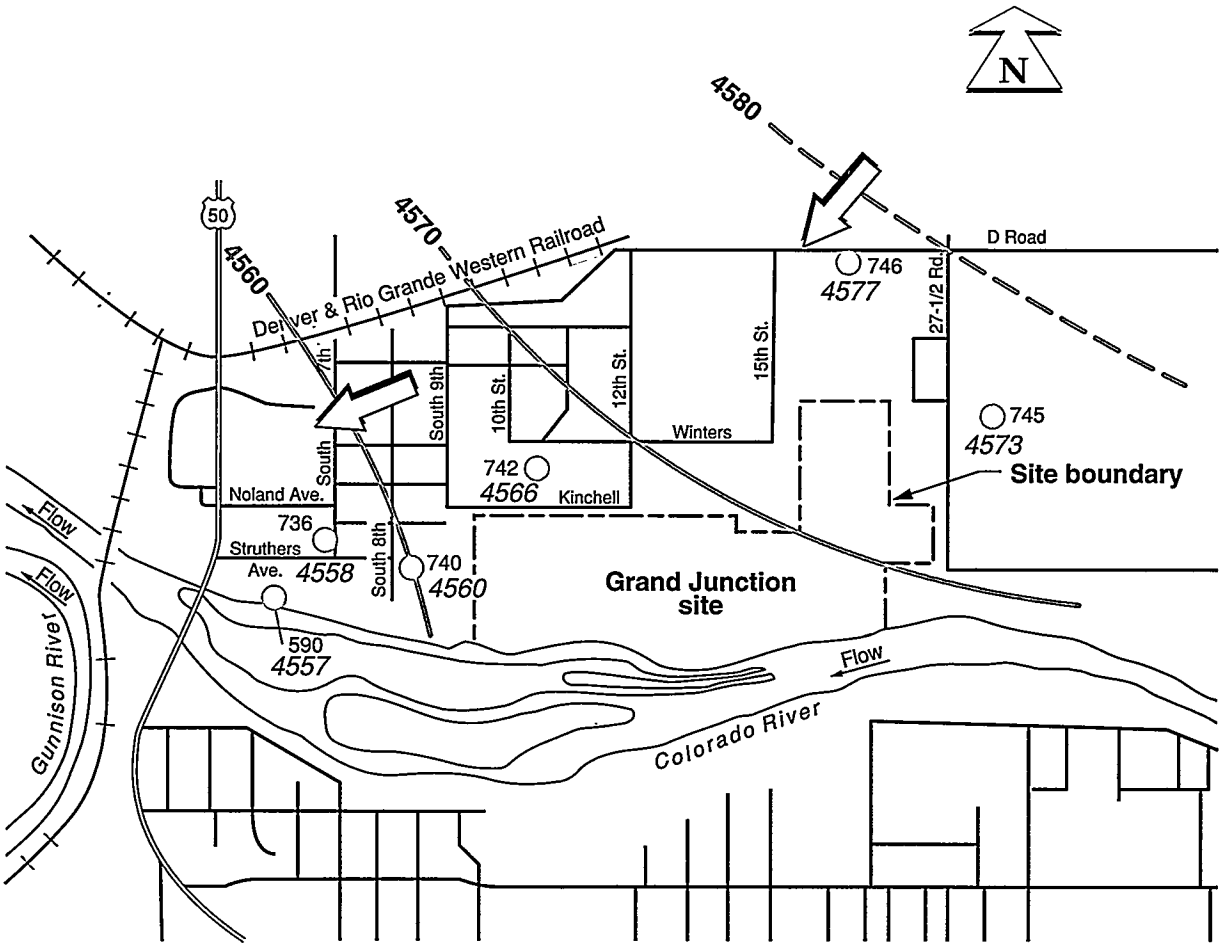
Figure 6-15
Ground Water and Surface Water Sampling Locations, Processing Site



Detail of surface water sampling locations planned for January 1995

ASER95/GRJ/PROSITEMONWELL

Figure 6-16
Ground Water Table Contours of the Alluvium, Processing Site



Note: Data collected June 1994.

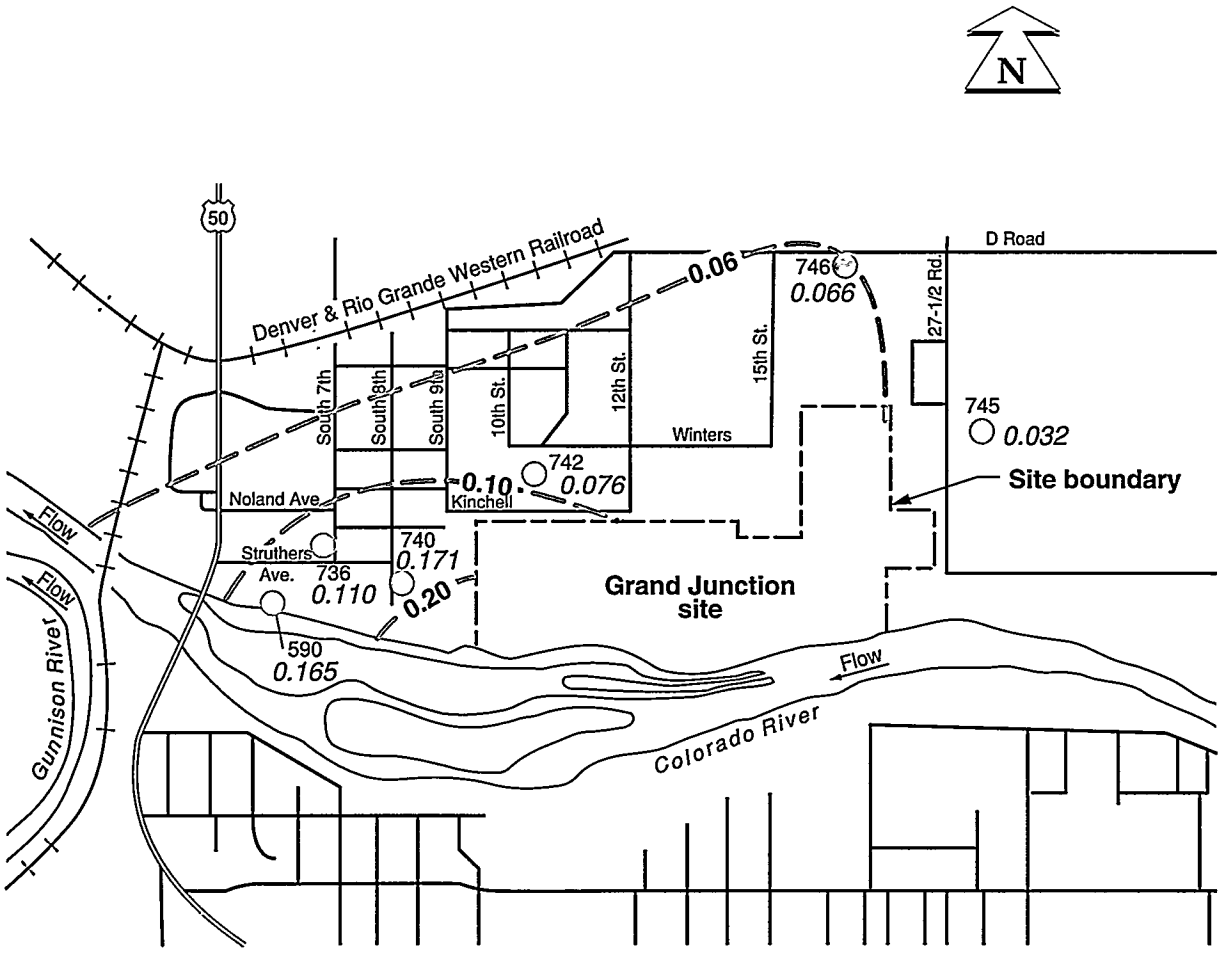
LEGEND

4560	Ground water elevation contour (ft above MSL, dashed where inferred)
740 ○ 4560	Alluvium ground water monitoring well; Ground water elevation
50	U.S. highway
⇨	Ground water flow direction

0.25 0 0.25 Mile

ASER95/GRJ/WATERTABLE

Figure 6-17
Uranium Concentrations in the Alluvial Aquifer, Processing Site



Note: Data collected June 1994.

LEGEND

0.06	Uranium concentration contour (mg/L, dashed where inferred)
746	Ground water monitoring well
0.066	Uranium concentration (mg/L)
50	U.S. highway

0.25 0 0.25 Mile

ASER95/GRJ/URNPLUMEMAP

Table 6-10 Ground water quality results, processing site

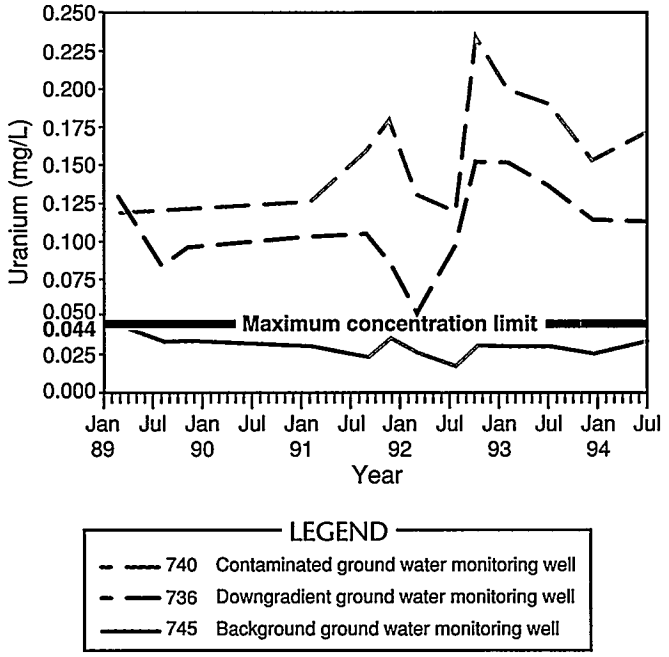
Indicator parameter	Guideline	Monitoring well location 745 (background)	740 (plume)	736 (downgradient)
Total dissolved solids	500[a]			
06/94		X	7600	7850
Sulfate	250[a]			
06/94		2840	3980	4010
Uranium	0.044[b]			
06/94		0.032	0.171	0.110

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Results are reported in milligrams per liter.

X – no sample taken.

Figure 6-18
Uranium Concentrations Over Time in the Alluvial Aquifer, Processing Site



ASER95/GRJ/URNCON

Background ground water quality in the alluvium shows uranium, molybdenum, and selenium concentrations and net gross alpha activities are above the maximum concentration limits.

Concentrations of total dissolved solids are elevated, with a marked decline in ground water quality away from the Colorado River. The variability in ground water quality probably comes from multiple contaminant and recharge sources, including irrigation canal leakage and deep field percolation, the Colorado River, and dissolution of salts from the underlying sedimentary rocks.

Water quality results indicate long-term historical fluctuation within a relatively broad range. Comparing analytical results of ground water samples collected during 1994 with existing water quality data indicates ground water quality at or downgradient of the processing site has not changed significantly.

Results of water quality sampling and ground water elevation measurements indicate no trends in ground water flow conditions or ground water quality that could affect human health or the environment.

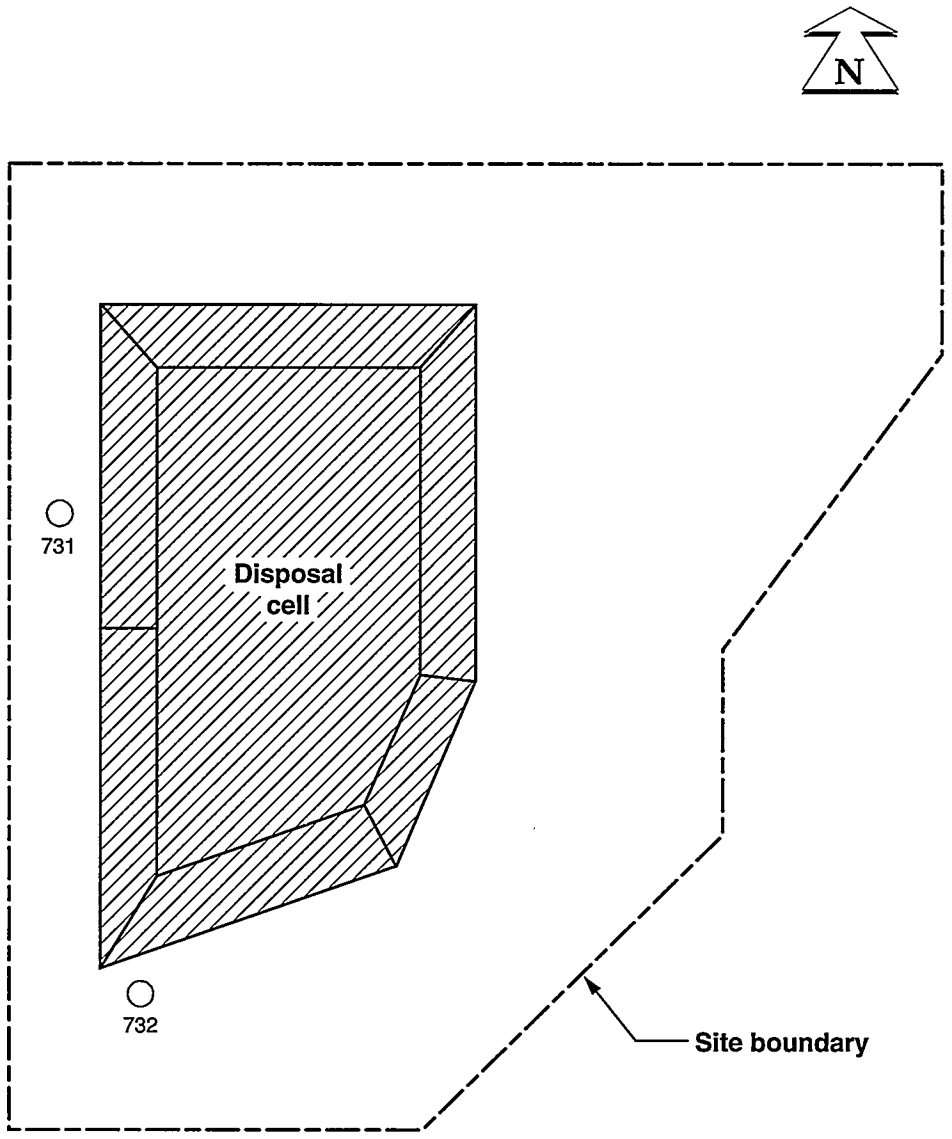
The current risk to human health or the environment is limited because water used for domestic and most other purposes is taken from the Grand Mesa Reservoir, approximately 25 mi upgradient from the processing site. With the exception of ground water discharge to newly constructed on-site ponds and a proposed pond west of the former processing site, ground water characteristics and use in the vicinity of the Grand Junction processing site is not expected to change substantially in the near future. The newly constructed on-site ponds are planned to be sampled during the January 1995 sampling event.

Cheney Reservoir Disposal Site

There is no compliance monitoring of the Cheney disposal cell because the uppermost aquifer (Dakota Sandstone) is hydrogeologically isolated by approximately 700 ft of Mancos Shale and because ground water in the Dakota Sandstone is limited use, Class III ground water.

Ground water was not monitored at the Cheney Reservoir disposal site during 1994. However, two shallow monitoring wells (***Figure 6-19***) have been installed as a best management practice, one near the northwest corner and one near the southwest corner of the disposal cell. Water level and water quality will be monitored during 1995 to evaluate the potential impact of the disposal cell to transient ground water in adjacent paleochannels.

Figure 6-19
Ground Water Monitoring Well Locations,
Cheney Disposal Site



ASER95/GRJ/GWMONLOCS

SITE DESCRIPTION AND LOCATION

The Gunnison UMTRA Project processing site is in a valley formed by the Gunnison River, approximately 10 mi downstream from the confluence of the Taylor and East rivers. The former Gunnison processing site lies between the Gunnison River and Tomichi Creek (*Figure 6-20*), which enters the Gunnison River near the site. The processing site is approximately 7640 ft above MSL. The processing site borders the city limits of Gunnison (population 4636), in Gunnison County (population 10,273), Colorado (DOC, 1990). The Gunnison County Airport borders the site on the north and east. Residual radioactive materials from the former processing site are being relocated to a disposal cell 8 mi to the east.

Between 1941 and 1970, the annual average rainfall in the Gunnison area was 11 inches. The annual average snowfall from 1951 to 1973 was 58 inches.

The local topography (mountains and valleys) influences winds in the upper Gunnison River Basin. However, the development of strong wind patterns, typical of mountain-valley settings, is somewhat weakened by the relatively small size of the airshed. Wind flow is predominantly from the north with an average speed of 7 mi per hour (*Figure 6-21*).

SITE HISTORY AND OWNERSHIP

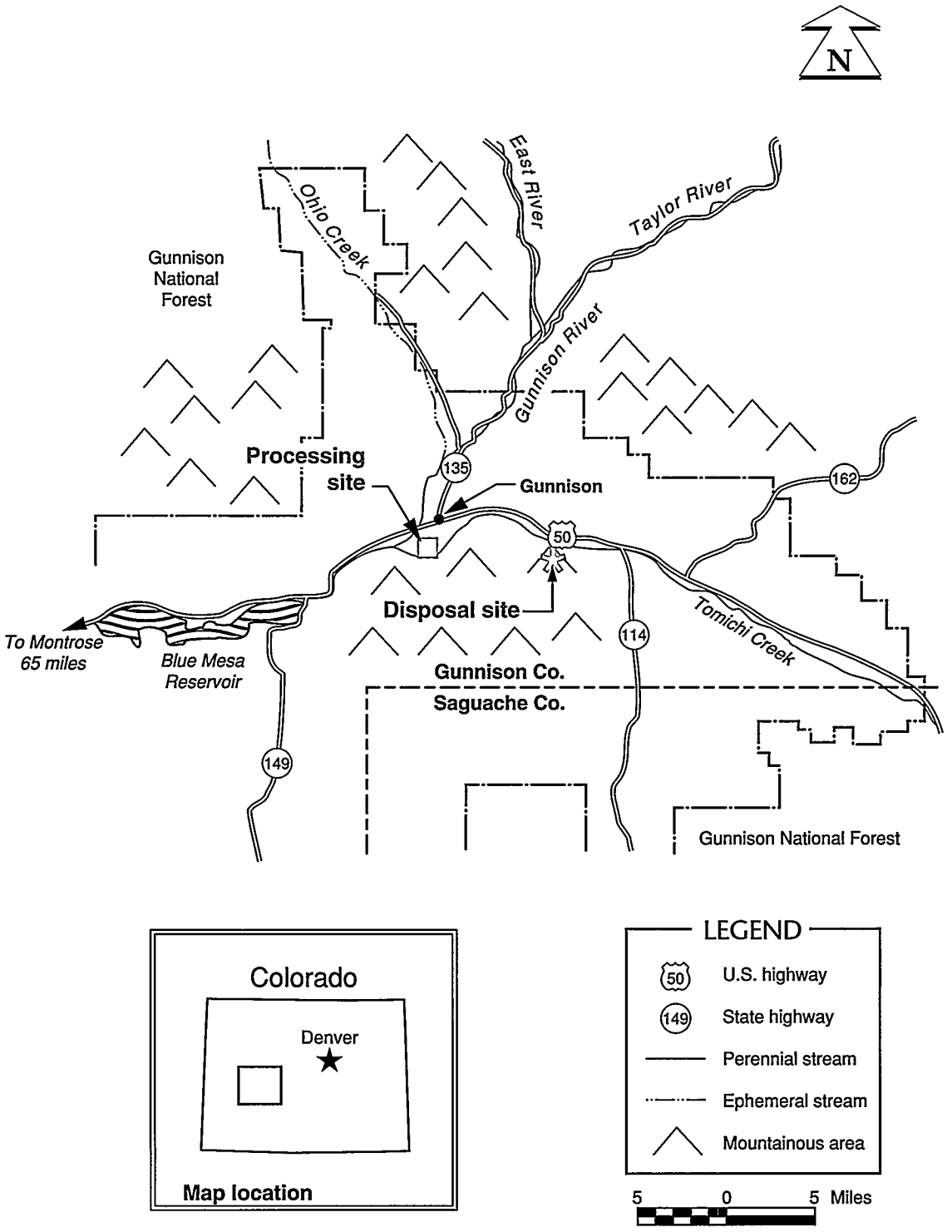
Gunnison Mining Company operated the processing site from February 1958 to December 1961. Kermac Nuclear Fuels Corporation operated the processing site from December 1961 until its closure in April 1962. The processing site was acquired and is currently owned by the state of Colorado.

Ore was trucked to the mill site from mines in the Cochetopa Pass area, about 25 mi southeast of Gunnison. The processing site had a capacity of 200 tons of ore per day. The ore was ground and then leached with sulfuric acid and sodium chlorate. A sodium carbonate solution was used to extract the uranium from the solvent. The washed solids were sent to the tailings pile. During its 4 years of operation, the mill processed about 540,000 tons of ore to produce 800 tons of uranium concentrate ("yellow cake").

The tailings were originally deposited in a rectangular pond confined by four dikes built of gravelly, sandy material scraped from the ground surface. The total surface area of the tailings pile was approximately 32 ac; the tailings are a maximum of 18 ft thick.

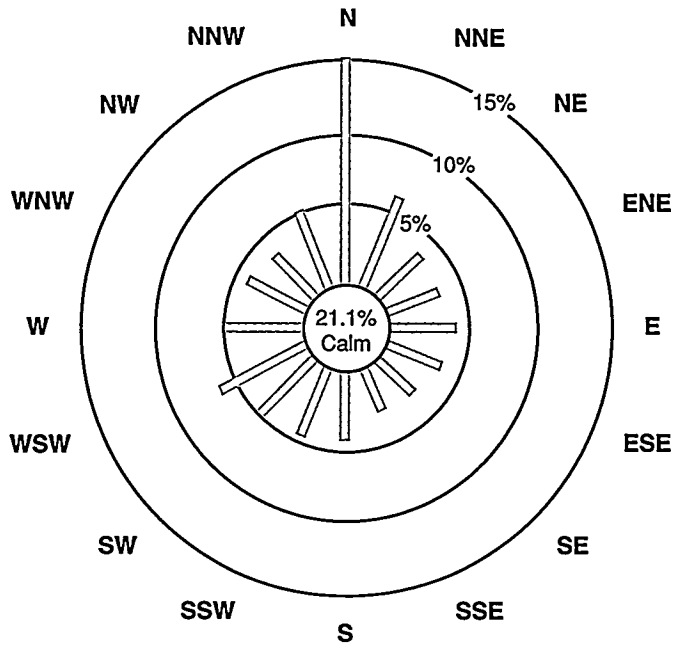
The tailings materials are primarily sands and fine sands with some clay and sandy clay slimes.

Figure 6-20
Gunnison Site Location



ASER95/GUN/SITELOC

Figure 6-21
Wind Rose



Ref: Gunnison County Airport.
Cumulative data 1973 through 1977.

ASER95/GUN/WINDGUN

SITE CHARACTERIZATION AND CLEANUP

Remedial action involves demolition of the mill buildings (Phase I), excavation and construction of the disposal cell, excavation of residual radioactive materials from the processing site and transportation to the disposal cell, and restoration of all areas disturbed by the remedial action activity (Phase II). Phase I remedial action was completed in 1992. Phase II remedial activities began in June 1992 and excavation of the disposal cell and tailings haul began in June 1993. By the end of the 1994 construction season, all of the residual radioactive materials (750,000 cubic yards) had been relocated to the disposal cell.

Before tailings placement, the disposal cell was excavated. The disposal cell should be completed by the end of 1995 and will consist of an earthen embankment containing the residual radioactive materials and a multilayer cover. A layer of low-permeability clay mixed with bentonite will be placed over the tailings to limit radon emissions and reduce water infiltration. The clay layer will be covered by a layer of coarse sand for lateral water drainage. A thick layer of soil will be placed over the sand layer to prevent frost on the radon barrier. A rock layer will be placed on the top and sideslopes to prevent erosion. By using only natural materials in the disposal cell, the longevity requirement of disposal will be achieved at the Gunnison site. All surface remedial action activities will be completed in 1995.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Gunnison, Colorado, complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet applicable regulatory requirements. In 1994, Gunnison site environmental compliance activities included monitoring fugitive dust and radon gas emissions, reporting certain quantities of hazardous materials used or stored at the site, planning spill prevention control and countermeasures, and adhering to transportation regulations and local regulations and permits.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*), the Gunnison site must comply with emergency planning and community right-to-know requirements. These requirements include notifications for threshold planning quantities of hazardous materials and for spills of reportable quantities of extremely hazardous materials.

To comply with requirements of EPCRA, Section 311, an inventory was developed for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. Notifications included the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Compliance with EPCRA, Section 312, was achieved by developing Tier II reporting forms for the 1993 inventoried materials and submitting them to the State Emergency Response Commission, local emergency planning committee, and local fire department by 1 March 1994. No materials were released into the environment that would fall under EPCRA reporting requirements.

Clean Water Act

The CDPHE, Water Quality Control Division, has authority over all CWA activities in Colorado.

National Pollutant Discharge Elimination System

Under the Colorado Discharge Permit System, the CDPHE issued discharge permits to the Gunnison site, including wastewater and storm water permits. Wastewater discharge permits were issued for the retention basins at the processing site (No. CO-0042889) and the disposal site (No. CO-0043401). Storm water permits have been issued for the processing site, disposal site, and the haul road. No discharges occurred during 1994 at the disposal site or the processing site.

Spill Prevention Control and Countermeasures Plan

In 1993, a plan was implemented to store oil and diesel fuel on-site. Secondary containment included earthen berms to control spills and posting and safety devices. During 1994, the site had no reportable spills.

Septic/Holding Tanks

Septic systems had been installed to meet local codes at the processing site and disposal site; their use continued during the 1994 construction season.

Clean Air Act

The CDPHE, Air Pollution Control Division, has regulatory authority for CAA requirements. The CDPHE has adopted the federal standards for total suspended particulate levels, including a 24-hour limit of 150 $\mu g/m^3$ and an annual limit of 60 $\mu g/m^3$ geometric mean. Although total suspended particulate monitoring is not required at the Gunnison site, the DOE has agreed to conduct modified total suspended particulate monitoring for fugitive dust. Fugitive dust did not exceed guidelines during 1994 at the Gunnison site.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings on the draft will be held during 1995 in the city of Gunnison.

Hazardous Materials Transportation Act

Residual radioactive materials transported to the Gunnison disposal site are subject to the requirements of the HMTA (49 USC §1801 *et seq.*). In 1994, approximately 630,000 cubic yards of residual radioactive materials were hauled from the processing site in compliance with all requirements of DOT exemption E-10594.

Executive Order 11990

In 1994, a wetlands mitigation plan was completed and ecological monitoring was conducted in accordance with the plan.

Environmental Permits

The Gunnison site obtained and operated under all required permits in 1994. ***Table 6-11*** lists all active permits for the Gunnison site from January 1994 to December 1994.

Table 6-11 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permit (U.S. Army Corps of Engineers)	12/91	Final received[a]	07/92	9200371	06/95
Colorado Discharge Permit System					
Process site wastewater	07/90	Final received[a]	06/92	CO-0042889	04/97
Disposal site wastewater	11/92	Final received[a]	07/93	CO-0043401	05/98
Process site storm water	09/92	Pending	Pending	COR-30193	03/95
Disposal site storm water	09/92	Final received[a]	10/92	COR-30264	03/95
Chance Gulch storm water	06/93	Final received[a]	08/93	COG-500259	09/97
Haul Road storm water	09/92	Final received[a]	10/92	COR-30265	03/95
Process site wastewater Amendment No. 1	08/92	Final received[a]	05/93	CO-0042889	04/97
Air emission notice/permits, CDPHE					
Process/haul route - earth moving[b]	12/91	05/92	Pending	90GU472F-1	NA
Process - demolition[c]	08/91	10/91	Pending	91GU657	NA
Disposal site - earth moving[a]	11/90	05/92	Pending	90GU472F-2	NA
Chance Gulch rock borrow site	12/91	02/92	Pending	91GU249F	NA
Sixmile Lane radon barrier borrow site	12/91	03/92	Pending	91GU953F	03/95
Land development - haul road[b] Tenderfoot Mountain	01/91	03/91	Pending	91GU022L	NA
Water rights, Colorado Division of Water Rights					
Surface Water - disposal site	05/92	09/92	10/92	92CW40	10/98
Water storage rights - disposal site	05/92	09/92	10/92	92CW41	10/98
Free use permits, Bureau of Land Management					
Sixmile Lane radon barrier borrow site	02/92	Final received[a]	07/92	COC53788	6/2002
Certificate of designation solid waste disposal (county)	–	Final received[a]	06/92	G-09-03260	6/2002

Table 6-11 Active permits (Concluded)

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Chance Gulch rock borrow site	03/92	Final received[a]	07/92	COC53787	NA
Gunnison County Land Use Change Permit	04/92	NA	05/92	27	NA

[a]Not applicable in 1994.
[b]Received revisions dated 01/15/93.
[c]Activity complete - requested deactivation 09/02/93.

NA – Not applicable.

ENVIRONMENTAL MONITORING

The DOE conducted a detailed environmental monitoring program at the Gunnison site in 1994, which included monitoring environmental gamma radiation and contaminant concentrations in air, surface water, and ground water. This program monitored the radioactive material and nonradiological hazardous constituents released into the environment, demonstrated compliance with the applicable guidelines, and indicated the efficiency of environmental protection measures.

Air Monitoring

Nonradiological Air Particulate Monitoring

The total suspended particulate monitoring system at the Gunnison processing site consists of two monitors (***Figure 6-22***). The results of total suspended particulate monitoring for 1994 are shown on ***Figure 6-23***.

Site water is used for dust suppression to control visible and off-site fugitive dust emissions during the Gunnison remedial action activities, as required in the air emissions permit.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Gunnison processing site was conducted at Stations 1 through 6, which were collocated with active radon monitoring stations (***Figure 6-22***). Because of the extremely cold weather in Gunnison, Stations 1 through 6 could not begin monitoring until 1 April 1994. Stations 7 and 9 were established on 16 May 1994 when the disposal site became accessible (***Figure 6-24***). Background measurements were conducted at Station 5, approximately 1.5 mi west of the processing site. Monitoring at all stations was discontinued on 30 November 1994, 1 month after remedial action ceased for the winter.

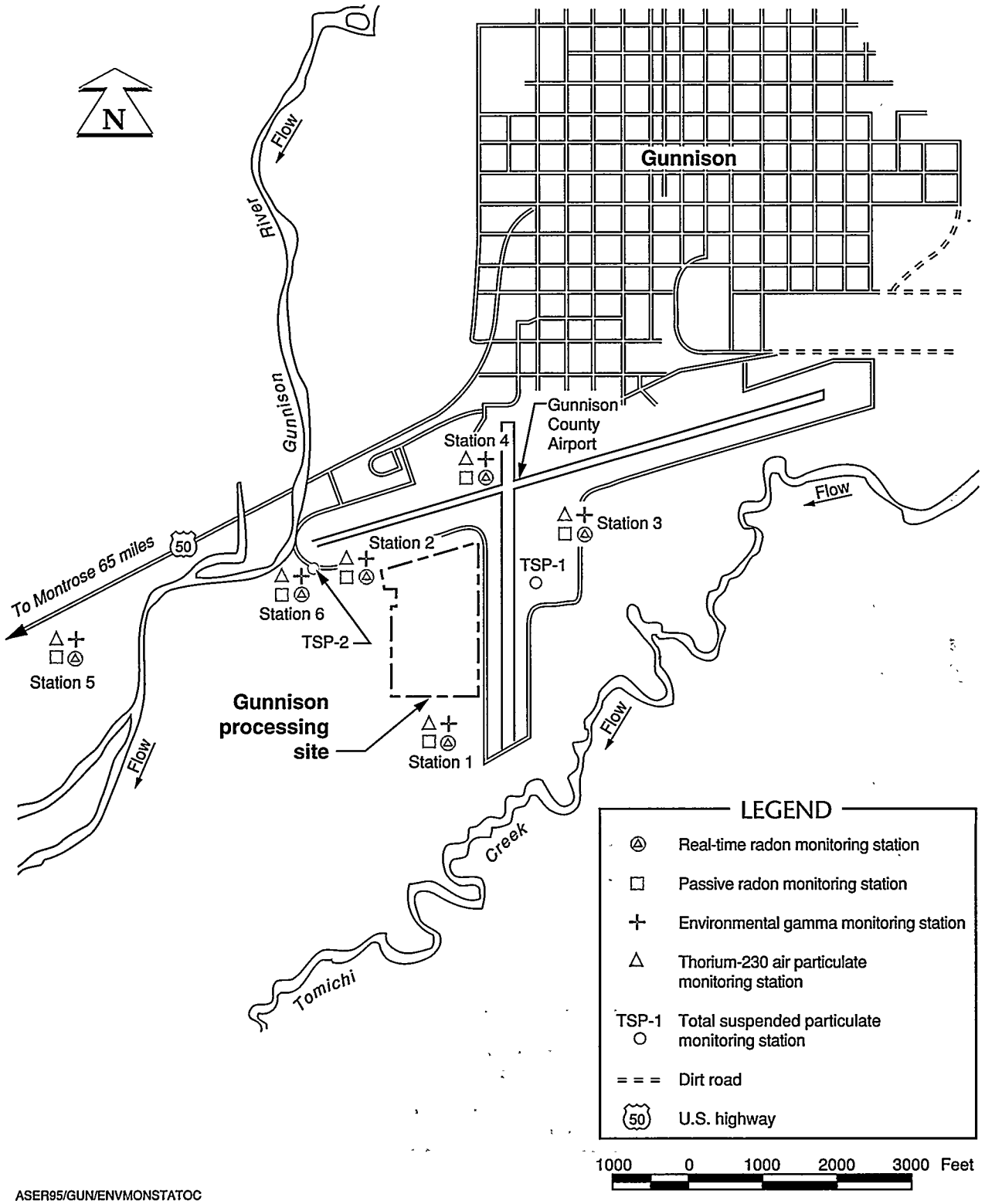
Table 6-12 summarizes site thorium-230 concentrations estimated from gross alpha measurements for the Gunnison site. The fourth quarter concentrations appear to be slightly elevated; during that quarter, only thorium-contaminated material was being remediated at the Gunnison site, and the Remedial Action Contractor used a conservative assumption that all the gross alpha detected was due to thorium-230. The estimated annual average thorium-230 concentrations at all stations were well below the DOE thorium-230 average annual guideline of 500×10^{-16} μCi/mL above background.

Figure 6-25 summarizes quarterly thorium-230 results that are above background concentration.

Radon Monitoring

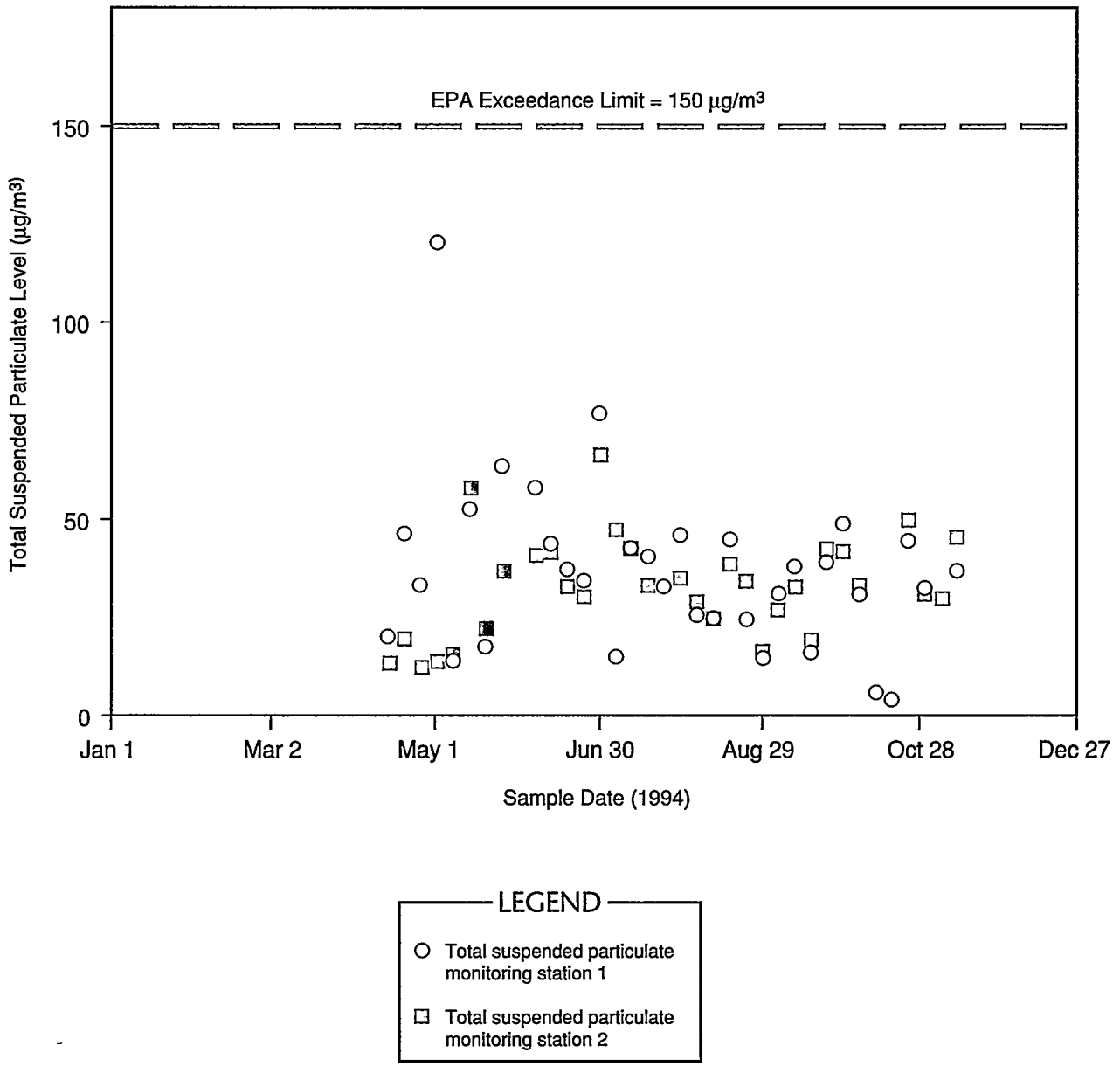
Real-Time Radon Monitoring. Processing site Stations 1 through 6 became operational on 1 April 1994. Monitoring was discontinued on 30 November 1994, 1 month after remedial action ceased for the winter. Background radon concentrations were measured at Station 5, 1.5 mi west of the site. ***Figure 6-22*** shows the locations of the real-time radon monitoring stations.

Figure 6-22
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site



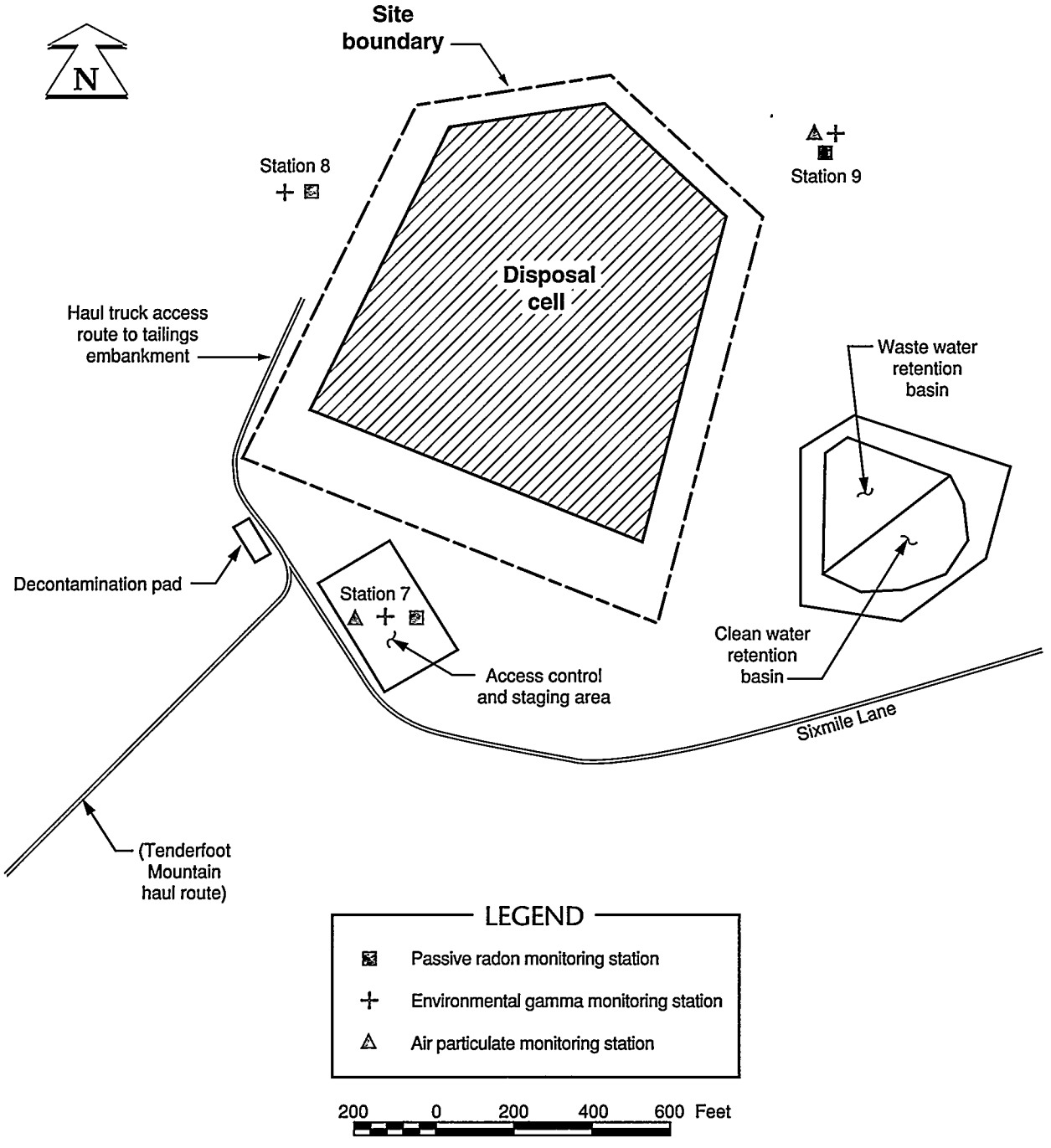
ASER95/GUN/ENVMONSTATOC

Figure 6-23
Total Suspended Particulates, Processing Site



ASER95/GUN/TSP

Figure 6-24
Environmental Air and Gamma Radiation Monitoring Stations, Disposal Site



ASER95/GUN/DISMONSTATIONS

Table 6-12 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} µCi/mL)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4[cd]	Average
1	a	67	19	59	47 (23)
2	a	84	12	32	44 (22)
3	a	44	9	35	28 (14)
4	a	49	7	33	29 (14)
5	a	44	4	19	23 (11)
6	a	38	4	24	22 (11)
7	b	14	16	36	22 (11)
9	b	11	7	22	13 (6)

[a]Stations 1-6 started 04/01/94
[b]Stations 7 and 9 started 05/16/94
[c]Environmental Stations discontinued 11/30/94
[d]Quarter 4 values represent assumption that total gross alpha is due to Th-230.

Note: Annual average based on available data.

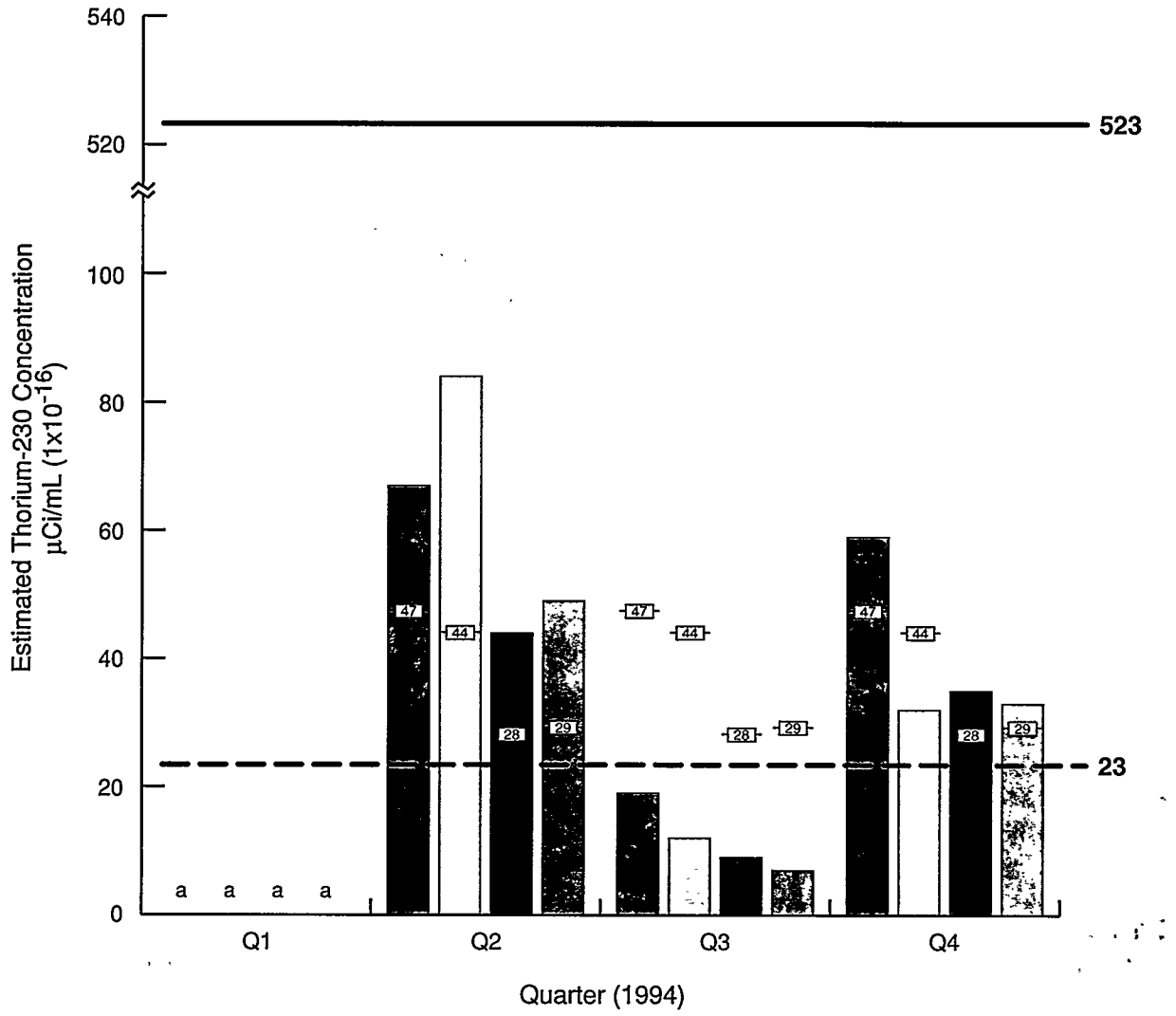
( ) indicate 10^{-8} picograms per milliliter.

Table 6-13 presents the quarterly 1994 average radon concentrations for all locations at the Gunnison site. The annual average background radon concentration measured at Station 5 was 0.48 x 10^{-9} µCi/mL. Although the annual average radon concentrations at Stations 1 and 2 were slightly higher than background, all of the annual average radon concentrations were much lower than the DOE guideline of 3 x 10^{-9} µCi/mL above background.

Figure 6-26 summarizes of quarterly real-time radon results that are above background concentration.

Passive Radon Monitoring. Five stations were established around the processing site perimeter (Stations 1 through 4 and Station 6). Background monitoring was conducted at Station 5 upwind of the site. Stations 7 through 9 were established around the perimeter of the

Figure 6-25
Environmental Airborne Radioactive Particulate (Thorium-230) Concentrations



[a]Stations 1-4 established during Quarter 2.

LEGEND

- Station 1
- Station 2
- Station 3
- Station 4
- 44 Annual average
- Annual guideline (500 + background)
- Annual background (Station 5)

ASER95/GUN/TAB1

Table 6-13 Real-time radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1		0.57	0.63	0.53	0.58
2		0.81	0.63	0.60	0.69
3		0.39	0.30	0.09	0.29
4		0.43	0.51	0.50	0.48
5		0.37	0.56	0.53	0.48
6		0.44	0.34	0.42	0.40

Notes: 1. Environmental Stations started 04/01/94.
2. 4th Qt. Environmental Stations discontinued 11/30/94.
3. Annual average based on available data.

disposal site. ***Figures 6-22 and 6-24*** show the locations of passive radon detectors at the Gunnison site.

Table 6-14 provides the quarterly passive radon monitoring results for 1994 at the Gunnison site. The annual average background radon concentration measured at Station 5 was 0.6 x 10^{-9} μCi/mL. All of the annual average radon concentrations were lower than the DOE guideline.

Figure 6-27 provides a summary of quarterly passive radon results that are above background concentration.

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulates and radon-222 were lower than the applicable guidelines. No significant releases occurred at either the processing or disposal site during 1994.

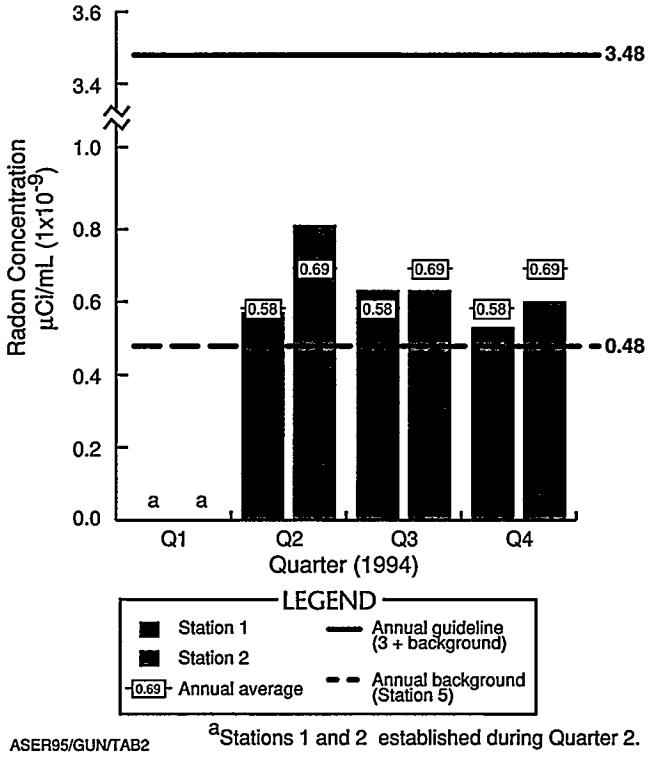
Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure from environmental gamma radiation in the environment around the Gunnison processing site. Monitors were placed at the perimeters of the processing site and the disposal site (***Figures 6-22 and 6-24***).

Nine dosimetry monitoring stations were active in 1994. Five environmental dosimeters placed on the site boundary (Stations 1 through 4 and 6) monitored the processing site. Background dose was measured at Station 5, 1.5 mi west of the processing site. Three environmental dosimeters were placed on the disposal site boundary (Stations 7 through 9).

Table 6-15 presents the results of the environmental dosimetry monitoring for the Gunnison site for 1994. The annual background dose equivalent was 158.4 ± 26.1 mrem at Station 5.

Figure 6-26
Real-Time Radon Concentrations



ASER95/GUN/TAB2

[a]Stations 1 and 2 established during Quarter 2.

Table 6-14 Passive (alpha-track) radon concentration (10^{-9} µCi/mL)

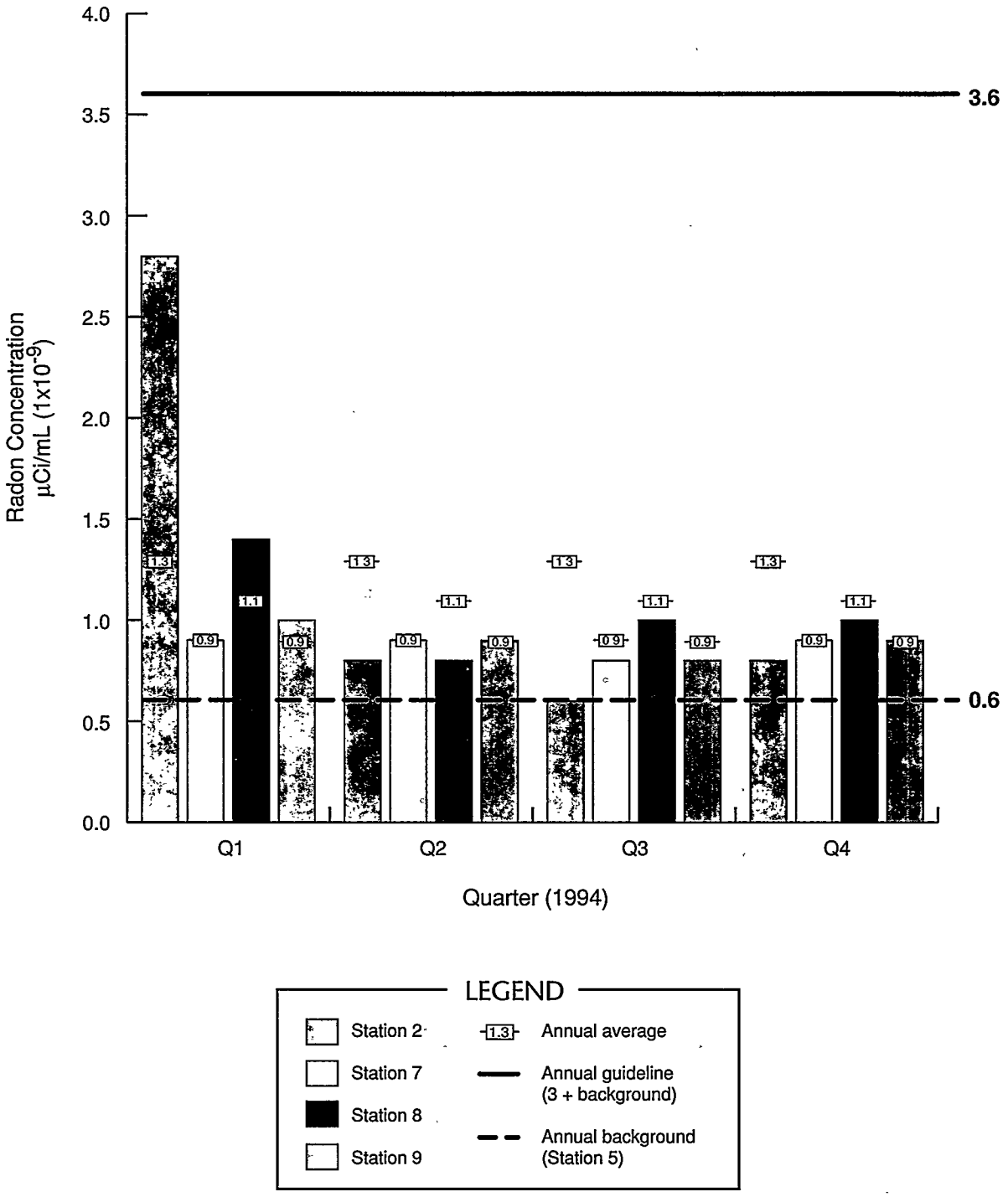
Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
1	1.2	0.6	0.7	0.9	0.8
2	2.8	0.8	0.6	0.8	1.3
3	0.8	0.5[b]	0.4	0.6	0.6
4	0.9	0.5	0.7	0.7	0.7
5	0.5	0.5[b]	0.5	0.8	0.6
6	1.0	0.5[a]	0.5	0.7	0.7
7	0.9	0.9	0.8	0.9	0.9
8	1.4	0.8	1.0	1.0	1.1
9	1.0	0.9	0.8	0.9	0.9

[a]At least 1 detector was less than the detectable limit, the remaining detectors were averaged.
[b]2 detectors were less than the detectable limit.

Environmental Gamma Radiation Monitoring Conclusions

None of the stations recorded environmental gamma radiation levels greater than the DOE annual guideline of 100 mrem above background, indicating that there were no significant releases to the environment.

Figure 6-27
Passive Radon Concentrations



ASER95/GUN/TAB3

Table 6-15 Environmental gamma dose equivalent (mrem)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	37.0 ± 14.5	40.6 ± 18.5	40.8 ± 7.9	44.2 ± 5.4	162.6 ± 25.4 (1.626 ± 0.254)
2	51.2 ± 17.8	60.2 ± 6.1	37.8 ± 10.0	42.8 ± 11.8	192.0 ± 24.4 (1.920 ± 0.244)
3	44.4 ± 6.6	46.2 ± 15.6	39.8 ± 7.9	38.6 ± 6.7	169.0 ± 19.9 (1.690 ± 0.199)
4	40.0 ± 10.1	44.0 ± 13.8	39.8 ± 6.5	34.4 ± 10.3	158.2 ± 21.0 (1.582 ± 0.210)
5	42.2 ± 14.8	44.0 ± 11.3	31.6 ± 12.5	40.6 ± 13.3	158.4 ± 26.1 (1.584 ± 0.261)
6	29.4 ± 9.7	39.6 ± 7.3	34.8 ± 6.7	30.4 ± 13.9	134.2 ± 19.6 (1.342 ± 0.196)
7	39.4 ± 11.5	54.2 ± 9.1	41.2 ± 9.9	48.2 ± 15.3	183.0 ± 23.4 (1.830 ± 0.234)
8	33.2 ± 2.6	50.2 ± 12.4	40.0 ± 6.3	43.0 ± 4.2	166.4 ± 14.8 (1.664 ± 0.148)
9	32.6 ± 5.8	52.6 ± 8.1	40.6 ± 4.8	40.6 ± 10.3	166.4 ± 15.1 (1.664 ± 0.151)

Note: All errors reported as 2 standard deviations.

( ) indicate millisieverts (mSv).

Surface Water Monitoring

Surface water was monitored for radiological contaminants to assess potential environmental impacts from remedial action site activities. *Table 6-16* provides results of the surface water analysis for radiological contaminants. Downstream water monitoring results were statistically indistinguishable from upstream results. In all cases, the results were well below DOE guidelines for water concentrations.

Surface water monitoring was conducted at two locations in 1994 to assess potential risks to human health and the environment.

Figure 6-28 shows the locations of the two surface water sampling points. Surface water sampling point 779 is located west of the former Gunnison processing site, at a campground pond used for pay fishing. Surface water sampling point 780 is located at the northeast corner of a gravel pit, south of the former Gunnison processing site. Filtered and unfiltered surface water samples were collected from these two locations in March 1994 and filtered samples were collected in October 1994.

Table 6-16 Surface water concentrations (10^{-9} μCi/mL)[a]

Location	Radionuclide	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	Guideline[b]
Gunnison River Upstream (01)	^{226}Ra	0.2 ± 0.4	0.0 ± 0.4	0.2 ± 0.6	0.0 ± 0.1	0.1 ± 0.2	100
	^{230}Th	0.9 ± 0.8	0.0 ± 0.6	0.1 ± 0.6	0.0 ± 0.5	0.3 ± 0.3	300
Gunnison River Downstream (02)	^{226}Ra	0.1 ± 0.4	0.2 ± 0.5	0.8 ± 0.8	0.0 ± 0.1	0.3 ± 0.3	100
	^{230}Th	2.6 ± 1.2	0.0 ± 0.8	1.1 ± 1.0	0.5 ± 0.4	0.8 ± 0.5	300
Tomichi Creek Upstream (03)	^{226}Ra	0.6 ± 0.6	0.7 ± 0.5	0.1 ± 0.4	0.3 ± 0.2	0.4 ± 0.2	100
	^{230}Th	1.8 ± 1.2	0.0 ± 0.3	1.0 ± 1.0	0.8 ± 0.6	0.9 ± 0.4	300
Tomichi Creek Downstream (04)	^{226}Ra	0.3 ± 0.5	0.3 ± 0.4	0.6 ± 0.6	0.2 ± 0.1	0.4 ± 0.2	100
	^{230}Th	2.0 ± 1.1	0.0 ± 0.4	-0.3 ± 0.6	0.6 ± 0.5	0.6 ± 0.4	300

[a]All errors reported as 2 standard deviations.

All surface water samples were analyzed for the following parameters: alkalinity, calcium, iron, magnesium, manganese, pH, potassium, sodium, specific conductance, sulfate, temperature, total dissolved solids, uranium, and zinc.

Surface Water Results

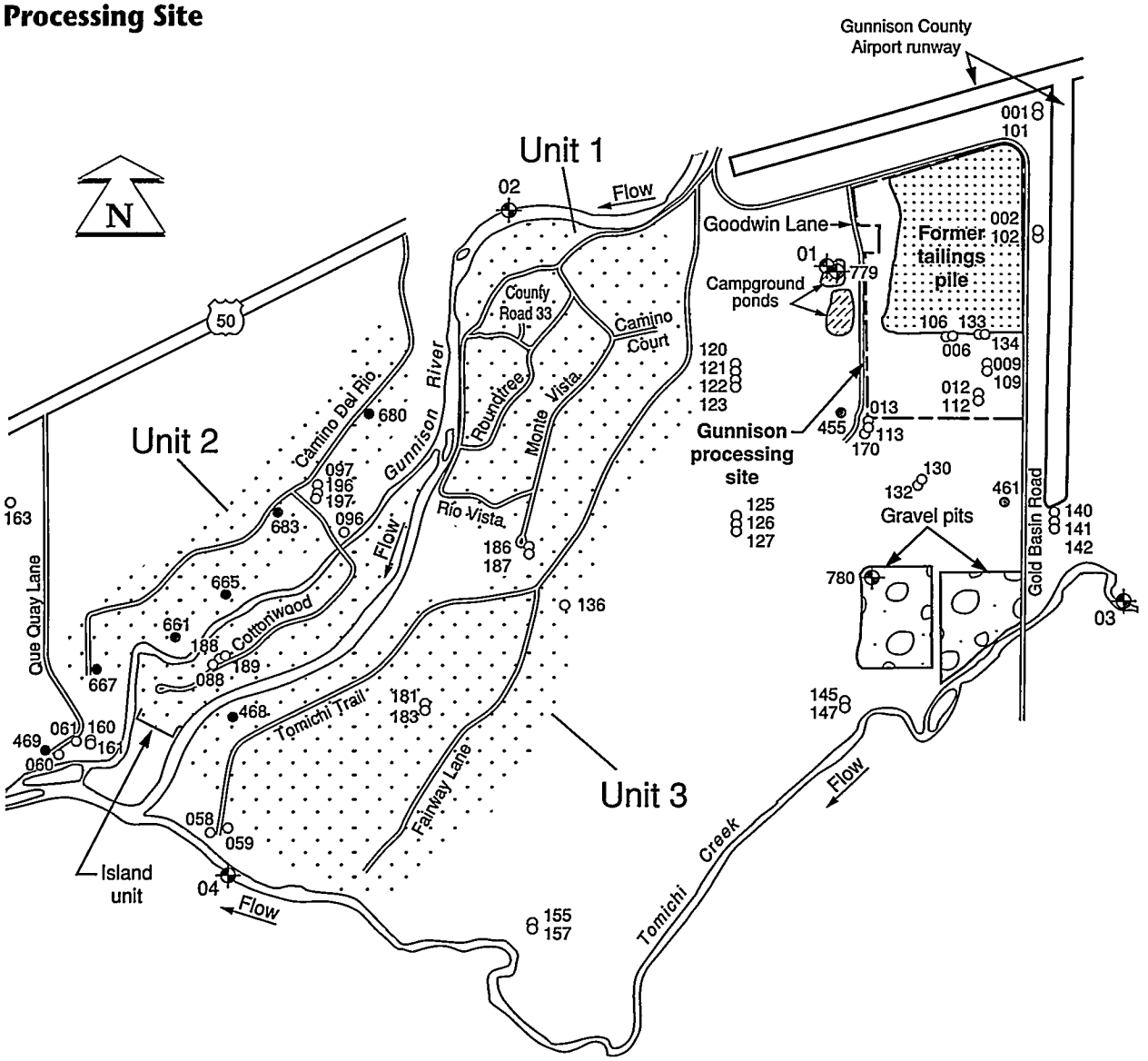
Surface water data collected in the vicinity of the former Gunnison processing site reveal that the constituents detected were within historical ranges defined for past surface water sampling (*Table 6-17*). Comparing the 1994 surface water results with the ground water standards for UMTRCA, the concentration of uranium at location 780 in the March 1994 sample was 0.065 mg/L, which exceeded the established ground water standard of 0.044 mg/L (*Table 6-17*).

Surface Water Conclusions

Surface water present in the gravel pit located south of the site has been contaminated by site-related constituents. Ground water discharge to the pit is the probable transport medium for contamination.

The campground pond located just west of the site is maintained as a pool through diversion of surface water from the Gunnison River. Historically, the campground pond has not indicated elevated constituents related to the site; sampling in 1994 did not indicate a site influence. Surface water samples were not collected during 1994 at the Gunnison disposal site.

Figure 6-28
Ground Water Monitoring Well and Surface Water Sampling Locations, Processing Site



ASER95/GUN/PROSITE

Table 6-17 Surface water quality results, processing site

Indicator parameter	Guideline	Campground pond (779)	Gravel pit (780)
Calcium	NA		
3/94		57.9	102
10/94		70.7	69.1
Magnesium	NA		
3/94		11.6	21.2
10/94		14.0	15.4
Uranium	0.044[a]		
3/94		0.007[b]	0.061
10/94		0.002	0.013

[a]Maximum concentration limit.
[b]Estimated value.

Notes: 1. Concentrations are reported in milligrams per liter.
2. Samples were filtered

NA – None available.

Ground Water Monitoring

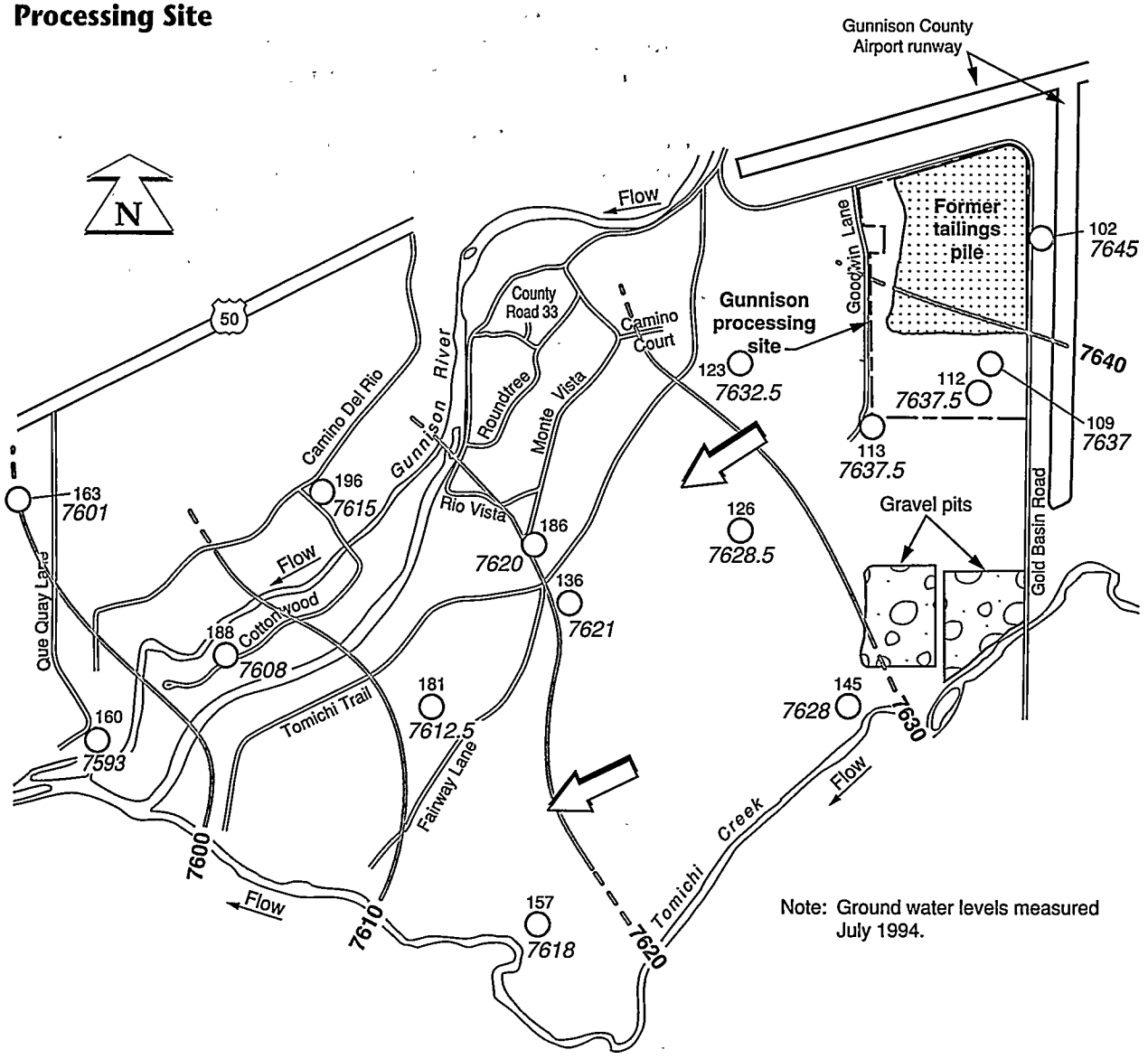
Processing Site

Ground water samples are being collected at the former Gunnison processing site to monitor water quality during surface remediation and to assess the extent of ground water contamination from former processing activities.

The Gunnison processing site is underlain by floodplain alluvial deposits associated with the Gunnison River and Tomichi Creek. These alluvial materials range in size from fine-grained clay to coarse-grained gravels and cobbles with occasional boulders. The thickness of these deposits at the site is at least 130 ft. ***Figure 6-28*** shows the locations of site monitoring wells.

Figure 6-29, a water table contour map, indicates that ground water generally flows southwest from the former processing site. The direction of horizontal ground water movement is comparable in the shallow, intermediate, and deep monitoring wells, indicating the alluvial aquifer is generally unconfined. The ground water flow velocity ranges from 56 to 1700 ft per year (silty alluvium/clean gravels and cobbles).

Figure 6-29
Potentiometric Surface for Shallow and Intermediate Monitoring Wells, Processing Site



ASER95/GUN/POTENSURF

During 1994, nineteen continuous ground water elevation data recorders were installed in 7 new and 12 existing monitoring wells downgradient from the site. The purpose of the instruments is to gather ground water elevation data to investigate the interaction between ground water and surface water in the area.

Figure 6-28 shows DOE monitoring well and domestic well ground water sampling locations. Monitoring well clusters 001/101 and 002/102 are background monitoring wells. The remainder of the monitoring wells measure baseline and/or downgradient water quality. Twenty-four DOE monitoring wells were sampled in March/April 1994; 10 DOE wells were sampled in June/July 1994; and 31 wells were sampled in October 1994.

Filtered ground water samples were collected from the DOE monitoring wells and analyzed for the following parameters:

- Field parameters: alkalinity, dissolved oxygen, ferrous and total iron (at selected monitoring wells) oxidation-reduction potential, pH, specific conductivity, and temperature.

- Laboratory analyses: arsenic, cadmium, calcium, chloride, cobalt, gross alpha and beta, iron, lead-210, magnesium, manganese, polonium-210, potassium, radium-226 and radium-228, sodium, sulfate, thallium, thorium-230, total dissolved solids, and uranium.

Eight private domestic wells were sampled in March/April 1994 and seven private domestic wells were sampled in October 1994. These wells are all located downgradient from the former processing site. Sampling is conducted in these wells to monitor the following: contaminant plume migration, private wells in the area used for irrigation and livestock uses, and domestic wells downgradient of the contaminant plume (to assess any potential impacts from the site).

Unfiltered ground water samples were collected from the private domestic wells and were analyzed for the following parameters:

- Field parameters: alkalinity, dissolved oxygen, oxidation-reduction potential, pH, specific conductivity, and temperature.

- Laboratory analyses: samples from well 468 were analyzed for arsenic, cadmium, calcium, chloride, cobalt, gross alpha and beta, iron, lead-210, magnesium manganese, net gross alpha, polonium-210, potassium, radium-226 and radium-228, sodium, sulfate, thorium-230, total dissolved solids, total organic carbon, and uranium. Samples from all other domestic wells were analyzed for uranium only.

Sulfate and uranium are used to define the areal extent of the contamination for the following reasons: they are found in very low background concentrations in ground water, they are chemical by-products of ore processing at the Gunnison mill, and they are geochemically conservative compounds. Other ground water contaminants of concern are cadmium, cobalt, iron, manganese, and some radioactive uranium decay products.

Ground Water Results. ***Table 6-18*** summarizes ground water quality results for the Gunnison processing site vicinity. Results are presented for a background monitoring well (102), a monitoring well in the contaminant plume (186), a downgradient monitoring well (160) that appears to be influenced by the leading edge of the contaminant plume, a downgradient domestic well (468) in the contaminant plume, and a downgradient domestic well (469) at the leading edge of the plume located near well 160.

Indicator parameters presented in ***Table 6-18*** (total dissolved solids, sulfate, and uranium) were selected because they demonstrate the current maximum probable extent of ground water contamination. The table shows that concentrations of total dissolved solids are approximately 340 to 355 mg/L in background samples, 910 to 935 mg/L in the contamination, and 430 to 445 mg/L at the outer edge of the contamination. Sulfate concentrations measured approximately 21 mg/L in background samples, but increased to 370 to 420 mg/L in the contamination, and decreased to 85 to 90 mg/L at the edge of the contamination. Uranium concentrations show a similar trend, with background concentrations at monitoring well 102 ranging from 0.003 to 0.004 mg/L, then increasing by one order of magnitude at monitoring well 186 (0.048 to 0.049 mg/L). Uranium concentrations at downgradient monitoring well 160 were slightly elevated above background (0.015 mg/L).

Uranium concentrations at domestic well 468 ranged from 0.044 to 0.049 mg/L. This well has historically shown elevated uranium concentrations. Uranium concentrations at domestic well 469, located on the north side of the Gunnison River, ranged from 0.001 to 0.004 mg/L.

Figure 6-30 illustrates the areal distribution of the sulfate contamination. The distribution of sulfate contamination (***Figure 6-31***) is very similar to that of uranium (***Figure 6-31***). ***Figures 6-32 and 6-33*** illustrate the trends of sulfate and uranium for three DOE monitoring wells over the past 4 years, showing background concentrations have remained relatively constant. The concentrations of uranium at monitoring well 160, located on the west side of the Gunnison River, indicate an apparent upward trend even though uranium at this location remains well below the maximum concentration limit.

Table 6-18 Ground water quality results, processing site

Well Location	Total dissolved solids (500[a])		Sulfate (250[a])		Uranium (0.044[b])	
	Apr-94	Oct-94	Apr-94	Oct-94	Apr-94	Oct-94
Background monitoring well 102	355	337	21.9	20.6	0.004[c]	0.003
Contaminant plume monitoring well 186	935	911	423	371	0.048	0.049
Downgradient monitoring well 160	432	444	92.2	86.5	0.015[c]	0.015
Downgradient domestic well 468	NA	745	NA	269	0.049	0.044
Domestic well 469 on north side of Gunnison River near well 160	NA	NA	NA	NA	0.004	0.001[c]

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.
[c]Estimated value.

Note: Concentrations are reported in milligrams per liter. All samples were filtered, except for wells 468 and 469 which were unfiltered.

NA – not analyzed.

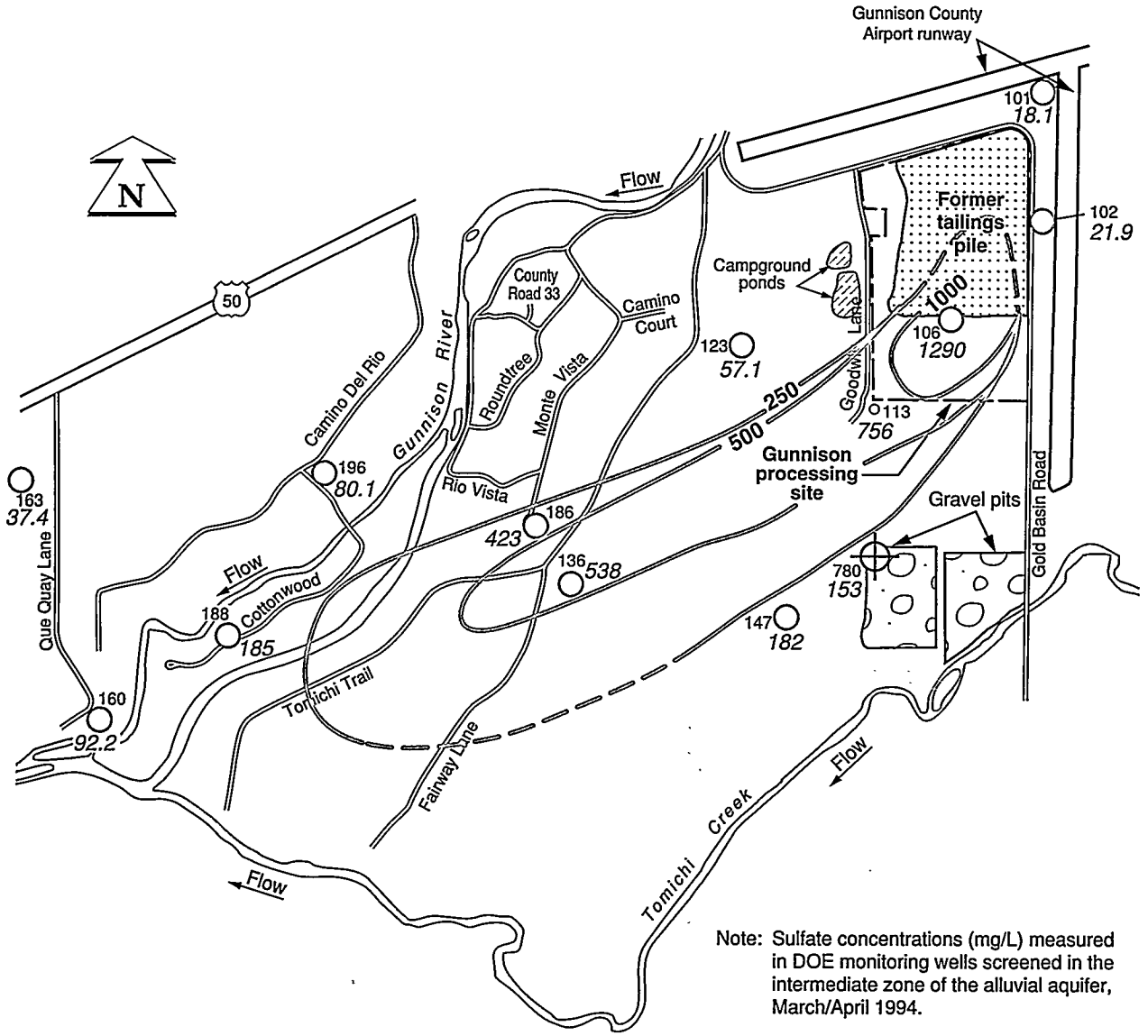
Ground Water Conclusions. Ground water sampling results for background monitoring wells show that concentrations of all measured regulated constituents were significantly below maximum oncentration limits. Samples collected during 1994 from wells downgradient of the former processing site were similar to samples collected in past years, indicating that former uranium milling activities have impacted ground water in the alluvial aquifer. Uranium concentrations continue to exceed maximum concentration limits in monitoring wells approximately 6,000 ft downgradient of the former processing site. Uranium concentrations in downgradient monitoring well 160 show a minor upward trend, indicating that the contaminants may be moving. However, domestic well 469, which is near well 160, does not show any indications of being impacted by the former processing site.

Disposal Site

Contaminated materials from the former Gunnison processing site are being moved to the Gunnison disposal site, approximately 6 mi east of the town of Gunnison. Ground water monitoring is required at the disposal site to assess the effectiveness of the disposal cell in isolating contaminants from the environment. ***Figure 6-34*** shows DOE monitoring well locations at the Gunnison disposal site that were sampled or where water levels were measured in 1994.

At the Gunnison disposal site, the uppermost aquifer occurs in the lower portion of a regional Tertiary gravel unit. ***Figure 6-35*** is a potentiometric map showing that ground water flows in an easterly direction. Depths to ground water beneath the disposal site range from

Figure 6-30
Sulfate Concentrations in the Alluvial Aquifer, Processing Site



Note: Sulfate concentrations (mg/L) measured in DOE monitoring wells screened in the intermediate zone of the alluvial aquifer, March/April 1994.

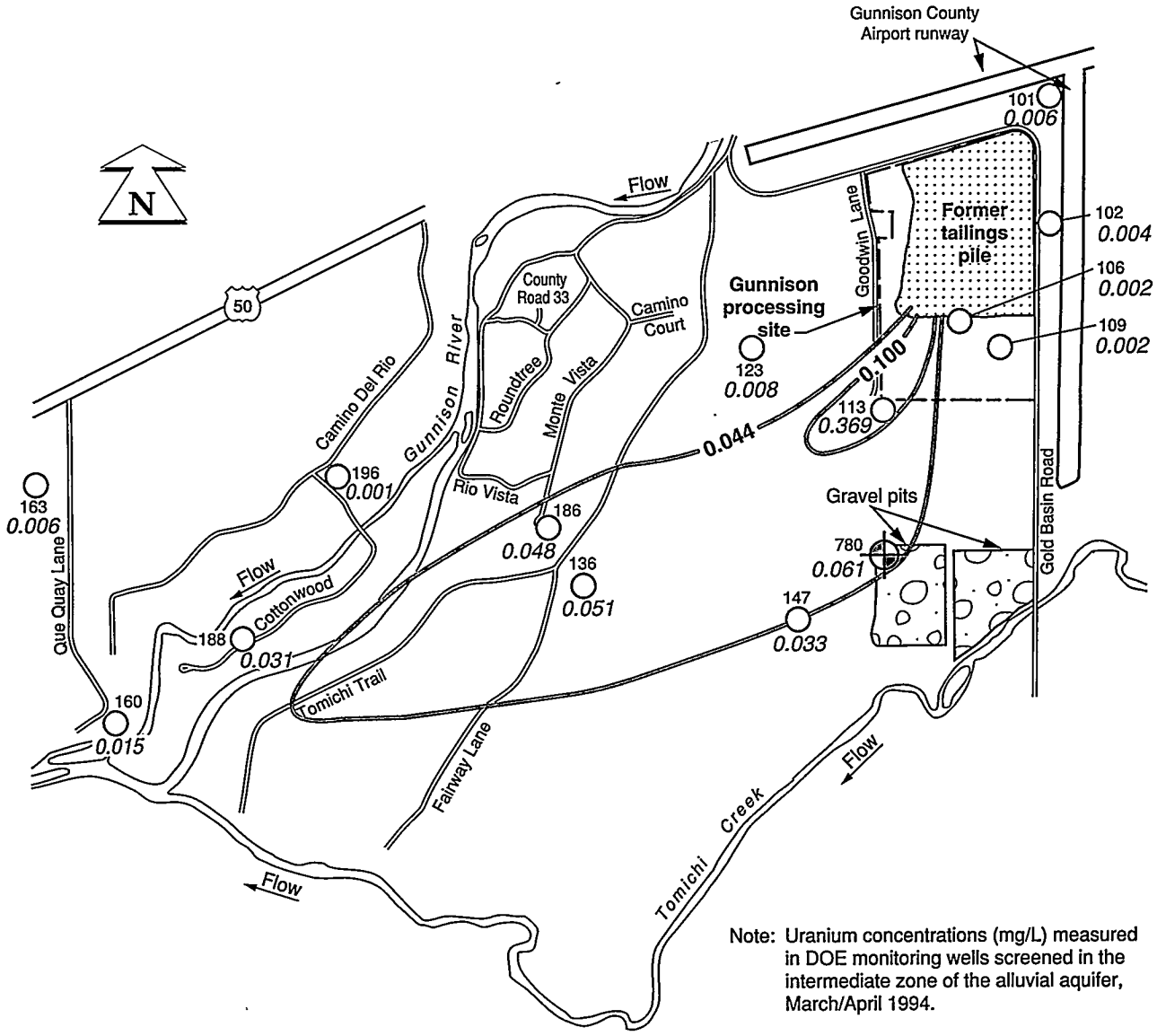
LEGEND

780 / 153	Surface water sampling location / Sulfate concentration (mg/L)
188 / 185	DOE ground water monitoring well / Sulfate concentration (mg/L)
250	Sulfate concentration contour (mg/L, dashed where inferred)
50	U.S. highway

500 0 500 1000 Feet

ASER95/GUN/SULPLUME

Figure 6-31
Uranium Concentrations for Intermediate Monitoring Wells, Processing Site



Note: Uranium concentrations (mg/L) measured in DOE monitoring wells screened in the intermediate zone of the alluvial aquifer, March/April 1994.

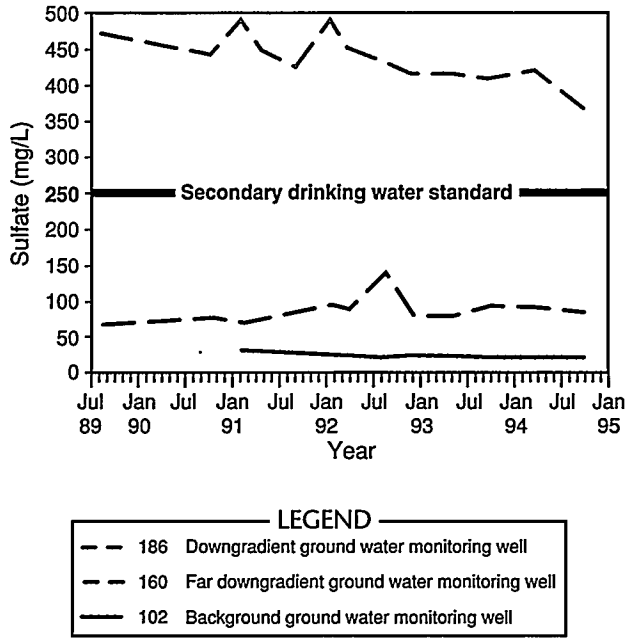
LEGEND

780 / 0.061	Surface water sampling location / Uranium concentration (mg/L)
188 / 0.031	DOE ground water monitoring well / Uranium concentration (mg/L)
0.044	Uranium concentration contour (mg/L, dashed where inferred)
50	U.S. highway

- 500 0 500 1000 Feet

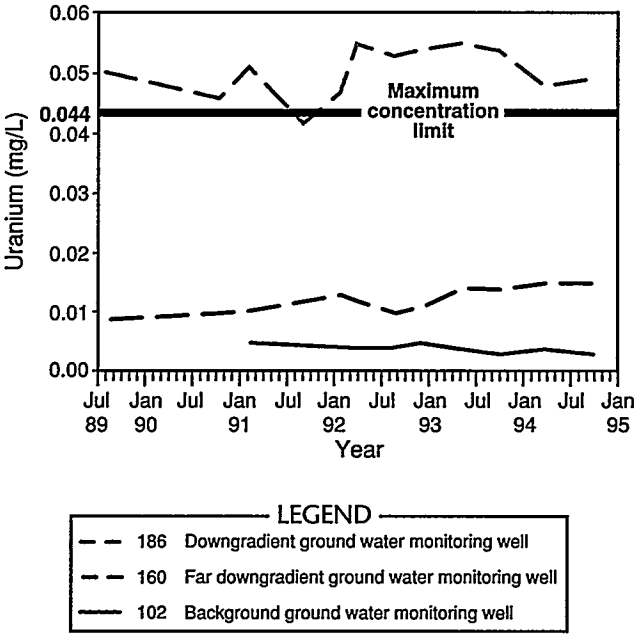
ASER95/GUN/URNPLUME

Figure 6-32
Sulfate Concentrations Over Time in the Alluvial Aquifer, Gunnison Processing Site



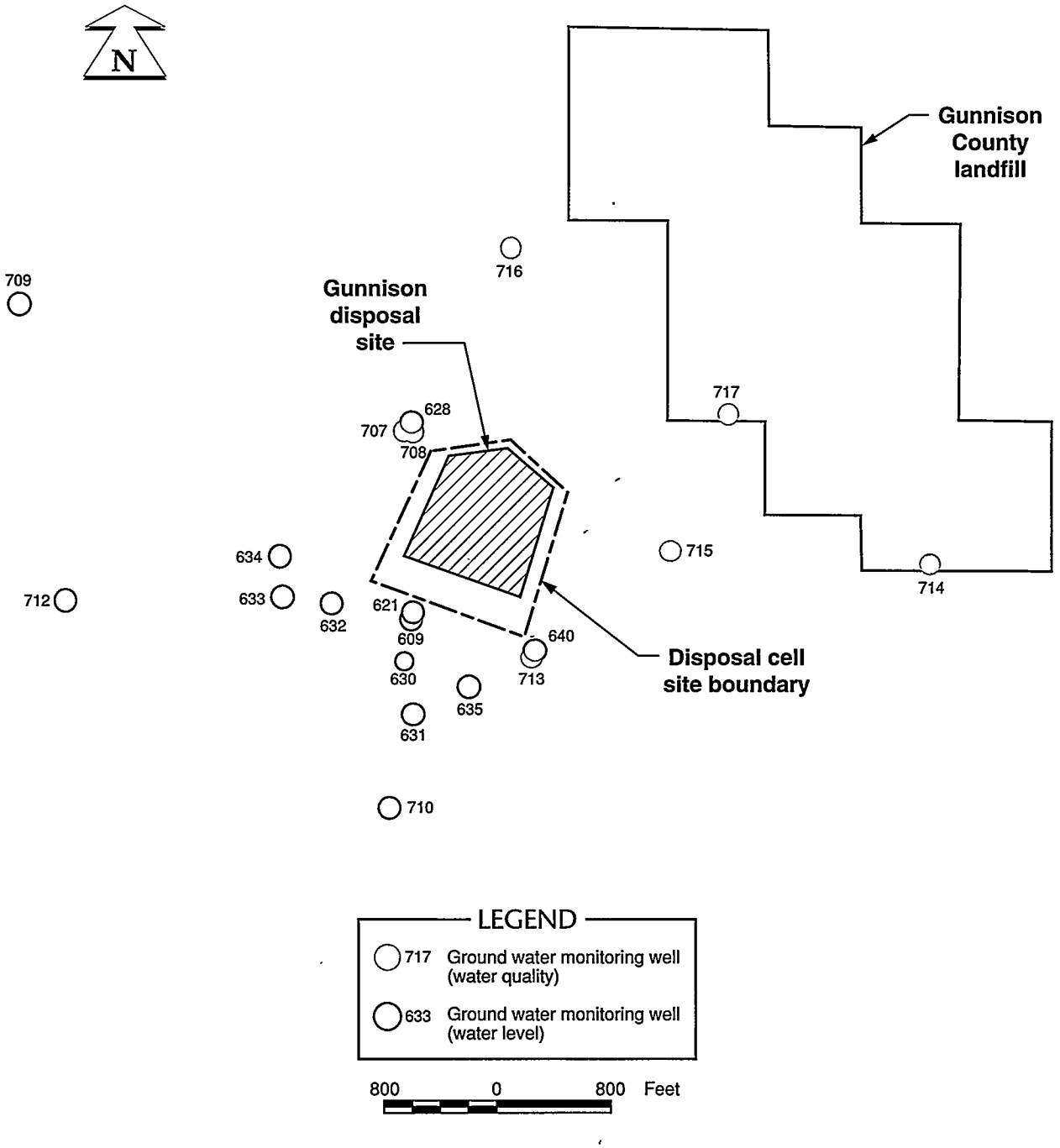
ASER95/GUN/GWQUAL

Figure 6-33
Uranium Concentrations Over Time in the Alluvial Aquifer, Gunnison Processing Site



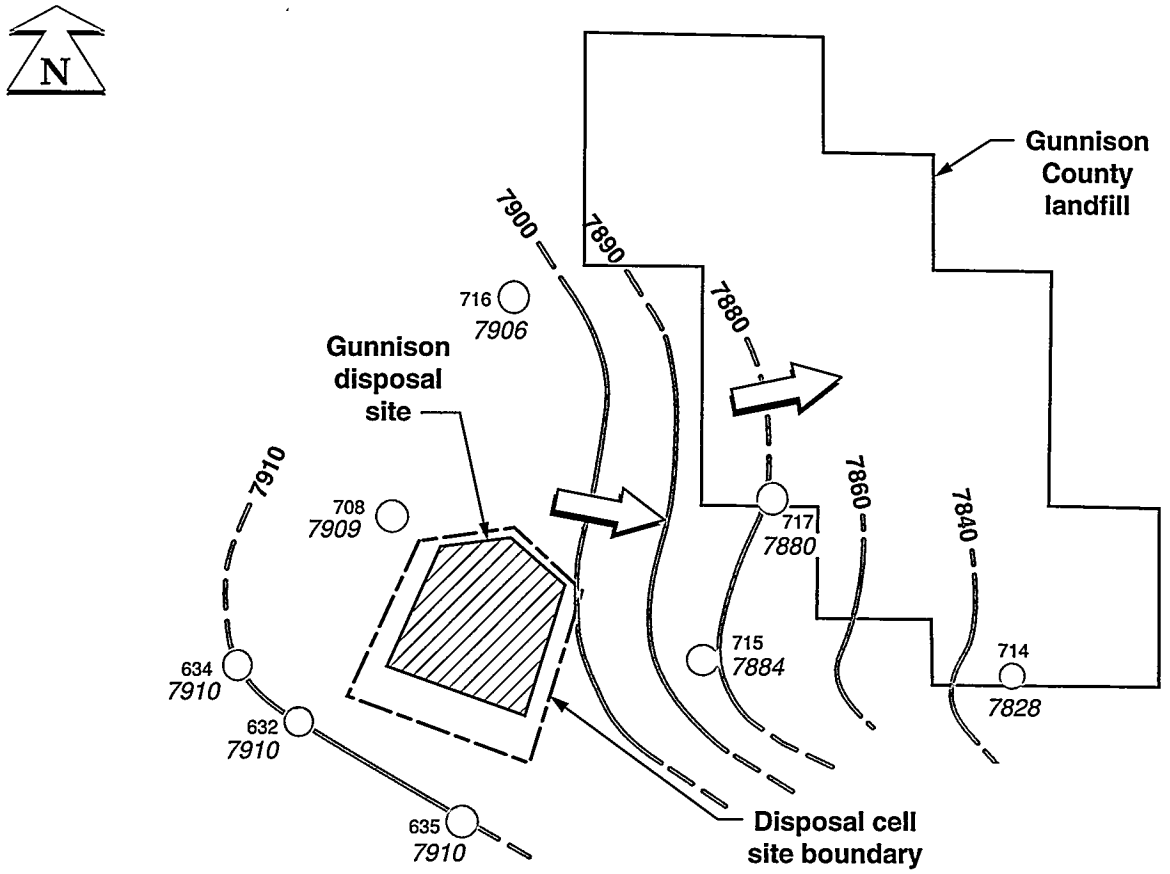
ASER95/GUN/URNCON

Figure 6-34
Ground Water Monitoring Well Locations, Disposal Site



ASER95/GUN/MONWELLLOCS

Figure 6-35
Potentiometric Surface Map of the Tertiary Gravel Aquifer, Disposal Site



Note: Water levels measured October 1994.

