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U.S. Department of Energy
Grand Junction Office

Site Environmental Report for Calendar Year 2001

July 2002

GRAND JUNCTION OFFICE

Work Performed Under DOE Contract No. DE–AC13–96GJ87460 for the U.S. Department of Energy

GJO-2002-341-FOS

U.S. Department of Energy
Grand Junction Office

Site Environmental Report
for Calendar Year 2001

July 2002

Prepared for
U.S. Department of Energy
Grand Junction Office
Idaho Operations Office

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Acronyms

Ag	silver
Al	aluminum
ALARA	As Low As Reasonable Achievable
APEN	Air Pollution Emission Notification
As	arsenic
B	boron
Ba	barium
Be	beryllium
BMP	best management practice
Bq	Becquerel
Ca	calcium
CAQCC	Colorado Air Quality Control Commission
CCR	Colorado Code of Regulations
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
CDT	conductivity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESQG	conditionally exempt small quantity generator
CFR	Code of Federal Regulations
Ci	curie
Cl	chlorine (chloride)
Co	cobalt
Cr	chromium
Cu	copper
DOE	U.S. Department of Energy
EA	environmental assessment
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
Fe	iron
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	finding of no significant impact
FOS	Facility Operations and Support (contractor)
g	gram
GJO	Grand Junction Office
GJORAP	Grand Junction Office Remedial Action Project
ha	hectare
Hg	mercury
ISMS	Integrated Safety Management System
K	potassium
kg	kilogram
lb	pound
LLW	low-level waste
LTSM	Long Term Surveillance and Maintenance
m^3	cubic meter

Acronyms (continued)

mg	milligram
mg/L	milligrams per liter
Mg	magnesium
Mn	manganese
µBq/mL	microbequerel per milliliter
µCi/mL	microcuries per milliliter
µg/L	micrograms per liter
Mo	molybdenum
mrem/yr	millirem per year
mSv	milliseivert
N	nitrogen
Na	sodium
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	nickel
NiCad	nickel-cadmium
NO_3	nitrate
ORNL	Oak Ridge National Laboratory
Pb	lead
PCB	polychlorinated biphenyl
pCi/L	picocuries per liter
PO_4	phosphate
POTW	publicly-owned treatment works
PPE	personal protective equipment
QA	quality assurance
QAPP	quality assurance program plan
QC	quality control
Ra-226	radium-226
Ra-228	radium-228
RCRA	Resource Conservation and Recovery Act
RDC	radon decay-product concentrations
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
Sb	antimony
Se	selenium
Si	silicon
SO_4	sulfate
Sv	sievert
Tl	thallium
TSCA	Toxic Substances Control Act
U	uranium
U-234	uranium-234
U-238	uranium-238
UMTRA	Uranium Mill Tailings Remedial Action (Project)

Acronyms (continued)

UMTRCA	Uranium Mill Tailings Radiation Control Act
V	vanadium
WQCC	Water Quality Control Commission (Colorado)
yd^3	cubic yard
yr	year
Zn	zinc

Executive Summary

This annual Site Environmental Report presents information pertaining to environmental activities conducted during calendar year 2001 at the U.S. Department of Energy (DOE) Grand Junction Office (GJO) facility in Grand Junction, Colorado. *WASTREN, Inc.*, the Facility Operations and Support (FOS) contractor for the GJO, prepared this report in accordance with the requirements of DOE Order 231.1, *Environment, Safety, and Health Reporting*, and supplemental guidance from DOE Headquarters. This report applies specifically to the GJO facility.

Primary GJO site activities in 2001 included facility operations and maintenance, waste management, and laboratory analysis of environmental samples from GJO and other DOE sites. Activities at the GJO are conducted in compliance with applicable Federal, State, and local regulations and requirements and by applicable DOE orders as directed by contract. Wastes are generated from the GJO Analytical Chemistry Laboratory, site remediation, and facility operations.

In 2001, the DOE officially transferred ownership of the site to the Riverview Technology Corporation (RTC) and now remains at the site under a lease agreement with the new owner. Although requirements for management of the site have been reduced, the GJO continues to monitor activities to ensure the protection of workers, public health and safety, and the environment. The types of monitoring include air monitoring for opacity and radionuclide emissions, radiological monitoring, and surface water and ground water monitoring. The GJO also conducts waste minimization and pollution prevention activities and manages wastes in compliance with all applicable laws.

Highlights for Calendar Year 2001

Radiological Monitoring

- The site contractor (*WASTREN, Inc.*) conducted off-site dose modeling for the GJO to determine compliance with National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 CFR Part 61, Subpart H; DOE Order 231.1, *Environment, Safety, and Health Reporting*; and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Modeling results indicated that the effective dose equivalent from all sources of airborne radiation emanating from the facility was more than 200 times less than the applicable DOE standard. No accidental releases of radioactivity occurred at GJO in 2001.

- Radionuclide concentrations (including Ra-226 and Ra-228) in samples collected from the Gunnison River in 2000 were below applicable standards in the Colorado Water Quality Control Commission's (WQCC's) Regulations No. 31 and 35 (surface water quality standards).

- Concentrations of total uranium in all samples from the site surface water locations (i.e.; the North Pond, South Pond, and the Wetland Area) exceeded the Gunnison River standard in 2001. The maximum total uranium concentration (1216 pCi/L [1770 µg/L]) was detected in the January 2001 sample from the Wetland Area. The North Pond, South Pond, and Wetland Area samples were also analyzed for gross alpha, gross beta, and radium-226 activity. Although gross alpha and gross beta activities in these samples were above instrument detection limits, no surface water quality standards currently exist for these constituents for comparison. The State surface water standard for radium 226+228 (5 pCi/L) was not exceeded in the samples collected from the North Pond, South Pond, and Wetland Area.

Nonradiological Monitoring

- Visible emissions from stationary sources in 2001 never exceeded the permit-specified limit of 20 percent opacity.

- No air permit limits were exceeded in 2001 in Analytical Chemistry Laboratory operations.

- Manganese was the only constituent reported in samples collected from the Gunnison River in 2001 to have exceeded a surface water standard. The Lower Gunnison location was reported at 79 µg/L, slightly above the standard of 50 µg/L. This also is only the second time since 1993, when the majority of the remediation was completed by, that manganese was reported to have exceeded the standard at this location.

- The North Pond, South Pond, and Wetland Area contain elevated quantities of some chemical constituents typically associated with uranium mill tailings (e.g., manganese, molybdenum, and sulfate). In 2001, however, only molybdenum and sulfate were reported elevated; these were elevated primarily in the Wetlands Area and to a lesser degree in the North and South Ponds.

- During 2001, no extremely hazardous substances or hazardous chemicals were stored at the GJO facility in amounts exceeding the threshold planning quantities established in Sections 311 and 312 of the Superfund Amendments and Reauthorization Act (SARA) Title III. No toxic chemicals were used at the GJO in excess of applicable threshold quantities established in Section 313 of SARA Title III, and no reportable releases of hazardous substances (as defined by Section 304 of SARA Title III) occurred at the GJO facility.

Ground Water Monitoring

- During 2001, concentrations of uranium, molybdenum, selenium, and total dissolved solids in samples from the alluvial aquifer exceeded ground water quality standards. The original ground water modeling of the alluvial aquifer predicted that concentrations of ground water contaminants will be below applicable standards within 50 to 80 years after removal of the contaminant source (uranium mill tailings).

Waste Management

- In 2001, the GJO operated as a conditionally exempt small quantity generator (CESQG) (as defined by the Resource Conservation and Recovery Act [RCRA]) by generating less than 100 kg (220 lb) per month and storing less than 1,000 kg (2,200 lb) of hazardous waste.

- The RCRA Interim Status container storage unit, Building 61C, was closed on September 27, 2001, in accordance with 40 CFR Part 265, Subpart G, and the Interim Status permit was terminated.

- The GJO shipped various RCRA-regulated wastes for treatment and disposal at off-site facilities in 2001. These wastes were 820.20 kg (1808.20 lbs) of hazardous waste, 1724 feet of spent fluorescent tubes for mercury recovery, and 18.12 kg (40 lbs) of batteries for recycling; both waste streams are regulated as Universal Waste.

- The GJO generated 928.26 kg (2046 lbs) of nonradioactive PCB wastes through 2001 and disposed of 916.25 kg (2020 lbs) total of these wastes in September 2001. The GJO generated 14.74 kg (32 lbs) of radioactive PCB waste in 2001, which was stored in compliance with TSCA.

- The GJO generated three 55-gallon drums (276 kg or 608 lb) of radioactive asbestos waste in CY2001. This waste was disposed of at the DOE's Cheney Disposal Cell in CY2001.

- The GJO generated approximately 397 kg (873 lbs) of low-level radioactive waste (LLW) in calendar year 2001. The GJO shipped 880 kg (1936 lbs) of LLW for treatment and disposal at off-site facilities in June 2001. Additionally in storage, is a 55-gallon drum (105 kg) with LLW generated in previous years that could not be shipped off site in June 2001 due to the presence of an isotope, polonium-209, which was not accepted by the disposal facility. A total of 502 kg (1104 lbs) are being managed on-site in waste storage as of the end of calendar year 2002. LLW is stored in a separate dedicated building to minimize exposure to workers and to isolate the materials from the environment.

- Remediation under GJORAP was completed in 2001. Under GJORAP, radiologically contaminated soil, building debris (including asbestos), and other radiologically contaminated wastes were managed to protect the environment and personnel, and were disposed at a DOE-owned repository. After contamination in an open land area or building is remediated, release surveys are performed and closeout reports prepared to release the area or building for unrestricted use. Approximately 2,295 m^3 (3,000 yd^3) of radiologically contaminated materials were remediated in 2001 during the demolition of Buildings 7A and 62 and associated structures. These materials, along with approximately 765 m^3 (1,000 yd^3) of radiologically contaminated materials remediated during 2000 and the last quarter of 1999 that had been temporarily stockpiled at a location northwest of Building 7 on the GJO facility, were hauled to DOE's Cheney Disposal Cell during 2001. Closeout reports were prepared for the footprints of the demolished buildings and the former location of the temporary stockpile area. The closeout reports contain verification statements by an independent verification contractor.

Waste Minimization

- Normal operations such as replacing batteries in electric vehicles and radios generate spent batteries at the GJO. The site routinely recharges nickel-cadmium (NiCad) batteries, and then reconditions the batteries to increase the number of possible recharges. NiCad batteries are sent to a recycling facility when the batteries can no longer be recharged. Lead-acid batteries from vehicles are sent to a local recycler. The GJO sent approximately 18.12 kilograms of lead-acid batteries to the local recycler in 2001.

- GJO returned 1,360 kg of sodium hydroxide to a vendor for reuse, donated over 6,660 pieces of personal protective equipment to local organizations, reused approximately 94,800 kg of carpet and baseboards, and found reuse opportunities for 1,310 kg of assorted items that would otherwise have been disposed of as RCRA-regulated wastes.

- The GJO generates used oil from equipment maintenance and ships the used oil to an appropriate processing, re-refining, or burning facility on a regular basis. The GJO generated less than 208 liters (55 gallons) of used oil in 2001; this oil was recycled through a local company.

- The GJO regularly recycles office paper, cardboard, glass, plastics, magazines, and newspaper through a local recycling service. In 2001, the site recycled over 38,000 kg (83,700 lbs) of these materials. The GJO shipped spent fluorescent tubes to the local landfill, which sends the tubes for recycling.

Integrated Safety Management System

The site operates under an Integrated Safety Management System (ISMS) implemented in March 2000. The objective of the ISMS is to "Do Work Safely" and to ensure the protection of workers, the public, and the environment. This is accomplished through the effective integration of environment, safety, and health management into all facets of work planning and execution. To support this objective, DOE has issued DOE Policy (P) 450.4, *Safety Management System Policy*; DOE P 450.5, *Line Environment, Safety, and Health Oversight*; and DOE P 450.6, *Secretarial Policy Statement, Environment, Safety, and Health.* The ISMS is fully described in the ISMS *Integrated Safety Management System Description* (DOE 2000c).

Environmental Quality Plan

The DOE–GJO, through the FOS Contractor, operated the site in 2001 under an environmental management system that adopts and implements the concepts of the International Organization for Standards, ISO 14000, "Environmental Management Systems". Operations at the site were reviewed in accordance with the standard and an Environmental Quality System for site operations was implemented. The system has operated under self-declaration as described by the Standard since February 1998. Self-declaration under the standard means that site operations are conducted under voluntarily adopted procedures, targets, and objectives that require continual improvement in systems and operations in areas that may affect the environment. The Environmental Quality System was incorporated as part of the ISMS implementation.

The overall aim of ISO 14000 is to support environmental protection and prevention of pollution in balance with socioeconomic needs. To accomplish this, the standard specifies the requirements of an environmental management system and is written to be applicable to all types and sizes of organizations and to accommodate diverse geographical, cultural, and social conditions. Each organization is free to create an environmental management system tailored to individual needs and operating requirements. The success of the system depends on commitment from all levels and functions, especially from top management. A system of this kind enables an organization to establish, and assess the effectiveness of, procedures to set an environmental policy and objectives, achieve conformance with them, and demonstrate such conformance to others.

Federal, State, and local laws and regulations, as well as numerous DOE directives, determine the regulatory envelope for the DOE–GJO. The DOE–GJO continues to support the management of site functions in accordance with the *Environmental Quality Plan* to ensure conformance with regulations and to seek out areas for improving and enhancing their approach to environmental management.

Site Transfer

In 2000, the DOE-GJO filed a petition with the Governor of Colorado requesting permission to defer remediation on several areas of the site until a later date. The process is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 120(h)(3). The Governor approved the request on August 15, 2001, clearing the way for final negotiation and transfer of the site to non-DOE ownership in September 2001, with the DOE–GJO remaining as a tenant on the site.

Distribution of this Document

The complete document can be viewed at the DOE–GJO Internet website at http://www.gjo.doe.gov. Hard copies may be obtained by contacting Audrey Berry, Public Affairs Specialist, at the DOE–GJO, 2597 B 3/4 Road, Grand Junction, CO 81503 (970-248-7727).

1.0 Introduction

The U.S. Department of Energy (DOE) Grand Junction Office (GJO) is a leased facility located in Mesa County, Colorado, immediately south and west of the Grand Junction city limits at 2597 B 3/4 Road (Figure 1-1). The GJO is 1 kilometer (0.6 mile) from heavily populated areas of Grand Junction. The population of the city of Grand Junction and surrounding areas is approximately 116,255. The facility encompasses 22.8 hectares (ha) (56.4 acres) in G.L.O. Lots 1, 6, and 7 in Sections 26 and 27, Township 1 South, Range 1 West, Ute Meridian, Mesa County, Colorado, at an elevation of approximately 1,390 meters (4,560 feet) above sea level (U.S. Geological Survey 1962).

The GJO lies adjacent to the Gunnison River and is separated from the river by an earthen flood-control dike. The facility occupies an elongated, north-south-trending tract bounded on the west by the river and on the north, south, and east by agricultural, open-range, and railroad lands. Moderate, semiarid climatic conditions prevail in the Grand Junction area. Daily temperatures range from an average maximum summer (June, July, and August) temperature of 32 °C (89 °F) to an average minimum winter (December, January, and February) temperature of –7.1°C (20 °F). Average annual precipitation in Grand Junction from 1962 to 1995 measured 22.1 centimeters (8.69 inches**).**

The GJO facility lands were acquired by the U.S. War Department in August 1943 to refine uranium for the Manhattan Project. Uranium was milled, analyzed, and stored on the GJO facility from 1943 to 1975. All known environmental contamination is believed to be the result of these past activities. Site characterization and remedial action studies to assess the radiological hazards at the facility began in 1984 (Henwood and Ridolfi 1986) when the facility was accepted into the DOE Surplus Facilities Management Program. Facility oversight was transferred to the Defense Programs Decontamination and Decommissioning Program in 1988. In 1990, oversight of the GJO was transferred to the Office of Environmental Management.

In planning for cleanup of the facility, DOE- GJO complied with the National Environmental Policy Act (NEPA) process and, pursuant to direction from DOE Headquarters, used the environmental management protocols of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), even though the site did not qualify for placement on the National Priorities List. A final remedial investigation/feasibility study-environmental assessment that addressed remediation of the facility was completed in 1989 (DOE 1989a). Removal of contaminated soils from open-land areas began in 1989 and was completed in June 1994 (Figure 1-2); cleanup of most of the remaining contamination in and beneath on-site buildings was completed in 2001 (see Section 3.0).

Ground water within the alluvial aquifer beneath the site is contaminated by the leached products of on-site uranium mill tailings. Water from the aquifer is not used for any purpose. All domestic surface water sources for the Grand Junction area are located upstream of the GJO facility or are obtained from the Colorado River drainage system. The Gunnison River, which converges with the Colorado River about 0.8 kilometer (0.5 mile) downstream of the facility, is used for seasonal recreation activities such as boating, fishing, and swimming.

In 2000, the DOE–GJO filed a petition with the Governor of Colorado requesting permission to defer remediation on several areas of the site until a later date. The process is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 120(h)(3). The Governor approved the request on August 15, 2001, clearing the way for final negotiation and transfer of the site to non-DOE ownership in September 2001. The DOE–GJO remains as a tenant on the site.

Approximately 270 people worked at the GJO facility during 2001. In February of 1999, the DOE leased the southern portion of the site to the Grand Junction Economic Partnership Small Business Incubator Project (Incubator). The Incubator houses approximately 20 small businesses that range in operation from machining equipment to distribution of foodstuffs. The offices are used primarily for service-type businesses. In December 2001, the DOE transferred ownership of a tract of land on the northwest portion of the property to the U.S. Army Reserves. Figure 1-3 presents the current site configuration.

The GJO mission is to provide project management, engineering, and scientific support to the Federal Government's environmental restoration programs. These programs include the Monticello Mill Tailings Site Remedial Action Project, the Atlas Tailings Pile custodianship, the DOE Long-Term Surveillance and Maintenance Program, and the UMTRA Ground Water Project. The site houses a fully equipped Analytical Chemistry Laboratory. Several technical projects with other DOE facilities and Federal agencies are conducted from the GJO facility.