LEGEND

635 / 7910	DOE ground water monitoring well Ground water elevation (ft above MSL)
7910	Ground water elevation contour (ft above MSL, dashed where inferred)
	Ground water flow direction

800 0 800 Feet

ASER95/GUN/TERTPOTENSURF

approximately 60 to 180 ft below land surface. Aquifer testing shows the uppermost aquifer responds as a confined aquifer at the disposal site. The primary direction of ground water flow is eastward, with an approximate linear ground water velocity ranging from 5 to 10 ft per year.

DOE monitoring wells 707, 708, and 713 through 717 (at the Gunnison disposal site) were sampled in June/July and October 1994. This sampling complied with the surface remediation ground water protection strategy presented in the site remedial action plan (DOE, 1992a).

Ground Water Results. Ground water samples collected in 1994 were analyzed for the following parameters on one or more occasions based on the quantity of water available (sample volume) for a given well.

- Field parameters: alkalinity, dissolved oxygen, oxidation-reduction potential, pH, specific conductivity, temperature, and turbidity.
- Laboratory analyses: antimony, arsenic, beryllium, cadmium, calcium, chloride, chromium, cobalt, copper, gross alpha and beta, iron, lead, potassium, magnesium, molybdenum, nickel, nitrate, radium-226 and radium-228, selenium, sodium, sulfate, thallium, tin, total dissolved solids, uranium, vanadium, and zinc.

These analyses include contaminants of concern identified in the tailings pore fluids; major constituents; and field parameters that may provide an early indication of changes in contaminant distribution.

Evaluation of ground water elevation data revealed a relatively stable ground water flow direction over time. Ground water table fluctuations are expected to result from variations in natural recharge (precipitation and snowmelt).

Comparing analytical results of ground water samples collected during 1994 with historical water quality data shows arsenic concentrations exceeded the maximum concentration limits at monitoring well 715. Concentrations or activities of arsenic, net gross alpha, and combined radium-226 and thorium-228 historically have exceeded maximum concentration limits in background ground water samples collected from the Tertiary gravel (uppermost) aquifer. No exceedances in net gross alpha or radium-226 and radium-228 activities were measured in 1994.

Ground Water Conclusions. With the exception of arsenic, concentrations or activities of all measured hazardous constituents at the disposal site were below maximum concentration limits in 1994. Several hazardous constituents, including arsenic, have historically

equaled or exceeded the proposed maximum concentration limits in some samples collected from the uppermost aquifer since the wells were constructed in 1988. These exceedances are the result of naturally occurring sources in the aquifer. Arsenic concentrations exceeded maximum concentration limits in 1993 before tailings disposal (January 1993) and during tailings disposal (June/July 1994 and October 1994). No significant changes have been noted in the water quality upgradient and downgradient of the disposal cell since the beginning of disposal site construction and tailings relocation. Surface remedial action construction has not affected the ground water quality in the uppermost aquifer (Tertiary gravels) at the Gunnison disposal site.

Ecological Monitoring

Mitigation Wetlands Monitoring

Surface remediation at the Gunnison site resulted in the destruction of almost 5 ac of USACE-regulated wetlands. To mitigate this loss, a wetlands enhancement plan was undertaken at six springs on Bureau of Land Management land that had been highly degraded by livestock (***Figure 6-36***) (DOE, 1994a). In late 1993, all six sites were fenced to keep livestock out. In addition, spring developments and the establishment of stock tanks outside the exclosures, were completed. The first year of a 5-year monitoring study of the recovery of the six sites was completed in 1994. This consisted of wildlife surveys in June and vegetation sampling in August. Vegetation sampling methods were the same as those used to sample existing conditions in 1993 (BLM, 1985; Daubenmire, 1959). It was determined that cattle had grazed the Houston Gulch mitigation site in 1994 so sampling at this location is representative of grazed conditions.

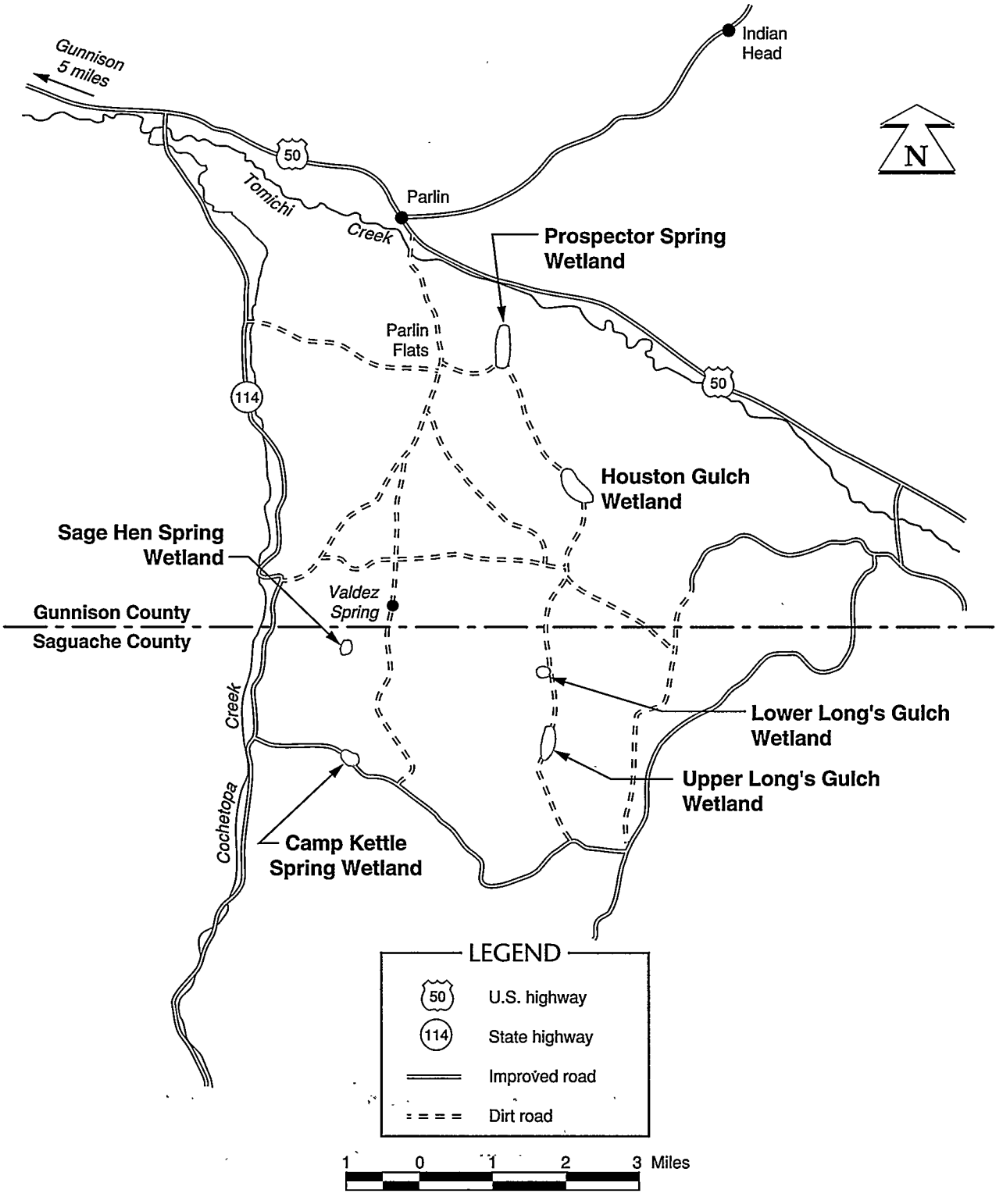
Wildlife Mitigation and Monitoring

As part of wildlife mitigation for the Gunnison site (DOE, 1992b), the final three riparian areas to be used for sage grouse mitigation were identified and fenced to exclude livestock. In addition, all spring developments and stock tank establishments were completed.

Aerial surveys of pronghorn antelope that winter in the Chance Gulch area near the Gunnison disposal site were conducted in 1994. These surveys indicate that remedial action activities at the disposal site are not impacting the pronghorn antelope.

When compared to last year's results, surveys of sage grouse leks (strutting ground used by sage grouse during the breeding season) indicated a 38 percent decline in the maximum number of males attending the Chance Gulch lek. Counts of male sage grouse at the off-site control leks also showed a decline in the number of males at three of the four leks surveyed (CDOW, 1994a).

Figure 6-36
Location Of Six Wetland Mitigation Sites in Gunnison and Saguache Counties



ASER95/GUN/SIXWETLANDS

Sage grouse brood counts were conducted at 11 riparian areas in 1994; no sage grouse broods were observed during this survey (CDOW, 1994b). Some of these riparian areas are near the disposal site and control areas; this data, along with the lek count data, indicates that the sage grouse population is declining in the Gunnison Basin and that this decline may be related to drought conditions (CDOW, 1994b).

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SITE DESCRIPTION AND LOCATION

The Maybell UMTRA Project processing site is in Moffat County, 25 mi west of the city of Craig and 5 mi northeast of the unincorporated village of Maybell (*Figure 6-37*). The former processing site is in a remote area of sagebrush and pinon-juniper habitat. The site is partly on Bureau of Land Management land and partly on private land. The principal land uses are grazing and hunting. Wetlands occur along Johnson Wash and Lay Creek near the site. Johnson Wash is a dry arroyo that runs close to the eastern border of the site and that joins Lay Creek about 2 mi south of the site. This creek is a tributary of the Yampa River; the confluence is about 5 mi southwest of the site.

The population of Moffat County is 11,357 (DOC, 1990). Although one historical site occurs near the site, it is not considered eligible for inclusion in the National Register of Historic Places.

The climate at the Maybell site is semiarid. The average annual precipitation is about 13 inches; snowfall averages more than 80 inches annually. Threatened and endangered species occur near the site along the Yampa River and include wintering bald eagles and the Colorado squawfish.

SITE HISTORY AND OWNERSHIP

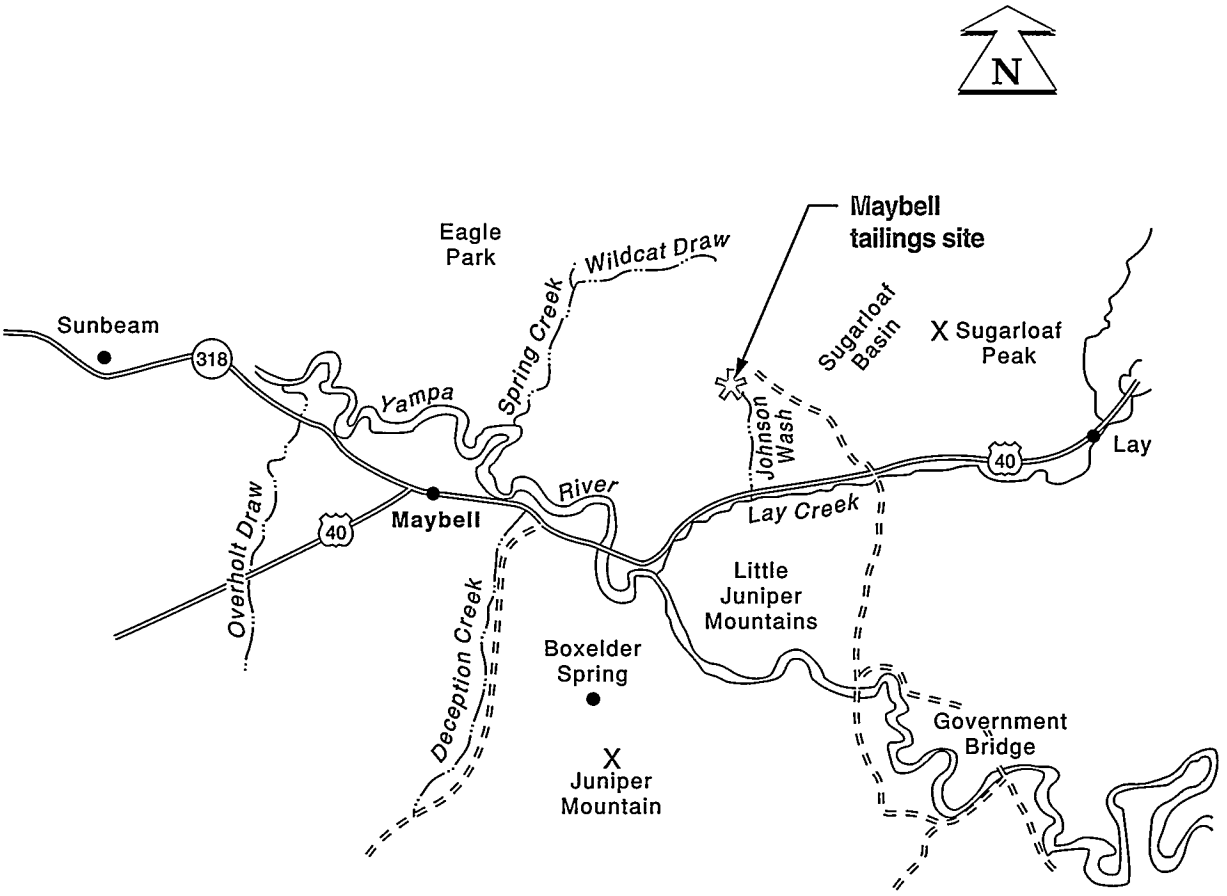
The Maybell site was established by the Trace Element Corporation in 1955 and 1956. Umetco assumed control of the site, and in 1957 the mill began operation. Uranium ore was obtained from nearby open pit mines. During the 7 years of operation by Umetco, the mill processed approximately 2.6 million tons of ore. After the mill shut down in November 1964, Umetco dismantled it and began stabilizing the tailings in 1971 in accordance with Colorado regulations. Remaining features include the tailings pile, building foundations at the former processing site, nearby open pit mines, and overburden piles associated with the area mines.

The northern portion of the site is on land administered by the Bureau of Land Management, and the southern portion is on private land. Prior to any remedial action at the proposed disposal site (the existing tailings pile location), a permanent jurisdiction transfer of Bureau of Land Management-administered land would be required to transfer administration of the disposal site to DOE. Privately owned lands would be acquired by the state of Colorado. The state of Colorado would then transfer titles of these lands to DOE prior to initiation of the remedial action.

SITE CHARACTERIZATION AND CLEANUP

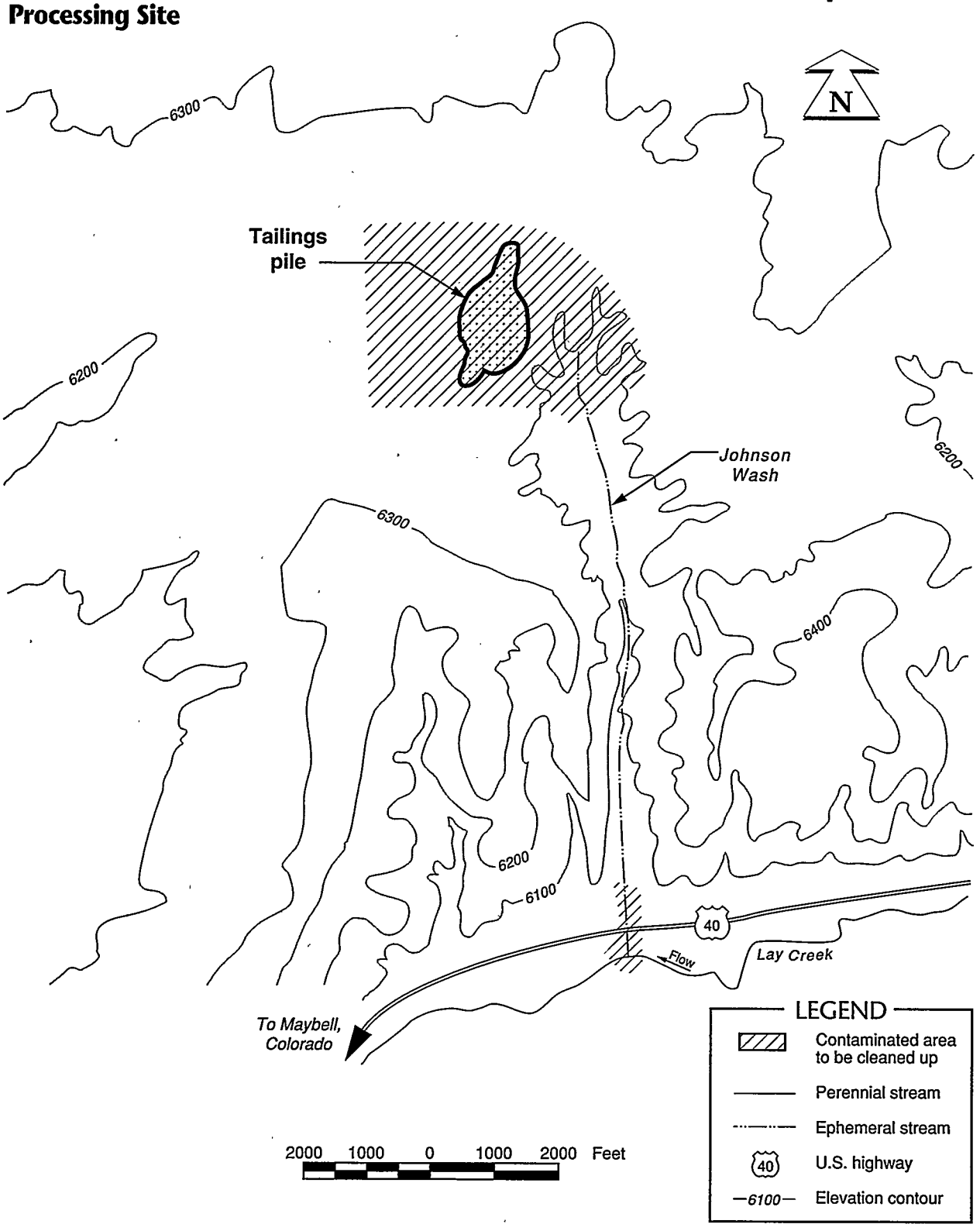
Contaminated areas at the Maybell site include the tailings pile and former processing site, areas adjacent to the tailings pile, areas bordering the former processing site, and areas along Johnson Wash and Lay Creek (*Figure 6-38*). The tailings pile contains approximately 2.8 million cubic yards of tailings. The former mill processing yard is located on the north side of the tailing pile. The yard contains an

Figure 6-37
Maybell Site Location



ASER95/MAY/SITELOC

Figure 6-38
Approximate Boundaries of Radium-226 Soil Contamination and Cleanup, Processing Site



ASER95/MAY/RAD-226BOUNDSA

estimated 20,000 cubic yards of contaminated demolition debris from the former mill structures. Areas to the north, west, and south sides of the tailings pile contain approximately 244,000 cubic yards of contaminated soils, including a raffinate pond adjacent to the southwest corner of the tailings pile. Approximately 240,000 cubic yards of contaminated soils exist as a result of wind dispersion of contaminated materials. Surface water flow has dispersed contamination from the processing site to drainage areas in Johnson Wash and Lay Creek. Some of the contamination in Johnson Wash and Lay Creek can be attributed to effluent from mill operations that was discharged to Johnson Wash. Approximately 61,000 cubic yards of contaminated materials are present in the two drainages. The total volume of contaminated materials is about 3.5 million cubic yards.

The proposed surface remedial action for the Maybell tailings site is to stabilize the tailings pile at its present location. The completed disposal cell would also contain the residual radioactive materials from the other areas of contamination adjacent to the tailings pile, including a contaminated area at the confluence of Johnson Wash and Lay Creek (*Figure 6-38*).

Supplemental surface cleanup standards may be applied by the DOE to the majority of the contaminated areas along Johnson Wash and Lay Creek under 40 CFR 192, Subpart C.

ENVIRONMENTAL COMPLIANCE STATUS

With site remedial action scheduled to begin in the spring of 1995, the UMTRA Project at Maybell will comply with federal and state regulations. Remedial action activities will be continuously evaluated for their environmental impact and to ensure that they meet applicable regulatory requirements. A 404 dredge and fill permit (199475466) and a site stormwater permit (COR-031206) were applied for in 1994.

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are analyzed to evaluate the ground water contamination resulting from processing site activities. In addition, sample results are evaluated for compliance with EPA ground water standards and applicable state standards.

Wetlands and threatened and endangered species surveys were conducted in 1994 for compliance with Executive Order 11990, *Protection of Wetlands*, and the Endangered Species Act (15 USC §1631 *et seq.*).

National Environmental Policy Act

The draft Maybell environmental assessment for surface remedial action was sent out for agency review in late 1993 and all comments were resolved in 1994. In addition, two rounds of comments were received from DOE Headquarters and were incorporated into the environmental assessment where appropriate. The Maybell

environmental assessment and finding of no significant impact were approved by DOE Headquarters in January 1995.

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Maybell UMTRA site.

ENVIRONMENTAL MONITORING

The DOE conducted a detailed environmental monitoring program for surface water and ground water at the Maybell site in 1994. This program monitored quantities of radioactive material and nonradiological hazardous constituents released into the environment.

Because surface remedial action at the Maybell site has not yet begun, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

Surface Water Monitoring

The Maybell tailings site is drained by Johnson Wash, an ephemeral tributary of Lay Creek. Lay Creek, located approximately 2 mi south of the site, is a perennial stream that flows southwest about 5 mi to the Yampa River.

Filtered surface water samples were collected in July and October 1994 from the vicinity of the Maybell site (***Figure 6-39***) to assess potential risk to fauna and flora near the site. In July 1994, locations 705, 706, 707 (along Lay Creek), and location 718 (in Rob Pit) were sampled. In October 1994, surface water samples were taken at the same four locations, as well as two additional locations on Johnson Wash (701 and 719) and a background location (721) in an ephemeral tributary that joins Lay Creek approximately 0.6 mi east of location 706. These surface water samples were analyzed for alkalinity, arsenic, cadmium, calcium, chloride, dissolved organic carbon, gross alpha, gross beta, iron, lead, magnesium, manganese, molybdenum, nitrate, pH, phosphate, potassium, radium-226, radium-228, selenium, sodium, specific conductance, sulfate, temperature, total dissolved solids, and uranium.

Surface Water Results and Conclusions

Concentrations of selected constituents from the surface water sampling events are presented in ***Table 6-19***. The EPA maximum concentration limit for uranium was exceeded in the Rob Pit sample (718), at locations 701 and 719 in Johnson Wash, and at locations 705 and 707 in Lay Creek. The maximum concentration limit for radium was exceeded at location 705.

Elevated concentrations of uranium in the Rob pit samples are expected because the water is in contact with naturally occurring

Figure 6-39
Surface Water Features and Sampling Locations, Processing Site

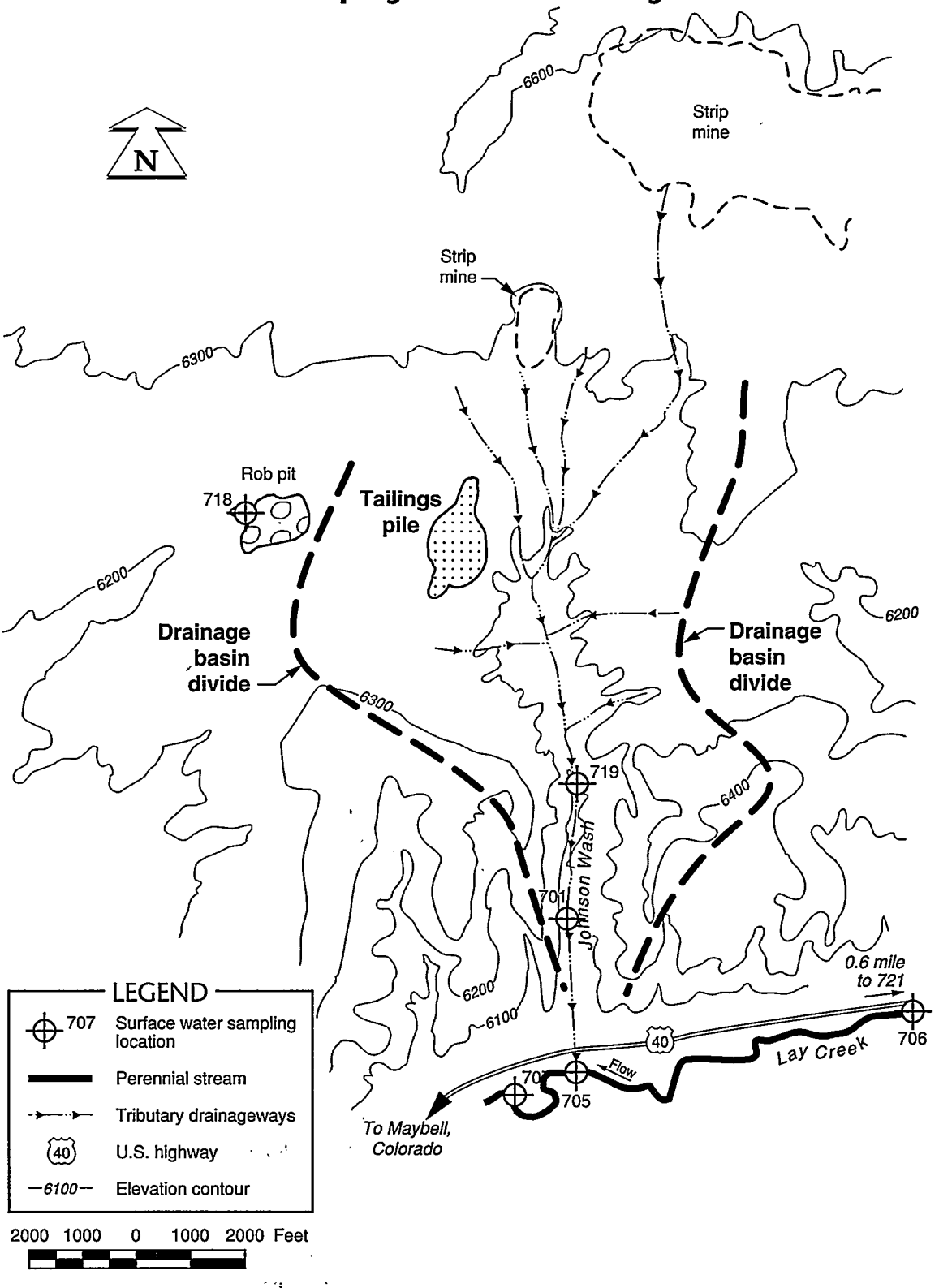


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Table 6-19 Concentrations of selected constituents in surface water samples collected near the Maybell processing site

Constituent concentration	Guideline	Location ID 701	705	706	707	718	719	721
Total dissolved solids	500[c]							
7/94		X	4590	2930	3650	3010	X	X
10/94		X	X	X	X	X	X	X
Radium-226 and -228[a]	5.0[b]							
7/94		X	5.6	0.0	0.10	4.6	X	X
10/94		X	X	X	X	X	X	X
Sulfate	250[c]							
7/94		X	1880	1550	1910	2110	X	X
10/94		X	X	X	X	X	X	X
Uranium	0.044[b]							
7/94		X	0.103	0.005	0.271	0.251	X	X
10/94		0.106	0.025	0.009	0.239	0.218	0.086	0.003

[a]Radium-226 and -228 in picocuries per liter.
[b]Maximum concentration limit.
[c]Secondary Drinking Water Standard.

Notes: 1. Results in milligrams per liter except where noted.
2. Samples collected in July and October 1994

X – no sample taken.

low-grade mineralization adjacent to and beneath the pit. Surface water samples from seeps in Johnson Wash have elevated concentrations of uranium resulting from accidental and routine discharge of tailings material into Johnson Wash during the period of operation and surface runoff encountering material released from the tailings pile, as well as material derived from mineralization in the Johnson Wash drainage area. Elevated levels of uranium in surface water samples from Lay Creek could also be attributed to release of contaminated material from the mill site, as well as material derived from mineralization in both the Johnson Wash and Lay Creek drainage areas. The mineralized trend in the region is present north and east of the mill site, and also south of the highway, thus providing a possible upstream source of uranium where Lay Creek crosses the trend. Concentrations of constituents in surface water samples from Lay Creek are dependent on the amount of stream flow and vary according to the time of year sampled. During periods of low flow, evaporation of standing water in ponds would tend to yield higher concentrations

than when the water is actively flowing. This is indicated by results of previous sampling from location 707 (during 1986-1988) when concentrations of uranium were consistently less than the maximum concentration limit. Additional sampling of surface water locations in Johnson Wash and Lay Creek will be done during 1995 to further evaluate the variability of concentrations of hazardous constituents and the potential impact to human health and the environment.

Ground Water Monitoring

The uppermost aquifer at the Maybell site is the upper sandstone unit of the Browns Park Formation. Unconfined ground water occurs within this formation at depths ranging from 35 to over 300 ft beneath the ground surface. Ground water in the uppermost aquifer flows to the southwest, as shown in ***Figure 6-40***.

The monitoring well locations (***Figure 6-40***) were chosen to provide a representative distribution of sampling points in order to define ground water flow directions and characterize ground water quality. In particular, because some wells will be decommissioned as part of construction activities (wells very close to and in the tailings pile), it was desirable to sample these wells in 1994 to further characterize conditions close to the tailings pile.

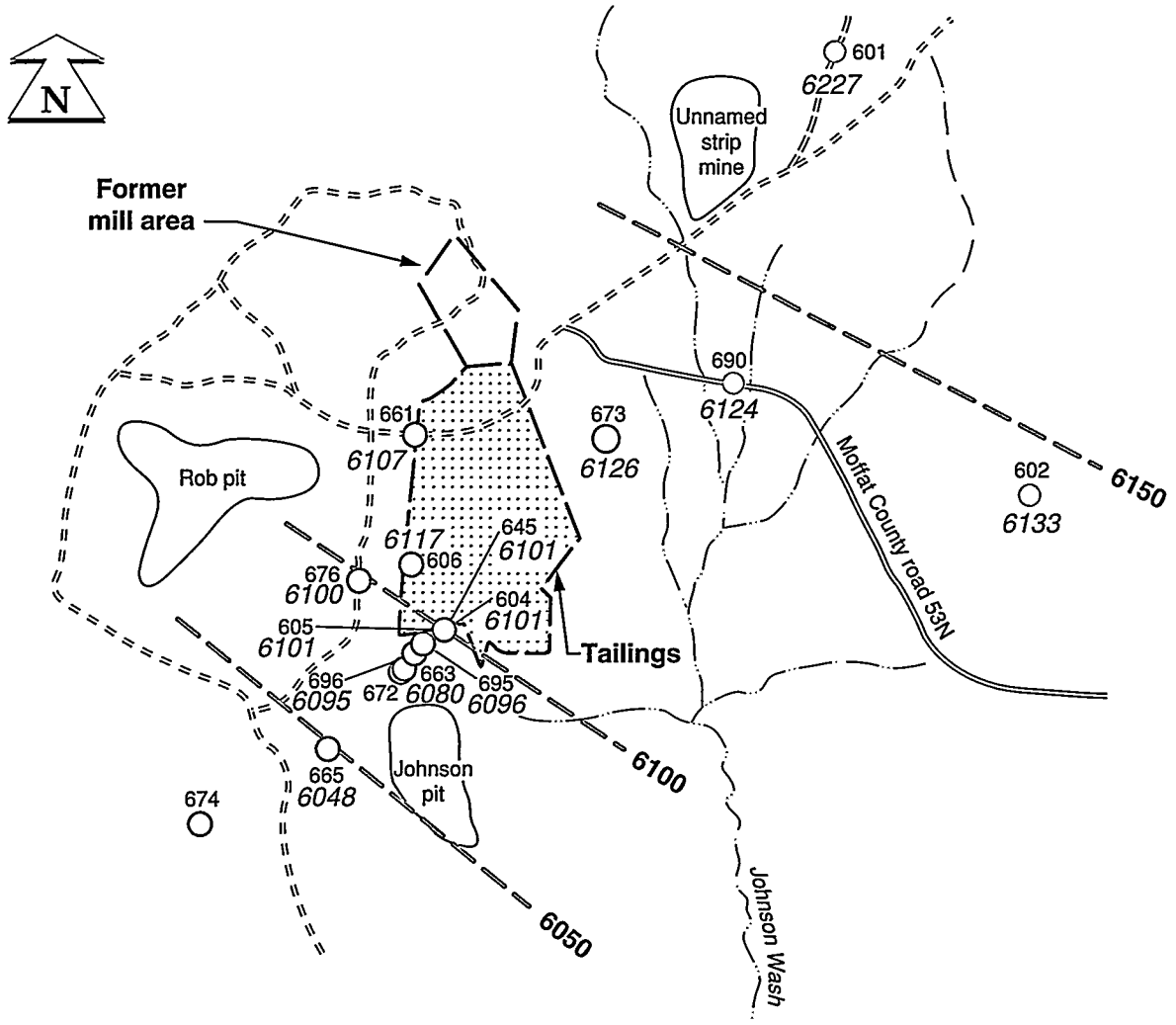
In July 1994, 12 monitoring wells were sampled. Monitoring wells 601, 602, and 690 were sampled to monitor upgradient background ground water quality. Monitoring wells 604, 605, 606, 645, 661, 663, 673, and 676 were sampled to monitor constituents at the tailings pile and immediately downgradient. Wells 645, 605, and 604 are a cluster that are used to monitor the vertical component of contaminant transport near the tailing pile. Monitoring well 665, located about 1300 ft downgradient of the tailings pile in the direction of ground water flow, was sampled to monitor changes in downgradient ground water quality. Another downgradient well (674) was not sampled in 1994.

Monitoring wells 695 and 696 were installed in November 1994 to monitor projected transient drainage from the future disposal cell and to monitor the effectiveness of surface remediation. These wells and wells 604 and 645 were sampled in November 1994 to establish baseline conditions in ground water prior to remediation.

Ground Water Results

Ground water samples collected in July 1994 were analyzed for alkalinity, arsenic, cadmium, calcium, chloride, dissolved organic carbon, dissolved oxygen, gross alpha, gross beta, iron, lead, magnesium, manganese, molybdenum, nitrate, pH, phosphate, potassium, radium-226, radium-228, reduction-oxidation potential, selenium, sodium, specific conductance, sulfate, temperature, total dissolved solids, turbidity, and uranium.

Figure 6-40
Ground Water Sampling Locations and Potentiometric Surface, Processing Site



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Uranium, radium, and nitrate were selected as indicator parameters because they are associated with the ore milling at the site. Molybdenum, selenium, and arsenic were selected as indicator parameters because their detection may signal a significant change in conditions at the tailings pile. Uranium and selenium are also naturally present above maximum concentration limits in the Browns Park Formation. *Table 6-20* summarizes ground water monitoring results for 1994.

Figure 6-41 shows uranium concentration over time for upgradient well 602, on-site well 606, and downgradient well 674 (not sampled in 1994). Uranium concentration at upgradient location 602 and on-site location 606 exceeded the maximum concentration limit (0.044 mg/L). On-site well 606 yielded results for uranium in 1994 that were similar to those found in 1993. The 1993 values for this location exceeded the previous historical maximum value. *Figure 6-42* shows nitrate concentrations over time for the same locations. In 1994, the maximum concentration limit for nitrate (44 mg/L) and the previous historical maximum value were exceeded in well 606.

Ground Water Conclusions

Uranium milling activities at the Maybell site have resulted in impacts to ground water quality adjacent to the site in the Browns Park Formation sandstone, as shown by elevated concentrations of uranium and nitrate in samples collected in 1994. Elevated concentrations of uranium are also present in ground water upgradient of the site as a result of naturally occurring mineralization in the area. The ground water in the Browns Park Formation is not currently used as a source of drinking water within 3 mi of the Maybell tailings site (DOE, 1993).

Table 6-20 Concentrations of selected constituents in ground water samples collected near the Maybell processing site

Constituent Concentration (mg/L)	Well ID				
	602	606	645	665	MCL
Uranium	0.071	0.220	1.02	0.024	0.044
Nitrate	<1	303	351	<1	44.0
Radium (pCi/L)	0.6	2.6	0.6	0.1	5.0
Arsenic	0.046	<0.005	<0.005	0.009	0.05
Selenium	<0.005	1.06	0.446	<0.005	0.01
Molybdenum	0.06	0.04	0.01	<0.01	0.1

Samples collected in July 1994.

MCL – maximum concentration limit.
mg/L – milligrams per liter.
pCi/L – picocuries per liter.

Figure 6-41
Uranium Concentrations, Processing Site

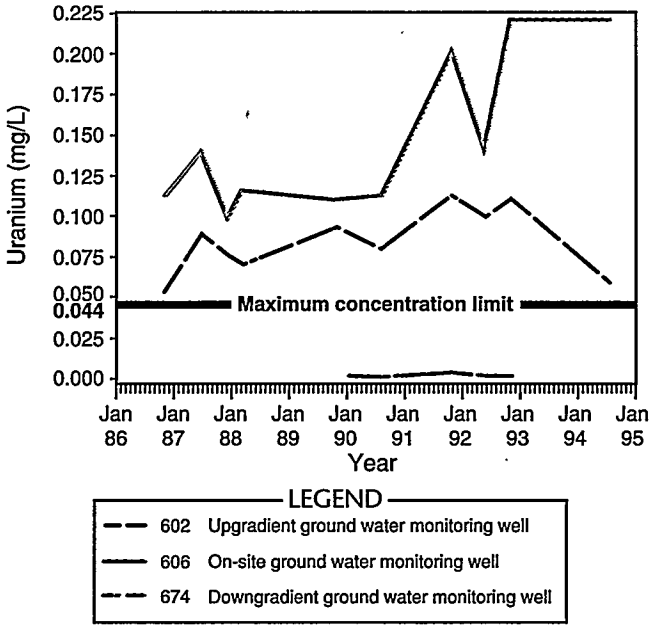

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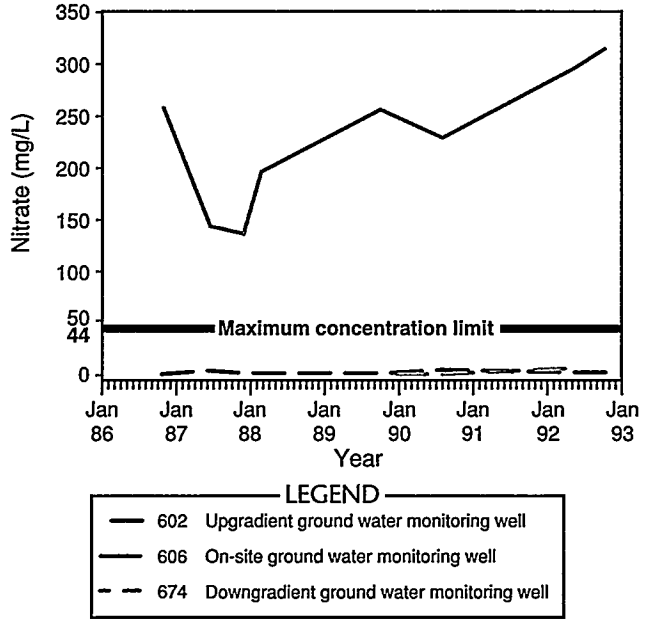
Figure 6-42
Nitrate Concentrations



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Ecological Monitoring

Wetlands

The wetlands along Johnson Wash and Lay Creek at the Maybell site were remapped in 1994. An application for supplemental standards for much of Johnson Wash and the contaminated portion of Lay Creek is still part of the proposed action. The successful application of supplemental standards along these two drainages would mean that none of the wetlands at the Maybell site would be impacted during surface remediation. Surveys for wetlands were conducted along the proposed electrical and water supply rights-of-way that may be used for the UMTRA Project. Wetlands were observed along the rights-of-way that run parallel to U.S. Route 40 and County Route 53.

Threatened and Endangered Species

Surveys were conducted for the Ute ladies tresses orchid (a threatened species) and the alcove orchid (a candidate species) in the riparian habitat along Johnson Wash and Lay Creek, at the Maybell borrow site location, and in appropriate habitat along the electrical and water s upply rights-of-way. Although appropriate habitat occurs along Lay Creek, these species were not observed. Appropriate habitat for these species does not occur along Johnson Wash because it is severely grazed. Habitat does not occur at the Maybell borrow site location because this area has been highly disturbed by previous borrow activities. Wetlands occurring next to this site provide potential habitat for these species. Of the five rights-of-way surveyed, appropriate habitat occurs in a small segment of the one that parallels U.S. Route 40 and the one along County Route 53. The orchids were not observed in these locations.

An addendum to the Maybell biological assessment was prepared and sent to the U.S. Fish and Wildlife Service. This addendum addressed the potential impacts the Maybell project could have on the critical habitat of the endangered fish species of the Upper Colorado River Basin and the alcove orchid. The addendum also provided an assessment of potential impacts on threatened and endangered species that may occur along the rights-of-way. It was determined that the project may have an affect on the critical habitat of the endangered fish species because water used for remedial action would result in a net depletion of water in the Upper Colorado River Basin. It was determined that the alcove orchid does not occur at any of the areas that may be disturbed during remedial action. In addition, use of any of the rights-of-way would not affect threatened and endangered or candidate species.

Ecological Risk Assessment

Surface water, sediment, and vegetation samples were collected at the Maybell site in October 1994. These samples will be used in the preparation of screening level ecological risk assessment for the site. This assessment is part of the baseline risk assessment that will be prepared for the site in 1995. The sample locations consisted of three locations along Lay Creek, two along Johnson Wash, one at the Rob Pit pond, and one from an unnamed drainage east of Johnson Wash.

SITE DESCRIPTION AND LOCATION

The Naturita UMTRA remediation site is located on the west side of the San Miguel River Valley floor in the canyonlands area of the Colorado Plateau of the western slope of the Rocky Mountains, in south-central Montrose County (*Figure 6-43*). In 1990, the U.S. Bureau of Census reported the county population at 24,423 (DOC, 1990). The Naturita site is adjacent to Colorado State Highway 141, approximately 25 mi east of the Colorado-Utah state line and approximately 2 mi northwest of the unincorporated town of Naturita, Colorado. The site occupies approximately 50 ac between Colorado Highway 141 and the San Miguel River and is approximately 5,500 ft above MSL; canyon walls rise on both sides of the valley to elevations of 6,250 ft.

There are no meteorological data directly available for the Naturita site. The nearest weather reporting station that recorded precipitation data is at the Umetco Uravan site (approximately 12 mi northwest of Naturita), where annual recipitation averaged 11.75 inches from 1961 to 1986; average annual snowfall for the same period was approximately 31 inches. No accurate wind data (wind speed/direction) are available for the Naturita site; however, valley winds below the Uravan site in the San Miguel River Canyon in which Naturita lies are predominantly out of the south-southwest (up-valley) and north-northwest (down-valley).

At the Disappointment Valley weather monitoring station, the closest monitoring station that collects wind speed data (approximately 15 mi southwest of the Naturita site), an average annual wind speed of approximately 6.3 mi per hour was recorded.

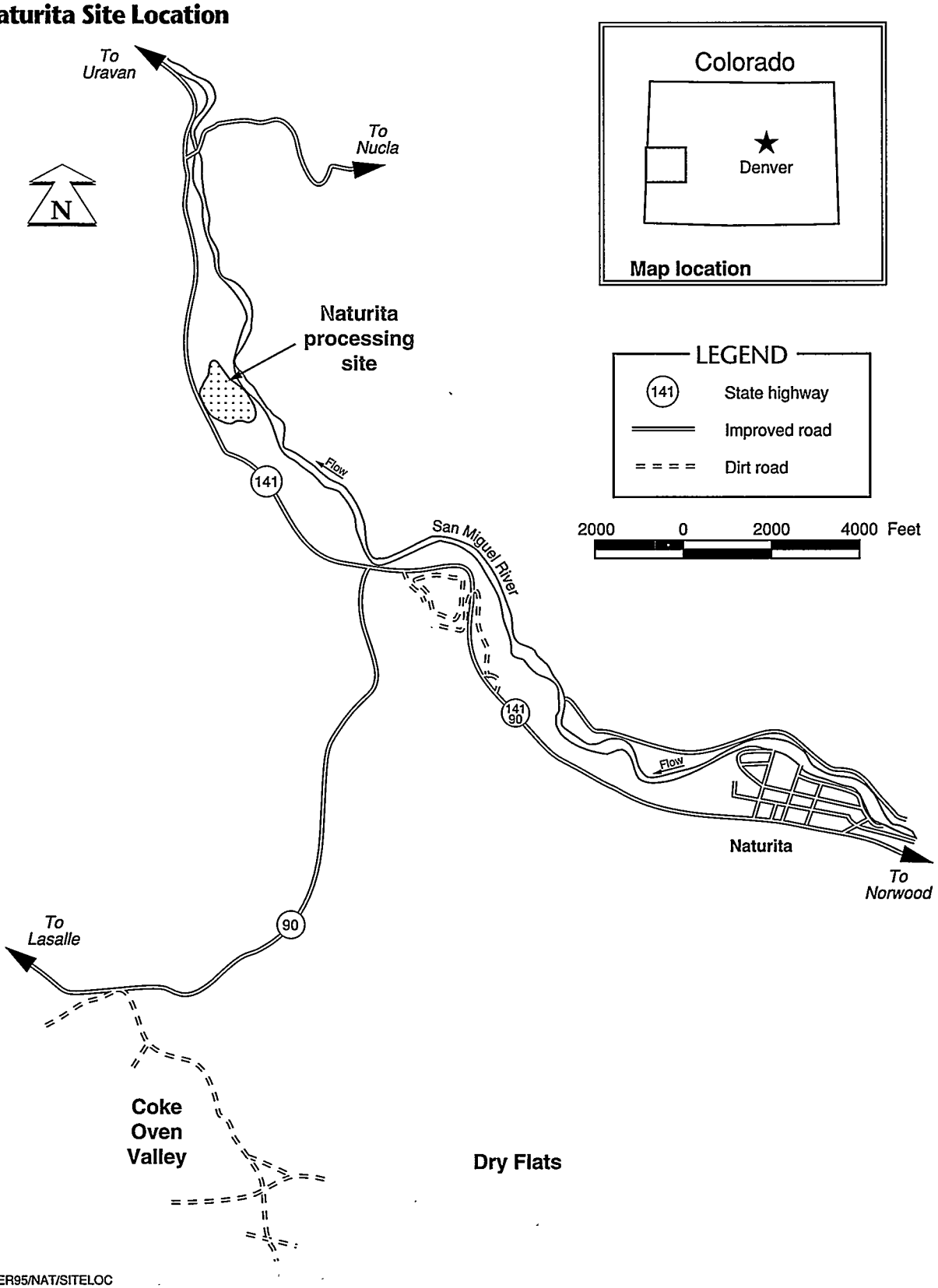
SITE HISTORY AND OWNERSHIP

When the Vanadium Corporation of America began operating the Naturita processing site in 1939, a salt-roast water-leach process was used for vanadium recovery. In 1942, the plant process was modified so that both uranium and vanadium could be extracted. The plant was shut down in 1945, with the end of World War II, and remained closed for 2 years. Ore processing for uranium resumed in 1947 and continued through 1958.

From late 1961 through early 1963, the Vanadium Corporation of America operated an upgrader plant at the site to upgrade lower grade ores. The upgraded ore processed at the Naturita site was shipped to Durango, Colorado, for further processing. The Naturita mill was permanently closed, dismantled, and all the equipment was decontaminated in 1963.

In 1974, Foote Minerals Inc. acquired the Naturita site. In 1976, Ranchers Exploration & Development Corporation purchased the tailings section of the Naturita site from Foote Minerals Inc. and between 1977 and 1979 removed the tailings and reprocessed them at

Figure 6-43
Naturita Site Location



the Durita, Colorado, site. As a result, there are no tailings remaining at the Naturita site. However, an estimated 400,000 cubic yards of residual radioactive materials at the site, primarily contaminated debris and soil, are the result of uranium/vanadium ore processing.

In 1989, Foote Minerals was acquired by Cyprus Metals Co. and became the Cyprus Foote Minerals Co. Under a remedial action agreement, the DOE assumed responsibility for residual radioactive materials and Cyprus Foote Minerals Co. assumed responsibility for materials at the Naturita site that had not been contaminated with residual radioactive materials. Under the remedial action agreement, the DOE has authority over the site until remediation activities are completed, at which time authority and ownership of the site reverts to Cyprus Foote Minerals.

SITE CHARACTERIZATION AND CLEANUP

Remedial Action at the Naturita site began in 1994 and is tentatively scheduled for completion in 1996. At present, remedial action involves demolition of the mill buildings, excavation of residual radioactive materials from the processing site and transportation to a nearby disposal location.

The disposal location is the Umetco Uravan site. If this location is chosen, the Naturita site residual radioactive material will be hauled to the Uravan site. Umetco Reclamation Corporation will dispose of the Naturita site material in accordance with UMTRCA Title I regulations.

ENVIRONMENTAL COMPLIANCE STATUS

UMTRA Project activities at the Naturita site must comply with federal, state, and local regulations and permits.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*) the Naturita site must comply with emergency planning and community right-to-know requirements.

Because the Naturita site did not commence initial startup operations until after 1 March 1994, Tier II form submittal will not be required until 1 March 1995. However, the site was inventoried for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, drummed materials, and uranium mill tailings. The inventory will be submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department on or before 1 March 1995.

Resource Conservation and Recovery Act

In 1994, the Naturita site made a detailed inventory and analysis of 73 drums of waste materials containing residual radioactive materials present at the site. All 73 drums of waste materials were determined to be residual radioactive materials and not RCRA hazardous waste. These materials will be deposited in the disposal cell.

Clean Water Act

The CDPHE has authority over all CWA (33 USC §1251 *et seq.*) activities in Colorado.

National Pollutant Discharge Elimination System

Under the Colorado Discharge Permit System, the CDPHE issued a stormwater discharge permit to the Naturita site. This single permit (COR030880) will serve as the required wastewater and storm water permits. No discharges occurred during 1994 at the processing site.

Spill Prevention Control and Countermeasures Plan

This plan addresses requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. In 1994, a spill prevention control and countermeasures plan was approved for a fuel tank farm. The tank farm was constructed in August of 1994. Earthen berms were designed and constructed around aboveground storage tanks and oil drum storage areas. These secondary containment systems provided adequate spill control. In November of 1994, due to the progress of remediation activities at the site, the tanks at the fuel farm were emptied and the tank farm dismantled in accordance with all applicable regulations.

Septic/Holding Tanks

A septic tank with a leach field was installed at the office trailer complex at the Naturita site in 1994 in accordance with all applicable requirements. There are no holding tanks at the Naturita processing site.

Clean Air Act

Total Suspended Particulates

The Naturita site complies with state requirements for fugitive dust emissions (total suspended particulates). Although the state of Colorado requires the control of fugitive dusts, monitoring was not required for fugitive dust at the Naturita processing site. However, dust was suppressed and emissions were controlled by applying water sprays during construction/remediation activities, as needed.

National Emission Standards for Hazardous Air Pollutants

Remediation/demolition operations at the Naturita processing site in 1994 included the torch cutting of lead-base painted materials and asbestos removal activities. Asbestos and lead emissions at the Naturita site met NESHAP requirements (40 CFR Part 61) in 1994.

National Environmental Policy Act

The draft Naturita environmental assessment was sent out for agency review in late 1993 and all comments were resolved in 1994. In 1994, it was determined that the proposed action would be to take the contaminated material at the Naturita site and dispose of it at the Uravan site, about 12 mi west of the Naturita site. The environmental assessment was revised to reflect this change. The Naturita environmental assessment and finding of no significant impact were approved by DOE Headquarters in January 1995.

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water

Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Naturita UMTRA site.

Hazardous Materials Transportation Act

Residual radioactive materials were transported from contaminated vicinity properties to the Naturita site in 1994. These materials were transported in full compliance with all applicable requirements of HMTA (49 USC §1801 *et seq.*) and DOT Exemption E-10594.

Endangered Species Act

Surveys were conducted for the southern willow flycather as part of the Naturita site's Endangered Species Act (16 USC §1531 *et seq.*) compliance efforts. None were found.

Noise Control

Noise control is regulated under Noise Abatement-Colorado Revised Statutes. The Naturita site developed and implemented a noise minimization plan in August of 1994. Because the Naturita site is a rural site, noise control is not a listed item in the site Conditional Use Permit. Baseline monitoring (1 month's monitoring) before commencement of site activities was conducted during four separate 24-hour periods and compared with 1 month's monitoring during periods when site operations were in progress. At least one 24-hour monitoring period per month will be conducted throughout the duration of the Naturita site operations, when operational activities are in progress. Additional monitoring will be conducted when site conditions change or if citizen complaints are received.

Environmental Compliance Permits

The Naturita processing site operated under all required permits during 1994 (*Table 6-21*).

Table 6-21 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Colorado Discharge Permit System					
Process site wastewater/ storm water (general)	05/90	Final received	09/94	COR-030880	03/95
Ground water discharge notice and plan (state)	08/87	Final received[a]	11/87	DP-513	11/94
Air quality construction permit (state)[b]	07/87	08/94	08/94	94M021DF	01/99

[a]Not applicable because final approval has been received.
[b]Air permit for screening equipment is required.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program at the Naturita processing site, including determining environmental gamma-dose equivalent and contaminant concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring

Nonradiological Air Particulate Monitoring

In 1994, monitoring was not required for fugitive dusts (total suspended particulates) at the Naturita site under Colorado regulations.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Naturita site was conducted at Stations 1, 2, 5, 7, and 8 (***Figure 6-44***). Station 1, which is located in the town of Naturita, provided background measurements. Monitoring began the beginning of June 1994.

The estimated thorium-230 concentrations at all stations (***Table 6-22***) were well below the DOE thorium-230 average annual guideline of 500×10^{-16} µCi/mL above background, indicating radioactive particulate releases from remedial action were not significant.

Radon Monitoring

Real-Time (Active) Radon Monitoring. Monitoring was performed at Stations 1 and 5. Background radon concentrations were measured at Station 1. ***Figure 6-44*** shows the locations of the real-time radon monitoring stations. Monitoring began on 05 June 1994.

The measured radon concentrations (***Table 6-23***) were much less than the DOE guideline of 3×10^{-9} µCi/mL above background, although Station 5 recorded results higher than background.

Passive Radon Monitoring. Five stations were established around the site. Background monitoring was performed at Station 1. ***Figure 6-44*** illustrates locations of passive radon detectors at the Naturita site. Monitoring began on 10 June 1994.

Again Station 5 was higher than background although all of the reported concentrations (***Table 6-24***) were much lower than the DOE guideline.

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulate and radon-222 were lower than the applicable guidelines. Station 5 recorded higher than background results because it is located on a contaminated vicinity property. Radon-222 concentrations should be near background when remedial action on this property is completed. No significant releases occurred at this site during 1994.

Figure 6-44
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site

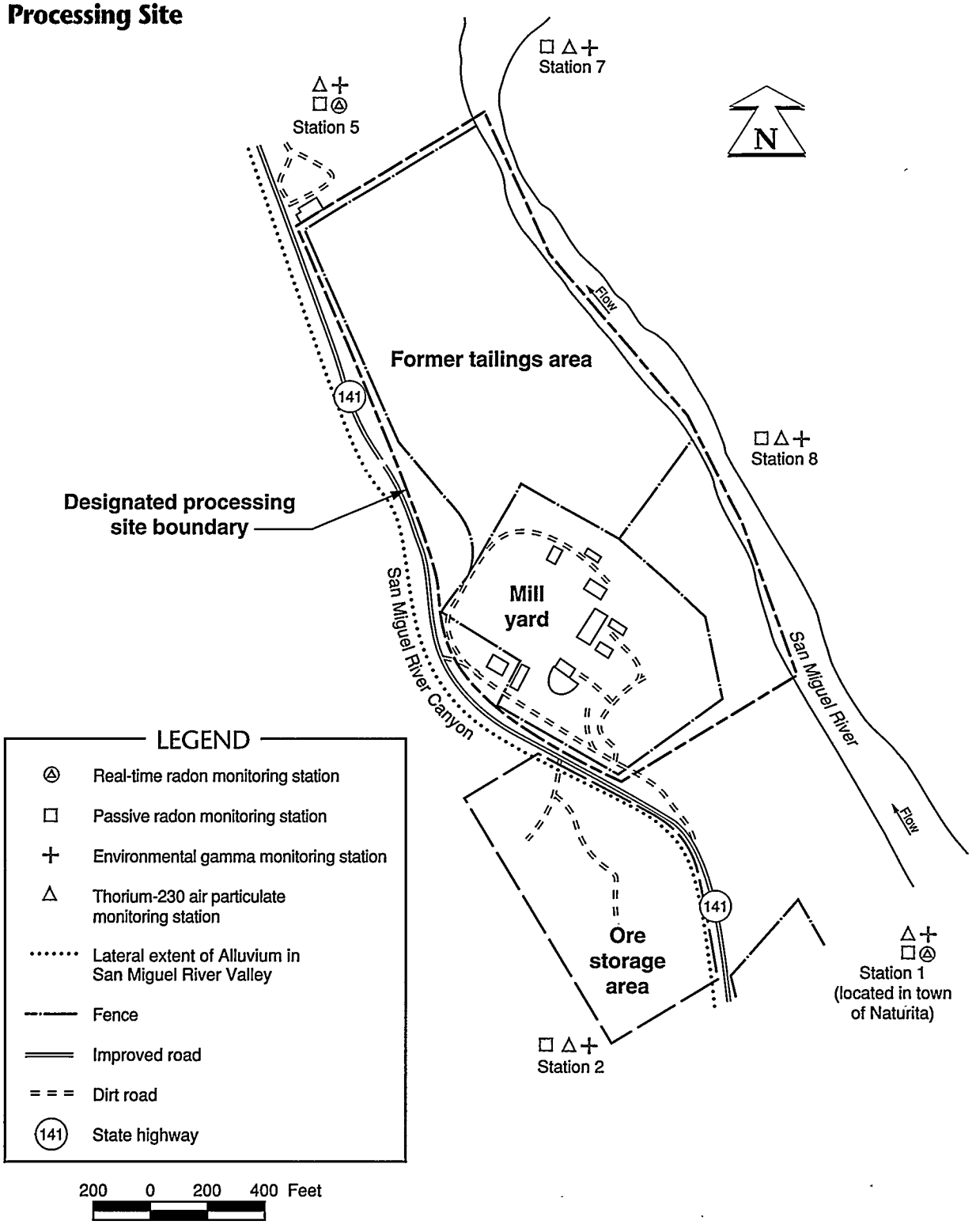


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Table 6-22 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} μCi/mL)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average[a]
1	X	5	5	5	5 (2)
2	X	6	6	4	5 (2)
5	X	9	6	6	7 (3)
7	X	8	4	5	5 (2)
8	X	6	5	6	6 (3)

[a]Annual average based on available data.
( ) indicate 10^{-8} picograms per milliliter.
X – no sample taken.

Table 6-23 Real-time radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	X	0.44	0.32	0.68	0.50[a]
5	X	1.62	1.49	1.48	1.50[a]

[a]Annual average based on available data.
X – no sample taken.

Table 6-24 Passive (alpha-track) radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
1	X	X	0.6	0.9	a
2	X	X	0.7	1.2	a
5	x	X	1.5	2.2	a
7	X	X	0.6	1.2	a
8	X	X	0.5	1.3	a

[a]Insufficient data for annual average.
X – no sample taken.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters around the site perimeter measured penetrating gamma radiation at the Naturita site (*Figure 6-44*). Monitoring began on 10 June 1994.

Five dosimetry monitoring stations were active in 1994. Background dose is measured at Station 1.

Of the locations for which quarterly dose equivalents are available, only Station 5 was statistically different from background (*Table 6-25*). Station 5 is located on a contaminated vicinity property.

Environmental Gamma Radiation Monitoring Conclusions

While this station measured gamma radiation significantly higher than background levels, there was insufficient data to determine the annual dose equivalent for comparison against the DOE guideline of 100 mrem per year above background. These measurements should be reduced to background levels when remedial action is completed.

Table 6-25 Environmental gamma dose equivalent[a] (mrem)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	b	b	32.0 ± 11.5	34.8 ± 12.8	c
2	b	b	48.8 ± 18.3	48.0 ± 6.3	c
5	b	b	108.8 ± 42.0	142.2 ± 28.6	c
7	b	b	38.6 ± 13.3	43.0 ± 11.5	c
8	b	b	48.0 ± 9.4	52.4 ± 16.6	c

[a]All errors reported as 2 standard deviations.
[b]Site monitoring began in Quarter 3; therefore, no data was collected for these quarters.
[c]Insufficient data for annual dose equivalent.

Surface Water Monitoring

As part of operational monitoring and NPDES monitoring requirements, the San Miguel River was sampled upstream and downstream of the Naturita site during the third and fourth quarters of 1994 to assess potential impacts from remedial action activities. The monitoring results for radiological contaminants are shown in *Table 6-26*. Downstream results are statistically indistinguishable from upstream results, indicating that no significant releases occurred in 1994. In all cases, the results were well below DOE guidelines for surface water concentrations.

Surface water was monitored to support the baseline assessment of risks associated with ground water contamination at the Naturita processing site. Six locations along the San Miguel River were sampled for surface water in April and November 1994. In November, a riparian spring located approximately 1200 ft north of the site was also sampled as part of an ecological evaluation for the site baseline risk assessment for ground water. At that time, unfiltered surface water samples and sediment samples were collected from each location.

Figure 6-45 shows the surface water sampling locations in the vicinity of the Naturita processing site. Surface water samples were collected from the San Miguel River at two locations upstream of the processing site (531 and 534), one location adjacent to the site (532), and three locations downstream of the site (535, 536, and 533). Location 538 is a riparian spring approximately 1200 ft. north and downgradient of the Naturita processing site.

Surface Water Results and Conclusions

Surface water at the Naturita processing site was analyzed for the following constituents: antimony, arsenic, bromide, calcium, chloride, dissolved organic carbon, fluoride, gross alpha, gross beta, iron, lead-210, magnesium, manganese, molybdenum, nitrate, polonium-210, potassium, radium-226 and radium-228, selenium, sodium, strontium, sulfate, thorium-230, total dissolved solids, uranium, vanadium, and zinc. Sulfate, total dissolved solids, and uranium are considered indicator parameters of contamination caused by the former uranium milling operations. *Table 6-27* summarizes 1994 processing site surface water quality data for these three indicator parameters from all locations along the San Miguel River. San Miguel River surface water data for samples collected in 1994 from locations adjacent (532) and downstream (533, 535, and 536) of the Naturita processing site were similarly equivalent in comparison to data obtained from upstream locations (531 and 534). Spring sample 538 exceeded the maximum concentration limits for uranium and the aesthetic limit for sulfate.

Ground Water Monitoring

Ground water was sampled in April 1994 to obtain baseline preconstruction information about the Naturita processing site and to support the site baseline risk assessment.

Table 6-26 Surface water concentrations[a] (10^{-9} μCi/mL)

Location	Radionuclide	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	Guideline
San Miguel River Upstream (01)	^{226}Ra	b	b	0.1 ± 0.3	0.5 ± 0.2	c	100
	^{230}Th	b	b	0.0 ± 0.6	0.2 ± 0.3	c	300
San Miguel River Downstream (02)	^{226}Ra	b	b	0.1 ± 0.3	0.7 ± 0.3	c	100
	^{230}Th	b	b	1.4 ± 1.0	0.6 ± 0.4	c	300

[a]All errors reported as 2 standard deviations.
[b]Site monitoring began in Quarter 3; therefore, no data was collected for these quarters.
[c]Insufficient data for annual average.

Beneath the processing site, three distinct water bearing units occur within the upper 300 ft. In descending order, these are alluvial floodplain deposits (sand and gravel) associated with the San Miguel River (11 - 24 ft thick); shales and mudstones of the Brushy Basin Member (110 - 165 ft thick) of the Morrison Formation (Jurassic); and sandstones of the Salt Wash Member (130 - 165 ft thick) of the Morrison Formation. Ground water in the floodplain alluvium is unconfined and flows to the northwest parallel to the present San Miguel River channel at an approximate rate of 20-60 ft per year.

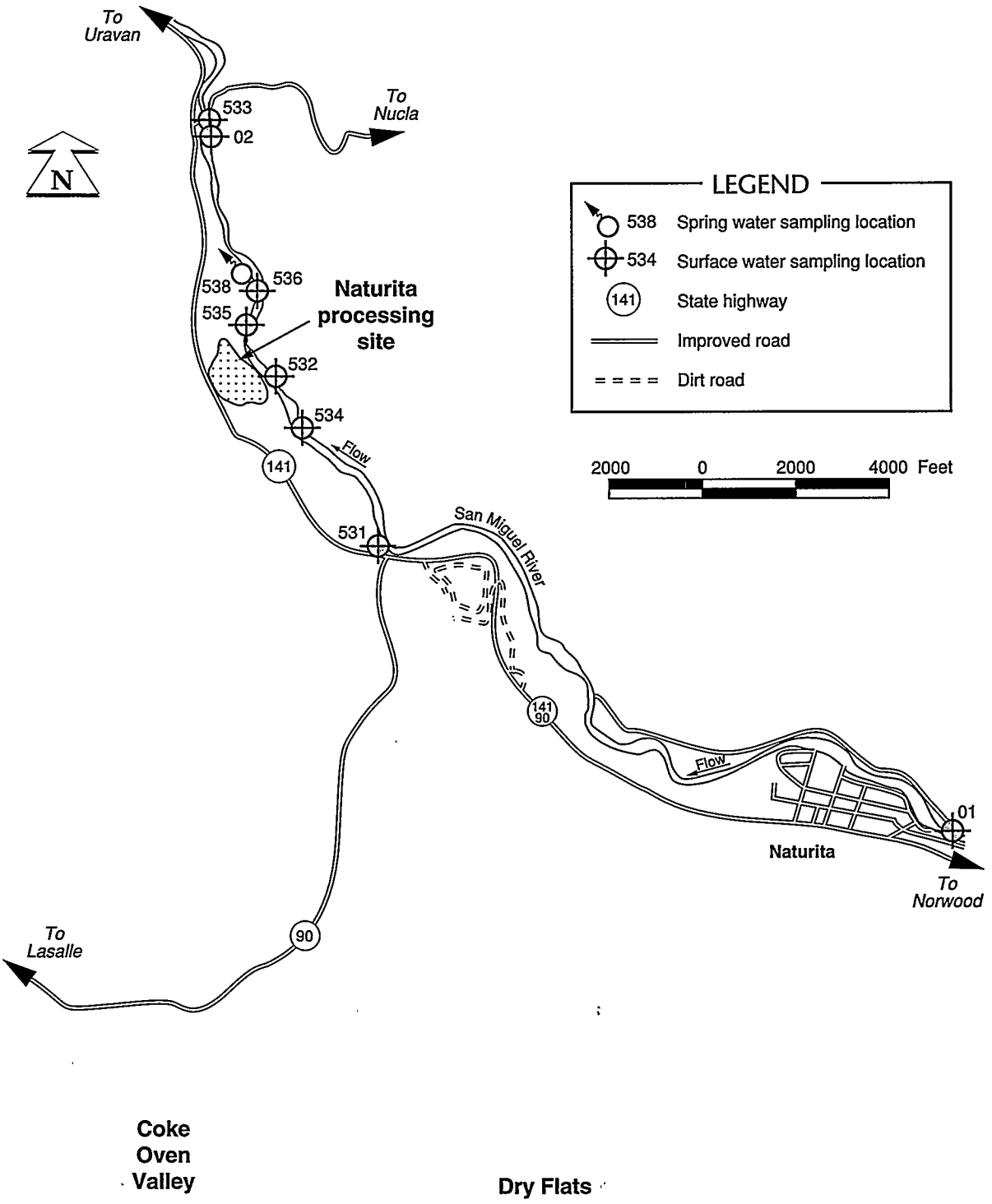
The Brushy Basin unit is a thick low-permeability formation that functions as an aquitard. There is no observed hydraulic interconnection between the alluvium at the surface and the confined groundwater within the Salt Wash Member.

Six monitoring wells, four completed in the alluvium and two completed in the Salt Wash Member, were sampled at the processing site to assess baseline conditions prior to the start of remedial action. ***Figure 6-46*** shows the processing site ground water monitoring locations that were sampled during 1994. ***Figure 6-47*** shows ground water table elevations, and flow direction within the surface alluvium.

Ground Water Results

Ground water at the Naturita processing site was sampled during April 1994 and analyzed for the following parameters: antimony, arsenic, bromide, calcium, chloride, dissolved organic carbon, fluoride, gross alpha, gross beta, iron, lead-210, magnesium, manganese, molybdenum, nitrate, polonium-210, potassium, radium-226 and radium-228, selenium, sodium, strontium, sulfate, thorium-230, total dissolved solids, uranium, vanadium, and zinc. Sulfate, total dissolved solids, and uranium are considered indicator parameters of ground water contamination caused by the former uranium milling operations. ***Table 6-28*** gives processing site, alluvial water quality data for these three indicator parameters from background well 547, on-site wells 505 and 506, and downgradient well 548.

Figure 6-45
Location of Surface Water Sampling Locations



ASER95/NAT/SURFWATWELLS

Table 6-27 Surface water quality results, processing site

Location	Sulfate		Total dissolved solids		Uranium	
	4/94	11/94	4/94	11/94	4/94	11/94
531 (upstream)	60	205	190	467	<0.001	0.002
532 (site)	59	209	210	465	<0.001	0.002
533 (downstream)	56	197	220	438	<0.001	0.002
534 (upstream)	56	193	220	444	<0.001	0.002
535 (downstream)	55	208	220	470	<0.001	0.002
536 (downstream)	60	190	230	441	<0.001	0.001
538 (spring-downgradient)	X	391[a]	X	847	X	0.110[b]

[a]Exceeds secondary maximum contaminant level of 250 mg/L.
[b]Exceeds maximum contaminant level of 0.044 mg/L.

X – no sample taken.
< indicates actual value is less than number indicated (limit of detection).

Ground Water Conclusions

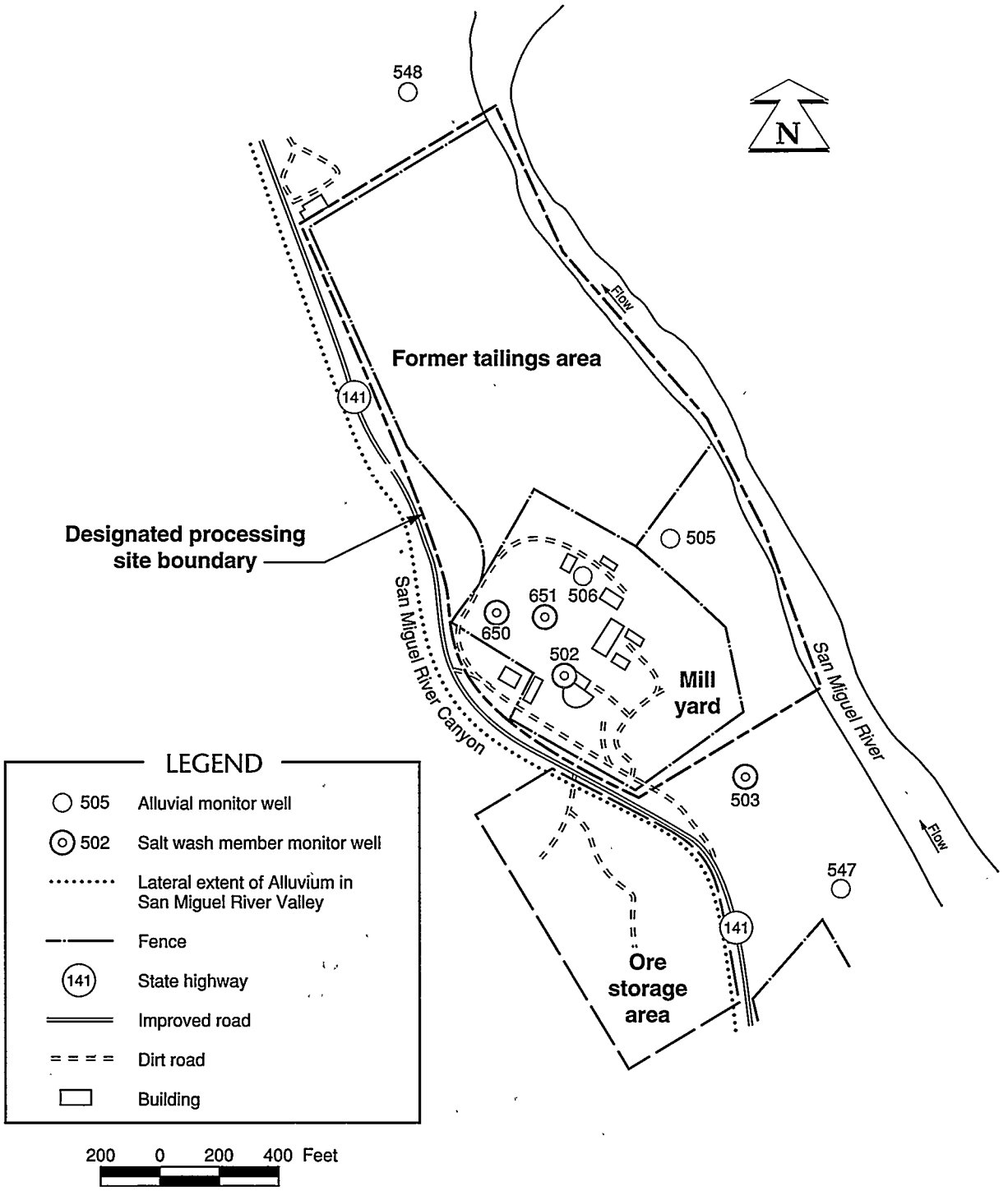
Net gross alpha, radium -226 and radium-228, and uranium concentrations exceeded the EPA maximum concentration limits in on-site and downgradient alluvial monitoring wells 505, 506 and 548 in 1994.

Ground water in the Salt Wash Member exhibits a strong upward hydraulic gradient. This gradient favors containment of the contaminants in the shallow alluvial aquifer below the processing site.

However, ground water quality in monitoring wells 502 and 503, completed in the Salt Wash Member, is characterized by concentrations of arsenic, and uranium, and activities of net gross alpha and radium (-226 and -228) that exceed the maximum concentration limits. This is the result of naturally occurring uranium mineralization in the Salt Wash Members beneath the processing site.

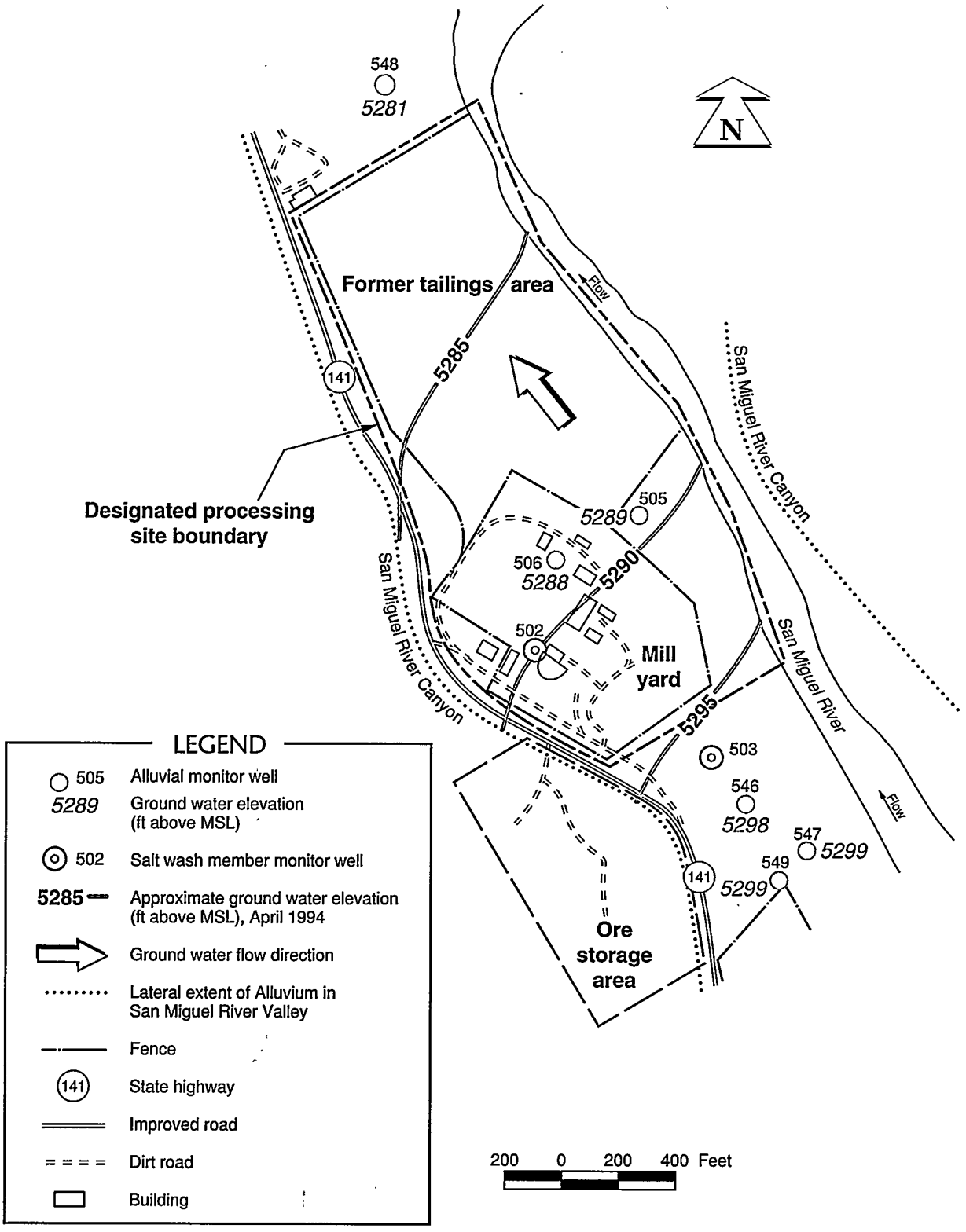
Figure 6-48 shows that the concentration of uranium, a primary indicator of contamination, fluctuates substantially with time in the alluvial system. However, overall uranium concentrations have remained constant or, possibly, have shown slight decreases. Consequently, *Figure 6-49* has been prepared to show the distribution of uranium in the alluvial aquifer based on the results of sampling performed in 1994 and previous data from 1992. Because tailings were removed from the site in 1979, the current distribution of uranium and other constituents in the alluvial aquifer may represent an apparent steady state distribution.

Figure 6-46
Locations of Monitoring Wells, Processing Site



ASER95/NAT/LOCMONWELLS

Figure 6-47
Water Table Surface in the Alluvial Aquifer, Processing Site



ASER95/NAT/WATTABLE

Table 6-28 Ground water quality results, processing site

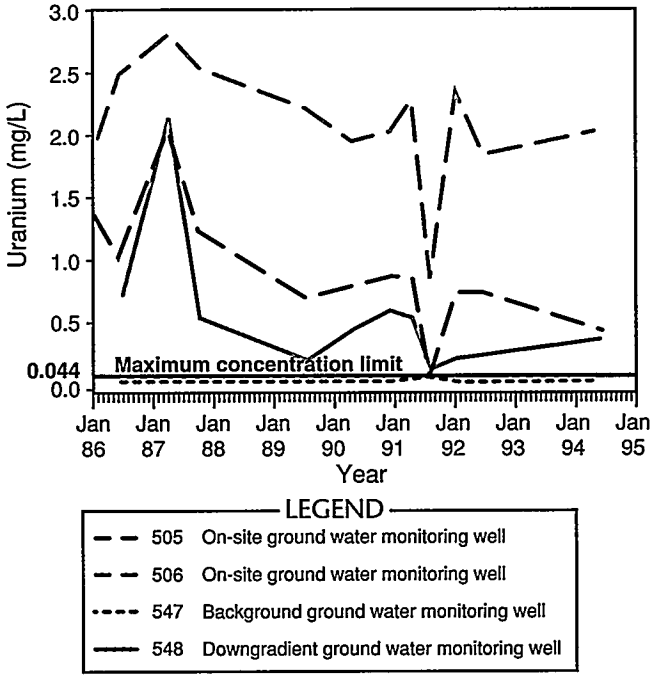
Indicator parameter	Guideline	DOE monitoring wells			
		Background	On-site		Downgradient
		547	505	506	548
Total Dissolved Solids	500[a]	835	1030	2150	670
Sulfate	250[a]	391	450	815	279
Uranium	0.044[b]	0.012	0.426	2.02	0.353

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Analytical results for samples collected in April 1994. Concentrations are reported in milligrams per liter.

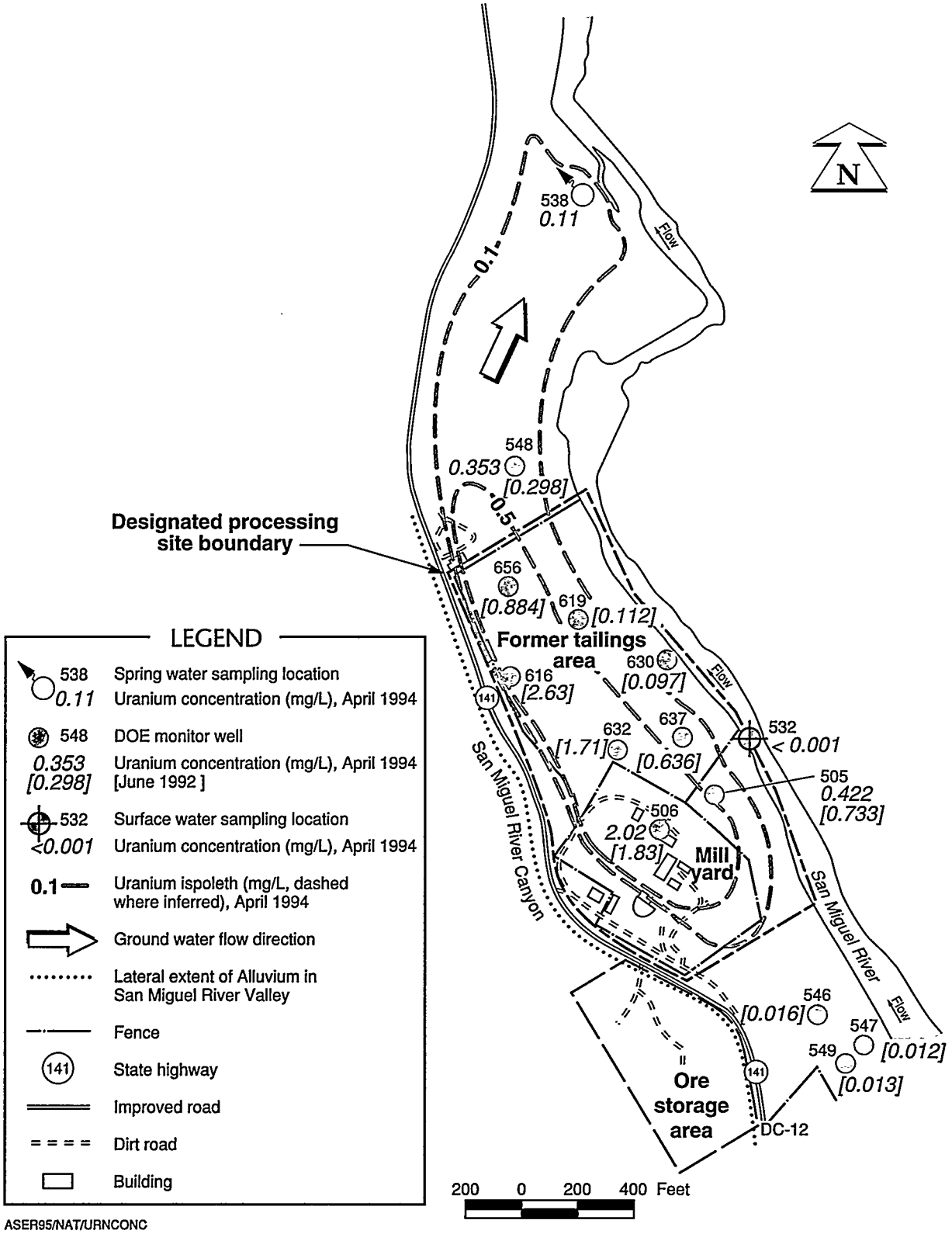
Further sampling of ground water at the Dry Flats alternate disposal site and Coke Oven borrow area have been suspended pending resolution of technical and administrative issues related to disposal at Uravan, Colorado.

Figure 6-48
Uranium Concentrations Over Time, Alluvial Wells, Processing Site



ASER95/NAT/URCON

Figure 6-49
Uranium Concentrations in Ground Water in the Alluvium, Processing Site



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Ecological Monitoring

Threatened and Endangered Species

Surveys for the southwestern willow flycatcher were conducted again in 1994. This species was not recorded from the area of the sites in previous surveys in 1990, 1991, and 1993. The 1994 survey area consisted of a 3-mi stretch of the San Miguel River up and down river from the site and the San Miguel at Tabeguache Creek Preserve along the river between the Naturita and Uravan sites. A 5-mi stretch of Dry Creek in the area of the Coke Oven borrow site was also surveyed. The southwestern willow flycatcher was neither heard nor observed during these surveys.

The biological assessment was revised in 1994. The previous version of the biological assessment had been sent to the U.S. Fish and Wildlife Service in 1990 and a biological opinion was received in December 1990. Remedial action was delayed for a few years, and consultation with U.S. Fish and Wildlife Service was reinitiated on 15 March 1993. A new list of species of potential concern was received. Subsequent to receiving this list, critical habitat for the endangered fish of the Upper Colorado River Basin was identified and the southwestern willow flycatcher was proposed as an endangered species. Therefore, the biological assessment was revised and it was determined that remedial action had the capability to affect the critical habitat of the endangered fish of the Upper Colorado River Basin. It was also determined that there would be no impact on the proposed southwestern willow flycatcher because this species does not occur at or near the Naturita site. However, since potential habitat exists, a survey for the southwestern willow flycatcher will be conducted in 1995. The revised biological assessment was finalized in 1994 and sent to the U.S. Fish and Wildlife Service.

Ecological Risk Assessment

Surface water, sediment, and vegetation samples wee collected at the Naturita site in November 1994. These samples will be used in the preparation of a screening-level ecological risk assessment for the site. This assessment is part of the baseline risk assessment that will be prepared in 1995.

Samples were taken from six locations along the San Miguel River and from one location at a backwater area near the river (538) (***Figure 6-45***). The San Miguel River samples were taken from rapidly flowing water. The backwater sample was taken from standing water with a slight flow leaving the area and entering the river. The backwater's source appeared to be ground water seepage; water from the river was not entering this location.

SITE DESCRIPTION AND LOCATION

The UMTRA Project at Rifle, Colorado, comprises two separate mills and tailings piles, known as the Old Rifle and New Rifle sites (*Figure 6-50*).

Old and New Rifle Sites

The Old Rifle site is east of the city of Rifle (*Figure 6-50*). U.S. Highway 6 runs along its north side, and the Denver & Rio Grande Western Railroad tracks are on its south side. The Colorado River is immediately south of the railroad tracks. The New Rifle site is west of the city of Rifle (*Figure 6-50*). The site is bordered by the Denver & Rio Grande Western Railroad tracks on the north and Interstate 70 and the Colorado River on the south. The valley in which the tailings are located is at an elevation of approximately 5300 ft above MSL. North of the tailings are steep cliffs and mesas up to 10,500 ft high. Long sloping mountains rise to 10,000 ft to the Grand Mesa National Forest on the south.

Estes Gulch Disposal Site

The Estes Gulch disposal site is approximately 6 mi north of the New Rifle site off Colorado State Highway 13 (*Figure 6-50*).

The 1990 census reports the Rifle population at 4636 and the Garfield County population at 29,974. The 1990 figures represent an increase since 1980 of 76 percent in the city and 57 percent in the county (DOC, 1990).

The semiarid, continental climate has low precipitation and humidity, large temperature variations, and high evaporation. The average annual precipitation is approximately 11 inches. Winter snows are fairly frequent but are mostly light and melt quickly. Monthly average air temperatures range from 22.6 °F in January to 70.3 °F in July.

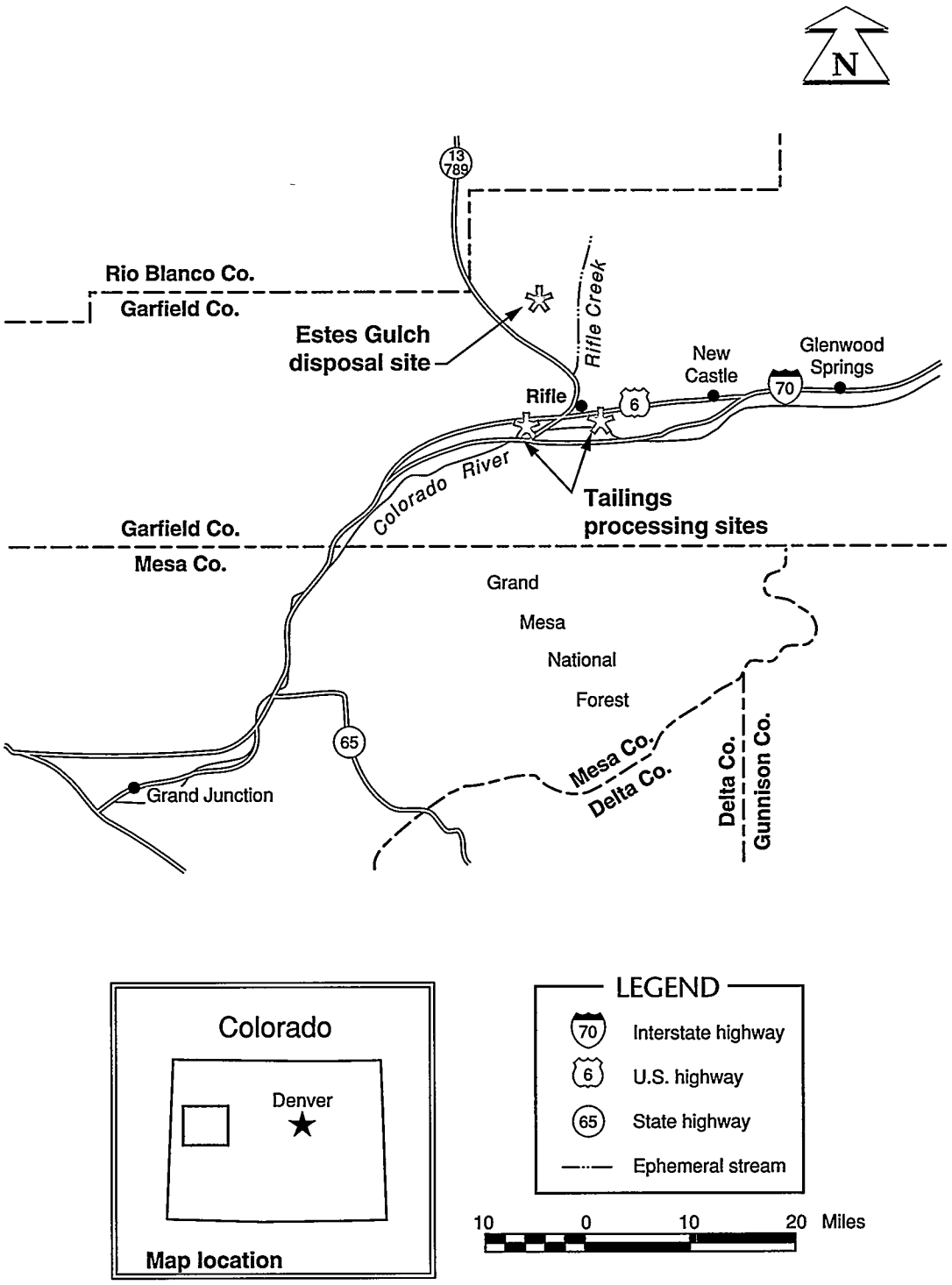
Weather data for Rifle are gathered primarily at the Garfield County Airport south of the city, outside the Colorado River Valley. The strongest winds are predominantly from the north and are channeled up and down the Colorado River Valley. The annual average wind speed is conservatively estimated at 6.4 mi per hour. *Figure 6-51* shows wind direction and frequency at the Garfield County Airport.

SITE HISTORY AND OWNERSHIP

The Old Rifle mill was operated from 1924 to 1932 to recover vanadium from roscoelite ores. The process was modified in the mid-1940's to extract uranium by acid leaching and subsequent processing. The mill operated using this process until 1958.

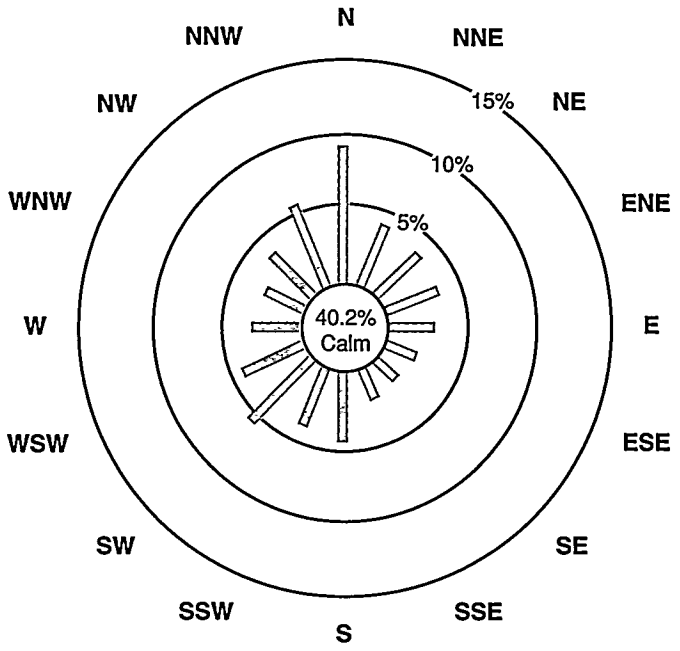
The New Rifle mill operated from July 1958 to December 1972. It was built as a part of a complex of upgraders that included Slick Rock, Colorado, and Green River, Utah. A total of 2.7 million tons of ore and upgrader products and tailings from other mills were processed. The milling processes at the New Rifle site separated and purified uranium products with solvent extraction.

Figure 6-50
Rifle Site Locations



ASER95/RFL/SITELOC

Figure 6-51
Wind Rose



Ref: Garfield County Airport.
Cumulative data 1959 through 1963.

ASER95/RFL/WINDRFL

The mills were initially operated by U.S. Vanadium Corporation, then by Union Carbide Corporation. The state of Colorado now owns both the Old and New Rifle sites. Approximately 761,000 tons of ore from the Uravan mineral belt, as well as the Rifle mine, were processed there for uranium and vanadium recovery, with an average grade of 0.31 percent uranium oxide. Approximately 411,000 tons of tailings were reprocessed at the New Rifle mill and deposited there.

SITE CHARACTERIZATION AND CLEANUP

Union Carbide partially stabilized the Old Rifle tailings pile in 1967, in accordance with applicable state of Colorado regulations. The southern edge of the pile was moved north, away from the river. The pile was fertilized and seeded with grasses, and a sprinkler system was installed to promote vegetation growth.

Before UMTRA remediation activities began, Union Carbide had partially stabilized the New Rifle tailings pile. Because of the lack of soil cover, the steep slopes, and the strong winds in the Colorado River Valley, the tailings pile had partially eroded. Approximately 1000 tons of mulch and fertilizer were applied to the pile, and native grasses were planted. An irrigation system was installed to promote vegetation growth.

UMTRA Project remedial action at the Old and New Rifle sites will consist of removing all residual radioactive materials from both sites for disposal at the Estes Gulch disposal site. The residual radioactive materials relocation will follow required interim regulations to eliminate the public health hazard presented by the abandoned mill facilities and unrestricted tailings impoundments.

The UMTRA Project began remedial action at the New Rifle site in 1993, and completion is expected in 1996. Remedial action at the Old Rifle site began, and tailings cleanup and haul were completed, in 1994. Backfill operation will commence in 1995 and will complete surface remedial action at the Old Rifle site.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Rifle, Colorado, complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet applicable regulatory requirements. In 1994, Rifle site environmental compliance activities included monitoring fugitive dust emissions, reporting certain quantities of hazardous materials used or stored at the site, spill prevention control and countermeasures planning and adherence to transportation regulations and permits.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*) the Rifle sites must comply with emergency planning and community right-to-know requirements, including notifications of threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

To comply with requirements of EPCRA, Section 311, a site inventory was developed for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. Notification included State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Compliance with the EPCRA, Section 312, was achieved by developing Tier II reporting forms for the 1993 inventoried materials and submitting them to the State Emergency Response Commission, the local emergency planning committee, and the local fire department by 01 March 1994.

Clean Water Act

The CDPHE, Water Quality Control Division, has regulatory authority over all CWA activities in Colorado.

National Pollutant Discharge Elimination System

Under the Colorado Discharge Permit System, the CDPHE issued discharge permits to the Rifle sites. Permits for storm water discharges were obtained for the Old Rifle (No. COR-030267), New Rifle

(No. COR-030266), and the Estes Gulch disposal site (No. COR-030194). Permits were issued for wastewater discharges from the retention basins at the disposal site (No. CO-0042757) and the processing sites under one permit (No. CO-0042552). No discharges occurred under the wastewater permits in 1994.

Storm water permit applications have been submitted to meet application deadlines. There were no releases in 1994.

Spill Prevention Control and Countermeasures Plan

Earthen berms have been designed and constructed around existing aboveground storage tanks and around drum storage areas. These secondary containment systems are designed to provide adequate spill control. In addition, plans for inspecting berms, detecting spills, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas. There were no releases in 1994.

Septic/Holding Tanks

A septic tank was installed near the office trailers on the New Rifle processing site in November 1988 and has been maintained following state and local requirements.

Clean Air Act

Total Suspended Particulates

The Rifle sites comply with the CDPHE, Air Pollution Control Division, monitoring requirements for fugitive dust. The CDPHE has adopted federal total suspended particulate levels, including a 24-hour limit of 150 $\mu g/m^3$ and an annual limit of 60 $\mu g/m^3$ geometric mean.

The CDPHE granted two air emission permits to the New Rifle and disposal sites in 1993. Under an approved protocol that meets CDPHE requirements, three total suspended particulate monitoring stations monitor total suspended particulates every 3 days. Quarterly reports are submitted to the department.

Off-site activities resulted in six total suspended particulate exceedances in 1994, on 17 May, 20 May, 10 June, 16 June, 07 November, and 01 December. No violations were issued to the site.

National Environmental Policy Act

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995. Hearings will take place in Grand Junction, Colorado, and may be held in Rifle, Colorado.

Hazardous Materials Transportation Act

Residual radioactive materials transported to the Estes Gulch disposal site are subject to the requirements of the HMTA (49 USC §1801 *et seq.*). Approximately 735,000 cubic yards of tailings were hauled

from the Rifle sites under DOT exemption E-10594 in 1994, and all requirements of the exemption were met.

Noise Control

Noise control is regulated under Noise Abatement-Colorado Revised Statutes, with specific requirements for the Rifle sites included in the Garfield County conditional-use permit. The DOE developed the Site-Specific Community Noise Minimization Plan on 04 March 1993, and implemented the plan on 05 October 1993 to ensure compliance with the conditional-use permit. The plan instituted engineering and administrative controls, as necessary, to reduce project-related sound impacts to residential areas bordering the site.

During periods of normal operations, sound level monitoring was conducted at six fixed monitoring stations in at least one 24-hour period three times each month. Additionally, monitoring was conducted when site conditions changed or citizens complained.

Environmental Compliance Permits

The Rifle sites obtained and operated under all required permits in 1994. *Table 6-29* lists all active permits under which the Rifle sites operated from January 1994 to December 1994. No permit violations were issued in 1994.

Table 6-29 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permit (U.S. Army Corps of Engineers)[a]	06/92	Final received[b]	08/92	190110228	07/97
Colorado Discharge Permit System Permits					
Process site wastewater	09/89	Final received[b]	01/92	CO-0042552	12/96
Disposal site wastewater	04/90	Final received[b]	04/92	CO-0042757	02/97
Process site storm water	09/92	Final received[b]	10/92	COR-030266[a]	03/95
			10/92	COR-030267[c]	03/95
Disposal site storm water	09/92	Final received[b]	08/92	COR-030194	03/95
Construction dewatering Disposal site (CDPHE)[d]	01/92	Final received[b]	02/92	COG-070206	NA
Air emission permits (CDPHE)					
Process site	06/88	01/89	Pending	88GA191	02/96
Disposal site	06/88	01/89	Pending	88GA190	02/96
Water rights (Colorado Division of Water Rights)					
Disposal site - retention basin surface	10/88	Final received[b]	01/89	88CW347	01/95
Process site water rights	–	Final received[b]	08/88	C377322	NA
Disposal site - retention basin storage	01/93	Final received[b]	04/93	93CW006	04/99
Hazardous waste storage (CDPHE)	11/88	–	02/90	OD7061567	NA

[a]New Rifle site.
[b]Not applicable in 1994.
[c]Old Rifle site.
[d]Terminated 5/25/93.

NA – Not applicable.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Rifle sites, including environmental gamma-dose equivalent and radionuclide and nonradionuclide concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring

Nonradiological Air Particulate Monitoring

Three total suspended particulate monitoring stations operate under an approved protocol that meets CDPHE, Air Pollution Control Division, requirements. Total suspended particulates are monitored every 3 days. Quarterly reports are submitted to the department. ***Figures 6-52 and 6-53*** present total suspended particulate monitoring station locations and data for the Rifle sites.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring was conducted in 1994 at the Old Rifle processing site, the New Rifle processing site, and the Estes Gulch disposal site. Stations 1 and 4 measured concentrations at the processing site boundaries. Stations 3, 5, and 7 gathered information in the predominant wind direction along the Colorado River between the two processing sites. Station 6 monitored the concentrations near the town of Rifle (***Figure 6-52***). Station 8 measured the Estes Gulch (***Figure 6-54***). Station 11, located approximately 12 mi east of Old Rifle and just off I-70, measured the background concentrations.

Table 6-30 summarizes site thorium-230 concentrations, estimated from gross alpha measurements for the Rifle sites. Although the estimated thorium concentrations for many stations were greater than background, the estimated annual average thorium-230 concentrations at all stations were well below the DOE thorium-230 average annual guideline of 500×10^{-16} μCi/mL above background. This finding indicates that radioactive particulate releases from remedial action were insignificant.

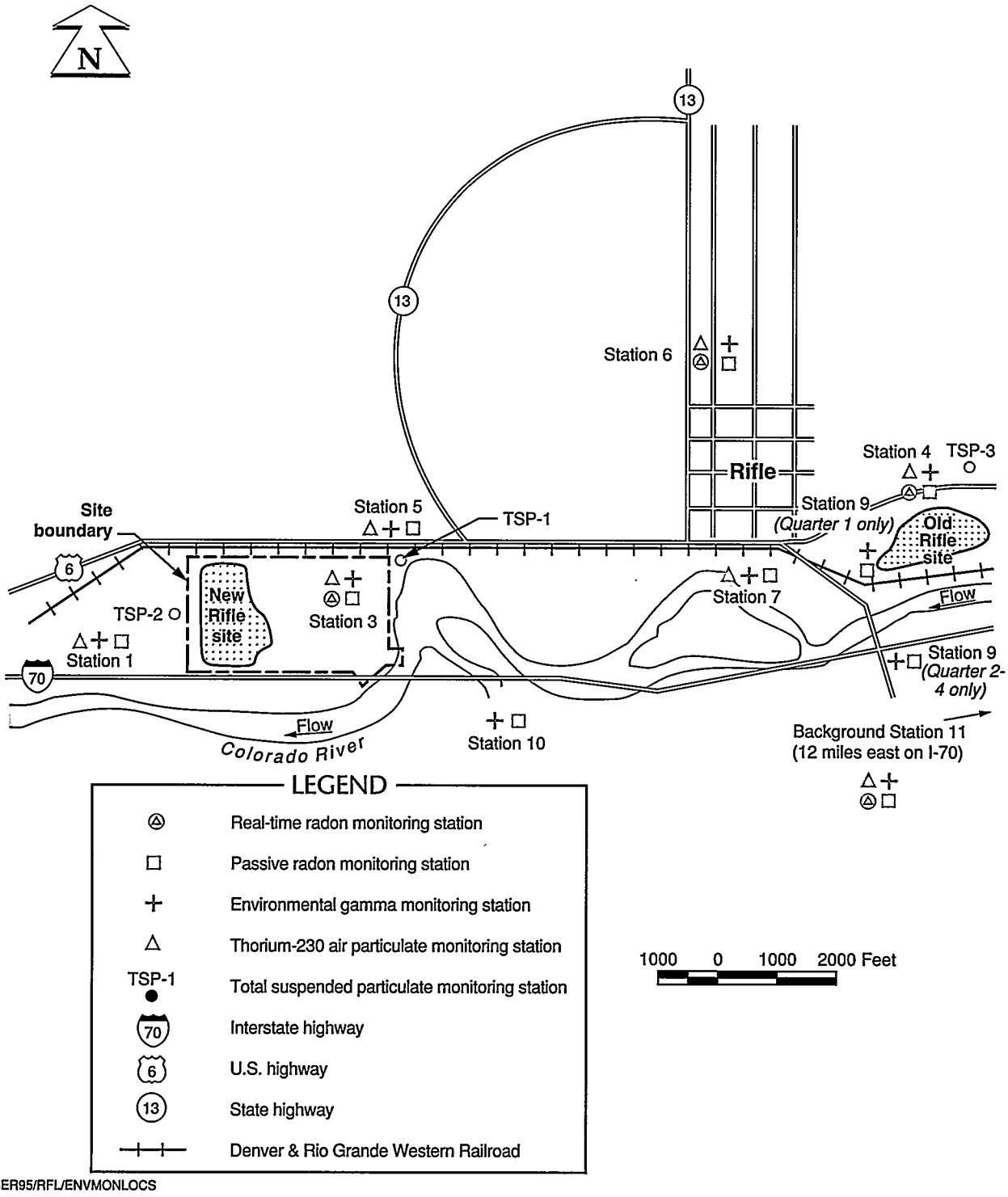
Figure 6-55 graphically illustrates estimated results for thorium-230 monitoring stations that recorded concentrations greatly above background.

Radon Monitoring

Real-Time Radon Monitoring. Monitors were located around the site perimeters and between the New Rifle and the Old Rifle processing sites. Background radon concentrations were measured at Station 11. ***Figure 6-52*** shows the locations of the real-time radon monitoring stations.

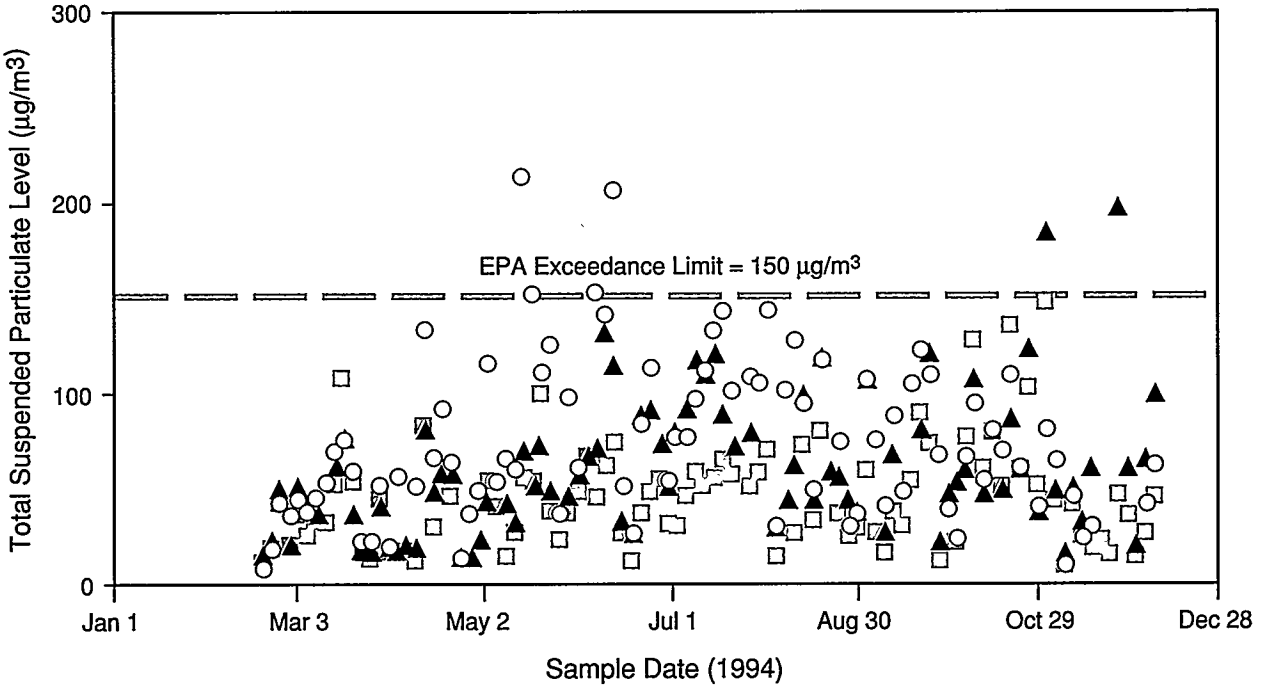
The annual average background radon concentration measured at Station 11 was 0.70×10^{-9} μCi/mL. Although radon concentrations

Figure 6-52
Environmental Air and Gamma Radiation Monitoring Stations



ASER95/RFL/ENVMONLOCS

Figure 6-53
Total Suspended Particulates, Processing Site

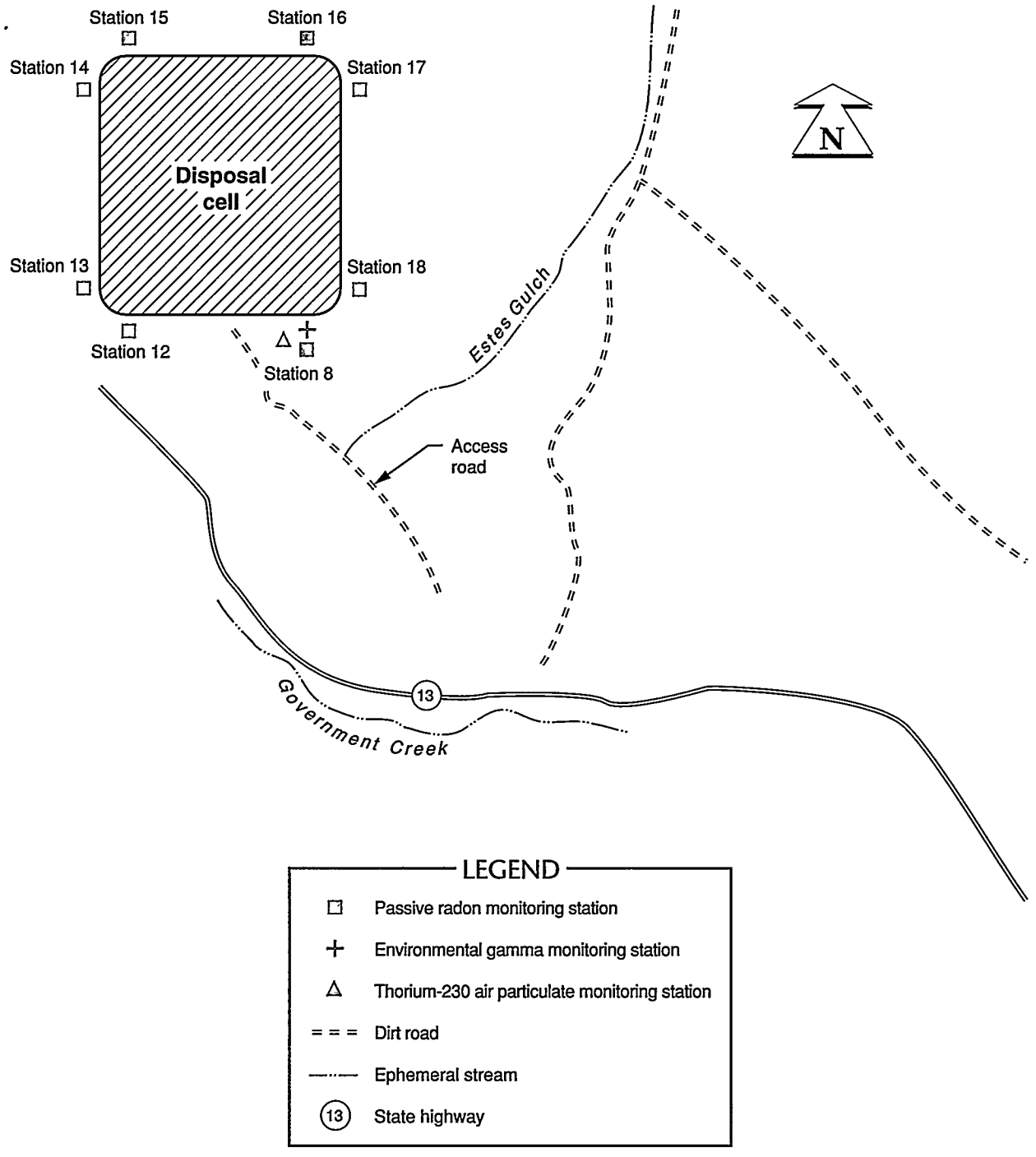


LEGEND

- ○ Total suspended particulate monitoring station 1
- □ Total suspended particulate monitoring station 2
- ▲ Total suspended particulate monitoring station 3

ASER95 /RFL/TSP

Figure 6-54
Environmental Air and Gamma Radiation Monitoring Stations, Estes Gulch Disposal Site



ASER95/DUR/ESTESENVLOCS

Table 6-30 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} µCi/mL)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average
1	77	135	141	40	100 (50)
3	177	491	324	120	283 (140)
4	124	142	530	90	226 (112)
5	128	139	127	38	110 (54)
6	90	64	27	19	50 (25)
7	95	73	63	22	64 (32)
8	111	405	725	162	357 (177)
11	58	52	11	11	34 (17)

( ) indicate 10^{-8} picograms per milliliter (pg/mL).

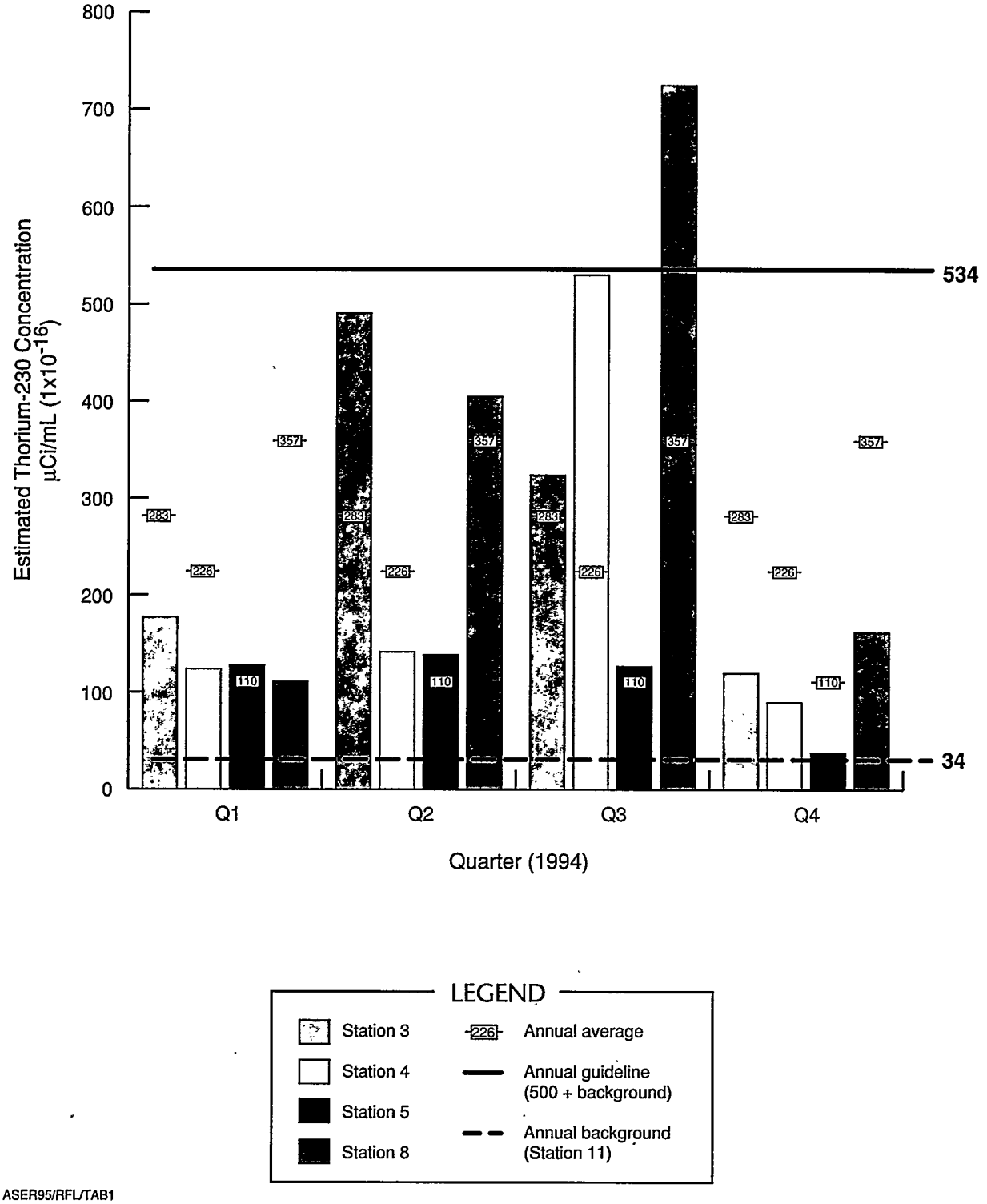
were greater than background levels at Station 4, they were less than the DOE annual average guideline of 3 x 10^{-9} µCi/mL above background. The elevated concentrations at the Rifle sites are expected to return to background levels after remedial action is completed. ***Table 6-31*** presents the quarterly average radon concentrations for all locations at the Rifle sites for 1994.

Figure 6-56 graphically illustrates results for real-time radon monitoring stations that recorded concentrations above background.

Passive Radon Monitoring. Seventeen stations were established around the Rifle sites. Eight stations (Station 8 and Stations 12 through 18) were established around the Estes Gulch disposal site. Background monitoring was performed at Station 11. ***Figures 6-52 and 6-54*** show locations of passive radon detectors at the Rifle sites.

Table 6-32 presents the passive radon monitoring results for stations at the Rifle sites. The annual average background radon concentration measured at Station 11 was 0.7 x 10^{-9} µCi/mL. Although the average concentrations at several locations were greater than background, all were less than the DOE guideline. Station 9 had a significantly elevated concentration in Quarter 1 because the monitoring station is at the edge of a significant accumulation of mill tailings and does not

Figure 6-55
Environmental Airborne Radioactive Particulate (Thorium-230) Concentrations



ASER95/RFL/TAB1

Table 6-31 Real-time radon concentration (10^{-8} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
3	0.81	0.85	1.04	0.83	0.88
4	3.37	2.82	3.15	2.25	2.90
6	0.54	0.50	0.53	0.57	0.54
11	0.58	0.73	0.81	0.68	0.70

accurately reflect the conditions away from the tailings. The monitoring location was moved at the end of Quarter 1 to a position more accurately reflecting the environmental exposure. The elevated concentrations at the Rifle sites, should return to background levels after remedial action is complete.

Figure 6-57 graphically illustrates results for passive radon monitoring stations that recorded concentrations greatly above background.

Air Monitoring Conclusions

All measured total suspended particulate results were below applicable guidelines with the exception of exceedances caused by off-site conditions. For the first quarter of 1994, Station 9 was in close proximity to the tailings pile and therefore is not representative of the radon exposure to the public. Measured concentrations of thorium-230 particulates and radon-222 were less than the applicable guidelines. No significant releases occurred from the site during 1994.

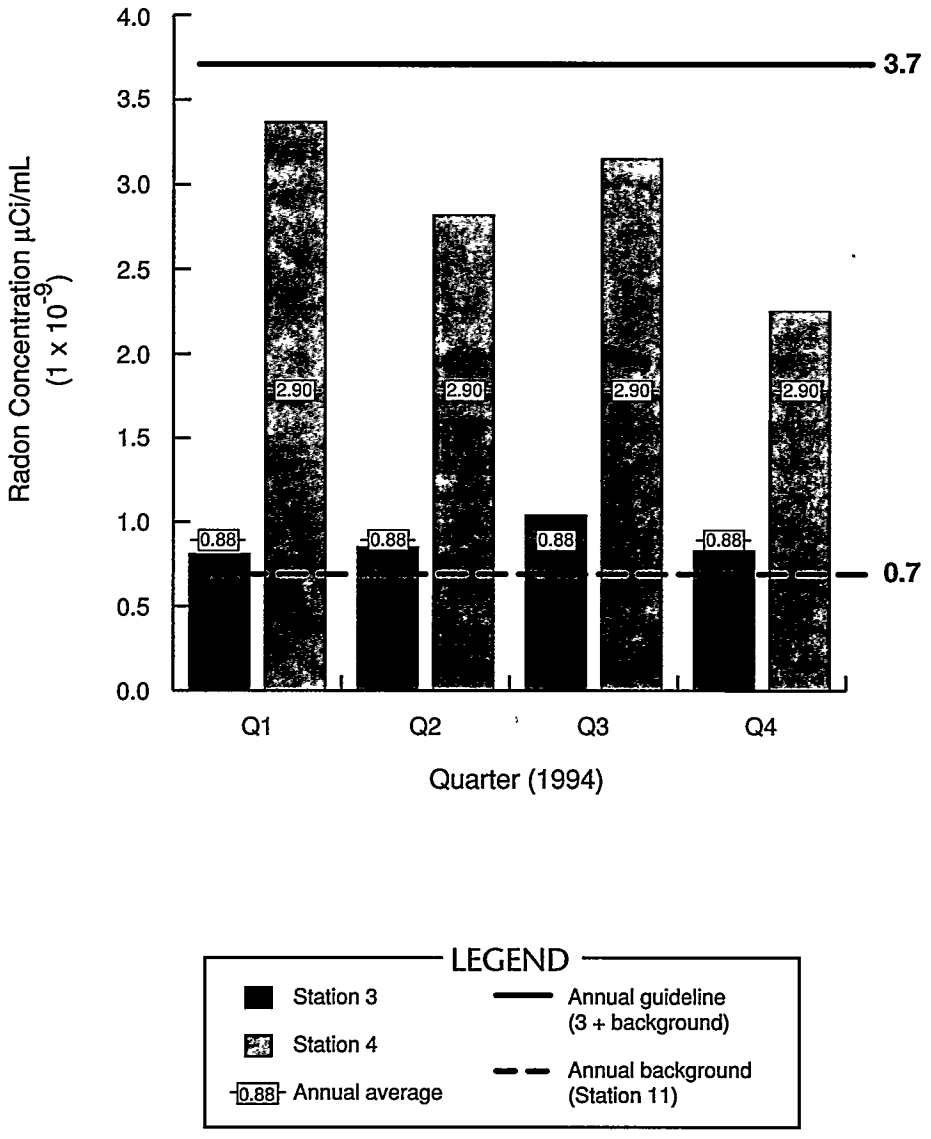
Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure to environmental gamma radiation in the environment around the Rifle processing sites and one location at the disposal site. Monitors were placed at the site perimeters as well as in key locations between the Old Rifle and New Rifle sites and the disposal site (*Figures 6-52 and 6-54*).

Ten dosimetry monitoring stations were active in 1994. Background dose equivalent was measured at Station 11.

Table 6-33 presents the results of the environmental dosimetry monitoring for stations at the Rifle sites for 1994. The annual background dose equivalent was 121.6 ± 17.2 mrem at Station 11. Of the locations for which annual dose equivalents were available, Station 1 and 4 were statistically different from background. The dosimeters at Station 9 were lost during the first quarter and Station 9 was moved at the end of that quarter to a location more accurately reflecting environmental exposure. The Quarter 4 dosimeter at Station 3 reported an anomalous reading and was not used.

Figure 6-56
Real-Time Radon Concentrations



ASER95/RFL/TAB2

Table 6-32 Passive (alpha-track) radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
1	2.8	1.3	1.7	1.2	1.8
3	1.1	0.8	1.3	0.8	1.0
4	4.2	2.5	3.2	1.7	2.9
5	0.9	0.6	0.6	0.6	0.7
6	0.6[a]	0.5[a]	0.7	0.6	0.6
7	1.0	1.0	0.8	0.6	0.8
8	1.4	1.2	3.0	1.5	1.8
9	21.8[b]	0.7	0.9	0.7	0.8
10	0.5	0.7[c]	0.6	0.6[a]	0.5
11	0.8	0.6	1.0	0.6	0.7
12	2.3	2.1	4.1	2.4	2.7
13	1.2	1.4	2.0	1.4	1.5
14	1.6	1.4	1.6	0.9	1.4
15	1.2	1.5	1.4	1.0	1.3
16	1.5	1.4	1.6	1.1	1.4
17	1.5	1.5	2.0	1.3	1.6
18	1.8	1.7	2.4	1.6	1.9

[a]At lest 1 detector was less than the detectable limit, the remaining detectors were averaged.
[b]Results not representative of environmental exposure. Station 9 moved after Quarter 1.
[c]2 detectors were less than the detectable limit, the result is based on remaining detector.

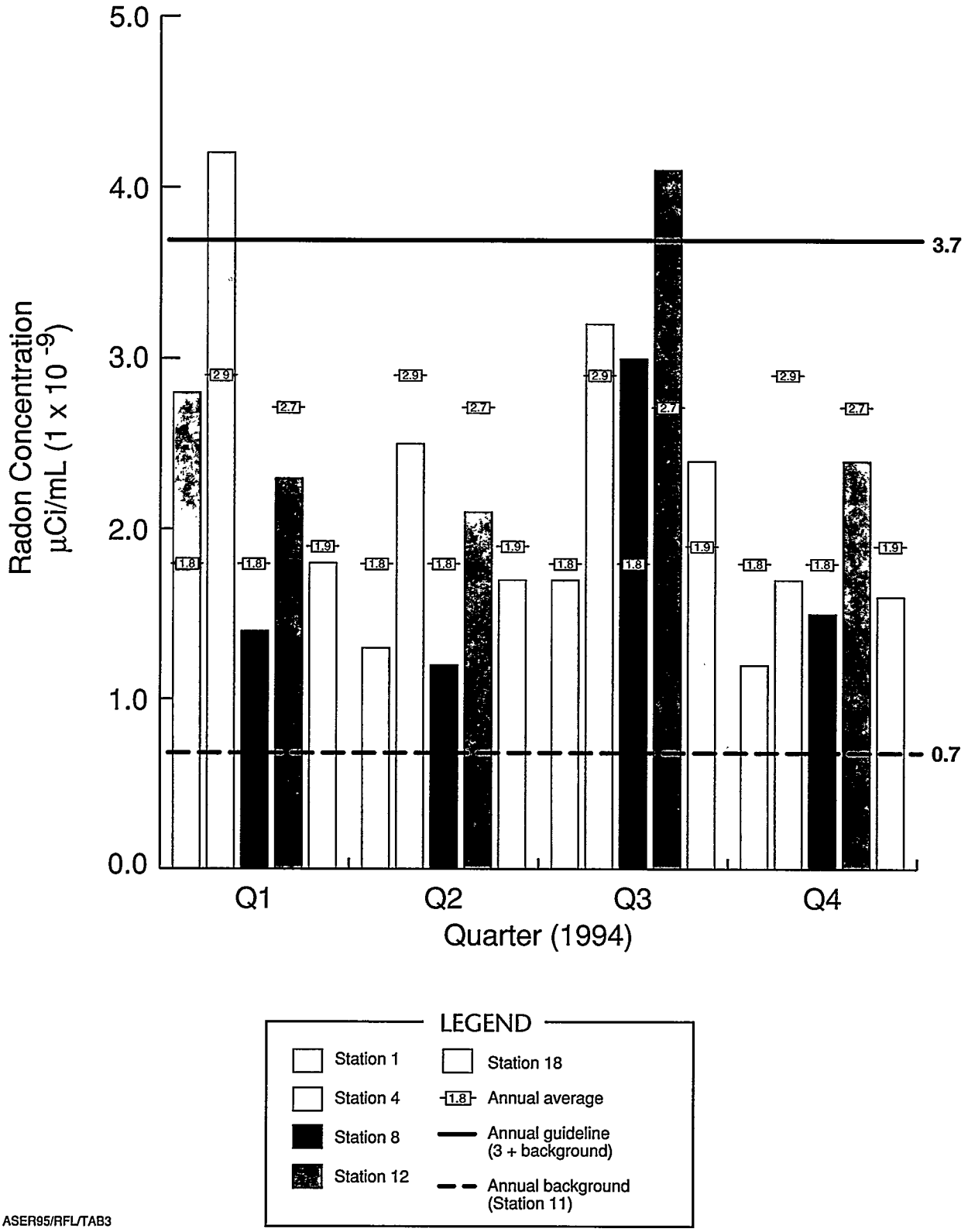
Figure 6-58 graphically illustrates results for environmental gamma radiation monitoring stations that recorded concentrations statistically above background.

None of the monitoring results indicated that the DOE dose equivalent guideline was exceeded, although levels at Station 4 are very close to the guideline. After remedial action, dose equivalents are expected to return to near-background levels.

Environmental Gamma Radiation Monitoring Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guideline that could be attributed to site remediation, indicating no significant releases to the environment during 1994.

Figure 6-57
Passive Radon Concentrations



ASER95/RFL/TAB3

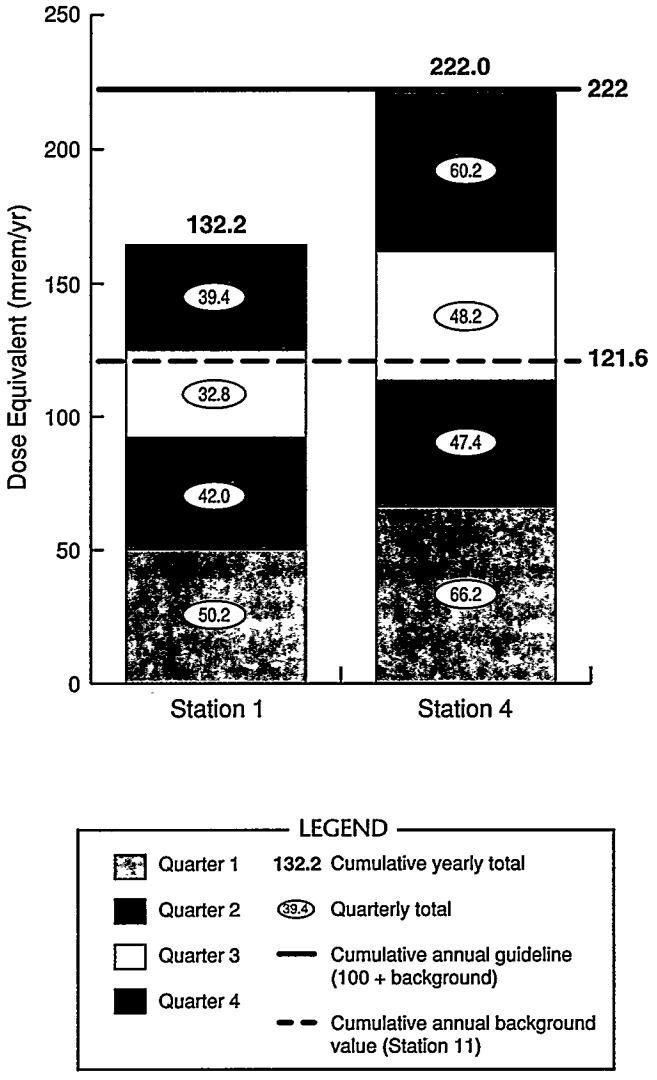
Table 6-33 Environmental gamma dose equivalent[a] (mrem)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	50.2 ± 15.0	42.0 ± 9.7	32.8 ± 9.3	39.4 ± 5.0	164.4 ± 21.2 (1.644 ± 0.212)
3	39.8 ± 10.7	33.4 ± 13.6	22.2 ± 15.6	d	95.4 ± 23.3[c] (0.954 ± 0.223)
4	66.2 ± 19.0	47.4 ± 22.4	48.2 ± 19.4	60.2 ± 3.8	222.0 ± 35.4 (2.220 ± 0.354)
5	38.0 ± 9.6	36.6 ± 6.3	26.8 ± 6.5	38.0 ± 7.1	139.4 ± 15.0 (1.394 ± 0.150)
6	32.8 ± 7.5	30.6 ± 14.3	29.0 ± 5.7	36.8 ± 4.3	129.2 ± 17.7 (1.292 ± 0.177)
7	36.4 ± 12.6	29.8 ± 11.5	28.6 ± 10.3	29.4 ± 7.6	124.2 ± 21.3 (1.242 ± 0.213)
8	38.0 ± 6.3	35.0 ± 8.1	33.4 ± 7.3	43.2 ± 4.6	149.6 ± 13.4 (1.496 ± 0.134)
9	b	29.8 ± 11.8	33.6 ± 7.0	34.6 ± 10.6	98.0 ± 17.3[c] (0.980 ± 0.173)
10	37.4 ± 9.5	32.2 ± 6.7	29.0 ± 5.3	28.4 ± 7.3	127.0 ± 14.7 (1.270 ± 0.147)
11	35.8 ± 9.3	26.2 ± 11.1	28.0 ± 6.5	31.6 ± 6.6	121.6 ± 17.2 (1.216 ± 0.172)

[a]All errors reported as 2 standard deviations.
[b]Lost dosimeter.
[c]Annual dose equivalent based on available data.
[d]Anomalous reading, not reported.

( ) indicate millisieverts.

Figure 6-58
Environmental Gamma Radiation Monitoring



ASER95/RFL/TAB4

Surface Water Monitoring

Surface water monitoring for radiological contaminants was conducted at the Old and New Rifle processing sites to assess potential environmental impacts from remedial action activities. Samples were taken from four locations (01, 02, 03, and 04) along the Colorado River (***Figure 6-59***). ***Table 6-34*** gives the radiological results of the surface water analyses.

Downstream radiological water monitoring results were statistically indistinguishable from upstream results. In all cases, the results were well below DOE guidelines given for water concentrations.

Figure 6-59 also shows locations of the following 13 additional surface water samples taken in the vicinity of the Rifle processing sites for the baseline risk assessment: 538, 541, 542, 545, 548, 568, 569, 570, 572, 573, 574, 575, and 576. Unfiltered surface water/sediment samples were collected from all locations except 576 in March 1994. Locations 570, 573, and 575 were resampled in August, and location 576 was sampled in December. Surface water was not collected at the Estes Gulch disposal site in 1994.

Surface water samples were analyzed for the following parameters at both the New Rifle and Old Rifle sites:

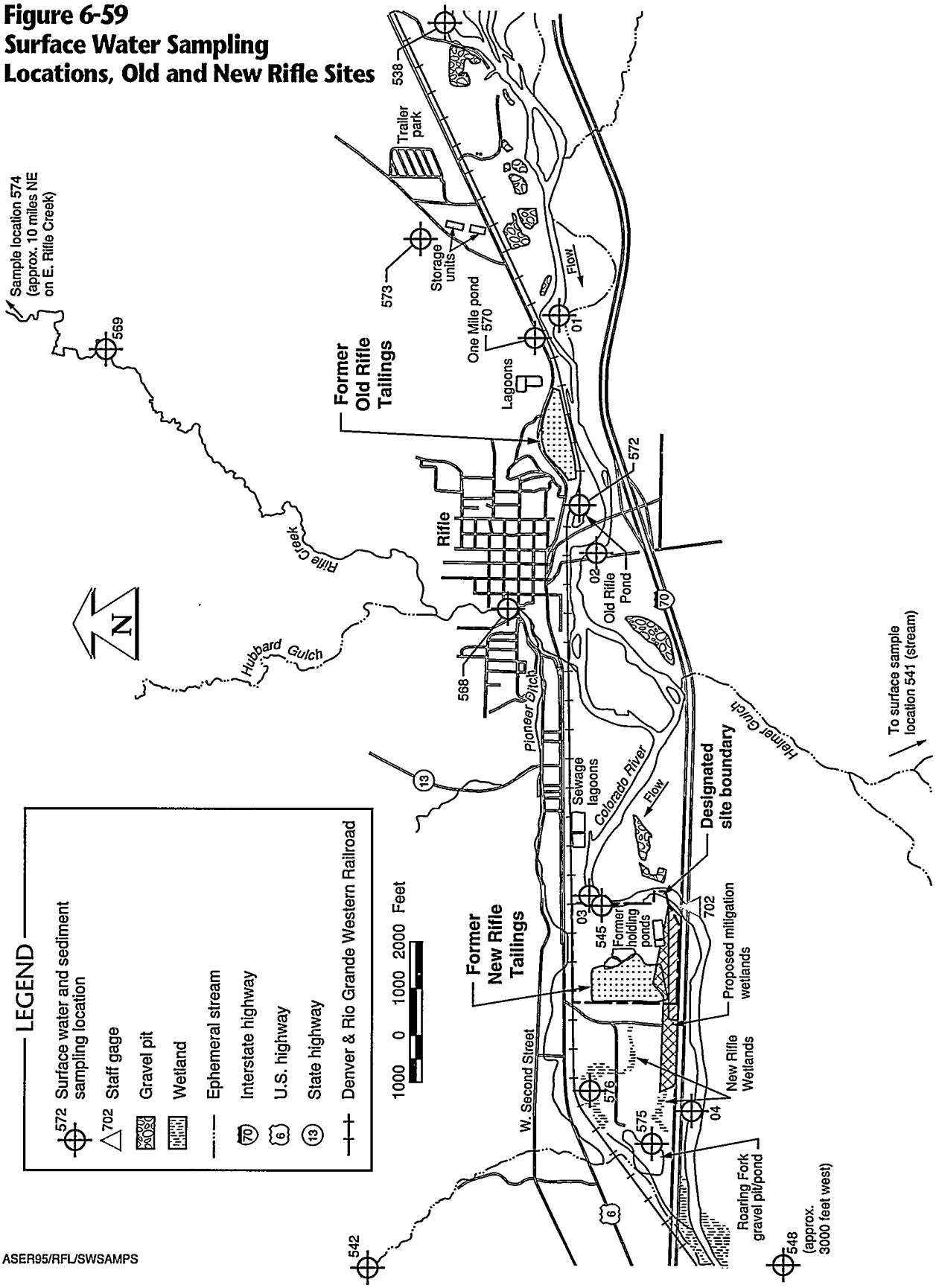
- Ammonium, arsenic, cadmium, calcium, chloride, dissolved organic carbon, fluoride, gross beta, iron, magnesium, manganese, molybdenum, net gross alpha, nitrate, potassium, radium-226 and radium-228, selenium, silica, sodium, sulfate, total dissolved solids, total organic carbon, uranium, vanadium, and zinc.

In addition to the surface water sampling, a staff gauge (location 702) was installed upstream of the New Rifle processing site in November 1994 (***Figure 6-59***). This staff gauge will be used in 1995 to monitor fluctuating stages of the Colorado River. Monitoring data may be used to support the selection and effectiveness of potential ground water remediation strategies.

Surface Water Results and Conclusions

March 1994 surface water data from the Colorado River upstream and downstream of the New Rifle and Old Rifle processing sites show that, in general, the constituents detected at the downgradient locations were not greater than their respective background concentrations (***Tables 6-35 and 6-36***). Upgradient surface water samples collected from the Pioneer Creek Ditch, Rifle Creek, One Mile Pond, and associated springs indicate that uranium occurs at low levels to slightly above the EPA maximum concentration limit (0.044 mg/L) for ground water in the vicinity of Rifle. Analytical results from sample location 575 collected at the Roaring Fork gravel pit downgradient from the New Rifle processing site indicate the presence of elevated concentrations for several parameters that exceeded EPA maximum concentration limits, including molybdenum, net gross alpha, nitrate, and uranium.

Figure 6-59
Surface Water Sampling Locations, Old and New Rifle Sites



ASER95/RFL/SWSAMPS

Table 6-34 Surface water concentrations (10^{-9} μCi/mL)[a]

Location	Radionuclide	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average	Guideline
Upstream Colorado River - Old Rifle (01)	^{226}Ra	0.3 ± 0.2	0.3 ± 0.3	0.8 ± 0.6	0.1 ± 0.1	0.4 ± 0.2	100
	^{230}Th	0.1 ± 0.5	0.1 ± 0.4	2.3 ± 1.4	-0.4 ± 0.2	0.5 ± 0.4	300
Downstream Colorado River - Old Rifle (02)	^{226}Ra	0.2 ± 0.2	0.1 ± 0.2	1.1 ± 0.6	0.4 ± 0.2	0.5 ± 0.2	100
	^{230}Th	0.7 ± 0.8	0.3 ± 0.5	1.5 ± 1.0	-0.3 ± 0.7	0.6 ± 0.4	300
Upstream Colorado River - New Rifle (03)	^{226}Ra	0.3 ± 0.2	0.2 ± 0.3	1.9 ± 0.6	0.6 ± 0.2	0.8 ± 0.2	100
	^{230}Th	0.7 ± 0.8	0.6 ± 0.6	1.0 ± 0.8	0.2 ± 0.3	0.6 ± 0.3	300
Downstream Colorado River - New Rifle (04)	^{226}Ra	0.3 ± 0.2	0.0 ± 0.2	1.4 ± 0.6	0.3 ± 0.2	0.5 ± 0.2	100
	^{230}Th	0.7 ± 0.8	0.4 ± 0.5	1.8 ± 1.0	0.3 ± 0.3	0.8 ± 0.4	300

[a]All errors reported as 2 standard deviations.

Table 6-35 Surface water quality results, New Rifle processing site

Indicator parameter	Guideline	Helmer Gulch 541	Pond NW of New Rifle 542	Colorado River (upstream) 545	Colorado River (downstream) 548	Gravel pit (downstream) 575	Wetland W of New Rifle 576
Total dissolved solids	500[a]						
03/94		818	285	580	582	5830	NA
Sulfate	250[a]						
03/94		228	14.5	123	120	3200	1800[d]
Molybdenum	0.1[b]						
03/94		0.01	<0.01	<0.01	<0.01	0.18	0.07[d]
Net gross alpha	15[b,c]						
03/94		6.35[c]	5.27[c]	0.24[c]	0.24[c]	-27.35[c]	
Nitrate	44[b]						
03/94		<1.0	<1.0	<1.0	<1.0	200	116[d]
Uranium	0.044[b]						
03/94		0.018	0.005	0.003	0.003	0.311	0.021[d]

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.
[c]Concentration reported in picocuries per liter.
[d]Sampled 12/94.

Note: 1. Concentrations are reported in milligrams per liter, except as noted.
2. With the exception of 576, samples were unfiltered.

< indicates the actual is less than the detection limit (number shown).
NA – not analyzed.

Table 6-36 Surface water quality results, Old Rifle processing site

Indicator parameter	Guideline	Colorado River (upstream) 538	Pioneer Ditch (upstream) 568	Rifle Creek (upstream) 569	One Mile Pond (upstream) 570	Pond (downstream) 572	One Mile Spring (upstream) 573	Rifle Creek (upstream) 574
Total dissolved solids	500[a]							
03/94		611	604	489	761	329	3780	399
Sulfate	250[a]							
03/94		133	223	181	253	59.1	2010	107
Nitrate	44[b]							
03/94		<1	<1	<1	<1	<1	<1	2.1
Uranium	0.044[b]							
03/94		0.003	0.006	0.005	0.010	0.017	0.048	0.003

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Notes:
1. Concentrations are reported in milligrams per liter.
2. Samples were unfiltered.
3. Because no downgradient samples were collected from the Colorado River in the vicinity of the Old Rifle site, there is less basis for comparison between Old Rifle surface water quality results.

< indicates actual is less than the detection limit (number shown).

The samples from Old Rifle location 572 detected uranium in the surface water. However, these concentrations are below maximum concentration limits and are in the same range as background ground water concentrations.

Results from limited sampling in August 1994 were not appreciably different from March results. The 1994 surface water sampling indicates no influence on Colorado River water quality; however, elevated concentrations of the above parameters in surface water at the Roaring Fork gravel pit suggest the pit is receiving contaminated discharge from an upgradient source.

Ground Water Monitoring

Ground water samples are being collected at the former Old and New Rifle processing sites to monitor changes in water quality that occur before, during, and after removal of the tailings piles and associated contaminated soil. To assess the extent of ground water contamination from former processing activities, the downgradient ground water quality before remediation was compared with the background water quality and the EPA maximum concentration limits in 40 CFR Part 192. Background ground water quality is defined as the quality of ground water that would be expected at the site if uranium processing activities had not occurred.

The Old and New Rifle processing sites are underlain by a dual aquifer system consisting of a shallow, unconfined aquifer in the alluvium lining the Colorado River Valley and a semiconfined aquifer in the Wasatch Formation (bedrock) beneath the alluvium. The thickness of

the alluvium at the sites averages approximately 20 ft. ***Figures 6-60 and 6-61*** show monitoring well locations at the New and Old Rifle processing sites.

The DOE installed several new wells at the Rifle sites in 1994. Three new shallow wells were installed in March to further support characterization of background water quality and extent of contamination for the Rifle baseline risk assessment. Two of these wells (605 and 606) were installed in the alluvial aquifer upgradient of the Old Rifle site. One well (620) was installed in the alluvial aquifer about 3 mi downgradient of the New Rifle tailings site. Two more wells (635 and 636) were installed in September downgradient of the New Rifle site near the Colorado River. These wells will be used to monitor interaction between the river and the alluvial aquifer.

The alluvial aquifer water table and Wasatch Formation potentiometric surface contour maps for the New Rifle site (***Figures 6-62 and 6-63***) show ground water generally flows southwest. Ground water at the New Rifle site in the alluvial aquifer flows southwest at a rate of approximately 300 ft per year. Ground water in the Wasatch Formation flows southwest at a rate of approximately 3 ft per year.

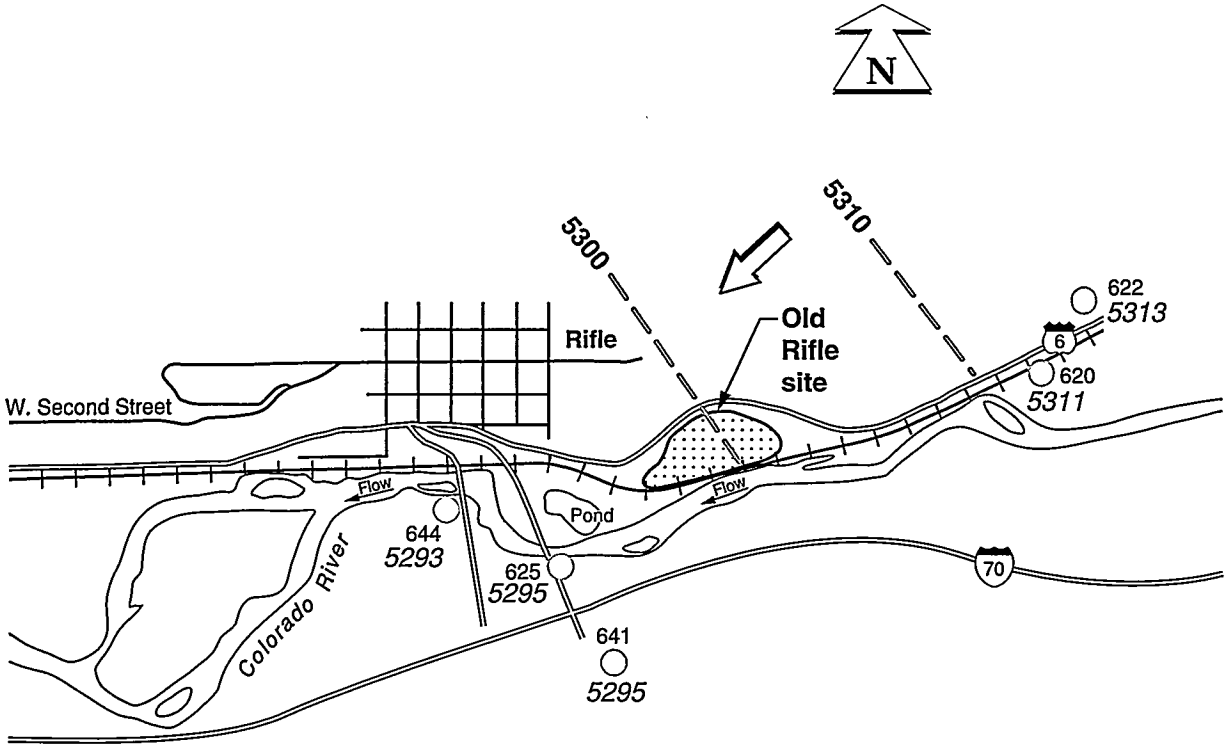
Alluvial aquifer water table and the Wasatch Formation potentiometric surface contour maps of Old Rifle were not developed for 1994 because remediation activities prevented gathering of sufficient surface water level data. However, representative historical data collected in 1992 (***Figures 6-64 and 6-65***) indicate that ground water at the Old Rifle site in the alluvial aquifer flows southwest. The average linear ground water flow velocity in the alluvial aquifer at Old Rifle is approximately 800 ft per year, and that ground water in the Wasatch Formation flows southwest at a rate of approximately 0.3 ft per year.

Wells that typify background water quality at both sites are Old Rifle wells 597 and 605. Wells that typify background water quality for the Wasatch Formation include New Rifle well 641 and Old Rifle well 620. Wells that typify downgradient ground water quality are 596 and 589 for the New Rifle alluvium and 611 and 622 for the New Rifle Wasatch Formation. Old Rifle wells that typify downgradient water quality are 590 and 600 for the alluvial aquifer.

Most ground water samples were collected in March and August 1994. Sampling of Wasatch wells was limited to the March sampling, while alluvial wells were sampled during March and August. Several locations were also sampled in December.

One private (domestic) well in the New Rifle site vicinity was sampled in March 1994 (New Rifle well 428). A total of 12 domestic locations were sampled during two sampling events, in August and December 1994. Results of the recent Rifle baseline risk assessment indicate that

Figure 6-60
Potentiometric Surface for the Wasatch Formation, Old Rifle Processing Site



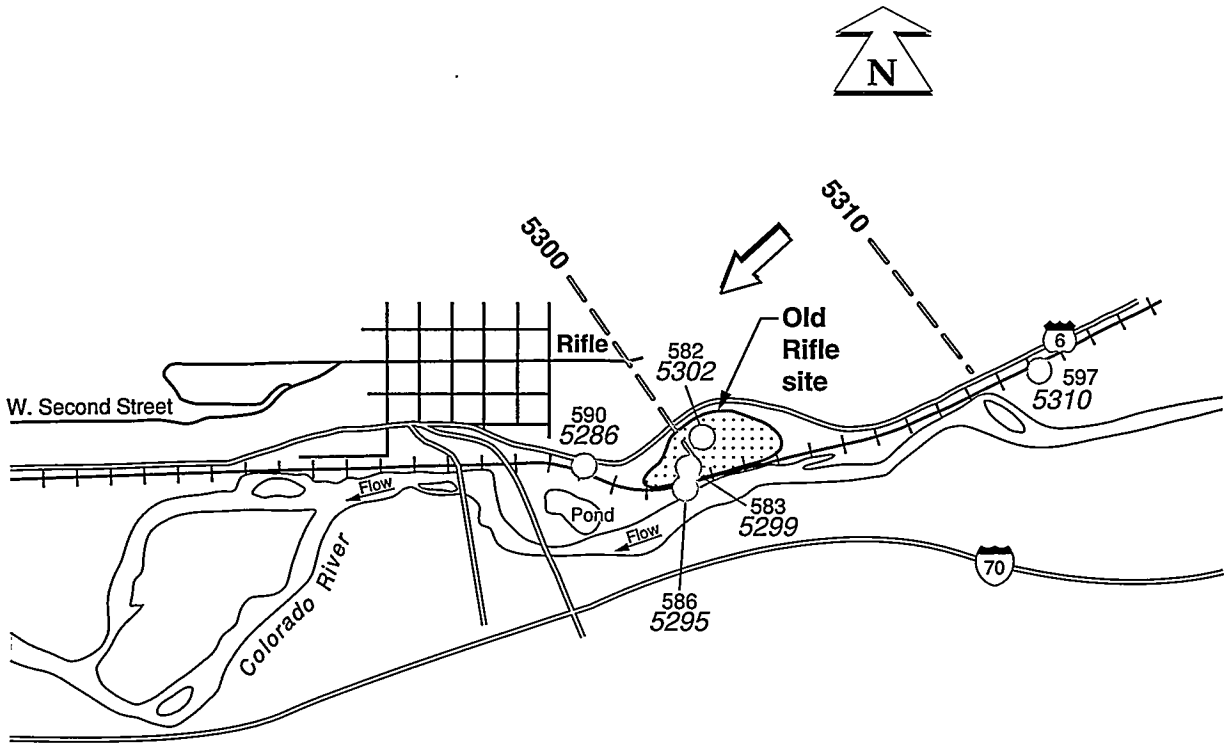
LEGEND

○ 622 *5313*	Wasatch ground water monitoring well Ground water elevation (ft above MSL), March 1992
5300	Ground water elevation contour (ft above MSL, dashed where inferred)
	Ground water flow direction
70	Interstate highway
6	U.S. highway
	Denver & Rio Grande Western Railroad

1000 0 1000 2000 3000 Feet

ASER95/RFL/WASMON

Figure 6-61
Potentiometric Surface for the Alluvial Aquifer, Old Rifle Processing Site



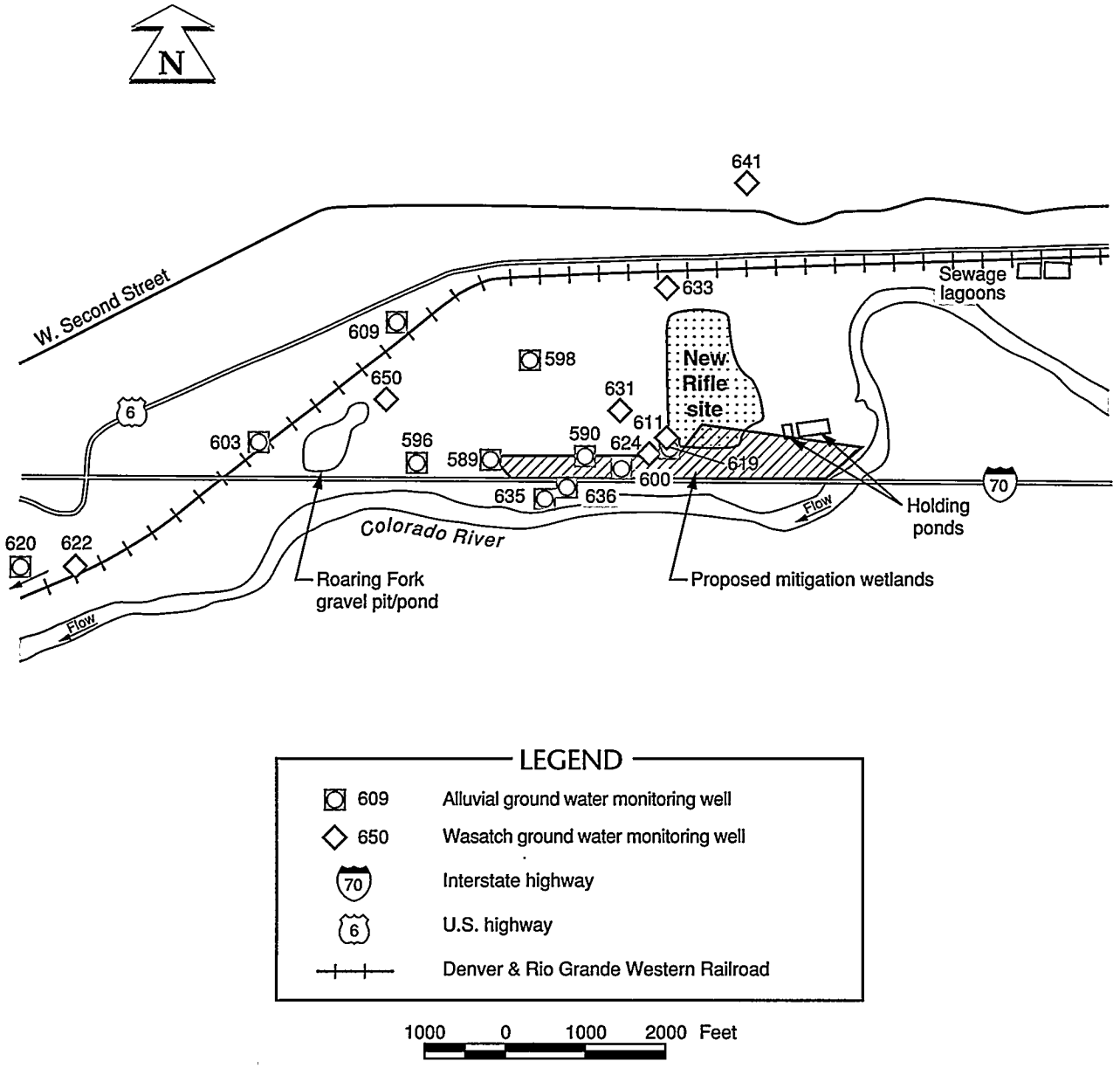
LEGEND

597 / 5310	Alluvial ground water monitoring well Ground water elevation (ft above MSL), March 1992
5300	Ground water elevation contour (ft above MSL, dashed where inferred)
	Ground water flow direction
70	Interstate highway
6	U.S. highway
	Denver & Rio Grande Western Railroad

1000 0 1000 2000 3000 Feet

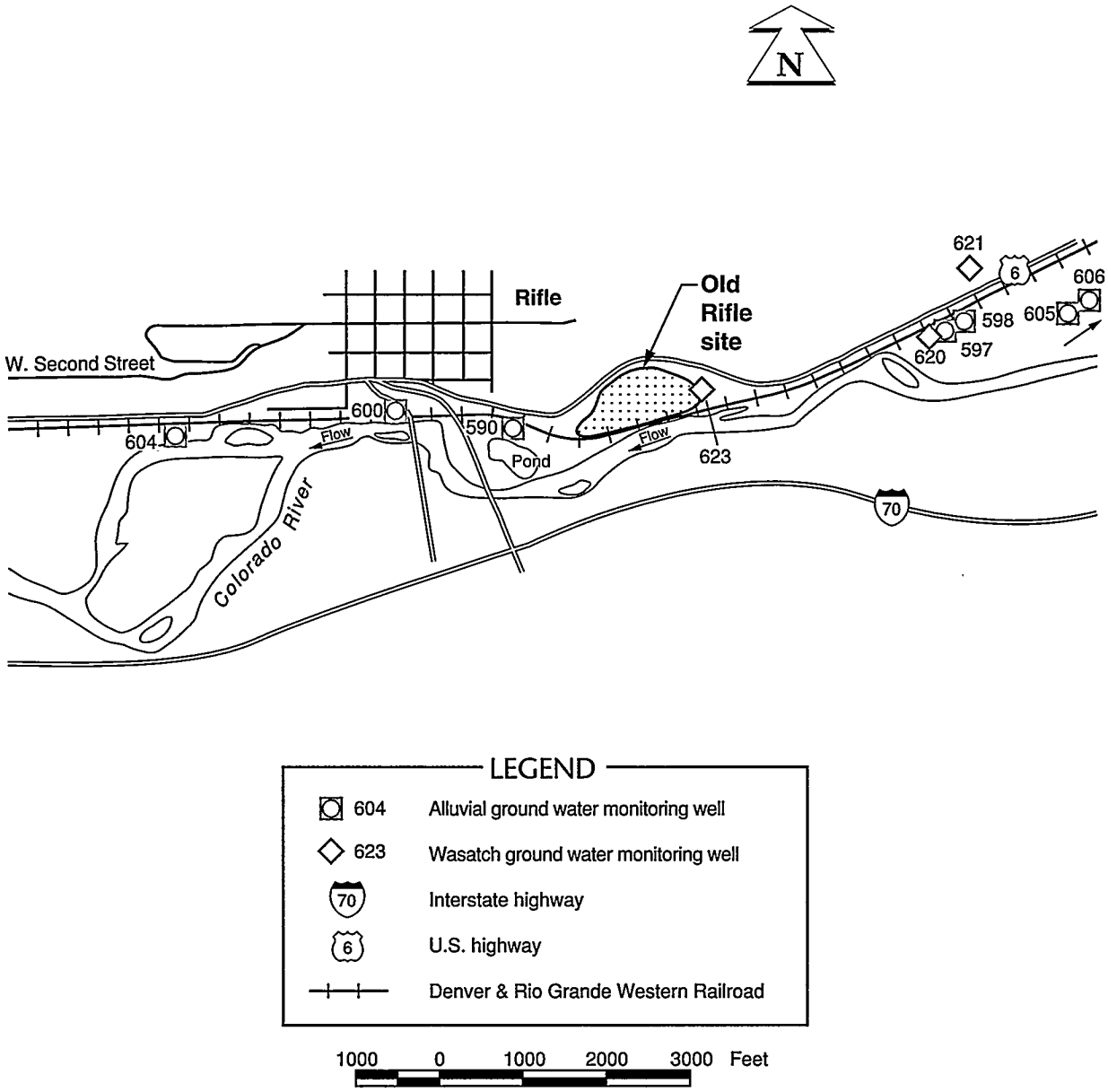
ASER95/RFL/ALLAQUIF

Figure 6-62
Ground Water Monitoring Well Locations, New Rifle Processing Site



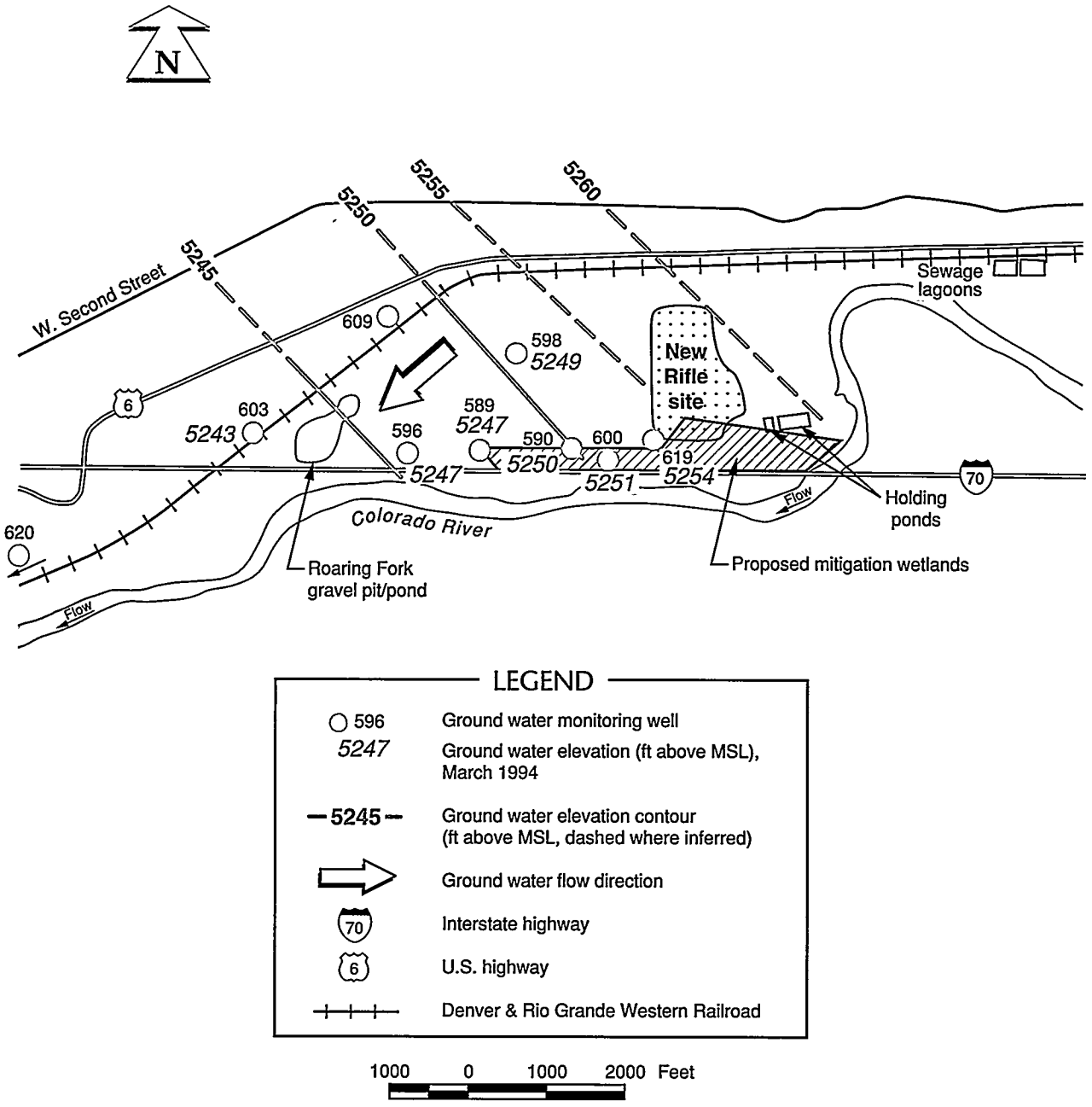
ASER95/RFL/MONITOR

Figure 6-63
Ground Water Monitoring Well Locations, Old Rifle Processing Site



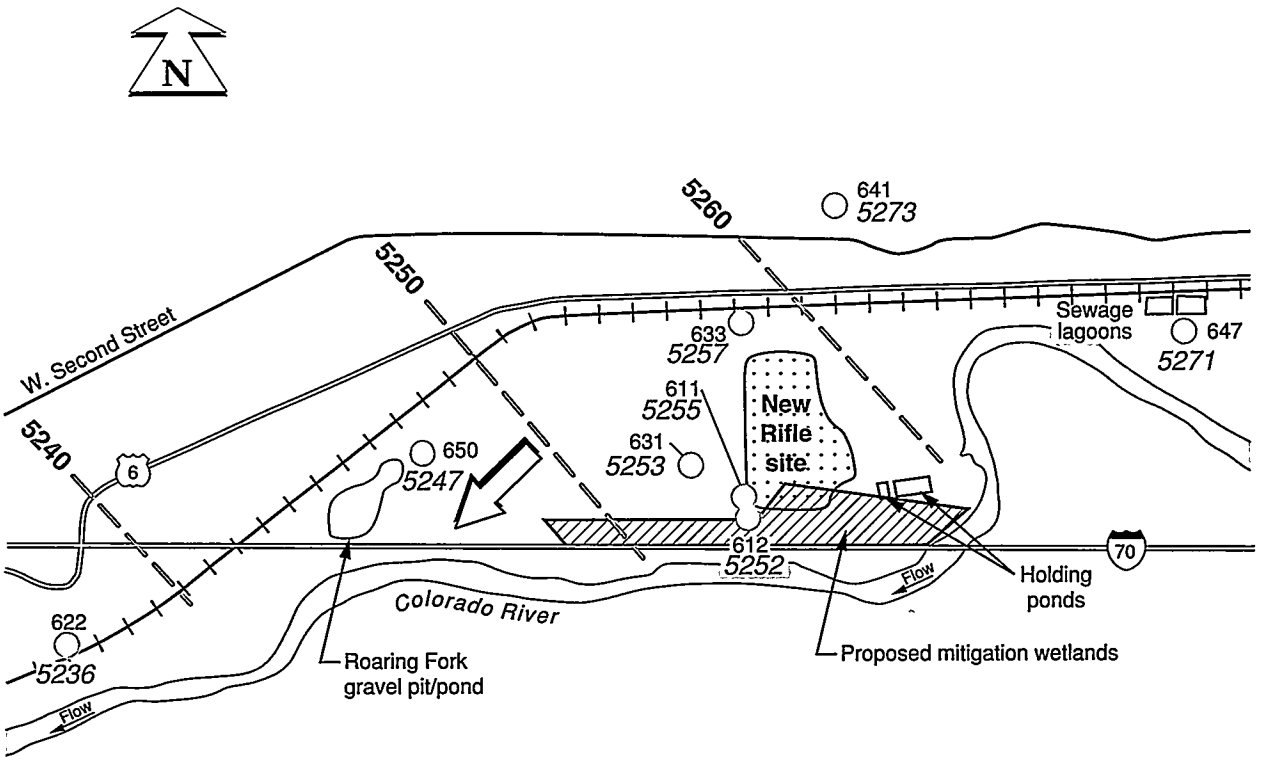
ASER95/RFL/MONWELLOC

Figure 6-64
Ground Water Table Contours for Alluvial Aquifer, New Rifle Processing Site



ASER95/RFL/WATTABLE

Figure 6-65
Potentiometric Surface for the Wasatch Formation, New Rifle Processing Site



LEGEND

650	Ground water monitoring well
5247	Ground water elevation (ft above MSL), March 1994
—5240—	Ground water elevation contour (ft above MSL, dashed where inferred)
	Ground water flow direction
70	Interstate highway
6	U.S. highway
	Denver & Rio Grande Western Railroad

1000 0 1000 2000 Feet

ASER95/RFL/POTEN

domestic wells north of U.S. Highway 6 have not been impacted by uranium processing activities. Private wells usually were analyzed for the same parameter list but were not filtered before analysis.

DOE monitoring wells at the Old and New Rifle processing sites are currently sampled for the following parameters:

- Field parameters — alkalinity, oxidation-reduction potential, pH, specific conductivity, and temperature.
- Laboratory analyses (filtered) — ammonium, arsenic, cadmium, calcium, chloride, chromium, dissolved organic carbon, dissolved oxygen, fluoride, gross alpha, gross beta, iron, magnesium, manganese, molybdenum, net gross alpha, nitrate, potassium, radium-226, radium-228, selenium, silica, sodium, sulfate, total organic carbon, total dissolved solids, uranium, vanadium, and zinc.

New Rifle Ground Water Results

Tables 6-37 and 6-38 summarize 1994 ground water quality results for the alluvial aquifer and the Wasatch Formation, respectively, in the New Rifle processing site vicinity. In *Table 6-37*, March and August 1994 results are presented for a monitoring well in the contaminated area (589), for a downgradient monitoring well (620), and for background wells 605 and 597. Indicator parameters presented in *Tables 6-37 and 6-38* (total dissolved solids, sulfate, nitrate, and uranium) were selected because they are mobile and therefore demonstrate the probable maximum migration of contaminated ground water in 1994.

In *Figures 6-66 and 6-67*, the variability of sulfate and uranium concentrations best displays the maximum areal extent of contamination in the alluvial aquifer at the New Rifle site. *Figures 6-68 and 6-69* show the trends for sulfate and uranium in the alluvial aquifer at New Rifle over the past 4 years.

Table 6-38 shows that, in March 1994, indicator parameters in the Wasatch aquifer were elevated in the contaminated well (well 611) in comparison to background (well 641), while the downgradient well (650) shows a significantly lower concentration of indicator parameters, except for nitrate, than concentrations in the contaminated well. This trend of relatively elevated concentrations near the tailings pile and relatively sharp decreases in concentrations downgradient from the pile is a result of the less transmissive hydrogeologic properties characteristic of the Wasatch Formation. Because of these characteristic properties, contaminants do not migrate as quickly or as extensively as in the more permeable alluvial aquifer. *Figures 6-70 and 6-71* are the New Rifle site sulfate and uranium distribution maps, respectively, for the Wasatch Formation. *Figures 6-72 and 6-73* show the trends for sulfate and uranium in the Wasatch Formation over the past 4 years.

Table 6-37 New Rifle processing site alluvial ground water quality results

Indicator parameter	Guideline	Monitoring well location 597 (background)	605 (background)	589 (contaminated)	620 (downgradient)
Total dissolved solids	500[a]				
03/94		1870	2520	12,200	6050
08/94		1940	2300	11,700	5820
Sulfate	250[a]				
03/94		787	977	7280	2670
08/94		931	855	9640	2940
Nitrate	44.0[b]				
03/94		<1	7.8	1110	1.2
08/94		X	X	1020	<1.0
Uranium	0.044[b]				
03/94		0.022	0.046	0.193	0.075
08/94		0.020	0.042	0.222	0.044

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Concentrations are reported in milligrams per liter.

X – no sample taken.
< indicates actual is less than the detection limit (number shown).

Table 6-38 Wasatch ground water quality results, New Rifle processing site

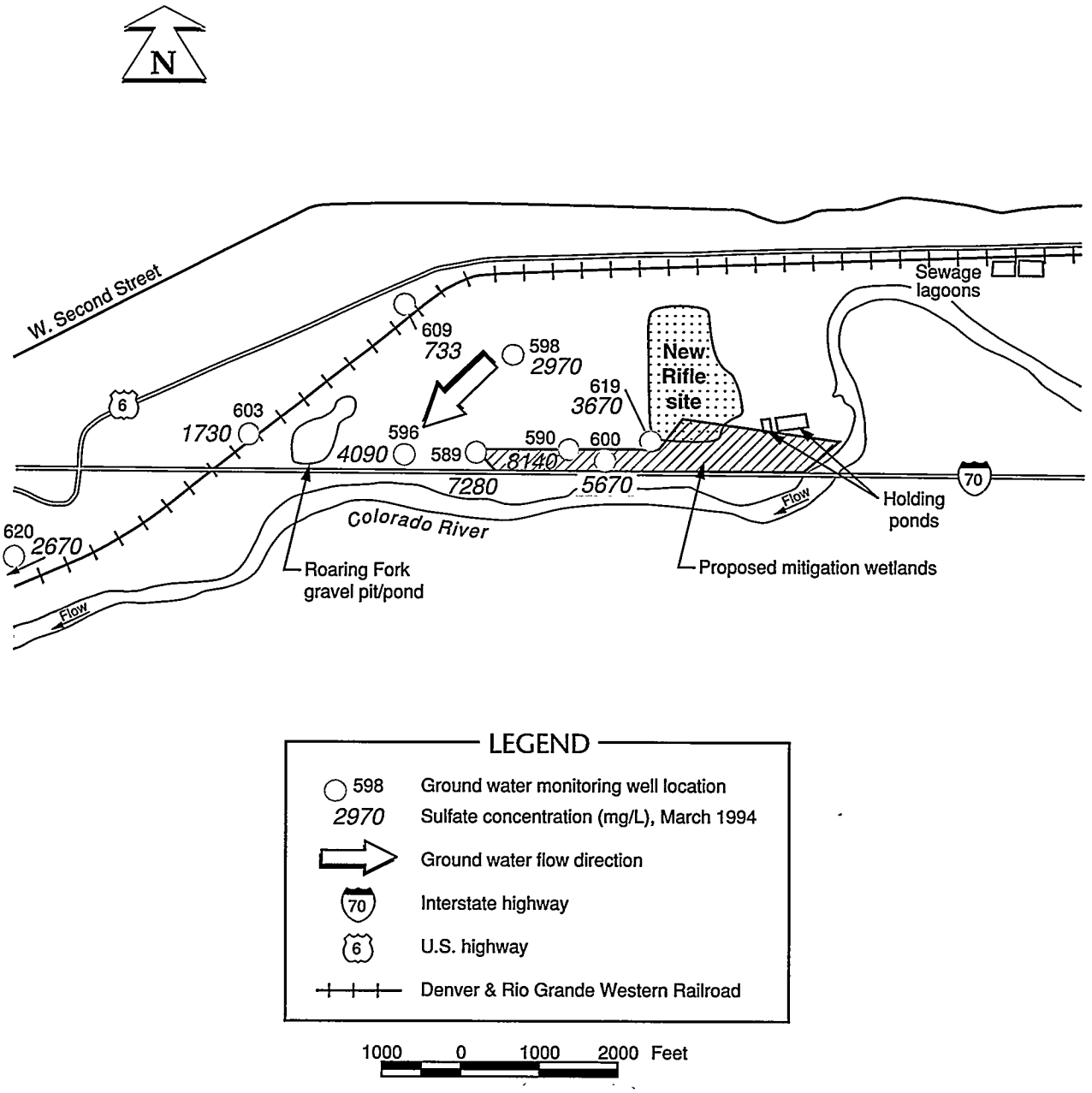
Indicator parameter	Guideline	Monitoring well location 641 (background)	611 (contaminated area)	650 (downgradient)
Total dissolved solids	500[a]			
03/94		2940	9540	3080
Sulfate	250[a]			
03/94		1090	6180	75
Nitrate	44.0[b]			
03/94		<1	<1	2.6
Uranium	0.044[b]			
03/94		0.004	0.085	0.002

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Concentrations are reported in milligrams per liter.

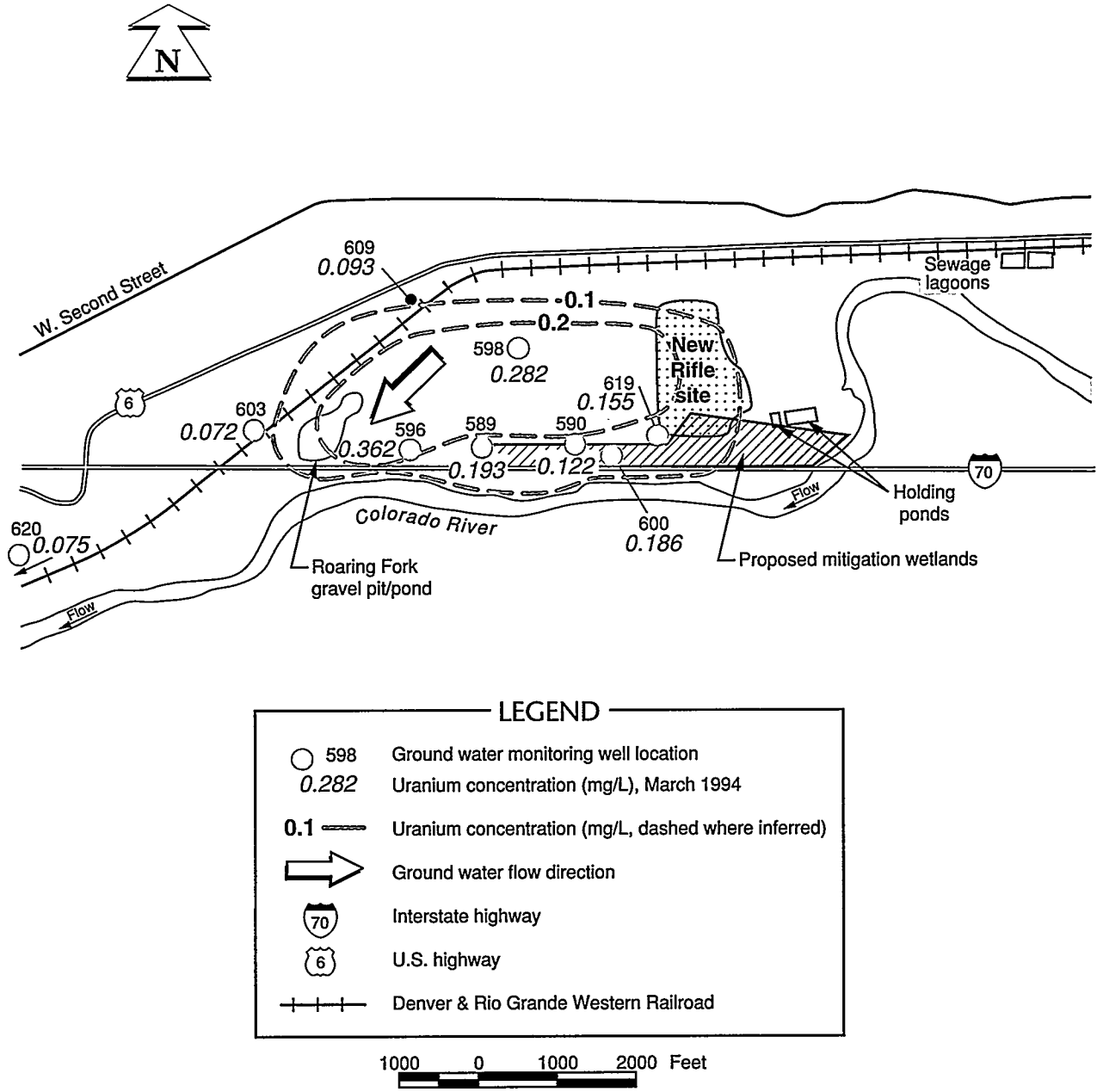
< indicates actual is less than the detection limit (number shown).