This annual Site Environmental Report for 2001 was prepared by *WASTREN, Inc.*, contractor for DOE-GJO until July 21, 2002. The purpose of this report is to provide DOE, State officials, the people of Colorado, and other interested parties with current information on GJO activities and the effects of these activities on the environment. The report is structured as follows:

- **Section 2** defines the laws and regulations that govern operations at the site and includes information about the site's compliance status.
- **Section 3** describes the environmental programs operating at the site.
- **Section 4** summarizes the data acquired under the radiological monitoring program.
- **Section 5** summarizes the data acquired under the nonradiological monitoring program (including waste management and pollution prevention).
- **Section 6** discusses in detail the ground water monitoring program and data.
- **Section 7** provides an overview of the quality assurance measures implemented at the site.
- **Section 8** provides the list of references used in the preparation of this document.

2.0 Compliance Summary

This section describes the status of GJO compliance with applicable Federal environmental regulations, describes current issues and actions such as environmental audits, and contains a summary of the permits held by the DOE–GJO for management of the GJO site. The GJO's EPA Identification number is CO6890090065.

2.1 Compliance Status

The DOE-GJO site operated during calendar year 2001 without receiving any notices of violation and did not have any occurrences that required reporting to outside agencies.

2.1.1 Comprehensive Environmental Response, Compensation, and Liability Act

Although the GJO facility was not placed on the National Priorities List by the U.S. Environmental Protection Agency (EPA), DOE–GJO elected to use the CERCLA management protocols for environmental cleanup of the facility. The Grand Junction Office Remedial Action Project (GJORAP) was initiated to remove contaminated materials associated with past uranium-milling activities on the site. A remedial investigation/feasibility study-environmental assessment (DOE 1989a) was completed in 1989, and a Record of Decision (DOE 1990) was made final and approved by the DOE Idaho Operations Office in April 1990.

The GJORAP Information Repositories required by CERCLA are in the Mesa County Library in Grand Junction and in the Technical Library at the GJO. The repositories were updated in January and July of 2000. The GJORAP Project was completed in September 2001; all available materials have been appropriately archived in accordance with GJO Records Management procedures.

In 2000, the DOE-GJO filed a *Request for Deferred Remediation* (DOE 2000c) under CERCLA 120(h)(3) to request permission of the Governor of Colorado to defer remediation on portions of the site and to transfer the site prior to completion of remedial action. CERCLA 120(h)(3) applies to the transfer of federally owned properties that are not officially CERCLA sites, but where the use, storage, or release of CERCLA hazardous substances has occurred. Approval of the request by the Governor was obtained on August 15, 2001, and transfer of the property to non-DOE ownership was completed in September 2001.

The areas that remain to be remediated are:

- A contaminated slab under Building 12A (this will be remediated when the building is demolished at the end of DOE use).
- An area of contaminated soil under the southwest corner of Building 20 (this will be remediated when the building is demolished at the end of DOE use).
- A 300-foot borehole well that contains two low-activity, radium foil sources (the sources have been encased and the well closed in compliance with State of Colorado requirements).

- Surface and ground water (subject to passive remediation discussed in Section 6 of this document).

The DOE-GJO has taken all appropriate measures to ensure protection of human health and the environment and, as required by CERCLA 120(h)(3), has committed to funding actions that may be required to remediate contamination resulting from past DOE activities at the site.

2.1.2 Superfund Amendments and Reauthorization Act, Title III, Executive Order 12856

DOE-GJO developed a Chemical Tracking System in 1995 to comply with the reporting and notification requirements of the Superfund Amendments and Reauthorization Act of 1986 (SARA), Emergency Planning and Community Right-To-Know Act of 1986 (Sections 311, 312, and 313); and Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.*

During 2001, no extremely hazardous substances or hazardous chemicals were stored at the GJO facility in amounts exceeding the threshold planning quantities established in Sections 311 and 312 of SARA Title III. No toxic chemicals were used at the GJO in excess of applicable threshold quantities established in Section 313 of SARA Title III, and no reportable releases of hazardous substances (as defined by Section 304 of SARA Title III) occurred at the GJO facility; therefore, the applicability of SARA Title III reporting requirements for calendar year 2000 is as follows:

- Sections 302-303: Planning Notification—not required.
- Sections 304: Extremely Hazardous Substance Release Notification—not required.
- Sections 311-312: Material Data Safety Sheets/Chemical Inventory—not required.
- Section 313: Toxic Chemical Release Inventory Reporting—not required.

Although "negative" reporting is not required under the statutes, DOE- GJO informed the Colorado Emergency Response Commission, the Mesa County Emergency Planning Committee, and the Grand Junction Fire Department by letter that no chemicals were stored in excess of the applicable thresholds during 2001.

2.1.3 Resource Conservation and Recovery Act

DOE-GJO usually operates under the special requirements (codified at Title 40, Section 261.5, of the *Code of Federal Regulations* [CFR]) for conditionally exempt small-quantity generators (CESQGs) of hazardous waste. GJO maintains its CESQG status by generating no more than 100 kilograms (kg) (220 pounds [lb]) of hazardous waste or 1 kg (2.2 lb) of acutely hazardous waste in a calendar month and storing no more than 1,000 kg (2,200 lb) before shipment for treatment and disposal. CESQG wastes are not subject to full regulation under 40 CFR 124, 262 through 266, 268, and 270; however, the generator must comply with certain requirements. CESQGs can accumulate waste on site and remain exempt from full regulation as long as

generation and storage requirements are not exceeded. If on-site waste accumulation exceeds 1,000 kg (2,200 lb), all the accumulated wastes become subject to small-quantity generator requirements, including the land disposal restrictions codified at 40 CFR 268.

In 2001, the GJO operated as a conditionally exempt small quantity generator (CESQG) by generating less than 100 kg (220 lb) per month and storing less than 1,000 kg (2,200 lb) of hazardous waste. Despite its CESQG status, the GJO maintained all programs necessary to operate as a small or large quantity generator if needed. Such programs generally include increased personnel training, inspections, and facility record keeping.

Hazardous and mixed wastes are generated primarily by the GJO Analytical Chemistry Laboratory and from co-mingled hazardous and residual radioactive material generated during site remediation. The GJO stores hazardous and mixed waste in satellite accumulation areas and in designated hazardous waste storage areas, including commercially manufactured storage modules (Buildings 61A and 61C). Hazardous wastes are shipped off the site to commercial treatment and disposal facilities once or twice each calendar year, or as required by law. The GJO maintained a storage facility for storage of mixed waste; this facility was in Interim Status under RCRA during 2001. The Interim Status container storage unit, Building 61C, was closed on September 27, 2001, in accordance with 40 CFR Part 265, Subpart G, and the Interim Status permit was terminated.

2.1.4 National Environmental Policy Act

During 1996, the *Environmental Assessment of Facility Operations at the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado* (DOE 1996a) was completed. This Environmental Assessment described the potential environmental and human health effects associated with operations at the GJO facility. Completion of the Environmental Assessment and issuance of the accompanying Finding of No Significant Impact reduced the number of activity reviews required under the NEPA at the site. In January 2000, the DOE-GJO prepared the *Environmental Assessment for the Transfer of the Department of Energy Grand Junction Office to Non-DOE Ownership* (DOE 2000d) to review the potential impacts, both environmental and economic, of the transfer of the site. Following public comment resolution, a finding of no significant impact (FONSI) was issued in April 2000.

As part of the site NEPA compliance program, the DOE- GJO submits information for the DOE-Headquarters NEPA Annual Planning Summary, which lists environmental assessments and environmental impact statements to be prepared during the year. The FOS Contractor operated under an environmental management system that required NEPA review of all pending actions.

2.1.5 Formerly Utilized Sites Remedial Action Program

The Formerly Utilized Sites Remedial Action Program controls the DOE procedures for release of contaminated sites, and GJORAP must meet the specific objectives of release surveys, with regard to different types of contamination requirements, in order to release property to the public. The standards are as follows:

Surface radioactivity on buildings and structures—Release surveys must show that average surface-contamination levels and hot spots are within guidelines and that reasonable efforts have been made to clean up removable radioactivity.

Volume of radioactivity in soil and concrete—Release surveys must show that average radionuclide and hot spot concentrations are within guidelines.

Airborne radon decay-product concentrations (RDCs)—Release surveys must show that RDCs are within guidelines.

External gamma radiation—Release surveys must show that average levels of gamma radiation inside occupied buildings or habitable structures and average levels of gamma radiation in outside areas do not exceed guidelines.

As low as reasonably achievable (ALARA) requirements—Release surveys must show that DOE's ALARA policy has been implemented and that quantities of radioactivity and residual radioactive material are as low as reasonably achievable.

The guidelines referenced above are detailed in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. This order will be superceded when 10 CFR 834 is promulgated; however, the guidelines will remain essentially the same.

Release Surveys

Remediation under GJORAP was completed in 2001. Under GJORAP, radiologically contaminated soil, building debris (including asbestos), and other radiologically contaminated wastes were managed to protect the environment and personnel, and were disposed at a DOE-owned repository (Section 3.4.3). After contamination in an open land area or building is remediated, release surveys are performed and closeout reports prepared to release the area or building for unrestricted use. By the end of 2001, GJORAP had demolished 16 buildings and remediated and/or verified for release for unrestricted use the remaining 33 buildings present at the facility at the close of 2001. Buildings 7A and 62, both radiologically contaminated, were demolished in 2001.

2.1.6 Clean Air Act/National Emission Standards for Hazardous Air Pollutants

In 1991, the Colorado Department of Public Health and Environment (CDPHE) granted DOE-GJO an air emission permit for the GJO Analytical Chemistry Laboratory. The permit established limitations on (1) the annual emissions of particulate matter, volatile organic compounds, and benzene; (2) the annual consumption of acids, volatile organic compounds, and benzene; and (3) the opacity of emissions. As in previous years, no limits were exceeded in 2000. Sample plant activities were moved from Building 7A to Building 46. The FOS Contractor Compliance Group evaluated the potential emissions from the stacks in Building 46 and worked with CDPHE to determine that no additional permitting would be required.

Off-site dose modeling using CAP88PC dose assessment software was conducted for the facility to determine compliance with the National Emission Standards for Hazardous Air Pollutants

(NESHAP), Subpart H; DOE Order 5400.1, *General Environmental Protection Program*; and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

The effective dose equivalents (EDEs) for the GJO point source radiological air emissions in units of millirem per year (mrem/yr) and millisieverts per year (mSv/yr) are presented in Section 4, Table 4-3. Calculation of the nonradon EDE for these point sources to the maximally exposed individual resulted in a value that is more than 800,000 times below the DOE and EPA standard of 10 mrem/yr. There were no point source radon emissions during 2001; therefore, the public EDE, which is derived by summing the individual point source EDEs calculated for radioparticulates and radon, is the same as the EDE for radioparticulates alone.

The EDEs for the GJO nonpoint source radiological air emissions are presented in Table 4–4. Calculation of the nonradon EDE to the maximally exposed individual resulted in a value that is almost 900 times below the DOE and EPA standard of 10 mrem/yr. The public EDE includes the radon source term and was derived by summing the individual nonpoint source EDEs calculated for radioparticulates and radon. The resulting total EDE is more than 200 times below the DOE standard of 100 mrem/yr.

2.1.7 Clean Water Act/National Pretreatment Program

Sewer effluent from the facility is routed to the publicly owned treatment works operated by the City of Grand Junction. In 2000, the City re-evaluated the status of the facility and determined that the GJO site no longer met the requirements of an "industrial user" as defined by the regulations. Therefore, the City did not renew the Class II Industrial Pretreatment Permit (No. 023). The site remains subject to the discharge limits established by the Industrial Pretreatment Program for the City. Pursuant to an exemption to DOE Order 5400.1, the GJO is no longer required to sample the sewer effluent produced at the site. The Analytical Chemistry Laboratory has implemented several new administrative controls to ensure compliance with all limits of the Industrial Pretreatment Program.

The GJO facility has no wastewater or storm-water discharges that are regulated by the National Pollutant Discharge Elimination System and, therefore, is not required to have discharge permits for its current activities and operations.

2.1.8 Clean Water Act/Executive Order 11990, *Protection of Wetlands*

Through the U.S. Army Corps of Engineers, DOE obtained a 404 permit for excavation of tailings-contaminated materials in riparian areas along the Gunnison River and in wetland areas. Restoration was completed in spring 1995, and monitoring began in August 1995. Results of the monitoring were documented in the *Fifth Annual Monitoring Report for the U.S. Department of Energy Grand Junction Office Wetland Mitigation Project* (DOE 1999a). The permit was officially terminated in 1996 because restoration activities were completed. Monitoring activities were continued through 2000 to demonstrate compliance with the mitigation requirements of the permit, with final termination of the permit in August 2000. All actions at the site that may affect the wetlands are reviewed in accordance with NEPA requirements and 10 CFR 1022.

2.1.9 Safe Drinking Water Act

The provisions of the Safe Drinking Water Act are not relevant to the GJO facility because neither ground water nor surface water at or near the site is used for public consumption. All water is provided to the site by the City of Grand Junction, whose drinking water system conforms to the requirements of the Safe Drinking Water Act.

2.1.10 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted in 1976 to fill the significant gap left by other Federal regulations. The Clean Air Act, the Federal Water Pollution Control Act, and other laws dealt with chemical substances only when they entered the environment as wastes (emissions to air and discharges to water). TSCA was created to regulate the manufacturing of chemical substances. TSCA provides EPA with authority to require testing of chemical substances, both new and old, entering the environment and to regulate them where necessary.

TSCA specifically addresses the use and management of PCBs and asbestos. The rate of generation of TSCA-related wastes at GJO is low and is generated primarily from replacement and removal of PCB-containing light ballasts. Asbestos waste is generated from the removal of asbestos-containing materials such as ceiling insulation, damper material, exterior siding (i.e., transite) and floor tile.

TSCA-regulated wastes generated at the site in 2001 included the following:

- 928.26 kg (2046 lbs) of nonradioactive PCB wastes through 2001 and disposed of 916.25 kg (2020 lbs) total of these wastes in September 2001.

- 14.74 kg (32 lbs) of radioactive PCB waste in 2000, which was stored in compliance with TSCA.

- 3.0 m^3 (17.0 yd^3) of radiologically contaminated asbestos waste during demolition of Building 7A. All of the Building 7A waste material was disposed at the Cheney Disposal Cell in July 2001.

- 12.2 m^3 (16.0 yd^3) of nonradioactive asbestos wastes during demolition of Building 18 in 2001, and disposed the total quantity at the county landfill in September 2001.

2.1.11 Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) governs the use, storage, registration, and disposal of pesticides. FIFRA categorizes pesticides as either "restricted use" or "general use". EPA may classify a pesticide as restricted use (1) if it is determined that substantial adverse effects to the applicator or environment may occur without additional regulatory restrictions or (2) if unreasonable harm to humans or the environment may occur, even if the pesticide is used as directed by the label instructions. FIFRA regulations require that restricted-use pesticides be used or applied only by a certified private or commercial applicator

or under the direct supervision of a certified applicator. There were no certified applications of pesticide at the site in 2001.

2.1.12 Endangered Species Act

Section 7 of the Endangered Species Act requires DOE to ensure that any actions authorized, funded, or performed at the facility do not "jeopardize the continued existence of threatened or endangered species and do not destroy or adversely modify critical habitat required for the continued existence of that species." The Gunnison River adjacent to the facility provides habitat for four endangered fish: the Colorado squawfish, humpback chub, bonytail chub, and razorback sucker. The GJO did not withdraw water from the Gunnison River in 2001 and has no plans for withdrawing water in the future.

2.1.13 National Historic Preservation Act

As required by the National Historic Preservation Act, DOE must identify all properties (i.e., buildings, structures, objects, artifacts) that may qualify for listing in the National Register of Historic Places, and then consider the effects of their actions on those properties determined eligible for listing before any undertaking. DOE has developed a comprehensive historic context for the Manhattan Project and Cold War period to provide a nationwide framework for determining the historic significance of the properties that are part of DOE's former nuclear weapons complexes and laboratories.

The buildings at the site were evaluated by an outside consultant in calendar year 1999 and are managed in accordance with an agreement reached with the State Historical Preservation Officer in June 2000.

2.1.14 Executive Order 11988, *Floodplain Management*

In 1976, the U.S. Army Corps of Engineers determined that the GJO facility was not in the 100-year or the 500-year floodplain of the Gunnison River due to the protection afforded by the dike. The Mesa County Housing and Urban Design Flood Insurance Rate Map (July 1978) places the GJO facility within the 1,000-year floodplain. No activities described by Executive Order 11988, *Floodplain Management*, as requiring a permit were conducted in 2001.

2.2 Current Issues and Actions

There were no major ongoing environmental issues at GJO and there were no nonroutine or unplanned releases to the environment during calendar year 2001. GJO uses external environmental audits, internal environmental audits, and management compliance assessments to evaluate environmental compliance and to implement corrective actions.

2.2.1 Assessments

During 2001, one external independent assessment of instrument calibration and seven customer or certification agency assessments on the Analytical Chemistry Laboratory were performed.

Corrective actions have been completed for six of the assessments and were underway for the two remaining open assessments at the end of CY 2001.

Four internal independent assessments were conducted by the FOS contractor during 2001. Assessments related to the environment included, radioactive source control, contamination control, radiation safety training, and quality system.

Contractor Quality Assurance coordinators completed six management assessments and one surveillance during 2001. These evaluations verified status of activities against performance measures during the two 6-month performance periods.

Representatives from the Colorado Department of Public Health and Environment visited the GJO for their annual inspection. The state is required to inspect the site's permitted waste storage facility each year as part of their RCRA compliance program. For the third year, the inspectors issued a Notice of Inspection confirming that the inspectors found no issues or areas of concern.

2.3 Summary of Facility Permits

Table 2-1 shows the types of permits that were active at the DOE-GJO site during 2001.

Table 2-1. Types of DOE-GJO Permits Active in 2001

Type of Permit	Issuing Agency	No. of Permits
RCRA Hazardous Waste Storage Permit Application, Part A	State of Colorado	1
Air Emission Permit	State of Colorado	1
Gravel Pit Permit	State of Colorado	1
Pond Permit	State of Colorado	2
Well Permit	State of Colorado	6

3.0 Environmental Program Information

Environmental programs at the GJO facility include air monitoring, water monitoring, radiological monitoring, environmental remediation, waste management, and pollution prevention. This section provides descriptions of all program elements except the ground water program, which is presented in Section 6.0, "Ground Water Monitoring and Protection Program." Air and water monitoring results and data, excluding ground water, are presented in Section 4.0, "Environmental Radiological Program Information," and Section 5.0, "Environmental Nonradiological Program Information." This section also presents brief discussions of data associated with environmental remediation, waste management, and pollution prevention.