Figure 6-66
Sulfate Concentrations for the Alluvial Aquifer, New Rifle Processing Site



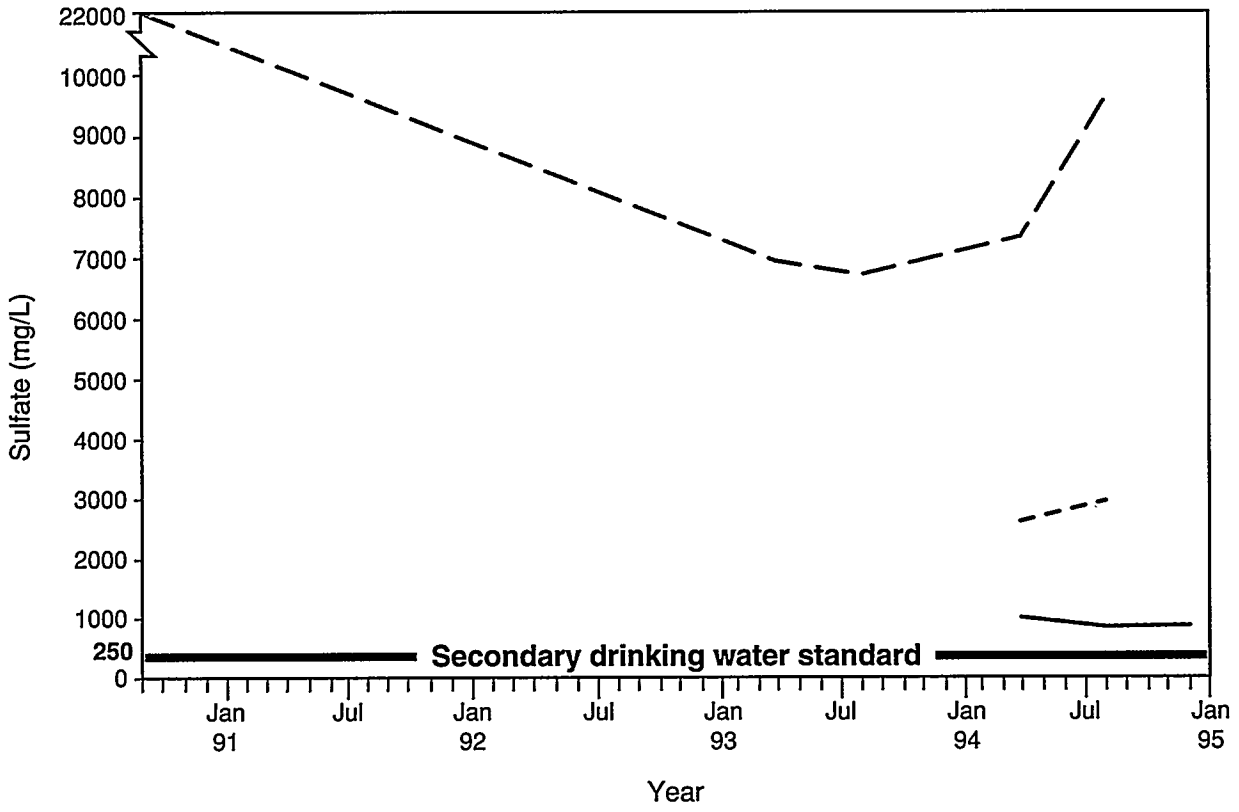
ASER95/RFL/SULFATE

Figure 6-67
Uranium Concentrations for the Alluvial Aquifer, New Rifle Processing Site



ASER95/RFL/URNMAP

Figure 6-68
Sulfate Concentrations Over Time in the Alluvial Aquifer, New Rifle Processing Site

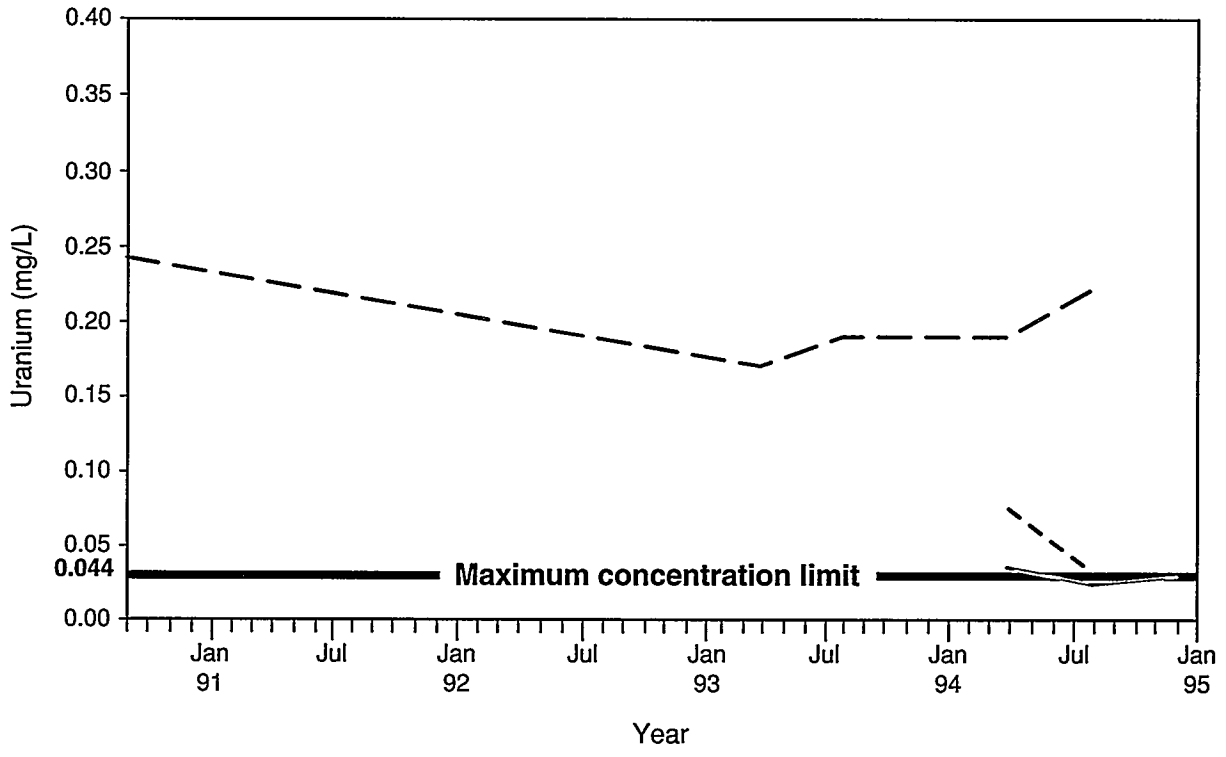


LEGEND

RFO-01-605	Background ground water monitoring well
RFN-01-620	Downgradient ground water monitoring well
RFN-01-589	Contaminated ground water monitoring well

ASER95/RFL/SULCON-592, 596, 598

Figure 6-69
Uranium Concentrations Over Time in the Alluvial Aquifer, New Rifle Processing Site

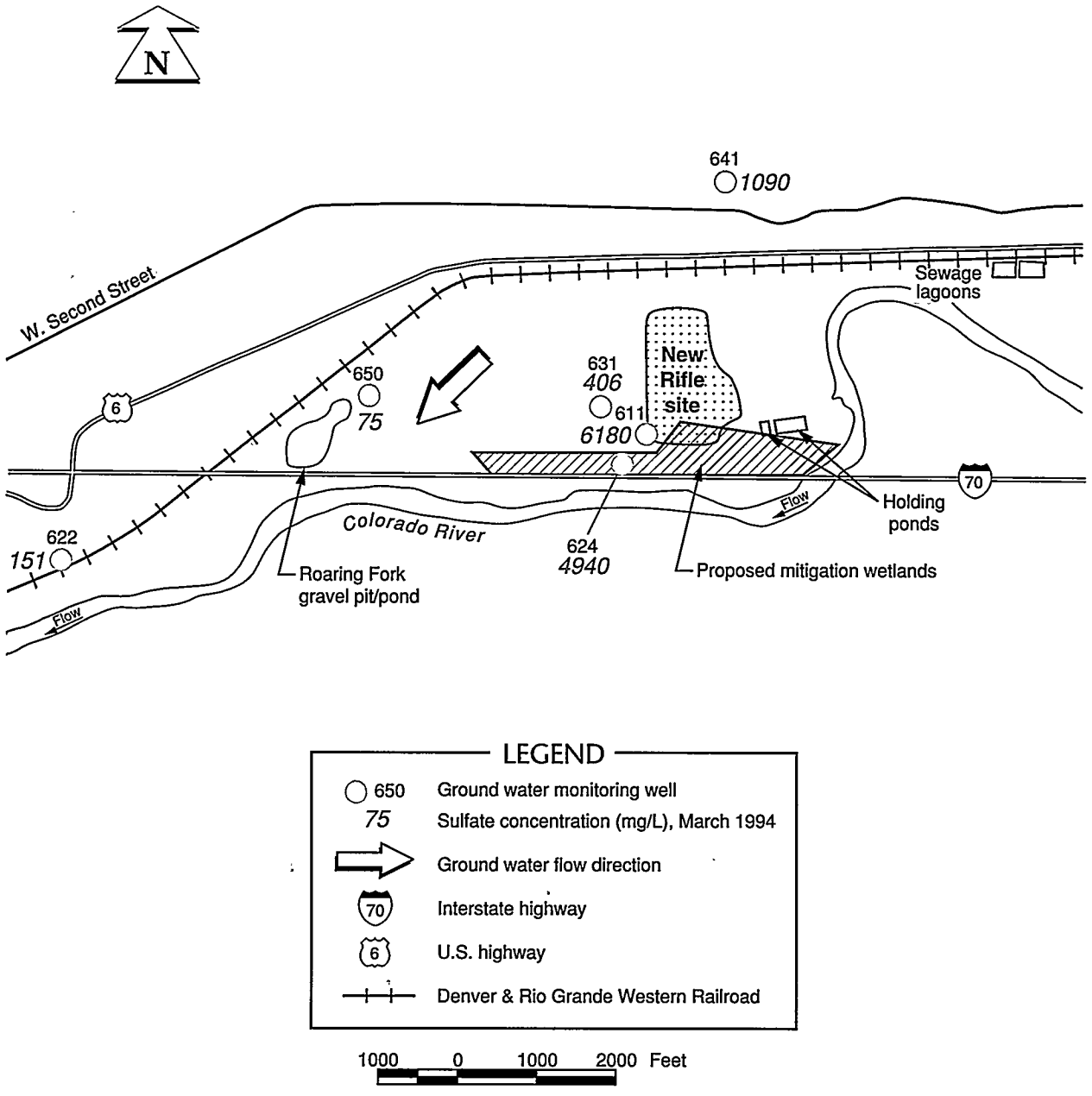


LEGEND

RFO-01-605	Background ground water monitoring well
RFN-01-620	Downgradient ground water monitoring well
RFN-01-589	Contaminated ground water monitoring well

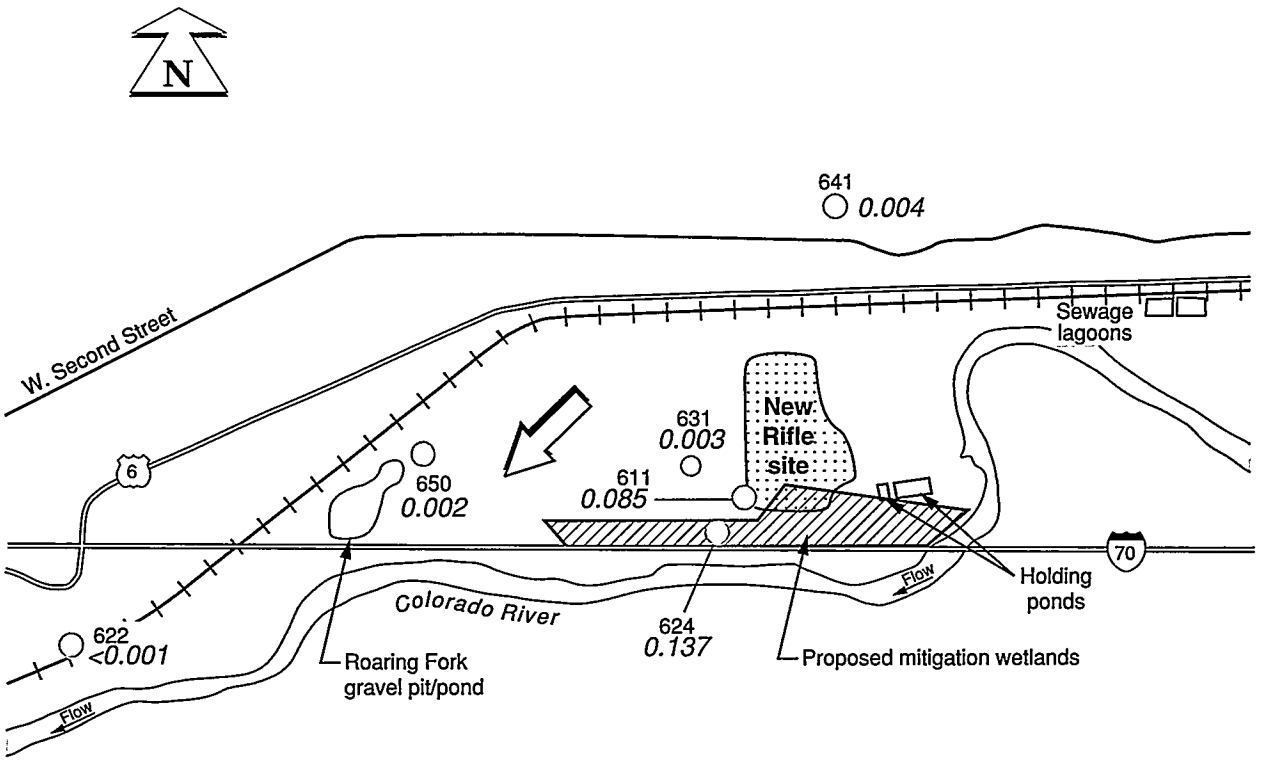
ASER95/RFL/URNCON-592, 596, 598

Figure 6-70
Sulfate Concentrations for Ground Water in the Wasatch Formation, New Rifle Processing Site



ASER95/RFL/SULDIS

Figure 6-71
Uranium Concentrations for the Wasatch Formation, New Rifle Processing Site



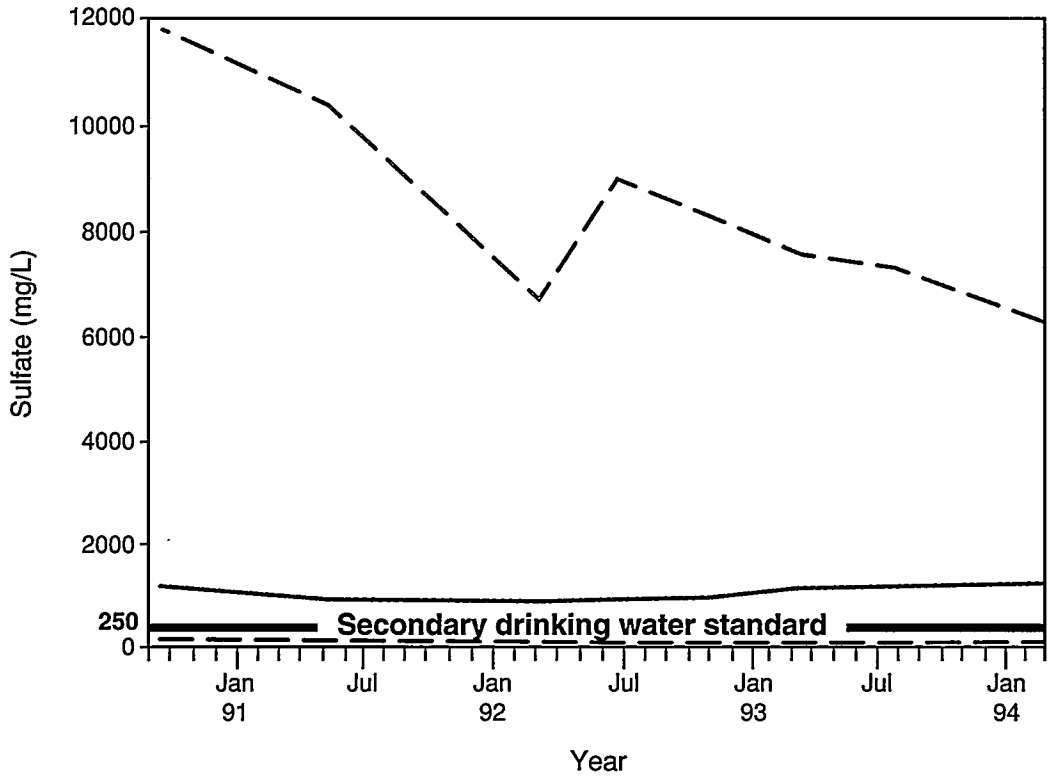
LEGEND

○ 650	Ground water monitoring well location
0.002	Uranium concentration (mg/L), 1994
⇨	Ground water flow direction
(70)	Interstate highway
(6)	U.S. highway
+++	Denver & Rio Grande Western Railroad

1000 0 1000 2000 Feet

ASER95/RFL/URNPLUME

Figure 6-72
Sulfate Concentrations Over Time in the Wasatch Formation, New Rifle Processing Site

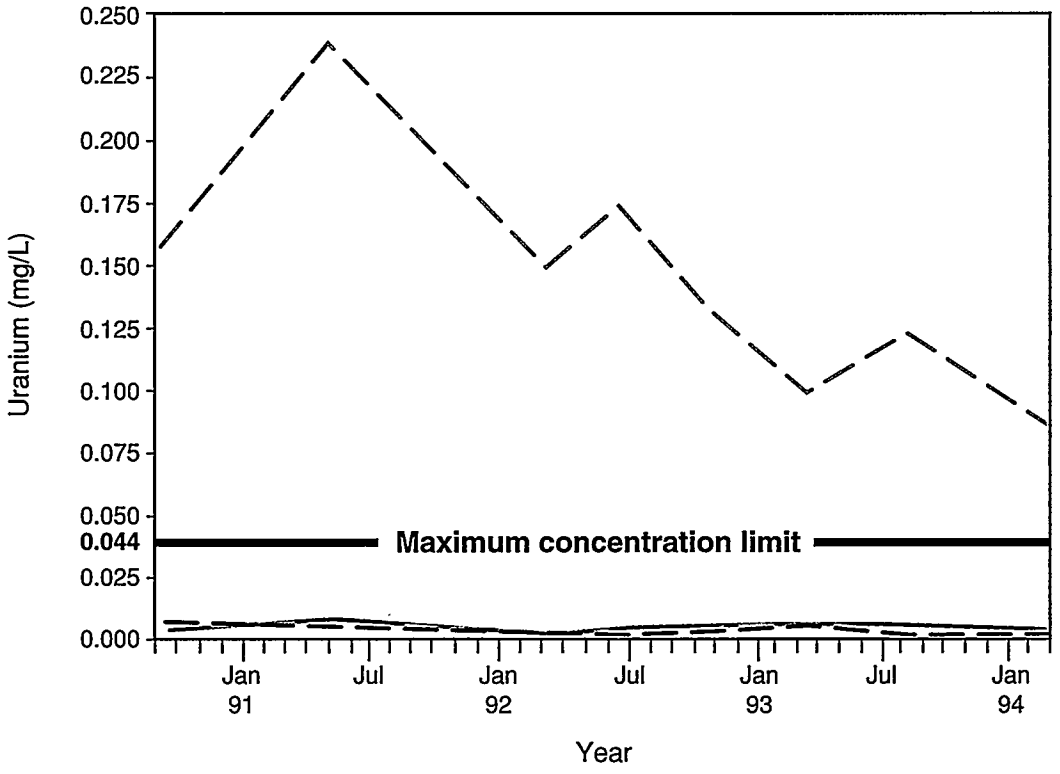


LEGEND

611	Contaminated ground water monitoring well
650	Downgradient ground water monitoring well
641	Background ground water monitoring well

ASER95/RFL/SULCON-611, 641, 650

Figure 6-73
Uranium Concentrations Over Time in the Wasatch Formation, New Rifle Processing Site



LEGEND

— —	611	Contaminated ground water monitoring well
— —	650	Downgradient ground water monitoring well
———	641	Background ground water monitoring well

ASER95/RFL/URNCON-611, 641, 650

Several hazardous constituents, including uranium, continue to be elevated above EPA maximum concentration limits in private wells sampled in 1994 in the New Rifle processing site vicinity. The source of this contamination has been investigated as part of the Rifle baseline risk assessment. The investigation showed that none of the local private wells are affected by site activities with the possible exception of private well 428.

Old Rifle Ground Water Results

Table 6-39 summarizes March and August 1994 ground water quality results for the alluvial aquifer in the Old Rifle processing site vicinity. The table presents results for a background monitoring well (605), a well in the contaminated area (590), and a downgradient monitoring well (600).

Sulfate, total dissolved solids and uranium were selected as indicator parameters because they demonstrate both the probable extent of ground water contamination and how the contamination is traveling.

The concentration ranges presented in *Table 6-39* suggest that Old Rifle site background alluvial ground water is naturally elevated with respect to indicator parameters. The areal extent of those contaminants in the alluvial aquifer at the Old Rifle site is much less extensive than at the New Rifle site. ***Figures 6-74 and 6-75*** show sulfate and uranium distributions within the alluvial aquifer in the Old Rifle site vicinity. Contamination at the Old Rifle site most likely discharges into the Colorado River a short distance downgradient from the site, where Wasatch beds of lower hydraulic conductivity direct ground water toward the river. ***Figures 6-76 and 6-77*** show trends in sulfate and uranium concentrations in the alluvium at Old Rifle over the past 4 years.

Because the underlying Wasatch Formation is much less transmissive than the alluvial aquifer, the extent of contamination in the Wasatch is even more limited. However, very limited ground water sampling was conducted in 1994 in the Wasatch Formation at Old Rifle.

Ground Water Conclusions

Ground water samples collected in 1994 and previous years from wells downgradient of the former processing sites show that former uranium milling activities have impacted alluvial and Wasatch Formation ground water. Total dissolved solids, sulfate, nitrate, and uranium are used to define the areal extent of the contamination because they are found in relatively low concentrations in background ground water, they are chemical by-products of ore processing at the Rifle mill, and they are geochemically nonreactive compounds. Other ground water contaminants of concern are arsenic, molybdenum, net gross alpha, radium-226 and radium-228, and selenium.

Table 6-39 Alluvial ground water quality results, Old Rifle processing site

Indicator parameter	Guideline	Monitoring well location 605 (background)	590 (contaminated area)	600 (downgradient)
Total dissolved solids	500[a]			
03/94		2520	2460	2020
08/94		2300	X	2080
Sulfate	250[a]			
03/94		977	1080	667
08/94		855	X	737
Uranium	0.044[b]			
03/94		0.046	0.110	0.009
08/94		0.042	X	0.009

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Concentrations are reported in milligrams per liter.

X – no sample taken.

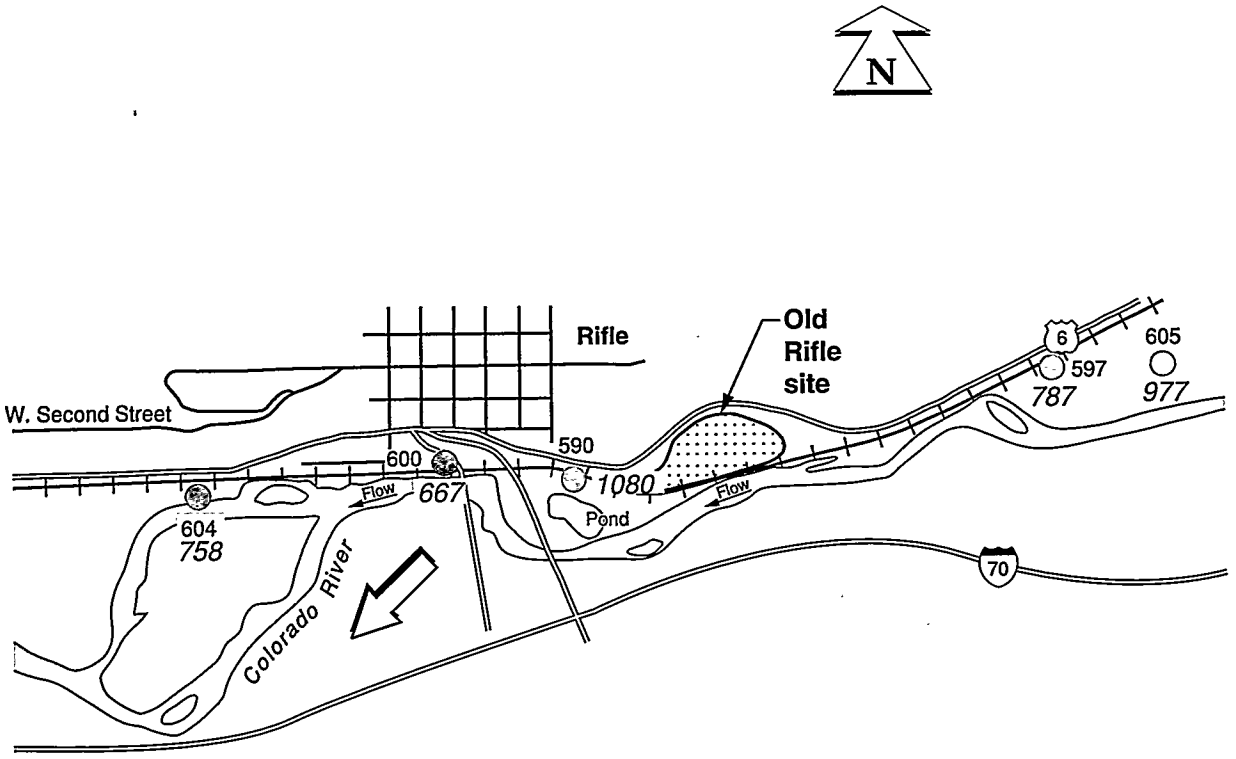
Results of ground water quality sampling in the New Rifle processing site vicinity generally indicate that contaminants continue to migrate southwest and toward the Colorado River.

Several hazardous constituents, including uranium, continue to be elevated above EPA maximum concentration limit in private wells sampled in 1994 in the New Rifle processing site vicinity. The source of this contamination has been investigated as part of the Rifle baseline risk assessment, and it has been determined that the source of contaminants, with the possible exception of well 428, is natural and not due to processing site activities.

Limited sampling in the Old Rifle processing site vicinity indicates that contamination in ground water downgradient of the site is not extensive. Contaminants are most likely discharged into the Colorado River a short distance southwest of the site. The Colorado River may act as a discharge boundary to ground water flow and contaminant transport.

No private wells have been impacted by uranium processing activities in the vicinity of the Old Rifle site.

Figure 6-74
Sulfate Concentrations for the Alluvial Aquifer, Old Rifle Processing Site



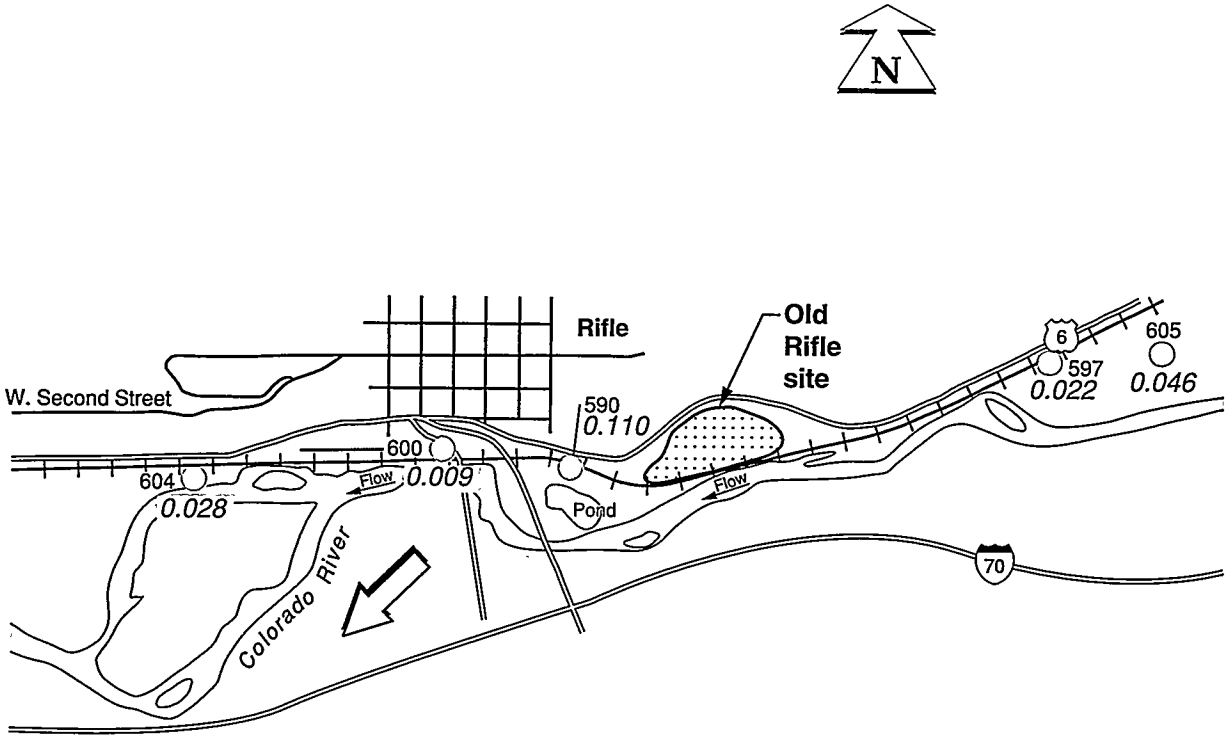
LEGEND

○ 604	Ground water monitoring well
758	Sulfate concentration (mg/L), March 1994
⇨	Ground water flow direction
(70)	Interstate highway
(6)	U.S. highway
+++	Denver & Rio Grande Western Railroad

1000 0 1000 2000 3000 Feet

ASER95/RFL/SULDISOLD

Figure 6-75
Uranium Concentrations for the Alluvial Aquifer, Old Rifle Processing Site



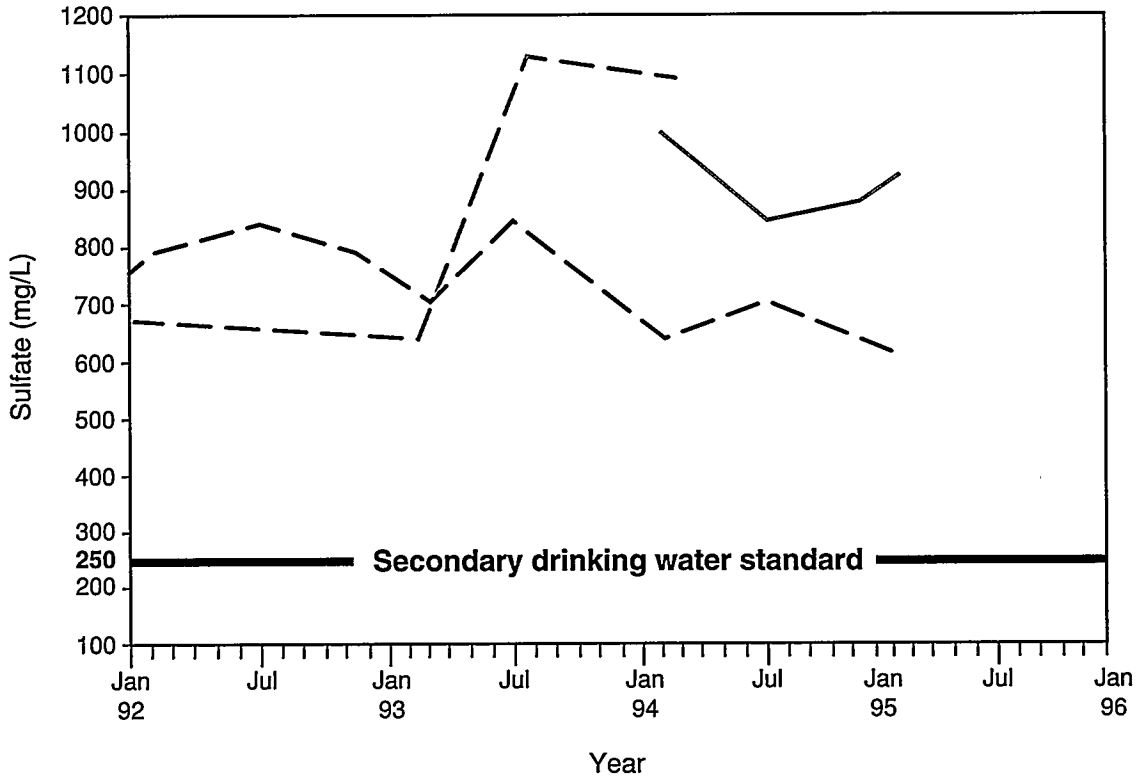
LEGEND

○ 604	Ground water monitoring well
0.028	Uranium concentration (mg/L), March 1994
⇨	Ground water flow direction
(70)	Interstate highway
(6)	U.S. highway
—+—+—	Denver & Rio Grande Western Railroad

1000 0 1000 2000 3000 Feet

ASER95/RFL/URNDISTRIB

Figure 6-76
Sulfate Concentrations Over Time in the Alluvial Aquifer, Old Rifle Processing Site

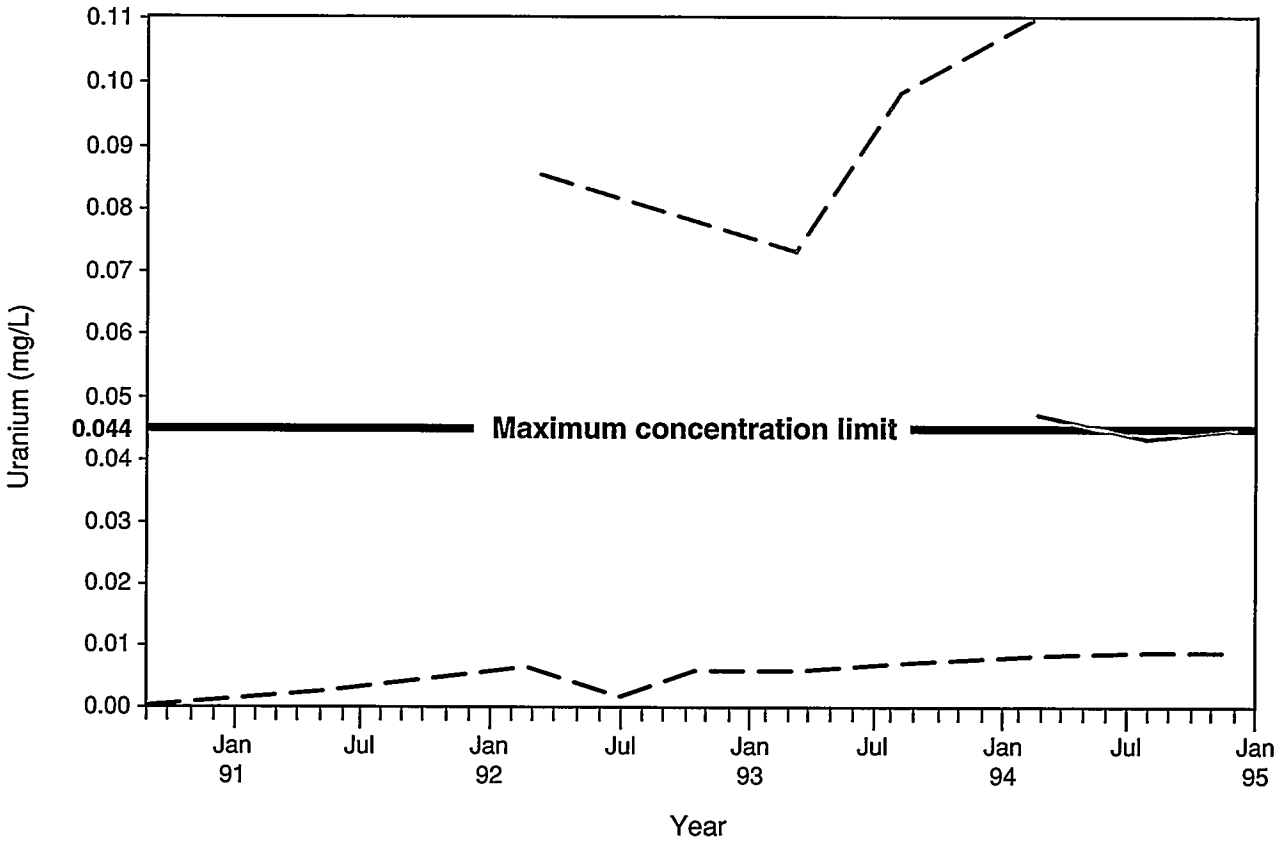


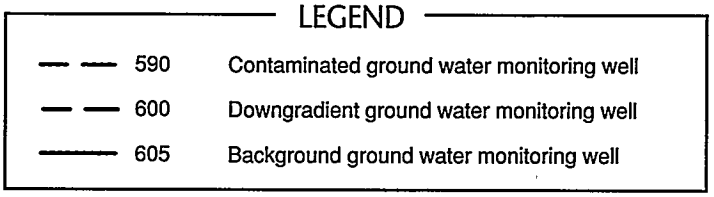
LEGEND

— —	590	Contaminated ground water monitoring well
— —	600	Downgradient ground water monitoring well
———	605	Background ground water monitoring well

ASER95/RFL/SULCON-590, 597, 600

Figure 6-77
Uranium Concentrations Over Time in the Alluvial Aquifer, Old Rifle Processing Site





ASER95/RFL/URNCON-590, 597, 600

Ground water was not monitored at the Estes Gulch disposal site in 1994 because the disposal cell is geologically isolated from the uppermost aquifer.

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SITE DESCRIPTION AND LOCATION

Two processing sites are near Slick Rock, Colorado, along the Dolores River in San Miguel County (*Figure 6-78*). The Union Carbide processing site is approximately 1 mi down river from the North Continent processing site and approximately 2 mi northwest of the Slick Rock, Colorado, post office. The North Continent processing site is approximately 1 mi northwest of the post office. Both sites are partially in the floodplain of the Dolores River. The Dolores River is the only permanent body of water in the area; dry washes are also in the area. The surrounding canyon contains steep cliff faces or steep slopes dominated by desert shrubs.

The major land use in the area is grazing. A gas sweetener plant is next to the Union Carbide site. The population of San Miguel County is approximately 3700 (DOC, 1990). Cultural resources near the processing and disposal sites have been identified and are being addressed during remedial planning (DOE, 1994b).

The climate in the area of the Slick Rock sites is arid. The mean annual precipation is 7 inches. The average annual snowfall is approximately 30 inches.

SITE HISTORY AND OWNERSHIP

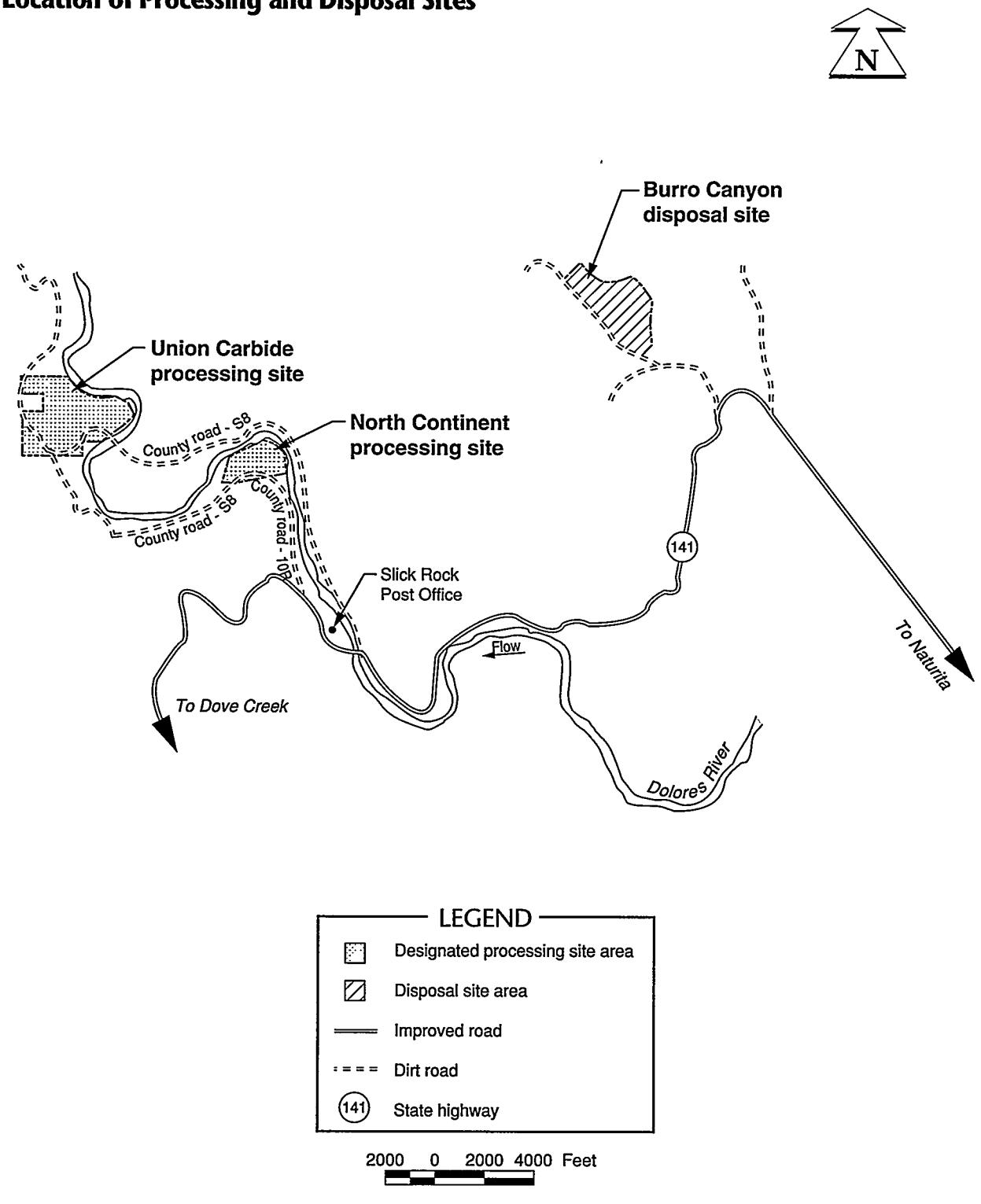
Historical records show evidence of milling activity at the Union Carbide site at the turn of the century. The mill became operational again in September 1957 and ceased operation in December 1961. Ore containing uranium and vanadium was mined in the Slick Rock area and trucked to the mill. The ore was upgraded, then trucked to a Union Carbide mill in Rifle, Colorado.

After the mill closed in 1961, the tailings pile was covered with 6 inches of soil and vegetated. All mill buildings have been removed from the site, although their concrete foundations remain. The original off-site recreational building and dormitory also still remain. San Miguel County has constructed a volunteer fire station on the Union Carbide site. Mobile homes have been removed from an off-site trailer park near the tailings pile; the off-site gas sweetener plant is currently occupied but is nonoperational.

Windblown contamination from the tailings left on the site extends downriver and across the mesa from the Union Carbide site. Seepage from the Union Carbide tailings pile has contaminated the shallow ground water in the alluvium beneath the pile. An estimated volume of 533,500 cubic yards of contaminated materials cover an estimated 92 ac of the Union Carbide site.

The original owner of the North Continent site, Shattuck Chemical Company, began operations in 1931. North Continent Mines, Inc. acquired the site in 1934. Title was subsequently passed through several other companies, and eventually to Umetco, the current owner, in 1957. The North Continent site was operated until the early 1960s.

Figure 6-78
Location of Processing and Disposal Sites



ASER95/SRK/SITELOC

The pile was covered with 6 inches of soil and vegetation. Seepage from the North Continent tailings pile has contaminated the shallow ground water in the alluvium beneath the site. There are no structures on the North Continent site. Contaminated materials at the North Continent site cover approximately 33 ac and have an estimated volume of 84,800 cubic yards.

The disposal site will be located on Bureau of Land Management-administered land in Burro Canyon approximately 5 mi east of the North Continent site. The area is used by ranchers for grazing cattle about 7 months of the year. The surrounding area is public land administered by the Bureau of Land Management that is used primarily for grazing, hunting, and other recreational uses, with occasional mineral development as market conditions warrant. Approximately 44 ac would be removed from future use.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Slick Rock sites is scheduled to begin in the spring of 1995. The planned action is to remove, relocate, and consolidate tailings-contaminated materials associated with the Union Carbide and North Continent sites in a disposal cell at Burro Canyon. This would affect approximately 125 ac of surface area at the sites. The disposal cell will be excavated and prepared for the emplacement of contaminated materials. The sites will be excavated to remove contaminated materials, and the materials will be transported by truck to the disposal cell. The disposal cell will be covered with a natural material, multicomponent cover. Maintenance of the cover will be detailed in a long-term surveillance plan.

Remedial action activities will require at least one temporary staging area for construction operations. The staging area will house several trailer offices, a fuel farm, and a parking area for employee vehicles and heavy earth-moving equipment. The location of the staging area will be determined by the Remedial Action Contractor and its subcontractors prior to remedial action.

Approximately 618,000 cubic yards of contaminated materials from both sites will be removed from the land surface and excavated to a depth protective of the public and the environment. The disposal cell will cover an area approximately 610 ft wide and 905 ft long along the southwest face of the mesa. The cell will include a radon barrier and an erosion protection layer. The height of the cell will range from 30 ft to 50 ft above the existing ground surface. The base of the cell will be excavated and compacted to prepare for placement of the contaminated materials. The remaining material will be left on the site, graded, and reseeded.

ENVIRONMENTAL COMPLIANCE STATUS

With site remedial action scheduled to begin in the spring of 1995, the UMTRA Project at Slick Rock will comply with federal and state regulations. Remedial action activities will be continuously evaluated

for their environmental impact and to ensure that they meet applicable regulatory requirements. In 1994, applications were made for a 404 dredge and fill permit (199575020) and a Colorado surface water discharge permit (in progress) for the processing sites.

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are analyzed to evaluate the ground water contamination resulting from processing site activities. In addition, sample results are evaluated for compliance with EPA ground water standards.

National Environmental Policy Act

Comments were received on the Slick Rock environmental assessment from the Bureau of Land Management, State of Colorado, and the U.S. Fish and Wildlife Service, along with comments from the Remedial Action Contractor and the DOE. The Slick Rock environmental assessment was revised where necessary as a result of these comments. The draft finding of no significant impact for the Slick Rock environmental assessment was also prepared. These documents were finalized near the end of 1994 and will be published in early 1995.

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of the 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Slick Rock UMTRA site.

Endangered Species Act

Surveys for threatened and endangered species were conducted at the Slick Rock sites in 1994. The biological assessment for this site was revised in 1994. The previous version of the biological assessment had been sent in 1993 to the U.S. Fish and Wildlife Service, which returned its biological opinion in August 1993. Because remedial action did not begin within 180 days of receipt of that opinion, consultation with the U.S. Fish and Wildlife Service had to be reinitiated.

A 24 May 1994 letter from the U.S. Fish and Wildlife Service indicated that critical habitat for the endangered fish of the Upper Colorado River Basin had been identified. The letter also indicated that the southwestern willow flycatcher had been proposed as an endangered species. The biological assessment was accordingly revised. It was determined that remedial action had the capability to affect the critical habitat of the endangered fish of the Upper Colorado River Basin. Because the southwestern willow flycatcher does not occur at or near the Slick Rock sites, it was determined that there would be no impact on the species. However, since potential habitat exists, a survey for the southwestern willow flycatcher will be conducted in 1995. The revised biological assessment was finalized

toward the end of 1994 and will be sent to the U.S. Fish and Wildlife Service in early 1995.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program for contaminants at the Slick Rock site. The purpose of the program is to monitor quantities of radiological and nonradiological hazardous constituents for the following reasons: to ensure protection of human health and the environment, to comply with regulatory guidelines, and to support site characterization activities. In 1994, surface water and ground water were sampled at the Slick Rock site.

Because surface remedial action at the Slick Rock site has not yet begun, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

Surface Water Monitoring

Surface water and sediment samples were collected at four locations, 692, 693, 694, and 696, along the Dolores River (***Figure 6-79***). The purpose of the sampling event was to evaluate the processing sites' impact on surface water and to support a baseline risk assessment. All surface water samples were analyzed for the following parameters:

- Field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, dissolved oxygen, turbidity, and temperature.
- Laboratory parameters: cadmium, calcium, dissolved organic carbon, magnesium, molybdenum, nitrate, selenium, total organic carbon, uranium, vanadium, and zinc.

All sediment samples were analyzed for cadmium, molybdenum, selenium, uranium, vanadium, and zinc.

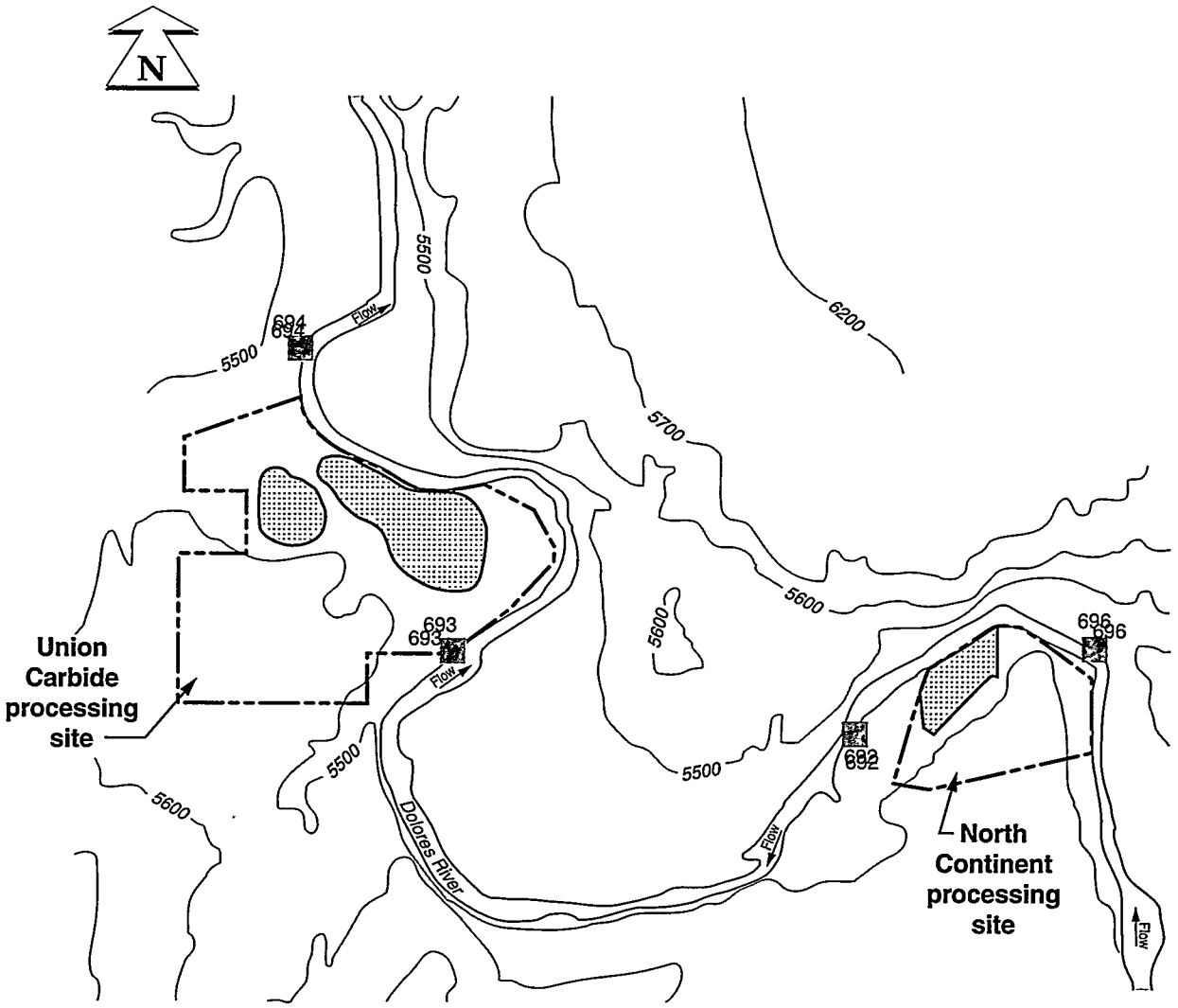
Surface Water Results and Conclusions

Uranium was used as an indicator parameter for surface water because it is the constituent most likely related to uranium processing at the site. The surface water concentrations of uranium are presented in ***Table 6-40***. The uranium concentrations in samples from locations 693, 694, and 696 were at or below the detection limit of 0.001 mg/L. The sample collected immediately downstream from the North Continent processing site, location 692, had a uranium concentration of 0.003 mg/L. These levels are well below the EPA maximum concentration limit for uranium of 0.044 mg/L. Surface water quality may be slightly impacted by tailings at the Slick Rock site, but only in the immediate vicinity of the North Continent processing site.

Ground Water Monitoring

Ground water was sampled in February 1994 at the Slick Rock processing sites to support baseline risk assessment efforts and monitor site-related contamination. Ground water was also sampled at the Burro Canyon disposal site in February and April 1994 to characterize water quality prior to construction of the disposal cell.

Figure 6-79
Surface Water Sampling Locations, North Continent and Union Carbide Processing Sites



LEGEND

696 ■	Surface water and sediment sampling location (approximate)
- - -	Designated site boundary
◯	Tailings pile
–5500–	Land surface elevation contour

1000 0 1000 Feet

ASER95/SRK/SURFACE WATER

Table 6-40 Uranium concentrations in surface water

Dolores River Sample Location	Uranium Concentration[a] (mg/L)
692	0.003
693	0.001
694	0.001
696	<0.001

[a]Maximum concentration limit is 0.004 mg/L.
Data collected in February 1994.

Three water-bearing units underlie the Slick Rock processing sites. From shallowest to deepest, they are the Dolores River alluvium, the Entrada Formation, which includes the Slick Rock and Dewey Bridge Members, and the Navajo Sandstone. The Dolores River alluvium is composed of unconsolidated clayey sands, sandy gravels, and cobbles. It occurs from the ground surface to a depth of approximately 20 ft at both the Union Carbide and North Continent sites.

The Entrada Formation underlies the Dolores River alluvium and crops out in the area of both tailings piles. Two members of the Entrada Formation are present, the Slick Rock Member and the Dewey Bridge Member. The Slick Rock Member underlies the alluvium at the North Continent site and is composed of eroded light brown fine-grained sandstone and reddish brown sandy shale. The Dewey Bridge Member underlies the Slick Rock Member at the North Continent site and directly underlies the alluvium at the Union Carbide site where the Slick Rock Member is absent. The Dewey Bridge Member consists reddish-brown clayey siltstone, fine-grained sandstone, and shale.

The Navajo Sandstone underlies the Entrada Formation and is composed of light-brown to reddish-brown fine-grained sandstone.

Ground water is unconfined in the Dolores River alluvium and semiconfined to confined in the Entrada and Navajo Formations. The depth to water in the alluvium at both processing sites is 5 to 20 ft. The alluvium and the upper portions of the Entrada Formation are believed to be hydraulically connected, based on well log data and ground water levels. Ground water in the Dolores River alluvium, which is hydraulically connected to the river, generally flows down the axis of the river.

Ground water at the Burro Canyon disposal site occurs in the upper, middle, and lower sandstone units of the Burro Canyon Formation. The sandstone layers consist of fine- to medium-grained sandstone 25 to 75 ft thick. The sandstone layers are hydraulically separated from

each other by thick interbedded claystone, mudstone, and siltstone sequences. Ground water in the upper sandstone is unconfined, and depth to water is approximately 75 to 110 ft. Ground water in the middle and lower sandstones occurs under confined conditions.

Monitoring wells at the processing sites provide representative ground water samples from on-site and downgradient areas in the alluvium, Entrada and Navajo Formations (***Figure 6-80***). Monitoring wells at the Burro Canyon disposal site provide baseline water quality data for the Burro Canyon Formation sandstones (***Figure 6-81***).

A total of 47 ground water locations were scheduled to be sampled during the 1994 sampling events. Ground water sampling locations included 8 monitoring wells at the North Continent site, 19 wells in the vicinity of the Union Carbide site, 16 wells at the Burro Canyon disposal site, 3 domestic wells, and 1 seep in the Entrada Formation.

All ground water samples were analyzed for the following parameters:

- Field parameters: alkalinity, dissolved oxygen, oxidation-reduction potential, pH, specific conductivity, turbidity, and temperature.
- Laboratory parameters: barium, boron, cadmium, calcium, chloride, chromium, dissolved organic carbon, gross alpha and beta, iron, lead-210, magnesium, manganese, molybdenum, polonium-210, potassium, radium-226, radium-228, selenium, silica, sodium, strontium, sulfate, thorium-230, total dissolved solids, uranium, vanadium, and zinc.

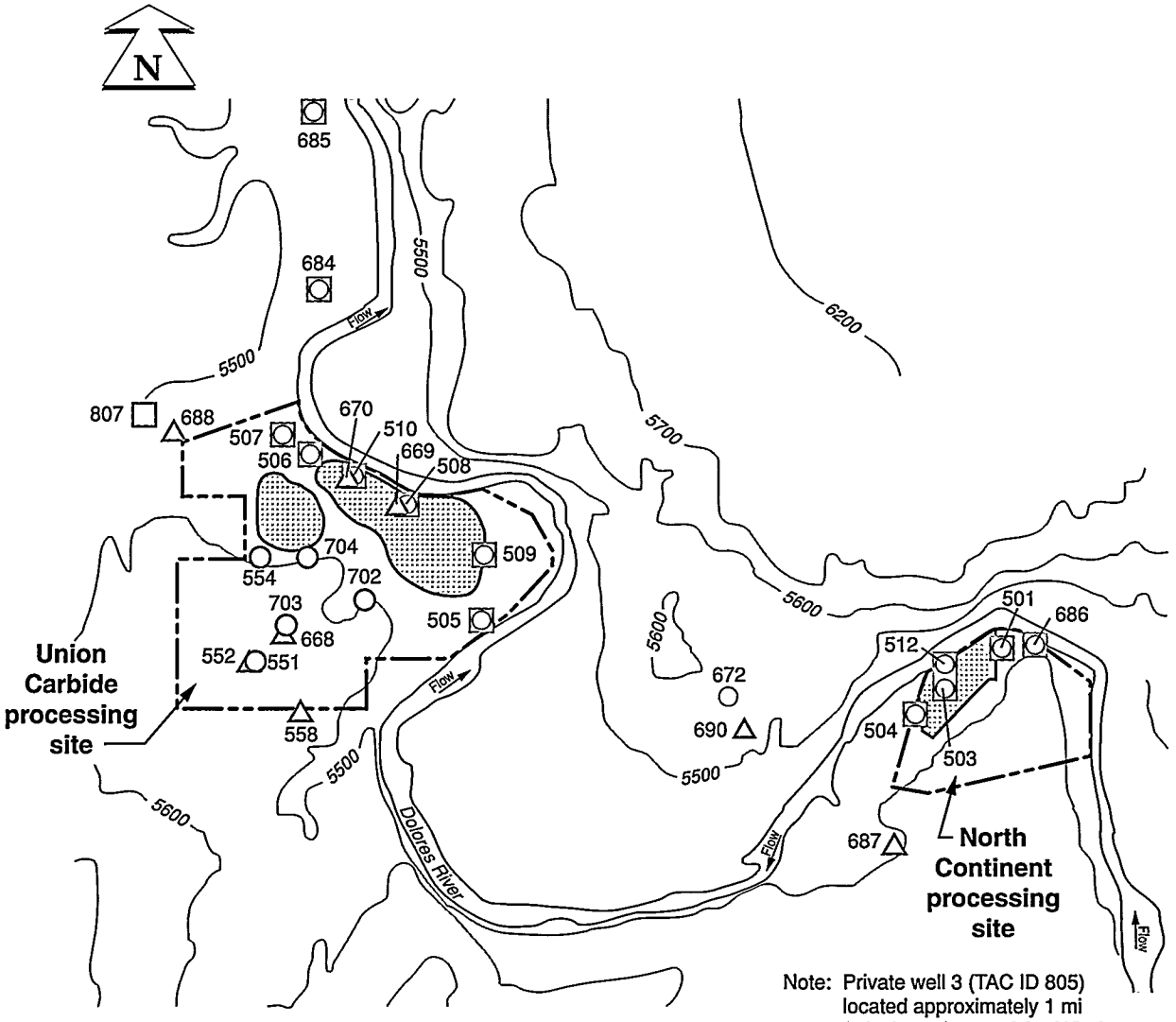
Depth to ground water was measured in all monitoring wells during the 1994 sampling event. Water-level elevation maps in the vicinity of the processing sites for the Dolores River alluvium, the Entrada Formation, and the Navajo Sandstone are presented in ***Figures 6-82, 6-83, and 6-84***.

Ground Water Results

Uranium was used as an indicator parameter at the Slick Rock site because it is related to processing activities at this site. ***Table 6-41*** presents the uranium concentrations in ground water for samples collected from the Dolores River alluvium completed monitoring wells.

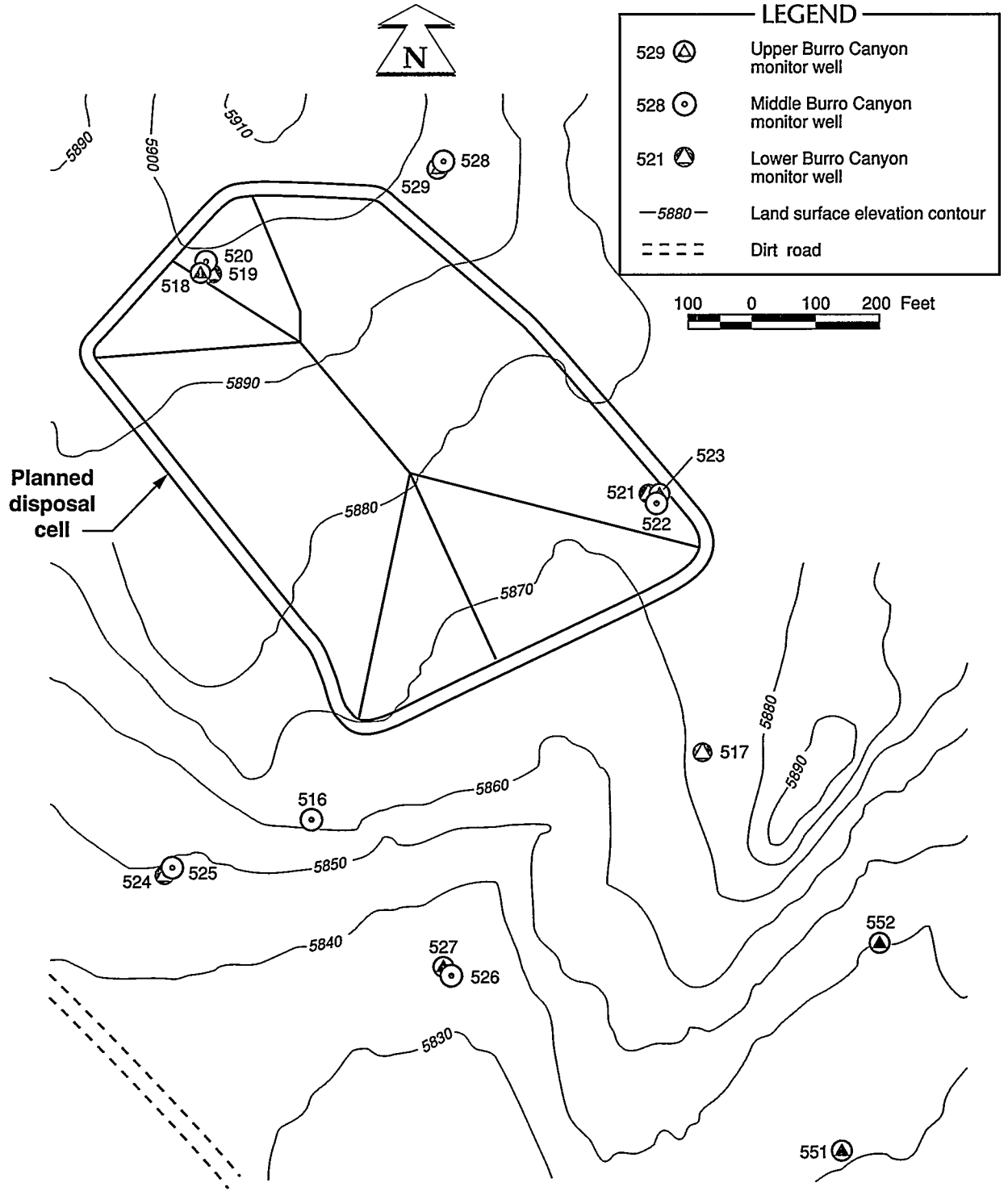
The distribution of uranium in ground water of the Dolores River alluvium is shown in ***Figure 6-85***. Uranium was detected at concentrations above the EPA maximum concentration limit of 0.044 mg/L in the Dolores River alluvium monitoring wells 503, 504, 506, 508, and 512. Uranium was not detected at levels above the maximum contaminant level in any samples from wells completed in the Entrada Formation or the Navajo Sandstone. All ground water samples which exceeded the EPA maximum concentration limits were from wells installed on or adjacent to the tailings piles. Uranium

Figure 6-80
Ground Water Quality Sampling Locations, North Continent and Union Carbide Processing Sites



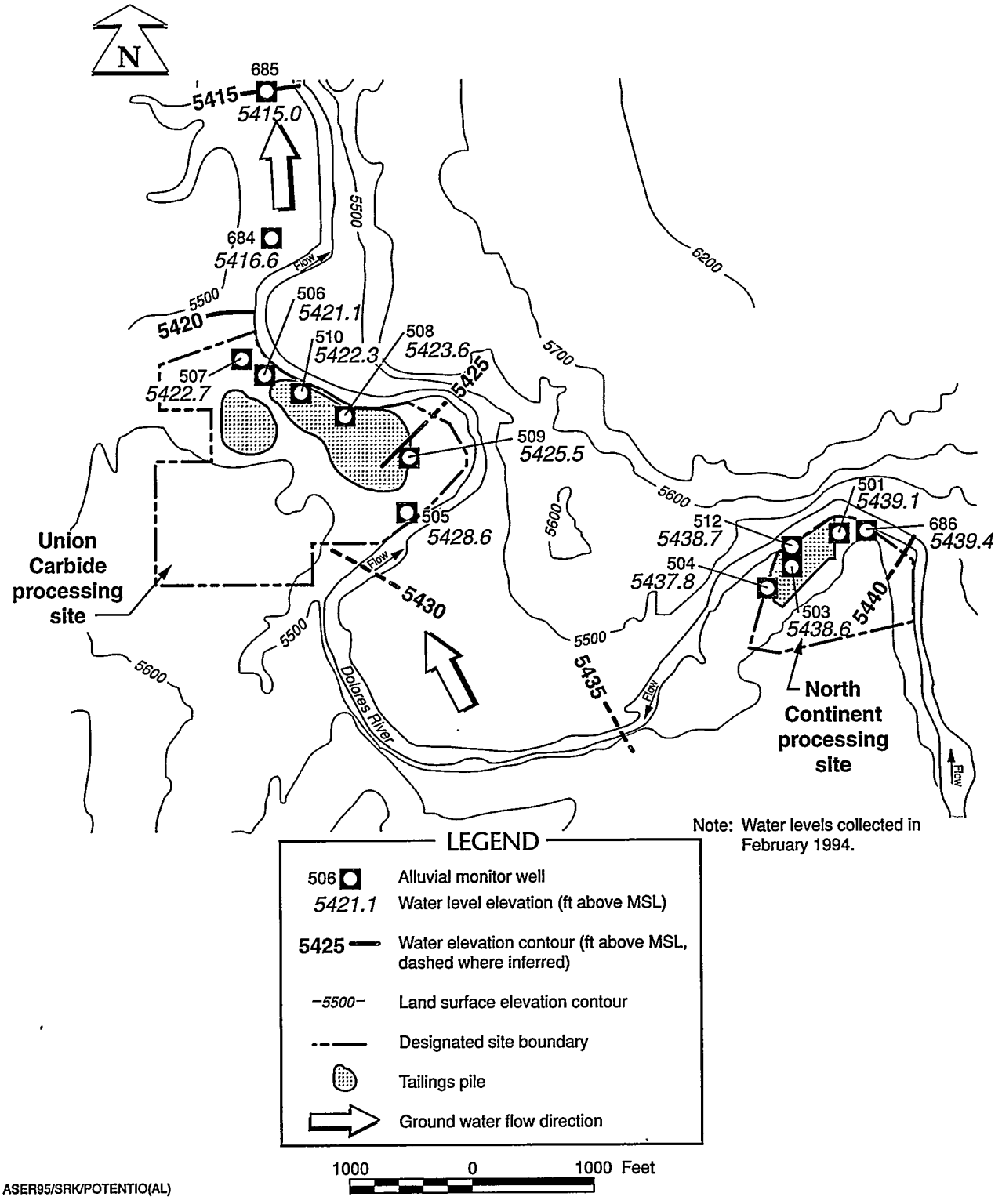
ASER95/SRK/WATQUAL

Figure 6-81
Location of Monitor Wells, Burro Canyon Disposal Site



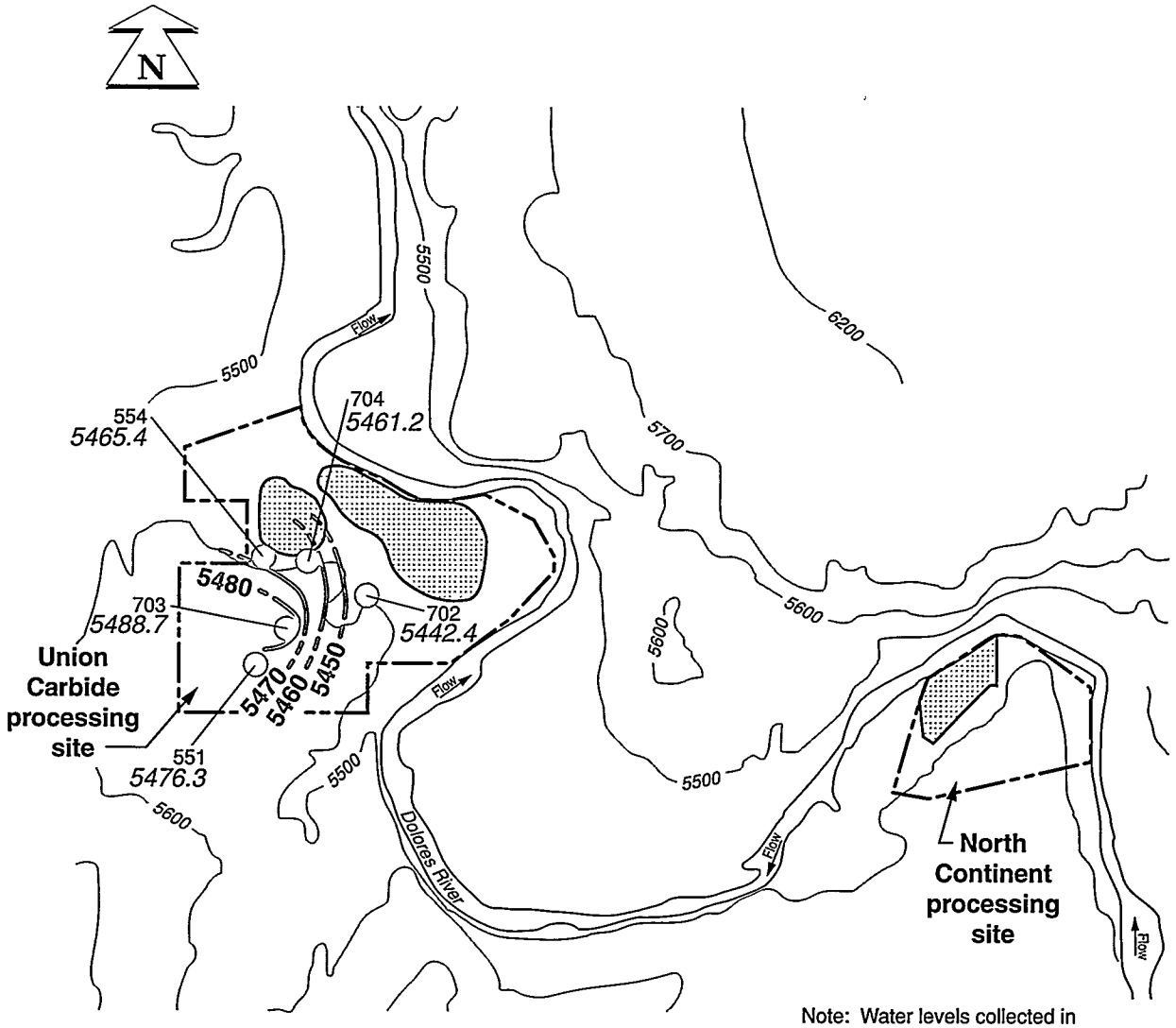
ASER95/SRK/MONWELLOCS

Figure 6-82
Potentiometric Surface for the Dolores River Alluvium, North Continent and Union Carbide Processing Sites



ASER95/SRK/POTENTIO(AL)

Figure 6-83
Potentiometric Surface for the Entrada Formation, North Continent and Union Carbide Processing Sites



Note: Water levels collected in February 1994 at the UC site.

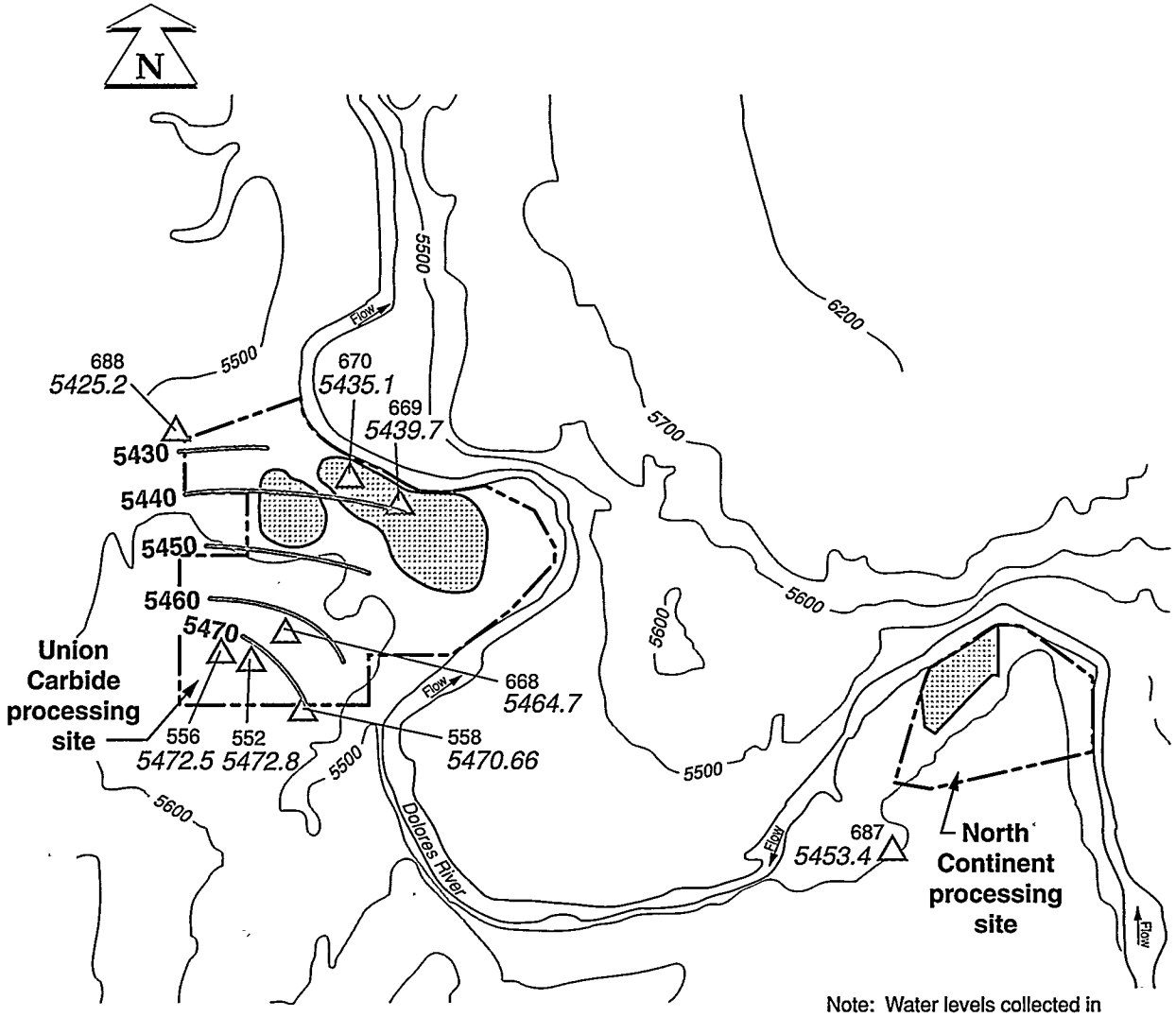
LEGEND

○ 702	Entrada sandstone monitor well
5442.4	Water level elevation (ft above MSL)
5470	Water elevation contour (ft above MSL, dashed where inferred)
–5500–	Land surface elevation contour
	Designated site boundary
	Tailings pile

1000 0 1000 Feet

ASER95/SRK/POTENTIO(ENT)

Figure 6-84
Potentiometric Surface for the Navajo Sandstone, North Continent and Union Carbide Processing Sites



ASER95/SRK/POTENTIO(NAV)

Table 6-41 Uranium concentrations in ground water of the Dolores River alluvium

Monitoring well	Uranium concentration[a] (mg/L)
501	0.033
503	3.86
504	3.33
505	0.025
506	0.238
507	0.015
508	0.133
509	0.025
510	0.167
512	0.232
684	0.009
685	0.02

[a]Maximum concentration limit is 0.044 mg/L.
Data collected in February 1994.

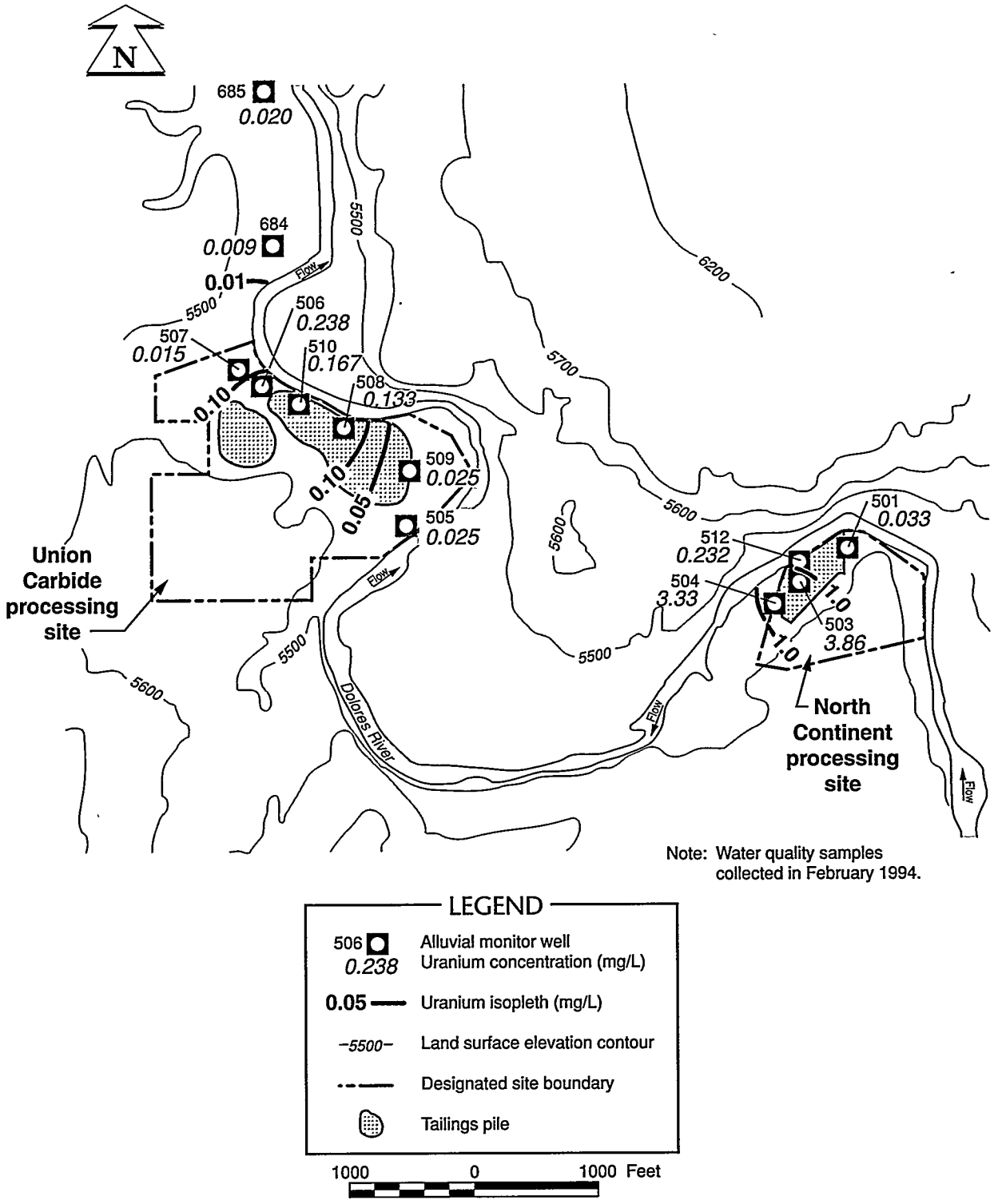
concentrations in ground water of the alluvium decrease rapidly immediately downgradient of the tailings piles.

Ground Water Conclusions

Ground water in the Dolores River alluvium flows down the axis of the Dolores River (***Figure 6-82***). Ground water in the Entrada Formation and the Navajo Sandstone flows to the east and north respectively (***Figures 6-81 and 6-82***). Ground water flow patterns at the Slick Rock site have remained fairly constant over time.

Uranium concentrations in water samples from monitoring wells 503, 504, 506, 508, and 512 (***Figure 6-80***) exceed the EPA maximum concentration limit, indicating that the tailing piles have impacted ground water quality at the site. The shallow ground water in the Dolores River alluvium is a pathway for contaminant migration. However, uranium concentrations in shallow ground water are greatly reduced immediately downgradient of both tailings piles, and migration of uranium into the underlying Entrada Formation and Navajo Sandstone has not been identified. Removal of the tailings from the former processing sites and transport to the Burro Canyon disposal site is scheduled to begin in the spring of 1995. Transport of the tailings to the disposal site will remove the source of contamination for the alluvium ground water, and uranium concentrations should return to background levels after a period of natural flushing.

Figure 6-85
Uranium Concentrations in Alluvial Ground Water, North Continent and Union Carbide Processing Sites



ASER95/SRK/URNCON

ECOLOGICAL MONITORING

Wetlands mitigation

The wetlands at and near the Union Carbide and North Continent Slick Rock sites were remapped in 1994. A USACE biologist toured the site and agreed with the wetlands mapping. It was determined that there are about 59 ac of riparian plant communities in the contaminated zone at both sites. Supplemental standards would likely be applied to a 17-ac area across the Dolores River from the Union Carbide site, which would not be disturbed.

The remaining 42 ac of riparian plant communities would be disturbed. Of this 42 ac, 10 ac along the river is dominated by willow and salt cedar. This riparian shrub plant community is under the jurisdiction of the USACE and San Miguel County. A 404 Permit and a County Wetlands Special Use Permit will be required to disturb the area. The remaining riparian plant communities do not meet the wetland hydrology and soils criteria as stipulated by the USACE and therefore are not USACE jurisdictional wetlands.

Threatened and endangered species

Surveys for threatened and endangered species were conducted at the Slick Rock sites, the Burro Canyon disposal site, and Disappointment Valley borrow site in 1994. In 1994, it was determined that a prairie dog town covered most of the land at the Burro Canyon disposal site and another town was just north of the proposed Disappointment Valley barrow site. The town at the disposal site appeared to be mostly abandoned, but some limited activity was noted. For this reason, a black-footed ferret survey was conducted at the Burro Canyon and Disappointment Valley sites in October, 1994. U.S. Fish and Wildlife Service guidelines for conducting such a survey were followed and neither the black-footed ferret nor its sign was observed.

Surveys for the southwestern willow flycatcher were conducted again in 1994. Surveys in 1990 and 1991 did not record this species in the area of the sites. The 1994 survey area consisted of a 16-mi stretch of the Dolores River up and down river from the sites. Additional surveys were also conducted in the 1-mi stretch of river encompassing both sites. The southwestern willow flycatcher was neither heard or observed during these surveys.

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40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants,* U.S. Environmental Protection Agency.

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings,* U.S. Environmental Protection Agency.

DOE Order

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United States Code

16 USC §1531 *et seq., Endangered Species Act.*

33 USC §1251 *et seq., Clean Water Act.*

42 USC §4321 *et seq., National Environmental Policy Act.*

42 USC §6901 *et seq., Resource Conservation and Recovery Act.*

42 USC §7401 *et seq., Clean Air Act.*

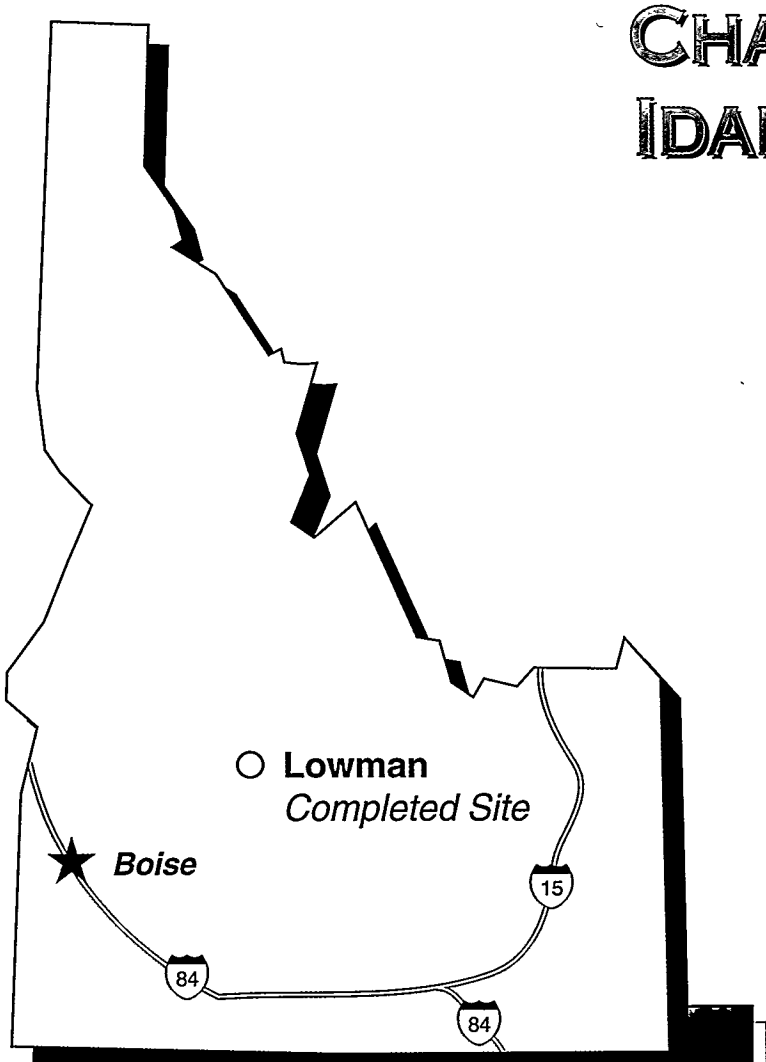
42 USC §9601 *et seq., Comprehensive Environmental Response, Compensation, and Liability Act.*

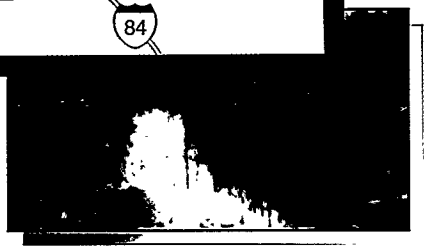
42 USC §11001 *et seq., Emergency Planning and Right-to-Know Act.*

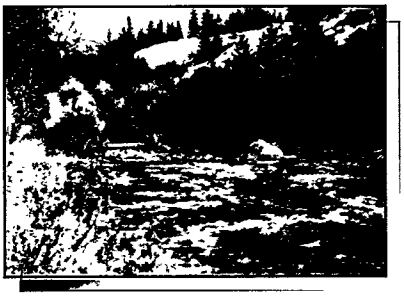
49 USC §1801 *et seq., Hazardous Materials Transportation Act.*

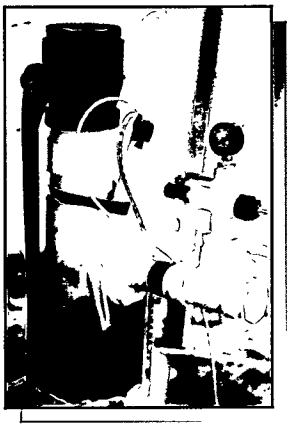
UMTRA PROJECT

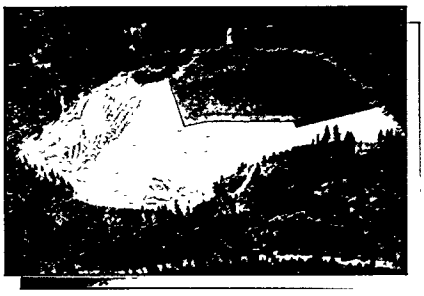
CHAPTER 7
IDAHO SITE











SITE DESCRIPTION AND LOCATION

The Lowman UMTRA Project site is on Clear Creek in the South Fork Payette River drainage basin in the western slope of the Sawtooth Range. he area immediately around the site is mountainous. The steep, heavily forested slopes are part of the Boise National Forest. The disposal cell covers about 9 ac of the 18-ac site. The east and south boundaries of the generally west-sloping site follow a ridge top. The site ranges from about 3850 ft above MSL at the entrance gate to about 4200 ft above MSL on the ridge top at the northeast corner of the site.

The estimated population of Boise County, Idaho, is 3509 (DOC, 1990).

Dry, warm summers and cold winters characterize the Lowman site. The varied topography of the region creates considerable differences in weather. Temperature and precipitation vary mostly with elevation, and the local topography significantly influences wind flow.

The nearest weather station is in the village of Lowman, about 0.5 mi from the site. From 1951 through 1973, the average annual maximum and minimum temperatures in Lowman were 60 °F and 27 °F. Temperature extremes for this period ranged from -35 °F to 107 °F. Temperatures below freezing are reported throughout the year.

SITE HISTORY AND OWNERSHIP

Between 1955 and 1960, the Porter Brothers Corporation of Boise, Idaho, operated the Lowman mill site to recover columbite/euxenite and monazite concentrates. Approximately 200,000 tons of dredge concentrates were processed at this site. Final concentrates were sent to the Mallinckrodt Chemical works at Hematite, Missouri. Radioactive sands with low-leachability characteristics remained at the site and were placed in the disposal cell during surface remedial action.

The Lowman site contained residual radioactive material (radioactive sands, concrete structures, rubble from the mill buildings, and soil) transported from the site by wind and runoff water. However, the heavily forested areas east and south of the site show no signs of radioactive contamination.

The state of Idaho acquired 37 ac of land for the disposal site from NWI Land Management Corporation. With site remediation complete, title to the disposal site is being processed for transfer from the state to the federal government under DOE jurisdiction. Title transfer is required under Section 104 (f)(B) of UMTRCA (42 USC §7901 *et seq.*).

SITE CHARACTERIZATION AND CLEANUP

When UMTRA remedial action was completed at the Lowman site, 129,400 cubic yards of residual radioactive material, including material from the site and all vicinity properties, had been relocated to a disposal cell. The disposal cell is capped with a radon/water

infiltration barrier. Because it was determined the site would revegetate itself naturally over time, the site was not seeded. To prevent destruction of the existing riparian habitat, supplemental standards under 40 CFR 192 Subpart C were applied to the areas adjacent to Clear Creek. Supplemental standards were also applied north of the windblown area to avoid the environmental harm that could result from removing the residual radioactive material.

ENVIRONMENTAL COMPLIANCE STATUS

The Lowman site was licensed by the NRC under the provisions of 10 CFR Part 40 when the NRC accepted the final long-term surveillance plan (DOE, 1994; NRC, 1994).

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval for publication and distribution for public review. Public hearings regarding the draft programmatic environmental impact statement will be held in 1995.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program for radiological and nonradiological materials in surface water and ground water. This program monitors the amount of radioactive and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action complete, air and gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

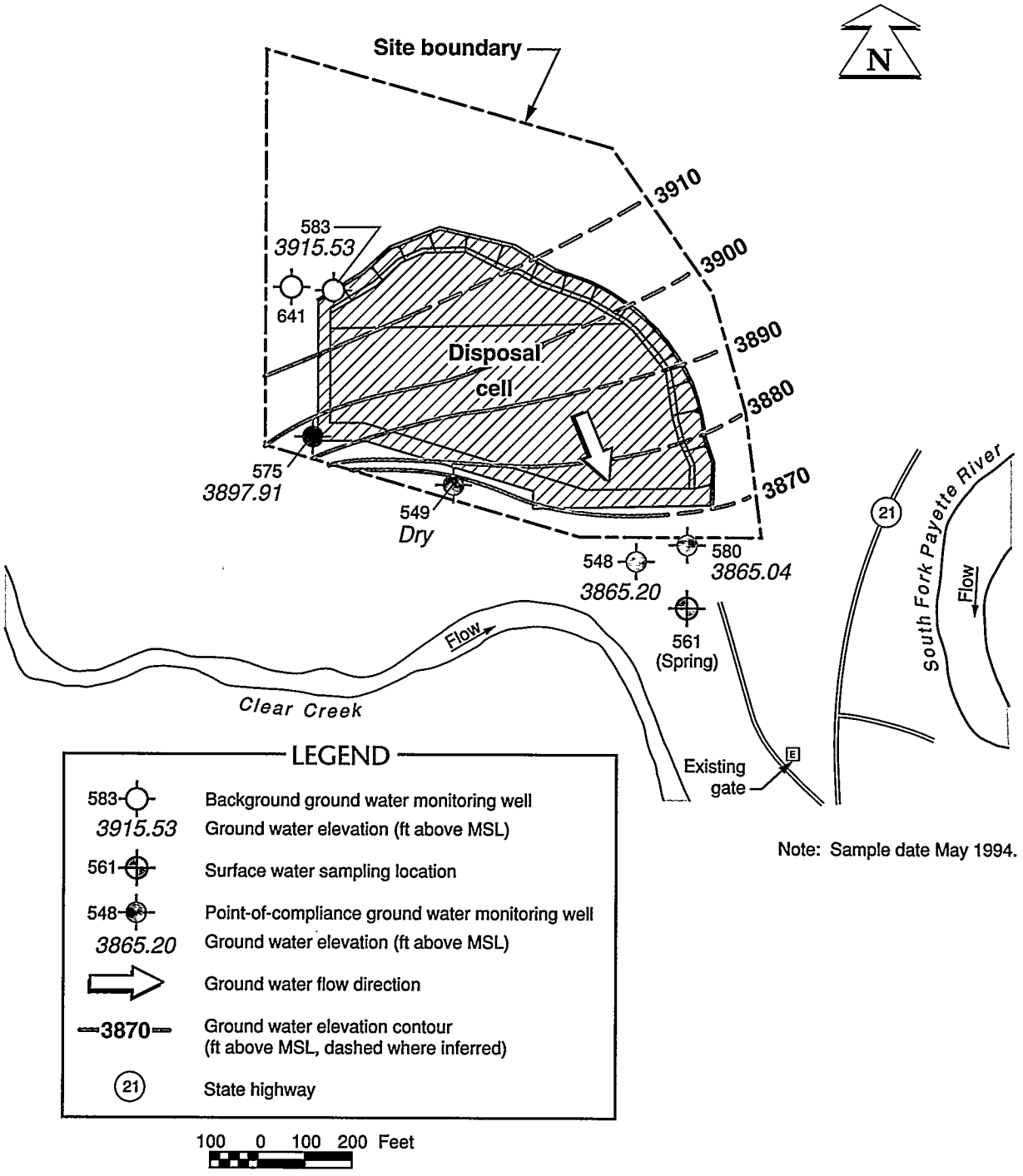
Surface Water Monitoring

In May 1994, surface water samples were collected from an on-site perennial spring near the southwest corner of the disposal cell (location 561). While technically regarded as a surface water location, spring 561 is considered a natural discharge point for shallow ground waters. ***Figure 7-2*** shows the location of spring 561 in relation to the disposal cell. Parameters selected for analysis included antimony, barium, chromium, lead, molybdenum, nitrate, uranium, and radionuclides.

Surface Water Results and Conclusions

Table 7-1 lists the analytical values for antimony (the indicator parameter), barium, and nitrate for the May 1994 sampling event. Antimony is considered an indicator parameter as well as a hazardous constituent because pore fluids collected from the tailings sand during site characterization exceeded the statistical maximum for background ground water quality. Barium and nitrate values are included as indicator parameters in ***Table 7-1*** because they were detected in tailings sand pore fluids collected during site characterization.

Figure 7-2
Surface Water and Ground Water Sampling Locations and Potentiometric Surface, Disposal Cell



Note: Sample date May 1994.

MAC: ASER95/LOW/POTENTIO

Table 7-1 Surface water quality results (surface location 561)

Indicator parameter	Guideline	Date	Concentration
Antimony	0.006	05-94	<0.003
Barium	1	05-94	0.11
Nitrate	44	05-94	7.7

Note: 1. Guideline is the maximum concentration limit for barium and nitrate, and Federal Primary Drinking Water Standard for antimony. Concentrations are reported in milligrams per liter.
< indicates value is less than number shown.

Sampling results indicate these sampled parameters are below EPA maximum concentration limits and background concentrations. Some values (such as antimony) are below the laboratory analytical detection limit.

Surface water quality at location 561 is not adversely affected by the disposal cell or by past uranium processing activities.

Ground Water Monitoring

Ground water beneath the Lowman site occurs in the basal portion of the surficial alluvium, in shallow weathered granodiorite bedrock, and within fractures that penetrate the unweathered, deeper portions of the granodiorite bedrock. In May 1994, ground water samples were collected from two background monitoring wells upgradient of the disposal cell and four monitoring (point-of-compliance) wells downgradient of the disposal cell. Parameters selected for analysis include antimony, barium, chromium, lead, molybdenum, nitrate, uranium, and radionuclides.

Ground Water Results and Conclusions

Figure 7-2 shows ground water sampling locations and the potentiometric surface of the disposal site in May 1994. These locations represent the long-term surveillance ground water monitoring network (upgradient monitoring wells 641 and 583, and downgradient point-of-compliance monitoring wells 548, 549, 575, and 580).

Analytical values for antimony (the indicator parameter), barium, and nitrate for the May 1994 sampling event are listed in ***Table 7-2***. Antimony is considered an indicator parameter and a hazardous constituent because pore fluids collected from the tailings sand during site characterization exceeded the statistical maximum for background ground water quality. Nitrate and barium values are included in ***Table 7-2*** because they consistently exceed laboratory detection limits in ground water samples and were detected in tailings sand pore fluids collected during site characterization. Nitrate and barium are easily detected and monitored in the site area.

Table 7-2 Ground water quality results, Lowman site

Indicator parameter[a]	Guideline	Monitoring well 583 (upgradient)	641 (upgradient)	548 (POC)	549 (POC)	575 (POC)	580 (POC)
Antimony	0.006	0.017	<0.003	<0.003	b	<0.003	<0.003
Barium	1	0.41	0.19	0.10	b	0.10	0.21
Nitrate	44	<1.0	5.6	10.5	b	8.0	<1.0

[a]May 1994 sampling date.
[b]Well did not yield enough water for sampling.

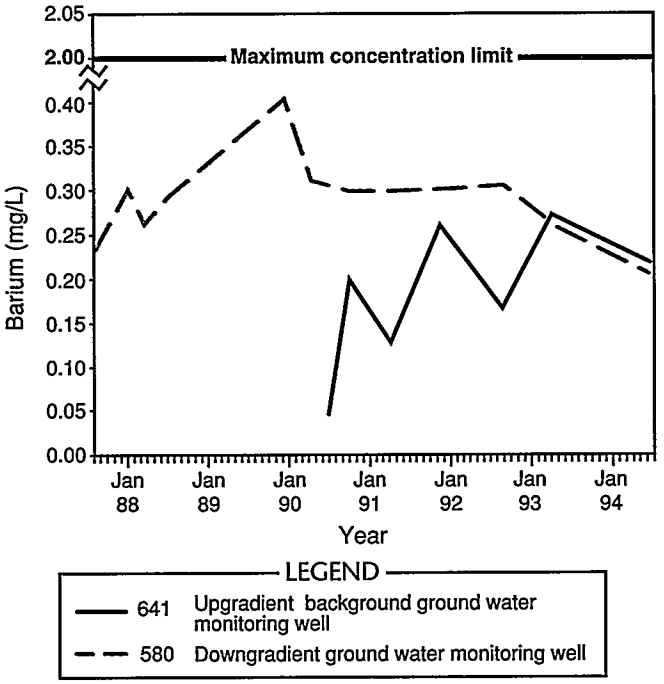
Notes: 1. Results are reported in milligrams per liter.
2. Guideline is the maximum concentration limit for barium and nitrate, and Federal Primary Drinking Water Standard for antimony.

< indicates actual is less than the detection limit (number shown).
POC – point of compliance.

Sampling results indicate that sampled parameters are below maximum concentration limits and background levels. *Figures 7-3 and 7-4* illustrate time plots for barium and nitrate. These plots show that these constituents are well below maximum concentration limits and that their concentrations vary seasonally.

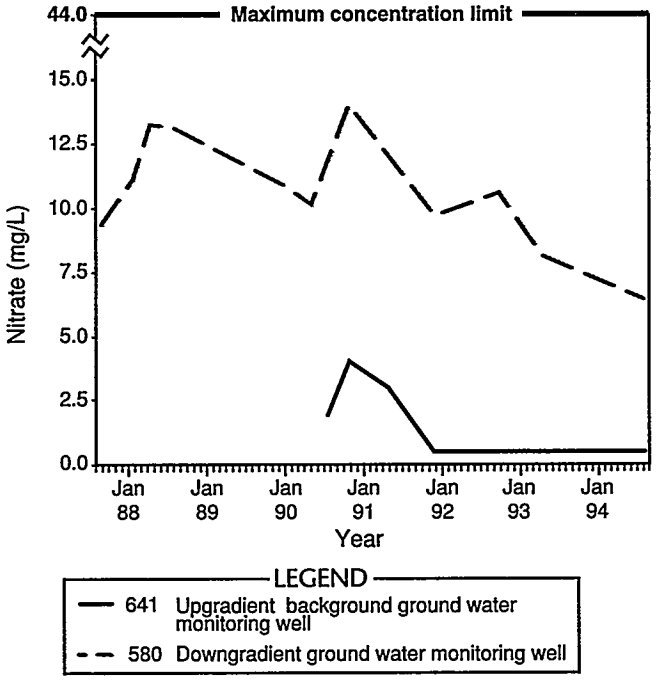
Results of ground water monitoring in 1994 at the Lowman disposal site indicates that ground water quality is not adversely affected by the disposal cell. The DOE has assessed the performance of the proposed disposal cell at the Lowman site in conjunction with the area's hydrogeologic system. This assessment has shown that the disposal cell will minimize and control releasing of hazardous constituents to ground water and surface water to the extent necessary to protect human health and the environment.

Figure 7-3
Barium Concentrations Over Time in Ground Water, Disposal Site



ASER95/LOW/BARCON

Figure 7-4
Nitrate Concentrations Over Time in Ground Water, Disposal Site



ASER95/LOW/NITCON

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Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material*, Nuclear Regulatory Commission.

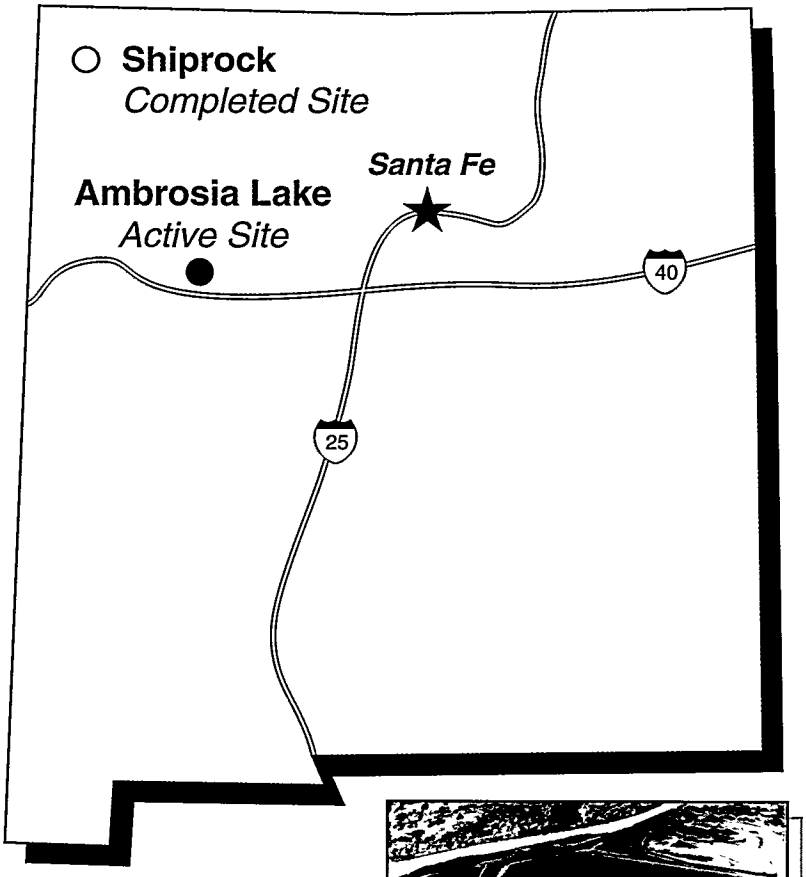
40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, Environmental Protection Agency.

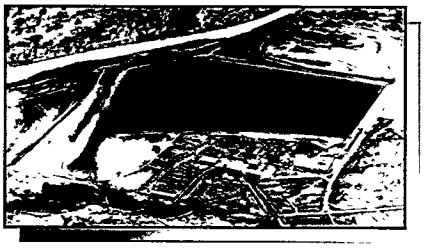
United States Code

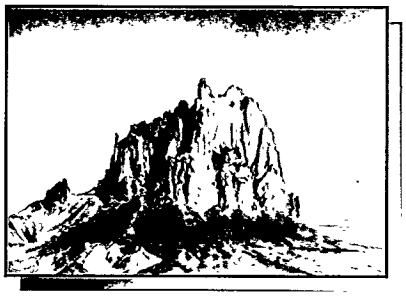
42 USC §7901 *et seq., Uranium Mill Tailings Radiation Control Act of 1978.*

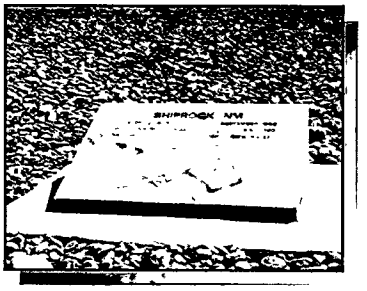
UMTRA PROJECT

CHAPTER 8
NEW MEXICO SITES









NEW MEXICO SITES

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at the Ambrosia Lake and Shiprock, New Mexico, sites during 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Ambrosia Lake

The Ambrosia Lake site is in McKinley County in western New Mexico. The site is undergoing remedial action. During 1994, air monitoring was conducted for thorium-230 particulate, radon-222, and environmental gamma radiation. Due to the absence of surface water at the site, surface water samples were not collected during 1994. However, ground water was monitored for radiological and nonradiological constituents during 1994.

Shiprock

The Shiprock site is in San Juan County in northwestern New Mexico. Site remedial action was completed in May 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

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SITE DESCRIPTION AND LOCATION

The Ambrosia Lake UMTRA site is in McKinley County (population 60,686), New Mexico, about 25 mi north of Grants (population 8626), New Mexico (DOC, 1990). The site is 1 mi east of New Mexico Highway 509 (***Figure 8-1***). The town closest to the tailings pile is San Mateo, about 13 mi southeast. The site is approximately 7000 ft above MSL, within the Ambrosia Lake Mining District and near the center of the Grants Mineral Belt. The immediate area includes several non-UMTRA uranium mills, numerous mine shafts and vents, tailings piles, and mine waste piles.

Land in the area is used for low-density grazing, dry land farming, mining and milling, and some commercial timber production. Most land near the site is privately owned, with the closest residence approximately 5 mi south of the site.

The New Mexico Environment Department operated a meteorological monitoring station approximately 0.25 mi north of the tailings pile from June 1978 to April 1979. Temperatures recorded at the station indicated a mean daily minimum of 41 °F and a mean daily maximum of 65 °F.

This region is characterized by large daily and annual temperature variations, low precipitation, and low relative humidity. The rainy season generally occurs in late summer, although rainfall patterns can vary considerably. The meterological monitoring station in San Mateo reported a long-term annual average precipitation of 8.83 inches.

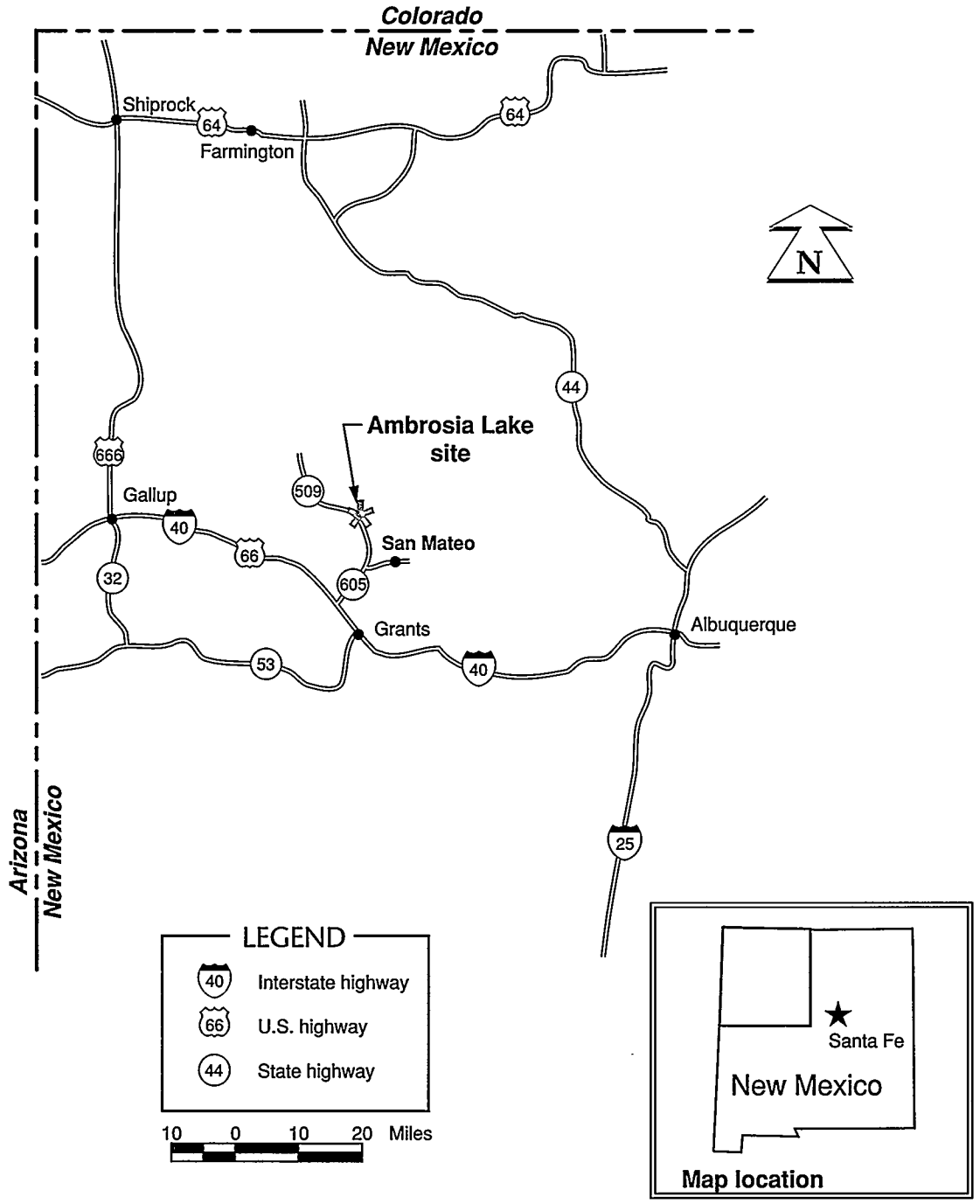
The average wind speed measured by the New Mexico Environment Department was 5.8 mi per hour. The wind blows most frequently from the west. ***Figure 8-2*** plots wind direction frequency measured at the Kerr-McGee Mill south of the Ambrosia Lake site.

SITE HISTORY AND OWNERSHIP

The Ambrosia Lake mill was constructed in 1957 by the Phillips Petroleum Company; Phillips operated the mill from June 1958 to March 1963. United Nuclear Corporation operated the mill from March to April 1963 and then used part of the mill as a resin ion exchange facility until 1982, when all operations ceased. The site is currently owned by the state of New Mexico. During its operating period, the mill processed 2.97 million tons of ore with an average uranium oxide concentration of 0.23 percent. An estimated 396,000 tons of tailings were removed from the site and used as mine fill. The volume of the remaining tailings is estimated at 2.5 million tons, or about 2 million cubic yards.

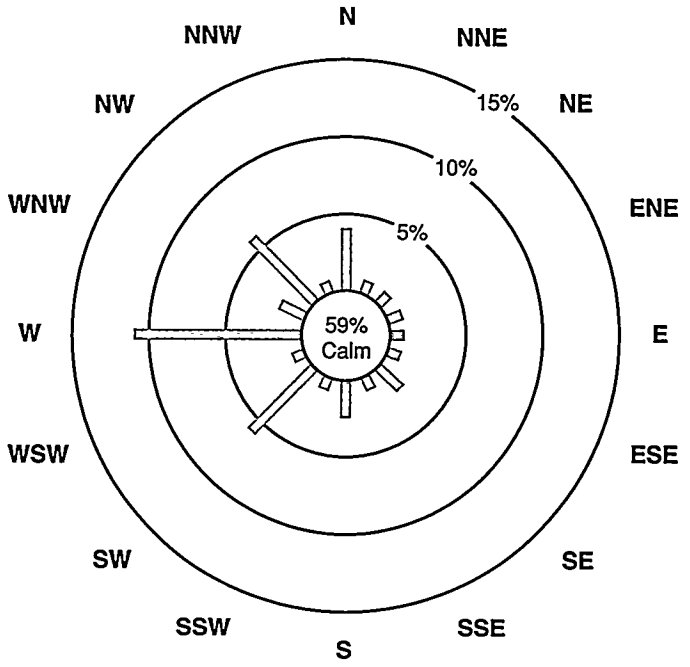
An alkaline sodium-carbonate leach process was used to extract uranium from ore at the Ambrosia Lake site. The alkaline mill solutions were continuously recirculated, regenerated with caustic soda, and recarbonated with carbon dioxide and soda ash. Pressurized pachuca tanks leached uranium from the ore. Drum filters separated

Figure 8-1
Ambrosia Lake Site Location



ASER95/AMB/SITELOC

Figure 8-2
Wind Rose



Ref: DOE, 1987.
Cumulative data 1959 through 1963.

ASER95/AMB/WINDAMB

uranium from the waste solution before the waste was pumped to the tailings pile. In the precipitation process, sulfuric acid and ammonia were converted to a sodium salt, which was disposed of in tailings ponds with other chemical constituents.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Ambrosia Lake site was conducted in two phases. In Phase I, UMTRA site facilities were constructed (fencing, retention ponds, and decontamination pads), and by 1989 all mill buildings were demolished. Phase II remedial action began in August 1992 and is scheduled for completion in 1995. In Phase II, all windblown and water-eroded tailings are being excavated and placed on the existing pile. The pile was reshaped in 1993 to form a single disposal cell, and the remaining tailings and windblown material were placed in the disposal cell in 1994. The disposal cell will be completed when covered with a layered, compacted clay radon/infiltration barrier, a bedding layer, and riprap erosion protection on the top and sides. Using only natural materials will ensure compliance with the disposal cell longevity requirements.

ENVIRONMENTAL COMPLIANCE STATUS

UMTRA Project activities at the Ambrosia Lake site complied with all applicable federal, state, and local regulations and permits in 1994.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*), the Ambrosia Lake site must comply with emergency planning and community right-to-know requirements.

In 1994, the site was in compliance with the requirements of EPCRA, Section 311, because the site was inventoried for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. The inventory was submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

In 1994, the site was in compliance with the requirements of EPCRA, Section 312, because Tier II reporting forms for the 1993 inventoried materials were developed and submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department on 1 March 1994.

National Environmental Policy Act

In compliance with the NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Ambrosia Lake UMTRA site.

Resource Conservation and Recovery Act

One underground storage tank was discovered in March 1994. The tank was surveyed and determined not to contain any RCRA-regulated wastes. It then was removed and properly disposed of.

Clean Water Act

The EPA has authority over all CWA activities in New Mexico.

National Pollutant Discharge Elimination System

In 1992, the EPA issued the Ambrosia Lake site a zero-discharge permit under the National Pollutant Discharge Elimination System. A general storm water permit was applied for in 1993. There were no wastewater discharges in 1994.

Spill Prevention Control and Countermeasures Plan

This plan addresses requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. Earthen berms were designed and constructed around existing aboveground storage tanks and oil drum storage areas. These secondary containment systems provide adequate spill control.

Septic/Holding Tanks

Septic/holding tanks were installed in accordance with all applicable requirements. The tanks are emptied at least once each year, or as required.

Clean Air Act

The Ambrosia Lake site complies with state requirements for fugitive dust emissions (total suspended particulates). Although the state of New Mexico requires the control of fugitive dusts, monitoring was not required for fugitive dust at the Ambrosia Lake site. Dust was suppressed and emissions were controlled by applying water sprays during construction activities, as needed.

Hazardous Materials Transportation Act

All materials transported at the Ambrosia Lake site were in full compliance with all applicable HMTA requirements (49 USC §1801 *et seq.*).

Environmental Compliance Permits

The Ambrosia Lake site operated under all required permits from 01 January 1994 to December 1994 (***Table 8-1***).

Table 8-1 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
National Pollutant Discharge Elimination System (EPA)					
Process site wastewater	10/87[a]	Final received[b]	8/92	NM0029742	09/97
Process site storm water (general)	10/93	Pending	Pending		
Ground water discharge notice and plan (state)	08/87	Final received[b]	11/87	DP-513	11/94
Air quality construction permit (state)[c]	07/87	Pending	Pending	Pending	None

[a]Resubmitted for zero discharge in 1992.
[b]Not applicable because final approval has been received.
[c]Air permit for screening equipment is required.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Ambrosia Lake site, including environmental gamma-dose equivalent and radionuclide/ nonradionuclide concentrations in air and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Surface water is not monitored because flow in the Arroyo del Puerto, the major watercourse in the Ambrosia Lake area, was sustained almost entirely by ground water discharged from mines located in deeper aquifers. Because ground water is no longer discharged from the mines, the flow in Arroyo del Puerto is now considered ephemeral, occurring only as a result of heavy rainfall. Definition of surface water quality in Arroyo del Puerto is not applicable to remedial action at the Ambrosia Lake site.

Air Monitoring

Nonradiological Air Particulate

In 1994, monitoring was not required for fugitive dusts (total suspended particulates) at the Ambrosia Lake site under New Mexico regulations.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Ambrosia Lake site was conducted at Stations 1 through 3 and 5, which were also equipped with real-time radon monitoring equipment (***Figure 8-3***). Station 1, approximately 5 mi south of the site, provided background measurements.

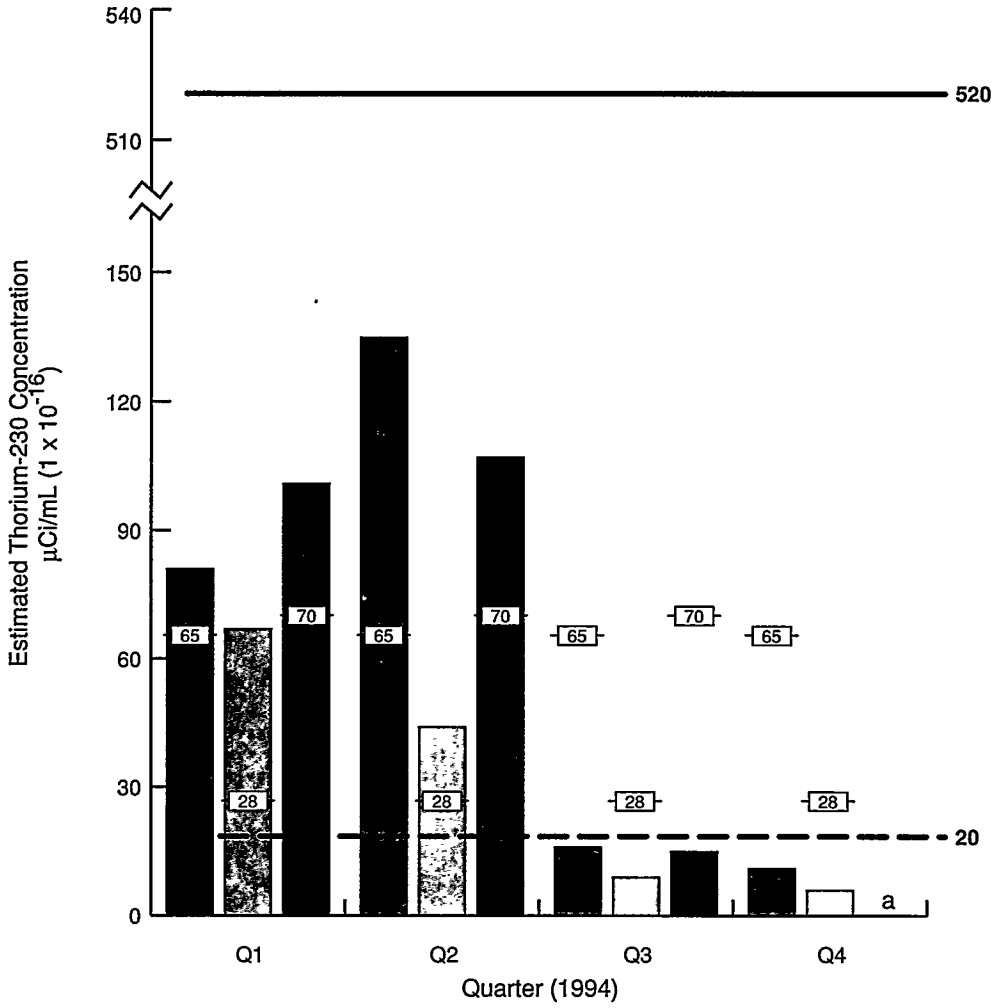
Table 8-2 summarizes site thorium-230 concentrations estimated from gross alpha measurements. All stations recorded concentrations higher than background. The estimated annual average DOE thorium-230 concentration at all stations was well below the thorium-230 average annual guideline of 500×10^{-16} μCi/mL above background, indicating radioactive particulate releases from remedial action were insignificant. The levels at all stations dropped significantly in the third and fourth quarters. Station 5 was discontinued on 06 October 1994 when the access control facility was demobilized and electrical power to the station was discontinued. All other monitoring was completed on 02 December 1994, one month after remedial action was completed at the Ambrosia Lake site.

Figure 8-3 graphically illustrates estimated results for thorium-230 monitoring stations that recorded concentrations above background.

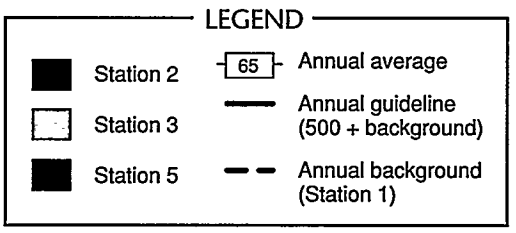
Radon Monitoring

Real-Time Radon Monitoring. Real-time radon monitoring was conducted at Stations 1 through 3 and 5 (***Figure 8-4***), with Station 1 providing background measurements.

Figure 8-3
Environmental Airborne Radioactive Particulate (Thorium-230) Concentrations

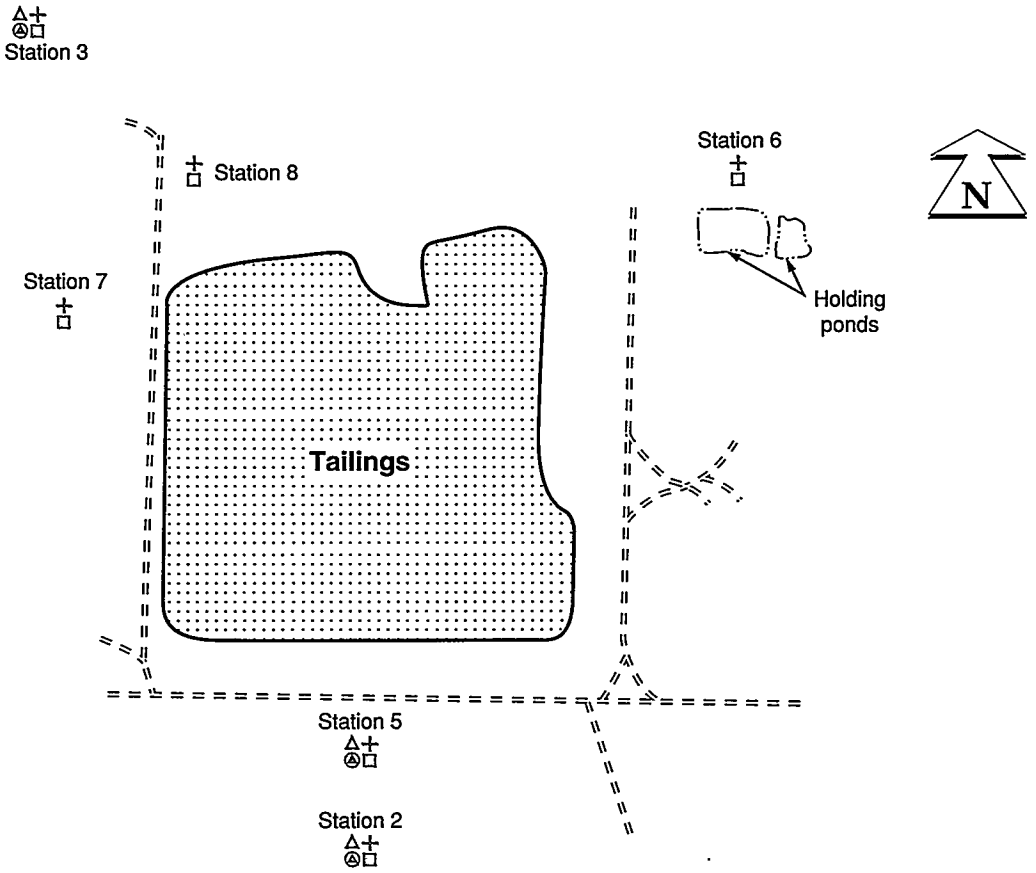


[a]Station 5 discontinued October 6,1994.



ASER95/AMB/TAB1

Figure 8-4
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site



ASER95/AMB/ENVMONSTAT

Table 8-2 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} µCi/mL)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average
1	44	30	8	5	20 (10)
2	81	135	16	11	65 (32)
3	67	44	9	6	28 (14)
5	101	107	15	a	70[b] (35)

[a]Station 5 discontinued 10/06/94.
[b]Annual average based on available data.

Note: Stations 1, 2, and 3 discontinued 12/02/94.

( ) indicates 10^{-8} picogram per milliliter (pg/mL).

Table 8-3 shows the 1994 quarterly average radon concentrations at the Ambrosia Lake site. The annual average background radon concentration measured at Station 1 was 1.3×10^{-9} µCi/mL. Although Stations 2 and 5 reported radon concentrations higher than background, none of the areas exceeded the DOE guideline of 3×10^{-9} µCi/mL above background. Station 5 was discontinued on 06 October 1994; all other monitoring was completed on 02 December 1994, 1 month after remedial action was completed at the Ambrosia Lake site.

Figure 8-5 graphically illustrates results for real-time radon monitoring stations that recorded concentrations above background.

Passive Radon Monitoring. Seven stations were established around the Ambrosia Lake site perimeter. Background monitoring was conducted south of the site at Station 1. *Figure 8-3* shows the locations of passive radon detectors at the Ambrosia Lake site.

The site passive radon monitoring results for stations during 1994 are presented in *Table 8-4*. The annual average background radon concentration measured at Station 1 was 1.9×10^{-9} µCi/mL. None of the stations reported annual average radon concentrations greater than the DOE guideline of 3×10^{-9} µCi/mL above background. Monitoring was discontinued on 02 December 1994, 1 month after remedial action was completed.

Table 8-3 Real-time radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	1.6	1.2	0.9	1.6	1.3
2	3.0	2.2	1.9	2.3	2.3
3	2.0	1.6	0.8	1.4	1.4
5	3.4	2.6	2.3	2.3[a]	2.6[b]

[a]Station 5 discontinued 10/06/94.
[b]Annual average based on available data.

Note: Station 1, 2, and 3 discontinued 12/02/94.

Figure 8-6 graphically illustrates results for passive radon monitoring stations that recorded concentrations above background.

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulate were less than the applicable guidelines. No significant releases occurred at this site during 1994.

All measured concentrations of radon-222 were less than the applicable guidelines. No significant releases occurred at the site during 1994.

Environmental Gamma Radiation Monitoring

Gamma radiation in the environment around the Ambrosia Lake site is monitored by a network of thermoluminescent dosimeters around the site perimeter (*Figure 8-4*).

Seven dosimetry monitoring stations were active in 1994. Background dose was measured at Station 1, approximately 5 mi south (upwind) of the site.

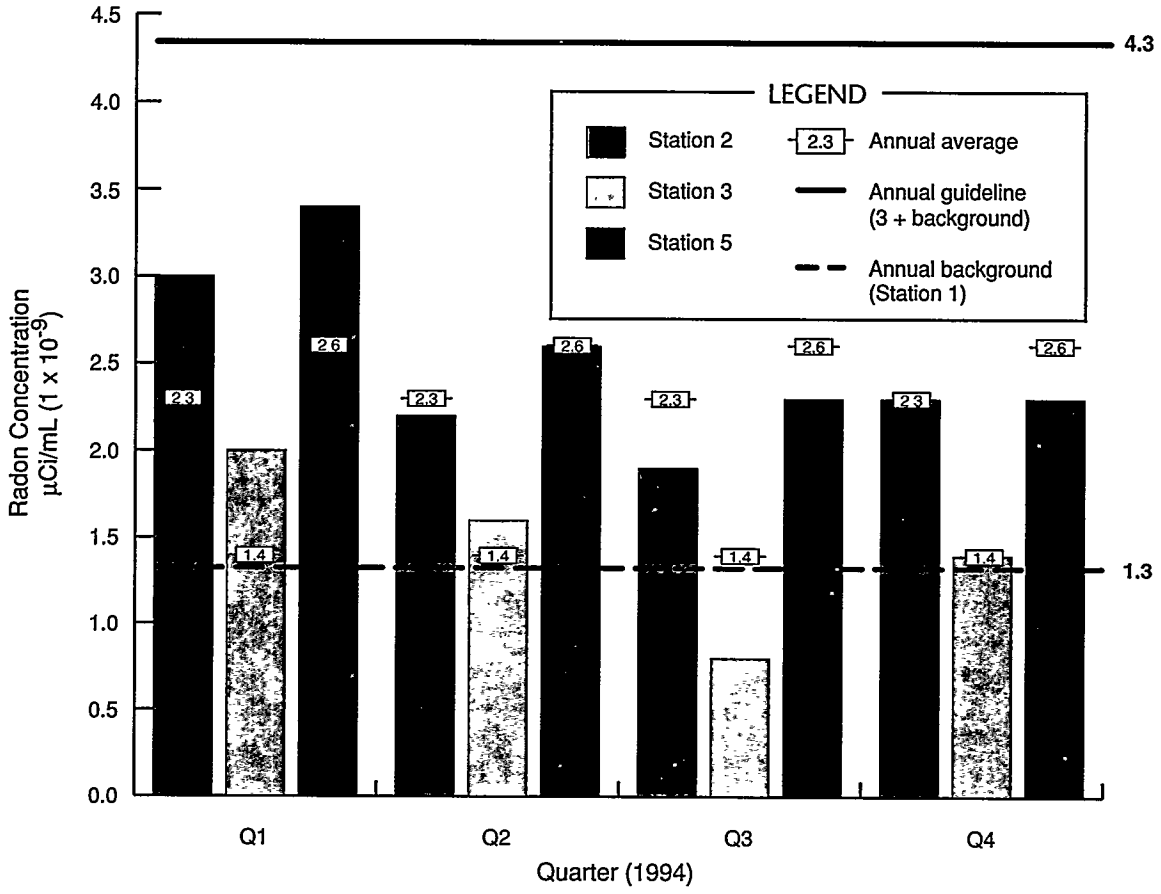
Table 8-5 presents the 1994 results of environmental dosimetry monitoring for stations at the Ambrosia Lake site. The annual background dose equivalent was 134.6 ± 26.1 mrem at Station 1.

Figure 8-7 graphically illustrates results, for environmental gamma radiation monitoring stations, that recorded concentrations statistically greater than above background.

Environmental Gamma Radiation Monitoring Conclusions

None of the measured dose equivalents exceeded the DOE guideline of 100 mrem above background.

Figure 8-5
Real-Time Radon Concentrations



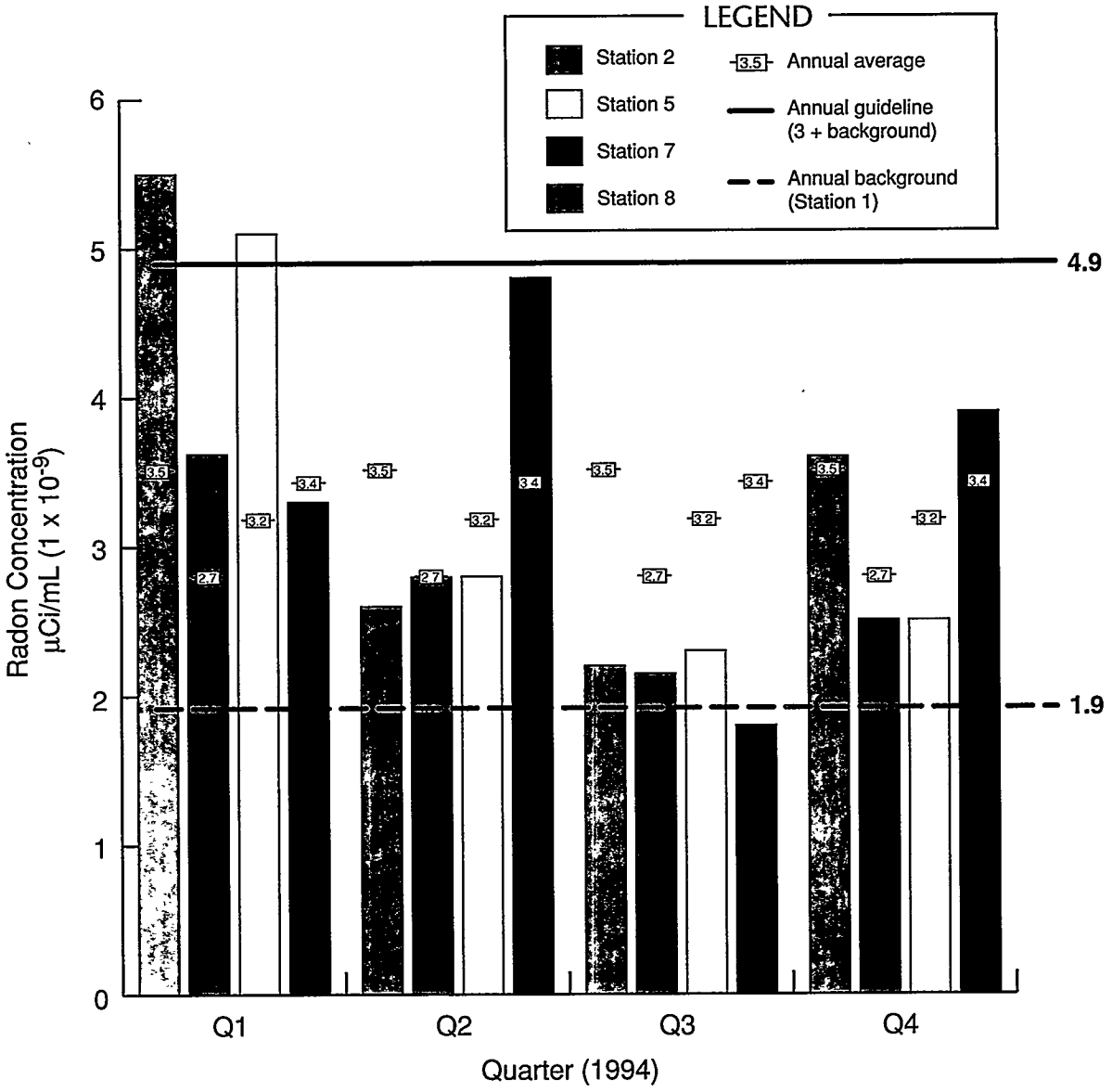
ASER95/AMB/TAB2

Table 8-4 Passive (alpha-track) radon concentration (10^{-9} µCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
1	2.5	1.3	1.7	2.1	1.9
2	5.5	2.6	2.2	3.6	3.5
3	2.9[a]	2.0	1.8	2.7	2.3
5	5.1	2.8	2.3	2.5	3.2
6	2.4	1.5	1.7	1.8	1.8
7	3.3	4.8	1.8	3.9	3.4
8	3.6	2.7	2.1	2.5	2.7

[a]Average of two detectors.

Figure 8-6
Passive Radon Concentrations



ASER95/AMB/TAB3

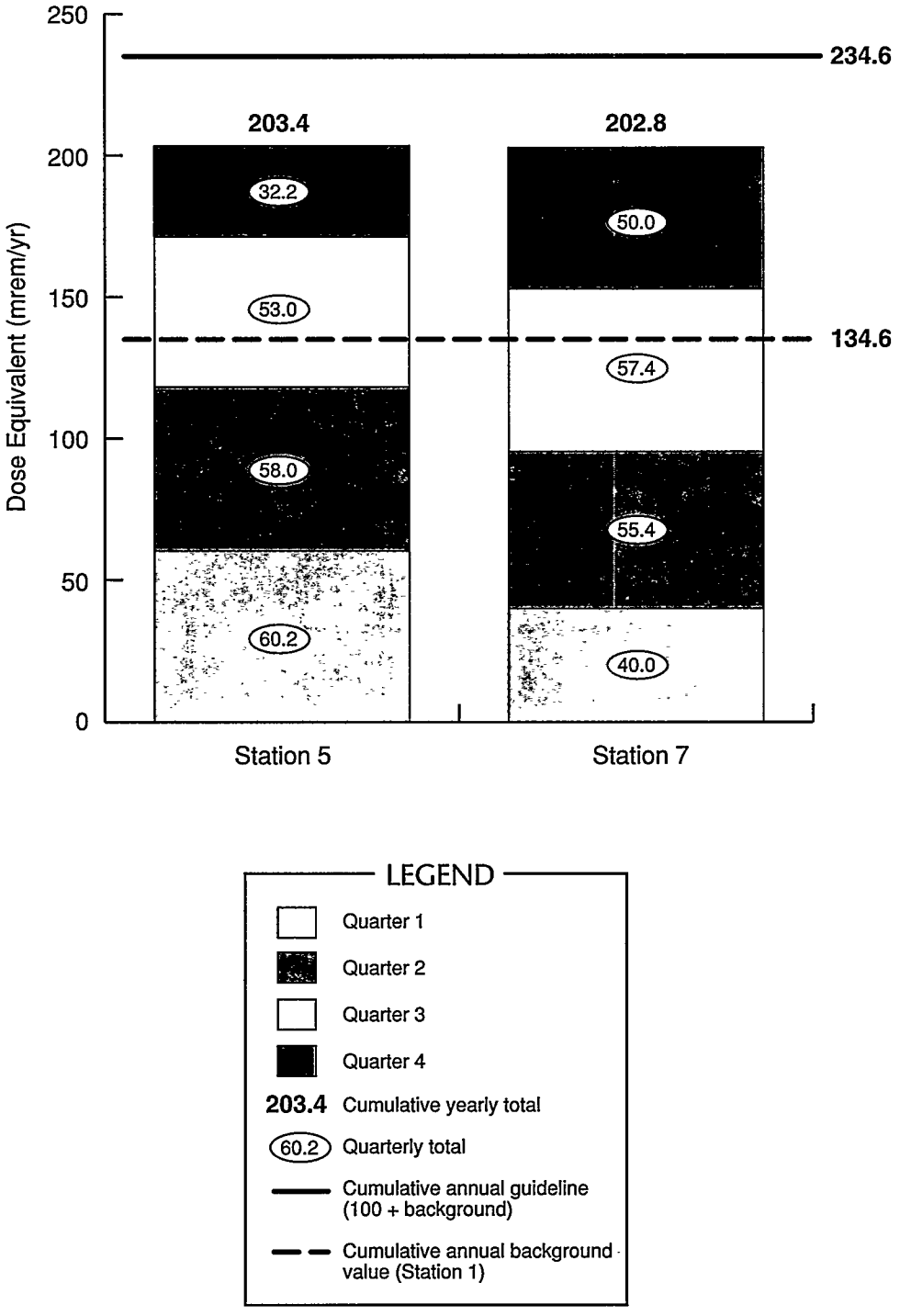
Table 8-5 Environmental gamma dose equivalent[a] (mrem)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	28.0 ± 19.9	41.0 ± 7.3	32.6 ± 5.9	33.0 ± 14.1	134.6 ± 26.1 (1.35 ± 0.26)
2	33.6 ± 11.7	47.4 ± 13.2	34.4 ± 6.1	33.6 ± 11.4	149.0 ± 21.9 (1.49 ± 0.22)
3	34.0 ± 17.4	38.6 ± 8.2	49.8 ± 7.3	35.0 ± 9.3	157.4 ± 22.6 (1.57 ± 0.23)
5	60.2 ± 22.0	58.0 ± 17.4	53.0 ± 11.7	32.2 ± 11.3	203.4 ± 32.4 (2.03 ± 0.32)
6	25.4 ± 13.7	43.2 ± 1.7	48.8 ± 5.4	36.2 ± 5.4	153.6 ± 15.8 (1.54 ± 0.16)
7	40.0 ± 24.7	55.4 ± 6.3	57.4 ± 7.9	50.0 ± 6.8	202.8 ± 27.5 (2.03 ± 0.28)
8	28.0 ± 12.8	40.2 ± 11.6	44.0 ± 7.3	40.8 ± 3.6	153.0 ± 19.1 (1.53 ± 0.19)

[a]All errors reported as 2 standard deviations.

( ) indicates millisieverts.

Figure 8-7
Environmental Gamma Radiation Monitoring



ASER95/AMB/TAB4

Ground Water Monitoring

Four water-bearing zones underlie the Ambrosia Lake site. From shallowest to deepest, they are the alluvium and weathered Mancos Shale; the Mancos Shale, which includes the Tres Hermanos-C_1 , -C2, -B, -A Sandstones; the Dakota Sandstone; and the Westwater Canyon Member of the Morrison Formation. Saturation of the alluvium and weathered Mancos Shale exists due to uranium mining activities in the area. Seepage from an unlined mill process water pond, discharge of mine water from the Ann Lee Mine, and seepage from the tailings have artificially recharged ground water in the alluvium and weathered Mancos Shale. The alluvium/weathered Mancos Shale zone is hydraulically separated from the underlying water-bearing zones by a thick sequence of low-permeability Mancos Shale.

Ground water was sampled in July 1994 at the Ambrosia Lake site to monitor ground water quality during disposal cell construction. The uppermost water-bearing zone, the alluvium and weathered Mancos Shale, is the only water-bearing zone potentially affected by cell construction and was the only zone monitored during the July 1994 sampling event. Monitoring wells completed in the alluvium and weathered Mancos Shale are shown in ***Figure 8-8***. Monitoring wells 674 and 793 were the only wells sampled during the July 1994 sample event. Well 793 contained only enough water for field analyses, while well 674 contained sufficient water for field and laboratory analyses.

All other wells completed in the alluvium/weathered Mancos Shale were either dry, destroyed during construction activities, or inaccessible due to construction of the disposal cell.

Ground water samples were analyzed for the following:

- Field analyses (wells 674 and 793): alkalinity, dissolved oxygen, oxidation-reduction potential, pH, specific conductivity, and temperature.

- Laboratory analyses (well 674): ammonium, arsenic, barium, calcium, chloride, chromium, cyanide, fluoride, gross alpha, gross beta, iron, lead, magnesium, manganese, molybdenum, nickel, nitrate, phosphate, potassium, radium-226, radium-228, selenium, silica, sodium, sulfate, sulfide, total dissolved solids, uranium, and zinc.

Ground water levels were measured in four wells completed in the alluvium/weathered Mancos Shale during the July 1994 monitoring event. ***Figure 8-9*** illustrates the water level elevations for this zone.

Ground water flow direction could not be determined from the four wells. However, historical data indicated that ground water flows radially away from the tailings pile.

Figure 8-8
Ground Water Quality Sampling Locations in the Alluvium and Weathered Mancos Shale

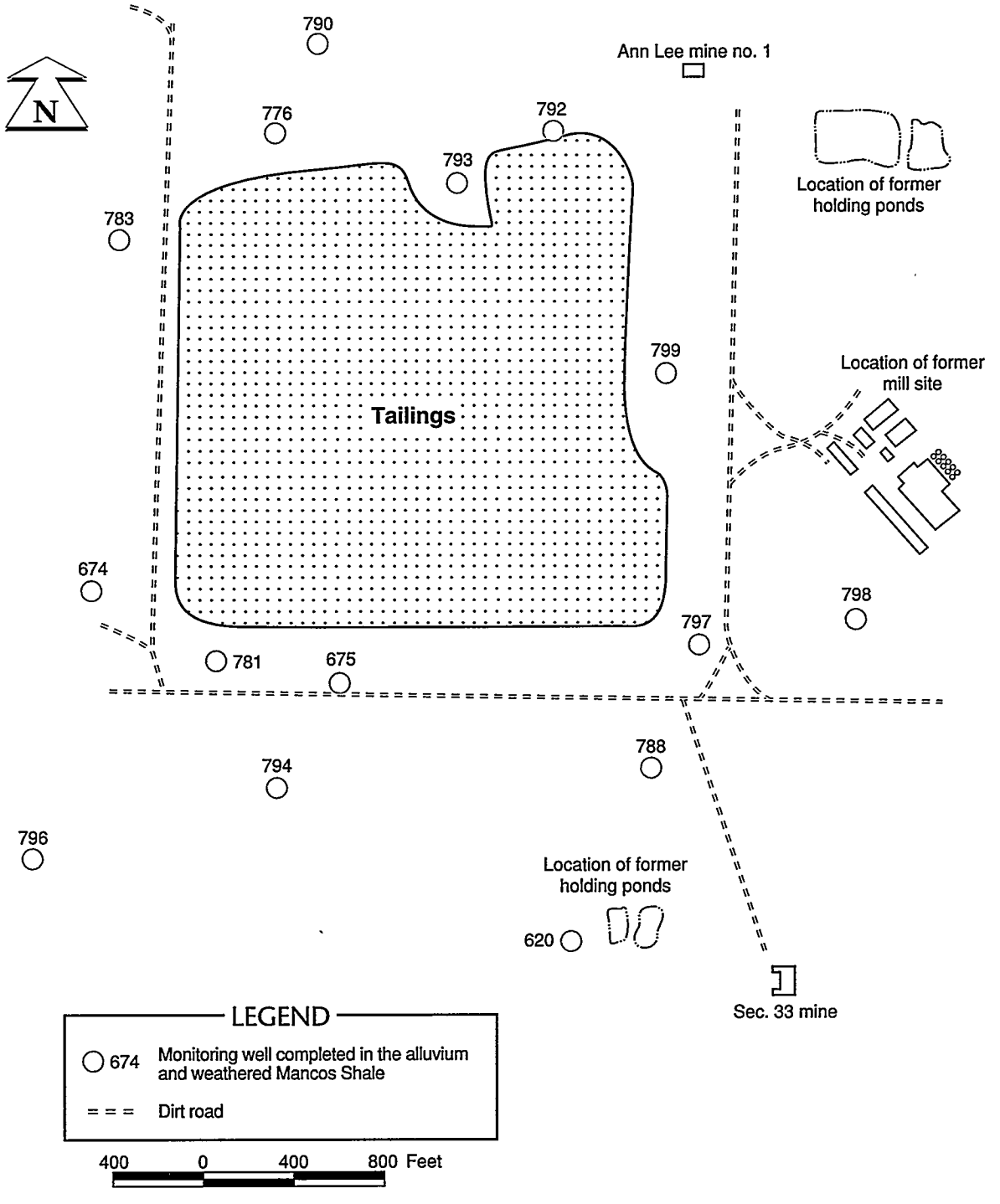
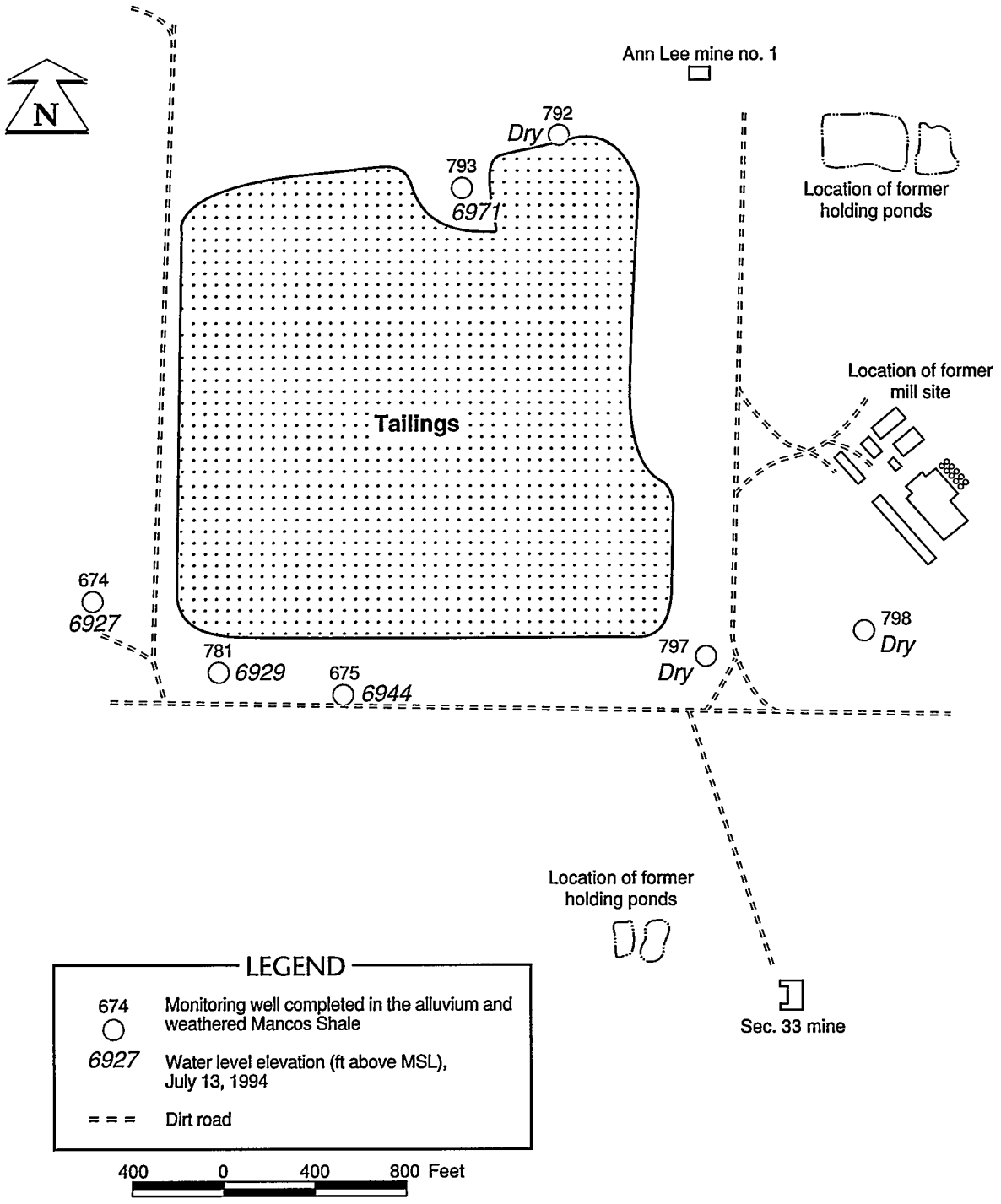


Figure 8-9
Ground Water Level Elevation in the Alluvium and Weathered Mancos Shale



ASER95/AMB/POTENTIO

Ground Water Results and Conclusions

Results from the 1994 sampling event show that at well 674, concentrations of molybdenum, nitrate, selenium, and uranium exceeded the EPA maximum concentration limits for ground water in the alluvium and weathered Mancos Shale (*Table 8-6*). Ground water in this uppermost water-bearing unit has been impacted by uranium milling activities at the Ambrosia Lake site. Since all water contained in the alluvium and weathered Mancos Shale at the site was initially derived from mining-related activities, the extent of contamination is the same as the extent of ground water. There are no potential receptors in the vicinity of the site because ground water in the uppermost water-bearing zone is not used for domestic or agricultural purposes.

Table 8-6 Alluvium and weathered Mancos Shale ground water quality results[a]

Well location	Molybdenum (MCL = 0.1)	Nitrate (MCL = 44)	Selenium (MCL = 0.01)	Uranium (MCL = 0.044)
674	6.9	57	2.3	2.9

[a]All results and maximum concentration limits in milligrams per liter.

MCL – maximum concentration limit.

SITE DESCRIPTION AND LOCATION

In San Juan County, New Mexico, the Shiprock site is on a 230-ac tract of the Navajo Indian Reservation (***Figure 8-10***). The site is approximately 1 mi south of the town of Shiprock.

Accurate population data for Shiprock (estimated population 7700) are difficult to obtain because it is unincorporated and has no defined boundaries. In addition, people who live as much as 10 or more miles from Shiprock often associate themselves with the town and are considered Shiprock residents. The population of San Juan County is 91,605 (DOC, 1990).

The elevation of the Shiprock site ranges from 4890 ft to about 5010 ft above MSL. The tailings disposal cell is on an alluvial terrace about 70 ft above the southwest bank of the San Juan River. A layer of terrace gravel 10 to 15 ft thick caps the terrace over the Mancos Shale bedrock. A cliff marks the edge of the terrace to the north and east. The cliff (about 60 ft high) is continuous except for a small area at the northwest part of the site where Bob Lee Wash drains to the north and breaches part of the cliff. Surface drainage in the area is generally north and east toward the San Juan River.

The region is semiarid, with an average precipitation of 6.4 inches. Vegetation is sparse, except along the river. Land along the river is used predominantly for low-density open grazing, north and south from the river, and irrigated farming. The annual average temperature at the Shiprock site is 52.3 °F. Temperatures measured from 1983 to 1984 ranged from 15 °F to 94 °F.

SITE HISTORY AND OWNERSHIP

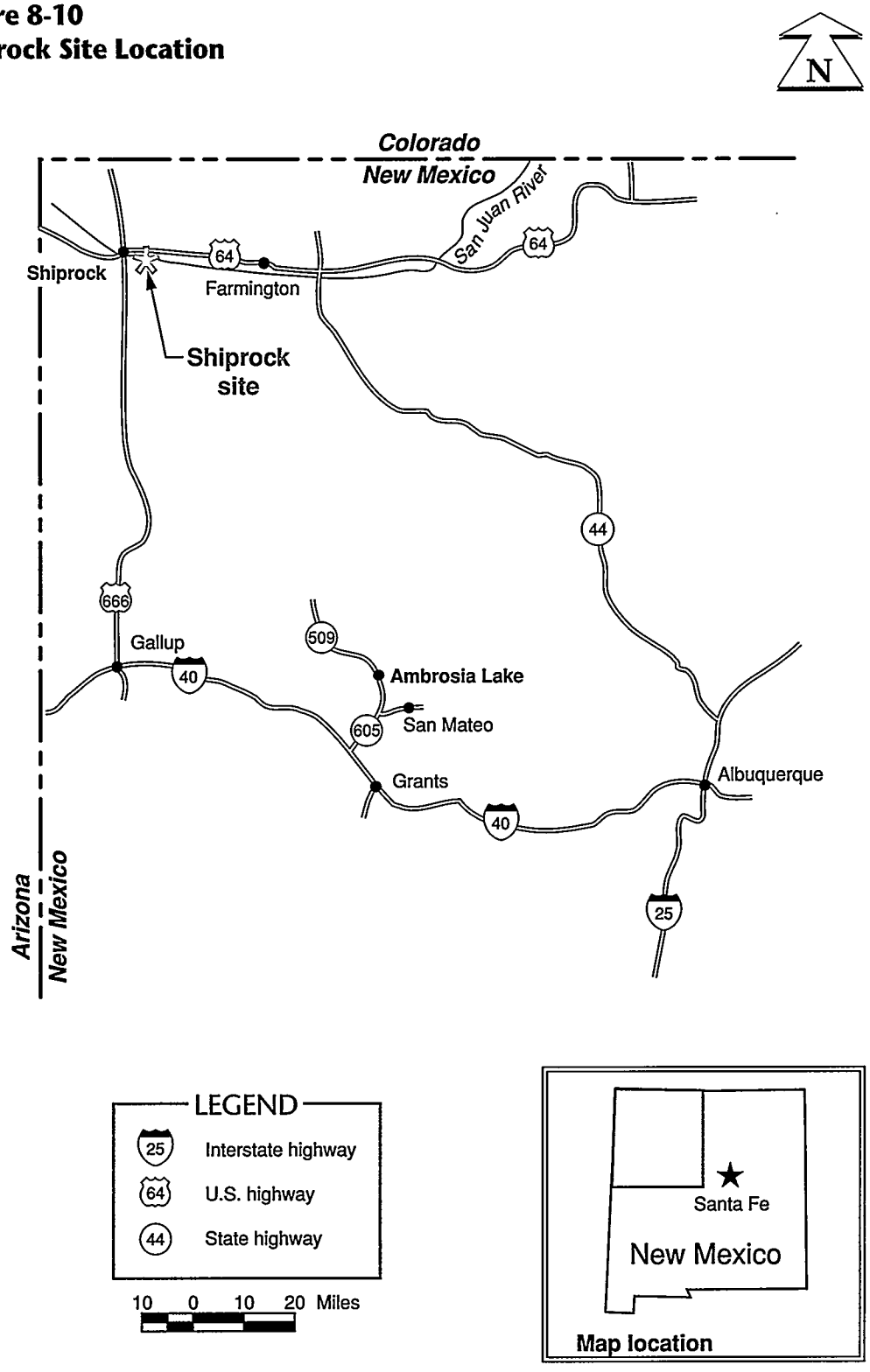
The former Navajo Mill at the Shiprock site was constructed and operated from 1954 to 1963 by Kerr-McGee Oil Industries, Inc., and from 1963 to 1968 by Vanadium Corporation of America and its successor, Foote Mineral Company. Before and during milling operations, the site was leased from the Navajo Nation. When this lease expired in 1973, the site reverted to the Navajo Nation.

The mill processed approximately 1.5 million short tons of ore and smaller quantities of bulk precipitates from the Monument Valley area and from purchased vanadium liquor. Ore processing consisted of crushing, leaching with sulfuric acid, washing, and solvent extraction.

Tailings from the washing circuit were pumped to tailings ponds. Raffinate from the solvent extraction operation was disposed of by evaporation in unlined lagoons west of the tailings piles.

The DOE and the Navajo Nation entered into a cooperative agreement pursuant to the provisions of UMTRCA (42 USC §7901 *et seq.*) to provide for planning, fund expenditures, remediation, and

Figure 8-10
Shiprock Site Location



long-term surveillance and maintenance for the disposal site. This cooperative agreement authorizes the Navajo Nation to transfer custody of the disposal site to the DOE until ground water remediation is completed. Ownership and control of the site will comply with a land-withdrawal agreement between the DOE and the Navajo Nation.

SITE CHARACTERIZATION AND CLEANUP

Surface remedial action at the Shiprock site began in 1984 and was completed in 1986, with 1,079,000 cubic yards of residual radioactive material, including 22,000 cubic yards of material from vicinity property remedial action, placed in the disposal site. The disposal cell is covered with a 7-ft-thick radon/water infiltration barrier and pit run rock and is sloped to drain into the permanent ditch. The arroyos along the escarpment adjacent to the disposal cell are filled and stabilized. The 76-ac disposal cell is fenced to discourage intrusion.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Shiprock site complete, the remaining surface-related compliance issues include NRC licensing under the provisions of 10 CFR Part 40 for long-term surveillance and maintenance, and continued surveillance and maintenance of the completed disposal site, as defined in the site long-term surveillance plan (DOE, 1993). Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected and analyzed to evaluate the ground water contamination resulting from the former uranium processing site activities.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will likely be held in 1995 at locations near the Shiprock site.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Shiprock site for contaminants in surface water and ground water. This program monitors the radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Shiprock site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

Surface Water Monitoring

The San Juan River forms the eastern and northern boundary of the site. A water intake for the city of Shiprock is located in the river

north of the site, near U.S. Highway 666. Surface water samples were collected in January 1994 at eight locations (546 through 553) along the San Juan River (*Figure 8-11*). One water sample was collected from a seep on the escarpment above the floodplain (location 425). One surface water sample was collected along the drainage ditch traversing the floodplain (location 655). Two water samples werecollected from wetland areas on the floodplain (locations 658 and 659), and one surface water sample was collected from Bob Lee Wash (location 662).

Filtered and unfiltered surface water samples were analyzed for some or all of the following constituents: alkalinity, antimony, arsenic, boron, cadmium, calcium, chloride, chromium, dissolved organic carbon, iron, lead, lead-210, magnesium, manganese, molybdenum, nickel, nitrate, pH, potassium, polonium-210, radium-226, selenium, silica, sodium, specific conductance, strontium, sulfate, temperature, thorium-230, total organic carbon, uranium, vanadium, and zinc.

Surface Water Results and Conclusions

Sulfate, uranium, and nitrate are considered indicators of contamination from the former uranium milling operations. *Table 8-7* lists the surface water quality data for these three indicators from two locations along the San Juan River, upstream (547) and downstream (548), and from a pond located below the escarpment seeps (658).

A comparison of surface water samples from the San Juan River downstream of the site to background samples collected upstream of the site showed no significant differences in quality related to the former uranium milling activities. Similarly, no changes attributable to the former milling operations were recognized in the water in Bob Lee Wash or in the wetlands downstream of Bob Lee Wash.

However, elevated concentrations were observed in surface water collected directly below the seeps along the escarpment, the canal, and the small wetland area at the base of the escarpment that receives water from seep 425.

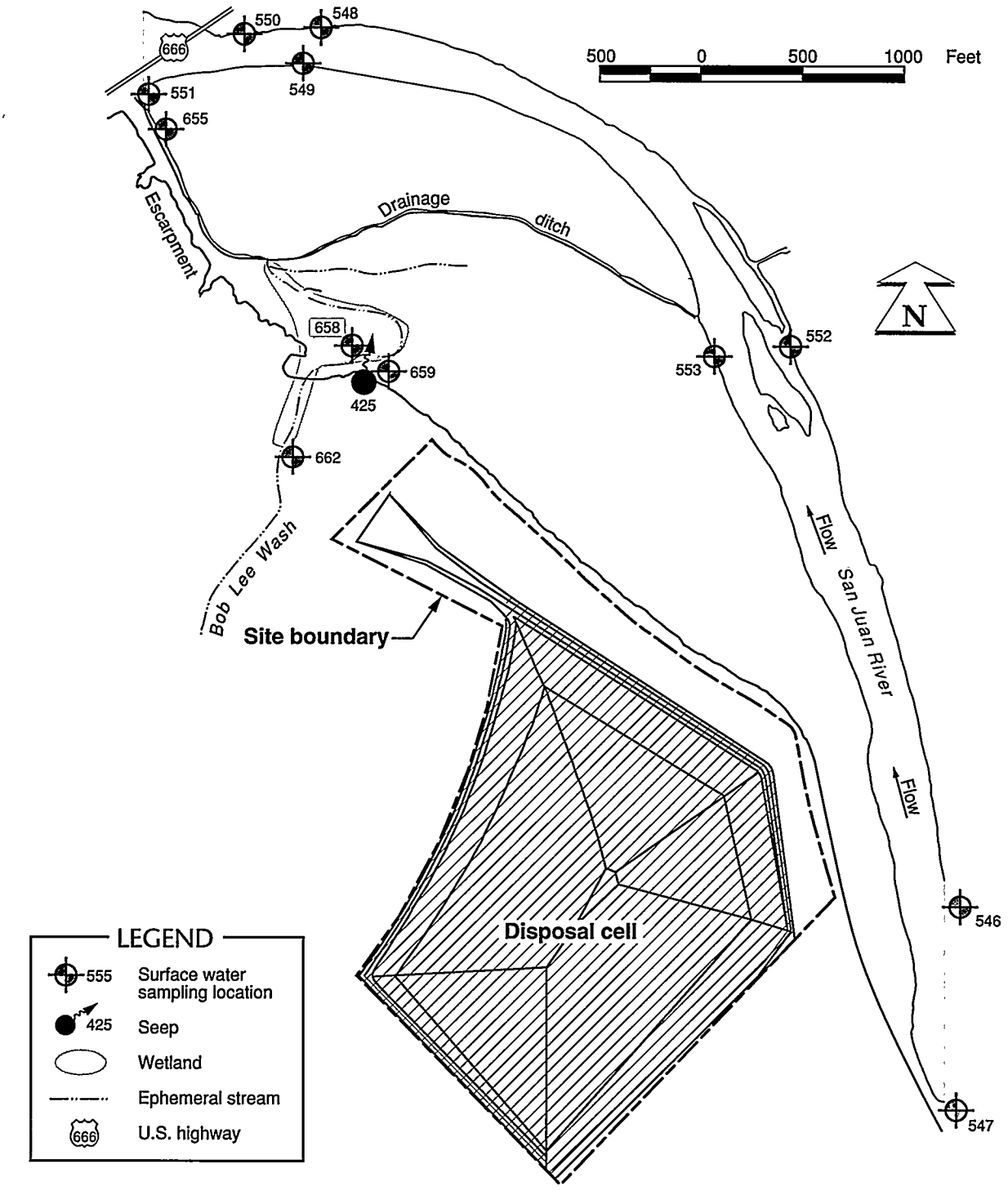
Ground Water Monitoring

The Shiprock site consists of two distinct, interconnected hydrogeological systems. These two systems, the terrace alluvium and the floodplain alluvium, are characterized by similar lithologies but have contrasting ground water flow systems and contaminant distribution.

Terrace Aquifer System

Ground water is present in the unconsolidated alluvium and the upper 20 to 30 ft of fractured Mancos Shale on the terrace beneath the former uranium mill site. Seepage from the milling activities significantly contributed to the volume of ground water present in the terrace, resulting in a mound of contaminated ground water that extends east,

Figure 8-11
Surface Water Sampling Locations



ASER95/SHP/LOCFLOODPLAIN

Table 8-7 San Juan River surface water quality results

Indicator parameter	Guideline	Monitoring well location 547 (upstream)	548 (downstream)	658 (pond below seep)
Sulfate	250[a]	155	154	2120
Uranium	0.044[b]	0.002	0.002	0.006
Nitrate	44[b]	1.0	1.0	3.0

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Notes: 1. Water samples are unfiltered (totals).
2. All water quality samples were taken in January 1994.
3. Surface water results are reported in milligrams per liter.

south, and west of the site. Contaminated ground water in the shale moves through fractures to the north and appears as seeps on the escarpment separating the terrace and the floodplain. Paleochannels eroded into the bedrock surface probably influence ground water movement in the alluvium on top of the shale.

Floodplain Aquifer System

Ground water is present in the alluvial materials that were deposited on an eroded Mancos Shale surface within the current flowage of the San Juan River. The silt, sand, gravel and cobbles deposits are typical of floodplains. Ground water throughout the floodplain aquifer is impacted with contaminants from the milling activities.

Terrace Ground Water Monitoring

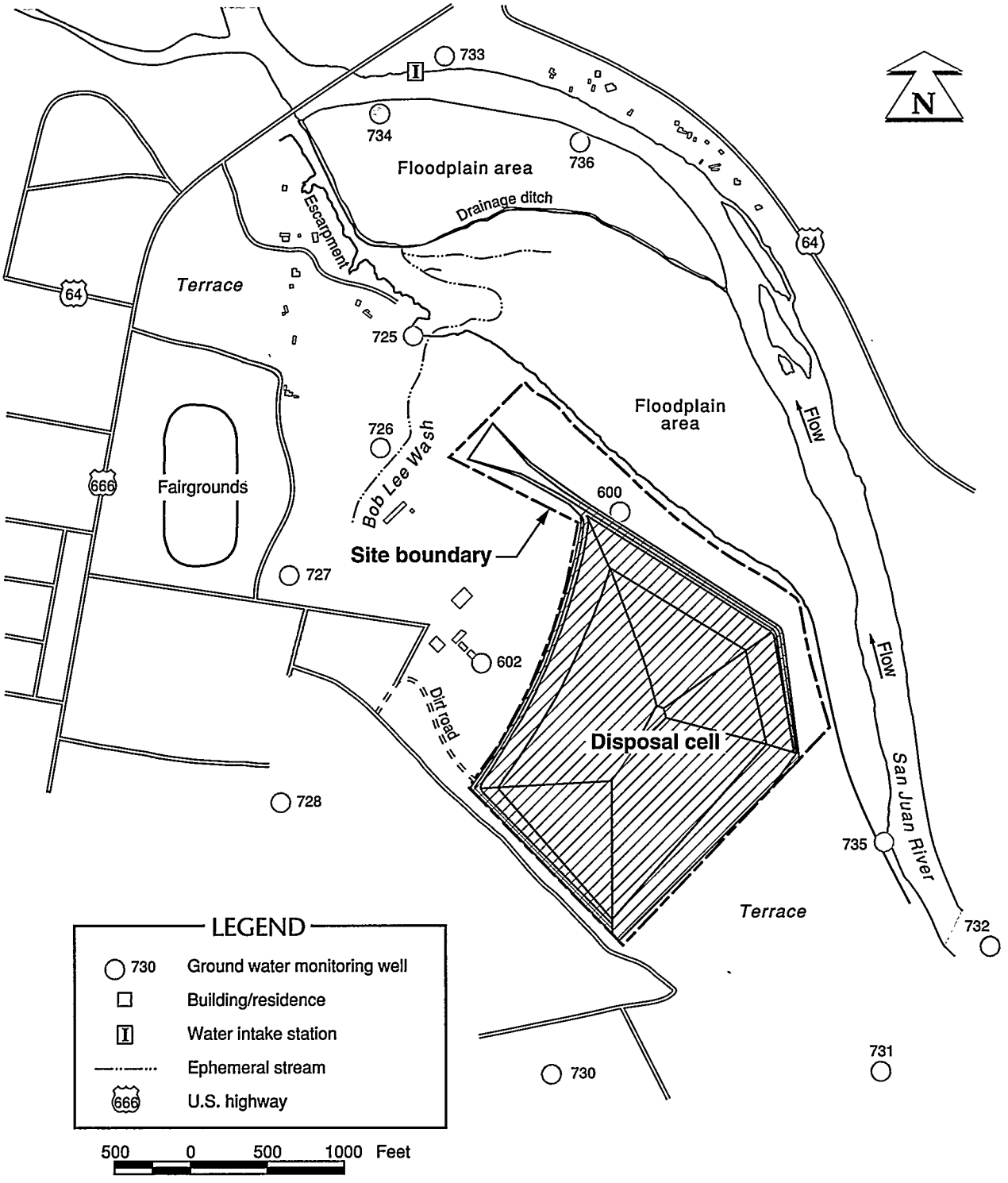
Water levels were measured in the terrace monitoring wells (***Figure 8-12***) to improve understanding of ground water flow patterns and to assess the amount of seasonal recharge reaching the water table.

In 1994, ground water samples were collected from terrace wells 600, 602, 725, 726, 727, 728, 730, and 731. Both unfiltered (total) and filtered ground water samples were collected from these wells and analyzed for some or all of the following constituents: alkalinity, ammonium, antimony, arsenic, boron, cadmium, calcium, chloride, dissolved organic carbon, fluoride, lead, lead-210, magnesium, manganese, mercury, molybdenum, nickel, nitrate, pH, polonium-210, potassium, radium-226, radium-228, selenium, silica, sodium, specific conductance, strontium, sulfate, temperature, thorium-230, total dissolved solids, uranium, vanadium, and zinc.

Terrace Ground Water Results

Monitoring wells completed in the terrace alluvium have not provided adequate information to define the areal extent of the contamination to the east, south, or west of the former mill site. All samples collected

Figure 8-12
Ground Water Monitoring Well Locations



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from terrace monitoring wells during 1994 show evidence of contamination by former milling activities.

Sulfate, uranium, and nitrate are considered indicators of ground water contamination from the uranium milling operations. ***Table 8-8*** lists the values for these parameters from well 602, near the disposal cell, and well 727, west and downgradient of the former mill site. Samples collected from these locations have historically shown evidence of impacts from the milling operations.

Terrace Ground Water Conclusions

There are insufficient water-level measuring points available to permit preparation of a ground water contour map for the terrace aquifer. However, geologic information suggests that the ground water in the terrace aquifer is expected to follow paleochannels to the southwest and west. The saturated thickness of the terrace alluvium above the bedrock is generally less than 3 ft, and water levels in the monitoring wells on the terrace recover slowly after sampling.

Ground water samples collected from terrace wells at and downgradient of the former processing site (***Figure 8-12***) show ground water beneath the terrace is contaminated by former uranium milling activities. However, the information available regarding the hydrogeologic characteristics of the ground water system in the terrace alluvium indicates the quantity of ground water in the terrace aquifer is limited.

Because of minimal recharge and the ground water flow, rapid changes in ground water quality on the terrace are not anticipated. Analytical data from well 602 show a trend toward decreasing uranium concentration (***Figure 8-13***), but no such trends can be recognized in well 600 or for the other constituents. Data from the other terrace wells are not sufficient to define trends.

Floodplain Ground Water Monitoring

The floodplain alluvium on both sides of the San Juan River contains shallow ground water that flows generally parallel to the river. Ground water in the floodplain alluvium is recharged from the river at the upstream end of the floodplain and discharges back into the river along the downstream end (***Figure 8-14***).

Ground water samples were collected from background monitoring wells 732 (upgradient) and 733 (downgradient) on the north side of the floodplain (***Figure 8-12***). Ground water samples were also collected from monitoring wells 734, 735, and 736, which were installed in 1993 on the floodplain on the south side of the San Juan River.

Ground water samples were analyzed for the following constituents: aluminum, ammonium, antimony, arsenic, boron, cadmium, calcium, chloride, dissolved organic carbon, dissolved oxygen, fluoride, lead,

Table 8-8 Terrace and floodplain ground water quality results

Indicator parameter	Guideline	Location: Terrace (SHP02) 602 (at source)	Terrace (SHP02) 727 (downgradient)	Floodplain (SHP01) 735 (contaminated)	Floodplain (SHP01) 734 (downgradient)	Floodplain (SHP01) 733 (background)
Sulfate	250[a]	16,600	12,200	4,330	6,920	2,930
Uranium	0.044[b]	0.864	0.465	0.112	0.083	0.026
Nitrate	44[b]	36	2,440	1,360	<1	<1

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Notes: 1. Results are reported in milligrams per liter.
2. Samples collected in January 1994.

< indicates actual is less than the detection limit (number shown).

Figure 8-13
Uranium Concentrations Over Time, Terrace Area

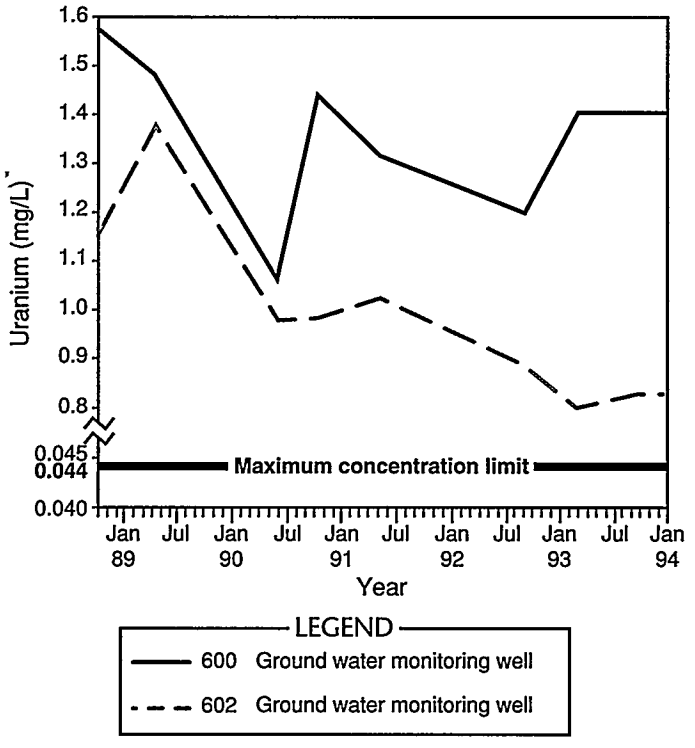

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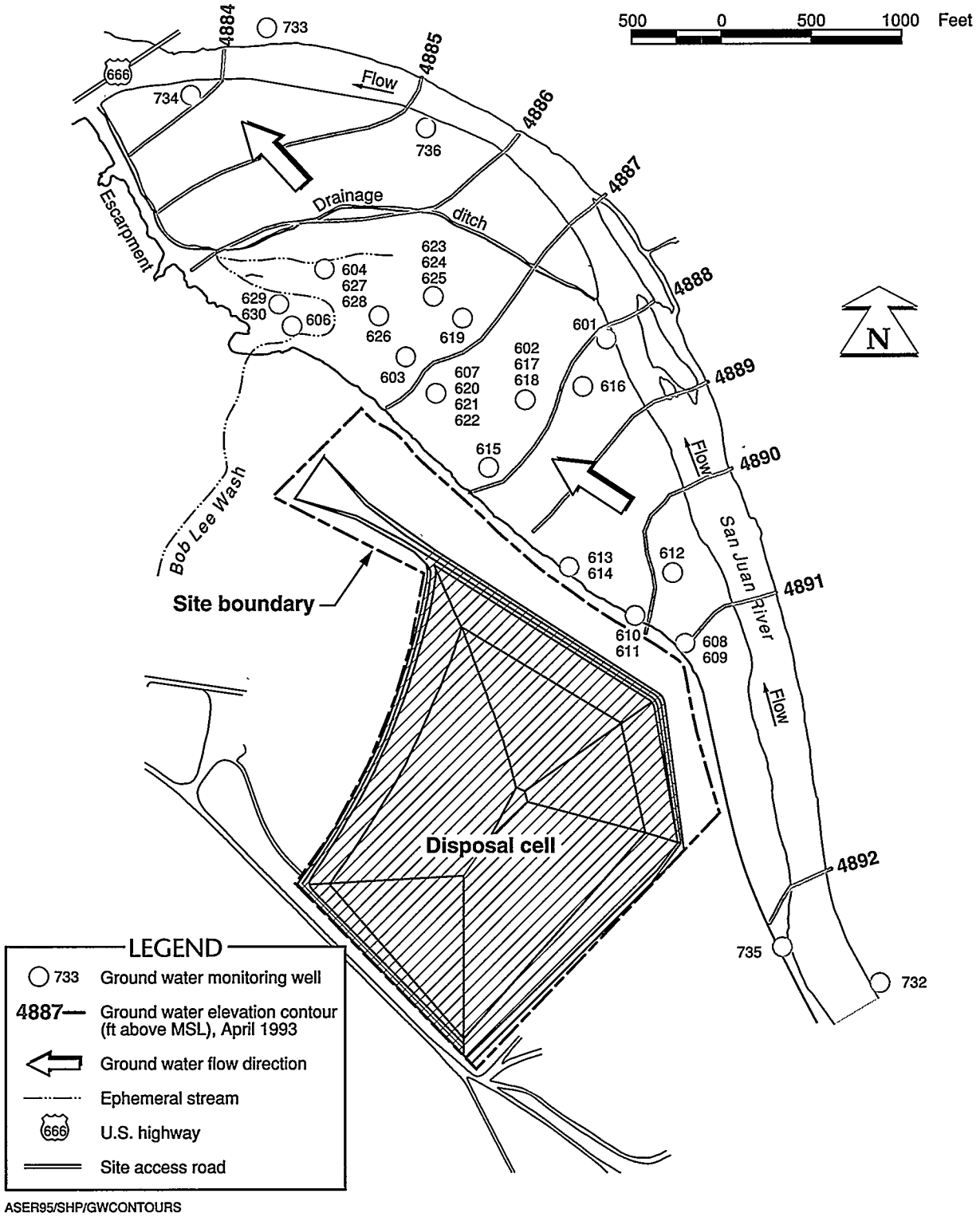
Figure 8-14
Ground Water Table Elevation Contours for the Floodplain Alluvial Aquifer



ASER95/SHP/GWCONTOURS

lead-210, magnesium, manganese, mercury, molybdenum, nickel, nitrate, polonium-210, potassium, radium-226, radium-228, selenium, silica, sodium, strontium, sulfate, thorium-230, total dissolved solids, uranium, vanadium, and zinc.

Floodplain Ground Water Results

All ground water samples collected in 1994 from the floodplain on the south side of the river are affected by the former milling operations. Sulfate, uranium, and nitrate are considered indicators of this contamination. ***Table 8-8*** gives water quality data for these three indicators from well 735 (in the contaminated area near the foot of the escarpment southeast of the disposal cell), well 734 (along the edge of the downstream end of the floodplain), and background well 733.

Ground water samples from wells 732 and 733, on the floodplain north of the river, indicate that sulfate concentrations in background ground water are relatively high, but uranium concentrations are low.

Floodplain Ground Water Conclusions

Ground water levels, measured in April 1993 at monitoring wells on the south side of the river, show that San Juan River water enters the floodplain along the upstream portion of the floodplain and discharges back to the river along the downstream portion (***Figure 8-14***). There is no indication that ground water from the floodplain on the south side of the river could move under the river to the floodplain on the north side. Therefore, the two wells installed during 1993 on the north side of the San Juan River are considered to be representative of background ground water quality beneath the floodplain.

Monitoring well 735, installed at the extreme upstream end of the floodplain on the south side of the river, was expected to provide data on the background ground water quality at that location. Analytical results, however, indicate that ground water at this well is also contaminated.

Contaminant concentrations in the monitoring wells have fluctuated over time, but no significant trends have been observed.

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics*, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

DOE (U.S. Department of Energy), 1994. *Long-Term Surveillance Plan for the Shiprock, New Mexico, Disposal Site*, DOE/AL/62350-60F, prepared by U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material*, Nuclear Regulatory Commission (1994).

United States Code

33 USC §1251 *et seq., Clean Water Act.*

42 USC §4321 *et seq., National Environmental Policy Act.*

42 USC §7401 *et seq., Clean Air Act.*

42 USC §7901 *et seq., Uranium Mill Tailings Radiation Control Act of 1978.*

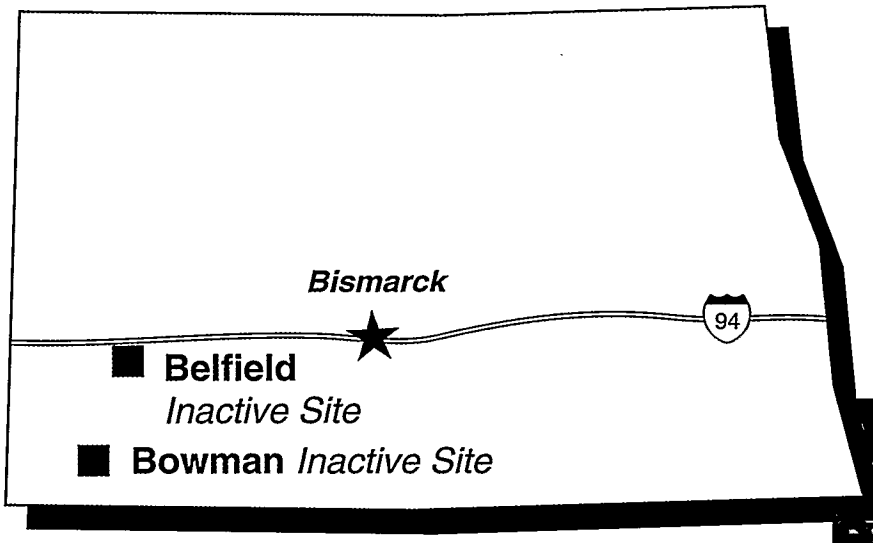
42 USC §9601 *et seq., Comprehensive Environmental Response, Compensation, and Liability Act.*

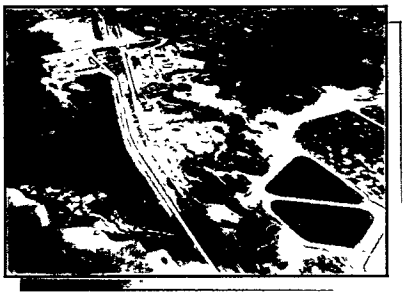
42 USC §11001 *et seq., Emergency Planning and Right-to-Know Act.*

49 USC §1801 *et seq., Hazardous Materials Transportation Act.*

UMTRA PROJECT

CHAPTER 9
NORTH DAKOTA SITES





NORTH DAKOTA SITES

This chapter provides UMTRA Project information on environmental protection program activities at the Belfield and Bowman, North Dakota, sites during 1994.

Numerous documents describe existing conditions at the UMTRA Project sites. These documents are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Belfield

The Belfield site is in Stark County in southwestern North Dakota. Site remedial action is scheduled to begin in 1996. No environmental monitoring was conducted at the Belfield site during 1994 pending resolution of the remedial action status of this site by DOE and the state of North Dakota.

Bowman

The Bowman site is in Bowman County in southwestern North Dakota. Site remedial action is scheduled to begin in 1996. No environmental monitoring was conducted at the Belfield site during 1994 pending resolution of the remedial action status of this site by DOE and the state of North Dakota.

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SITE DESCRIPTION AND LOCATION

The Belfield UMTRA Project site is in Stark county in southwestern North Dakota (*Figure 9-1*), approximately 1 mi southeast of the town of Belfield.

The inactive Belfield lignite ashing site is bounded on the south by the Burlington Northern Railroad tracks and on the north by the North Branch of the Heart River. The site covers 10.7 ac and contains ash-contaminated soil.

Belfield has been affected by the decline in the oil industry that began in 1982. The present population is composed of farmers and small business owners. Area towns are small, with populations ranging between several hundred to several thousand. The 1990 population of Stark County was 22,800. The 1990 population of Belfield was 887 (DOC, 1990).

The site is in the Northern Great Plains and has a semiarid climate. The average annual temperatures recorded 19 mi east of the Belfield site at Dickinson, North Dakota, are 54 °F (maximum) and 30 °F (minimum), with extremes of 105 °F and -35 °F for the 30-year period of record. The annual average rainfall is 16 inches, 80 percent of which falls between April and September. Average annual snowfall is 30 inches. The predominant wind direction recorded at Dickinson is west-northwest at an average annual speed of 13 mi per hour.

SITE HISTORY AND OWNERSHIP

Uraniferous lignite was processed at the Belfield site in the 1960s. Uranium-rich ash from the rotary kiln process was loaded into rail cars and transported to uranium mills in Rifle, Colorado, and Ambrosia Lake, New Mexico. Ash-contaminated soil remains at the processing site.

The site is used for commercial, light industrial, and agricultural activities.

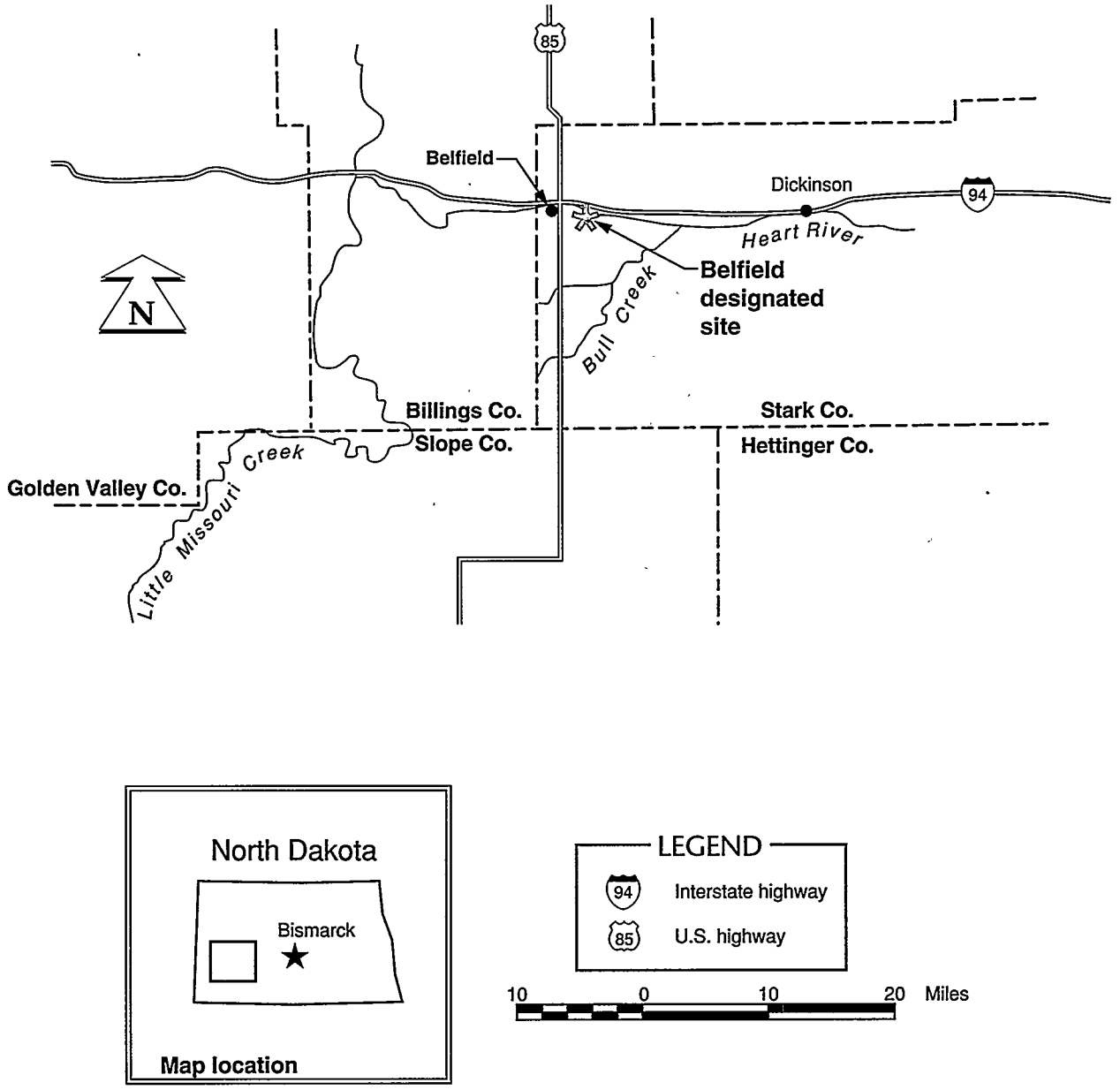
The Burlington Northern Railroad and Gary and Julie Newton of Belfield own the Belfield site. A construction company (L.P. Anderson Construction), a propane supply company (Cenex), and a rabbit grower currently occupy the site.

SITE CHARACTERIZATION AND CLEANUP

The Belfield designated processing site covers 10.7 ac. An additional 20 ac have been contaminated by windblown material, creating approximately 58,000 cubic yards of ash-contaminated soil requiring remediation. Remedial action for this site probably will be carried out through a remedial action agreement with the property owners. The ash-contaminated soils have slightly elevated concentrations of molybdenum, arsenic, and radium-226.

In the proposed remedial action, scheduled to start in fiscal year 1996, all residual radioactive material from the Belfield site will be relocated

Figure 9-1
Belfield Site Location



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to the Bowman site for codisposal. Materials from both sites will be consolidated and stabilized in a single disposal cell. The disposal cell will be covered with a low-permeability infiltration/radon barrier and erosion protection cover to ensure long-term stability of the cell, retard infiltration, reduce seepage of tailings fluids to ground water, and prevent radon emanation.

Remedial action will also include cleanup of vicinity properties. Vicinity properties are properties outside the designated site boundary that have been contaminated by dispersed lignite ash or by the removal and use of contaminated soils before the potential hazards were known.

ENVIRONMENTAL COMPLIANCE STATUS

National Environmental Policy Act

In compliance with NEPA (42 USC 4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995.

ENVIRONMENTAL MONITORING

Because surface remedial action at the Belfield site has not begun, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. Furthermore, surface water and ground water were not sampled during 1994.

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SITE DESCRIPTION AND LOCATION

The Bowman UMTRA Project site is in Bowman County in southwestern North Dakota (*Figure 9-2*). The Bowman site is approximately 7 mi west of the town of Bowman (DOC, 1990). Bowman is about 65 mi southwest of the Belfield site.