In addition to the environmental programs, GJO has a comprehensive ISMS and Radiological Control Program to minimize workplace hazards and to ensure protection to employees and the public. These programs are described in the *GJO Health and Safety Standards* (DOE 1996b), the *GJO Site Radiological Control Manual* (DOE 2000), and the *U.S. Department of Energy Integrated Safety Management System, Grand Junction Office* (DOE 2000b).

3.1 Air Monitoring

3.1.1 Meteorology

Meteorological monitoring was conducted in 2001 at the GJO facility to support off-site dose calculations. The meteorological monitoring station is located in the northern portion of the facility (Figure 3–1); monitoring began in November 1993. Parameters measured consisted of wind speed, wind direction, temperature, barometric pressure, precipitation, and relative humidity. Hourly standard deviation of wind direction was calculated and used to determine atmospheric stability. Wind data collected during 2001 were processed to create a stability array distribution, which was converted into a wind file for input to the EPA-approved model CAP88PC, to calculate the year 2001 off-site effective dose equivalent. Details on the model and input parameters are provided in Section 4.1, "Radiological Air Emissions, " and Section 4.2, "Radiological Dose Modeling."

3.1.2 Air Emissions Monitoring and Estimation for Radiological Constituents

Radiological air-emissions monitoring and estimation was conducted on the GJO facility to assess the potential radiation dose to members of the public that could result from site operations and to demonstrate compliance with the dose standards established by NESHAP, 40 CFR Part 61, Subpart H; and DOE Order 5400.5. During 2001, a business leasing space on the GJO facility was considered the nearest member of the public to any source of radiological air-emissions.

Point sources of radioactive air emissions on the GJO facility during 2001 included the exhaust stacks for the Sample Preparation Facility (Sample Plant) and the Analytical Chemistry Laboratory. The AIMTech/ORNL sample preparation laboratory included in previous years did not perform any activities in CY2001 to contribute to radiological air emissions and ceased operation in October 2001.

Radioactive air emissions are generated during environmental sample preparation such as grinding, blending, and digestion of environmental samples. Radioactive air emissions from the Sample Plant, which performs grinding and blending activities, are subject to an air handling control device before release to the atmosphere. In CY2001, the Sample Plant was relocated from Building 7A to Building 46 (Figure 3-1). The Baghouse (an air-handling control formerly located in the demolished Building 62) was replaced in the new Sample Plant with a high-efficiency filtration system that utilizes replaceable mini-pleat filters (DOP rating at 95 percent on 0.3 micron particle size).

Non-point-source radioactive air emissions on the GJO facility during 2001 were generated from soil transfer activities associated with the remediation of contamination caused by previous uranium mill operations, and from Calibration Test Pit emissions.

Point Source Particulates

One point source (the Sample Plant) and one grouped source (the Analytical Chemistry Laboratory) contributed to radionuclide emissions from the GJO facility during 2001. The four Analytical Chemistry Laboratory point sources were combined into a grouped source because they have similar function, controls, and location (Figure 3–1).

EPA granted an indefinite waiver of sampling requirements for the GJO Analytical Chemistry Laboratory and required that the Sample Plant emissions be subject to periodic confirmatory measurements (Novemeber 2, 1990, and December 20, 1991 correspondence between EPA and DOE- GJO). The GJO Analytical Chemistry Laboratory radionuclide emissions were estimated according to guidelines in 40 CFR Part 61, Appendix D. Radiological emissions from the Sample Plant are isokinectically sampled whenever sample preparation activities are performed. However, due to failure of the sampling equipment following relocation to the new building early in 2001, EPA approved use of engineering calculations to meet the measurement requirements of the this point source. Therefore, the Sample Plant emissions for CY2001 were also estimated according to guidelines in 40 CFR 61, Appendix D.

The GJO point and group sources, effluent controls, estimation of control efficiency, and distance from the points of release in Building 7 to the maximally exposed individual (MEI) are presented in Table 3–1. The MEI is a business leasing space on the DOE–GJO facility, and represents the member of the public receiving the largest dose from all sources of radionuclide emissions combined. The radionuclides released from these point sources and estimated total emission levels during 2001 are presented in Section 4.1.1. Point source dose modeling results are provided in Section 4.2.

Table 3–1. GJO Point Source Information

Point Source	Type of Control	Efficiency (%)	Distance to Nearest Receptor
Sample Plant	High-efficiency filtration system	95	122 meters (402 feet)
Grouped Source	**Type of Control**	**Efficiency (%)**	**Distance to Nearest Receptor**
GJO Analytical Chemistry Laboratory[a] (4 sources total)	Wet scrubbers	50–75	152 meters (502 feet)

[a]Emissions were estimated according to guidelines in 40 CFR Part 61, Appendix D.

Nonpoint Source Particulates

Fugitive emissions from contaminated soil transfer activities were the source of non-point radioactive air emissions from the GJO facility during 2001. Remediation of contaminated soil under two buildings (Buildings 7A and 62 on Figure 3-1) that were demolished during 2001, and removal of a contaminated soil stockpile contributed to the non-point radioactive air emissions. Together, these projects involved the excavation and removal of approximately 786 m^3 (1,028 yd^3) of radiologically contaminated soils.

The radionuclides released from these activities and estimated total emission levels during 2001 are presented in Section 4.1.2. Nonpoint source dose modeling results are presented in Section 4.2.

Atmospheric Radon

The source of radon emissions from the GJO facility is the Calibration Test Pit area. (Figure 3–1). Estimates of radon emissions from the Calibration Test Pits are based on radon flux measurements from selected pads.

3.1.3 Air Emissions Monitoring and Estimation for Nonradiological Constituents

Air emissions monitoring and estimation for nonradiological constituents is conducted on the GJO facility to demonstrate compliance with specific permit and Air Pollution Emission Notification (APEN) exemption requirements. Air emission sources of nonradiological constituents at the GJO facility include the Analytical Chemistry Laboratory and the Sample Plant. These sources are regulated by the Colorado Air Quality Control Commission (CAQCC) Regulation No. 3.

The GJO Analytical Chemistry Laboratory is subject to the requirements of Air Emission Permit No. 90ME402–1 issued by the Air Pollution Control Division of the CDPHE, which granted final approval in January 1994. The permit specifies visible emission (opacity) limits; sets limits on particulate matter (as acids), volatile organic compounds, and benzene emissions; and sets maximum consumption rates on acids, volatile organics, and benzene. The Sample Plant emission source was granted APEN and permit exemptions by the Air Pollution Control Division.

Opacity

Air Emission Permit No. 90ME402–1, the APEN/permit exemptions granted to the Sample Plant, and CAQCC Regulation No. 1 require that visible emissions from sources at the site not exceed 20 percent opacity. No emissions requiring opacity observations occurred during 2001.

Permitted Releases

In addition to the opacity requirement, Air Emission Permit No. 90ME402–1 for the GJO Analytical Chemistry Laboratory establishes limits on (1) the annual emissions of particulate matter, volatile organic compounds, and benzene and (2) the annual consumption of acids, volatile organic compounds, and benzene. Consumption rates are monitored annually to demonstrate compliance with these permit conditions.

The APEN exemption granted for the Sample Plant establishes limits on the quantity of soil processed annually. Soil processing is monitored to demonstrate compliance with this APEN exemption requirement. Section 5.0 provides a comparison of the 2001 chemical consumption and quantity of soil processed with permit limitations.

3.2 Water Monitoring

The GJO monitors the surface water and ground water on and adjacent to the GJO facility (Note: Sewer effluent entering the city sewer system was monitored monthly through March 2000 when it was discontinued). This section presents descriptions of monitoring performed in 2001 associated with the surface water, and includes a brief summary for the discontinuance of the sewer effluent monitoring. Section 6.0 presents descriptions of ground water monitoring activities and results.

3.2.1 Sewer Effluent

The GJO sewer effluent consists of domestic sewage from the facility, including that from tenant businesses, and wastewater discharges from the GJO Analytical Chemistry Laboratory, Building 32, and microfiche processing center. The GJO sewer system discharges to the city sewer system, which is routed to the City of Grand Junction Publicly Owned Treatment Works (POTW).

From March 1989 to June 1999, the DOE–GJO was subject to the provisions of a Class II Industrial Pretreatment Permit issued to the DOE–GJO under the authority of the City of Grand Junction's Industrial Pretreatment Program, Chapter 38 of the Code of Ordinance; the Colorado Water Quality Control Act; and the Federal Water Pollution Control Act as amended by the Clean Water Act of 1977. In accordance with the regulatory provisions of the Industrial Pretreatment Program and with the City of Grand Junction's approval, the DOE–GJO did not renew its Industrial Pretreatment Permit after it expired in June 1999 (DOE 2001b and Tonello 2001). Sampling of the sewer effluent for nonradioactive constituents continued as a best management practice (BMP) during the first quarter of 2000, after which time it was discontinued.

The GJO sewer effluent was also monitored for radioactive constituents during the first quarter of 2000. This sampling was conducted to demonstrate compliance with the standards and requirements established by DOE Orders 5400.1 and 5400.5. In March 2000, the DOE–GJO facility received approval from the Albuquerque Operations Office to discontinue this monitoring; therefore, no monitoring of the sewer effluent for radioactive constituents was conducted after March 2000.

The approval by DOE to discontinue monitoring for radioactive constituents was based on historically low activity and administrative controls in place that ensure compliance with DOE Order 5400.5. The City of Grand Junction does not require the DOE- GJO to monitor for radioactive constituents as compliance with DOE orders ensures that the effluent discharged is below the less stringent local limits.

Sewer Effluent Monitoring for Radioactive and Nonradioactive Constituents

The primary sources of radioactive and nonradioactive liquid discharges to the GJO sewer system are the Analytical Chemistry Laboratory and Building 32 (Environmental Laboratory)(Figure 3-1).

Radioactive liquids are generated in the course of environmental sample preparation and analysis and are discharged directly to the GJO sewer system. Administrative controls are in place to ensure that the level of radioactivity does not exceed levels established in DOE Order 5400.5, conservatively set at 1.5×10^{-7} microcuries per milliliter (µCi/mL) (5,550 microbequerels per milliliter [µBq/mL]) at the sewer outfall.

In 2001, as part of the revision to the *Analytical Chemistry Laboratory Chemical Hygiene Plan* (*WASTREN,* current version) a complete review of all waste management practices, including disposal options for aqueous process waste streams and excess aqueous samples. The intent of the waste management review was to clarify practices where appropriate, and provide more specific direction if necessary. The Analytical Chemistry Laboratory 's current practice for disposal of aqueous process wastes and excess aqueous samples is acid neutralization to meet effluent pH standards prior to discharge to the city sewer system.

As a part of this waste management review, a baseline composition of the Analytical Chemistry Laboratory effluent was derived from calculations of chemicals contributed from the laboratory's analytical procedures themselves, and also from the theoretical disposal of all aqueous client samples. Both process knowledge and analytical data from the current calendar year were used to calculate the values. The management practices currently exercised by the Analytical Chemistry Laboratory to maintain compliance with effluent limitations on pH, radioisotopes, and total toxic organics were also reviewed. It was concluded, and concurred by the city, that with the exception of mercury, all discharges from the Analytical Chemistry Laboratory to the city sewer system meet the current local limits and all other discharge limitations contained in the city code of ordinances (Grand Junction Code, Section 38-49). Any new processes or significant changes to the existing laboratory processes or procedures will require the city's review prior to any discharge to the sanitary sewer system.

Mercury is subject to a "zero-discharge" effluent standard. To prevent any discharge of this constituent from future Analytical Chemistry Laboratory activities, the laboratory will temporarily hold any samples for which mercury analysis is requested. During this time, the laboratory will prepare a process-specific analysis of all waste streams that will be generated during the mercury analysis and any other analyses requested, and determine the management provisions for these wastes. This waste management plan for controlling inadvertent mercury discharges to the sewer system was approved by the city (DOE 2001b and Tonello 2001).

3.2.2 Surface Water

Surface water monitoring is conducted to verify compliance with State water quality standards and to detect changes in water quality resulting from remedial actions. Surface water sources at or near the GJO facility consist of the North Pond, South Pond, Wetland Area, and Gunnison River, all of which contain water year-round. The North Pond, South Pond, and Wetland Area are located on the GJO facility, and the Gunnison River is contiguous to the facility's west and north boundaries (Figure 3–2). The wetland was created in spring 1994 from the excavation of contaminated soils during GJORAP operations. This area was not backfilled after excavation, which resulted in a depression that is recharged by ground water. The wetland area was expanded in August 2000 as requested by the U.S. Army Corps of Engineers following a review of the annual reports submitted between 1995 and 1999 as per the 10040 Permit. Approximately 344 cubic meters of soil to a depth of 12 inches were removed in an effort to increase the percentage of area permanently inundated by water and to decrease the alkali concentration in the soil. Although the majority of the wetland is dry during low ground water periods (September through March), a portion of the area was designed to contain water year-round for monitoring purposes; this area forms the sampling location called the Wetland Area.

In accordance with the WQCC regulation entitled "Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins" (5 CCR 1002–35), the State has designated four use classifications for the segment of the Gunnison River near the GJO facility: (1) Recreation—Class I, (2) Cold Water Aquatic Life—Class I, (3) Domestic Water Supply, and (4) Agriculture. Table 5–3 lists the State water quality standards associated with these classifications and lists the more stringent standard if more than one exists. Where table value standards were adopted by the WQCC, the numerical criteria provided were used to determine the standard. These standards were used to evaluate the North Pond, South Pond, and Wetland Area because those surface water features are in hydraulic contact with the Gunnison River.

The surface water sampling locations are near the shore of the Gunnison River adjacent to the facility (Upper Middle Gunnison), downstream of the facility (Lower Gunnison), near the western shores of the North and South Ponds, and at the Wetland Area (Figure 3–2). An upstream location on the Gunnison River (Upper Gunnison) was formerly sampled from 1982 through 2000, and will be referred to in the report when comparison to an upgradient (or background) river location is

warranted. This river location, along with one of the two locations adjacent to the site were discontinued in CY2001 following an evaluation of both the ground water and surface water monitoring performed at the GJO. This evaluation was conducted for management under the Long Term Surveillance and Maintenance (LTSM) Program which oversees site monitoring following the transition to private ownership which occurred in CY2001.

Surface water samples were initially collected quarterly during the removal of tailings and contaminated soil from the facility (1990 through 1994). A 9-month sampling frequency was phased in as remediation neared completion. Sample collection from the North Pond, South Pond, and
Wetland Area was changed to the 9-month frequency following the December 1993 sampling event, and the Gunnison River locations were changed to the 9-month frequency following the September 1994 sampling event. The 9-month sampling frequency was implemented to allow for an annual assessment of compliance with State water quality standards and to observe seasonal fluctuations in contaminant concentrations. The 9-month frequency results in four rounds of sampling over a 3-year period.

The surface water sampling locations are near the shore of the Gunnison River adjacent to the facility (Upper Middle Gunnison), downstream of the facility (Lower Gunnison), near the western shores of the North and South Ponds, and at the Wetland Area (Figure 3–2). An upstream location on the Gunnison River (Upper Gunnison) was formerly sampled from 1982 through 2000, and will be referred to in the report when comparison to an upgradient (or background) river location is warrented. This river location, along with one of the two locations adjacent to the site were discontinued in CY2001 following an evaluation of both the ground water and surface water monitoring performed at the GJO. This evaluation was conducted for management under the LTSM Program that oversees site monitoring following the transition to private ownership which occurred in CY2001.

Surface water alkalinity, turbidity, pH, conductivity, and temperature were determined in the field; surface water samples were collected and analyzed at the GJO Analytical Chemistry Laboratory for metals (arsenic, chromium, iron, manganese, molybdenum, selenium, and vanadium), a major cation (magnesium), major anions (chloride, nitrate, and sulfate), radionuclides (gross alpha/beta and total uranium), and total dissolved solids. These analytes are used to characterize general water quality and to monitor the effects of alluvial ground water under the GJO facility on surface water quality. Historical and 2000 maximum analyte concentrations in samples from the Gunnison River are compared with applicable State standards in Section 5, Table 5–3.

3.3 Environmental Remediation

GJORAP encompasses activities associated with the removal of uranium mill tailings and mill-related contamination from earlier GJO operations. All known on-site radiological contamination of ground water, surface water, and soils and most of the building contamination is believed to be a result of those past activities. Remedial action site investigations formally began in 1984 when the facility was accepted into the DOE Surplus Facilities Management Program. The GJORAP remedial investigation/feasibility study report for the GJO (DOE 1989a) was issued in July 1989 and the Record of Decision (DOE 1990) was issued in April 1990.

Removal of uranium mill tailings and contaminated soil began in late 1989, and most of the contamination was removed by 1994. Additional small deposits of contaminated soil subsequently were removed during remedial action activities conducted during 1998 through 2001. The total volume of uranium mill tailings and tailings-contaminated material removed from open land areas for the duration of the project was approximately 195,985 m^3 (256,340 yd^3). The tailings and related materials occupied approximately 13.5 hectares (33.3 acres). The primary locations of remediation included the North Pond and South Pond areas, areas located on the north and northwest of the property, and the dike along the Gunnison River. Environmental remediation activities in 2001 included removal of stockpiled radiologically contaminated debris and underlying contaminated soil.

In addition to soil, ground water, and surface water contamination, 24 buildings at the GJO facility at the start of GJORAP remediation in 1989 contained radiological contamination as a result of past uranium milling, sample preparation, and brokerage activities (Buildings 1, 2, 6, 7/7A, 12/12A, 18, 20, 28, 31, 31A, 32, 33, 34, 35, 36, 37, 39, 42, 44, 46, 52, 62, 938, and 3022). By the end of 2001, GJORAP had demolished 16 buildings and remediated and/or verified for release for unrestricted use the remaining 33 buildings present at the facility. Buildings 7A and 62, both radiologically contaminated, were demolished in 2001.

3.3.1 GJORAP Activities

Remediation under GJORAP was completed in 2001. Under GJORAP, radiologically contaminated soil, building debris (including asbestos), and other radiologically contaminated wastes were managed to protect the environment and personnel, and were disposed at a DOE-owned repository (Section 3.4.3). After contamination in an open land area or building is remediated, release surveys are performed and closeout reports prepared to release the area or building for unrestricted use.

Approximately 2,295 m^3 (3,000 yd^3) of radiologically contaminated materials were remediated in 2001 during the demolition of Buildings 7A and 62 and associated structures. These materials, along with approximately 765 m^3 (1,000 yd^3) of radiologically contaminated materials remediated during 2000 and the last quarter of 1999 that had been temporarily stockpiled at a location northwest of Building 7 on the GJO facility, were hauled to DOE's Cheney Disposal Cell during 2001. Closeout reports were prepared for the footprints of the demolished buildings and the former location of the temporary stockpile area. The closeout reports contain verification statements by an independent verification contractor.

Uncontaminated Buildings 18 and 19 were demolished in 2001 under GJORAP. Building 18 had been released for unrestricted use in 1996 following remediation of underlying contaminated soil, and Building 19 had been released for unrestricted use in 1997 following a radiological release survey. A total of approximately 1,030 m^3 (1,350 yd^3) of uncontaminated debris from these buildings were hauled to the Mesa County Landfill in January and September 2001.

Although the structure of Building 12, which houses the GJO computer system, was remediated and released for unrestricted use, radiologically contaminated concrete and soil were left in place under the

building so that operations in Building 12 could continue. DOE–GJO submitted a request to the State of Colorado to defer remediation until after DOE–GJO ceases operations in the building. Building 20, the GJO Analytical Chemistry Laboratory, was approved by DOE–AL for release for unrestricted use following a release survey based on an approved derived concentration guideline level. Radiologically contaminated soil and debris were left in place under the southwest corner of the building so that laboratory operations could continue. DOE–GJO included this contamination in the *Request for Deferred Remediation* (DOE 2000c), which was filed in 2000 and approved in 2001.

3.3.2 Wetland Restoration and Monitoring

As required by Section 404 of the Clean Water Act, approximately 0.61 ha (1.5 acres) of wetland habitat, 3.0 ha (7.4 acres) of riparian habitat (1.3 ha [3.1 acres] of jurisdictional and 1.7 ha [4.2 acres] of nonjurisdictional), and 4.3 ha (10.7 acres) of upland (nonjurisdictional) habitat were revegetated in 1994 and 1995 (Figure 3–3). Special conditions of the Section 404 permit (No. 10040) required a 5-year monitoring program to evaluate the effectiveness of wetland revegetation, and stipulated that the U.S. Army Corps of Engineers (COE) would review the final results of the mitigation at the end of the monitoring period, and determine if the permit conditions were adequately met.

The DOE–GJO submitted an annual monitoring report to the U.S. Army Corps of Engineers each October from 1995 through 1999. Final review of the mitigation by the COE resulted in their request for the DOE–GJO to excavate soils from a barren portion of land within the southernmost wetlands area. The goal of the excavation was to increase the percentage of area permanently inundated by water and to decrease the alkali concentration in the soil. The DOE–GJO finalized its obligations under Permit 10040 by completing the wetlands area excavation in August 2000. Approximately 344 m^3 (450 yd^3) of soil were removed to a depth of approximately 12 inches. The wetlands area was contoured and the shoreline left irregular. The edges of the area will be inundated periodically as the water levels rise in spring, allowing wetlands and riparian vegetation to establish where there currently are none. The GJO did not perform any activities in the wetlands during 2001.

3.4 Waste Management

The GJO routinely generates small volumes of waste regulated under RCRA or TSCA, radioactive waste, and mixed waste contaminated with radioactivity and RCRA-regulated constituents. Occasionally, the GJO generates mixed waste contaminated with radioactivity and TSCA-regulated constituents. The GJO stores waste prior to shipment off site to commercially licensed treatment and disposal facilities. Programs, policies, and procedures are in place to minimize waste generation and manage wastes that cannot be minimized in compliance with applicable Federal and State regulations and DOE directives.

3.4.1 RCRA-Regulated and Mixed Waste Management

Hazardous and mixed wastes are generated primarily by the GJO Analytical Chemistry Laboratory and from co-mingled hazardous and residual radioactive material generated during site remediation. The GJO stores hazardous and mixed waste in satellite accumulation areas and in designated hazardous waste storage

areas, including commercially manufactured storage modules (Buildings 61A and 61C). Hazardous wastes are shipped off the site to commercial treatment and disposal facilities once or twice each calendar year, or as required by law. The GJO maintained a storage facility for storage of mixed waste; this facility was in Interim Status under RCRA during 2001. The Interim Status container storage unit, Building 61C, was closed on September 27, 2001, in accordance with 40 CFR Part 265, Subpart G, and the Interim Status permit was terminated.

The GJO has implemented strict characterization and segregation requirements (waste minimization efforts) to reduce the amount of waste classified and managed as hazardous or mixed. Administrative controls such as establishing Radioactive Materials Management Areas, limiting the use of materials, and surveying wastes for segregation as radioactive or nonradioactive further reduces the volume of LLW generated at the GJO.

In 2001, the GJO operated as a CESQG by generating less than 100 kg (220 lbs) per month and storing less than 1,000 kg (2,200 lbs) of hazardous waste. Despite its CESQG status, the GJO maintains all programs necessary to operate as a small or large quantity generator if needed. Such programs generally include increased personnel training and facility record keeping.

The GJO shipped various RCRA-regulated wastes for treatment and disposal at off-site facilities in 2001. These wastes were 820.20 kg (1808.20 lbs) of hazardous waste, 1724 feet of spent fluorescent tubes for mercury recovery, and 18.12 kg (40 lbs) of batteries for recycling; both waste streams are regulated as Universal Waste.

3.4.2 PCBs and Asbestos

Wastes containing asbestos and PCBs are generated during building maintenance, renovation, or demolition, and the GJO Analytical Chemistry Laboratory occasionally uses very small quantities of PCBs as reference standards for PCB testing. Although all PCB-containing transformers at the site were retrofilled in the late 1980s, many of the ballasts in older fluorescent light fixtures contain PCBs, and when these ballasts fail they become a waste regulated under TSCA.

As asbestos or PCB waste is generated, process knowledge or radiation surveys are used to determine whether the material is also contaminated with residual radioactive material and must be managed as a radioactive waste. At the GJO:

- Nonradioactive asbestos waste is disposed of in the Mesa County Landfill.
- All radioactive asbestos is disposed of in the Cheney Disposal Cell.
- Nonradioactive PCB wastes are shipped off site for treatment and disposal. Radiologically contaminated PCB wastes were stored on site because in 2001 awaiting commercial disposal at a facility fully permitted to accept radioactive PCB waste.

During 2001, the GJO generated approximately 13.0 m^3 (17.0 yd^3) of radiologically contaminated asbestos waste during demolition of Building 7A All of the Building 7A waste material was disposed at the Cheney Disposal Cell in July 2001.

In addition, the GJO generated approximately 12.2 m^3 (16.0 yd^3) of nonradioactive asbestos wastes during demolition of Building 18 in 2001, and disposed the total quantity at the county landfill in September 2001.

The GJO generated 928.26 kg (2046 lbs) of nonradioactive PCB wastes through 2001 and disposed of 916.25 kg (2020 lbs) total of these wastes in September 2001.

Typical radioactive PCB wastes generated by the GJO consist of soils from site cleanup, personal protective equipment that became contaminated during cleanup, and light fixtures and ballasts removed from contaminated buildings. The GJO generated 14.74 kg (32 lbs) of radioactive PCB waste in 2000, which was stored in compliance with TSCA.

In addition to PCB wastes regulated under TSCA, asbestos wastes, including some radiologically contaminated, were both generated, stored, and disposed in CY2001. Included in waste storage at the beginning of the year, were three 55-gallon drums (276 kg or 608 lbs) of radioactive asbestos waste generated in CY2000. This waste was generated as a result of a utility trench remediation project performed adjacent to Building 20 on the north side (Figure 1-2). The waste material consisted of pipe wrap debris, soil, and personal protective equipment (PPE). This waste was disposed at the DOE's Cheney Disposal Cell in July 2001.

3.4.3 Residual Radioactive Material

Residual radioactive material is defined by 40 CFR Part 192, Section 192.01, as "(1) Waste (which the Secretary determines to be radioactive) in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents of the ores; and (2) Other wastes (which the Secretary determines to be radioactive) at a processing site which relate to such processing, including any residual stock of unprocessed ores or low-grade materials." Because ores were once processed at the GJO, surface soils and many buildings at the site were contaminated with residual radioactive material. Therefore, during remediation of the GJO facility under the GJORAP, the GJO generates residual radioactive material in the form of excavated soil, facility demolition and remodeling debris, equipment, investigation-derived waste, and residue from laboratory analysis of residual radioactive material. The Cheney Disposal Cell, located approximately 17 miles from the GJO in Mesa County, Colorado, receives residual radioactive material from GJORAP activities.

Remediation in 2001 involved demolition of Buildings 7A and 62 and the associated fanhouse and electrical transformer pad; remediation of contaminated soil under the demolished buildings; removal of the radiologically contaminated debris stockpile located northwest of Building 7; and remediation of contaminated soil under the stockpile area. Demolition debris, remediated soil, and stockpiled materials totaling approximately 3,060 m^3 (4,000 yd^3) was disposed at the Cheney Disposal Cell in June and July 2001.

3.4.4 Low-Level Waste Management

Radioactive wastes that are clearly not residual radioactive material do not qualify for disposal at the Cheney Disposal Cell and must be managed as LLW in compliance with DOE Order 435.1, *Radioactive Waste Management*. The GJO generates LLW from the analysis of environmental samples received from other DOE sites. Typical LLW includes soil sample residues; excess sample materials; contaminated sand derived from the cleaning of sample grinders and blenders; Sample Plant fines; laboratory debris such as planchettes, filters, latex gloves, paper wipes, and glassware; and resins used for radionuclide separation. Occasionally, the GJO generates LLW as fluids from decontamination of treatability study equipment and excess sealed radioactive sources.

The GJO has implemented strict radiological characterization and segregation requirements (waste minimization efforts) to reduce the amount of waste classified and managed as LLW (DOE 1995c). Administrative controls such as the establishment of Radioactive Materials Management Areas, limiting the use of materials in those areas, and surveying wastes for segregation as contaminated or noncontaminated further reduces the volume of LLW.

The GJO generated approximately 397 kg (873 lbs) of LLW in CY2001. The GJO shipped 880 kg (1936 lbs) of LLW for treatment and disposal at off site facilities in June 2001. This LLW had been generated since the previous LLW shipment (March 2000). The LLW generated in 2001 (as of November 21, 2001) is currently being stored on-site. Additionally in storage, is a 55-gallon drum (105 kg) with LLW generated in previous years which could not be shipped off site in June 2001 due to the presence of an isotope, Polonium 209, which was not accepted by the disposal facility. A total of 502 kg (1,104 lbs) is currently managed on-site in waste storage (Building 61D on Figure 1-2). LLW is stored in a separate dedicated building to minimize exposure to workers and to isolate the materials from the environment.

3.5 Pollution Prevention

As indicated, the GJO generates small amounts of hazardous and radioactive waste. Although the potential volume of waste reduced is small, the GJO actively incorporates pollution prevention as part of a larger goal of prudent environmental management. Wastes generated from GJO operations are reduced at the source wherever technically and economically feasible. Recycling options are explored for wastes that cannot be prevented though source reduction. Treatment options are considered for wastes that cannot be prevented or recycled. Disposal is the final option after all other avenues have been considered.

3.5.1 Source Reduction

Source reduction at the GJO is achieved primarily through material substitution and waste segregation. Substitution involves replacing a hazardous material with a less hazardous or nonhazardous material. Examples include replacing hazardous solvents and scintillation fluids with nonhazardous substitutes. However, the GJO uses relatively few hazardous materials, most of which are required for laboratory analytical procedures, and thus the potential for reduction through substitution is small. Waste segregation involves separating hazardous from nonhazardous materials, and separating radiologically contaminated materials from noncontaminated materials. Examples include use of Radioactive Materials Management

Area principles to keep materials from becoming radiologically contaminated, and use of radiological surveys to segregate radioactive from nonradioactive waste.

The GJO actively attempts to reduce wasteful practices and to replace inefficient equipment. For example, as older, less efficient fluorescent light tubes and fixtures fail, they are replaced with newer, more energy-efficient ones, many of which have automatic shutoff switches. Employees are encouraged to use their computers to reduce the amount of paper waste, and many manuals and administrative documents are available on-line rather than as paper copies.

During calendar year 2001, the GJO replaced all fluorescent light ballasts that could contain PCBs in the capacitor or potting mixture. Although this effort created a one-time increase in the amount of TSCA-regulated waste generated, it is hoped that the result will be a decrease in overall TSCA-regulated waste generated by the site through avoidance of future PCB spills.

3.5.2 Reuse and Recycling

The GJO generates several types of hazardous and nonhazardous waste on a regular basis that are suitable for recycling or reuse. These materials include spent fluorescent tubes, spent batteries, scrap metal, office paper, cardboard, aluminum cans, and lead.

Normal operations such as replacing batteries in electric vehicles and radios generate spent batteries at the GJO. The site routinely recharges nickel-cadmium (NiCad) batteries, and then reconditions the batteries to increase the number of possible recharges. NiCad batteries are sent to a recycling facility when the batteries can no longer be recharged. Lead-acid batteries from vehicles are sent to a local recycler. The GJO sent approximately 480 kilograms of lead-acid batteries to the local recycler in 2001.

The GJO generates used oil from equipment maintenance and ships the used oil to an appropriate processing, re-refining, or burning facility on a regular basis. The GJO generated less than 208 liters (55 gallons) of used oil in 2001; this oil was recycled through a local company.

The GJO regularly recycles office paper, cardboard, glass, plastics, magazines, and newspaper through a local recycling service. In 2001, the site recycled over 38,000 kg (83,700 lbs) of these materials. The GJO shipped spent fluorescent tubes to the local landfill, which sends the tubes for recycling.

Many materials at GJO are not wastes because they are still usable without reprocessing. These materials include office furniture, construction materials, paints and solvents, and lead bricks used for shielding. In Calendar Year 2001, the GJO transferred 50 kilograms (110 lbs) of sodium iodide detectors to a local vendor for reuse rather than disposing of them as hazardous waste; as other sodium iodide detectors become excess to GJO needs they will be also be transferred to the local vendor. The GJO also transferred over 6,660 items of personal protective equipment to local emergency response organizations, such as the local police and fire departments.

3.5.3 Affirmative Procurement

The GJO purchases materials with recycled content whenever practical. These efforts are coordinated under the Contracts and Procurement group as part of their affirmative procurement program. The affirmative procurement program favors the acquisition of environmentally preferable and energy-efficient products and services.

The Contracts and Procurement group routinely adds language to contracts that specifies a preference for the use of recycled or otherwise recovered materials and removes language that prohibits the use of recycled materials.

Purchase orders for hazardous materials not already used at the GJO are reviewed before commitment of funds. This review allows the GJO to track hazardous materials kept on site, and includes a discussion with the requestor to determine whether alternate compounds or materials could be substituted for the hazardous materials and could thus reduce or eliminate the generation of hazardous waste.

3.6 Sediment Characterization

Sediment sampling was conducted in the North and South Ponds, the wetland area, and the river upstream of GJO between August 20 and 30, 2001, to determine whether concentrations of milling-related contaminants are within regulatory standards or risk thresholds. Because of their fine-grained nature and high organic content, sediments that have accumulated since GJO soil remediation have the potential to adsorb and retain contaminants. This sampling event gives a more complete characterization of sediment composition at the GJO site than the previous limited sampling.

Thirty-nine samples were collected from 15 locations at the South Pond, North Pond, wetland, and Gunnison River upstream of the GJO on August 20, 21, and 30, 2001. Complete acid digestion was conducted on the unfiltered samples using a microwave digestion protocol based on EPA Manual SW-846, Method 3051. To determine the influence of site water contaminants on the sediment, the average analyte values obtained from the background samples up stream of the site were compared to on-site results. Theoretically, the difference would be attributable to GJO site contamination. Any soil minerals that contribute to the analyte concentrations should be indicated by the background samples.

Sediment samples were analyzed for gross alpha, gross beta, arsenic, chloride, total chromium, iron, magnesium, manganese, molybdenum, nitrate, selenium, sulfate, total uranium, and isotopic uranium. These constituents are present in elevated concentrations in surface water or ground water and/or pose potential ecological or human health risks.

Sediment sampling locations are provided on Figure 3-4. Radiochemical analytical results of the sediment sampling and analysis that was performed in CY2001 are presented in Section 4.5. and nonradiological analytical results are presented in Section 5.4.

4.0 Environmental Radiological Program Information

Environmental radiological monitoring programs at the GJO facility include sampling and estimation of air emissions, surface water, and ground water. Detailed descriptions of the monitoring programs, except ground water, were provided in Section 3.0. Results of air emissions and surface water monitoring are described in this section, and the ground water program description and monitoring results are described in Section 6.0. Assumptions are described and radiological dose estimates are presented, along with details on the specific models used in performing calculations, where appropriate.

All radiological air emissions and releases from the GJO in 2001 were within the limits provided in NESHAP, 40 CFR Part 61, Subpart H; and DOE Order 5400.5. Air-emission dose assessments and comparison to applicable Federal and DOE standards are provided in Section 4.2. A comparison of radionuclide concentrations in surface water to applicable DOE orders and State standards is provided in Sections 4.4. No unplanned releases of radioactivity occurred at the GJO in 2001.

4.1 Radiological Air Emissions

Three types of radiological air emissions were monitored or estimated on the GJO facility in 2001: point source radioparticulates, nonpoint source radioparticulates, and radon. The radionuclides and annual release rates for each type of radiological air emission are provided in the following sections.

4.1.1 Point Source Radionuclides

The radionuclides that contributed to more than 10 percent of the 2001 potential effective dose equivalent (EDE) from the monitored release point are presented in Table 4–1. Radiological emissions from both the GJO Analytical Chemistry Laboratory and the Sample Plant were estimated according to guidelines in 40 CFR Part 61, Appendix D. As mentioned in Section 3.1.2, radiological emissions from the Sample Plant are typically directly monitored using an isokinetic sampler. A problem resulting from the relocation of the Sample Plant (isokinetic sampling conditions were breached) necessitated the use of Appendix D estimates with the approval of EPA. Release rates, provided in curies per year (Ci/yr) and bequerels per year (Bq/yr), represent the summed release rates of these radionuclides from all point sources (the Analytical Chemistry Laboratory and the Sample Plant). Total uranium in grams is provided, as calculated from the uranium-238 activity. The half-life for each isotope is also reported.