The Bowman lignite ashing site is bounded by the Burlington Northern Railroad tracks on the north and cultivated fields and pastureland on the east, south, and west. The 12.1-ac site is separated into two tracts by an unpaved county road and is overgrown with nonnative grasses. Structures and equipment used at the site have been removed; only a small amount of concrete rubble and a few pieces of piping remain.

In 1990, the population of the town of Bowman was 1740 and the population of Bowman County was 3600 (DOC, 1990).

Data recorded at the Bowman weather station 7 mi east of the site are almost identical to those recorded at Dickinson, North Dakota. Bowman and Dickinson are in the Northern Great Plains, where the climate is semiarid. The average annual temperatures recorded at Dickinson are 54 °F (maximum) and 30 °F (minimum), with extremes of 105 °F and -35 °F for the 30-year period of record. The annual average rainfall is 16 inches, 80 percent of which falls between April and September. The average annual snowfall is 30 inches. The predominant wind direction recorded at Dickinson is west-northwest, with an average annual speed of 13 mi per hour.

SITE HISTORY AND OWNERSHIP

Uraniferous lignite was processed at the Bowman site in the 1960s. Uranium-rich ash from the rotary kiln process was loaded into rail cars and transported to uranium mills in Rifle, Colorado, and Ambrosia Lake, New Mexico.

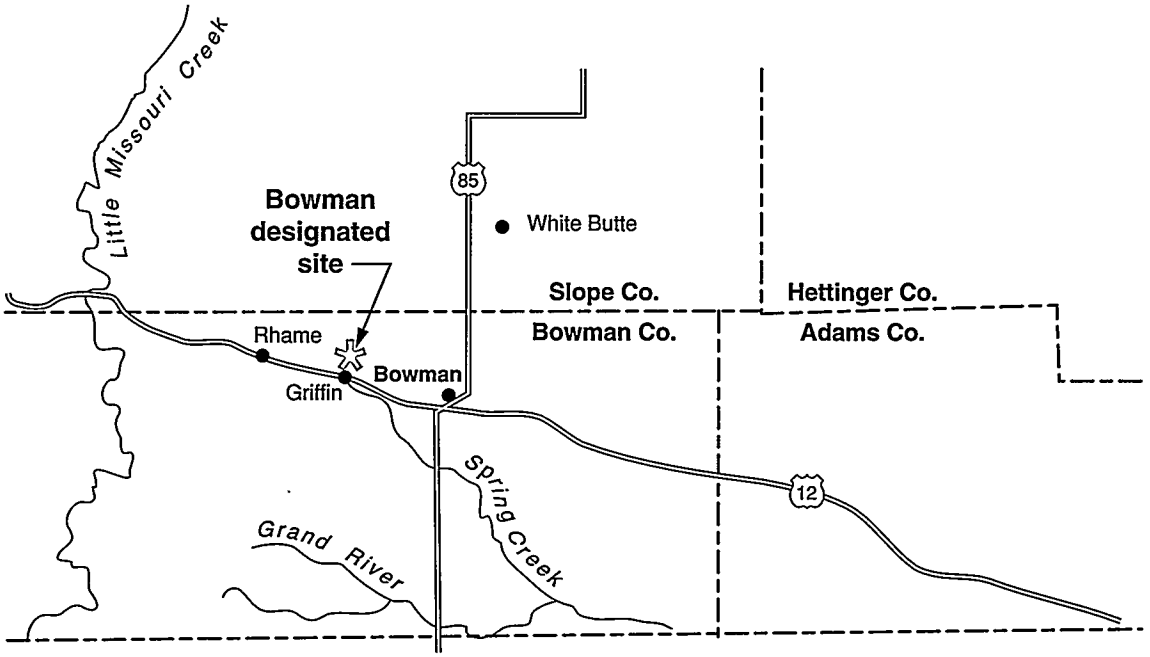
The Bowman site is on private property owned by Roger Stearns. In fiscal year 1995, the DOE will authorize the state of North Dakota to acquire the privately owned tracts within the site boundaries. The acquisition will be based on recent state appraisals.

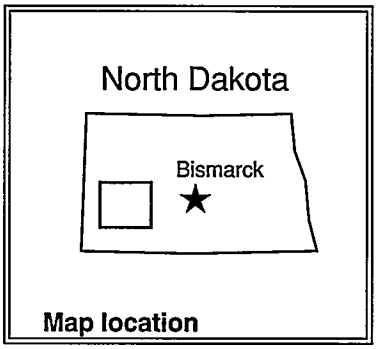
SITE CHARACTERIZATION AND CLEANUP

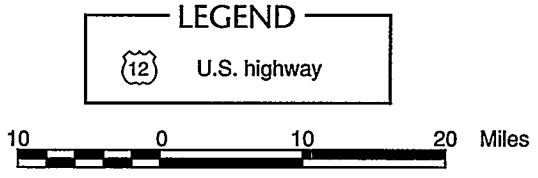
The Bowman designated processing site is 12.1 ac. An additional 53 ac have been contaminated by windblown materials, creating approximately 128,400 cubic yards of ash-contaminated soils that require remediation. The ash-contaminated soils have slightly elevated concentrations of molybdenum, arsenic, and radium-226.

In the proposed remedial action, scheduled to start in fiscal year 1996, all residual radioactive material from both the Belfield and the Bowman sites will be consolidated and stabilized in a single disposal cell on the Bowman site. The disposal cell will be covered with a low-permeability infiltration/radon barrier and erosion protection cover to ensure long-term stability of the cell, retard infiltration, reduce seepage of tailings fluids to ground water, and prevent radon emanation.

Figure 9-2
Bowman Site Location







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Remedial action will also include cleanup of one associated vicinity property. Vicinity properties are properties outside the designated site boundary that have been contaminated by dispersed lignite ash or by the removal and use of contaminated soils before the potential hazards were known.

ENVIRONMENTAL COMPLIANCE STATUS

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. The draft was prepared in 1994 and was awaiting DOE approval for publication and distribution for public review. Public hearings on the draft will beheld in 1995.

ENVIRONMENTAL MONITORING

Because surface remedial action at the Bowman site has not begun, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. Furthermore, surface water and ground water were not sampled during 1994.

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics,* Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

Code of Federal Regulations

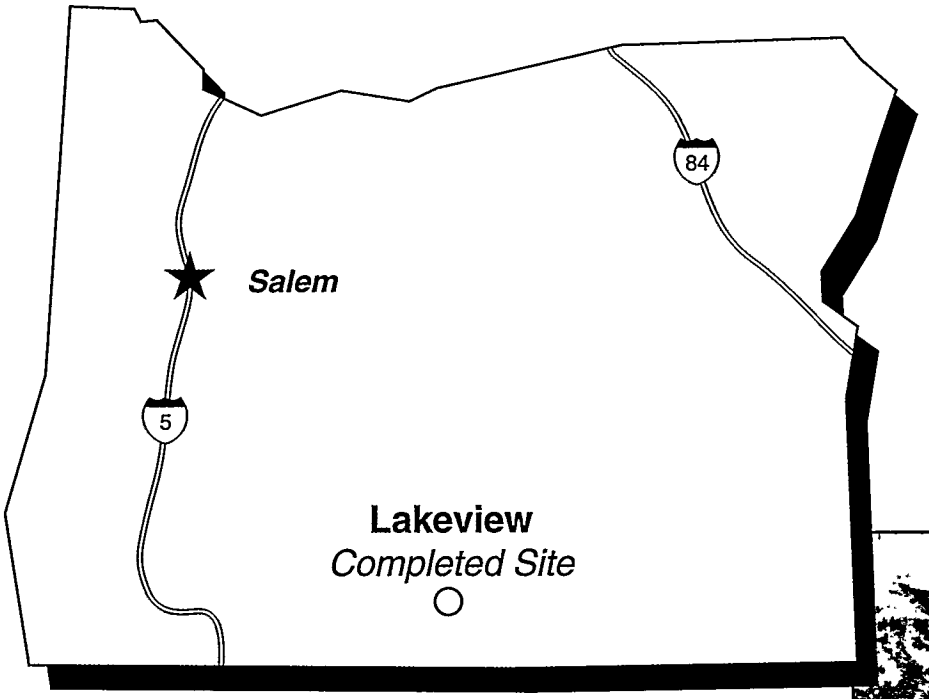
40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

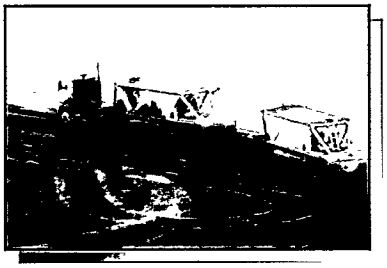
United States Codes

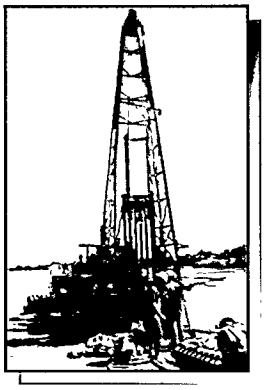
42 USC §4321 et seq., *National Environmental Policy Act.*

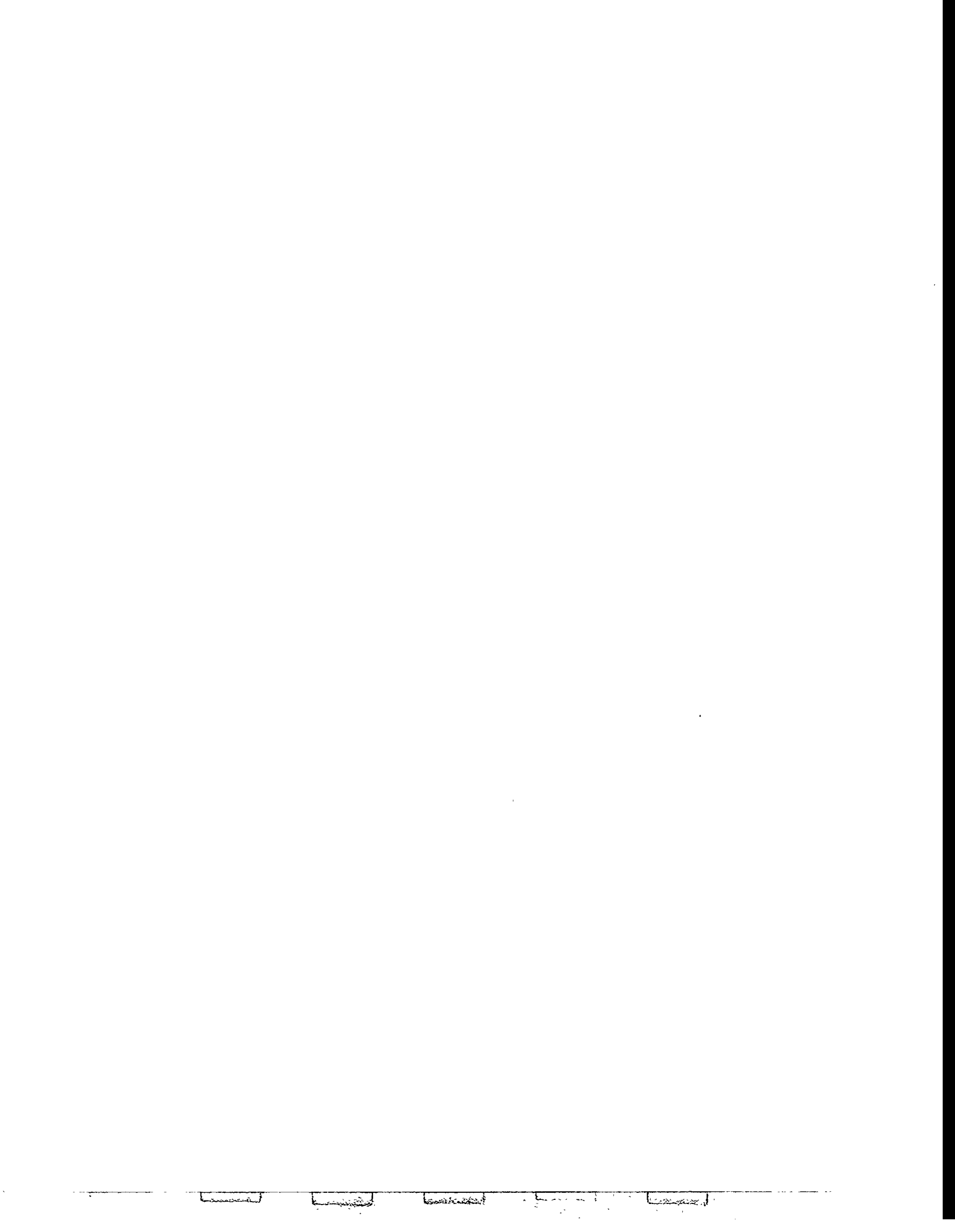
UMTRA PROJECT

CHAPTER 10
OREGON SITE









OREGON SITE

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at the Lakeview, Oregon, site during 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental assessments and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Lakeview

The Lakeview site is in Lake County in south-central Oregon. Site remedial action was completed in October 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, surface water and ground water were monitored in 1994 for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

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SITE DESCRIPTION AND LOCATION

The Lakeview processing site is approximately 1.5 mi northwest of the town of Lakeview in Lake County, Oregon (*Figure 10-1*). Klamath Falls is about 96 mi west of the site, and the California-Oregon border is approximately 16 mi south.

The Lakeview processing site covers 258 ac; approximately 30 ac were covered by the tailings pile, approximately 64 ac contained the evaporation ponds, and approximately 164 more acres were occupied by the former mill structures, the former ore storage area, and miscellaneous areas.

The areas north and west of the processing site are swampy during much of the year due to the high water table and geothermal springs. East of the site, the land is swampy during the spring and early summer and remains dry until fall and winter.

The Lakeview disposal site, also known as the Collins Ranch disposal site, is located about 7 mi north of the processing site near the northern end of Goose Lake Valley, a large flat mountain valley at 4750 ft above MSL (*Figure 10-1*). Mountain peaks in surrounding ranges to the east and west (in the Fremont National Forest) reach elevations of more than 8000 ft above MSL. The area contains many lakes; the largest is Goose Lake, about 17 mi south of the disposal site. Vegetation consists of pine cover in the higher mountain areas with trees, sage, and scrub brush in the foothills. The valleys are grassy meadows used primarily as ranch land.

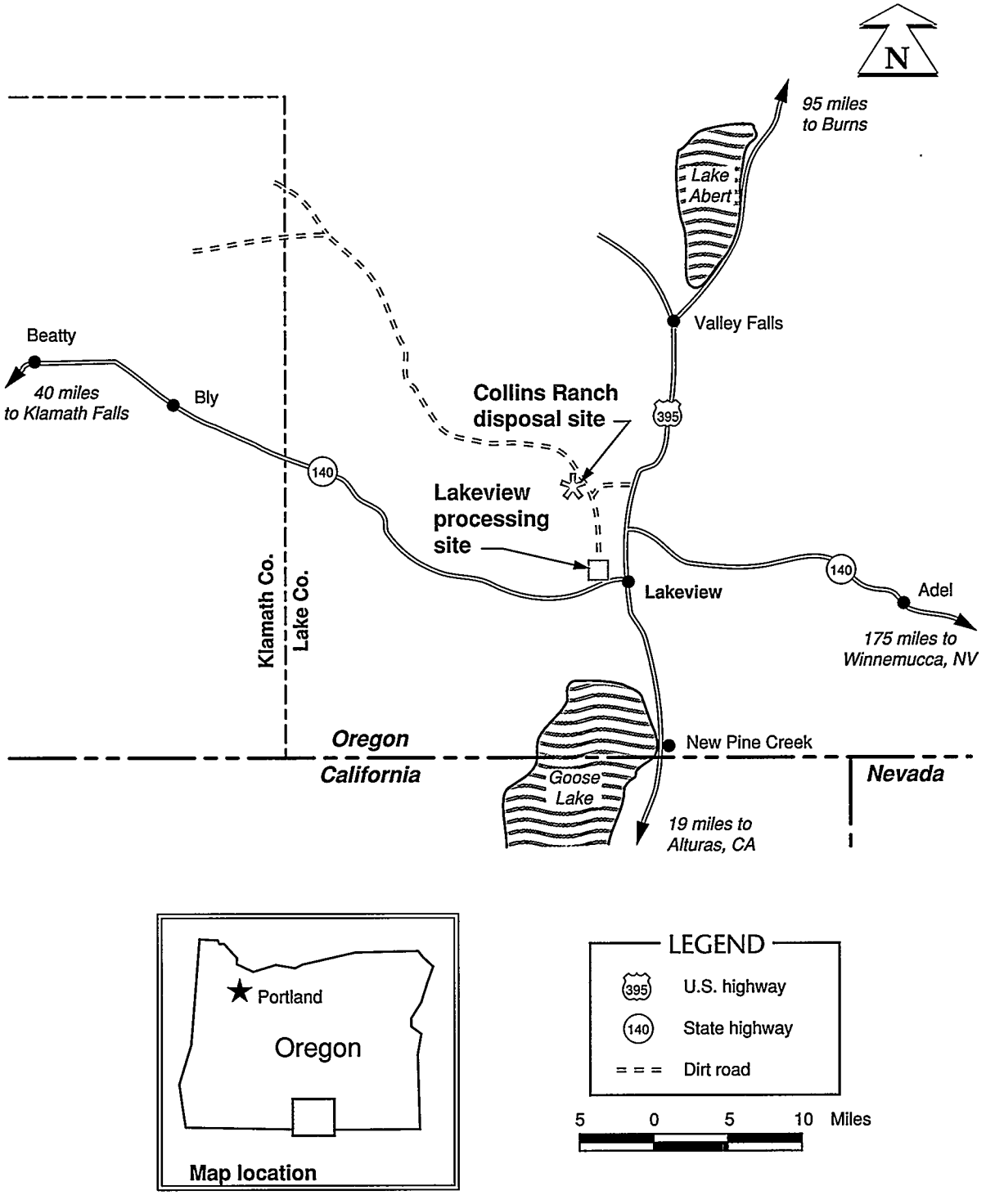
The nearby city of Lakeview is the major population center in Lake County. The estimated 1993 Lakeview population was 2530. The 1990 population of Lake County was 7186 (DOC, 1990).

Lakeview receives moderate amounts of precipitation (2.5 inches in both December and January), mostly in the form of sleet and snow; light snow (1 to 2 inches per month during the spring and fall), and minor rainfall (0.25 to 0.5 inch per month during summer). Average annual precipitation is 16 inches, with 61 inches of snow. Average high summer temperatures are 70 °F to 80 °F; average winter lows are below 25 °F.

SITE HISTORY AND OWNERSHIP

The Lakeview Mining Company constructed the Lakeview uranium processing mill in 1958. Between 1960 and 1978, the property had six owners, including the Atlantic Richfield Company. Atlantic Richfield conducted a cleanup operation on the site under a plan approved by the Oregon State Health Division. In 1977, the property was sold to Precision Pine Lumber Company, which used the site and structures as a lumber mill and stockpile for sawdust and scrap waste. In 1987, Goose Lake Lumber Company purchased the property containing the mill buildings, office area, and acreage for timber storage. Precision Pine Lumber Company retained title to the former tailings pile area

Figure 10-1
Lakeview Site Location



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until it was sold to John Ryan. Portions of the site were subsequently acquired by the county.

From 1958 to 1961, the mill treated 130,000 tons of ore using a sodium chlorate and sulfuric acid leach process. Ore processed at the mill site came from the White King and Lucky Lass mines, approximately 16 road miles northwest of Lakeview.

Although the state of Oregon presently holds title to the Lakeview disposal site, the site is surrounded by ranch land owned by John and Bridget Collins. The disposal site title is being processed for transfer from the state to the federal government. When the title transfer process is complete, the NRC will proceed with site licensing.

SITE CHARACTERIZATION AND CLEANUP

Atlantic Richfield conducted remedial action activities from 1974 to 1977 at the Lakeview tailings site, cleaning up and stabilizing the former mill area, partially excavating material in the evaporation ponds, and applying cover material over the tailings pile. The DOE remedial action began in September 1986 and was completed in October 1989. During this remedial action, 736,000 tons of dry uranium mill tailings were moved about 7 mi from the old mill site to the Collins Ranch/Lakeview disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

Surface remedial action at the Lakeview site is complete. The remaining surface-related compliance issues for the disposal site are NRC licensing under the provisions of 10 CFR Part 40 and continued surveillance and maintenance. This continued surveillance and maintenance includes point-of-compliance ground water monitoring, as defined in the site long-term surveillance plan (DOE, 1994).

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples were collected from the processing site and analyzed to further evaluate the ground water contamination resulting from the former uranium processing site activities.

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Public scoping meetings for this document were held in 1993, and the preparation of the draft took place in 1994. The draft is in DOE Headquarters in Washington D.C. awaiting final approval for publication and distribution for public review. Public hearings on the draft programmatic environmental impact statement will be held in 1995.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Lakeview site for contaminants in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the

environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Lakeview site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA Project environmental monitoring program in 1994.

Surface Water Monitoring

Surface water and sediment sampling were not conducted at the Lakeview processing or disposal site during 1994.

Ground Water Monitoring

Processing Site

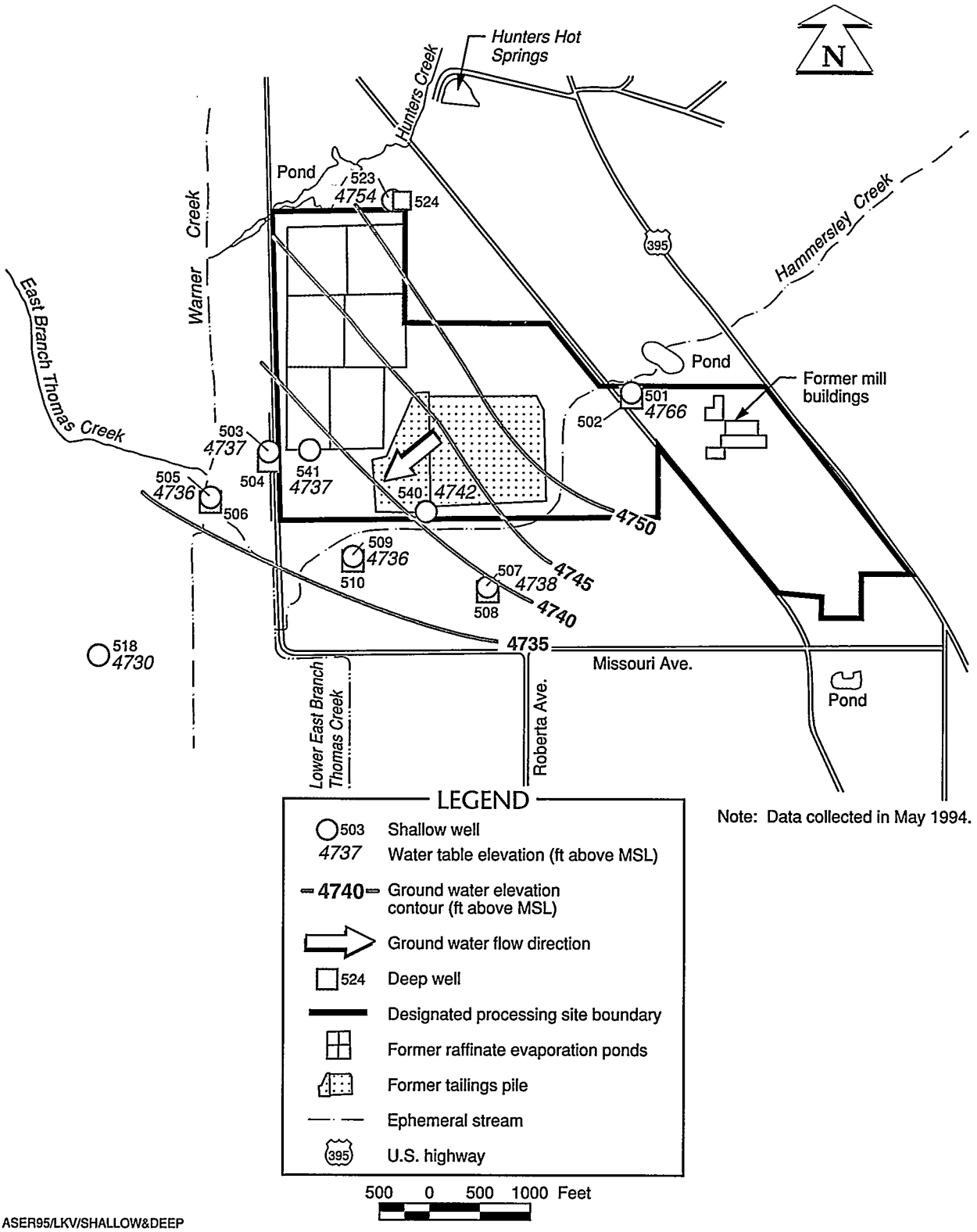
In 1994, ground water samples were collected at the former Lakeview processing site to monitor water quality changes that have occurred since the removal of the tailings pile, evaporation ponds, and associated contaminated soil. To assess the extent of ground water contamination caused by former processing activities, the baseline ground water quality was compared to the background ground water quality and the EPA maximum concentrations limits in 40 CFR Part 192. Background ground water quality is defined as the quality of ground water that would be expected at the site if uranium processing activities had not occurred. Conversely, baseline ground water quality (measured at a monitoring well) is defined as water quality influenced by uranium processing activities.

A known geothermal resource area, Hunters Hot Springs, is located approximately 2000 ft north of the former mill site. Hunters Hot Springs provide an upgradient source of thermal water that recharges surface water and ground water sources in the site vicinity. The presence of Hunters Hot Springs leads to two distinct types of background ground waters: geothermal ground waters influenced by Hunters Hot Springs, and nongeothermal ground water found upgradient of the tailings site area of the site. (See ***Figure 10-4***.)

The former processing site is underlain by more than 2000 ft of unconsolidated sediments. Shallow unconsolidated silt and sandy clay (from the ground surface to approximately 20 ft deep) are underlain by discontinuous lenses of unconsolidated to consolidated water-bearing gravels, sands, and silts. DOE monitoring wells used to characterize the ground water quality at the former processing site generally consist of clusters of two wells: a shallow well screened and filter-packed from about 16 to 30 ft deep, and a deeper well screened and filter-packed from about 70 to 80 ft. ***Figure 10-2*** shows shallow and deep DOE monitoring well locations at the processing site.

Measuring water elevations better defines ground water movement and the relationship between ground water and surface water. ***Figure 10-2*** shows the water table elevation contours of the shallow ground water zone at the processing site. The ground water table beneath the

Figure 10-2
Water Table Elevation Map and Shallow and Deep Well Locations, Processing Site



Lakeview processing site generally occurs 4 to 10 ft below land surface, under unconfined to semiconfined conditions. Ground water moves southwest at estimated average linear flow velocities of 50 ft per year in the shallow zone and 160 ft per year in the deep zone. These zones are hydraulically connected.

The following DOE monitoring wells were sampled in May 1994: 501 through 510, 523, 524, 540, and 541. Well 501 and 502 are low-temperature background monitoring wells. Wells 523 and 524 are high-temperature (geothermal) background monitoring wells. The remaining wells are downgradient from the former evaporation pond area and/or the tailings pile areas (***Figure 10-2***).

Seven private wells were sampled in May 1994. These wells are located downgradient from the former processing site beyond the extent of the contaminant plume (***Figure 10-3***).

Filtered and unfiltered ground water samples were collected from DOE monitoring wells and from private wells, then analyzed for the following field parameters: alkalinity, dissolved oxygen, ferrous iron, oxidation-reduction potential, pH, specific conductivity, and temperature. Laboratory analyses were conducted for the following analytes: ammonium, arsenic, calcium, chloride, fluoride, iron, magnesium, manganese, molybdenum, nickel, potassium, silica, sodium, strontium, sulfate, tin, total dissolved solids, total organic carbon, uranium, vanadium, and zinc.

Lakeview processing site ground water quality results are summarized in ***Table 10-1***. In addition to total dissolved solids and sulfate, arsenic and molybdenum were selected as indicator parameters because they have historically exceeded their maximum concentration limits. Manganese, iron, vanadium, nickel, tin, and zinc also were analyzed to assess potential risks to human health and the environment. Major cationic and anionic constituents and the field parameters are analyzed to track changes in background and baseline ground water quality and in contaminant migration.

Sulfate appears to best define the extent of site-related contamination in ground water. The distribution of sulfate concentration data suggests that separate contaminated areas are associated with the location of the former tailings pile and evaporation ponds (***Figure 10-4***). These areas are also influenced by different types of background ground water (nongeothermal or geothermal; ***Figure 10-4***). Geothermal background ground water is influenced by Hunters Hot Springs. It typically has higher temperatures and a different geothermal signature than nongeothermal ground water.

Figure 10-3
Domestic Well Sampling Locations, Processing Site Vicinity

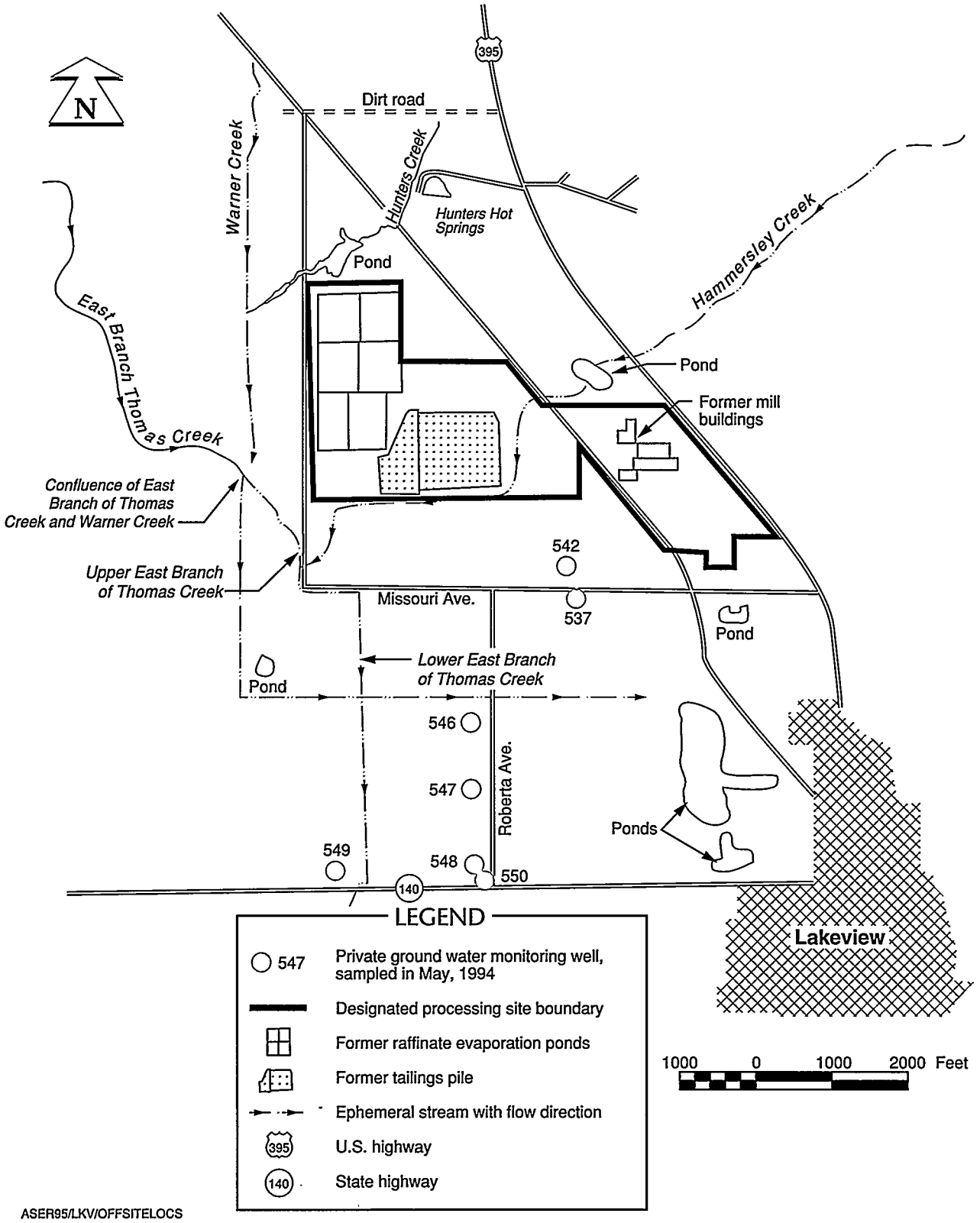


Table 10-1 Ground water quality results, processing site

Well location	Total dissolved solids (500[a])	Sulfate (250[a])	Arsenic (0.05[a])	Molybdenum (0.1[b])	Uranium (0.044[b])
Nongeothermal ground water influence					
Background well 501	154	3	<0.005	<0.01	<0.001
Contaminated well 540	4000	2970	<0.005	<0.01	0.005
Geothermal ground water influenced					
Geothermal background well 524	640	203	0.038	0.05	<0.001
Contaminated monitoring well 503	6490	3340	0.072	0.12	<0.001
Downgradient monitoring well 505	3950	1870	0.006	0.17	<0.001
Downgradient domestic wells					
Domestic well 537	268	8	<0.005	<0.01	<0.001
Domestic well 546	308	7	0.009	<0.01	<0.001
Domestic well 548	4380	1030	0.007	<0.01	<0.001

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Notes: 1. Concentrations are reported in milligrams per liter. Samples were unfiltered.
2. All samples collected May 1994.

< – indicates actual is less than the detection limit (number shown).

Ground Water Results and Conclusions

Processing Sites

Ground water elevation data show that ground water flow direction has remained relatively stable over time. Water levels are expected to fluctuate as a result of natural recharge and discharge and localized pumpage in private wells.

Compared with historical water quality data, analytical results of ground water samples collected during 1994 indicate no significant changes in water quality. ***Figure 10-5*** graphs sulfate trends over the past 10 years. Sulfate concentrations are very low in nongeothermal background ground water (less than 20 mg/L) and somewhat higher in geothermal background ground water (about 200 mg/L). Ground water has higher sulfate concentrations (2,600 to 3,400 mg/L) in contaminated wells influenced by both nongeothermal (monitoring well 540) and geothermal ground water (monitoring well 503). Downgradient, sulfate concentrations decrease significantly as distance from the processing site increases (monitoring well 518). ***Table 10-1*** compares selected ground water quality results for nongeothermal monitoring well 501 and geothermal monitoring well 524 to downgradient monitoring wells influenced by the two types of background ground waters.

Figure 10-4
Sulfate Concentrations in the Shallow Aquifer, Processing Site

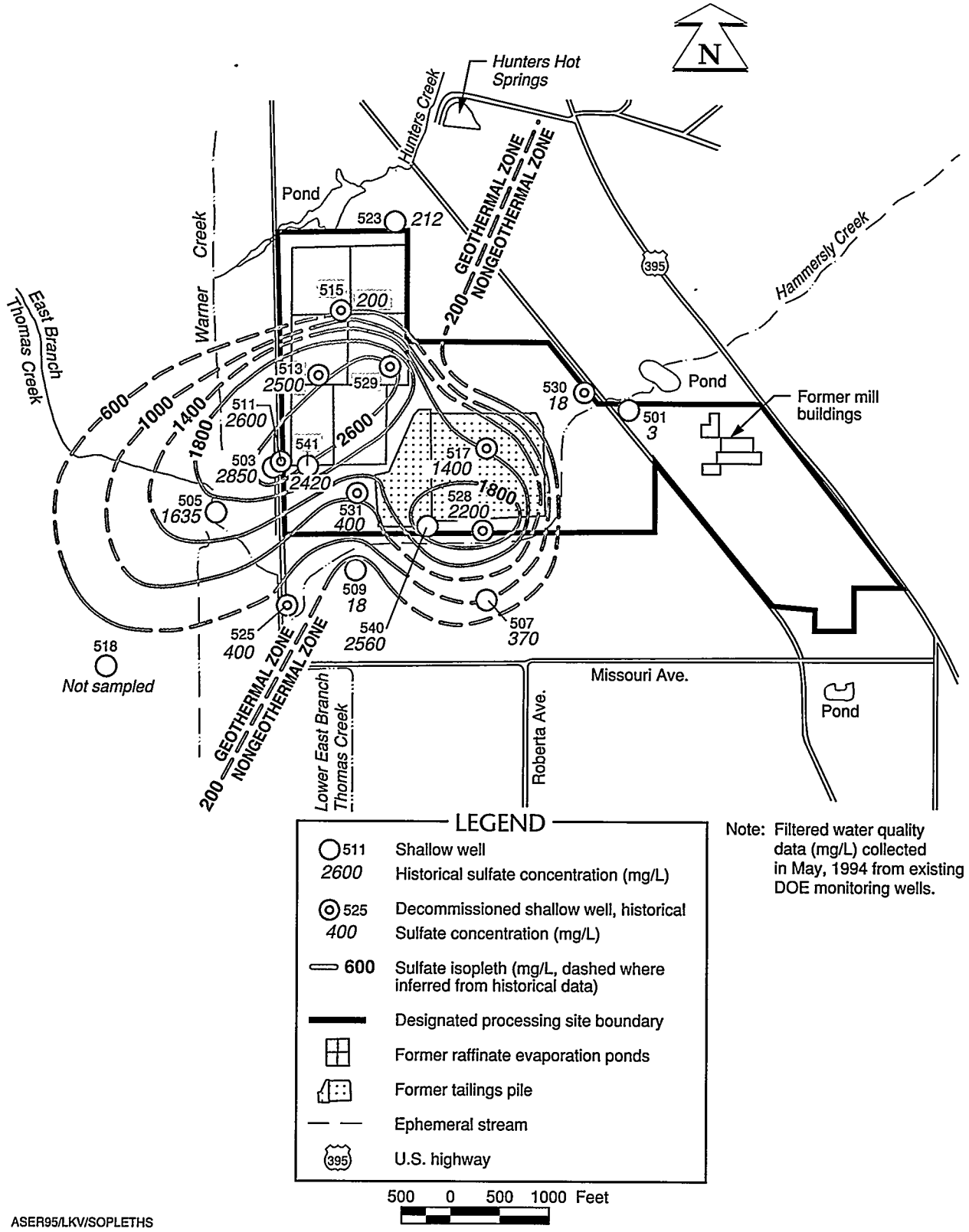
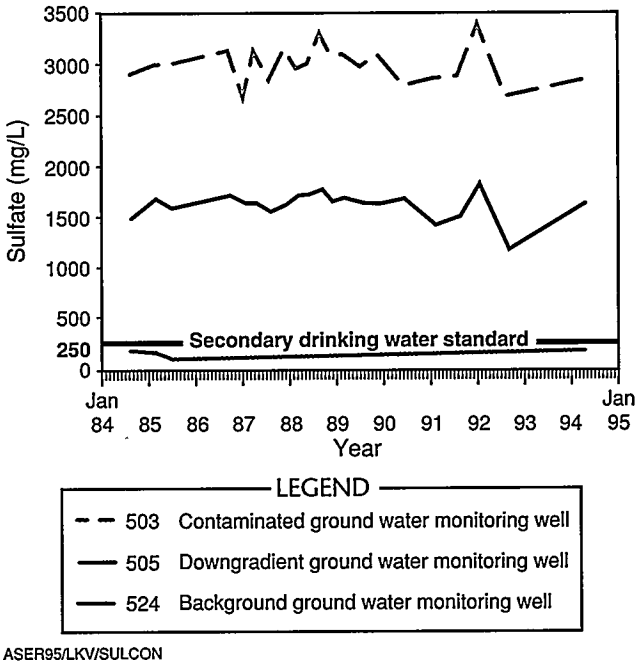


Figure 10-5
Sulfate Concentrations Over Time in the Lacustrine Aquifer, Processing Site



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Arsenic and molybdenum exceeded maximum concentration limits in the shallow zone in 1994. Of the potentially hazardous constituents that do not have maximum concentration limits, only chloride, manganese, iron, sodium, and sulfate exceeded background values in wells screened within this zone in 1994.

There were no exceedances of maximum concentration limits in samples collected from monitor wells completed in the deeper zone of the aquifer.

Ground water samples collected in previous years from DOE wells downgradient of the Lakeview processing site show the shallow ground water is affected by the former uranium milling activities. Two hazardous constituents, arsenic and molybdenum, are of particular concern. Manganese concentrations were significantly elevated compared to background. However, lumber-milling activities and elevated naturally occurring concentrations in the area also may contribute manganese to the ground water. Therefore, elevated manganese concentrations may not be related solely to uranium processing activities.

Arsenic concentrations were also significantly elevated above background. However, arsenic also occurs naturally in geothermal ground waters such as in the deep background monitoring well 524

(*Table 10-1*). Therefore, elevated arsenic also may not be solely related to uranium processing activities.

Locations of downgradient domestic wells sampled in 1994 are given in *Figure 10-3*; representative results are provided in *Table 10-1*. Wells located south-southeast of the site (for example, well 537) have a nongeothermal ground water source and do not appear to be influenced by site-related contamination. Wells located in an area about 1 mi south of the site (wells 548 and 550) contain poor-quality ground water with elevated levels of total dissolved solids and sulfate.

However, ground water in these wells is not thought to be influenced by site-related contamination because of their distance from the known area of contamination, lack of site-specific indicators such as molybdenum and uranium, and lack of continuity with the identified area of contamination. For example, domestic well 546, located between the area of site-related contamination and domestic wells 548 and 550, has low levels of sulfate and total dissolved solids (*Table 10-1*), suggesting that the elevated sulfate in wells 548 and 550 is independent of the site.

Disposal Site

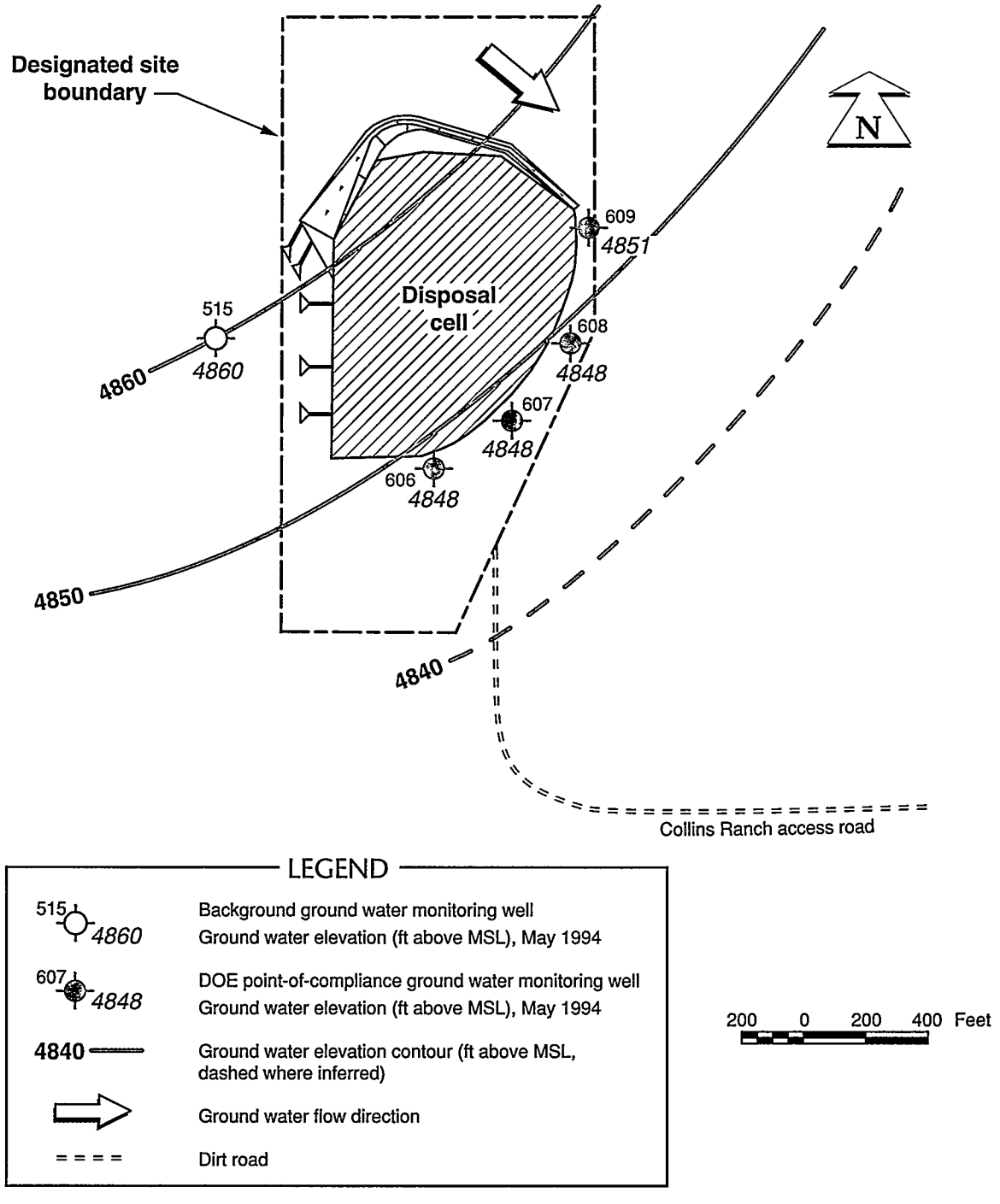
Contaminated materials from the former Lakeview processing site were moved to the Collins Ranch site for disposal. The disposal cell is designed for long-term containment of contaminated process materials. Ground water monitoring is required at the disposal site to assess the potential releases of contaminants to ground water.

The Collins Ranch disposal site is underlain by up to 1000 ft of unconsolidated to consolidated sands, silts, and high-plasticity clays from ancient lakebeds.

Figure 10-6 shows the DOE monitoring well locations at the Collins Ranch disposal site that were sampled in 1994. *Figure 10-6* also shows water table contours. Ground water beneath the disposal site ranges from 10 ft below land surface upgradient of the disposal cell to 125 ft below land surface downgradient of the disposal cell at the point of compliance. Unconfined to semiconfined ground water is expected within the fine silty sands and clayey silts. Ground water flows primarily southeast, with an approximate linear ground water velocity of 10 to 20 ft per year.

At the disposal cell, nine DOE monitoring wells (515, and 606 through 609) were sampled in May 1994 to monitor baseflow conditions. Monitoring well 515 is the background (upgradient) monitoring well closest to the disposal cell. Wells 606 through 609 are DOE point-of-compliance monitoring wells, at the downgradient edge of the disposal cell (*Figure 10-6*). These wells are screened approximately 150 ft below land surface. Point-of-compliance wells 602, 603, 604, and 605, screened at approximately 100 ft below land surface, were not sampled

Figure 10-6
Ground Water Table Contours for the Lacustrine Aquifer, Disposal Site



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in 1994 because there was insufficient water in the well to allow sample collection.

Ground water samples collected in 1994 were analyzed for the following field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, and temperature. Laboratory analyses were conducted for the following analytes: arsenic, cadmium, calcium, chloride, fluoride, iron, potassium, magnesium, manganese, molybdenum, nickel, sodium, silica, strontium, sulfate, total dissolved solids, uranium, vanadium, and zinc.

Ground water elevation data at the Lakeview disposal site show that the direction of ground water flow has remained relatively stable over time. Ground water levels are expected to fluctuate from variations in natural recharge (precipitation and snowmelt). Compared with historical water quality data, analytical results of ground water samples collected during 1994 indicate no significant changes in ground water quality.

Concentrations or activities of all measured hazardous constituents downgradient of the disposal cell were comparable to background values and in 1994 were below the established maximum concentration limits in the point-of-compliance wells. Water quality of background ground water at the disposal site was compared to samples collected from the point of compliance. No significant differences were noted between the water quality upgradient of the disposal cell from that at the point of compliance. Water quality data collected from the point-of-compliance wells demonstrate the disposal cell is performing in accordance with the design requirements.

ECOLOGICAL MONITORING

The vegetative study at the Collins Ranch disposal cell, which had been ongoing since 1991, was not conducted in 1994. Vegetation monitoring at this disposal cell will be conducted in 1995.

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics*, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

DOE (U.S. Department of Energy), 1994. *Long-Term Surveillance Plan for the Collins Ranch, Disposal Site, Lakeview, Oregon*, DOE/AL/62350-19F, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Material*, Nuclear Regulatory Commission.

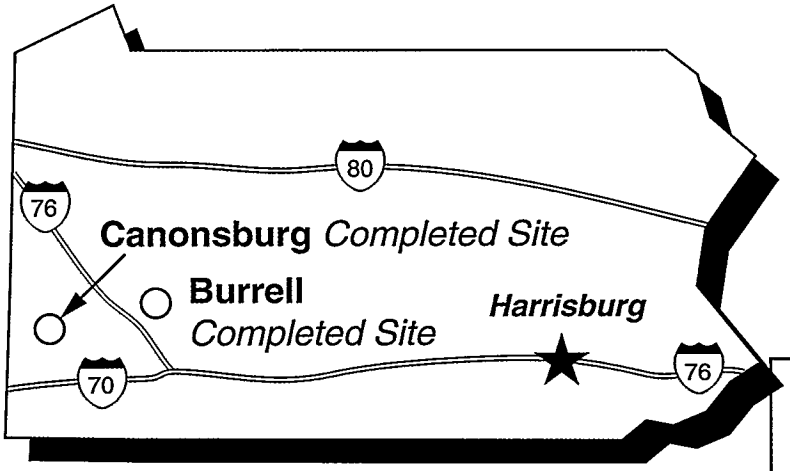
40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency.

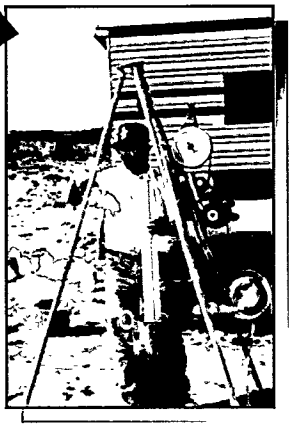
United States Code

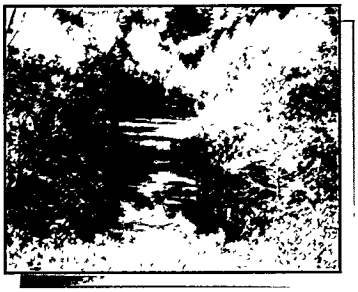
42 USC §4321 *et seq.*, *National Environmental Policy Act.*

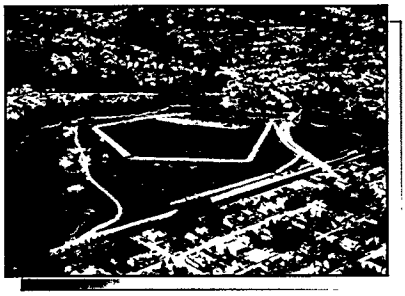
UMTRA PROJECT

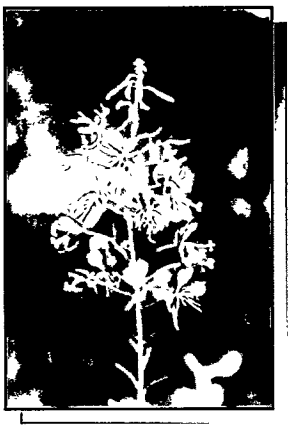
CHAPTER 11
PENNSYLVANIA SITES

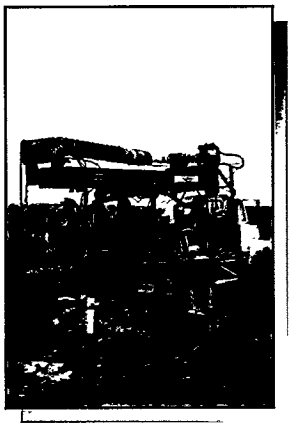


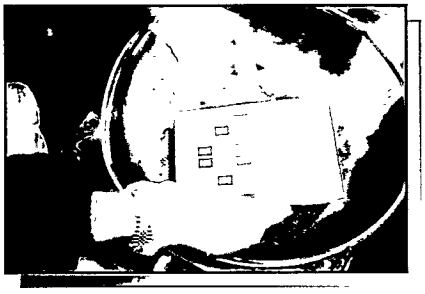












PENNSYLVANIA SITES

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at the Burrell and Canonsburg, Pennsylvania, sites, during 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Burrell

The Burrell site is in Indiana County in southwestern Pennsylvania. Site remedial action was completed in July 1987. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. Under the long-term surveillance and maintenance plan, the DOE Grand Junction Projects Office is responsible for sampling surface water and ground water at the Burrell site.

Canonsburg

The Canonsburg site is in Washington County in southwestern Pennsylvania. Site remedial action was completed in December 1985. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

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SITE DESCRIPTION AND LOCATION

The Burrell site is not one of the uranium processing sites designated in the UMTRCA (42 USC §7901 *et seq.*), but is considered a vicinity property associated with the Canonsburg, Pennsylvania, site. The Burrell site is an inactive landfill, 1 mi east of the borough of Blairsville (population 3595), in rural southwestern Pennsylvania (***Figure 11-1***) in Indiana County (population 89,994) (DOC, 1990). The property is bordered on the south by the Conemaugh River and on the north by the Conrail railroad tracks. The site ranges in elevation from approximately 930 ft above MSL at the Conemaugh River to approximately 1005 ft at the top of the tailings embankment. The Burrell vicinity property covers approximately 72 ac.

The Burrell site is in the humid continental climate region. This region experiences distinct seasons that are slightly moderated by the Great Lakes and the Atlantic seaboard. The average annual temperature is approximately 50 °F. The average annual precipitation is 44 inches. The wind is predominantly from the west and northwest. Wind distribution reflects a strong topographical influence on local wind conditions, with an annual average wind speed of 4.7 mi per hour.

SITE HISTORY AND OWNERSHIP

The Pennsylvania Railroad owned and operated the Burrell site as a railroad landfill from 1956 to 1957. A total of 86,000 wet tons of radioactively contaminated material was removed from the Canonsburg site and placed at the Burrell site. The radioactively contaminated material was moved by railroad from Canonsburg and dumped into the landfill.

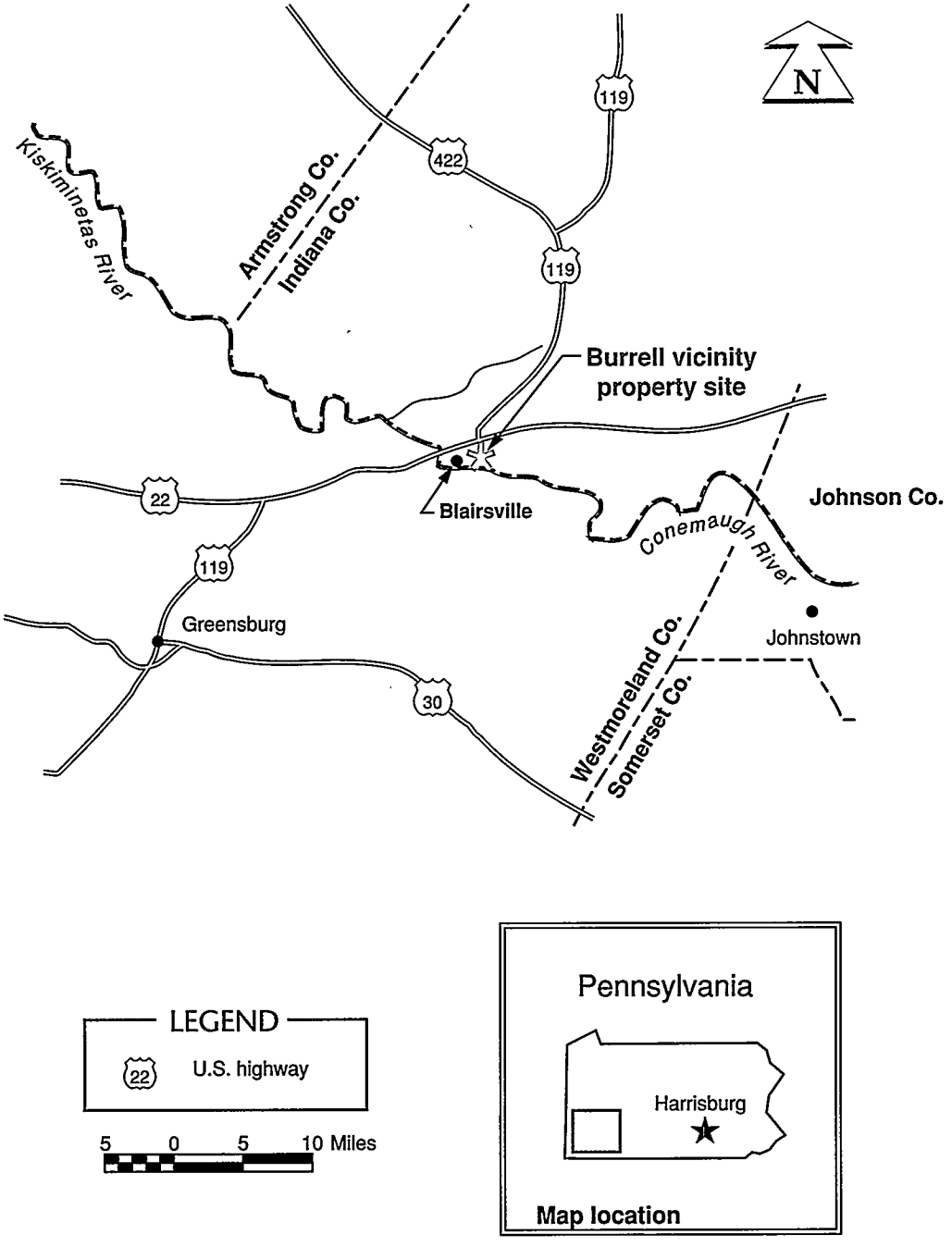
Civil action in the United States District Court for the western district of Pennsylvania finalized federal acquisition of the Burrell site in 1988. In accordance with this civil action, the federal government is the recorded owner of the Burrell site.

SITE CHARACTERIZATION AND CLEANUP

A one-time disposal operation caused the radiological contamination at the Burrell site. From October 1956 through January 1957, Vitro Rare Metals Company disposed of radioactively contaminated materials that reportedly contained carbonate cake, pitchblende, calcium fluoride, and magnesium fluoride. The total radium-226 and uranium-238 activity in the contaminated materials was estimated at 4 curies and 1.3 curies, respectively. These materials were distributed between the Conrail tracks and the ponds in the western portion of the Burrell site. Approximately 75 percent of the contaminated materials were deposited between 10 and 36 ft below the surface.

Remedial action at the Burrell site consisted of excavating all contaminated materials and placing them into a single disposal cell with a clay liner and 3-ft-thick radon barrier. Erosion protection consists of a 1-ft drain layer (coarse sand) and a 1-ft layer of riprap. Remedial action started in December 1985 and was completed in July 1987.

Figure 11-1
Burrell Site Location



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ENVIRONMENTAL COMPLIANCE STATUS

In 1994, the NRC accepted the Burrell long-term surveillance plan, which established the Burrell site under the general license in 10 CFR 40.27 (DOE, 1994; NRC, 1994).

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval for publication and distribution for public review. Public hearings regarding the draft programmatic environmental impact statement will be held in 1995.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Burrell site for contaminants in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Under the long-term surveillance and maintenance plan, the DOE Grand Junction Projects Office is responsible for sampling surface water and ground water at the Burrell site. Since the DOE UMTRA Project did not conduct any environmental monitoring at the Burrell site during 1994, no monitoring results are reported here.

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SITE DESCRIPTION AND LOCATION

The Canonsburg site is within the borough of Canonsburg, Washington County, in southwestern Pennsylvania, approximately 20 mi southwest of downtown Pittsburgh (*Figure 11-2*).

The Canonsburg site is bounded on the north and west by Chartiers Creek, on the east by Strabane Avenue, and on the south by the Conrail railroad tracks. The residential community of Canonsburg is north and east of the site. South of the site and the railroad is the township of North Strabane. The site ranges in elevation from approximately 930 to 970 ft above MSL. Slopes are gentle across the site except for one steep slope along the west and northwest, which drops about 30 ft to the creek bed. Shallow bedrock in this area consists of shale and siltstone. On the site, it is exposed only in the bed of Chartiers Creek and in the bottom of an erosional rill north of the site, just beyond the northeast-directed outflow channel.

Four municipalities are within a 1-mi radius of the Canonsburg site: the boroughs of Canonsburg and Houston, and the townships of Chartiers and North Strabane. Nearly 30 percent of this area is residential, and the area also includes several industries and the commercial centers of Canonsburg and Houston.

The population of Washington County is 204,584. The population of the borough of Canonsburg is 9200; of Houston, 1445; of Chartiers, 7603; and of North Strabane, 815 (DOC, 1990).

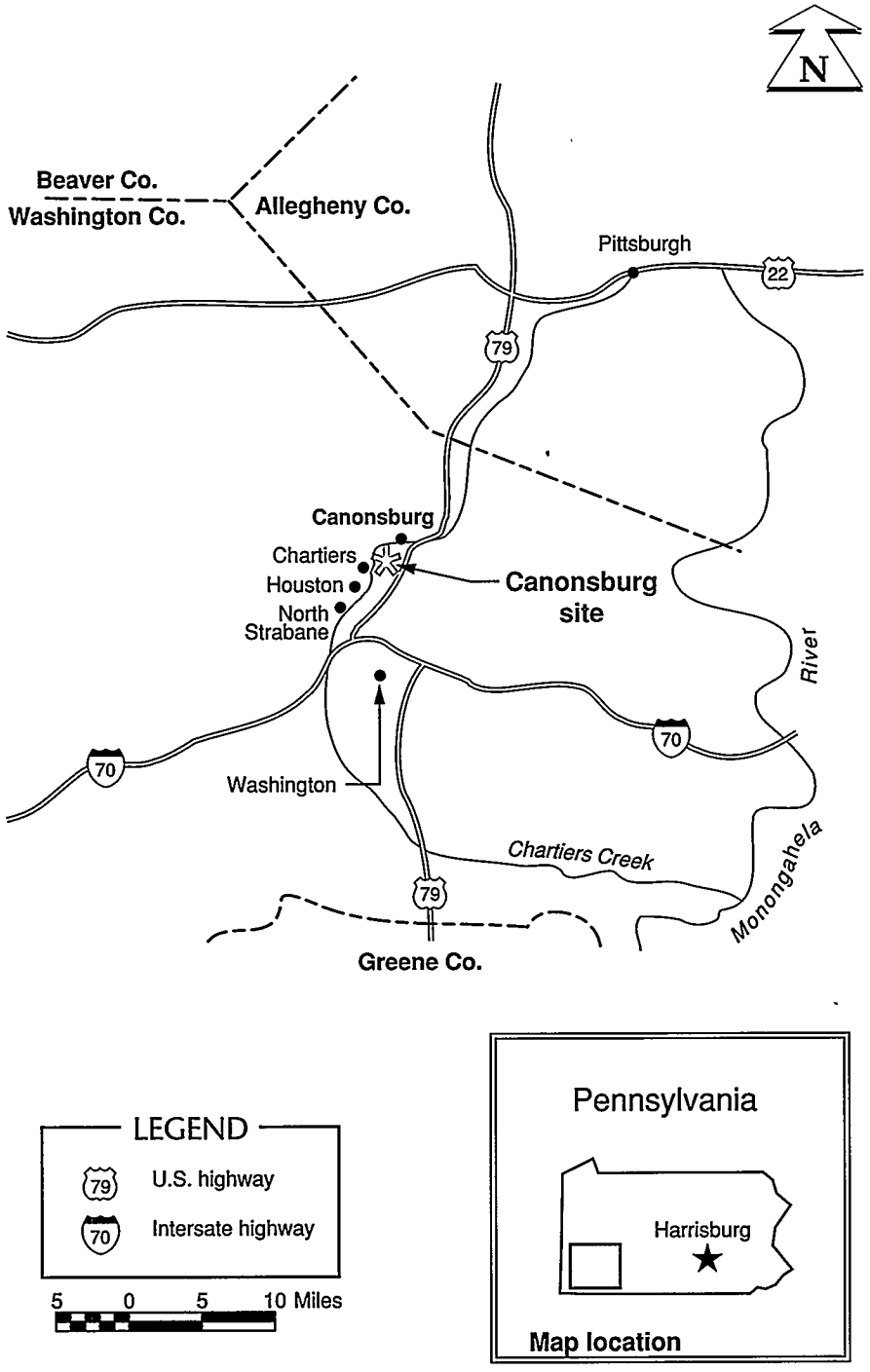
The Canonsburg site is in the humid continental climatic region. This region experiences distinct seasons that are slightly moderated by the Great Lakes and the Atlantic seaboard. The average annual temperature is approximately 50 °F. The average annual precipitation is 37 inches and the average annual snowfall is 45 inches. The wind is predominantly from the west-northwest, with an average annual speed of 4.7 mi per hour.

SITE HISTORY AND OWNERSHIP

Standard Chemical Company owned the Canonsburg facility from 1909 to 1922, producing vanadium and then radium from Colorado Plateau carnotite ore. Vitro Rare Metals Company purchased the property in 1922, extracting radium and uranium salts from on-site residues and carnotite ore. The operation turned to recovering uranium from ores, concentrates, and other materials in 1942. Operations ceased by 1957.

Vitro Rare Metals Company stored the remaining residues and processing wastes on the site, then sold the real property to developers in 1962 while retaining title to the uranium-containing materials. In 1965, with a permit from the state of Pennsylvania, Vitro Rare Metals Company buried the radioactive contaminated materials beneath a low permeability layer of slag covered by clean fill material. In 1966, the

Figure 11-2
Canonsburg Site Location



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property was developed into the Canon Industrial Park. The state of Pennsylvania acquired the property in 1982.

The state of Pennsylvania currently owns the Canonsburg site. The state bought the site from Canon Development Company and numerous private owners. Title to the site is being processed for transfer from the state to the federal government, under the jurisdiction of the DOE. This title transfer is required under Section 104(f)(B) of UMTRCA (42 SC §7901 *et seq.*).

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Canonsburg site was conducted in three areas (A, B, and C; see "Environmental Monitoring," below). The Canon Industrial Park in Area A was contaminated to depths of up to 6 ft. A large subsurface portion of Area B was contaminated by fill material placed on the original contaminated surface and as much as 20 ft of cover material placed over that. Area C contained residual radioactive material at least 10 ft deep from liquid process waste piped to a pond in that area. The pond was filled with processing waste and later covered with tailings materials and waste from nearby steel mills. Depth to ground water in the area generally varied from 10 to 20 ft. Minor ground water contamination was evidenced by elevated uranium concentrations, particularly in and around Area C (the mill site waste disposal lagoon).

The Canonsburg site was cleaned up to meet criteria established in the site remedial action plan. Approximately 172,000 cubic yards of residual radioactive material were placed in the disposal cell. Radium-226 levels in vicinity property material were below concentrations requiring encapsulation (100 pCi/g for projected radium-226). Therefore, the vicinity property materials were placed in the area immediately west of the encapsulation cell and within a fenced area (after the area was surveyed to ensure no material in place exceeded the 100 pCi/g for radium-26). A clean cover at least 2 ft thick was placed over all vicinity property material. Area C was cleaned up to meet unrestricted-use criteria in accordance with EPA regulations. The area has been backfilled with clean soil and is available for release to the state of Pennsylvania.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Canonsburg site complete, the only compliance issues remaining are NRC licensing, finalizing the long-term surveillance and maintenance plan required under 10 CFR Part 40, and ground water monitoring.

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Public scoping meetings for this document were held in 1993, and preparation of the draft took place in 1994. The draft was at DOE Headquarters in Washington D.C. awaiting final approval to be published and distributed for public review. Public

hearings regarding the draft programmatic environmental impact statement will be held in 1995.

With surface remedial action complete, active environmental permits are not needed for the Canonsburg site.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Canonsburg site for contaminants in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Canonsburg site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA Project environmental monitoring program in 1994.

Surface Water Monitoring

Surface water samples were collected at six locations, 601 through 606, along Chartiers Creek in October 1994 (***Figure 11-3***). The purpose of the sampling event was to evaluate the disposal site impact on surface water and to support baseline risk assessment recommendations.

Surface water alkalinity, dissolved oxygen, oxidation-reduction potential, pH, specific conductivity, turbidity, and temperature were determined in the field during sample collection. Surface water samples were analyzed for ammonium arsenic, boron, calcium, chloride, iron, magnesium, manganese, molybdenum, potassium, radium-228, sodium, sulfate, total dissolved solids and uranium.

Surface Water Results and Conclusions

Uranium is considered an indicator parameter at Canonsburg because it is the constituent most likely related to uranium processing activities at the site. Uranium concentrations for upgradient, on-site and downgradient surface water sampling locations are presented in ***Table 11-1***.

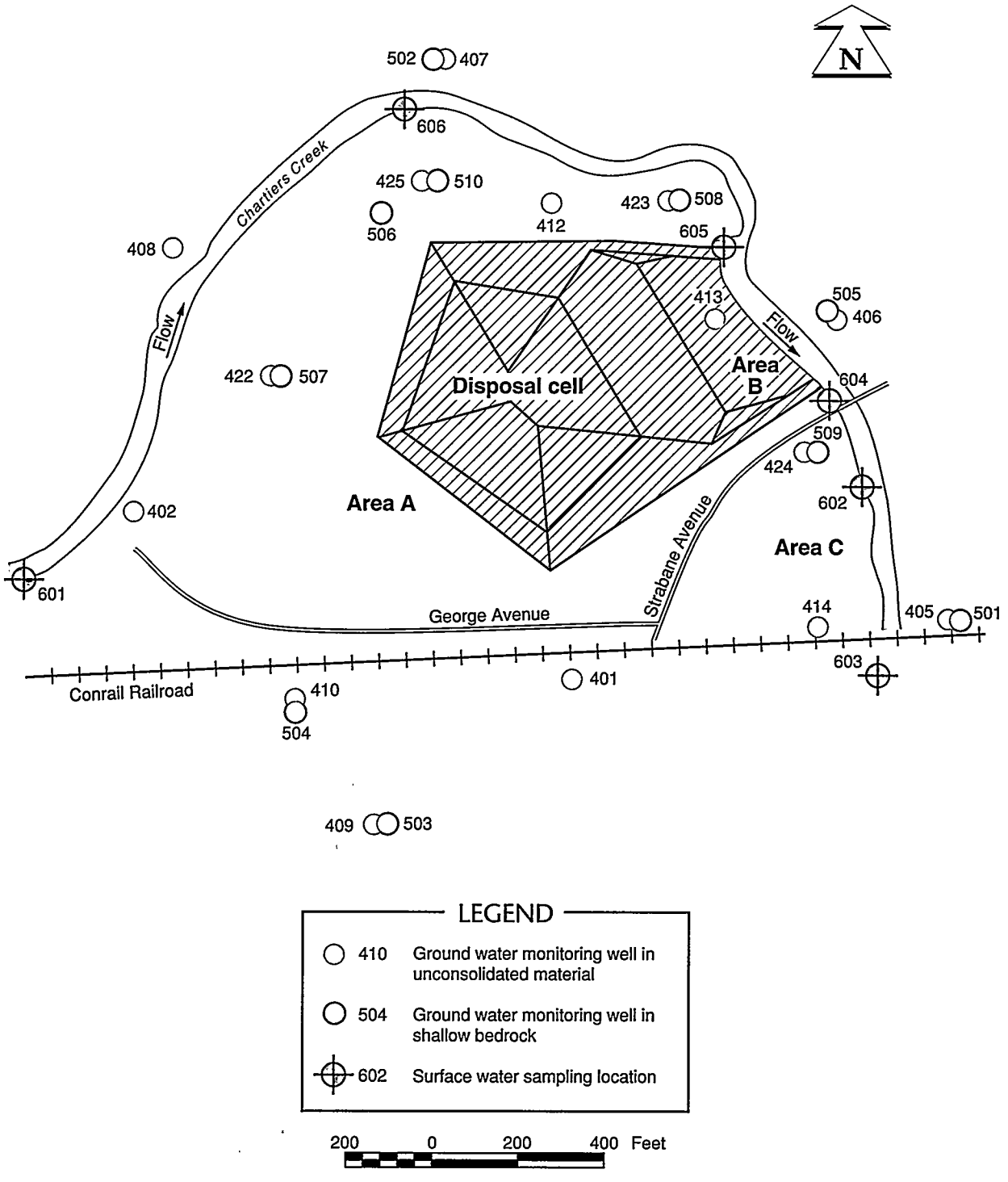
Uranium was not detected in any surface water samples collected during the October 1994 sampling event. Surface water quality in Chartiers Creek does not appear to be impacted by the disposal site.

Ground Water Monitoring

Ground water was sampled in October 1994 at the Canonsburg site to support long-term surveillance monitoring requirements and the baseline risk assessment.

The Canonsburg site is situated on a sequence of unconsolidated materials overlying the bedrock. The unconsolidated materials generally consist of up to 30 ft of soil, clay, alluvium, and fill material. The bedrock, which belongs to Casselman Formation of the Conemaugh Group, consists of interbedded gray and black

Figure 11-3
Surface Water Sampling and Ground Water Monitoring Well Locations, Disposal Site



ASER95/CAN/SWSAMPS

Table 11-1 Surface water quality results

	Chartiers Creek sample location	Uranium concentration[a] (mg/L)
Upgradient	601	<0.001
On-site	605	<0.001
Downgradient	602	<0.001

[a]Maximum concentration limit is 0.044 mg/L.

carbonaceous shales and sandy shales with several thin coal seams and limey shales.

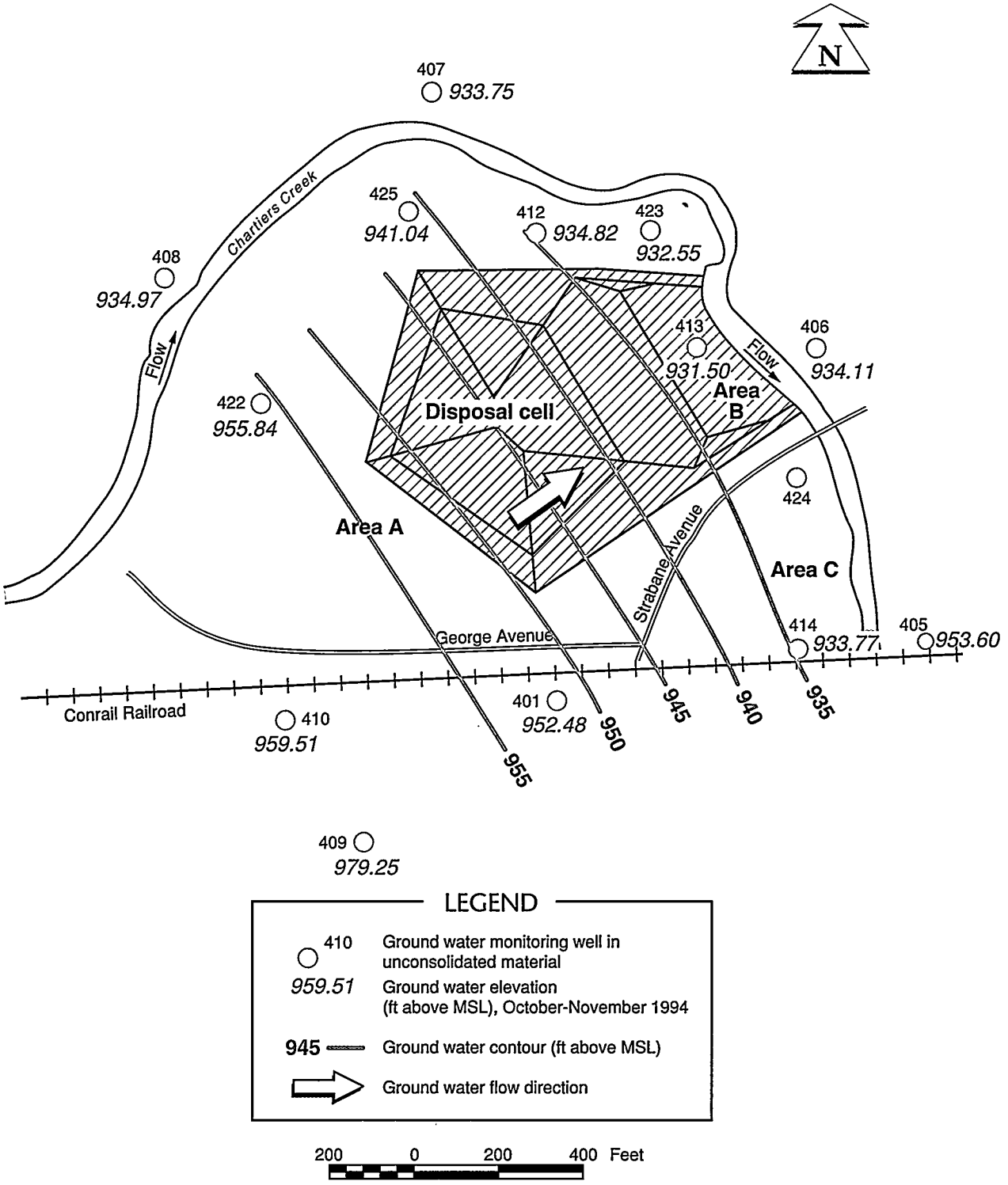
Ground water occurs in the unconsolidated materials under unconfined (water table) conditions; in the underlying Casselman Formation bedrock, ground water occurs under semiconfined to confined conditions. Depth to ground water in the unconsolidated materials ranges from 3 to 14 ft below land surface. These two units appear to be hydraulically connected, and the vertical gradient is downward. Ground water generally flows northeast toward Chartiers Creek in both the unconsolidated materials and bedrock (***Figures 11-4 and 11-5***). Neither unit functions as a viable aquifer, and ground water is not used as drinking water or for other domestic or industrial purposes.

Monitoring wells at the Canonsburg site provide representative ground water samples from upgradient, on-site, and downgradient areas in the unconsolidated materials (400 series) and the shallow bedrock (500 series) (***Figure 11-3***).

A total of fifteen monitoring wells were sampled in October 1994. Seven monitoring wells at the Canonsburg site (410, 412, 413, 414, 502, 504, and 505) were sampled to meet compliance monitoring requirements. Monitoring wells 410 and 504 are used to evaluate background conditions; the remaining wells are used to evaluate crossgradient and downgradient ground water quality. Eight additional monitoring wells (422 through 425, 507 through 510) were installed in October 1993 and sampled for the second time in October 1994.

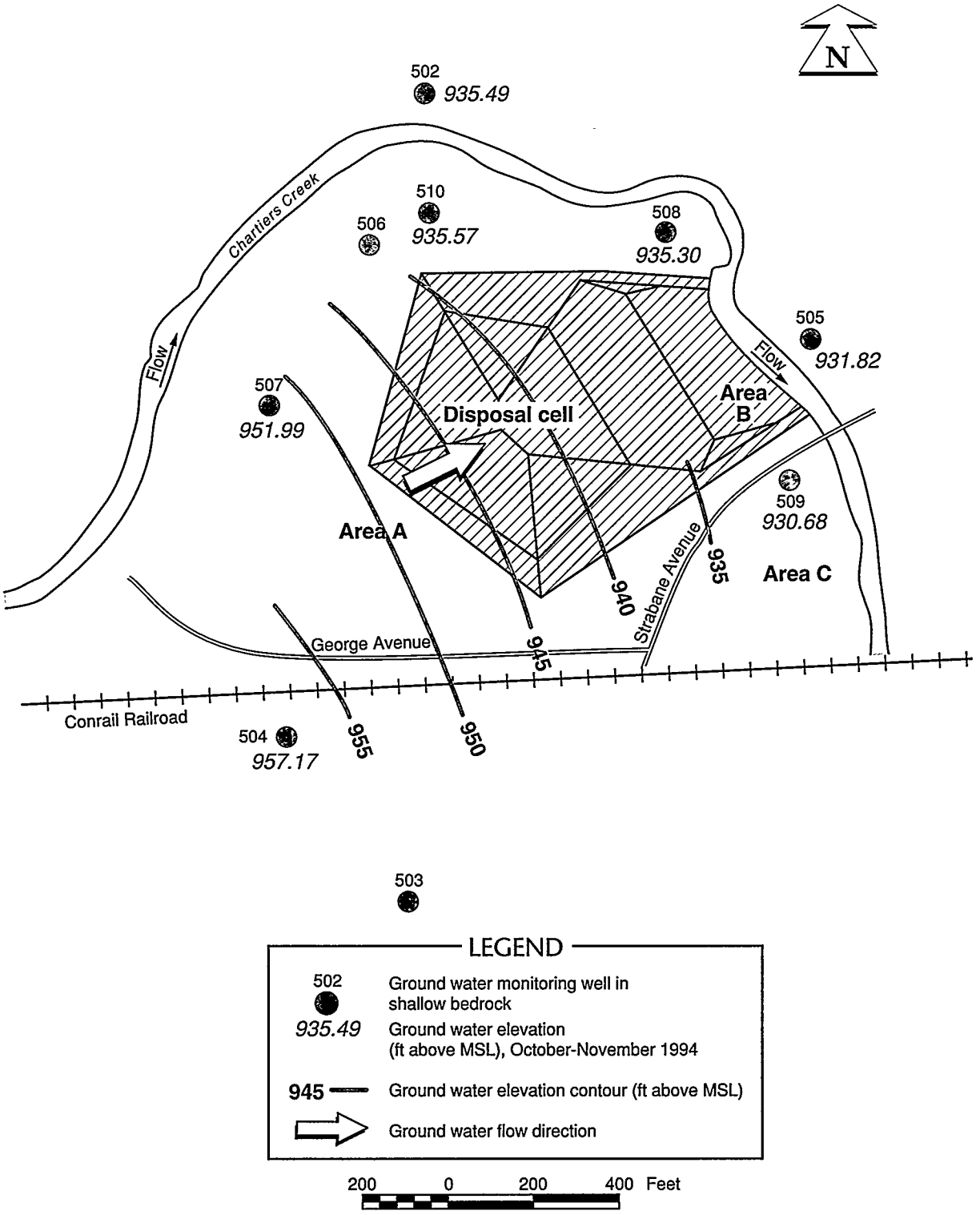
Ground water samples alkalinity, dissolved oxygen, pH, oxidation/reduction potential, specific conductivity, and temperature were determined in the field during sample collection. Ground water samples were analyzed for ammonium, arsenic, boron, calcium, chloride, dissolved organic carbon, gross alpha and beta, iron, magnesium, manganese, molybdenum, potassium, radium-226 and radium-228, selenium, sodium, strontium, sulfate, total dissolved solids, and uranium

Figure 11-4
Potentiometric Surface of the Unconsolidated Materials, Disposal Site



ASER95/CAN/POTENURN

Figure 11-5
Potentiometric Surface of the Shallow Bedrock, Disposal Site



ASER95/CAN/POTGWSHAL

The depth to water was also measured in all monitoring wells sampled during the 1994 sampling event.

Uranium is considered an indicator parameter at Canonsburg because it is the constituent most likely related to uranium processing activities at the site and because it is mobile in ground water.

Ground Water Results

Based on ground water elevations in monitoring wells, ground water in the unconsolidated materials and shallow bedrock generally flows northeast toward Chartiers Creek (***Figures 11-4 and 11-5***). The uranium concentrations in ground water at the Canonsburg site are presented on ***Figure 11-6***. ***Table 11-2*** presents the ground water uranium concentrations at background, on-site, and downgradient monitoring well locations. The maximum concentration limit of 0.044 mg/L for uranium in ground water was exceeded in ground water samples from monitoring wells 412, 413, and 414. Uranium concentrations in ground water from these three monitoring wells have historically been near or above the ground water maximum concentration limit.

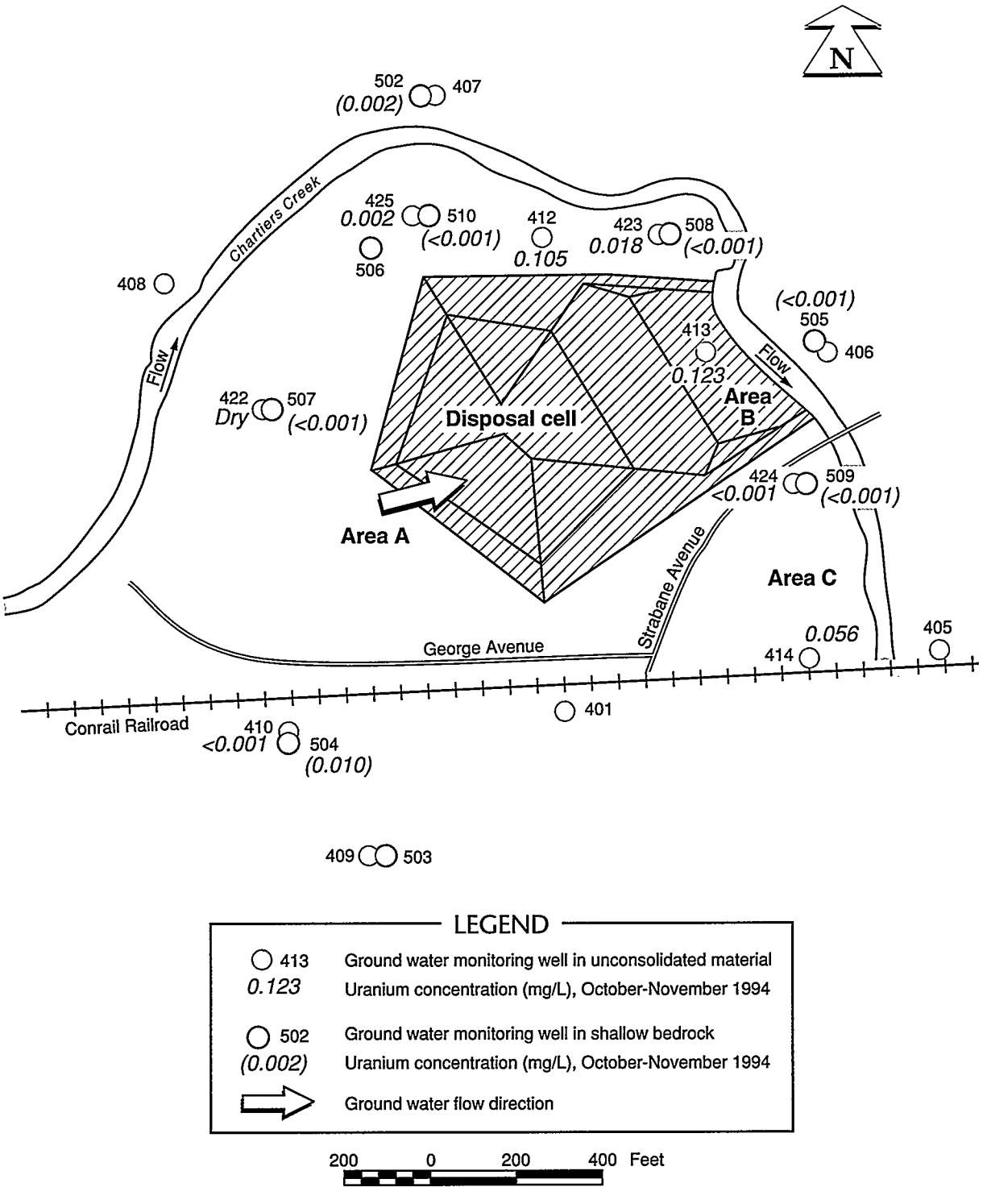
Ground Water Conclusions

The ground water flow pattern has remained relatively constant over time.

Uranium concentrations exceed the EPA maximum concentration limit for ground water in several wells, indicating that the tailings have impacted ground water quality in the unconsolidated material. Uranium is the key indicator of site-related contaminant migration in ground water beneath the Canonsburg site. Uranium is mobile in ground water at the site because of the neutral pH conditions and the abundance of bicarbonate, which acts as a complexing agent. The shallow ground water in the unconsolidated materials and bedrock is a pathway for contaminant migration. This ground water is hydraulically connected with surface water in Chartiers Creek, but there is no evidence of site-related contamination in the surface water. There are no receptors in the vicinity of the site because shallow ground water is not used as drinking water or for other domestic or industrial purposes.

Ground water at the Canonsburg site will be sampled again in October 1995 to meet compliance requirements.

Figure 11-6
Uranium Concentrations in Ground Water of the Unconsolidated Material and Shallow Bedrock, Disposal Site



ASER95/CAN/URNDISTRIB

Table 11-2 Ground water quality results

	Monitoring well location	Uranium[a]
Unconsolidated material		
Background	410	<0.001
On-site	413	0.123
Downgradient	424	<0.001
Shallow bedrock		
Background	504	0.010
On-site	510	0.002
Downgradient	508	<0.001

[a]Concentrations reported in milligrams per liter. Sampling period is October 1994.

Notes: 1. Guideline is maximum concentration limit (0.044 mg/L).
2. Monitoring wells are representative of the respective units.

< indicates actual is less than the detection limit (number shown).

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics*, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

DOE (U.S. Department of Energy), 1994. "Long-Term Surveillance Plan for the Canonsburg, Pennsylvania Disposal Site, Canonsburg, Pennsylvania," U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

NRC (U.S. Nuclear Regulatory Agency), 1994. Personal communication Joseph J. Holonich, Chief High-Level Waste and Uranium Recovery Projects Branch, Division of Waste Management, NRC, Washington, D.C. with Albert R. Chernoff, Project Manager, DOE UMTRA Project, Albuquerque, New Mexico, not dated.

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics*, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

Code of Federal Regulations

10 CFR Part 40, *Domestic Licensing of Source Materials*, Nuclear Regulatory Commission.

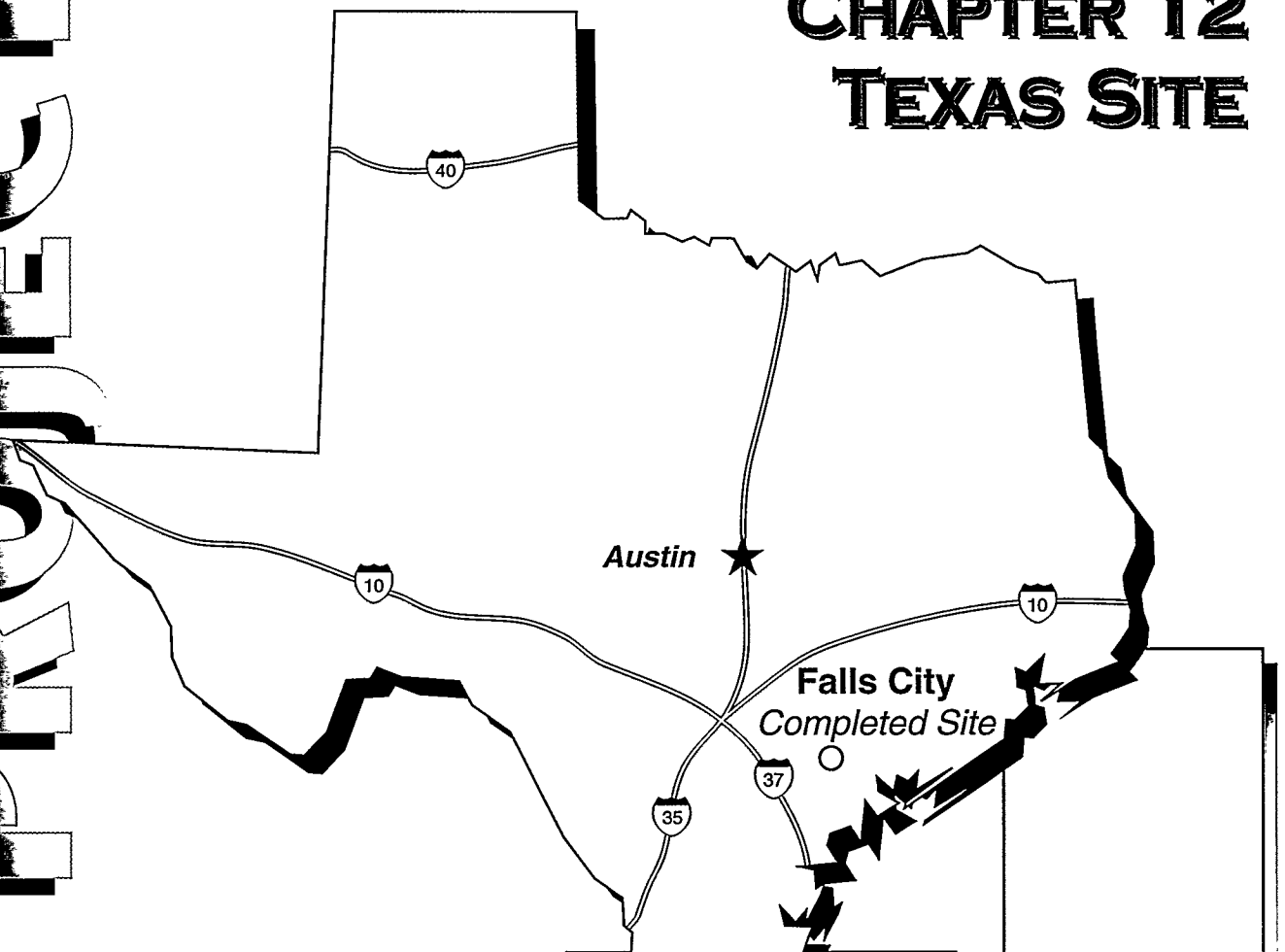
United States Code

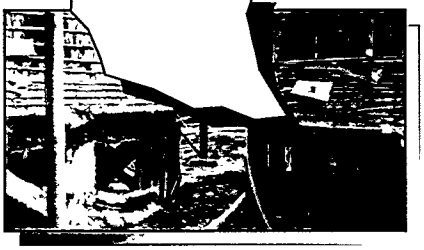
42 USC §4321 *et seq.*, *National Environmental Policy Act.*

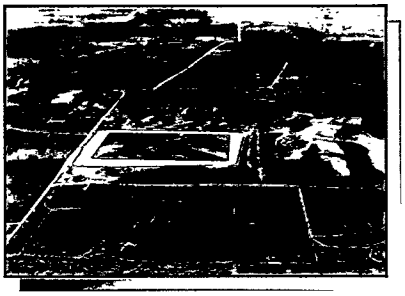
42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act.*

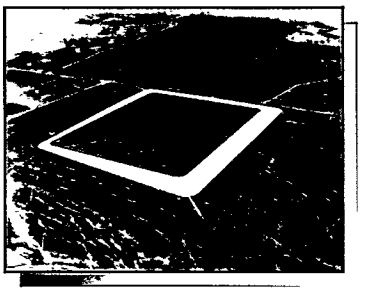
UMTRA PROJECT

CHAPTER 12
TEXAS SITE









SITE DESCRIPTION AND LOCATION

The Falls City UMTRA Project site is in Karnes County, Texas, approximately 8 mi southwest of the town of Falls City and 46 mi southeast of San Antonio, Texas (*Figure 12-1*). The tailings site at Falls City consists of two parcels: Parcel A (the former mill site, one mill building, five tailings piles, and one tailings pond northwest of the intersection of Farm-to-Market Road 1344 [FM-1344] and FM-791) and Parcel B (a tailings pile north of the intersection of FM-1344 and FM-791).