The GJO point source emission data are entered into the EPA-approved dose assessment model, CAP88PC, to estimate the off-site dose from these radioparticulate emissions. Point source dose modeling results are provided in Section 4.2.

Table 4–1. GJO Point Source Radionuclides and Annual Release Rates

Radioisotope	Release Rate Ci/yr[a]	Bq/yr	Half-life (yr)
Uranium-238	7.13e-09	2.64e+02	4.47×10^{9}
Thorium-234	6.32e-09	2.34e+02	0.066
Protactinium-234	6.32e-09	2.34e+02	2.23×10^{-6}
Uranium-234	7.05e-09	2.61e+02	2.45×10^{5}
Thorium-230	1.83e-09	6.77e+01	7.54×10^{4}
Radium-226	1.07e-08	3.96e-02	1.60×10^{3}
Polonium-218	1.07e-08	3.96e-02	5.92×10^{-6}
Lead-214	1.38e-09	5.11e-01	5.10×10^{-5}
Lead-210	1.30e-09	4.81e-01	22.3
Polonium-210	1.31e-09	4.85e-01	0.379

[a] $1\ Ci = 3.70 \times 10^{10}\ Bq$

4.1.2 Nonpoint Source Radionuclides

Fugitive particulate emissions from soil removal and transfer activities in 2001 were estimated using the methods described or established in EPA Publication AP-42, "Compilation of Air Pollutant Emission Factors," and current industry practice.

Emissions were calculated for excavation and drop operations separately and summed to yield the total mass of fugitive emissions. The total mass of fugitive emissions was converted to individual radionuclide source strength using an activity-per-unit-mass value for each radionuclide. Analytical results for specific isotope activities in the soil material (total uranium, radium-226, and thorium-230) were used to calculate the activities of other decay series radionuclides present in the soil. The radionuclides released from these operations and estimated total emission levels during 2001 are presented in Table 4–2. Release rates represent the total emission level in curies per year and bequerels per year for these radionuclides from all nonpoint sources. Total uranium in grams is calculated from the uranium-238 activity. The half-life for each isotope is also reported.

The GJO nonpoint source emission data listed in Table 4–2 were entered into the EPA-approved dose assessment model, CAP88PC, to estimate the off-site dose from these radioparticulate emissions. Nonpoint source dose modeling results are provided in Section 4.2.

4.1.3 Atmospheric Radon

Atmospheric radon was estimated from selected radon flux measurements from the Calibration Test Pits. The nonpoint radon-emission release rate from the GJO was 0.22 Ci/yr. There were no point source radon emissions during 2001.

Table 4–2. GJO Nonpoint Source Radionuclides and Annual Release Rates

Radioisotope	Release Rate Ci/yr[a]	Bq/yr	grams/yr	Half-life (yr)
Actinium-227	2.77e-08	1.03e+03	–	21.8
Actinium-228	5.69e-09	2.11e+02	–	6.99×10^{-4}
Bismuth-210	5.87e-07	2.17e+04	–	0.0137
Bismuth-211	2.77e-08	1.03e+03	–	4.07×10^{-6}
Bismuth-214	5.90e-07	2.18e+04	–	3.79×10^{-5}
Lead-210	5.87e-07	2.17e+04	–	22.3
Lead-211	2.77e-08	1.03e+03	–	6.87×10^{-5}
Lead-214	5.90e-07	2.18e+04	–	5.10×10^{-5}
Polonium-210	5.87e-07	2.17e+04	-	0.379
Polonium-214	5.90e-07	2.18e+04	–	5.19×10^{-12}
Polonium-215	2.77e-08	1.03e+03	–	5.64×10^{-11}
Polonium-218	5.90e-07	2.18e+04	–	5.92×10^{-6}
Protactinium-231	2.77e-08	1.03e+03	–	3.28×10^{4}
Protactinium-234m	4.54e-07	1.68e+04	–	2.23×10^{-6}
Radium-223	2.77e-08	1.03e+03	–	0.0313
Radium-226	5.90e-07	2.18e+04	–	1.60×10^{3}
Radium-228	5.69e-09	2.11e+02	–	5.75
Thallium-207	2.77e-08	1.03e+03	–	9.08×10^{-6}
Thorium-227	2.77e-08	1.03e+03	–	0.0513
Thorium-228	5.69e-09	2.11e+02	–	1.913
Thorium-230	5.35e-07	1.98e+04	–	7.54×10^{4}
Thorium-231	2.14e-08	7.92e+02	–	2.91×10^{-3}
Thorium-232	6.25e-09	2.31e+02	–	1.405×10^{10}
Thorium-234	4.54e-07	1.68e+04	–	0.066
Uranium-234	4.58e-07	1.70e+04	–	2.45×10^{5}
Uranium-235	2.14e-08	7.92e+02	–	7.04×10^{8}
Uranium-238	4.54e-07	1.68e+04	–	4.47×10^{9}
Uranium (total)	–	–	1.35	–

[a] 1 Ci = 3.70×10^{10} Bq

4.2 Radiological Dose Modeling

Off-site dose modeling of the 2001 GJO radioactive air emissions was conducted to evaluate compliance with NESHAP, 40 CFR Part 61, Subpart H; and DOE Order 5400.5. Both regulations establish a "maximally exposed individual" (MEI) dose limit of 10 mrem/yr for exposure to airborne radioparticulate emissions (excluding radon) from DOE facilities. DOE Order 5400.5 requires that the effective dose equivalent (EDE) to the public from all sources of radiation (including radon) not exceed

100 mrem/yr, and requires calculation of a collective population dose (dose to residents within an 80-kilometer radius of the facility). The collective population dose includes the radon source term, when present. The DOE orders do not provide a standard of comparison for the collective population dose.

The CAP88PC model was used to calculate the EDE for the MEI from all point and nonpoint sources. The EDE represents potential doses rather than actual doses because these doses were calculated rather than measured. During 2001, several small businesses leased buildings on the DOE–GJO facility. The MEI was identified as the on-site member of the public that received the largest dose contributed by all DOE–GJO sources of radionuclide emissions during CY 2001. The EDE for the MEI was calculated by summing the dose contribution from all sources at this location.

User-supplied variables to the CAP88 PC model include the distance for individual assessment, source radionuclides and annual release rates, height and diameter of the exhaust stack, plume rise type, annual ambient temperature, annual precipitation, wind data, and atmospheric lid height. Meteorological data were collected on site. According to the U.S. Census Bureau figures for 2000, the population within 80 kilometers (50 miles) of the GJO was 149,788. Population centers in the assessment area include Cedaredge, Clifton, Collbran, DeBeque, Delta, Fruita, Gateway, Grand Junction, Mesa, Olathe, Palisade, and Whitewater.

4.2.1 Point Source Dose Assessments

The EDEs for the GJO point source radiological air emissions in units of millirem per year and millisieverts per year (mSv/yr) are presented in Table 4–3. Modeling determined that the MEI in CY2001 was a business leasing space in Building 7 with an EDE of 1.18e-05 mrem/yr from all point source radioparticulate emissions. Calculation of this nonradon EDE to the maximally exposed individual resulted in a value that is more than 800,000 times below the DOE and EPA standard of 10 mrem/yr.

There were no point source radon emissions during 2001; therefore, the public EDE, which is derived by summing the individual point source EDEs calculated for radioparticulates and radon, is the same as the EDE for radioparticulates alone.

Table 4–3. Effective Dose Equivalent Attributable to Point Source Airborne Radiological Emissions From the GJO Facility During 2001

EDE Type	Standard	Effective Dose Equivalent
EDE from Airborne Radioparticulates	10 mrem/yr [a]	1.18e-05 mrem/yr or 1.18e-07 mSv/yr [b]
Public EDE	100 mrem/yr [c]	1.18e-05 mrem/yr or 1.18e-07 mSv/yr
Collective Population Dose	No Standard	1.48e-05 person-rem/yr or 1.48e-07 person-Sv/yr [d]

[a] DOE and EPA standard (40 CFR 61.92); excludes radon
[b] 1 mrem/yr = 0.01 mSv/yr
[c] DOE standard, includes radon
[d] 1 person-rem/yr = 0.01 person-Sv/yr

4.2.2 Nonpoint Source Dose Assessments

The EDEs for the GJO nonpoint source radiological air emissions are presented in Table 4–4. Modeling determined that the MEI in CY2001 was a business leasing space in Building 7 with an EDE of 4.73e-02 mrem/yr from all non-point source radioparticulate emissions. Calculation of the nonradon EDE to the maximally exposed individual resulted in a value that is almost 200 times below the DOE and EPA standard of 10 mrem/yr. The public EDE includes the radon source term and was derived by summing the individual nonpoint source EDEs calculated for radioparticulates and radon. The resulting total EDE is more than 1,200 times below the DOE standard of 100 mrem/yr.

Table 4–4. Effective Dose Equivalent Attributable to Nonpoint Source Airborne Radiological Emissions From the GJO Facility During 2000

EDE Type	Standard	Effective Dose Equivalent
EDE from Airborne Radioparticulates	10 mrem/yr [a]	4.73e-02 mrem/yr or 4.73e-04 mSv/yr [b]
Public EDE (including radon)	100 mrem/yr [c]	8.01e-02 mrem/yr or 8.01e-04 mSv/yr
Collective Population Dose (including radon)	No Standard	6.39e-03 person-rem/yr or 6.39e-05 person-Sv/yr [d]

[a] DOE and EPA standard (40 CFR 61.92); excludes radon
[b] 1 mrem/yr = 0.01 mSv/yr
[c] DOE standard, includes radon
[d] 1 person-rem/yr = 0.01 person-Sv/yr

4.3 Radiological Sewer Effluent

The GJO sewer effluent was last monitored for radioactive constituents during the first quarter of 2000. This sampling was conducted to demonstrate compliance with the standards and requirements established by DOE Orders 5400.1 and 5400.5. In March 2000, based on historical data, the DOE–GJO facility received approval from the Albuquerque Operations Office to discontinue this monitoring; therefore, no monitoring of the sewer effluent for radioactive constituents was conducted after March 2000 (DOE 2000g). Additional information is provided in Section 3.2.1. Historical sewer effluent data can be found in each of the previous Annual Site Environmental Reports from 1982 through 2000.

4.4 Surface Water

4.4.1 Gunnison River

Radionuclide concentrations in samples collected from the Gunnison River in 2001 were below applicable standards in the CDPHE WQCC's Regulations No. 31 and 35 (surface water quality standards. Historical and 2001 maximum radionuclide concentrations in the Gunnison River are presented and compared with applicable surface water quality standards in Section 5.3, Table 5–3. Table A–2 in Appendix A presents the Gunnison River surface water sampling results for 2001.

Total uranium concentrations in 2001 were relatively constant in the Gunnison River samples with respect to sampling location. All results reported for total uranium were well below the 40 pCi/L standard (Section 5.3, Table 5–3). No significant increase or decrease in total uranium concentration was observed when the analytical results of upstream samples were compared to results from downstream samples.

Following remediation (early 1990s), locations on the Gunnison River, both upstream, adjacent to the site, and downstream were reported generally between 5 and 10 pCi/L total uranium – well below the standard of 40 pCi/L. Figure 1 in Appendix B shows measured total uranium concentrations from January 1989 through June 2000. Table A-1 in Appendix A shows the total uranium reported for the downstream location (Lower Gunnison) and the location adjacent to the site (Upper Mid-Gunnison) in CY2001.

The remaining two river locations monitored historically, the upstream location (Upper Gunnison) and another location adjacent to the site (Middle Gunnison), were discontinued for monitoring as determined by an evaluation performed under the LTSM Program, the current program overseeing GJO ground water and surface water monitoring following the site transition from government to private ownership.

As a result of the LTSM evaluation, Ra-226 + 228 was removed from the analyte list as it was consistently below the standard of 5 pCi/L. Uranium was designated as the principle radiological constituent of concern (COC) because, as a conservative species, it is more representative of current migration of site-related contaminants in ground water in the alluvial aquifer, which is in direct communication with surface water at the site. The Gunnison River surface water concentrations of uranium will continue to be monitored for changes that may result from passive remediation (natural flushing) of ground water at the GJO facility.

The Gunnison River surface water samples were also analyzed for gross alpha and gross beta activity. Although no surface water quality standards currently exist for these constituents, analytical results indicate that gross alpha and gross beta activities were near or below detection limits.

4.4.2 North Pond, South Pond, and the Wetland Area

Water in the North Pond, South Pond, and the Wetland Area is recharged by the shallow alluvial aquifer underlying the facility and shows the same radiological characteristics as the aquifer. Table A–2 in Appendix A presents the North Pond, South Pond, and the Wetland Area surface water sampling results for 2001. The surface water quality standard used for the Gunnison River samples (40 picocuries per liter [pCi/L]) (58 micrograms per liter [µg/L]) was used to evaluate total uranium concentrations in samples from the North Pond, South Pond, and the Wetland Area. Concentrations of total uranium in all samples from the site surface water locations (i.e., the North Pond, South Pond, and the Wetland Area) exceeded the Gunnison River standard in 2001 (Table 5–4, Section 5.3). The maximum total uranium concentration (1216 pCi/L [1770 µg/L]) was detected in the January 2001 sample from the Wetland Area. Uranium concentrations in the North Pond, South Pond, and Wetland Area samples are presented and compared with the applicable surface water quality standard in Section 5.3, Table 5–4.

Figures 2, 3, and 4 in Appendix B show measured total uranium concentrations in the Wetland Area, North Pond, and South Pond sample locations, respectively.

The North Pond, South Pond, and Wetland Area samples were also analyzed for gross alpha and gross beta. Although gross alpha and gross beta activities in these samples were above instrument detection limits, no surface water quality standards currently exist for these constituents for comparison.

An estimate of changes in on-site surface water quality resulting from remedial action would be premature; only ten surface water-sampling rounds have been conducted since remediation of open-land areas was completed in June 1994. Surface water remediation is expected to mirror ground water remediation because the on-site surface water sources are recharged by alluvial ground water. Surface water quality should improve over time as passive remediation (natural flushing) of the alluvial aquifer continues. Ground water modeling of the alluvial aquifer predicts that ground water and water in the on-site ponds will be remediated to below applicable standards within 50 to 80 years after mill tailings removal. This 50- to 80-year period is within the 100-year cleanup period required under UMTRCA ground water regulations (40 CFR 192) as indicated in the GJORAP Record of Decision (DOE 1990).

4.5 Sediment

Analytical results are summarized in Table 4-5 and screening criteria are described in Table 4-6. The three background samples were averaged to compare to the site samples. All of the analytes had concentrations above background in at least a few of the samples, but those of potential concern when compared to sediment screening criteria are arsenic, manganese, molybdenum, and selenium. Those that are very high, but have no screening criteria for sediment, are chloride, gross alpha, gross beta, sulfate, uranium, and vanadium. Overall, the North Pond had the highest levels of contaminants, the Wetland Area had the next highest, and the South Pond had the lowest levels. Radiochemical results are discussed below in this section, whereas, nonradiological results are presented in Section 5.4.

Of the analytes found in concentrations elevated above background, uranium is the only one that has any regulatory constraints. Uranium guidelines were established for soils for the GJO remedial action, and can lend some context to the sediment results. Background levels average 1.01 mg/kg, while concentrations on the site range from 4.2 to 128 mg/kg. The GJORAP standard of 106 picocuries per gram (pCi/g) converts to 150 mg/kg, which compares favorably to the sediment results. Uranium is one of the most mobile of the mill-related constituents, contributing to its ubiquitous appearance in site samples, from soils to water. In the context of ecological risk, there are no guidelines for sediment uranium concentrations.

Table 4-5. Sediment Sampling Analytical Results

Sample No	RU-1	RU-2	RU-3	SP-1	SP-2	SP-3	SP-4	SP-5	NP-1	NP-2	NP-3	NP-4	W-1	W-2	W-3	W-4
%solids	0.877	0.723	0.6	0.711	0.679	0.774	0.781	0.726	0.503	0.716	0.69	0.437	0.871	0.826	0.826	0.832
As	5.5	4.8	8	8.3	9.3	10.8	10	9.5	19.9	11.9	12.3	16.2	10.3	7.3	8.1	7.5
Cl	5.1	4.6	6	58	72.2	114.2	102.4	56.9	1107	565	1383	828	1871	448	395	1418
Cr	7.2	6.5	9.5	8.3	11	8	7.8	7.2	10.7	10.3	3.8	7.1	22.4	12.8	21.1	11.8
Gr A	5.8	7.5	12.2	13.1	19.6	13.3	19.1	13.6	40.2	14.9	30	55.6	6.6	15.9	10.8	10.4
Gr B	16.2	14	21.5	25.2	27.8	22.9	22.8	23	42.4	28.9	35.5	66.1	18.1	24.2	20.3	22
Fe	11,700	9,654	13,700	10,408	12,842	10,013	9,936	10,358	15,288	18,017	8,246	11,648	17,222	13,801	16,223	
	12,860	11,913														
Mg	5,089	4,398	7,467	5,021	8,588	5,271	4,904	5,358	7,932	6,006	3,971	5,561	9,265	6,574	7,736	9,099
Mn	345	293	472	278	330	261	210	264	1064	501	480	1062	285	291	259	364
Mo	0.5	0.43	0.5	3.8	5.5	3.4	2.6	3.3	5.4	1.7	7.4	15.3	2.6	4.4	4.4	6.7
NO_3	0.4	0.43	0.52	1.3	1	0.81	0.9	0.4	1.6	1	0.9	0.9	1	0.9	2.5	3.1
Se	1.9	1.94	2.83	1.1	2.1	1.7	1.5	1.8	14.5	3.6	8.1	16	1.3	1.8	2.2	1.9
SO_3	1,294	279	358	6,315	9E+05	18,346	18,694	8,870	8,608	5,391	11,696	7,323	22,044	6,320	15,617	
	28,004	14,031														
U	1	0.83	1.2	17	24.3	11.8	10.6	16.5	79.1	20.8	75.8	128	3.9	6.8	4.2	23.2
V	19.5	14.7	20.5	30	39.9	27.4	27.9	28.6	84.3	43.3	22.6	118	60.8	42.5	71.8	38.2

These results show that there has been some influence of site contamination on the sediments. However, the only analytes with ecorisk-significant concentrations are arsenic, manganese, molybdenum, selenium, and vanadium (Section 5.4).

Table 4-6. Screening Criteria for Sediment Sampling Analysis

Constituent	Background	Range, mg/kg	Screening Criteria
As	6.1	7.3–19.9	5.9
Cl	5.2	58–1,388	NA
Cr	7.7	3.8–22.4	36.3
Gr A	8.5	6.6–55.6	NA
Gr B	17.2	20.3–66.1	NA
Fe	11,685	8,246–17,222	18,840
Mg	5,651	3,971–9,617	NA
Mn	370	210–1,064	614.7
Mo	0.48	1.7–15.3	0.17
NO_3	0.45	0.81–3.1	NA
Se	2.22	1.1–14.5	5
SO_3	644	5,391–28,000	NA
U	1.01	4.2–128.0	150
V	18.2	22.6–118.0	36,930

5.0 Environmental Nonradiological Program Information

The GJO monitors and estimates nonradiological air emissions from the Analytical Chemistry Laboratory and samples nonradiological analytes in the GJO groundwater and surface water. Results of nonradiological air emissions monitoring and surface water sample analyses are presented in this section. Results for both nonradiological and radiological ground water monitoring are presented in Section 6.0. There were no releases of nonpermitted hazardous substances or other unplanned releases at the GJO in 2001.

5.1 Nonradiological Air Emissions

An assessment of nonradiological air emissions at the GJO facility includes monitoring of opacity if required, annual chemical consumption, and annual quantity of soil processed by the GJO Sample Preparation Laboratory.

No observations of visible emissions (opacity) from facility stationary sources were required in 2001.

5.1.1 Permitted Releases

The annual record of chemical consumption by the Analytical Chemistry Laboratory, required by Air Emission Permit No. 90ME402–1, is summarized in Table 5–1. Chemical consumption was calculated from 2001 purchase records, in combination with inventory quantities. The annual quantity of soil processed by the Sample Plant was 0.113 metric tons (0.124 short tons), which is 0.19 percent of the permitted annual quantity of 60 metric tons (66 short tons) stated in the APEN/permit exemption. The records of chemical consumption and quantity of soil processed demonstrate that no limits were exceeded in 2001.

Table 5–1. Annual Record of Chemical Consumption by the Analytical Chemistry Laboratory

Chemical	Permitted Annual Consumption	Annual Consumption	Percent of Permitted Annual Consumption
Acids	900 gallons (3,407 liters)	158.4 gal. (599.5 L)	17.6
Volatile Organic Compounds	2,000 gallons (7,571 liters)	38.7 gal. (146.5 L)	2
Benzene	13 gallons (49 liters)	-0-	-0-

5.2 Nonradiological Sewer Effluent

Sampling of the sewer effluent was last sampled in March of 2000, after which time it was discontinued. (DOE 2000f). As stated in Section 3.2.1 (in greater detail): “In accordance with the regulatory provisions of the Industrial Pretreatment Program, and with the City of Grand Junction's approval, the DOE–GJO did

not renew its Industrial Pretreatment Permit after it expired in June 1999 (DOE 2001b and Tonello 2001)." Additional information is provided in Section 3.2.1.

5.3 Nonradiological Surface Water Sampling and Analysis

5.3.1 Gunnison River

Nonradiological analyte concentrations in samples from the Gunnison River in 2001, with the exception of manganese, were below or within acceptable ranges of applicable State standards.

Historical and 2001 maximum analyte concentrations in the Gunnison River are presented and compared with current applicable State standards in Table 5–3. Several constituents (Ra-226, barium, calcium, cadmium, potassium, sodium, and lead) measured in 2000 were not measured in 2001 due to changes made to the suite of analysis by the LTSM Program as a result of the ground water and surface water evaluation performed. This was because either the standards were not exceeded historically or a relationship could not be established between alluvial ground water contamination and concentrations in the Gunnison River, or they were determined to be the constituents that will provide the information necessary to evaluate the progress of the natural flushing of the ground water in the alluvial aquifer, which is in direct communication with the river.

Table A–1 in Appendix A presents the Gunnison River surface water sampling results for 2001. That table contains analytical results for several constituents that are not presented in Table 5–3 because no surface water quality standards currently exist for these constituents.

Manganese was the only constituent reported in samples collected from the Gunnison River in 2001 to have exceeded a surface water standard. The Lower Gunnison location was reported at 79 µg/L, slightly above the standard of 50 µg/L. This also is only the second time since 1993, when the majority of the remediation was completed by, that manganese was reported to have exceeded the standard at this location. A time-concentration graph for this location and constituent is presented in Appendix B, Figure 6. For comparison, the upgradient location (i.e., Upper Gunnison), is shown on Figure 5 in Appendix B also.

Nonradiological contaminants that exceeded the applicable groundwater standards in 2001 alluvial ground water samples (molybdenum, selenium, and total dissolved solids) were not present in concentrations above applicable surface water standards in Gunnison River samples (Note: Only selenium has a surface water standard). Surface water concentrations for these constituents will continue to be monitored for changes that may result from passive remediation (natural flushing) of ground water at the GJO facility.

Table 5-2. Comparison of State Surface-Water-Quality Standards to 2001 and Historical Maximum Concentrations in the Gunnison River[a,b]

Constituent	State Standard	2001 Maximum			Historical Maximum[c]		
		Up-Gradient	Adjacent to Site (Upper Mid Gunnison)	Down-Gradient (Lower Gunnison)	Up-Gradient	Adjacent to Site	Down-Gradient
Common Ions (mg/L)							
Chloride	250.0	-	9.04	12.2	12.4	12.6	80
Nitrate (as N)[d]	10.0	-	0.924	0.897	6	6	6
Sulfate	480	-	291	317	513	512	584
Field Measurements							
pH	6.5-9.0	-	8.3-8.3	8.29-8.29	7.20-9.04	7.29-9.19	7.33-9.01
Metals (mg/L)[e]							
Arsenic	0.05	-	0.00074	0.0007	0.011	0.0086	0.011
Chromium+6	0.011	-	<0.0013	<0.0013	0.0092	0.0123	0.0057
Iron	0.300	-	<0.0062	<0.003	0.44	0.1	0.32
Manganese	0.050	-	0.0388	0.079	0.2	0.0766	0.122
Selenium	0.008	-	0.0067	0.0066	0.0096	0.014	0.0148
Radiological (pCi/L)							
Uranium[f]	40	-	4.6029	7.8318	10.42	14.39	23.358

[a] CDPHE Water Quality Control Commission surface water standards; Regulation No. 31 and 35, effective March 2, 1999 and January 30, 1999, respectively.

[b] "-" indicates no data available; "<" indicates that the maximum concentration was below the detection limit (number shown is detection limit).

[c] Based on maximum concentrations observed from 1980 through 2000.

[d] Nitrate (as N) was derived for measured nitrate using the conversion $N = NO_3 \div 4.427$.

[e] All values given are for dissolved constituents.

[f] Uranium concentrations that were measured in milligrams per liter were converted to picocuries per liter for comparison. The conversion assumes isotopic equilibrium and an activity of 0.687 pCi/µg.

5.3.2 North Pond, South Pond, and the Wetland Area

The North Pond, South Pond, and Wetland Area contain elevated quantities of some chemical constituents typically associated with uranium mill tailings (e.g., manganese, molybdenum, and sulfate). In 2001, however, only molybdenum and sulfate were reported elevated; these were elevated primarily in the Wetlands Area and to a lesser degree in the North and South Ponds. As with the radionuclides, Gunnison River surface water quality standards were used to evaluate measured concentrations of nonradiological analytes in the North Pond, South Pond, and Wetland Area. Table A–2 in Appendix A presents the 2001 sampling results for these surface water analytes.

Chloride, pH, and sulfate concentrations in samples collected from the North Pond, South Pond, and Wetland Area in 2001 exceeded surface water quality standards for those analytes in a least one location. Arsenic was not reported above the standard at any location, as it had been from the Wetlands Area in CY2000. Table 5–4 compares 2001 maximum concentrations for these constituents (along with uranium) in samples from these surface water areas with applicable State standards. Figures 2 through 4, 8 through

10, 12, and 14 in Appendix B show time-concentration plots for uranium, sulfate, chloride, and pH, respectively. The Upper Gunnison River data for these constituents are also provided in Appendix B for comparison. Future sampling of the North Pond, South Pond and Wetlands area will continue to monitor these constituents.

Table 5–3. Comparison of 2001 Maximum Chloride, pH, Sulfate and Uranium Concentrations in Samples from the North Pond, South Pond, and Wetland Area with State Standards

Constituent	State Standard	North Pond	South Pond	Wetland Area
Chloride	250 mg/L	242	115	3,010
Ph	6.5–9.0	8.62	8.80	9.56
Sulfate	480 mg/L	1630	1,500	34,700
Uranium	40 pCi/L	78	179	1216

5.4 Nonradiological Sediment Sampling and Analysis

Analytical results are summarized in Table 4-5. The three background samples were averaged to compare to the site samples. All of the analytes had concentrations above background in at least a few of the samples, but those of potential concern when compared to sediment screening criteria are arsenic, manganese, molybdenum, and selenium. Those that are very high (but that have no screening criteria for sediment) are chloride, gross alpha, gross beta, sulfate, uranium, and vanadium. Overall, the North Pond had the highest levels of contaminants, the Wetland Area had the next highest, and the South Pond had the lowest levels.

5.4.1 Arsenic

The average background concentration for arsenic in river sediments was 6.1 milligrams per kilogram (mg/kg), and the site levels ranged from 7.3 to 19.9 mg/kg. Arsenic is a uranium mill-related contaminant, but is also naturally occurring in area soils, giving it a high background level. Sediment threshold effect concentrations (TEL) are 5.9 mg/kg (NOAA 1999). It is not a highly mobile contaminant, and tends to be bound in the non-soluble phase of the aquifer, which contributes to its appearance in all of the samples. Arsenic is also elevated in some ground and surface water locations at the GJO site.

5.4.2 Manganese

Manganese is elevated above background levels only in the North Pond samples. Background concentrations average 370 mg/kg, and North Pond concentrations are 480 to 1,064 mg/kg. Sediment screening criteria show a TEL of 615 mg/kg of this constituent. Since background levels are slightly high for

this analyte, only two of the North Pond samples are of potential concern for ecological risk.

5.4.3 Molybdenum

Background samples had average molybdenum levels of 0.48 mg/kg, and site concentrations ranged from 1.7 to 15.3 mg/kg. This analyte is a mill-related contaminant that has typically been elevated in ground and surface water sampling, and was retained as an ecological contaminant of potential concern (E-COPC). The TEL of 0.17 mg/kg indicates that all of the site samples are of potential concern for this element.

5.4.4 Selenium

Selenium has an average background of 2.22 mg/kg, leaving only North Pond samples of potential concern, with levels of 3.6 to 16.0 mg/kg. The TEL criteria of 5.0 mg/kg
(Haines, et al. 1994) is applicable to three of the four North Pond samples. Selenium is another mill-related constituent that has historically been elevated in ground and surface water at the site, but is also typically high in the Gunnison River drainage due to selenic soils.

Other constituents that were significantly higher than background levels in at least a few of the samples include chloride, gross alpha, gross beta, nitrate, sulfate, and vanadium. None of these have any sediment screening criteria. For vanadium, the NOAA reference values indicate that 50 mg/kg is an average background concentration, and site concentrations range from 22.6 to 118 mg/kg (site background samples were 18.2 mg/kg). Only three of the site samples would fall above the NOAA background concentration guideline.

In conclusion, these results show that there has been some influence of site contamination on the sediments. The only analytes with ecorisk-significant concentrations are arsenic, manganese, molybdenum, selenium, and vanadium. For this reason, more detailed analyses should be conducted on those samples that exceed ecorisk guidelines by analyzing the bioavailable portion of the sediment. This can be done by leaching the samples with 5-percent nitric acid (HNO_3) before analysis, which will release only the adsorbed cations and some of the carbonate mineral phase of the sample.

All of the samples, including background, should be acid-leached by agitating them in acid for four hours, then filtering through a 0.45 micrometer (µm) filter before submitting to the lab for analyses. Table 5-4 lists the samples and the analytes recommended.

Table 5-4. Additional Sediment Analyses

Arsenic	All samples	Manganese	RU1,2,3; NP1, NP4
Molybdenum		Selenium	RU1,2,3; NP1, NP3, NP4
Vanadium			

After the additional analyses, results will be compared to existing ecorisk guidelines to determine whether any further precautions are warranted. Should the results be within the guidelines, existing institutional controls (DOE 2000d) will be adequate for protection of environmental and public health. Sampling should be conducted again in 5 years to assess changes over a longer term.

6.0 Ground Water Monitoring and Protection Program

Ground water in the alluvial aquifer beneath the GJO facility is contaminated from leached constituents of uranium mill tailings generated during milling operations. Uranium mill tailings removal from open-land areas on the facility began in late 1989, and most of the tailings and contaminated soil were removed from those areas by 1994. Modeling of the alluvial aquifer predicts that concentrations of ground water contaminants will be below applicable standards within 50 to 80 years after removal of the contaminant source (DOE 1990).

The objective of the ground water monitoring and protection program is to verify improvement in ground water quality and to verify the effectiveness of passive remediation (natural flushing) of the alluvial aquifer. This section characterizes the GJO hydrogeology, describes the 2001 ground water sampling and analysis activities, provides ground water analytical results, and interprets trends in ground water remediation to date. Responsibility for the ground water monitoring program was transferred to the LTSM Program in September 2000.

Several constituents (Ra-226, barium, calcium, cadmium, potassium, sodium, and lead) measured in 2000 were not measured in 2001 due to changes made to the analysis suite by the LTSM Program as a result of the ground water and surface water evaluation performed. This was because either the standards were not exceeded historically or a relationship could not be established between alluvial ground water contamination and concentrations in the Gunnison River, or they were determined to be the constituents that will provide the information necessary to evaluate the progress of the natural flushing of the ground water in the alluvial aquifer

6.1 Hydrogeology

Two hydrogeologic units are of importance at the GJO facility: the unconsolidated alluvial aquifer along the Gunnison River and the underlying Morrison Formation aquitard. These two units and the Gunnison River itself influence ground water flow and discharge into the river.

The alluvial aquifer consists of two facies: a poorly sorted, unconsolidated basal gravel unit with a silt and sand matrix and an overlying unit of silty sand (Figure 6–1). Drill-hole logs from 1984 well installations indicate that both units are laterally continuous throughout the GJO site. The portion of the alluvial aquifer underlying the GJO facility occupies about 22.8 ha (56.4 acres) of the Gunnison River floodplain; its thickness ranges from 6 to 21 meters (20 to 70 feet) but averages between 6 and 8 meters (20 and 25 feet). Bounded on the west and north by the river and on the east by the shales and sandstones of the Morrison Formation, the aquifer is open to the south where the alluvium continues along the east boundary of the river. Aquifer pumping tests show that the hydraulic conductivity of the alluvium is approximately 9 meters (30 feet) per day and the specific yield is on the order of 0.05. Generally, depth to ground water ranges from 1.5 to 3 meters (5 to 10 feet). Currently, the alluvial ground water is not used for any purpose.

Field observations suggest that a simple depositional model is adequate to represent the alluvial aquifer. The basal portion was deposited as the Gunnison River migrated from the east to its present position. During this migration, older alluvial sediments to the west were eroded, and a new layer of sediment was left behind. This deposition resulted in a continuous layer of gravel, sand, and silt.

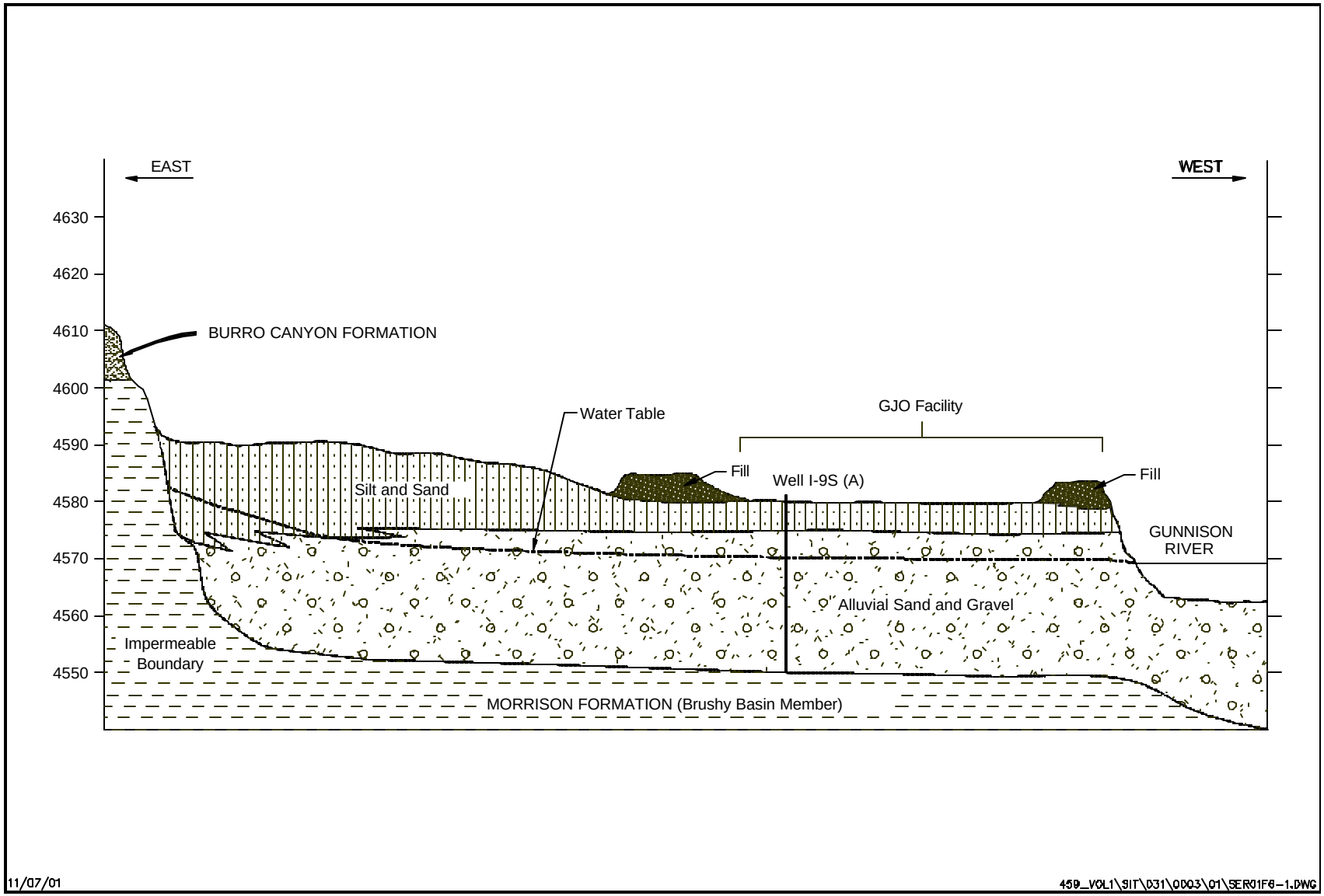

Figure 6–1. Typical Geologic Cross Section of the Alluvial Aquifer Beneath the DOE-GJO Facility

Periodic flood events deposited sand and silt on top of the gravel to produce the alluvial stratigraphy shown in Figure 6–1. Such a depositional model is similar to the alluvial-floodplain facies model of Allen (1970); the primary difference between the two is that the alluvium at the GJO facility was deposited in an area that was more restricted laterally, and where, as a result, the water flowed more swiftly. The result is a thicker and more consistent basal gravel unit than the Allen model would indicate. Figure 6–2 presents a typical stratigraphic column at the GJO facility.