The Falls City area is primarily agricultural (cattle grazing and cropland), with about 14 farmhouses within 1 mi of the site. Open pit mines are scattered throughout the area. Approximately 460 people live in Falls City; the approximate population of Karnes County is 4337 (DOC, 1990).

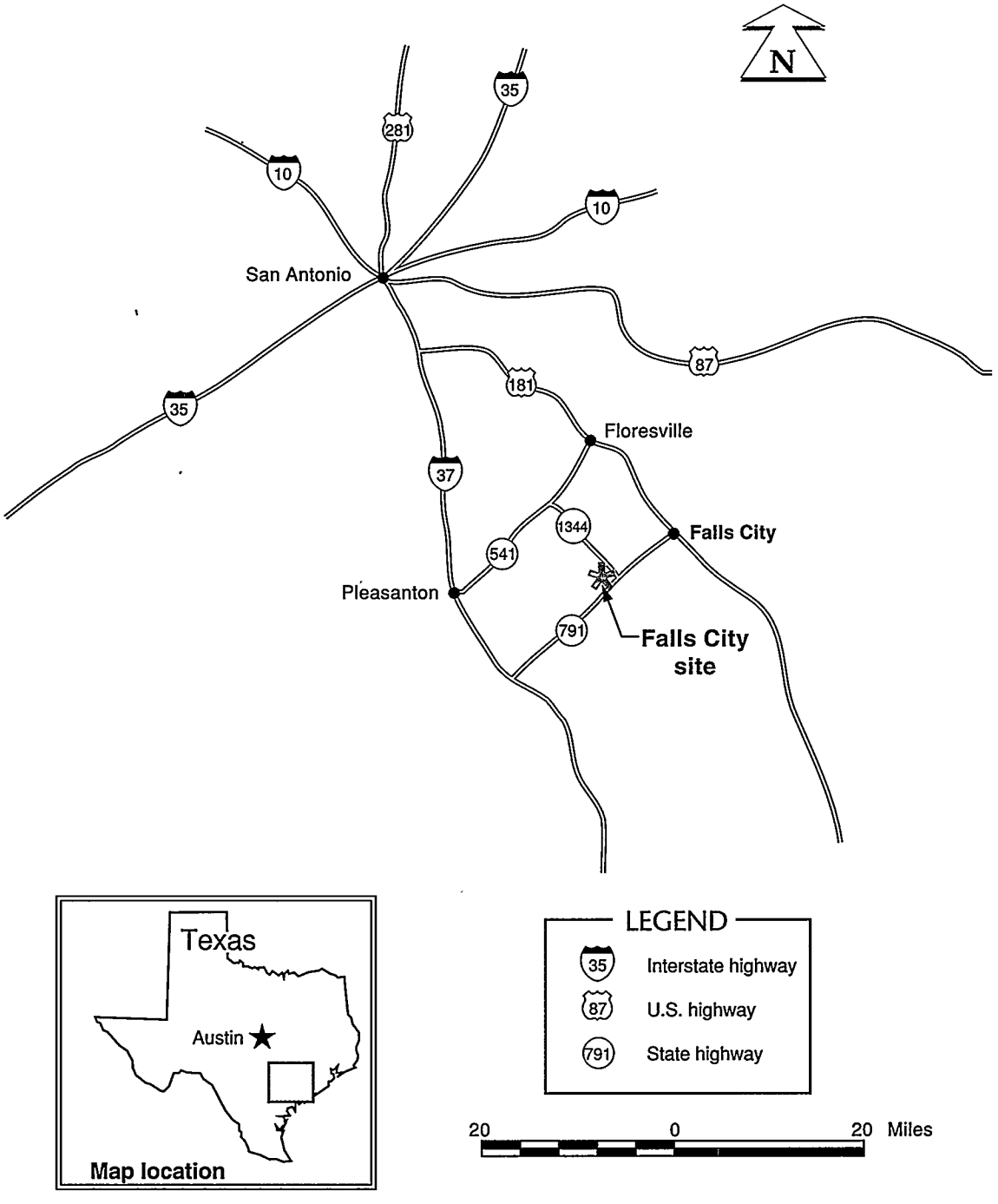
The average annual rainfall is 30.3 inches per year, with the most rainfall falling in late spring, summer, and early fall. The average annual rainfall reported from the San Antonio International Airport from 1951 through 1980 was 26.8 inches. Winds are predominantly northerly in the winter and southeast to southerly in the spring, summer, and fall (*Figure 12-2*). From 1951 through 1980, the average maximum temperature for San Antonio was 77 °F, while the average minimum was 55 °F.

SITE HISTORY AND OWNERSHIP

Susquehanna Western, Inc., began building a uranium mill at the Falls City site in April 1961 and operated the mill until August 1973. The mill used a sulfuric acid leach extraction process to treat approximately 2.5 million tons of ore. More than 3.1 million tons of waste tailings and processing solutions from the Susquehanna Western, Inc., milling operation were impounded in seven separate ponds. Four of those ponds were originally open pit mines excavated into the ore-bearing sandstone. The tailings ponds were 30 to 35 ft deep and unlined, except for natural-clay foundation soils and sediments.

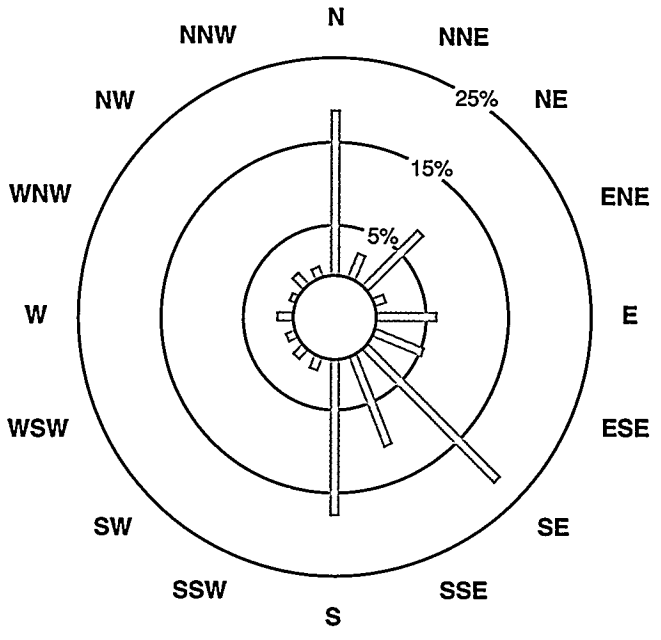
In 1975, the mill site and residual tailings piles were sold to Solution Engineering, Inc. From late 1978 to early 1982, Solution Engineering, Inc., conducted secondary solution mining of uranium from four of the piles (piles 1, 2, 4, and 7). Their operation included a system of shallow injection/recovery wells and an ion exchange resin/carbon bed treatment system to recover uranium and molybdenum from solution. The uranium leaching agent was acid water from tailings pond 7. Residual process waters were pumped back to this pond. All ponds were evaporated except for pond 6, which is thought to have been recharged by natural seepage. Spent filter carbon, extracted molybdenum, and calcium carbonate wastes were stored in drums for eventual off-site disposal or dumped into a small pit adjacent to the northern border of tailings pile 1.

Figure 12-1
Falls City Site Location



ASER95/FCT/SITELOC

Figure 12-2
Wind Rose



Ref: DOE, 1991.
Cumulative data 1979 through 1985.

ASER95/FCT/WINDFCT

The state of Texas currently owns the site, but the title is being processed for transfer to the federal government.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Falls City, Texas, site began in 1992. When UMTRA remedial action was completed in May of 1994, 4,509,000 cubic yards of residual radioactive material, including material from the site and all vicinity properties, had been placed in or relocated to the disposal cell. The material was recontoured to provide proper drainage and capped with a radon/water infiltration barrier. After final grading, all disturbed areas were mulched and seeded. The sides of the disposal cell were covered with riprap (rock armor) and the top was provided a vegetative cover. The disposal cell covers 125 ac within the 525-ac site.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action complete, the remaining compliance issues include NRC licensing under the provisions of 10 CFR Part 40 and the site long-term surveillance plan (in preparation) for continued long-term surveillance and maintenance of the completed disposal site.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994.

At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings on the draft will be held in 1995 in the vicinity of Falls City.

ENVIRONMENTAL MONITORING

At the Falls City site, the DOE conducted an environmental monitoring program in 1994 for contaminants in air, surface water, and ground water. This program monitored the amount of radiological and nonradiological hazardous constituents released into the environment, demonstrated compliance with applicable guidelines, and indicated the efficiency of environmental protection measures. Because the disposal cell was covered in March 1994, air and environmental gamma radiation monitors data were collected for the first quarter of 1994 only. All data was within regulatory limits.

Air Monitoring

Nonradiological Air Particulate Monitoring

The Falls City site was not required to monitor fugitive dust emissions (total suspended particulates) in 1994.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Falls City site was conducted at Stations 1 through 4, which were collocated with active radon monitoring stations (***Figure 12-3***). Stations 2 and 4 were established to give additional information for residential locations. Station 1 provided background measurements. Monitoring was discontinued on 11 March 1994, 1 month after the disposal cell was covered.

None of the stations reported concentrations greatly different from background (187 x 10^{-16} µCi/mL]. In addition, the estimated average thorium-230 concentration at all stations (***Table 12-1***) was well below the thorium-230 average annual guideline of 500 x 10^{-16} µCi/mL above background, indicating radioactive particulate releases from remedial action were not significant.

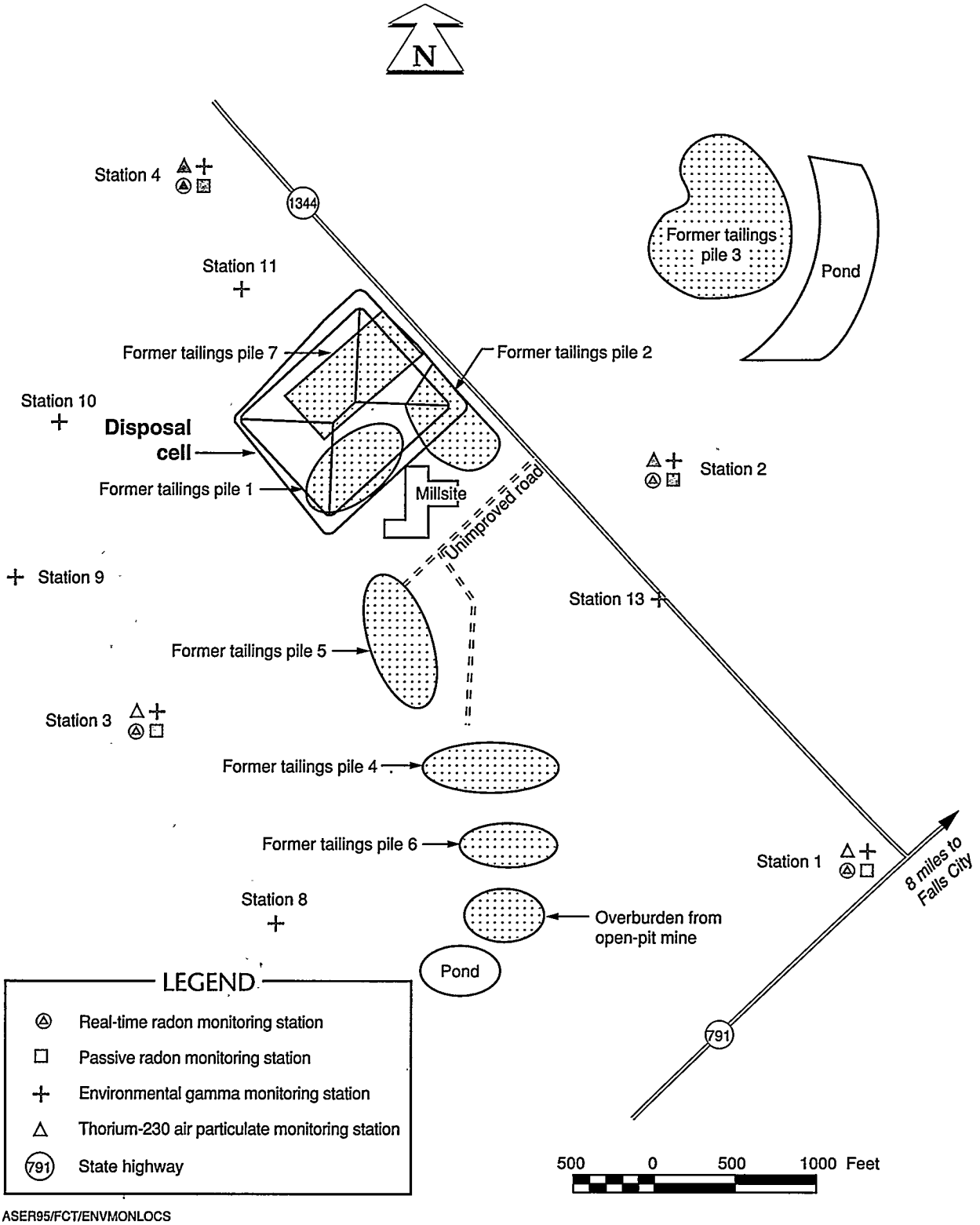
Radon Monitoring

Real-Time Radon Monitoring. Background radon concentrations were measured at Station 1, south of the site. ***Figure 12-3*** shows the locations of the real-time radon monitoring stations. Monitoring was discontinued on 11 March 1994, 1 month after the disposal cell was covered.

The average background radon concentration measured at Station 1 was 0.73 x 10^{-9} µCi/mL. Although radon concentrations (***Table 12-2***) were slightly greater than background levels (0.82 x 10^{-9} µCi/mL for Station 3), they were much less than the DOE guideline of 3 x 10^{-9} µCi/mL above background.

Passive Radon Monitoring. Four stations were established around the site. Background monitoring was performed at Station 1 south of the site. ***Figure 12-3*** illustrates locations of passive radon detectors at

Figure 12-3
Environmental Air and Gamma Radiation Monitoring Stations



ASER95/FCT/ENVMONLOCS

Table 12-1 Estimated airborne Th-230 radioactive particulate concentrations (10^{-16} µCi/mL)

Station	Quarter 1
1	187 (93)
2	197 (98)
3	170 (84)
4	157 (78)

( ) indicate 10^{-8} picograms per milliliter.

Table 12-2 Real-time radon concentration (10^{-9} µCi/mL)

Location	Quarter 1
1	0.73
2	0.66
3	0.82
4	0.65

the Falls City site. Monitoring was discontinued on 11 March 1994, 1 month after the disposal cell was covered.

The average background radon concentration measured at Station 1 was 1.0×10^{-9} µCi/mL. No reported average concentrations (*Table 12-3*) were statistically different from background, and all were much lower than the DOE guideline.

Table 12-3 Passive (alpha-track) radon concentration (10^{-9} µCi/mL)

Location	Quarter 1
1	1.0
2	0.9
3	1.1
4	1.1

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulate and radon-222 were lower than the applicable guidelines. No significant releases occurred at this site during 1994.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters around the site perimeter measured penetrating gamma radiation at the Falls City site (*Figure 12-3*). Monitoring was discontinued on 11 March 1994 after remedial action was completed at the Falls City site.

Nine dosimetry monitoring stations were active in 1994. Background dose is measured at Station 1, southeast of the site.

The background dose equivalent was 19.6 ± 2.3 mrem at Station 1. Of the locations for which dose equivalent measurements are available, only Station 13 was statistically different from background (*Table 12-4*).

Table 12-4 Environmental gamma dose equivalent[a] (mrem)

Location	Quarter 1
1	19.6 ± 2.3
2	20.6 ± 7.4
3	21.6 ± 4.6
4	22.2 ± 6.5
8	27.6 ± 6.1
9	23.0 ± 6.6
10	24.0 ± 10.8
11	23.2 ± 3.3
13	29.4 ± 6.7

[a]All errors reported as 2 standard deviations

None of the locations with measurements greater than background was elevated enough to lead to an annual dose equivalent that would exceed the DOE guideline of 100 mrem per year above background. Natural outcroppings of uranium ore in the vicinity of the Falls City site contribute to minor variations in the ambient gamma radiation field. Small differences in the gamma dose equivalent between the measurement locations is to be expected, given the geologic conditions at the Falls City site.

Environmental Gamma Radiation Monitoring Conclusions

No significant releases occurred at this site in 1994. Minor differences in monitoring results are the results of natural variations in the geology of the Falls City site.

Surface Water Monitoring and Results

Surface water from stock ponds in the vicinity of the Falls City site was monitored for contaminants to assess potential environmental impacts from the site (***Figure 12-4***). ***Table 12-5*** gives the results of the surface water analyses of unfiltered samples. At some locations, aluminum slightly exceeded EPA water quality criteria for livestock. All other constituents were well below the criteria.

Ground Water Monitoring

The Falls City site is underlain by sedimentary rock that dips gently southeast. These strata are composed locally of generally unlithified sand, silt, and clay deposits. The site rests on outcrops of the Dubose Clay Member, Deweesville Sandstone Member, Conquista Clay Member, and the Dilworth Member of the Whitsett Formation. The Deweesville/Conquista and Dilworth aquifers are two low-yield aquifers that occur in the upper 100 to 200 ft of the Whitsett Formation sediments underlying the site.

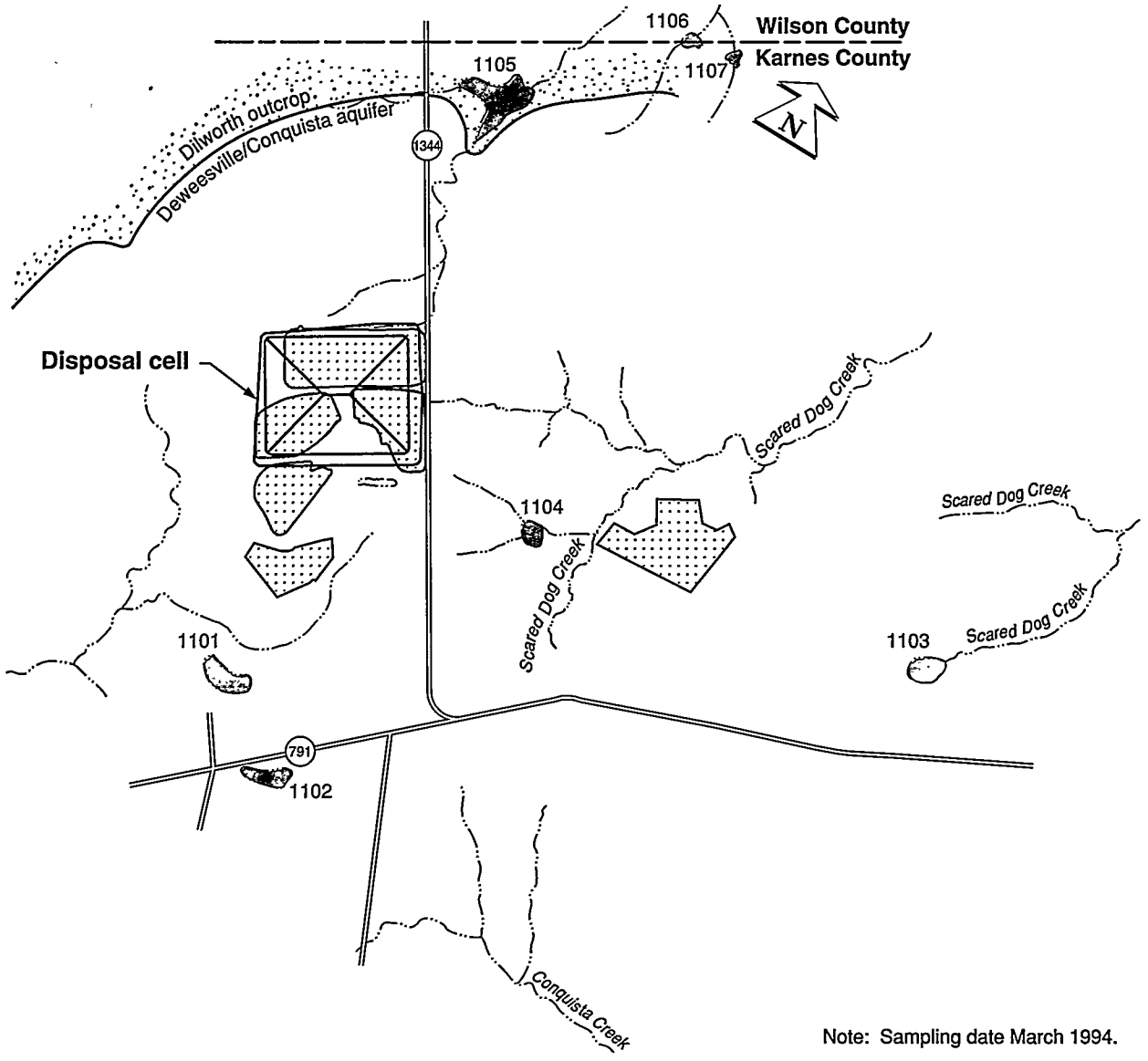
Ground water elevations were measured and samples were collected from 19 monitoring wells at the Falls City site during January and September 1994. Fifteen ground water elevation data recorders, a barometric pressure data logger, and a recording rain gauge were installed at the site in October 1994. These instruments will monitor site ground water level fluctuations and weather conditions. Potentiometric surface maps based on October 1994 data for the Deweesville/Conquista and Dilworth aquifers are shown in ***Figures 12-5 and 12-6***, respectively.

In 1994, ground water monitoring consisted of sampling 17 wells screened in the upper Deweesville/Conquista aquifer and 2 wells screened in the underlying Dilworth aquifer (***Figure 12-7***). The Deweesville/Conquista aquifer monitoring wells are within or just beyond the edge of four areas of ground water contamination identified at the site. Due to disposal cell construction activities, some monitoring wells screened in the zone of ground water contamination in the Dilworth aquifer were decommissioned and no longer exist. Ground water sampling in the Dilworth aquifer consisted of monitoring background and downgradient ground water quality conditions.

In addition to routine sampling of site monitoring wells and as part of a land and water use survey, eight local livestock wells were sampled in March 1994 to assess water quality (***Figure 12-7***). The sampled wells range from about 30 to 440 ft deep and are situated upgradient, crossgradient, and downgradient of the site.

The last water quality sampling round was completed in January 1995. The next regularly scheduled water quality sampling round is scheduled for September 1995.

Figure 12-4
Surface Water Sampling Locations



ASER95/FCT/SURSAMPLOCS

Table 12-5 Surface water quality data for unfiltered samples

Parameter	Concentration protective of livestock[a]	Location ID 1101	1102	1103	1104	1105	1106	1107
Aluminum	5.0	2.2	5.7	2.5	5.1	6.9	4.1	11.2
Arsenic	0.2	0.014	0.028	0.016	0.023	0.013	0.015	0.020
Cadmium	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	1.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	0.10	<0.003	0.017	0.006	0.010	0.003	0.008	0.028
Mercury	1.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate	440	<1.0	1.1	<1.0	<1.0	<1.0	2.9	4.3
pH	NCA	8.44	6.90	7.44	8.01	8.67	7.94	7.73
Selenium	0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulfate	1000	20	11	7.5	5	23	43	20
TDS	3000	124	116	187	260	221	226	282
Uranium	NCA	0.003	0.006	0.005	0.030	0.005	0.003	<0.005

[a]Reference - National Academy of Sciences (NAS), *Water Quality Criteria 1972*, Washington, D.C. 1993.

Note: Surface water samples collected March, 1994. Results are reported in milligrams per liter.

< indicates the actual value is less than the detection limit (number shown).
TDS – total dissolved solids.
NCA – no NAS criterion available.

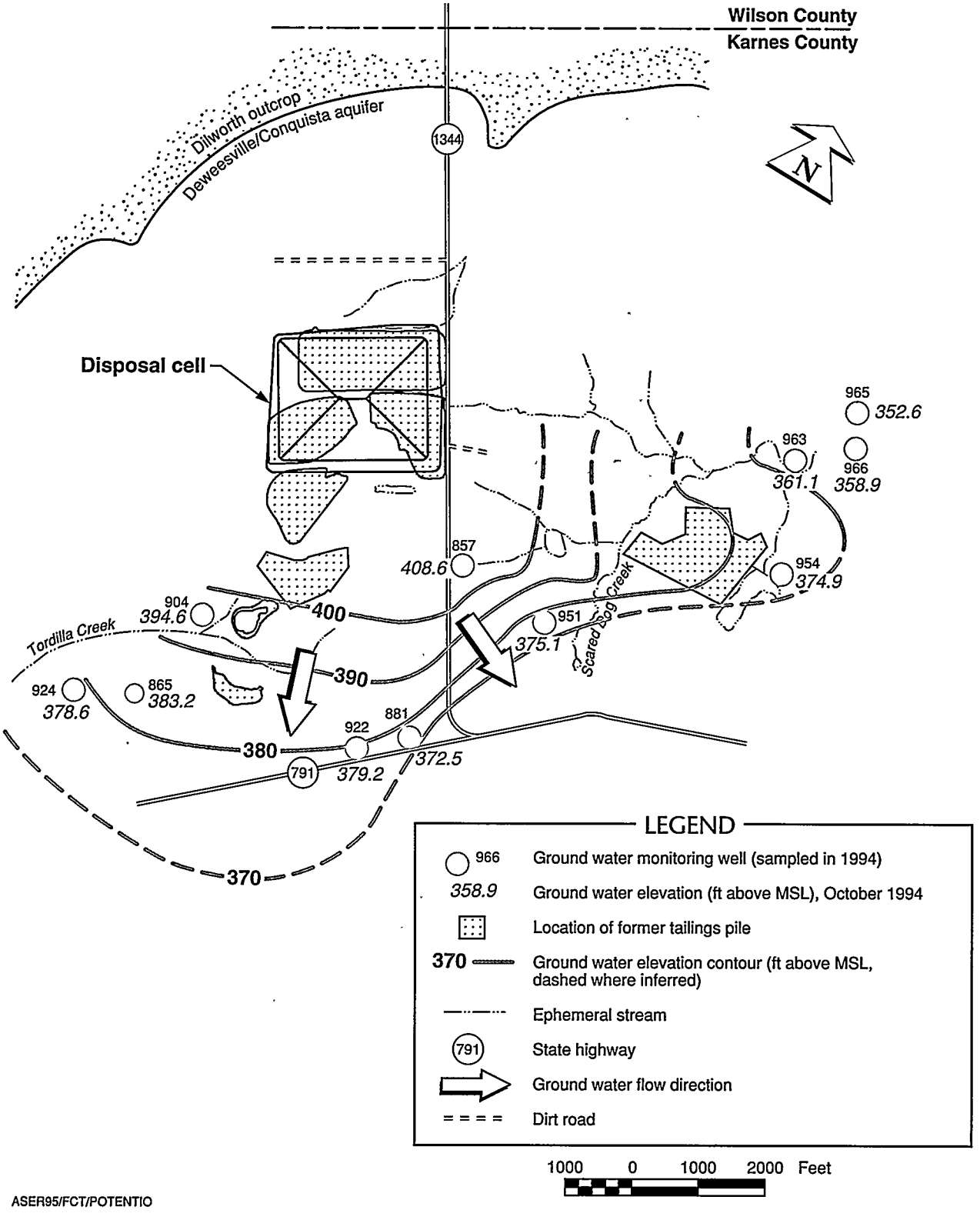
Ground Water Results and Conclusions

Ground water geochemistry at the Falls City site is complex because no single ground water quality parameter can quantify the extent of ground water contamination. Therefore, several indicator parameters related to uranium processing activities were selected for analysis: aluminum, calcium, pH, sulfate, and uranium. Aluminum is a good indicator of acidic conditions. Examining calcium-to-sulfate ratios in ground water distinguishes natural mineralization from tailings seepage. Uranium occurs naturally as well in tailings seepage. ***Table 12-6*** shows ground water quality data for the Deweesville/Conquista and Dilworth aquifers.

Contamination from uranium processing activities is present in ground water within the Deweesville/Conquista aquifer; however, the extent of contamination has not been determined due to the limited number of sampling locations off-site.

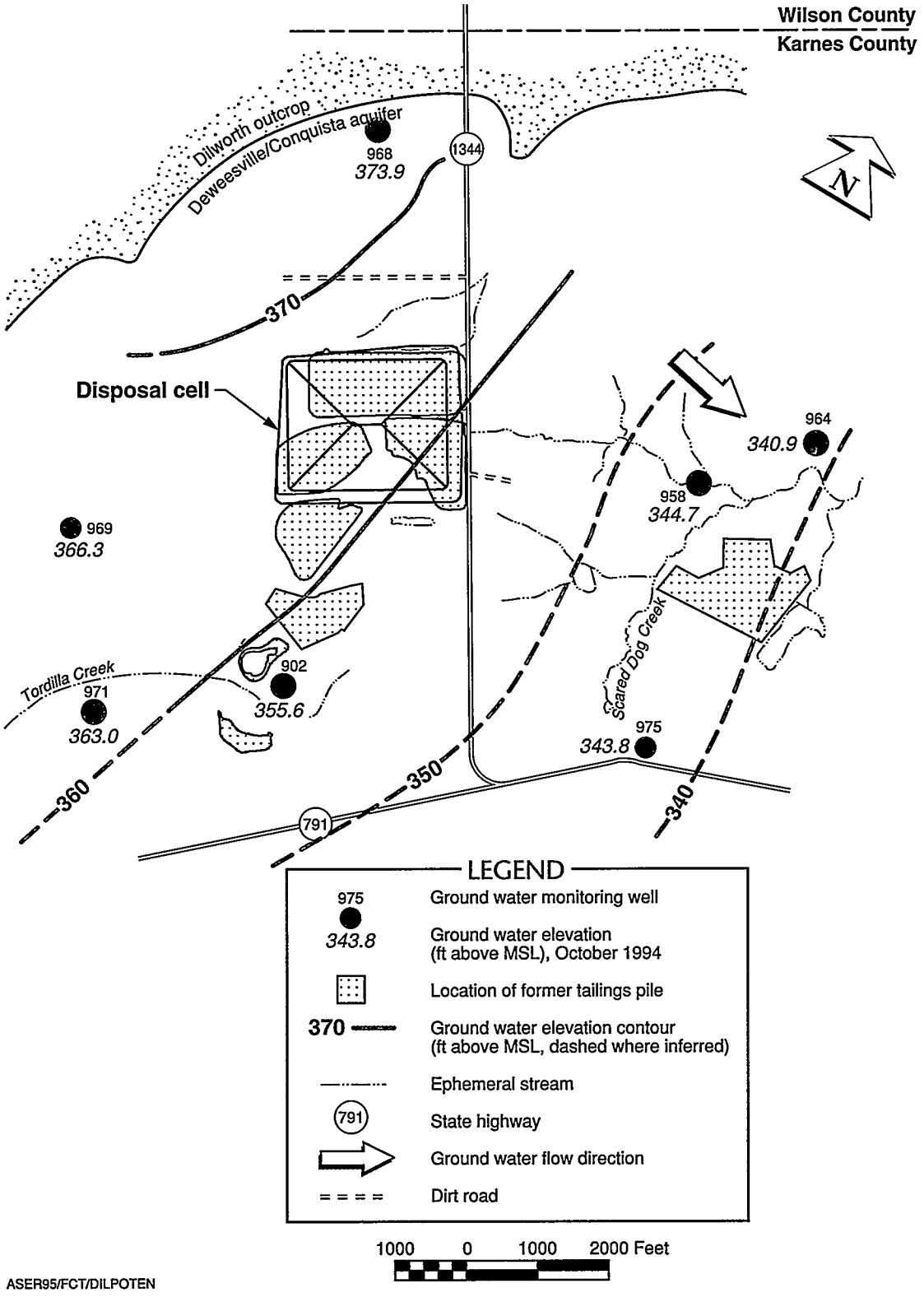
Analyses of ground water from private livestock wells, summarized in ***Table 12-7***, illustrate a broad range of water quality from relative low salinity (total dissolved solids) in upgradient well 1003 to relatively high salinity in crossgradient well 1012. The maximum concentration limit for lead was exceeded in upgradient well 1003. However, lead in a filtered sample from the same well was below detection, indicating that the lead was in suspended material. The maximum concentration

Figure 12-5
Potentiometric Surface of the Deweesville/Conquista Aquifer



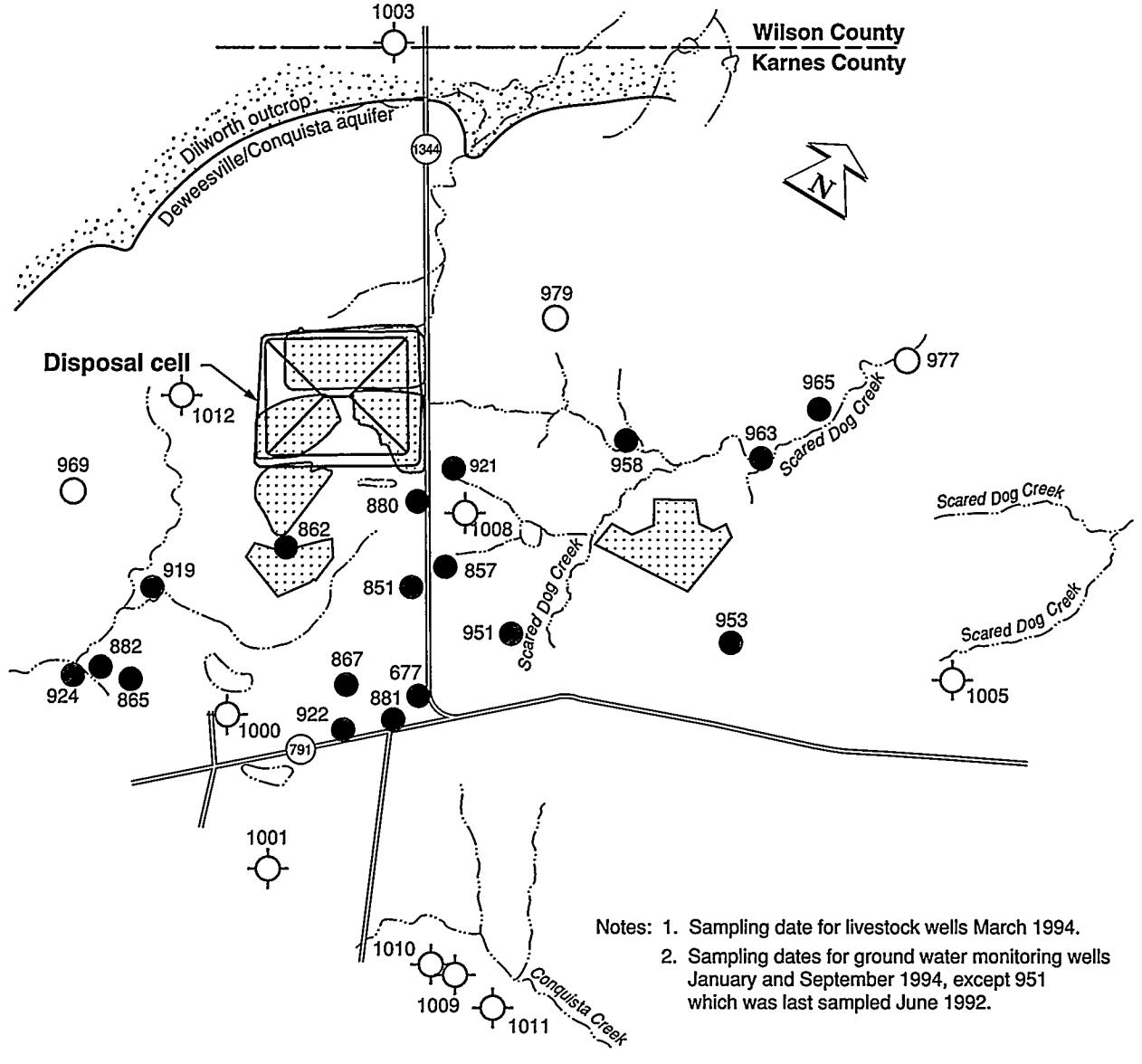
ASER95/FCT/POTENTIO

Figure 12-6
Potentiometric Surface of the Dilworth Aquifer



ASER95/FCT/DILPOTEN

Figure 12-7
Ground Water Monitoring Well Locations



Notes: 1. Sampling date for livestock wells March 1994.
2. Sampling dates for ground water monitoring wells January and September 1994, except 951 which was last sampled June 1992.

LEGEND

1001	Sampled livestock well		Location of former tailings pile
922	Ground water monitoring well (Deweesville/Conquista)		Ephemeral stream
969	Ground water monitoring well (Dilworth)	791	State highway

1000 0 1000 2000 Feet

ASER95/FCT/GWSAMPLOCS

Table 12-6 Ground water quality data

Deweesville/Conquista aquifer				
Indicator parameter	Guideline	Background well 951	Contaminated well 880	Downgradient well 922
Aluminum	0.05 - 0.2[a]	0.05	61.1	<0.10
Calcium	NA	338	506	898
pH	NA	7.05	3.42	4.74
Sulfate	250[a]	910	10100	1880
Uranium	0.044[b]	0.0162	2.32	0.001

Dilworth aquifer			
Indicator parameter	Guideline	Background well 969	Downgradient well 977
Aluminum	0.05 - 0.2[a]	<0.05	1.2
Calcium	NA	493	229
pH	NA	6.66	4.59
Sulfate	250[a]	1080	1310
Uranium	0.044[b]	0.002	0.028

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Notes: 1. Ground water samples were collected September 1994. Results are reported in milligrams per liter.
2. Monitoring well 951 was last sampled in June 1992.

< indicates actual is less than the detection limit (number shown).
NA – Not available.

limit for uranium was exceeded in two downgradient wells (1005 and 1008). Both wells are thought to be in the Dilworth sandstone and therefore are below the identified site-related contamination. The uranium may come from natural uranium mineralization. Concentrations of sulfate and total dissolved solids exceeded guidelines protective of livestock in three wells located crossgradient and downgradient of the site (1012, 1011, and 1005). These wells are also thought to be beyond the influence of site-related contamination and the relatively high concentrations of sulfate and salinity probably reflect the natural occurrence of gypsum (calcium sulfate) in the aquifers.

Table 12-7 Private livestock well ground water quality data for unfiltered samples

Parameter	Water concentration protective of livestock[a]	Private livestock well location								
		1003 (upgradient)	1000 (cross-gradient)	1012 (cross-gradient)	1001 (down-gradient)	1005 (down-gradient)	1008 (down-gradient)	1009 (down-gradient)	1010 (down-gradient)	1011 (down-gradient)
Aluminum	5	0.24	0.23	0.05	0.12	0.15	<0.05	<0.05	0.08	0.17
Arsenic	0.2	<0.005	<0.005	0.011	<0.005	<0.005	0.006	<0.005	<0.005	0.046
Cadmium	0.005	0.003	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Chloride	NCA	361	33	1370	1290	2710	896	483	570	460
Cobalt	1.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	0.1	0.57	0.021	<0.003	0.004	<0.003	<0.003	0.003	<0.003	<0.003
Mercury	1.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
pH	NCA	8.67	6.52	6.27	9.21	5.97	6.77	7.74	7.87	5.91
Selenium	0.05	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005
Sulfate	1000	4.2	4.5	1440	27	1840	555	740	678	1930
TDS	3000	554	1640	4990	2250	7850	2600	2330	2320	3860
Uranium	NCA	0.001	0.001	<0.001	<0.001	0.174	0.461	<0.001	<0.001	<0.001

[a]Reference - National Academy of Sciences, *Water Quality Criteria 1972*, Washington, D.C. 1973.

Note: Private well samples collected March 1994. Results are reported in milligrams per liter.

< – indicates the actual value is less than the detection limit (number shown).
TDS – total dissolved solids.
NCA – No NAS criterion available.
NA – not analyzed.

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics*, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.

Code of Federal Regulations

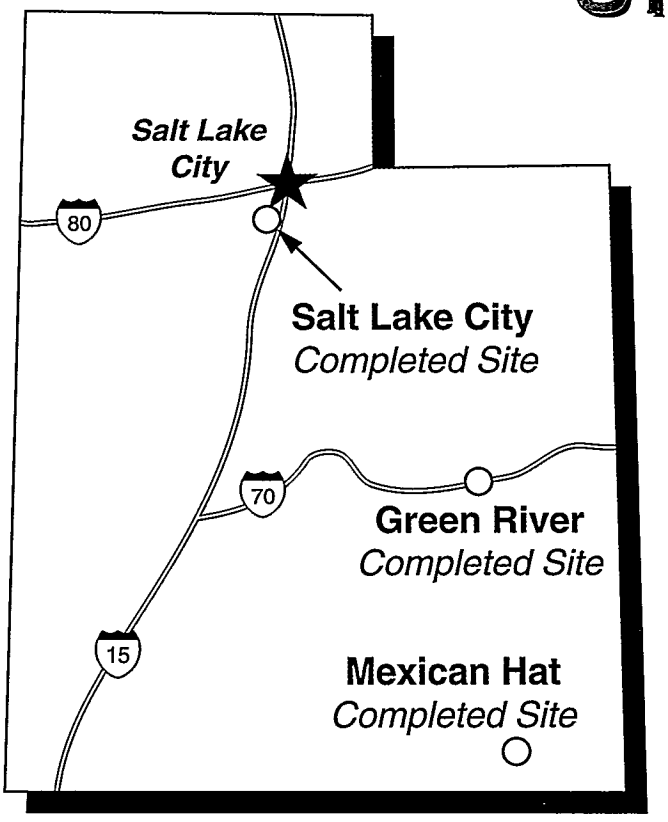
10 CFR Part 40, Domestic Licensing of Source Material, Nuclear Regulatory Commission (1994)

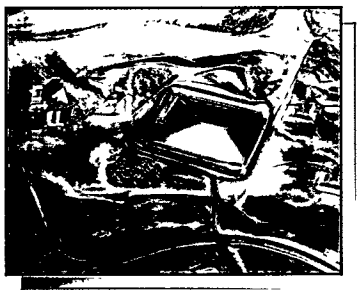
United States Codes

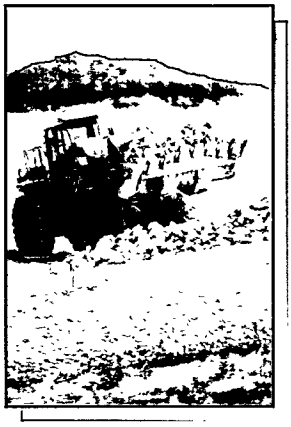
42 USC §4321 et seq., National Environmental Policy Act, January 1, 1970.

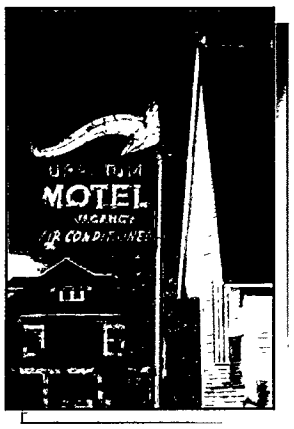
UMTRA PROJECT

CHAPTER 13
UTAH SITES









UTAH SITES

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at the Green River, Mexican Hat, and Salt Lake City, Utah, sites during 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Green River

The Green River site is in Grand County in eastern Utah. Site remediation was completed in 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Mexican Hat

The Mexican Hat site is on Navajo Nation land approximately 1.5 mi southwest of Mexican Hat, Utah. Remedial action was completed in late 1994. During 1994, the air was monitored for both thorium-230 particulate and radon-222. Environmental gamma radiation monitoring was conducted as well. In addition, ground water was monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters at this site are discussed here. Due to the lack of available surface water in the immediate vicinity of the site, surface water samples were not collected during 1994.

Salt Lake City

The Vitro processing site is in Salt Lake County; the South Clive disposal site is in Tooele County. Both sites are in northern Utah. Remedial action at the Vitro processing site was completed in 1988; air monitoring and environmental gamma radiation monitoring were not conducted at this site in 1994. However, surface water and ground water were monitored in 1994 for radiological and nonradiological constituents. Only the constituents defined as indicator parameters at this site are discussed here.

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SITE DESCRIPTION AND LOCATION

The Green River UMTRA Project disposal site is in Grand County, Utah, about 1.5 mi southeast of the city of Green River, in east central Utah (*Figure 13-1*). The main track of the Denver & Rio Grande Western Railroad is north of the site and U.S. Highway 70 is south of the site. Brown's Wash, an intermittent stream, flows between the railroad tracks and the disposal site and joins the Green River west of the site. The disposal site is in the northern part of the Canyon Lands section of the Colorado Plateau, which is bordered on the north by the Book Cliffs and on the south by the San Rafael Valley. The area contains flat to hilly terrain, cliffs, mesas, and the Gray Canyon of the Green River. The site lies at an elevation of approximately 4100 ft. The Green River is approximately 3000 ft west of the disposal site. The physiography of the immediate area is described as the Mancos Shale Lowland and Green River Desert.

Historically, population growth in the Green River area has been related primarily to uranium mining and milling activities. Beginning in 1980, the population began to decline as energy exploration and production decreased, area uranium mines closed, and other employment opportunities dwindled. The population of Grand County is 6620; the population of Green River is 866 (DOC, 1990).

The climate in the Green River area is arid, with large ranges in daily and annual temperatures. From 1951 through 1980, annual temperatures averaged 52 °F, ranging from 23 °F in January to 78 °F in July.

The average annual precipitation at Green River from 1951 through 1980 was 6 inches; the average annual snowfall was 10 inches. Rainfall was fairly evenly distributed throughout the year.

SITE HISTORY AND OWNERSHIP

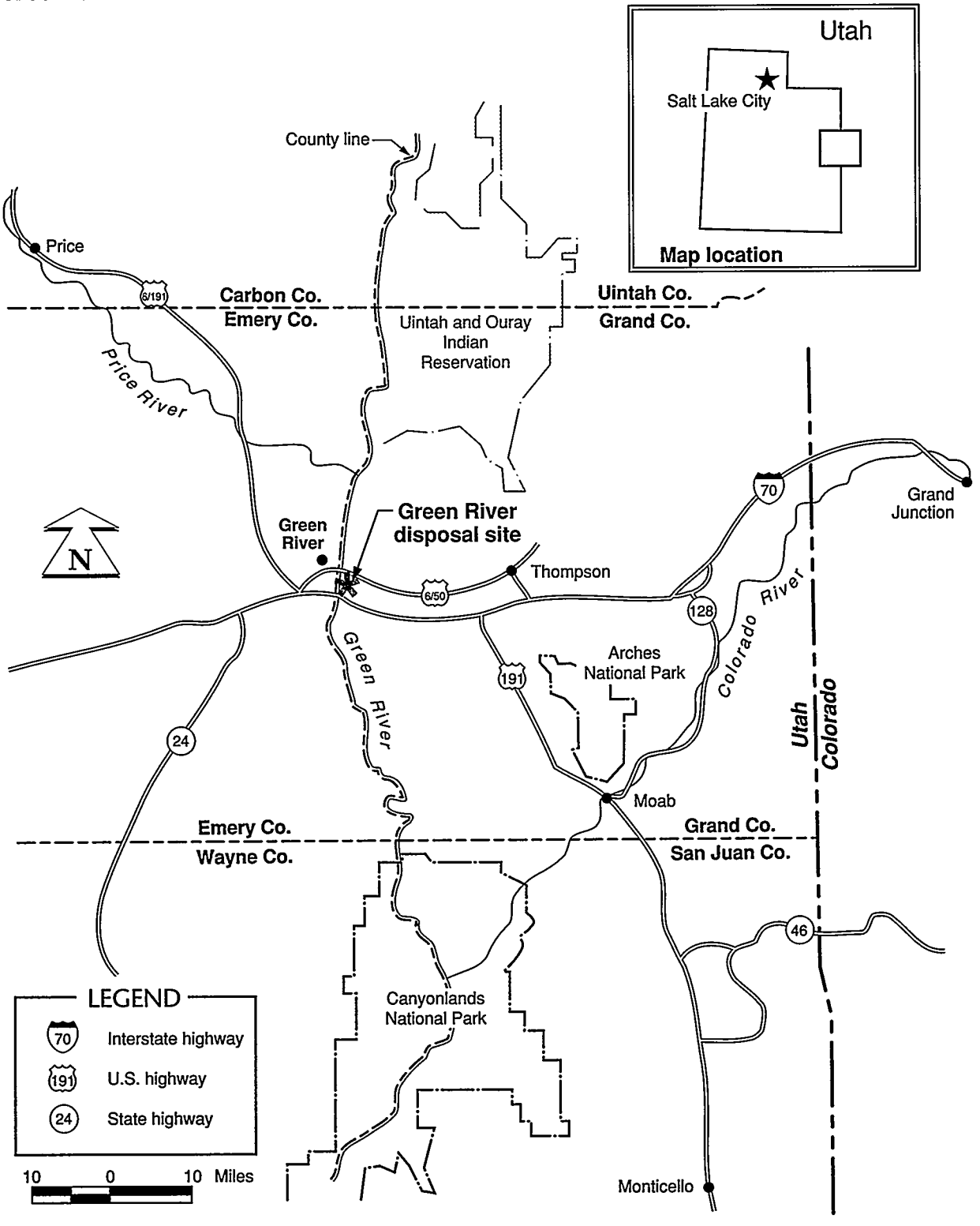
The Green River site is owned by the state of Utah, which acquired it from Umetco Minerals Corporation in 1988. Title to the site is being processed for transfer from the state to the federal government, under the jurisdiction of the DOE. This title transfer is required under Section 104 (f)(B) of UMTRCA (42 USC §7901 *et seq.*).

The mill at the Green River site was built in 1957 by Union Carbide Corporation. Operating from March 1958 through January 1961, the mill processed 183,000 tons of ore averaging 0.29 percent uranium oxide; the ore concentrate was shipped by rail to the company's processing plant in Rifle, Colorado.

SITE CHARACTERIZATION AND CLEANUP

Remedial action began in November 1988 and was complete in September 1989. Mill tailings, the windblown contaminants stockpile, and the vicinity property contaminants stockpile were stabilized on the former processing site in a permanent disposal cell. The excavated tailings and residual radioactive materials consist of approximately 382,000 cubic yards of material. After remedial action, the area of

Figure 13-1
Green River Site Location



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excavation was backfilled, graded to promote surface drainage, and revegetated. All other areas disturbed at the site by remedial action were backfilled and graded to promote surface drainage.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Green River site complete, the remaining surface-related compliance issues include NRC licensing under the provisions of 10 CFR Part 40. These provisions require long-term surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring, as defined in the site long-term surveillance plan (DOE, 1994).

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995 at a location in the vicinity of the Green River UMTRA site.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Green River site, which consists of the former processing site area and the adjacent disposal cell. This program monitors quantities of radioactive material and nonradiological hazardous constituents in surface water and ground water demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Green River site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1994.

Surface Water Monitoring

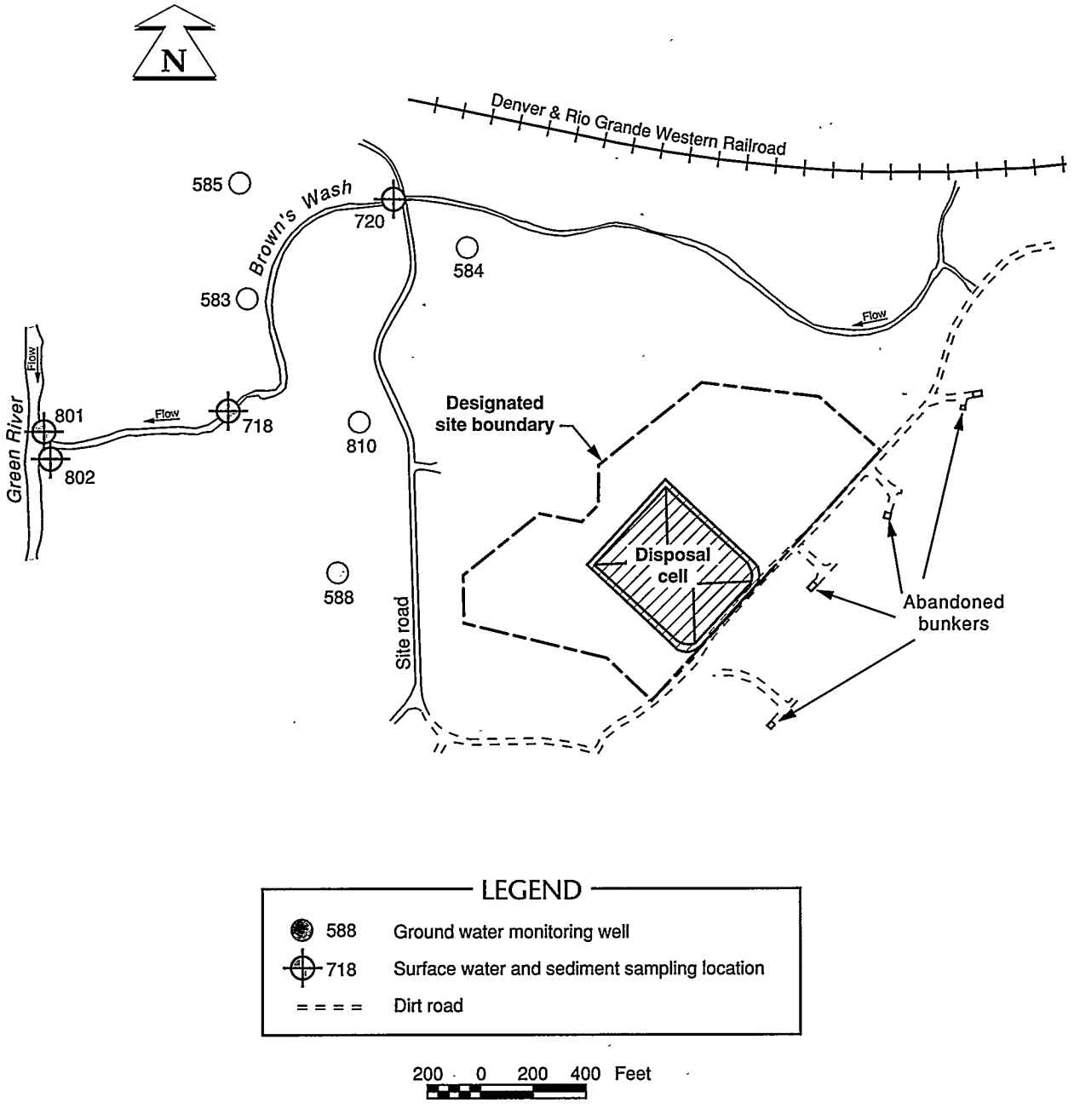
Surface water features in the vicinity of the Green River site include the Green River, Brown's Wash, and several ephemeral drainages.

The disposal cell was completed in 1989 on an elevated alluvial terrace approximately 600 ft south of Brown's Wash. No surface water features are closely associated with the disposal cell.

In past years, surface water samples were collected from the Green River and from Brown's Wash, an ephermeral stream that flows only during prolonged rainy seasons and storm events. Samples collected from the Green River were obtained upstream and downstream of the confluence of Brown's Wash and the Green River. Analysis of these samples indicates the former uranium milling processes have not affected the water quality of the Green River.

Surface water samples were collected in 1994 in support of the baseline risk assessment at two locations in Brown's Wash (718 and 720), both downstream from the processing site area (***Figure 13-2***).

Figure 13-2
Surface Water and Ground Water Monitoring Well Locations, Processing Site



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Water samples were collected from stagnant puddles on bedrock surfaces at these two locations. Thirty-two chemical parameters were measured, including major ions, nitrate and trace elements associated with uranium ore (molybdenum, selenium, and uranium) and the milling process (nitrate). Analytical results for nitrate, selenium, and uranium are shown in *Table 13-1*.

Surface Water Results

Analytical results indicate that nitrate, selenium, and uranium are above the UMTRA Project maximum concentration limits in surface water at location 718. At location 720, uranium is above the UMTRA Project maximum concentration limit.

Surface Water Conclusions

Elevated levels of nitrate, selenium, and uranium at Brown's Wash surface water samples may be due to a combination of the following factors:

- Natural presence of these constituents in the area.
- Constituents become concentrated as standing water evaporates.
- Sampling techniques (fine-grained material captured with the water during sampling may contribute toward the final analysis).
- Contribution through seeps along Brown's Wash of contaminated ground water from saturated alluvium at the processing site.

Ground Water Monitoring

In 1994, ground water monitoring was conducted in the vicinity of the remediated processing site area and the disposal cell.

Processing Site

Figure 13-2 shows the locations of processing site area monitoring wells sampled in 1994 in support the baseline risk assessment data collection effort. These monitoring wells are completed in saturated alluvial sediments associated with Brown's Wash.

Ground Water Results

Table 13-2 shows the concentrations of indicator parameters nitrate, selenium, total dissolved solids, and uranium in January 1994 ground water processing site samples for wells 583, 588, and 810. Concentrations of nitrate, selenium and uranium are well below the EPA maximum concentration limits.

Ground Water Conclusions

The 1994 monitoring data for the former processing site area do not indicate significant impacts to ground water in the alluvial sediments due to uranium processing. However, historical site data indicate that contamination related to the processing site is present in the Brown's Wash alluvium.

Disposal Cell

Ground water from disposal cell monitoring wells was sampled in June 1994 in compliance with long-term surveillance and monitoring requirements. The ground water protection strategy at the disposal cell

Table 13-1 Surface water quality results

Parameter	Date	UMTRA Guideline[a]	Location 718	Location 720
Nitrate	06/94	44	708	<1[b]
Selenium	06/94	0.05	0.28	<0.008[b]
Uranium	06/94	0.044	1.5	0.054

[a]Maximum concentration limit.
[b]Below analytical detection limit.

Notes: 1. Sample was unfiltered.
2. Results are reported in milligrams per liter.

Table 13-2 Ground water quality results in the vicinity of the processing site

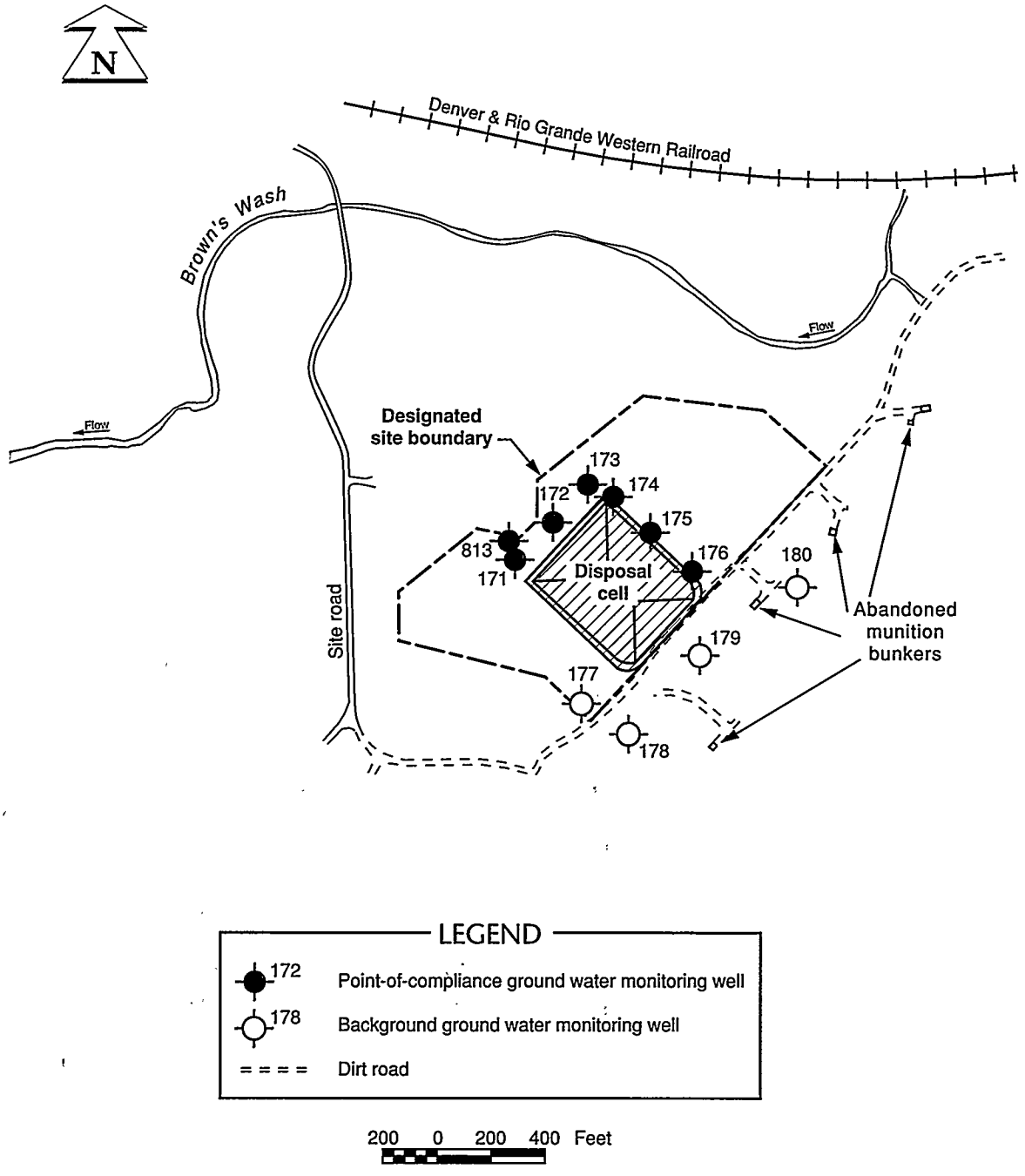
Indicator parameter	UMTRA Guideline	Monitoring well location 583	588	810
Uranium	0.044[a]			
01/94		0.002	0.002	0.002
Nitrate	44[a]			
01/94		<1	<1[c]	3.3
TDS	500[b]			
01/94		6520	2620	3820
Selenium	0.01[a]			
01/94		<0.005[c]	0.006	<0.005[c]

[a]Maximum concentration limit.
[b]Secondary Drinking Water Standard.
[c]Below the analytical detection limit (value shown).

Note: Results reported in milligrams per liter.

TDS – Total dissolved solids.

Figure 13-3
Ground Water Monitoring Well Locations, Disposal Cell



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requires that concentrations of designated hazardous constituents in point-of-compliance monitoring wells downgradient of the disposal cell must meet either the maximum concentration limits or baseline concentration limits.

Figure 13-3 shows the point-of-compliance monitoring network at the Green River disposal cell. The network consists of seven downgradient and crossgradient monitoring wells (171 through 176, and 813) and four baseline upgradient wells (177 through 180). A point-of-compliance well is located at a point where ground water quality must meet specific standards. These monitoring wells are completed in sandstones, siltstones, shales, and limestones of the Cedar Mountain Formation. The alluvium at the disposal site is very thin or absent, is unsaturated, and is subsequently not monitored. The disposal site was sampled in June 1994.

Figure 13-4 illustrates the potentiometric surface of the aquifer underlying the disposal cell in June 1994 and shows that ground water flows to the northwest.

Ground Water Results

Ground water samples collected from disposal cell monitoring wells were analyzed for major ions and trace elements associated with uranium ore and the milling processes. *Table 13-3* lists concentrations of nitrate, selenium, total dissolved solids and uranium. In 1994, no constituents exceeded the site-specific ground water protection limits proposed for the disposal cell (DOE, 1994).

Total dissolved solids ranged from 6000 to 8000 mg/L, a normal background level in the site area for shallow ground water in the Cedar Mountain formation.

Ground Water Conclusions

The results of 1994 ground water monitoring at the Green River disposal cell provide information that is consistent with established knowledge of disposal cell performance and site hydrogeology. The following conclusions can be made:

- Ground water in the disposal site area flows northwest.
- Concentrations of hazardous constituents are below background or proposed ground water protection limits (DOE, 1994).
- Total dissolved solid concentrations are within the normal range of background measurements for the site area.

Figure 13-4
Potentiometric Surface of the Upper Cedar Mountain Formation

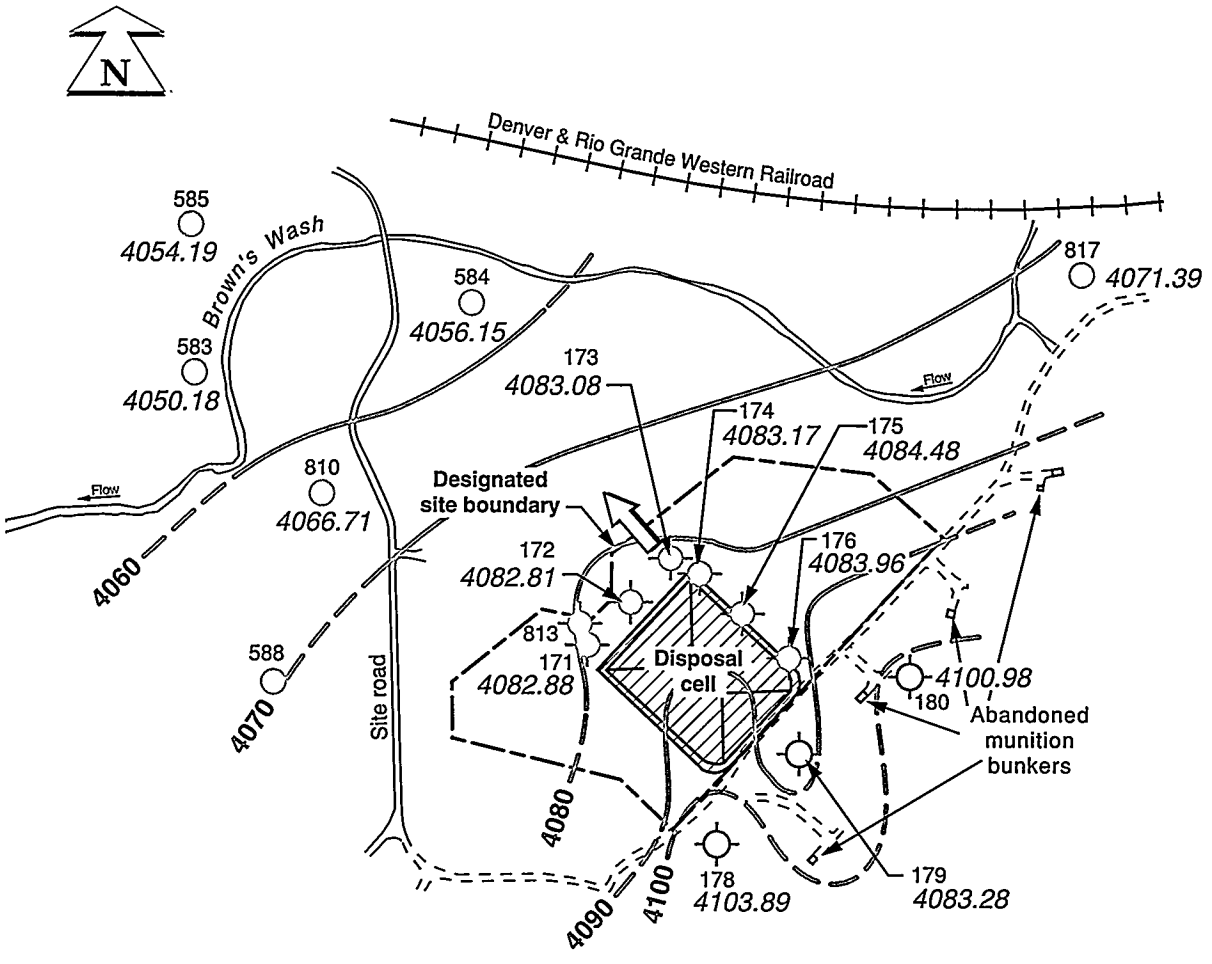

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Table 13-3 Ground water quality results, at the Green River disposal cell

Indicator parameter	Guideline[a]	Monitoring well location 179 (upgradient)	176 (crossgradient)	813 (downgradient)
Nitrate	293			
06/93		173	120	<1[b]
12/93		171	195	<1[b]
06/94		141	183	<1[b]
Uranium	0.229			
06/93		0.116	0.066	0.055
12/93		0.126	0.051	0.045
06/94		0.182	0.074	0.052
Selenium	2.5			
06/93		0.65	0.15	<0.02[b]
12/93		0.44	0.10	<0.005[b]
06/94		0.42	0.28	<0.005[b]
TDS	NA			
06/93		6120	7220	6740
12/93		6100	7270	6850
06/94		6140	7330	6890

[a]Proposed Green River ground water protection limits for the disposal cell.
[b]Value less than reportable limit of detection.

Notes: 1. Results are reported in milligrams per liter.
2. Protection limits derived from site background levels and EPA maximum concentration limits.

TDS – total dissolved solids.
NA – not applicable.

Sediment Monitoring

Sediment samples were collected in 1994 locations 718, 720, 801 and 802 (*Figure 13-2*) in support of the baseline risk assessment. Locations 718 and 720 are in Brown's Wash, downstream from the former processing site, and locations 801 and 802 are at the confluence of Brown's Wash and the Green River. Cadmium, nitrate, selenium and uranium concentrations for these four locations are shown in *Table 13-4*.

Sediment Results

Sediment analysis appear to correlate well with surface water results. Surface water quality data from location 718 shows high levels of nitrate, selenium, and uranium, suggesting contamination from the processing site. Analytical values from Brown's Wash location 720 are lower, indicating less contamination. Sediment analysis from locations 801 and 802 shows no contamination from the processing site.

Sediment Conclusions

Sediment analysis shows processing site contamination in Brown's Wash. Sediment contamination appears to be confined to the immediate vicinity of the former processing site. The contamination is probably a result of the following factors:

- Tailings were stored directly adjacent to Brown's Wash and were dispersed by both wind and water.
- Runoff from the tailings area into Brown's Wash allowed tailings material to commingle with natural sediments.
- Ground water from saturated alluvium that discharges to Brown's Wash is contaminating the sediments.

Table 13-4 Sediment analysis at the Green River UMTRA site[a]

	Sediment sampling location			
Constituent	**718**	**720**	**801**	**802**
Cadmium				
06/94	0.18	<0.23[b]	<0.19[b]	<0.19[b]
Nitrate				
06/94	680	<12[b]	20	30
Selenium				
06/94	<0.9[b]	<1.2[b]	<0.95[b]	0.94[b]
Uranium				
06/94	X	X	<0.001[b]	<0.001[b]

[a]Reported in parts per million.
[b]Below analytical detection limit.

Note: All locations are downstream from processing site

X – no sample taken.

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SITE DESCRIPTION AND LOCATION

The Mexican Hat UMTRA Project site is in San Juan County on Navajo Nation land, 1.5 mi southwest of the town of Mexican Hat, Utah (*Figure 13-5*). The community of Halchita is 0.5 mi southwest of the mill site.

The tailings site is in an area surrounded by ephemeral streams that drain mainly toward the north to the San Juan River (about 1 mi away). The elevation at the site is approximately 4300 ft above MSL. Vegetation is sparse and consists of various drought-resistant plant species adapted to the dry, desert environment.

Population growth in the area of the tailings site is primarily related to energy development activities such as coal, oil, and gas exploration and development. The population of the nearby communities fluctuates and is difficult to estimate. The population of San Juan County is 12,621 (DOC, 1990).

The Mexican Hat tailings site is arid, with large ranges in daily and annual temperatures. The winters are cold (temperatures below freezing prevail from November through March), and summers are hot, with high temperatures ranging from 90 to 100 °F. Average annual precipitation is 6 inches. Precipitation is fairly evenly distributed throughout the year. Snowfall is usually light. Mexican Hat received an annual average of 3.3 inches of snow from 1951 through 1980.

Strong winds are not common in the Colorado Plateau. Average wind speeds have been recorded at 9 mi per hour at Blanding, Utah, approximately 70 air miles northeast of the Mexican Hat site (*Figure 13-6*).

SITE HISTORY AND OWNERSHIP

Approximately 2.2 million tons of ore were processed from 1957 to 1965 at the Mexican Hat site. Much of the ore processed at the Mexican Hat mill contained large quantities of sulfides, some of which were used for a sulfuric acid plant at the site. Two separate piles covered most of the site. The upper pile covered approximately 25 ac and the lower pile covered approximately 43 ac.

The DOE and the Navajo Nation entered into a cooperative agreement pursuant to the provisions of UMTRCA (42 USC §7901 *et seq.*) to provide for the planning, expenditure of funds, remediation, and long-term surveillance and maintenance of the disposal site. This agreement calls for custody of the disposal site to be transferred from the Navajo Nation to the DOE until ground water remediation is complete.

Ownership and control of the site will comply with a custody agreement between the DOE and the Navajo Nation.

Figure 13-5
Mexican Hat Site Location

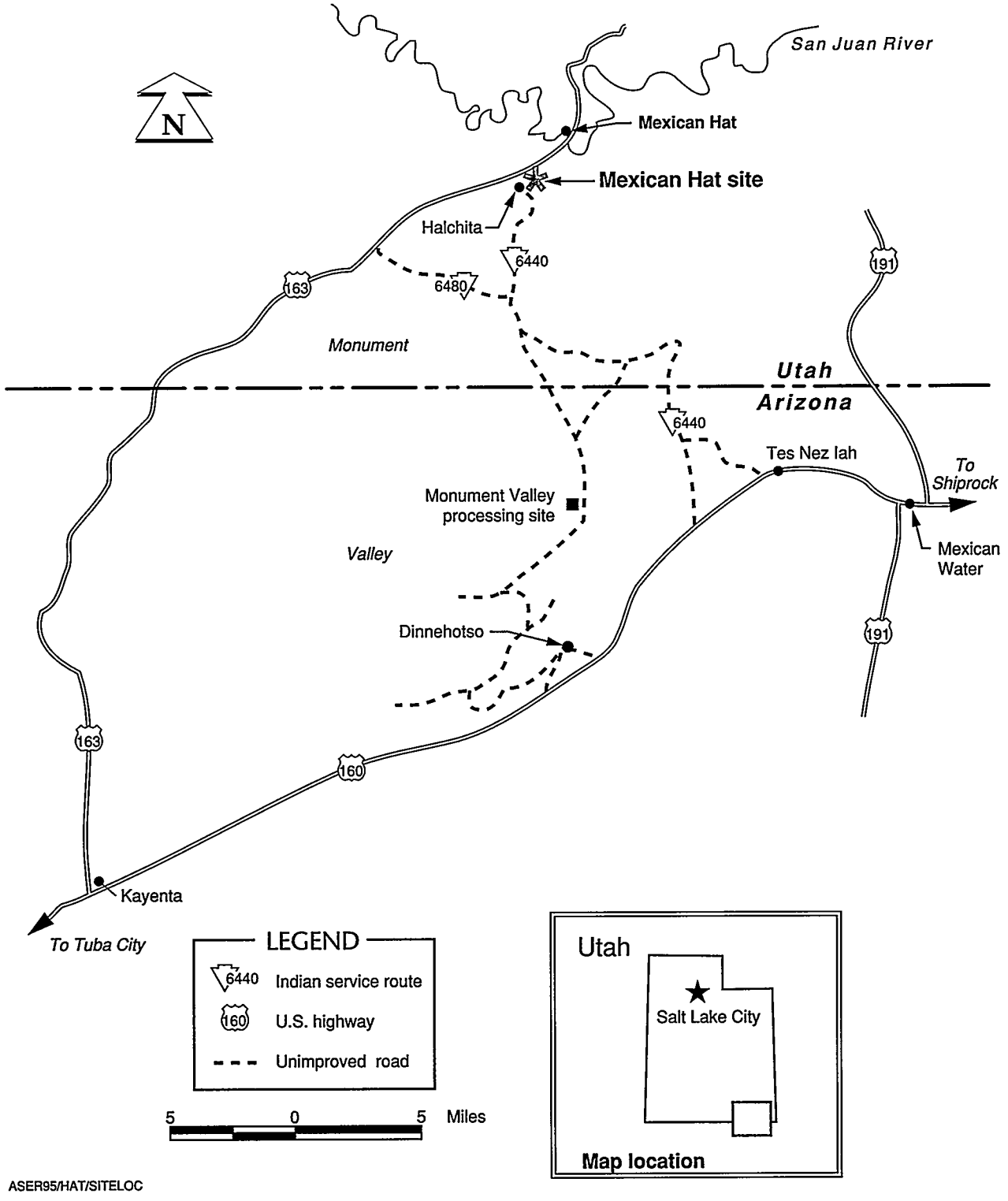
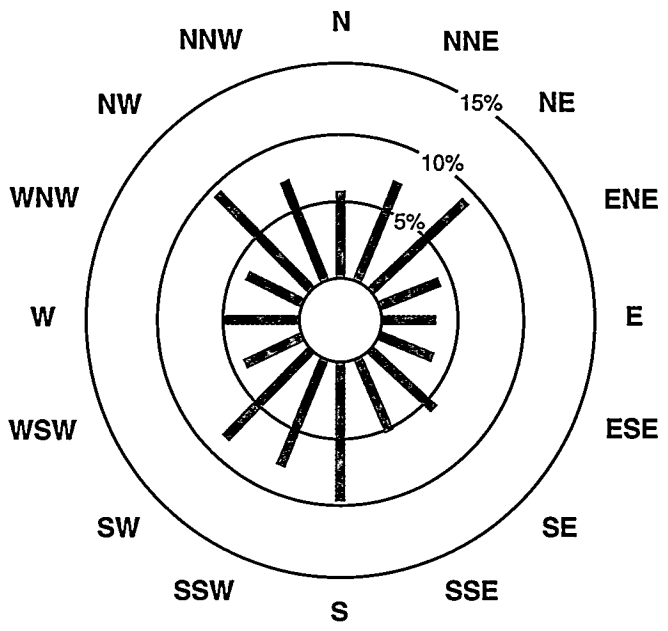


Figure 13-6
Wind Rose



Ref: Blanding, Utah.
Cumulative data 1977 through 1978.

ASER95/HAT/WINDHAT

SITE CHARACTERIZATION AND CLEANUP

At the Mexican Hat site, tailings from the upper pile were combined with the lower pile. The tailings and associated windblown contaminated soils were consolidated into a single contoured pile in the location of the lower tailings pile and covered with a radon barrier of compacted soil.

Remedial action was suspended during 1990 but began again in August 1992. At the end of 1992, approximately 90 percent of the construction at the Mexican Hat site was complete, with the upper part of the tailings pile relocated to the lower pile in preparation for stabilization. Most windblown materials surrounding the mill site had been remediated. The primary 1993 construction activity was placement of contaminated materials from the Monument Valley, Arizona, UMTRA Project site in the Mexican Hat disposal cell.

After the contaminated material was placed and compacted, a radon barrier of silty sand amended with bentonite clay was placed over the pile to reduce radon flux. Layers of rock were then placed on the pile for erosion protection. The Mexican Hat disposal cell was completed in the fall of 1994.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Mexican Hat complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet all regulatory requirements. Mexican Hat site environmental activities in 1994 include complying with surface waters discharge permits controlling fugitive dust emissions, reporting certain quantities of hazardous materials used or stored at the site, spill prevention control and countermeasures planning, and adhering to transportation and local regulations.

Emergency Planning and Community Right-to-Know Act

Under EPCRA (42 USC §11001 *et seq.*), the Mexican Hat site must comply with the EPCRA requirements, including notifications for threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

In 1994, the site was in compliance with the requirements of EPCRA, Section 311, because the site had been inventoried for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. The inventory was submitted to the state Emergency Response Commission, the local emergency planning committee, and the local fire department.

In 1994, the site was in compliance with the requirements of EPCRA, Section 312; Tier II reporting forms for the materials inventoried in 1993 were developed and submitted to the state Emergency Response Commission, the local emergency planning committee, and the local fire department on 01 March 1994.

No materials were released into the environment that would fall under EPCRA reporting requirements.

Clean Water Act

National Pollutant Discharge Elimination System

A NPDES permit (No. UT-0024945) was issued by the federal EPA 1990 as a no-discharge permit for the retention basin at the Mexican Hat site. A general storm water permit application for the site was submitted to the EPA in November 1993. The site applied for an individual storm water permit from the federal EPA in February 1993. There were no storm water releases in 1994.

Spill Prevention Control and Countermeasures Plan

This plan addresses requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. Earthen berms were designed and constructed around existing aboveground storage tanks and around drum storage areas. These secondary containment systems are designed to provide adequate spill control. In addition, berm inspection plans for spill detection,

emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas. There were no releases in 1994.

Septic/Holding Tanks

The Mexican Hat site has one septic tank and drainfield. It is emptied yearly or as necessary. The Navajo Office of Environmental Health has regulatory jurisdiction for septic/holding tanks.

Clean Air Act

The EPA determined that the Mexican Hat site is not a major source of fugitive dust emissions as defined under regulations for the prevention of significant deterioration. The major pollutant is fugitive emissions (total suspended particulates) from nonpoint sources; therefore, the Mexican Hat site does not require a permit from the EPA and fugitive dust monitoring was not conducted. Visible emissions of fugitive dusts were strictly controlled during 1994 using water and proper work practices, as required by the Navajo Nation Environmental Protection Agency.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review and comment. Public hearings regarding the draft programmatic environmental impact statement will be held in 1995 in or near Mexican Hat.

Hazardous Materials Transportation Act

All residual radioactive materials transported to the Mexican Hat site were in full compliance with all applicable requirements of HMTA (49 USC §1801 *et seq.*).

Environmental Permit Compliance Status

The Mexican Hat site obtained and operated under all required permits in 1994. All active permits under which the site operated during 1994 are listed in ***Table 13-5***.

Site-Specific Requirements

Because the site is on Navajo Nation land, it is under the jurisdiction of both the Navajo Nation Environmental Protection Agency and the federal EPA, Region IX.

Table 13-5 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
NPDES permits (EPA)					
Process site wastewater (state)	01/90	Final received[a]	06/92	UT-0024945	09/95
Process site storm water (EPA) (individual)	01/93	Final received[a]	12/93	UTRIOA05F	11/98
Process site storm water (general)	10/93	Final received[a]	11/90	b	NA
Water rights					
Consigned water service	12/87	1/88	08/88	R1490	10/95
Water use permit (Navajo Nation)	02/93	Final received[a]	03/93	93030	03/94
Borrow permit (BIA)					
B4/RB7	03/89	Final received[a]	11/93	115-93	12/95
Revocable use permit (BIA)					
Expanded tailings site	05/87	Final received[a]	09/87	TC-87-902	07/93
Expanded tailings site (renewal request)	05/93	Pending		TC-87-902	09/94[c]
Free use permit (BLM)					
Bluff Pit	02/89	Final received[a]	04/92	UTU66338	05/97
Sugarloaf Quarry	NA	Final received[a]	10/92	UTU66339	05/97
Sugarloaf Quarry - revision to material quantity	NA	Final received[a]	05/93	UTU66339[c]	05/97

[a]Not applicable in 1994.
[b]Permit is overdue from agency.
[c]Renewal request, see N-01-02738.

NA – Not applicable.
BIA – Bureau of Indian Affairs.
BLM – Bureau of Land Management.

ENVIRONMENTAL MONITORING

The DOE implements a detailed environmental monitoring program for contamination at the Mexican Hat site, including environmental gamma radiation and radiological and nonradiological constituents in air and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

Due to the lack of available surface water at the site, surface water samples were not collected during 1994.

Air Monitoring

Nonradiological Air Particulate Monitoring

Because the major pollutant is fugitive emissions (total suspended particulates) from nonpoint sources, the Mexican Hat site does not require an EPA permit and fugitive dust monitoring was not performed. Visible emissions of fugitive dust are strictly controlled using water and proper work practices.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Mexican Hat site was conducted at Stations 1 through 5. Background measurements were made at Station 1 (***Figure 13-7***). Monitoring was discontinued on 15 August 1994, 1 month after the disposal cell was covered.

The estimated average thorium-230 concentration at all stations (***Table 13-6***) was well below the thorium-230 average annual guideline of 500×10^{-16} µCi/mL above background. This indicates radioactive particulate releases from remedial action were not significant.

Radon Monitoring

Real-Time Radon Monitoring. Real-time radon monitoring was conducted at Stations 1, 4, and 5. Background radon concentrations were measured at Station 1, upwind (southwest) of the site (***Figure 13-7***). Monitoring was discontinued on 15 August 1994, 1 month after the disposal cell was covered.

All measurements (***Table 13-7***) were much lower than the DOE guideline of 3×10^{-9} µCi/mL above background.

Passive Radon Monitoring. Nine stations were established around the site (Stations 1 to 9). Background monitoring was again performed upwind, at Station 1 (***Figure 13-7***). Monitoring was discontinued at the end of September because remedial action was completed earlier in the calendar quarter.

All measurements (***Table 13-8***) were much lower than the DOE guideline.

Figure 13-7
Environmental Air and Gamma Radiation Monitoring Stations

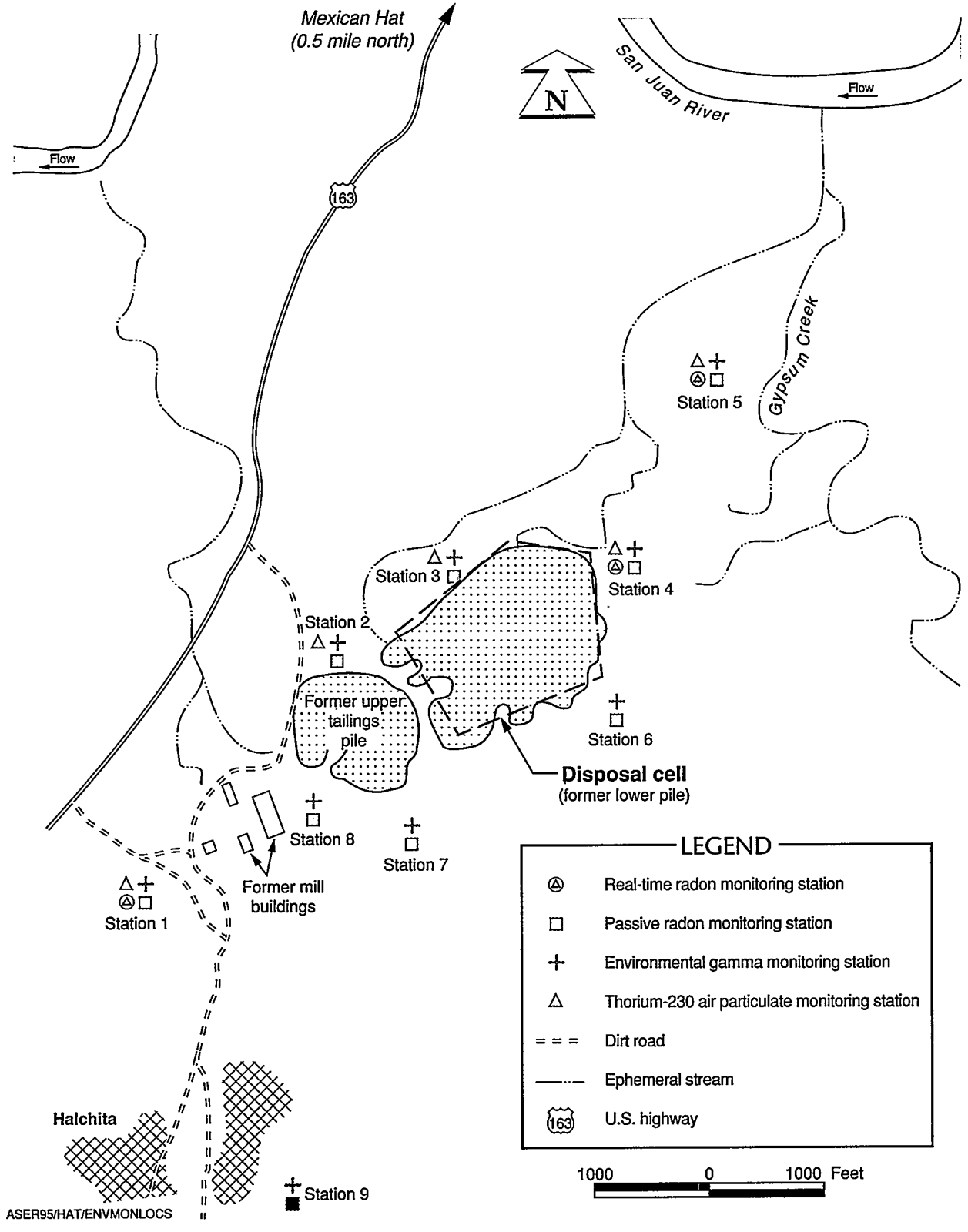


Table 13-6 Environmental airborne radioactive particulate concentrations (10^{-16} μCi/mL)

Station	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average
1	29	15	7	a	19 (9)
2	29	15	6	a	19 (9)
3	30	16	7	a	20 (10)
4	33	23	6	a	24 (12)
5	24	15	5	a	16 (8)

[a]Monitoring was discontinued.

( ) indicate 10^{-8} picograms per milliliter.

Table 13-7 Real-time radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	0.63	0.30	0.26	a	0.42
4	0.86	0.36	0.23	a	0.55
5	0.44	0.22	0.21	a	0.30

[a]Monitoring was discontinued.

Table 13-8 Passive (alpha-track) radon concentration (10^{-9} μCi/mL)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
1	1.0	0.5[a]	0.4	c	0.7
2	0.8	0.5[b]	0.5[a]	c	0.7
3	1.3	0.5[b]	<0.4	c	1.0
4	1.3	0.5	0.5[a]	c	0.8
5	0.7	<0.3	<0.4	c	0.7
6	1.2	0.4[a]	0.9	c	0.9
7	1.2	0.5	0.9	c	0.9
8	0.9	0.4[a]	0.6[a]	c	0.6
9	0.8	<0.3	0.4[b]	c	0.7

[a]At least 1 detector was less than the detectable limit; the remaining detectors were averaged.

[b]2 detectors were less than the detectable limit; the result is based on remaining detector.

cMonitoring was discontinued.

< Indicates all detectors were less than the detectable limit; the detection limit is reported.

Air Monitoring Conclusions

All concentrations of thorium-230 particulates and radon-222 were lower than the applicable guidelines. No significant releases occurred from the site during 1994.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure to penetrating gamma radiation in the environment around the Mexican Hat site. Monitors were placed at the site perimeter as well as near adjacent communities. Stations 1, 5, and 9 were placed near local communities (*Figure 13-7*). Background monitoring was performed at Section 9. Nine dosimetry monitoring stations were active in 1994. Monitoring was discontinued at the end of September because remedial action was completed earlier in the calendar quarter.

None of the stations recorded dose equivalents statistically different from background (*Table 13-9*).

Environmental Gamma Radiation Monitoring Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guidelines, indicating no significant releases occurred.

Table 13-9 Environmental gamma dose equivalent[a] (mrem)

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1	41.6 ± 11.8	36.8 ± 4.3	36.8 ± 7.4	X	115.2 ± 14.6 (1.152 ± 0.146)
2	33.2 ± 2.6	29.6 ± 9.2	28.4 ± 5.2	X	91.2 ± 10.9 (0.912 ± 0.109)
3	39.6 ± 14.9	32.6 ± 5.2	31.8 ± 9.2	X	104.0 ± 18.3 (1.040 ± 0.183)
4	47.0 ± 18.8	36.6 ± 5.8	33.6 ± 5.8	X	117.2 ± 20.5 (1.172 ± 0.205)
5	34.6 ± 10.2	27.8 ± 3.8	27.0 ± 1.4	X	89.4 ± 11.0 (0.894 ± 0.110)
6	41.4 ± 12.0	33.6 ± 9.9	b	X	c
7	37.6 ± 7.6	32.8 ± 13.1	b	X	c
8	43.6 ± 10.8	35.8 ± 11.0	32.0 ± 4.0	X	111.4 ± 15.9 (1.114 ± 0.159)
9	35.2 ± 7.7	30.2 ± 3.0	28.4 ± 3.3	X	93.8 ± 8.9 (0.938 ± 0.089)

[a]All errors reported as 2 standard deviations.
[b]Lost dosimeter.
[c]Insufficient data for annual dose equivalent.

Note: Annual dose equivalent based on available data.

( ) Indicate millisieverts.
X – no sample taken.

Ground Water Monitoring

Ground water was sampled in April/May and December 1994 to monitor the effects of surface remediation activities. Ground water is present in two units beneath the site, the Halgaito Shale Formation and the Honaker Trail Formation. The ground water in the shallower zone, the Halgaito Shale, is contained in fractures. It occurs over a limited area and is primarily the result of milling operations. Controlled by fracture orientation, water within the Halgaito Shale flows east at an approximate rate of 30 ft per year. ***Figure 13-8*** shows ground water sampling locations for the Mexican Hat site. Monitoring wells in the Halgaito Shale were decommissioned either as a result of surface remediation activities or because they did not contain sufficient water for sampling. Therefore, ground water seeps are used as the monitoring points for water within the Halgaito Shale Formation.

Because there are no monitoring wells completed in the Halgaito Shale at the site, a ground water contamination map cannot be constructed. However, the ground water seeps that were sampled indicate contaminated ground water is flowing to the east in the vicinity of the site.

Ground water within the Honaker Trail Formation flows northeast at an approximate rate of 4 ft per year. ***Figure 13-9*** shows a 1988 estimate of the potentiometric surface map and ground water flow direction in the Honaker Trail Formation. Currently, monitoring well 909 is the only Honaker Trail monitoring well at the site, and it is used to monitor the water quality of the Honaker Trail Formation.