Upgradient ground water (southeast of the facility) has water quality characteristics similar to those of the Gunnison River, although major ion concentrations increase slightly as the ground water residence time increases. Before uranium mill tailings were removed from the facility, ground water flowing beneath the facility became contaminated with the leached constituents of uranium mill tailings—uranium, arsenic, radium, selenium, and molybdenum. Only uranium and molybdenum, however, were mobile enough to migrate throughout the downgradient portion of the aquifer.

Underlying the alluvial aquifer at the GJO facility is the Morrison Formation, which in the Grand Junction area consists of the Brushy Basin and Salt Wash Members. The formation is composed primarily of shale, although minor lenticular sandstones are present in the upper Brushy Basin Member and increasing sandstone facies occur in the Salt Wash Member. The Morrison Formation serves as an aquitard beneath the facility, inhibiting downward ground water flow and preventing hydraulic communication between the overlying alluvial aquifer and the underlying Entrada Sandstone aquifer.

At the GJO facility, the Gunnison River incises only the upper part of the Brushy Basin Member. Brushy Basin shales are exposed along the valley margins and underlie the alluvium. This framework results in free-flowing ground water in the alluvial aquifer because Brushy Basin shales act as a relatively impermeable boundary beneath the aquifer and along the valley margins.

Recharge of the alluvial aquifer occurs mainly through fluctuations in the Gunnison River and, to a much lesser extent, precipitation. During normal flows of the Gunnison River, ground water enters the alluvial aquifer from the river along the southern perimeter of the GJO facility and flows to the north. Ground water is discharged into the river along the north and west boundaries of the facility. During periods of high river flow, Gunnison River water recharges the alluvial aquifer and ground water flow is toward the middle of the aquifer.

6.2 Ground Water Sampling and Analysis

In 2001, GJO ground water monitoring involved one sampling event. The DOE continued ground water sampling under a long-term monitoring strategy that was designed to verify the progress of natural flushing of the alluvial aquifer in the 50- to 80-year period predicted in the Record of Decision (ROD)(DOE 1990). Prior to 2001, this strategy involved sampling select monitoring wells every 9 months. The 9-month sampling frequency was implemented to allow an annual assessment of compliance with ground water standards and to allow for seasonal fluctuations in contaminant concentrations. This schedule resulted in four sampling rounds over a 3-year period. However, at the request of the State of Colorado, monitoring will be performed at the same time every year (in the winter where historical data indicates the highest concentrations occurred as a result of the low-flow conditions) to minimize seasonal fluctuations.

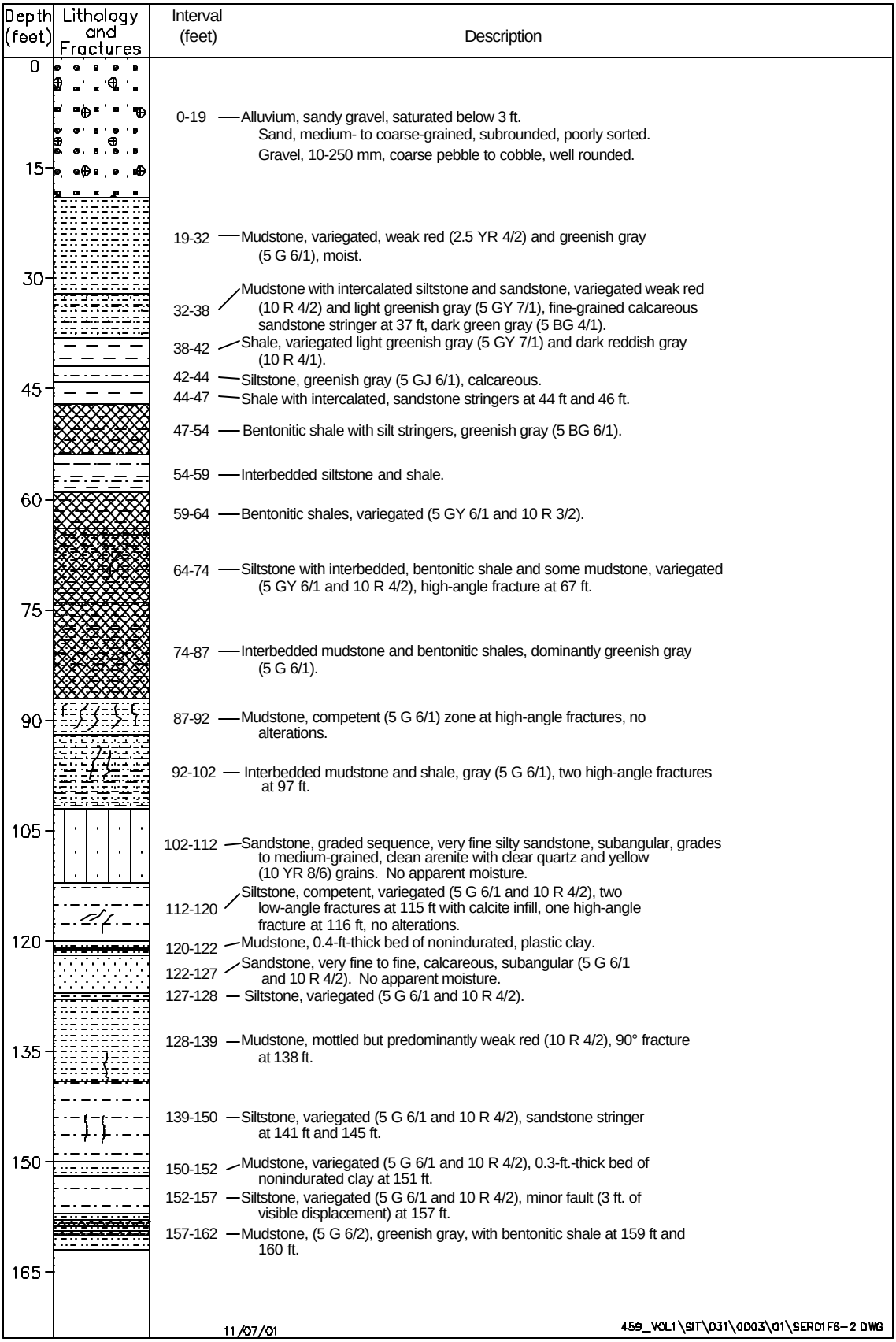

Figure 6–2. Typical Stratigraphic Column at the DOE-GJO Facility (from well GJ84-18)

At the direction of the DOE–GJO, the LTSM Program evaluated the ground water and surface water monitoring strategy at the GJO facility. The purpose of the evaluation was to determine the feasibility of decreasing the number of monitoring locations and analytes, while maintaining the objectives and regulatory requirements of the monitoring program. Based on this evaluation, 42 of 48 wells were abandoned in CY2000, leaving 6 wells for ongoing monitoring purposes. Included are five on-site wells (8–4S, 6–2N, 11–1S, 14–13NA, and 10–19N) and one downgradient well (GJ84–04) (Figure 6-3). The upgradient well (GJ84–09) was abandoned, leaving only historical data for background comparison. The wells were abandoned in accordance with the State of Colorado Water Well Construction Rule 15 (2 CCR 402–2). The LTSM Program will conduct future ground water sampling for the GJO site.

The 2001 ground water samples were collected in January. Sampling procedures and protocol are described in the Sampling and Analysis Plan (DOE 1995a), which incorporates the standard procedures published by EPA (1985, 1987) and DOE (1987). The ground water monitoring program is detailed in the Environmental Monitoring Plan (DOE 2001).

Monitoring wells sampled and the constituents analyzed are summarized in Appendix C. These wells are in or downgradient of formerly contaminated areas of the facility and represent on-site and downgradient conditions. Monitoring well locations sampled in 2001 are shown in Figure 6–3.

Ground water alkalinity, turbidity, pH, conductivity, and temperature were determined in the field; ground water samples were collected and analyzed at the GJO Analytical Chemistry Laboratory for metals (arsenic, chromium, iron, manganese, molybdenum, selenium, and vanadium), a major cation (magnesium), major anions (chloride, nitrate, and sulfate), radionuclides (gross alpha/beta and total uranium), and total dissolved solids. These analytes are used to characterize general water quality and to monitor the alluvial ground water under the GJO facility.

6.3 Ground Water Analytical Results and Trends

During 2001, concentrations of uranium, molybdenum, selenium, and total dissolved solids in samples from the alluvial aquifer exceeded ground water quality standards (Figure 6–4). Table 6–1 lists 2001 and historical maximum analyte concentrations compared with Federal and State ground water quality standards. Table 6–1 combines Federal and State standards for comparison and lists the more stringent standard if more than one exists.

Analytical results of samples collected from ground water monitoring wells in 2001 are presented in Tables A–2 in Appendix A. The tables contain analytical results for several constituents that are not presented in Table 6–1 because either no ground water quality standard currently exists for these constituents or the measured concentration was below applicable State standards.

To date, 22 ground water sampling events have been conducted since remediation of open-land areas was completed. Time-concentration plots in Appendix B, as well as a statistical study of uranium and molybdenum values from well GJ84–04, indicate aquifer cleanup is progressing.

6.3.1 Radionuclide Ground Water Sampling Results

Uranium contamination is widespread throughout the alluvial aquifer beneath the facility. Uranium activities above the UMTRCA standard of 30 pCi/L (combined uranium-234 and uranium-238

activity; approximately equal to 0.045 mg/L) were recorded in samples from all alluvial wells analyzed for uranium during 2001 (6 of 6 wells) (Table A–1 in appendix A and Figures 16–21 in Appendix B). No background wells were sampled in 2001. The highest uranium concentration recorded in 2001, 448 pCi/L (0.668 mg/L), was measured in a sample from on-site well 8–4S, located near the dike in the southern portion of the facility. Examples of wells where sample results have consistently exceeded the UMTRCA uranium standard include on-site well 11–1S and downgradient well GJ84–04. Figures 18 and 21 in Appendix B show uranium concentrations in samples collected from wells 11–1S and GJ84–04 from approximately 1990 to September 2001. For comparison, Figure 15 in Appendix B shows background uranium concentrations in samples from historic well GJ84–09 from 1989 through 1999.

Gross alpha activities exceeding the UMTRCA standard of 15 pCi/L have been recorded in on-site wells in previous Site Environmental Reports. Only one of the six wells sampled during 2001 exceeded this standard—on-site well 8–4S located near the dike in the southern portion of the facility. Results were reported at 67 pCi/L. Historical data for this parameter in the alluvial aquifer is provided in previous Site Environmental Reports.

Table 6–1. Comparison of Federal and Ground Water Quality Standards to 2001 and Historical Maximum Concentrations in the Alluvial Aquifer[a,b,c]

		2001 Maximum			Historical Maximum[d]		
Constituent	Federal/State Standard	Up-Gradient (Background)	On-Site	Down-Gradient (GJ84–04)	Up-Gradient (Background)	On-Site	Down-Gradient
Common Ions (mg/L)							
Nitrate (as N)[e]	10.0	–	9.2162	<0.031	1.5812	69.5731	3.6142
Total Dissolved Solids[f]	2210	–	4000	2720	2180	10200	8620
Metals (mg/L)							
Arsenic	0.05	–	0.0095	0.008	0.0114	0.68	0.031
Chromium	0.05	–	<0.0013	<0.0013	0.010	0.039	0.112
Molybdenum	0.1	–	0.229	0.138	0.023	19.	0.413
Selenium	0.01	–	0.106	0.0001	0.0025	0.685	0.05
Radiological (pCi/L)							
Gross Alpha (excluding Radon & Uranium)[g]	15	–	67.354	1.551	71.02	1073.14	620.52
Uranium-234+238[h]	30.0	–	448.228	138.897	22.77[i]	6039	1006.5

[a] Standards from the Uranium Mill Tailings Radiation Control Act, revised in 1986.

[b] CDPHE Water Quality Control Division, Regulation No. 41, Basic Standards for Ground Water, effective March 2, 1999. Standards in the "Potentially Usable Quality" classification were used for GJO ground water.

[c] "–" indicates no data available; "<" indicates that the maximum concentration was below the detection limit (number shown is detection limit).

[d] Based on maximum concentrations observed from 1984 through 2000.

[e] Nitrate (as N) was derived for measured nitrate using the conversion $N = NO_3 \div 4.427$.

[f] This is a site-specific standard calculated as background x 1.25. The background value is based on an average of the 1991-1999 sampling events.

[g] Measured values represent total gross alpha minus uranium activity. Negative values indicate uranium concentrations exceeded gross alpha activity. Uranium concentrations that were measured in grams were converted to pCi/L. The conversion assumes equilibrium and an activity of 0.687 pCi/µg.

[h] Total uranium concentrations that were measured in grams were converted to uranium-234+238 in pCi/L for comparison. The conversion assumes equilibrium and an activity of 0.671 pCi/µg.

[i] Extreme-values testing of uranium results from samples collected in 1985 and 1989 indicated that two values (201 pCi/L and 84 pCi/L) were outliers; these values from upgradient wells were not included in this table.

Historically, radium-226 contamination appeared to be localized in areas of buried tailings, which are now remediated. In 2001, as a result of the LTSM evaluation Ra-226 + 228 were removed from the analyte list as historical levels were consistently below the standard of 5 pCi/L following remediation. Another result of the evaluation was the designation of uranium as the principle radiological constituent of concern (COC) because, as a conservative species, uranium is more representative of current migration of site-related contaminants in ground water in the alluvial aquifer.

6.3.2 Nonradionuclide Ground Water Sampling Results

As with uranium, molybdenum contamination is also widespread in the alluvial aquifer. Samples from two of five on-site wells (8-4S and 14-13NA) and the single downgradient well (GJ84-04) sampled in 2001 contained concentrations of molybdenum in excess of the UMTRCA ground water standard of 0.1 mg/L (Figure 6–4). The highest concentration (0.229 mg/L) was measured in a sample from on-site well 14–13NA. There is no consistent increase or decrease in elevated molybdenum concentrations with respect to time in the alluvial aquifer. For example, the concentration of molybdenum in samples collected from on-site well 8–4S has decreased since 1989, particularly since 1992 following the majority of the subsurface remediation, and are reported only slightly above the standard (Figure 28 in Appendix B). The concentration of molybdenum in samples collected from on-site well 14–13NA has consistently exceeded the UMTRCA ground water standard even following remediation (Figure 29 in Appendix B). Molybdenum concentrations in samples from historic background and downgradient wells GJ84–09 and GJ84–04 are illustrated in Figures 27 and 30 in Appendix B, respectively.

Arsenic contamination is localized in the area formerly occupied by a large tailings pile, and arsenic concentrations exceeding the UMTRCA/State standard of 0.05 mg/L have been recorded in samples from on-site wells in previous Site Environmental Reports. None of the six wells sampled during 2001 exceeded this standard. Historical data for this analyte in the alluvial aquifer is provided in previous Site Environmental Reports. Figure 32 in Appendix B shows that measurements of arsenic in samples from historic on-site well 14–6NA consistently exceeded the UMTRCA standard. This well was not sampled in 2001, as it was removed in 2000 as determined by the surface water and ground water evaluation performed for the LTSM Program. Background arsenic concentrations in samples from historic well GJ84–09 are shown in Figure 31 in Appendix B for comparison.

Selenium concentrations exceeded the UMTRCA standard of 0.01 mg/L in samples from two of five on-site wells in 2001 (Figure 6–4). The highest selenium concentration, 0.106 mg/L, was detected in a sample from on-site well 6–2N. This well also yielded the highest selenium concentration in 2000. As with molybdenum, no consistent increase or decrease in elevated selenium concentration with respect to time was observed in the alluvial aquifer. For example, although above the standard, the concentration of selenium in samples collected from on-site well 8–4S has decreased since 1990, particularly since 1992 following remediation (Figure 35, Appendix B), whereas the concentration of selenium in samples collected from on-site well 6–2N has consistently exceeded the UMTRCA ground water standard (Figure 34, Appendix B). Samples from historic background well GJ84–09 have always contained concentrations below the standard (Figure 33, Appendix B).

Nitrate concentrations did not exceed the UMTRCA and State ground water standard of 10 mg/L (nitrate as nitrogen) in ground water samples collected in 2001. The maximum nitrate (as nitrogen) concentration of 10.39 mg/L reported in CY2000 was measured in a sample from on-site well 6–2N. Nitrate concentrations were also reported in 2001 well below the standard in the downgradient location, well GJ84–04 (Figure 6-4).

In 2001, concentrations of total dissolved solids exceeded the aquifer-specific State standard of 2,210 mg/L (1.25 times background) in samples from three of five on-site wells (10-19N, 14-13NA, and 6-2N) and the one downgradient well (GJ84-04) (Figure 6–4). The highest dissolved solids concentration recorded in 2001 (3980 mg/L) occurred in a sample from on-site well 10–19N. Samples from this well have consistently contained dissolved solids in concentrations that exceed the State standard, as have those from the downgradient well (Figure 25 and 26, in Appendix B, respectively).