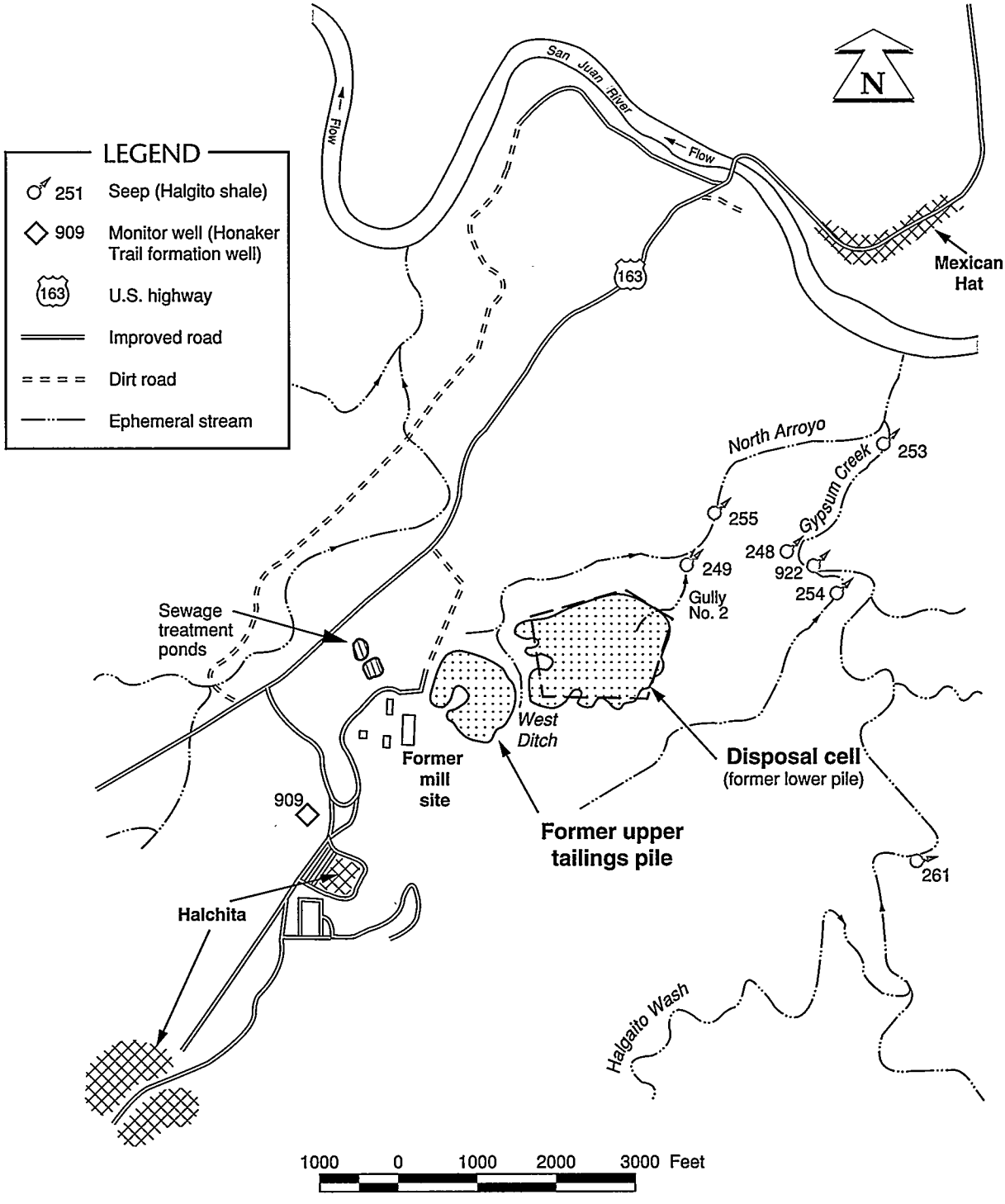
Ground water in the Honaker Trail Formation within the vicinity of the site is not used for domestic or agricultural purposes due to its naturally poor quality, which is characterized by high concentrations of total dissolved solids and hydrogen sulfide and by areas of naturally occurring petroleum. The nearby San Juan River provides sufficient quality and quantity for the resource needs of the area.

Ground Water Results

Ground water samples were analyzed for a variety of constituents, including the contaminant indicator parameters nitrate and uranium (***Table 13-10***). Nitrate and uranium are good indicators of ground water contamination because they travel at about the same rate as ground water flow, they are by-products of the milling operation, and the concentrations of nitrate and uranium in natural water are relatively low.

The water quality of the seeps, with the exception of the background seep (261), indicates the former mill operations have affected ground water in the Halgaito Shale Formation. The results from monitoring well 909 show uranium concentrations above the EPA maximum concentration limit in the Honaker Trail Formation upgradient from the former processing site.

Figure 13-8
Ground Water Monitoring Locations



Note: Well and seep locations are approximate.

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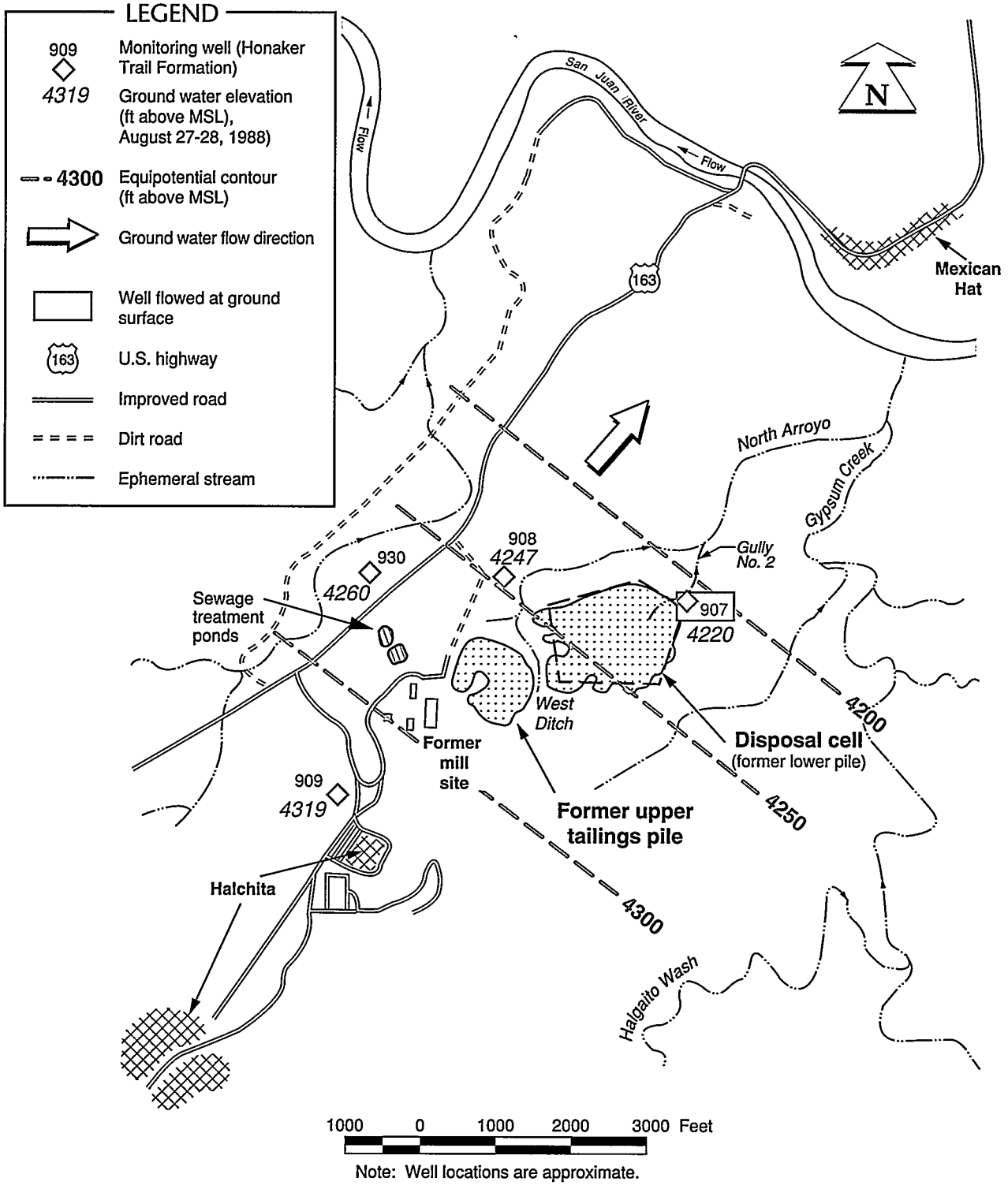
Figure 13-9
Potentionetric Surface, Honaker Trail Formation



Note: Well locations are approximate.

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Table 13-10 Water quality results, in milligrams per liter (mg/L) Mexican Hat, Utah, 1994

	Nitrate (MCL = 44 mg/L)		Uranium (MCL = 0.044 mg/L)	
Monitoring Location	April-May	December	April-May	December
Downgradient seeps				
248	73	88	0.604	0.592
249	687	800	1.15	0.816
253	X	124	X	0.379
254	416	494	0.580	0.747
255	633	X	1.29	X
922	74	203	0.340	0.503
Upgradient seep				
261	X	<1.0	X	0.094
Honaker Trail Well				
(upgradient) 909	9	8	0.051	0.052

MCL – maximum concentration limit.
X – no sample taken.

Ground Water Conclusions

Ground water within the Halgaito Shale Formation downgradient from the site is affected by the former milling operations, which included mill tailings disposal. The extent of contamination in ground water is shown by the locations of the seeps. Contaminated ground water is moving east through fractures in the Halgaito Shale at a rate of approximately 30 ft per year. Contaminated water from the seeps apparently does not reach the San Juan River. Because the amount of water discharged from the seeps is so small, the water probably evaporates before reaching the river.

The results from well 909 indicate that background uranium concentrations in the Honaker Trail Formation are slightly above the maximum concentration limit.

SITE DESCRIPTION AND LOCATION

The Salt Lake City UMTRA processing site is a 128-ac property 4 mi south-southwest of the center of Salt Lake City, Utah (*Figure 13-10*). The processing site is bounded on the north by Mill Creek, on the east by the tracks of the Denver & Rio Grande Western Railroad, on the south by 3300 South Street, and on the west by 900 West Street. An industrial area faces the processing site on 900 West Street.

The Salt Lake City disposal site (the South Clive disposal site) is in Tooele County, Utah, approximately 81 mi due west of Salt Lake City (*Figure 13-10*). The disposal site is in a relatively flat area along the eastern edge of the Great Salt Lake desert. The desert extends approximately 60 mi from the Nevada-Utah border on the west to a series of north-south trending mountain ranges on the east. In the disposal site vicinity, the eastern border of the desert is formed by the Cedar Mountains that rise to elevations of approximately 7700 ft above MSL. The proximity of this mountain range results in a westerly surficial drainage pattern at the disposal site.

Some 437,000 people live within 6 mi of the Salt Lake City processing site. The estimated population of South Salt Lake City is 10,129. The population of Salt Lake County is 725,956 (DOC, 1990).

An estimated 25,526 people lived within 50 mi of the South Clive disposal site at the time of the 1980 census; near the disposal site, most of the land is uninhabited.

The processing site area is semiarid. Temperatures range from 28 °F in January to 77 °F in July. The average rainfall is about 15 inches per year. Prevailing winds are south through southeast with a mean speed of 8.7 mi per hour; strong winds tend to come from the west or northwest. The area receives summer thunderstorms and winter snowfall.

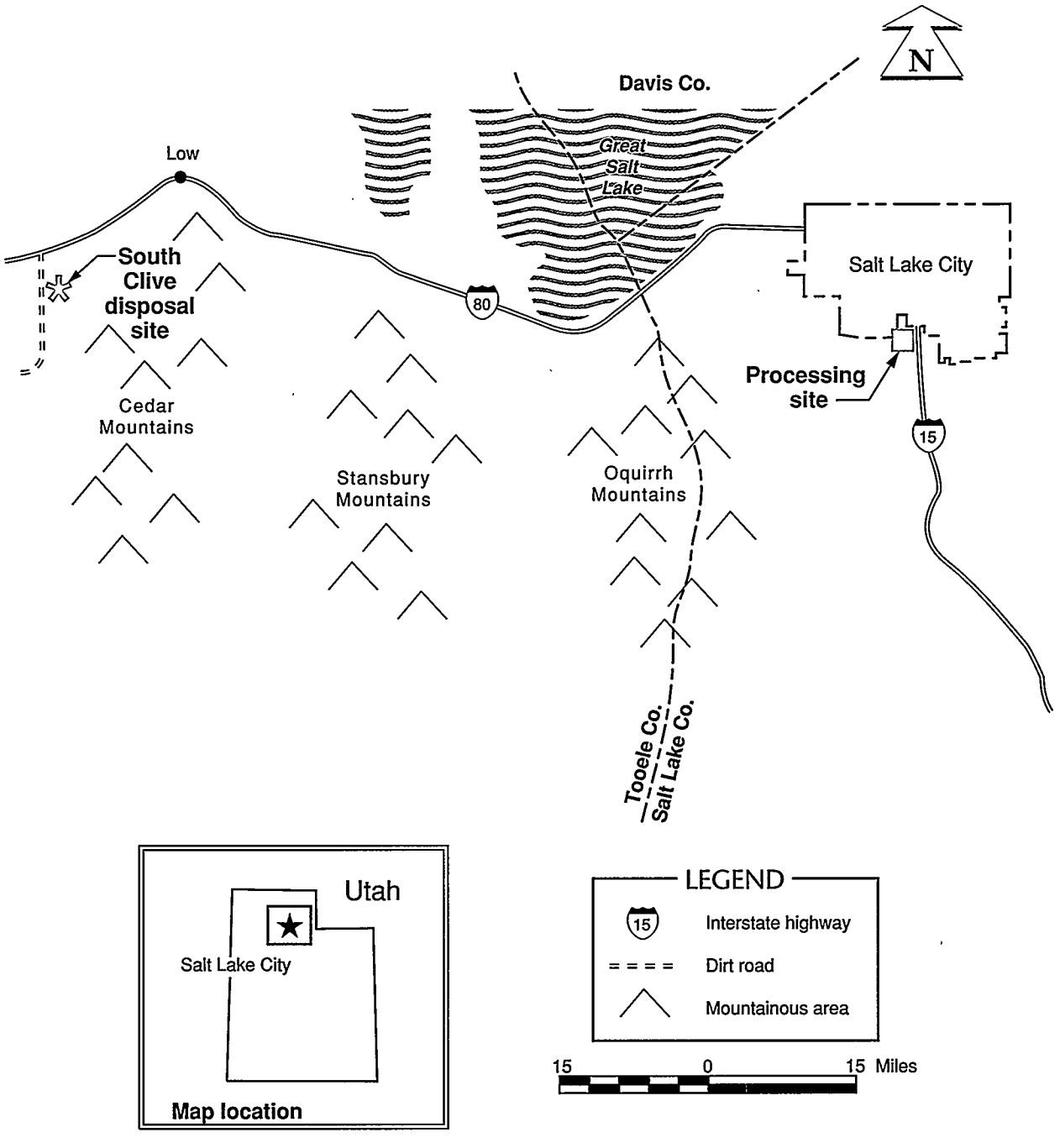
The South Clive disposal site area is arid. Normal monthly temperatures range from 27 °F in January to 79 °F in July. The annual precipitation is only 5 inches.

SITE HISTORY AND OWNERSHIP

In 1951, Vitro Rare Metals Company acquired a plant originally built during World War II to produce alumina from alunite. Vitro Rare Metals Company converted the plant to process uranium ore and operated the plant from 1951 to 1964. In 1964, the mill was converted to produce vanadium from Idaho Ferrophosphorous (resulting from elemental phosphorous production). Vanadium production ceased in July 1968. Plant demolition began in 1968 and was complete in 1970.

The state of Utah holds title to the South Clive disposal site, and the Salt Lake City processing site is owned by the Central Valley Water Reclamation Facility Board. The state must transfer title for the

Figure 13-10
Salt Lake City Processing Site and South Clive Disposal Site Locations



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disposal site to the federal government before the NRC will license the disposal site under provisions of 10 CFR Part 40.

SITE CHARACTERIZATION AND CLEANUP

When the plant was dismantled in 1970, the radioactively contaminated materials from the processing operations remained on the site (approximately 1.6 million cubic yards of uranium mill tailings and over 850,000 cubic yards of other contaminated material). Surface remedial action, conducted by the state of Utah under the direction of the UMTRA Project, began in 1984 and was completed in 1988. A total of 2,798,000 cubic yards of residual radioactive materials were removed from the former processing site and surrounding vicinity properties and transported and stabilized in the South Clive disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

With the surface remedial action at the Salt Lake City processing site complete, the compliance issues remaining for surface remediation are NRC licensing under provisions of 10 CFR Part 40. Before licensing, the NRC must concur with the completion reports for the South Clive disposal site and the Salt Lake City processing site. Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected at the processing site and analyzed to further evaluate ground water contamination from the former uranium processing activities.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings on the draft programmatic environmental impact statement will be held in 1995.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for surface water and ground water contamination at the Salt Lake City processing site. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action complete, air and environmental gamma radiation monitoring data are no longer collected for the UMTRA environmental monitoring program at the processing site or the South Clive disposal cell. Ground water data have not been collected at the South Clive disposal cell due to the very poor quality of naturally occurring ground water at the site (total dissolved solids ranging from 19,000 to 50,000 mg/L).

Surface Water Monitoring

Surface water and sediment samples were collected at the processing site in December 1994 at upstream and downstream locations along

Mill Creek and at on-site locations along South Vitro ditch (*Figure 13-11*). Surface water in South Vitro ditch is derived from a storm sewer located at the south end of South Vitro ditch and from the unnamed ditch which drains a marshy area between the eastern boundary of the site and Interstate Highway 15. The downstream sample from Mill Creek is downstream of the point of discharge for South Vitro ditch near the northwest corner of the site. This sample is also immediately downstream of the Central Valley Water Reclaimation Facility point of discharge for treated sewage effluent.

Surface Water and Sediment Results and Conclusions

Indicator parameters reflect the sharp contrast between background water quality conditions and tailings-contaminated water. The indicator parameters selected for the processing site are chloride, molybdenum, sulfate, total dissolved solids, and uranium. These parameters are representative of contaminants derived from processing activities and tailings piles that have migrated into the shallow aquifer at the site.

Results of sampling performed during the fourth quarter of 1994 suggest that site-related contaminants occur in surface water in South Vitro ditch (*Table 13-11*). This is indicated by the presence of both molybdenum and uranium at levels several times higher than those found in Mill Creek or the unnamed ditch to the east of the site. This contamination may be the result of direct discharge of shallow ground water into the ditch or indirect discharge by way of a storm sewer sump-pump. This sump-pump is at the railroad underpass located immediately southeast of the processing site (*Figure 13-11*).

A comparison of the December 1994 surface water data from south Vitro ditch to aquatic life water quality values indicates that the observed concentrations of uranium and molybdenum do not pose a threat to aquatic life (*Table 13-11*). Chloride concentrations could have an impact on aquatic life (*Table 13-11*). However, it is not clear that chloride is the result of site-related contamination. Other possible sources would be from road salt.

Water quality data for Mill Creek show slight increases in chloride, molybdenum, total dissolved solids, and uranium levels downstream of the site. However, further sampling will be required to verify that these minor increases are site related. Again, only chloride exceeds guidelines for chronic effects to aquatic life (*Table 13-11*).

A previous sampling round of sediments in South Vitro ditch (in 1993) indicated the presence of elevated molybdenum in sediments from the north end of South Vitro ditch. Sampling in the fourth quarter of 1994 verified this. In addition, elevated concentrations of arsenic, copper, lead, and silver were detected in sediments from South Vitro ditch and the unnamed ditch to the east of the site (*Table 13-12*). However, it is not clear whether these contaminants are site related or whether they

Figure 13-11
Surface Water Sampling and Ground Water Monitoring Well Locations, Processing Site

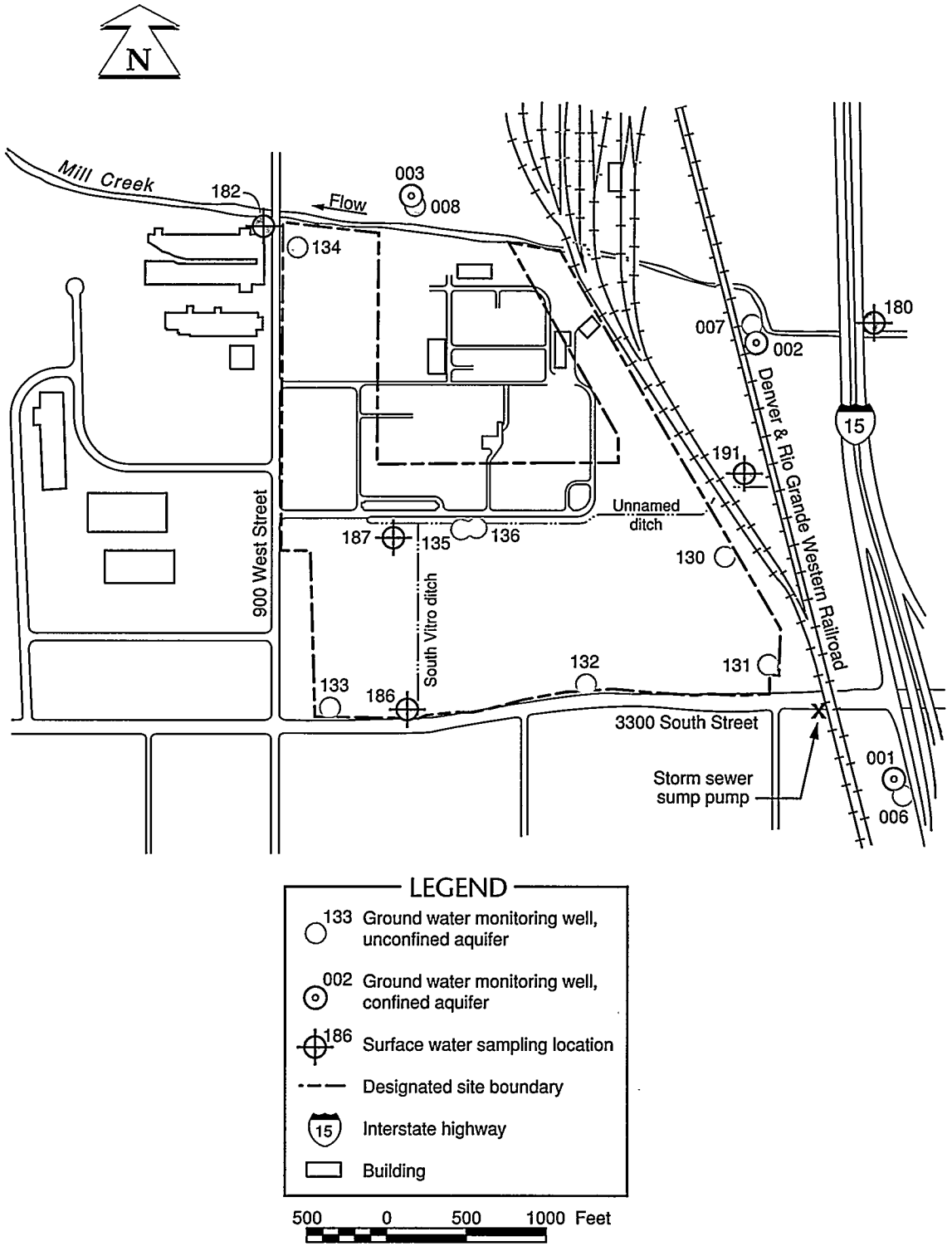

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Table 13-11 Unfiltered surface water quality results, processing site

Parameter	Aquatic life water quality guideline	Mill Creek sampling locations		Unnamed ditch	South Vitro ditch	
		180 upstream	182 downstream	191 east of site	186 south end	187 north end
Chloride	230[a]	122	279	769	240	324
Molybdenum	0.79[b]	<0.01	0.02	0.01	0.12	0.13
Sulfate	NA	138	133	138	179	242
Total dissolved solids	NA	729	960	1710	1040	1220
Uranium	8.4[c]	0.002	0.007	0.008	0.023	0.028

[a]From EPA (1991), chronic Federal Water Quality Criteria for the protection of freshwater aquatic life.
[b]Value from Eisler (1989).
[c]From water hardness chronic criteria (CDPHE, 1991).

Note: Concentrations are reported in milligrams per liter. Samples collected December 1994.

NA – guideline not available.

Table 13-12 Sediment sample analytical results, processing site

Parameter	Guideline[a]	Mill Creek Sampling Locations		Unnamed ditch	South Vitro ditch	
		180 upstream	182 downstream	191 east of site	186 south end	187 north end
Arsenic	8.2	4	14	54	13	61
Copper	20	18	33	141	92	404
Lead	47	25	29	485	245	344
Molybdenum	NA	<1	<2	2	13	158
Silver	1.0	0.2	0.3	1.4	0.3	5.6
Uranium	NA	2	3	5	6	10

[a]From potential toxicity levels for flora and fauna Hull and Suter (1994).

Note: Concentrations are reported in milligrams per kilogram. Samples collected December, 1994.

NA – guideline not available.

are the result of other industrial operations in the Salt Lake City area. Guidelines for potential toxic effects to flora and fauna indicate that the concentrations of arsenic, copper, lead, and silver may be toxic to flora and fauna (*Table 13-12*).

Ground Water Monitoring

Ground water in the vicinity of the Salt Lake City processing site is generally characterized by two aquifer systems: a shallow, unconfined system and a deeper, confined system. The two aquifers are separated by interbedded layers of low-permeability clays and silts. Wells within the confined aquifers at depths from 70 to 330 ft below the ground surface are under substantial artesian pressure, with ground water flowing from several wells.

Ground water levels in the unconfined aquifer range from 5 to 15 ft or more below the ground surface. Topographic lows in the vicinity of the site are perennially marshy. The ground water flows primarily from southeast to northwest toward the Great Salt Lake. *Figure 13-12* shows a water table map of the shallow unconfined aquifer. A potentiometric map of the deeper confined aquifer was not constructed because there were not adequate ground water elevation data available for this unit.

The ground water monitoring network at the site consists of ten wells screened in the shallow unconfined aquifer and three wells screened in the deeper confined aquifer. The shallow unconfined aquifer monitoring wells are upgradient of the contamination, within the contamination, and downgradient.

Ground water was sampled in February and December 1994. The next water quality sampling round is scheduled for July 1995.

Ground Water Results and Conclusions

The confined aquifer was not sampled during the first quarter of 1994. Fourth-quarter sampling of the confined aquifer is consistent with previously collected samples and does not indicate site-related contamination of the confined aquifer (*Table 13-13*). However, background water quality data are not available for the confined aquifer.

Ground water in the shallow unconfined aquifer is contaminated as a result of uranium processing activities (*Table 13-14*). Results from the first- and fourth-quarter sampling round showed that concentrations of arsenic, molybdenum, and uranium exceeded maximum concentration limits in ground water in the shallow unconfined aquifer beneath the site. However, arsenic has been reported at levels above maximum contaminant levels in the shallow aquifer throughout the Salt Lake Valley (Seiler and Waddell, 1983).

Figure 13-13 shows the approximate extent of contamination based on sulfate distributions in the shallow aquifer at the processing site.

Figure 13-12
Ground Water Table Contours of the Unconfined Aquifer, Processing Site

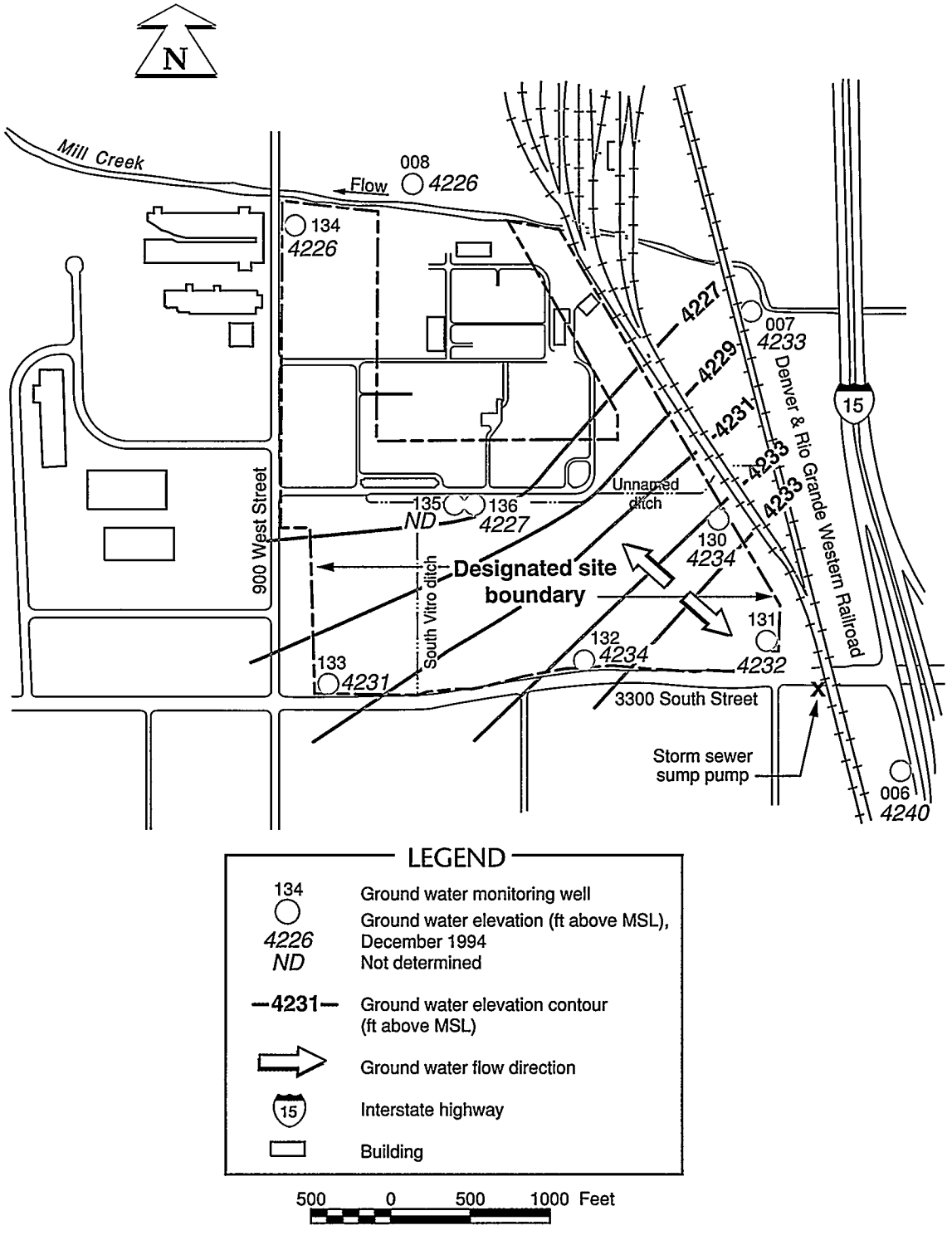

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Table 13-13 Deeper confined aquifer ground water quality results, processing site

Indicator parameter	Guideline	Monitoring well location 002	003
Chloride	250[a]	9	14
Molybdenum	0.10[b]	<0.01	<0.01
Sulfate	250[a]	3	27
Total Dissolved Solids	500[a]	297	298
Uranium	0.044[b]	0.001	0.001

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.

Note: Concentrations are reported in milligrams per liter. Samples collected December, 1994.

Table 13-14 Shallow unconfined aquifer ground water quality results, processing site

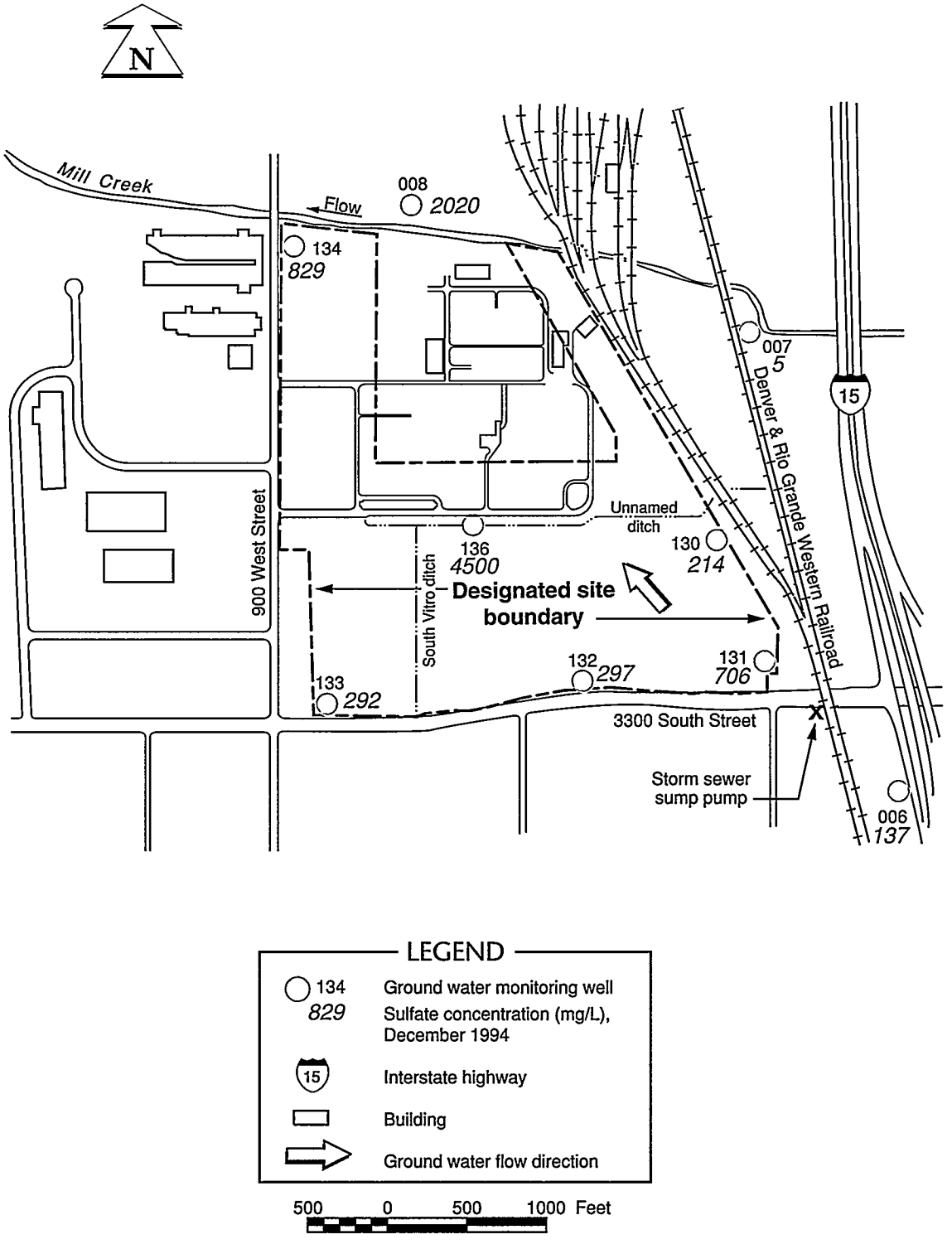
Indicator parameter	Guideline	Monitoring well location 007 (background)	136 (contamination)	134 (downgradient)
Chloride	250[a]	69	2,760	136
Molybdenum	0.10[b]	<0.01	0.07	0.02
Sulfate	250[a]	5	4,500	829
Total dissolved solids	500[a]	565	12,700	1,480
Uranium	0.044[c]	<0.001	0.057	0.049

[a]Secondary Drinking Water Standard.
[b]Maximum concentration limit.
[c]Maximum concentration limit (0.044 mg/L) is the mass equivalent of 30 pCi/L, assuming uranium-234 and uranium-238 are in equilibrium.

Note: Concentrations are reported in milligrams per liter. Sample collected December 1994.

Contaminant migration in ground water in the unconfined aquifer west and northwest of the processing site may be occurring, but the full extent of contamination is not known because no monitoring wells were established at downgradient, off-site locations. Increased concentrations of sulfate and the other indicator parameters in wells on the south and east boundaries of the site (monitoring wells 130, 131, and 132) indicate that contamination of the shallow aquifer is extending into these areas of the processing site.

Figure 13-13
Sulfate Concentrations in the Unconfined Aquifer, Processing Site



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United States Codes

42 USC §4321 *et seq.*, *National Environmental Policy Act.*

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act of 1978.*

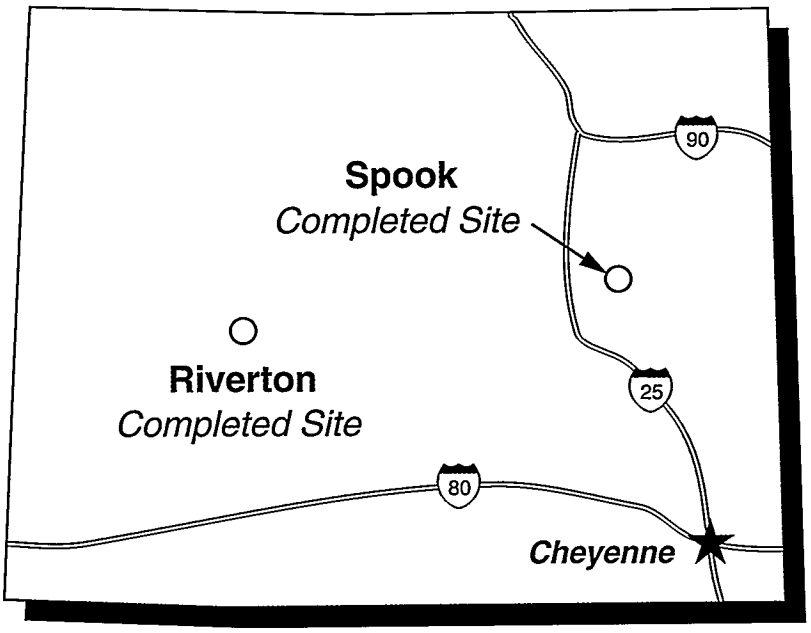
42 USC §9601 *et seq.*, *Comprehensive Environmental Response, Compensation, and Liability Act.*

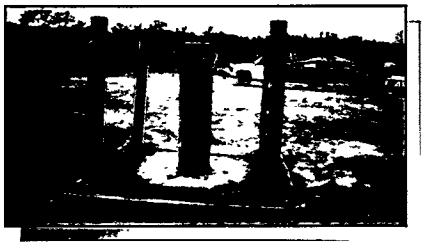
42 USC §11001 *et seq.*, *Emergency Planning and Right-to-Know Act.*

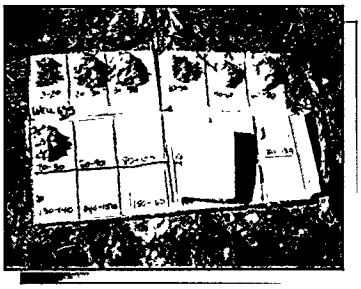
49 USC §1801 *et seq.*, *Hazardous Materials Transportation Act.*

UMTRA PROJECT

CHAPTER 14
WYOMING SITES







WYOMING SITES

This chapter provides detailed UMTRA Project data on environmental monitoring activities conducted at Riverton and Spook, Wyoming, during 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental assessments and remedial action plans, are available at the DOE UMTRA Project, DOE Environmental Restoration Division, Albuquerque, New Mexico.

Riverton

The Riverton site is in Fremont County in western Wyoming. Site remediation was completed in November 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1994. However, during 1994, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Spook

The Spook site is in Converse County in eastern Wyoming. The DOE completed site remediation in May 1990. The NRC licensed the disposal cell in 1993. The Spook site was not sampled in 1993, pursuant to the approved NRC ground water compliance strategy. The NRC agreed that no postremedial action ground water monitoring would be required as part of the implementation of supplemental standards. Therefore, no data are presented in this report.

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SITE DESCRIPTION AND LOCATION

The Riverton UMTRA Project site is in Fremont County, Wyoming, 2.5 mi southwest of the city of Riverton, on private land within the boundaries of the Wind River Indian Reservation (Northern Arapaho and Shoshone Indian tribes).

The Riverton site is on a nearly level alluvial terrace in the Wind River Basin, approximately 13,000 ft upstream of the confluence of the Wind and Little Wind rivers. The Wind River is approximately 4000 ft north of the site and the Little Wind River is approximately 3000 ft southeast of the site (*Figure 14-1*).

The estimated populations of Fremont County, Wyoming, and the city of Riverton are 33,662 and 9202, respectively (DOC, 1990). The Riverton area is primarily agricultural, with several residences in the immediate site vicinity. Much of the area also is used as pasture for cattle and horses. A privately owned sulfuric acid plant is adjacent to the west boundary of the site.

The Riverton area is arid (the Wind River mountain range hinders the passage of moisture). The average annual precipitation is 8 inches. Most of the infiltration of precipitation occurs from April through June.

The Riverton area is influenced by cold air masses from Canada and prevailing warm, westerly winds. From 1951 to 1980, 207 days per year averaged minimum temperatures of 32 °F or less, and 37 days per year averaged maximum temperatures of 90°F or more.

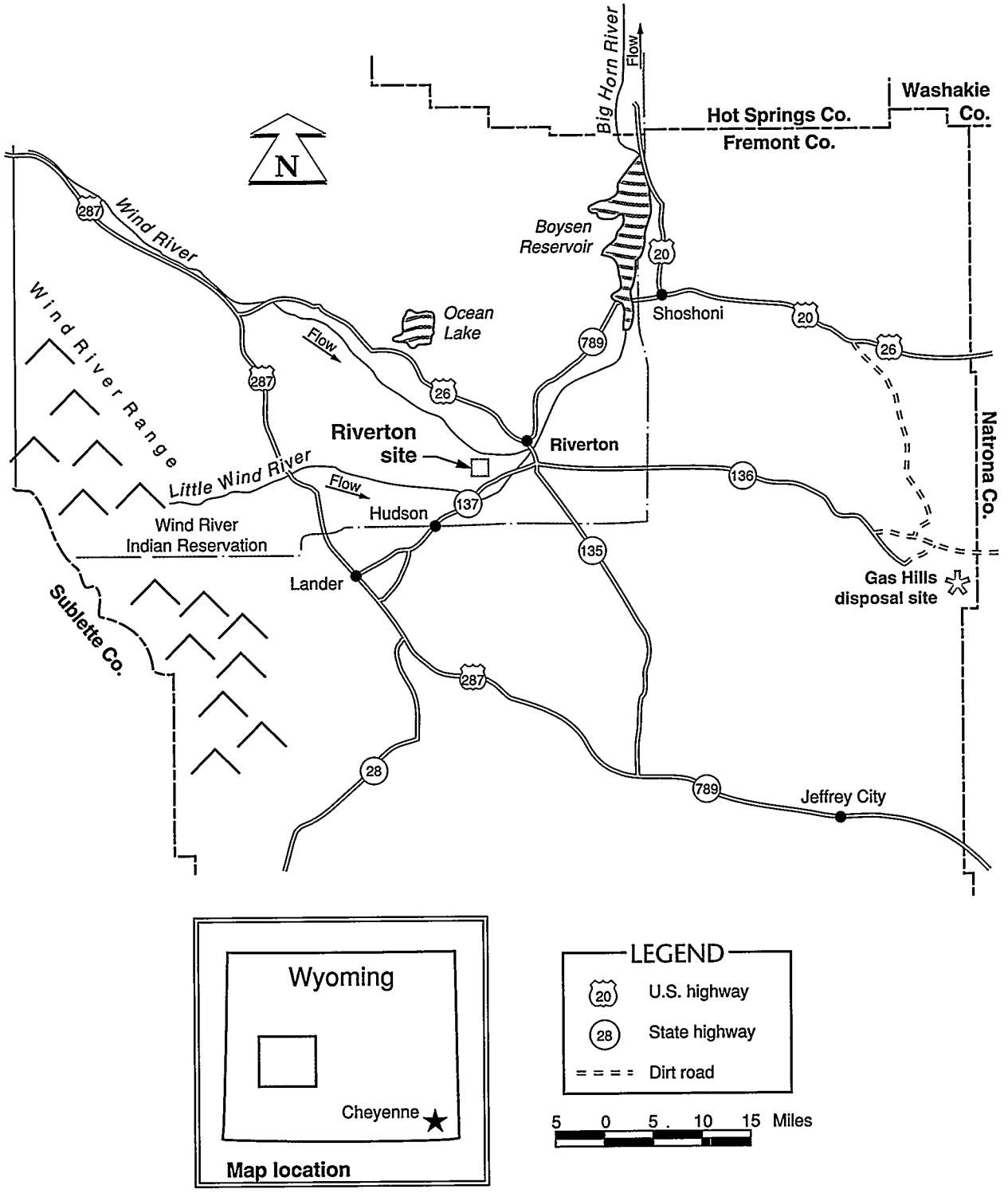
SITE HISTORY AND OWNERSHIP

The mill at the Riverton tailings site was constructed in 1958. Fremont Minerals, Inc., initially operated the mill to treat uranium ores from the surrounding area. A sulfuric acid plant was also part of the mill facilities. The uranium mill closed in 1963. Koch Sulfur Products Company still operates the sulfuric acid plant.

The mill used both sulfuric acid and carbonate circuits. Clarified solutions from the acid leaching process were fed to a solvent extraction circuit and subsequently stripped with caustic soda to precipitate the uranium. During its 4 years of operation, the mill processed approximately 900,000 tons of ore. Waste solids from the uranium ores were transferred to a tailings pile adjacent to and southeast of the mill.

The state of Wyoming purchased the Riverton site from Lome Drilling & Well Service, Inc., in July 1987. In November 1987, the state of Wyoming, the DOE, and Chemical Marketing Services, Inc. (now Koch Sulfur Products Co.), entered into a remedial action and land purchase agreement for the 218-ac processing site. Under the agreement, Koch Sulfur made partial payment for the deed to approximately 5 ac and certain limited surface uses. The existing

Figure 14-1
Riverton Site Location



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remedial action agreement will guarantee access to the site for UMTRA Ground Water Project activities.

SITE CHARACTERIZATION AND CLEANUP

The tailings pile covered approximately 70 ac and contained approximately 1 million cubic yards of tailings. Approximately 140 ac within the designated area, including the pile site, were contaminated. Wind dispersed the tailings, contaminating approximately 50 additional acres outside the site boundaries.

Between 1988 and 1990, the uranium mill was demolished and the tailings pile and contaminated soils were removed from the site and surrounding area. The soils were excavated until the radium concentrations met UMTRA Project guidelines (40 CFR §192.12).

Approximately 1.8 million cubic yards of residual radioactive material were removed from the site and disposed of at the Gas Hills site (*Figure 14-1*). This site is licensed by the NRC and operated by Umetco. The excavation was backfilled with clean fill, graded to form a crown, and planted with rye grass. Surface remediation was completed in November 1989.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Riverton site complete, the remaining compliance issue is ground water monitoring.

National Environmental Policy Act

In compliance with NEPA (42 USC §4321 *et seq.*), a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings on the draft programmatic environmental impact statement will be held in 1995.

ENVIRONMENTAL MONITORING

At the Riverton site, the DOE conducts an environmental monitoring program for contaminants in surface water and ground water. This program monitors the amount of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environment protection measures.

With surface remedial action at the Riverton site complete, air and environmental gamma radiation monitoring data were not collected in 1994. In addition, no surface water or sediment samples were collected in 1994.

Ground Water Monitoring

The Riverton site sits on shale and sandstone rock units of the Wind River Formation. The Wind River Formation consists of five hydrogeologic units of interest that underlie the Riverton site. They are, in descending order, a surficial aquifer consisting of alluvium and

sandstone; a leaky shale layer that limits ground water movement (aquitard); a semiconfined sandstone aquifer; a low permeability shale aquitard; and a confined sandstone aquifer.

The surficial aquifer consists of 15 to 20 ft of alluvial sand and gravel underlain by a discontinuous layer of sandstone. The water table ranges from approximately 6 to 10 ft below land surface across the site. Ground water flows east-southeast (***Figure 14-2***). The surficial aquifer has an approximate ground water flow velocity of 160 ft per year. A 5 to 10 ft thick leaky shale aquitard underlies the surficial aquifer.

The semiconfined sandstone aquifer underlies the leaky shale aquitard. This unit is from 15 to 30 ft thick and is continuous throughout the Riverton site. Ground water flows in approximately the same direction and under the same gradient as in the surficial aquifer (***Figure 14-3***). The semiconfined sandstone has and estimated average linear velocity of 170 ft per year.

Water levels in monitoring wells completed in the surficial and simiconfined aquifers located south and east of the former tailings area have nearly identical ground water table elevations, indicating a lack of vertical gradient between the two at the present time. When the mill was in operation, however, the drainage from the tailings pile would have mounded the ground water in the surficial aquifer, resulting in a downward gradient and movement of contaminants into the semiconfined aquifer.

Between the semiconfined and confined sandstone aquifers are about 40 ft of low permeability shale containing discontinuous sandstone lenses. The confined sandstone unit is at least 50 ft thick.

Water level data from monitoring wells completed in the confined sandstone indicate that ground water flows nearly due south (***Figure 14-4***). An upward gradient from the confined sandstone aquifer into the shallower aquifers prevents contaminants from moving down into the confined sandstone or deeper aquifers that supply area domestic and municipal wells.

Twenty-three domestic wells have been identified in the site area (***Figure 14-5***). All these wells are completed in the confined sandstone aquifer or deeper aquifers at depths greater than 100 ft, except for two shallow (less than 35 ft deep) stock wells completed in the surficial aquifer (431 and 442). The Riverton well field is more than 7000 ft of the site (north of the Wind River). Riverton's municipal water supply is obtained from this well field between October and April. During the growing season (May through September), water is taken from the Wind River.

Figure 14-2
Ground Water Table Elevations for the Surficial Aquifer

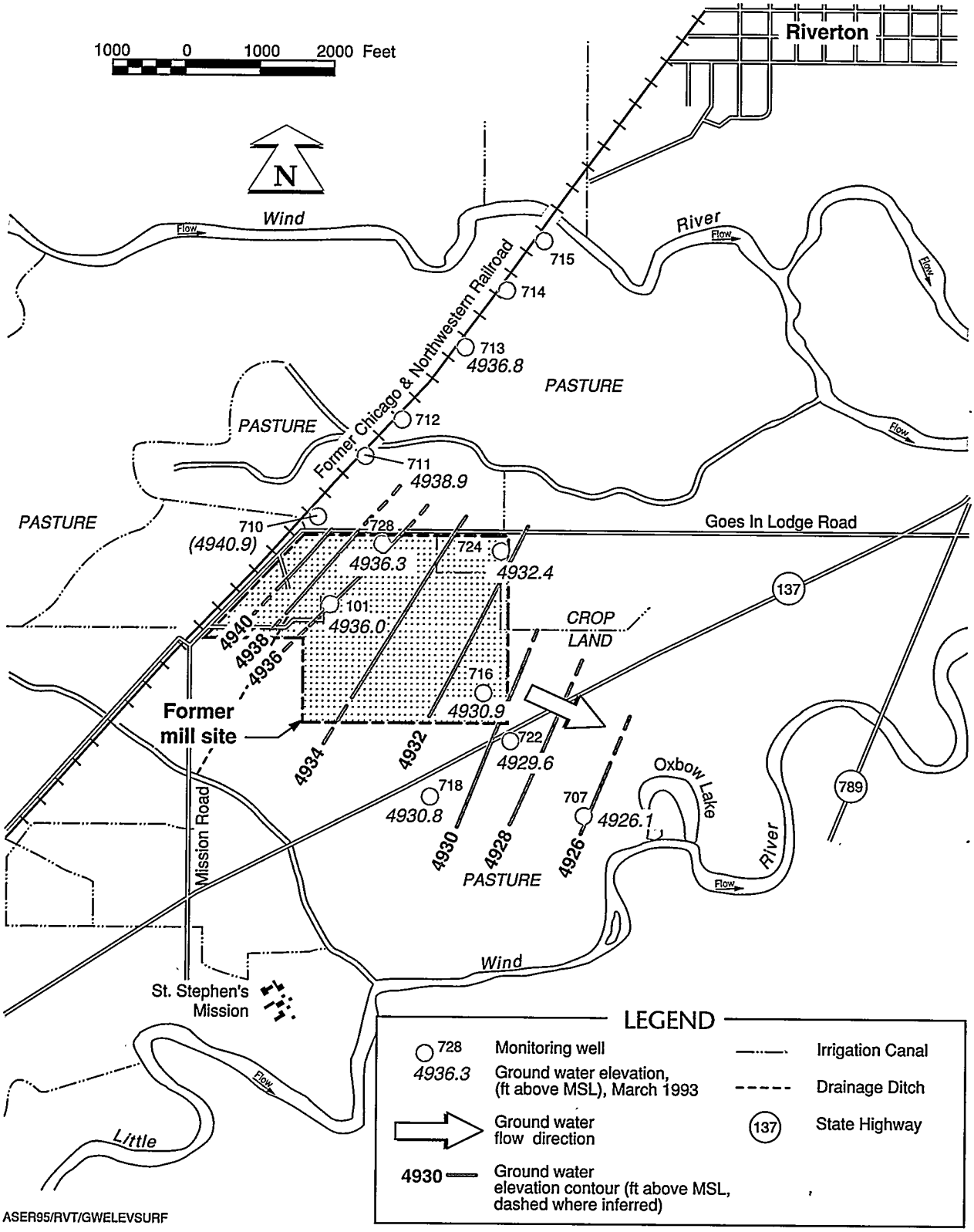

Figure 14-3
Ground Water Table Elevations for the Semiconfined Sandstone Aquifer

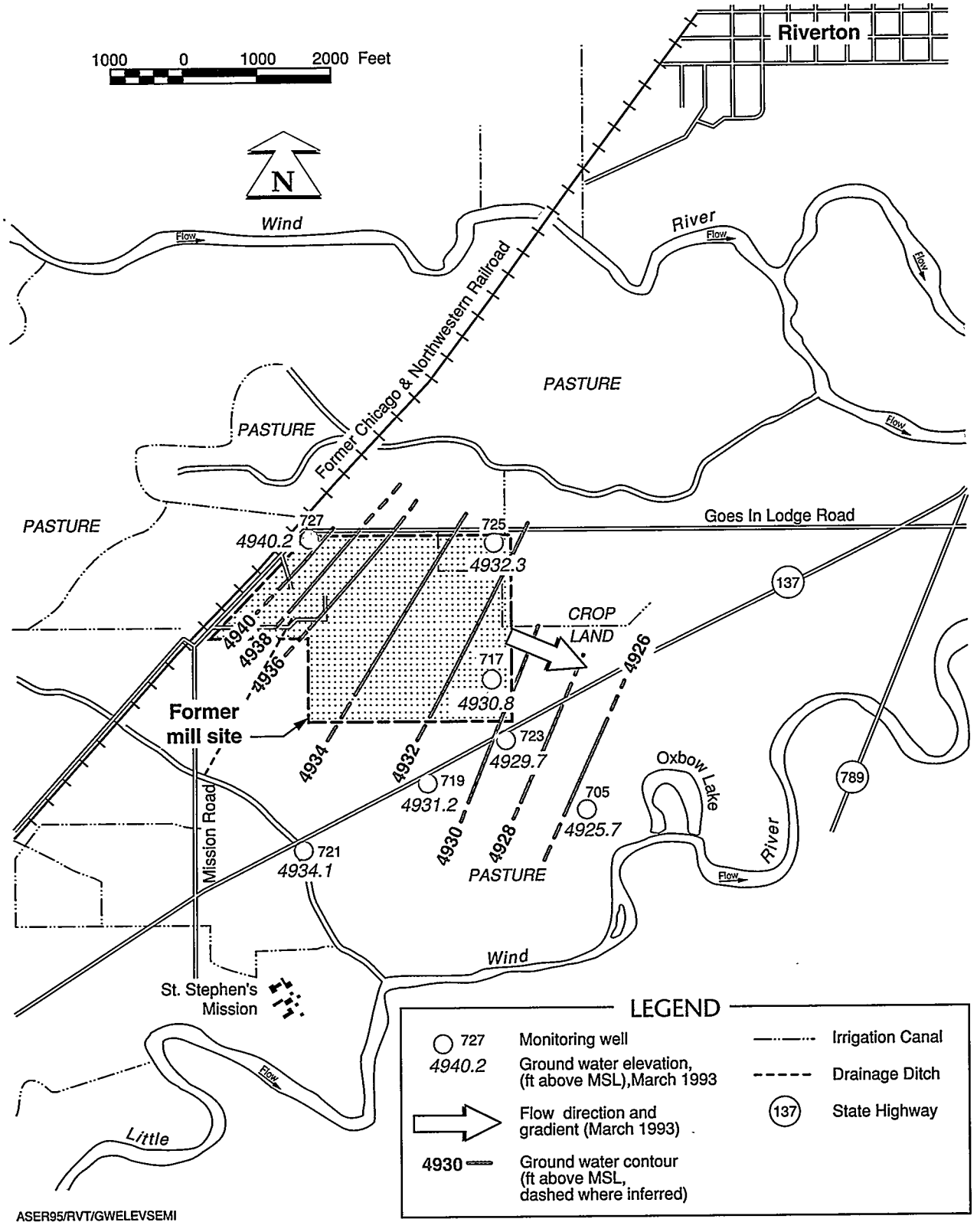

Figure 14-4
Potentiometric Surface Contours of the Confined Sandstone Aquifer

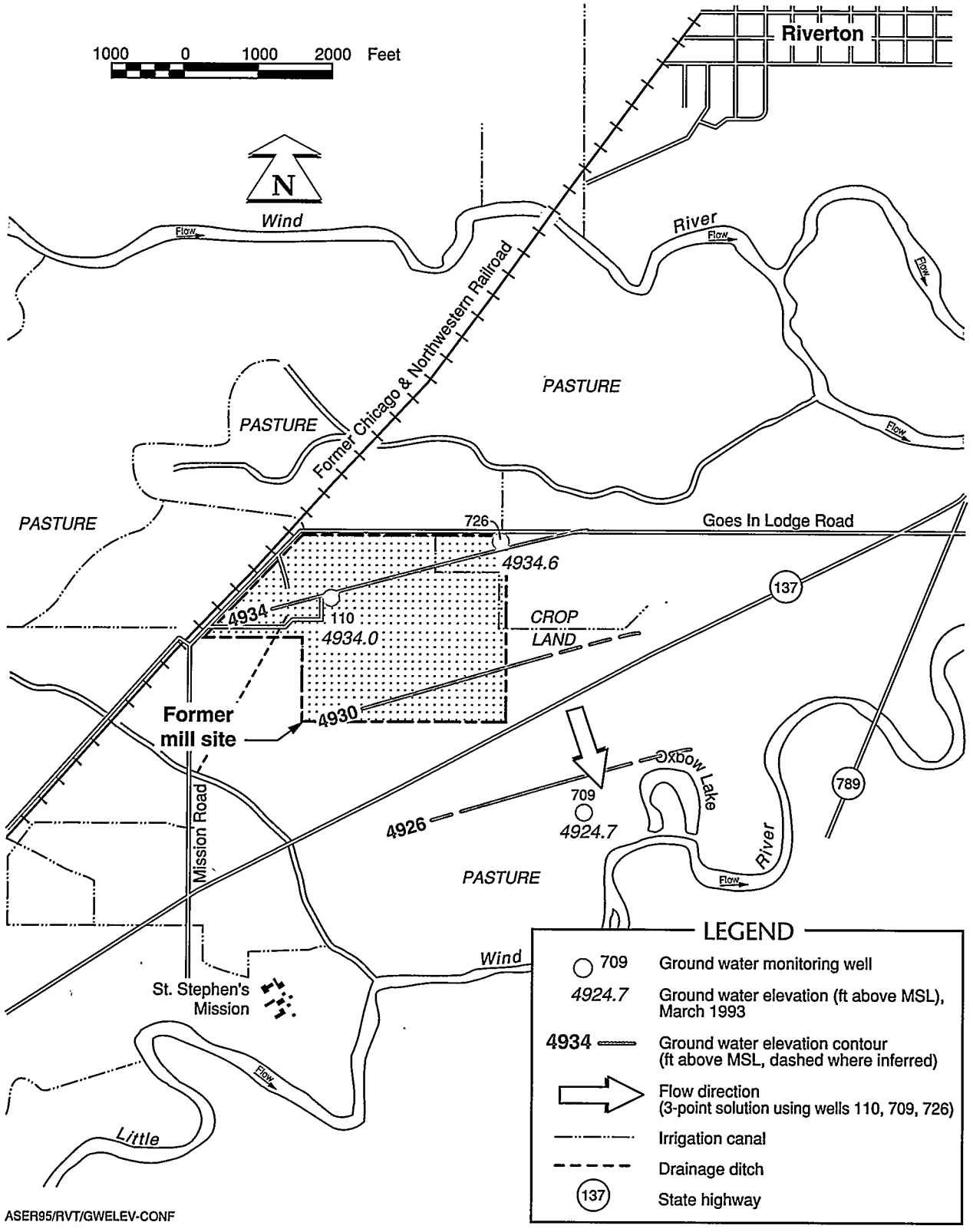

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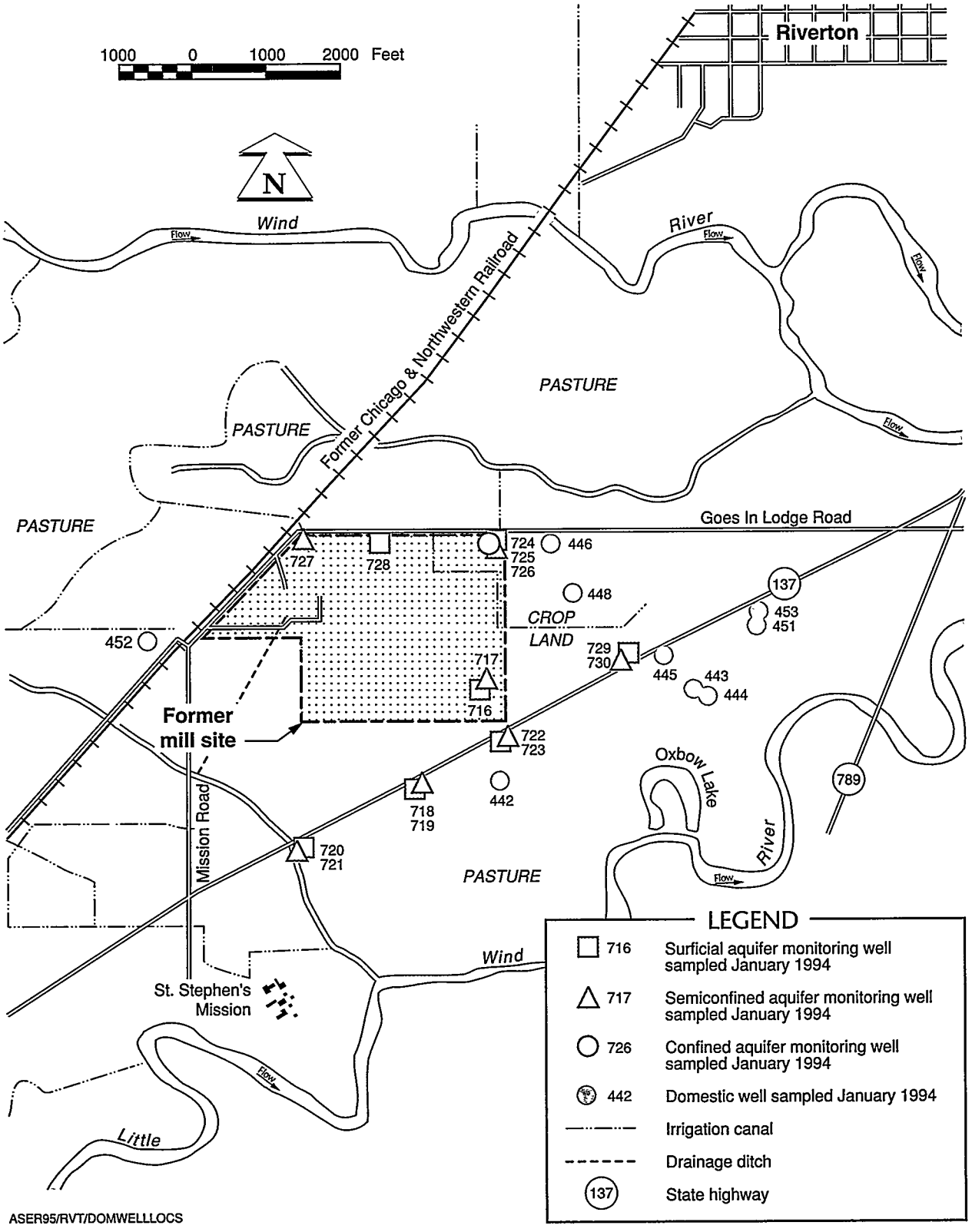
Figure 14-5
Ground Water Sampling Locations



In January 1994, samples were collected from 15 monitoring wells installed in 1993 to obtain additional characterization information regarding contaminant distribution in the surficial, semiconfined, and confined aquifers (***Figure 14-5***). Additionally, nine domestic wells completed in the confined aquifer were sampled to complete an assessment of potential impacts to domestic water sources located near the site.

Ground water samples were analyzed for the following parameters: arsenic, molybdenum, nickel, selenium, sulfate, total dissolved solids, total organic carbon, uranium, and vanadium. Additionally, alkalinity, dissolved oxygen, pH, reduction-oxidation potential, specific conductance, temperature, and turbidity were determined in the field during sample collection.

Other hydrologic data gathered during 1994 included ground water and surface water elevations. Ground water elevation data is used to determine horizontal flow directions and velocities and to assess vertical gradients. Variations in water levels can indicate the relationship between surface water and ground water regimes as well as the influence of infiltration from irrigation canals and precipitation. To collect nearly continuous data on ground water levels, pressure transducers and data loggers were installed in nine monitoring wells in 1994. Ground water level measurements were also made in 14 other wells. In addition, surface water level measuring points were established near the Little Wind River and at the wetland east of the site. These points will be surveyed, and periodic readings will be made in the future.

Ground Water Results

The 1994 ground water sampling results indicate that the maximum concentration limits for molybdenum and uranium were exceeded in three wells (716, 718, and 722) completed in the surficial aquifer (***Table 14-1***). The 1994 results for the surficial aquifer samples are consistent with historical data on the distribution of site-related contamination.

The results of the 1994 domestic well sampling did not show any indication of site-related contamination in the confined aquifer. These results are consistent with previous sampling of other domestic wells in the area.

Ground Water Conclusions

Ground water monitoring information obtained during 1994 confirmed the previously established concepts regarding the extent of contamination in the vicinity of the Riverton site. EPA maximum concentration limits were only exceeded in surficial aquifer samples from beneath the southeastern edge of the former processing site and immediately downgradient (southeast) of the site. Samples from domestic wells located near the site confirmed that site-related contamination has not impacted the confined aquifer. Consequently,

Table 14-1 Surficial aquifer ground water quality results

Parameter	Guideline[a]	Background[b]	Monitor well 716 (on-site)	Monitor well 718 (downgradient)	Monitor well 722 (downgradient)
Molybdenum	0.1	0.003-0.020	0.24	0.15	0.11
Uranium	0.044	<0.001-0.008	0.72	0.33	1.57

[a]Maximum concentration limit.
[b]Statistical range of background values.

Note: all data in milligrams per liter.

continued used of the ground water from the confined aquifer for domestic purposes is not considered to pose any risk to human health.

SITE DESCRIPTION AND LOCATION

The Spook processing and disposal site is in northern Converse County, Wyoming, approximately 48 mi northeast of Casper (*Figure 14-6*). The Spook site is situated in the southern end of the Powder River Basin, a deep structural basin that lies along the east flank of the Middle Rocky Mountains. Sedimentary rocks in the area generally dip less than 2 degrees to the northeast. The gently rolling topography in the vicinity of the site has an elevation of approximately 5100 ft. Drainage in the area is to the east and southeast toward the Dry Fork of the Cheyenne River, an intermittent stream approximately 1 mi south of the site. Surface drainage is controlled to the north by the Cheyenne River Divide.

The southern part of the Powder River Basin contains significant uranium and coal deposits. The site is underlain by uranium mineralization associated with an alteration front in sandstone in the Tertiary Wasatch Formation. Uranium has been mined from open-pit mines (including the Spook pit) along the alteration front in the area. The Bear Creek uranium mill site (an UMTRCA Title II site) is approximately 2 mi north of the Spook site.

The area is sparsely populated; the nearest town, Glenrock, is 31 mi south of the site. The climate is semiarid and cool with moderate humidity. The average annual precipitation (measured in the Casper area) is 11 inches, with 60 percent of the precipitation falling during the spring and summer months. The ground is covered principally with short-grass prairie vegetation.

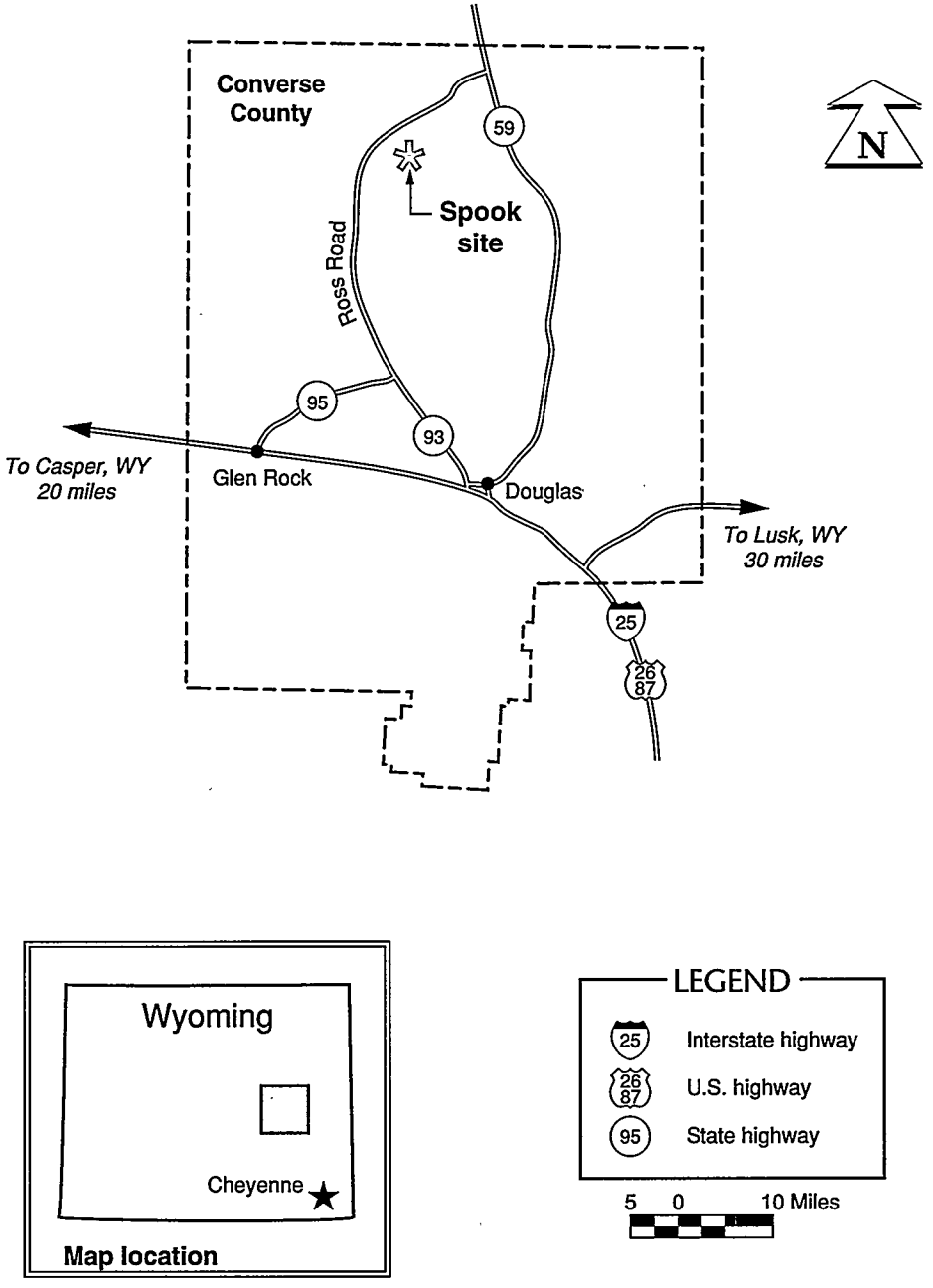
SITE HISTORY AND OWNERSHIP

Through the 1960s, much of the uranium ore mined in the United States was processed by private companies under contract to the federal government for use in national defense research and weapons development. The Spook site was formerly mined for this purpose by the Wyoming Mining and Milling Company and by Western Nuclear, Inc.

The Spook open-pit mine was first excavated in 1962. It operated as a producing mine until 1966. A total of 42,600 tons of uranium ore were extracted. Uranium ore from the Spook mine was initially processed at the uranium mill in Jeffrey City, Wyoming, 165 mi west of the site. As lower-grade ore was mined, it became more economical to process the ore on the site, so a uranium upgrading plant was established at the Spook site.

The uranium milling process at the Spook upgrader consisted of an acid-curing process used in conjunction with percolation heap leaching. In this process, crushed sandstone containing the uranium was agglomerated into small pellets containing ore, water, and sulfuric acid. These pellets or precipitate were then processed by ion exchange. The barren, washed pellets were disposed of in the open-pit mine. Some liquid was removed from this precipitate, leaving a thick

Figure 14-6
Spook Site Location



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slurry that was trucked to the uranium mill at Jeffrey City. The residue sands (tailings) were placed on the surface at the mill site or receded into the open-pit mine. The solutions used in the process were disposed of on the tailings pile and in the acid pond 1500 ft south of the mill site.

The state of Wyoming acquired title to a 13.5-ac surface area over the disposal cell and subsequently transferred title to the U.S. government.

SITE CHARACTERIZATION AND CLEANUP

Surface remediation at the Spook processing site consisted of stabilizing the residual radioactive materials in a disposal cell in the bottom of the Spook open-pit mine. Surface remedial action was completed in November 1989. An estimated 269,600 cubic yards of uranium mill tailings and other residual radioactive material were consolidated and stabilized in the disposal cell. The disposal cell includes a basal clay layer and is covered with a fine-grained infiltration and radon barrier. These features were designed to minimize infiltration, seepage, and migration of leachate from the bottom of the cell. The state of Wyoming then backfilled the Spook open-pit mine with overburden material. The surface was restored and revegetated. The top of the disposal cell is approximately 35 ft below the existing land surface.

ENVIRONMENTAL COMPLIANCE STATUS

In 1993, the NRC accepted the Spook long-term surveillance plan (DOE, 1992), which established the Spook disposal site under the general license in 10 CFR 40.27. The surface remedial action ground water protection strategy at the Spook site concurred upon by the NRC is application of supplemental standards based on limited use of ground water in the uppermost aquifer because of widespread ambient contamination. The limited-use designation is based on ground water in the uppermost aquifer not being currently or potentially a source of drinking water because it contains widespread, ambient uranium and selenium contamination resulting from 1) naturally-occurring conditions (natural uranium mineralization associated with an alteration front), and 2) the effects of broadscale human activity not related to uranium milling operations (uranium exploration and mining activities) such that it cannot be effectively cleaned up for drinking or other beneficial purposes using treatment methods reasonably employed in public water supply systems.

National Environmental Policy Act

In compliance with the NEPA (42 USC 4321 *et seq.*) a programmatic environmental impact statement for the UMTRA Ground Water Project is being prepared. Preparation of the draft took place in 1994. At the end of 1994, the draft was at DOE Headquarters awaiting approval to be published and distributed for public review. Public hearings regarding the draft will be held in 1995.

ENVIRONMENTAL MONITORING

Under the Spook long-term surveillance plan accepted by the NRC as a requirement for issuing the general license, no ground water monitoring is required at the Spook site (DOE, 1993).

REFERENCES

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DOE (U.S. Department of Energy), 1993. *Final Long-Term Surveillance Plan for the Spook, Wyoming, Disposal Site*, UMTRA-DOE/AL-350215, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 1987. *Environmental Assessment-Remedial Action at the Riverton Uranium Mill Tailings Site, Riverton, Wyoming*, final, UMTRA-DOE/EA-0254, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

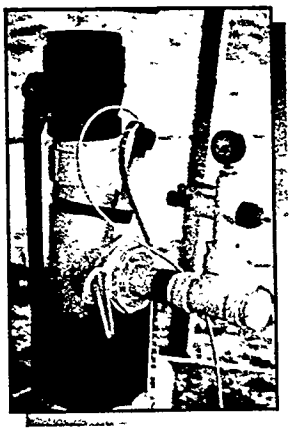
40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency (1994).

United States Code

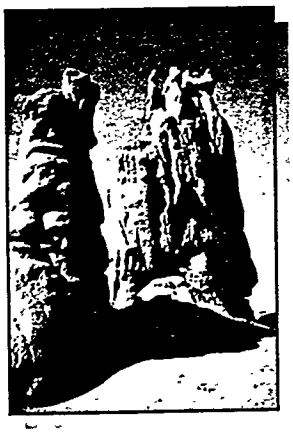
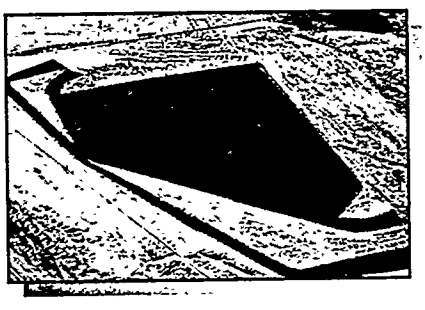
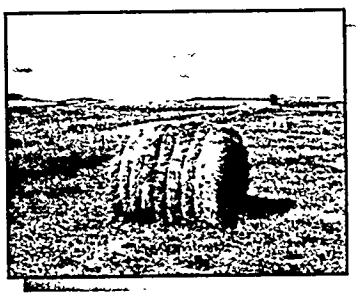
42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

UMITRA PROJECT

CHAPTER 15
GLOSSARY





ALARA	Phrase and acronym meaning as low as reasonably achievable. Used to describe a method of controlling and managing radiation exposure and emissions to the public as far below specified limits as economically, technically, and practically feasible.
Aliquot	Fraction of a field sample taken for complete processing through an analytical procedure (a laboratory sample of a field sample).
Alluvium	Detrital deposit of sediments resulting from surface water flows such as rivers, flood plains, lakes, estuaries, and alluvial fans at the foot of mountain slopes.
Alpha particle	Type of particulate radiation (identical to the nucleus of the helium atom) consisting of two protons and two neutrons.
Ambient air	Atmosphere surrounding people, plants, and structures. Does not include the air immediately adjacent to emission sources.
Amines	Class of organic compounds derived from ammonia by replacing one or more hydrogens with organic radicals used in uranium ore processing to concentrate uranium in the solvent extraction process.
Analytes	Element or constituent for which a sample may be analyzed.
Aquifer	Saturated layer of rock or soil below the ground surface that can supply usable quantities of ground water to wells and springs. Aquifers can be sources of water for domestic, agricultural, and industrial uses.
Aquitard	A layer of rock or soil below the ground surface that is characterized by low permeability and that does not readily permit water to pass through it. Aquitards serve to confine ground water flow between aquifers.
Atomic Energy Commission	Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian applications. Abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration (now part of the DOE and NRC).
Background Ground Water Quality	The quality of ground water that would be expected at the site if uranium processing activities had not occurred.
Background radiation	Ionizing radiation from sources other than the laboratory. Background radiation may include cosmic radiation; radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.
Backlog	On-site waste awaiting permitted treatment, storage, or disposal options.

CHAPTER 15 — GLOSSARY

Baseline risk assessment	Site-specific assessment of demographic, geographic, physical, chemical, and biological factors influencing the extent of actual or potential harm to human health and the environment.
Beta particle	Negatively charged particle (identical to the electron) emitted during decay of certain radioactive atoms. Most beta particles are blocked by an 0.6-centimeter aluminum barrier.
Blank	Sample of the carrying agent (gas, liquid, or solid) normally used to selectively measure a material of interest; this sample is subjected to the usual analytical process to establish a baseline or background value. This value is then used to adjust or correct the routine analytical results.
Calibration	Adjustment of system flow, temperature, humidity, and pressure gauges and determination of system accuracy using known sources and instrument measurements. Conducted using standard operating procedures and sources traceable to the NIST.
Chain of custody	Method for documenting the history and possession of a sample from the time of collection (through analysis and data reporting) to its final disposition.
Class Y Th-230	Derived air concentration as specified in DOE Order 5480.11, *Radiation Protection for Occupational Workers*. Class Y refers the range of half-times for retention in the pulmonary region of the lung as being greater than 100 days.
Cleanup	Removal or stabilization of contaminants to eliminate or reduce the risk to human health and the environment.
Code of Federal Regulations	Codification of all regulations developed and finalized by federal government agencies in the *Federal Register*.
Confined aquifer (conditions)	Aquifer under greater than atmospheric pressure, banded above and below by layers with distinctly lower permeabilities than the aquifer itself.
Continuous Water Level Recorder	Generally a commercially manufactured data collection and storage instrument featuring a durable long life battery. This instrument is placed in a well or other installation for a period of days, weeks, or months and programmed to collect and store water level measurements at specified intervals over a specified period of time.
Constituent	Substance found in ground water or soil pores that may or may not be naturally occurring or desirable.
Contaminant	Undesirable substance from uranium processing activities that may affect human health and the environment.

Contaminated plume	Ground water area portion of the naturally occurring ground water by impacted contaminants from uranium processing activities.
Contamination	Deposition of unwanted radioactive material on the surfaces of structures, areas, objects, and personnel including infiltration into ground water.
Cooperating agency	Federal, state, local, or tribal agency participating in scoping and document preparation for an environmental impact statement.
Cooperative agreement	Agreement between the DOE and an affected state or Indian tribe that defines the roles and responsibilities of the parties in implementing the UMTRA Project.
Curie	One Curie equals 3.70×10^{10} nuclear transformations per second.
Data validation	Systematic review of sampling, custody, and analysis documentation to verify compliance with established procedures and to assess data quality.
Derived concentration guideline	Concentration of a radionuclide in air or water that, under 1-year continuous exposure by one exposure mode (for example, drinking water or breathing the air), results in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and the lens of the eye.
Detection limit	Lowest concentration at which an analyte in a given sample medium can be unambiguously distinguished for a given confidence level using a particular combination of sampling and measurement procedures, sample volume, analytical detection limit, and processing procedure.
Disposal cell	Engineered embankment designed to isolate residual radioactive materials from the environment.
Dose	Term denoting the quantity of radiation energy absorbed.
Downgradient	Coincident to the general direction of ground water flow with respect to a geographic reference point; e.g., a source of contamination. With regard to ground water flow, similar to downstream.
Effluent	Liquid or gaseous waste discharge to the environment.
Effluent monitoring	Collection and analysis of samples or measurements of liquid, gaseous, or airborne effluent to characterize and quantify contaminants and process stream characteristics, assess radiation exposure to members of the public, and demonstrate compliance with applicable standards.
Environmental assessment	Document determining the potential for significant impact to the environment from an action.

Environmental impact statement	Document describing and evaluating the potential significant impact on the environment from several alternative actions, including no action.
Environmental surveillance	Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media to determine the environmental quality of an industry or community. Commonly performed at sites containing nuclear facilities.
Eolian	Sediments deposited as a result of the transporting action of the wind.
Ephemeral stream	Stream or a portion of a stream flowing only in direct response to precipitation.
Exposure pathway	Route by which materials could travel between the point of release and the point of delivery of a radiation or chemical dose to a person.
Facies	Part or layer of a rock body as differentiated from other parts by appearance or composition.
Facies sequence	Succession of vertically related facies of sediments or rocks.
Filtered ground water sample	Water sample filtered through a 0.45-micron filter to remove micron-size colloidal particles suspended and floating in the water.
Fugitive dust	Dust and dust-like materials generated from waste storage areas and administration areas and originating from construction activities.
Gamma-dose equivalent	Dose equivalent derived from external radiation at a depth of 1 centimeter in tissue.
Gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin with no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other forms of electromagnetic radiation (such as microwave, visible light, and radio waves) have longer wavelengths (lower energy) and cannot cause ionization.
Gross alpha	Total amount of measured alpha activity without identification of specific radionuclides.
Gross beta	Total amount of measured beta activity without identification of specific radionuclides.
Ground water	Supply of water under the earth's surface that fills spaces between materials such as sand, soil, or gravel. In aquifers, ground water occurs in sufficient quantities that it can be pumped for drinking water, irrigation, and other purposes.
Ground water monitoring	Periodic sampling and analysis of ground water to measure water levels and detect the possible presence of chemicals.

Ground water plume	Defined area of ground water contamination.
Ground water remediation	Treatment of ground water to decrease the amount or mobility of contaminants.
Hazardous and Solid Waste Amendments	HSWA of 1984 to RCRA that greatly expanded the scope of hazardous waste regulation. Through the HWSA, Congress directed the EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.
Hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or extraction procedure toxicity (yielding toxic constituents in a leaching test). In addition, the EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term generally refers to any waste that the EPA believes could pose a threat to human health and the environment if managed improperly. RCRA regulations set strict controls on managing hazardous waste.
Heap-leaching	Placing crushed ore in a pile underlain by an impermeable membrane to collect water and dissolved minerals removed from the ore by the process water.
Hydraulic conductivity	Ratio of flow velocity to driving force (head) for ground water flow in a porous medium (saturated sediments or rock).
Hydraulic gradient	In an aquifer, the rate of change of pressure head (usually in 0.01 ft of water) per unit distance of flow at a given direction (down the gradient).
Hydrology	Study of the properties, distribution, and circulation of water through the local environment.
Indicator parameter	A constituent introduced into the ground water by milling operations. These constituents are above background ground water concentrations and do not necessarily impact public health and the environment. Indicator parameters are selected based on their mobility and/or risk potential so as to provide early information on contamination zone movement.
Intercomparison program	Program that prepares, distributes for analysis, and compiles results for samples of known composition to assess analytical proficiency.
Ionization	Removal of electrons from an atom by means of interaction with radiation.
Isopleth	Line on a map or chart drawn through points of equal size or concentration.

Isotope	Atom with the same atomic number but different mass number. Isotopes usually have the same chemical properties, but could have very different radiological properties (such as half-life and type of radiation emitted).
Leachate	Water percolating through the bottom of a dump, landfill, or disposal cell.
Less than detectable	Measurement or calculated concentration that is not statistically different from the associated background or control value at a selected confidence level.
Level C	Quality control measure that provides low detection limits, a wide range of calibrated analytes, matrix recovery information, laboratory process control information, and known precision and accuracy.
Liquor	Process water that has dissolved the minerals from the ore.
Maximum concentration limit	Greatest amount of a contaminant present in water that will not produce adverse health effects after either short- or long-term consumption.
Mill site	See processing site.
Millirem	mrem. Dose equivalent that is one-thousandth of a rem.
Minimum detection level	Minimum amount of the constituent or species of interest that can be observed by an analytical instrument and distinguished from background and instrument noise with a specified degree of probability.
Mixed waste	Hazardous waste contaminated with low-level radioactive materials.
Monitor	Process of measuring certain constituents or parameters in an effluent stream continuously or at a frequency that permits a representative estimate of the amount to be taken over a specified interval of time.
National Emission Standards for Hazardous Air Pollutants	Standards found in the Clean Air Act that set limits for such pollutants as beryllium and radionuclides.
National Environmental Policy Act	Federal legislation, passed in 1969, regulating the issuance of permits for constructing and operating facilities that have the potential to impact the environment or public health. NEPA requires federal agencies to prepare an EIS when major actions are taken.
National Pollutant Discharge Elimination System	Federal program under the Clean Water Act, requiring permits for discharges into surface waterways.
NIST-traceable source	Particular source calibrated using the NIST that has traceable documentation.

Nonpoint source	Nonconfined area from which pollutants are discharged into a body of water, air, or soil.
Occurrence	Sudden release or sustained deviation from a regulated or planned operation that has environmental protection and compliance significance.
On-site	Area within the boundaries of a facility or site where public access is or can be controlled.
Operable unit	Discrete action comprising an incremental step toward comprehensively addressing site problems. Operable units may address specific areas of a site, specific site problems, or initial phases of an action performed over time or any actions that are concurrent but located in different parts of the site.
Perched	Ground water separated from an underlying body of ground water (usually the first aquifer) by unsaturated rock or sediments.
Permeability	Capacity of a rock or sediment to transport a fluid (usually water) as a rate of flow for a given distance through a given interval of time.
Piezometer	Well point used to measure the level to which water from a given aquifer will rise under its full head.
Point source	Single defined point (origin) of release such as stack, vent, pipe, or other discernable conveyance in water, air, or soil.
Pore fluid	Fluids within the pores of sediment, rock, or tailings (usually referring to the liquids contained in the porosity).
Potable water	Water suitable for consumption.
Potentiometric surface	Surface or level to which ground water in a screened well in a confined aquifer would rise by hydrostatic pressure.
Processing site	Location where uranium ore was milled to remove the uranium.
Quality assurance	Action in environmental monitoring to ensure the reliability of monitoring and measurement data. Aspects include procedures, interlaboratory comparison studies, evaluations, and documentation.
Quality control	Routine application of procedures within environmental monitoring to obtain required standards of performance in monitoring and measurement processes. Procedures include instrument calibration, control chart development, and replicate and duplicate sample analysis.
Radioactive emissions	Release of radioactive material to the environment.

Radionuclide	Radioactive nuclide. There are several hundred known radionuclides, both artificially produced and naturally occurring. Characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay process.
Raffinate pond	Pond receiving the process water after removal of the uranium. Some uranium and other unwanted dissolved minerals remain in this raffinate water.
Random sample	Sample obtained in such a manner that all items or members of the lot or population have an equal chance of being selected.
Release	Unintentional discharge to the environment. Environment is broadly defined as any water, land, or ambient air.
Rem	Unit of radiation dose equivalent that takes into account different kinds of ionizing radiation and permits them to be expressed on a common basis. The dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by the necessary modifying factors.
Remedial action	Action consistent with the final remedy following a formal examination of the nature and extent or threat of a release, assessment of the risk, and selection of the final remedy based on an evaluation of possible alternatives.
Representative sample	Sample taken to depict the characteristics of a lot or population as accurately and precisely as possible. Representative sample may be a "random sample" or a "stratified sample," depending upon the objective of the sampling and the characteristics of the conceptual population.
Residual radioactive material	Uranium mill tailings determined by the DOE to be radioactive due to processing uranium ore and other waste at a processing site that the DOE determines to be radioactive and that relates to such processing.
Resource Conservation and Recovery Act	Amendment to the first federal solid waste legislation (the Solid Waste Disposal Act of 1965). In RCRA, Congress established initial directives and guidelines for the EPA to regulate hazardous wastes.
Riprap	Layer of large rock placed over a disposal cell as the final cover or cap.
Sample	1) Subset or group of objects selected from a larger set called the population; 2) extracted portion of a subset of an effluent stream or environmental medium.
Sampling	Extracting a prescribed portion of an effluent stream or an environmental medium for inspection and/or analysis.

Secondary Drinking Water Standards	Nonenforceable taste, odor, or appearance guidelines. When the taste, odor, and color of drinking water are below these guideline values, user complainants about water quality decline.
Site characterization	Provides the information needed to identify site hazards and select worker protection methods.
Solid Waste Management Unit	Any discernible unit at which solid waste has been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid waste has been routinely and systematically released. Potential release sites include waste tanks, septic tanks, firing sites, burn pits, sumps, landfills (material disposal areas), outfall areas, LANL canyons, and contaminated areas resulting from leaking product storage tanks (including petroleum).
Static ground water elevation	Level to which ground water in a given aquifer will rise under its hydrostatic head under static well conditions (i.e., the well has not been pumped recently and the level is stabilized).
Superfund Amendments and Reauthorization Act	Act modifying and reauthorizing CERCLA. Title III of this act is also known as the Emergency Planning and Community Right-to-Know Act of 1986.
Supplemental standard	Standard that may be applied when contaminant concentration limits are greater than maximum concentration limits. The UMTRA Project may apply for supplemental standards when 1) ground water is not a current or potential source of drinking water due to poor quality or limited quantity; 2) ground water cleanup would create more environmental harm than benefit; or, 3) cleanup is not technically feasible.
Thermoluminescent dosimeter	Used to monitor the amount of radiation exposure.
Tolerance limit	Confidence limit frequently used in quality control work that applies to a percentage of the individual values of the population.
Total dissolved solids	Total dissolved, suspended, and colloidal particles in the water.
Total suspended particulates	Concentration of particulates suspended in the air irrespective of their nature, source, or size.
Toxicity characteristic leaching procedure	Analytical method to determine the mobility of both organic and inorganic compounds in liquid, solid, and multiphase wastes and the applicability of land ban regulations to a waste.
Transmissivity	Description of an aquifer's capability to transport ground water in relation to the aquifer thickness.

Transuranic	Element with an atomic number greater than uranium.
Unconfined Aquifer	An aquifer located at or near the land surface with a free water surface where the pores contain water that is at atmospheric pressure. Water levels in an unconfined aquifer rise and fall in response to differences in recharge and discharge influences.
Unfiltered surface water sample	Sample containing dissolved, suspended, and colloidal particles.
Upgradient	Counter to the general flow direction of ground water with respect to a geographic reference point; e.g., a source of contamination. With regard to ground water flow, similar to upstream.
Uranium mill tailings	The sand-like portion of a metal-bearing ore remaining after some or all of the uranium has been extracted.
Vicinity property	Property outside a designated site boundary that has been contaminated by tailings dispersed by wind or water erosion or by people before the potential hazards of tailings were known.
Volatile organic compound	Liquid or solid organic compound with a tendency to spontaneously pass into the vapor state.
Water table	Boundary between the underground unsaturated zone and the saturated zone. Level to which a well screened in the unconfined aquifer would fill with water.
Wetland	Lowland area, such as a marsh or swamp, inundated or saturated by surface water or ground water sufficient to support hydrophytic vegetation typically adapted for life in saturated soils.

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