Sampling for Target Compound List volatile organic compounds, semivolatile organic compounds, pesticides, and PCBs was not conducted in 2001, as additional data on these constituents was not required to meet regulatory requirements. Historical data for these analytes in the alluvial aquifer is provided in previous Site Environmental Reports.

7.0 Quality Assurance

WASTREN, Inc., and MACTEC-ERS, the DOE–GJO contractors, have a joint quality assurance (QA) program that adopts the requirements and the philosophy of DOE Order 5700.6C, *Quality Assurance*. The GJO QA Program provides a structured approach for the application of QA principles to work performed for DOE and is implemented through the *GJO Quality Assurance Standards* (DOE [current version]). AIMTech/ORNL's QA program is implemented through *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program* (ORNL 1992).

A Quality Assurance Program Plan (QAPP) was developed for specific environmental monitoring and surveillance needs at the GJO and is appended to the Environmental Monitoring Plan (DOE 1995b). The primary purposes of the QAPP are to ensure that environmental data are valid and traceable and that they fulfill the requirements of the QA program. In addition, the QAPP addresses organizational responsibility, QA procedures, records, and audits. Field and laboratory quality control (QC), chain-of-custody, performance reporting, and independent data verification are addressed by the organizations responsible for the work performed.

7.1 Sampling

Methods used for effluent monitoring and environmental sampling at the GJO are described in the *Sampling and Analysis Plan* (DOE 1995a). ORNL sampling procedures are detailed in the *Environmental Technology Section Procedures Manual* (ORNL 1993). The *Environmental Monitoring Plan* (DOE 1995b) outlines the procedures used for sample collection and documentation. Use of these procedures ensures that the samples are representative and that the analytical data are accurate, comparable, precise, and complete. QA sampling procedures include collecting field duplicates, equipment blanks, and trip blanks; conducting frequent QA surveillances to ensure compliance with the sampling plan; and documenting and tracking sample custody with chain-of-custody procedures.

7.2 Laboratory Analysis

The GJO Analytical Chemistry Laboratory performs analyses in support of GJO environmental monitoring programs and implements QA requirements through the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (DOE[current version]). The Analytical Chemistry Laboratory's objective is to provide high-quality analytical data that meet environmental monitoring program requirements. The Analytical Chemistry Laboratory meets this objective by implementing a laboratory protocol that ensures that each sample is properly labeled, that analytical results are obtained and reported correctly, and that a well-documented sample history is maintained. QA measures address organizational responsibility, training and qualification of personnel, laboratory records, records control, laboratory QC, data acceptance, sample analysis, data recording and calculation, data deficiencies, chain of custody, procurement of services, and quality assessment. Analytical methods are presented in the *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures* (DOE [current version]) and *Requirements for Quality Control of Analytical Data* (ORNL 1990).

The GJO Analytical Chemistry Laboratory maintains an internal QA organization to provide independent data review and evaluation of QC data. The QA staff includes in its audit program an evaluation of the effectiveness of the Analytical Chemistry Laboratory QA program.

As mandated by DOE Order 5400.1, the GJO Analytical Chemistry Laboratory participates in the DOE interlaboratory QA program coordinated by the DOE Environmental Measurements Laboratory. This interlaboratory program is designed to test the accuracy of the environmental measurements being reported to DOE by its contractors. Real or synthetic environmental samples that have been prepared and thoroughly analyzed at the program laboratory are distributed to the contractors for analysis, and the results are compiled for comparison. The Analytical Chemistry Laboratory also participates in the Environmental Resource Associates administered Water Pollution/Water Supply for organic, inorganic, and radionuclide testing capabilities and the AIHA administered Proficiency Testing Program for Airborne Contaminants for airborne metals.

7.3 Data and Records Management

Data and records management objectives for environmental monitoring are established to maximize active use, maintenance, disposition, and preservation of required program information in an efficient and cost-effective manner. These objectives have been achieved and are being maintained through the use of systematic and applied controls through all phases of a record's life cycle.

Records are created both on paper and electronically in a retrievable format and are protected against deterioration, damage, and inadvertent loss. Records generated in support of environmental monitoring are subject to the requirements of 36 CFR, Parts 1220 through 1234, and guidance in the *Environmental Monitoring Plan* (DOE 1995b).

Laboratory analytical results of environmental samples are received electronically into an Oracle database. These data are maintained, protected, and archived by the GJO Information Resource Group.

8.0 References

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Appendix A

Water Monitoring Data

Table A-1. Surface-Water Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

Sample Location	Ticket Number	Sample Date	Radiological Data		Non-Radiological Data						
			Alpha (pCi/L) [b]	Beta (pCi/L)	Filtered Alkalinity (as $CaCO_3$) (ppm)	Unfiltered Alkalinity (as $CaCO_3$) (ppm)	As (µg/L)	CDT [c] (µmhos/cm)	Cl (µg/L)	Cr (µg/L)	Fe (µg/L)
		Standard	-	-	-	-	50	-	250000	11	300
Lower Gunnison	NDN-055	01/23/2001	<5.14	<4.94	138	139	0.7	977	12200	<1.3	<3
North Pond	NDN-056	01/23/2001	76.8	41.4	86	93	0.41	3880	242000	<1.3	<6.7
South Pond	NDN-051	01/23/2001	128.35	58.49	63	26	9.6	3180	115000	<1.3	<6.1
	NDN-052	01/23/2001	157.4	67.28	-	-	9.4	-	116000	<1.3	<3.3
Upper Mid Gunnison	NDN-054	01/23/2001	5.47	5.63	142	147	0.74	916	9040	<1.3	<6.2
Wetland Area	NDN-057	01/23/2001	1016.99	<587.73	306	321	11.3	37900	3010000	<1.3	<13.8

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[b] Values with units of pCi/L multiplied by 10^{-9} will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.
[c] Conductivity measured in micromhos per centimeter.

Table A-1 (continued). Surface-Water Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

Sample Location	Ticket Number	Sample Date	Non-Radiological Data								
			Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	NO_3 (µg/L)	ORP [d] (mV)	pH	Se (µg/L)	SO_4 (µg/L)	TDS [e] (mg/L)
		Standard	-	50	-	44270 [f]	-	6.5-9.0	8	480000	-
Lower Gunnison	NDN-055	01/23/2001	31300	79	3.5	3970	149	8.29	6.6	317000	680
North Pond	NDN-056	01/23/2001	120000	7.1	5.5	<137.4	154	8.62	5.4	1630000	2920
South Pond	NDN-051	01/23/2001	75900	8.5	83.3	147	176	8.8	0.93	1500000	2480
	NDN-052	01/23/2001	75400	5	84.9	<137.4	-	-	0.93	1490000	2480
Upper Mid Gunnison	NDN-054	01/23/2001	29800	38.8	2.5	4090	184	8.3	6.7	291000	605
Wetland Area	NDN-057	01/23/2001	1280000	6.5	487	<3440	178	9.56	1.4	34700000	57600

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[d] Oxidation Reduction Potential measured in millivolts.
[e] Total dissolved solids.
[f] Standard has been converted from “as Nitrogen” to “as NO_3” for comparison purposes.

Table A-1 (continued). Surface-Water Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

			Non-Radiological Data		
Sample Location	Ticket Number	Sample Date	Temperature (°C)	U [g] (µg/L)	V (µg/L)
		Standard	-	58.22	-
Lower Gunnison	NDN-055	01/23/2001	0	11.4	<1.5
North Pond	NDN-056	01/23/2001	3.6	113	9.2
South Pond	NDN-051	01/23/2001	4.6	261	4.8
	NDN-052	01/23/2001	-	258	4.1
Upper Mid Gunnison	NDN-054	01/23/2001	-0.1	6.7	<1.5
Wetland Area	NDN-057	01/23/2001	6.9	1770	8.3

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[g] Uranium standard (40 pCi/L) converted to µg/L for comparison purpose. The conversion assumes equilibrium and an activity of 0.687 pCi/µg.

Table A-2. Groundwater Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

			Radiological Data		Non-Radiological Data							
Sample Location	Ticket Number	Sample Date	Alpha (pCi/L) [b,d]	Beta (pCi/L)	Filtered Alkalinity (as $CaCO_3$) (ppm)	Unfiltered Alkalinity (as $CaCO_3$) (ppm)	As (µg/L)	CDT [c] (µmhos/cm)	Cl (µg/L)	Cr (µg/L)	Fe (µg/L)	H_2O Depth (feet)
		Standard	-	-	-	-	50	-	-	50	-	-
10-19N	NDN-060	01/24/2001	106.6	44.33	330	328	2.3	4940	271000	<1.3	379	13.52
	NDN-061	01/24/2001	86.57	51.76	-	-	2.2	-	271000	<1.3	350	-
11-1S	NDN-059	01/24/2001	81.08	23.91	177	179	0.5	881	7700	<1.3	<3	16.84
14-13NA	NDN-062	01/24/2001	95.44	44.35	165	161	9.5	3600	14000	<1.3	<3	6.25
6-2N	NDN-064	01/25/2001	118.56	46.01	250	251	1.2	3160	97000	<1.3	<3	14.32
8-4S	NDN-058	01/24/2001	526.27	100.42	276	287	1.6	2280	81400	<1.3	<3	12.25
GJ84-04	NDN-063	01/25/2001	143.76	58.16	179	198	8	3420	113000	<1.3	37.4	9.77

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[b] Values with units of pCi/L multiplied by 10^{-9} will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.
[c] Conductivity measured in micromhos per centimeter.
[d] Gross alpha data is not converted for radon and uranium contributions; therefore standard not provided in table. See section 6.3.1 for discussion.

Table A-2 (continued). Groundwater Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

			Non-Radiological Data									
Sample Location	Ticket Number	Sample Date	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	NO_3 (µg/L)	ORP [e] (mV)	pH	Se (µg/L)	SO_4 (µg/L)	TDS [f] (mg/L)	Temperature (°C)
		Standard	-	-	100	44270 [g]	-	-	10	-	2210	-
10-19N	NDN-060	01/24/2001	139000	2270	42.6	<344	1	7.25	0.37	2130000	3980	13.4
	NDN-061	01/24/2001	140000	2260	42.1	<344	-	7.09	0.44	2150000	4000	-
11-1S	NDN-059	01/24/2001	26900	44.6	61.8	<68.7	151	7.31	1.4	250000	583	13.7
14-13NA	NDN-062	01/24/2001	71000	4310	229	<137.4	148	-	0.38	1740000	3000	14.2
6-2N	NDN-064	01/25/2001	72000	1550	44.1	34100	163	7.53	106	1400000	2560	17
8-4S	NDN-058	01/24/2001	50200	128	209	40800	113	7.13	64.8	819000	1750	13
GJ84-04	NDN-063	01/25/2001	63000	3460	138	<137.4	76	7.1	0.1	1580000	2720	13

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[e] Oxidation Reduction Potential measured in millivolts.
[f] Total dissolved solids.
[g] Standard has been converted from “as Nitrogen” to “as NO_3” for comparison purposes.

Table A-2 (continued). Groundwater Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

			Non-Radiological Data		
Sample Location	Ticket Number	Sample Date	Turbidity (NTU) [h]	U [i] (µg/L)	V (µg/L)
		Standard	-	44.70	-
10-19N	NDN-060	01/24/2001	6.9	148	<1.5
	NDN-061	01/24/2001	-	148	<1.5
11-1S	NDN-059	01/24/2001	6.32	140	4
14-13NA	NDN-062	01/24/2001	5.74	220	12.5
6-2N	NDN-064	01/25/2001	0.68	241	11.2
8-4S	NDN-058	01/24/2001	9.13	668	12
GJ84-04	NDN-063	01/25/2001	2.54	207	14

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[h] Nephelometric turbidity units.
[i] Uranium standard (30 pCi/L) converted to total uranium for comparison purpose. The conversion assumes equilibrium and an activity of 0.671 pCi/µg.

Table A-3. QA/QC Chemistry Data Collected At and Near the GJO Facility During 2001 [a]

Sample Location	Ticket Number	Sample Date	Radiological Data: Alpha (pCi/L) [b]	Radiological Data: Beta (pCi/L)	Non-Radiological Data: As (µg/L)	Cl (µg/L)	Cr (µg/L)	Fe (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)
Equipment Blank	NDN-053	01/23/2001	<2.19	<3.79	<0.2	378	<1.3	<3	<6.4	<0.2	<0.8

Sample Location	Ticket Number	Sample Date	Non-Radiological Data: NO_3 (µg/L)	Se (µg/L)	SO_4 (µg/L)	TDS [c] (mg/L)	U (µg/L)	V (µg/L)
Equipment Blank	NDN-053	01/23/2001	<68.7	<0.1	77.9	25	<0.17	<1.5

[a] A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).
[b] Values with units of pCi/L multiplied by 10^{-9} will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.
[c] Total dissolved solids.

Appendix B

Time-Concentration Graphs

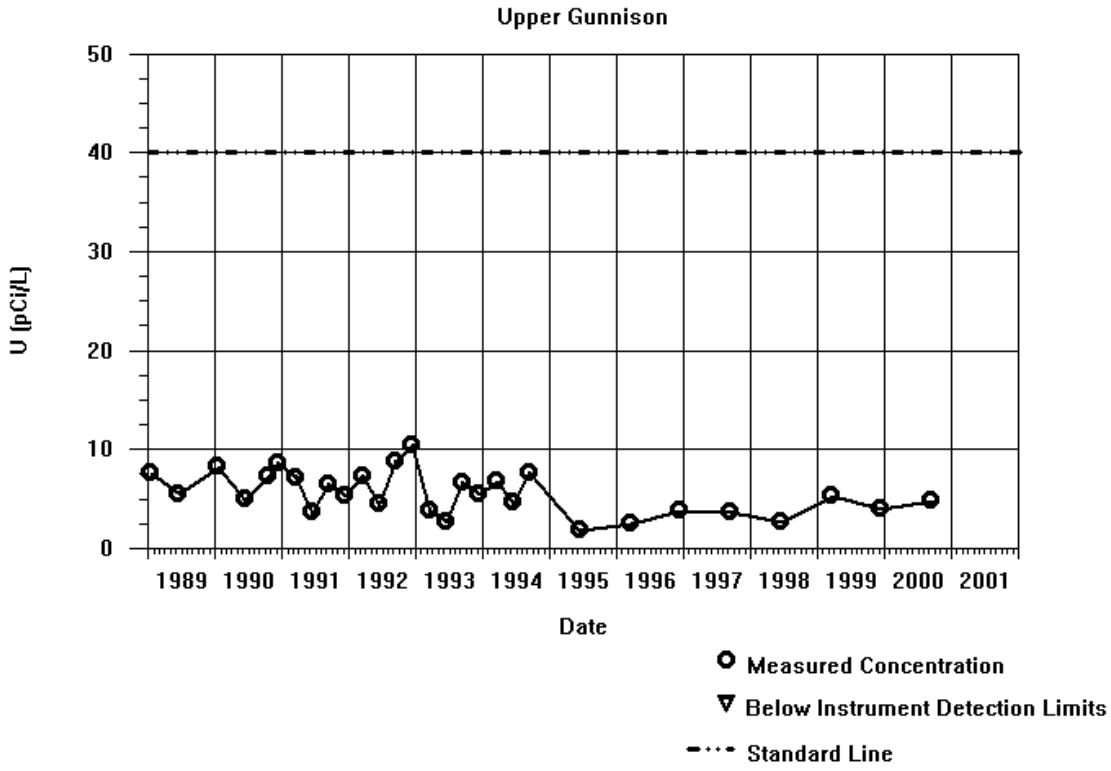

Figure B–1. Uranium Concentrations at the Upper Gunnison Sampling Location

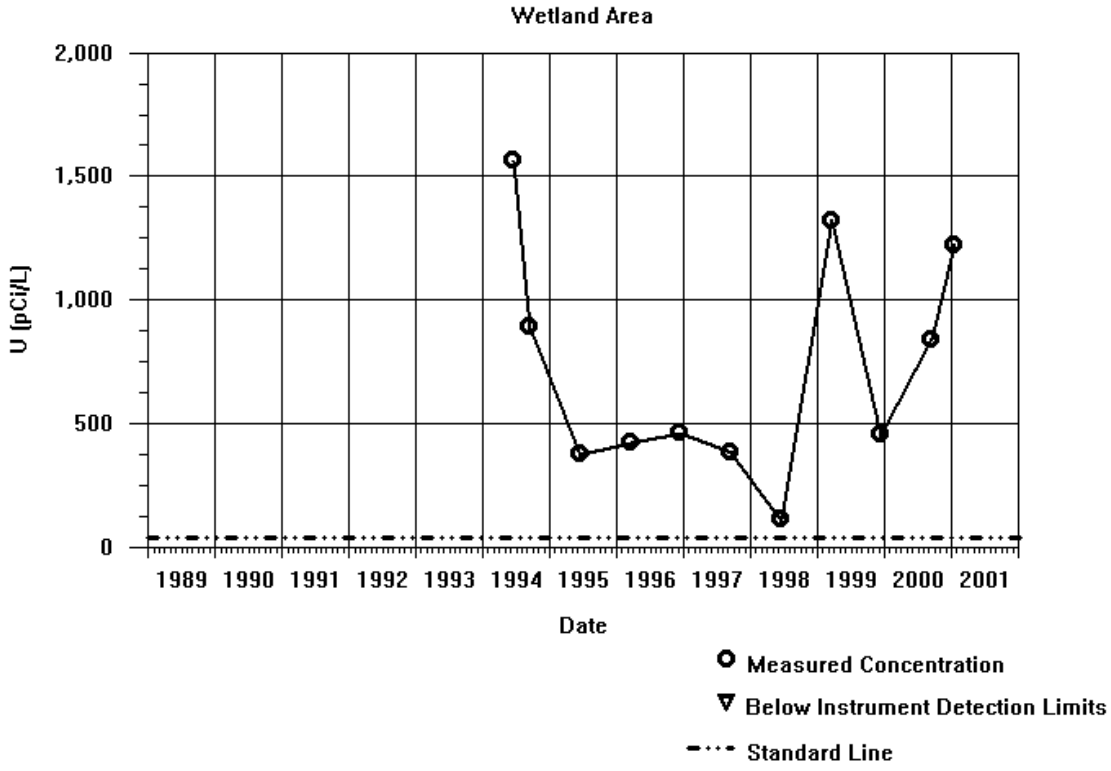

Figure B–2. Uranium Concentrations at the Wetland Area Sampling Location

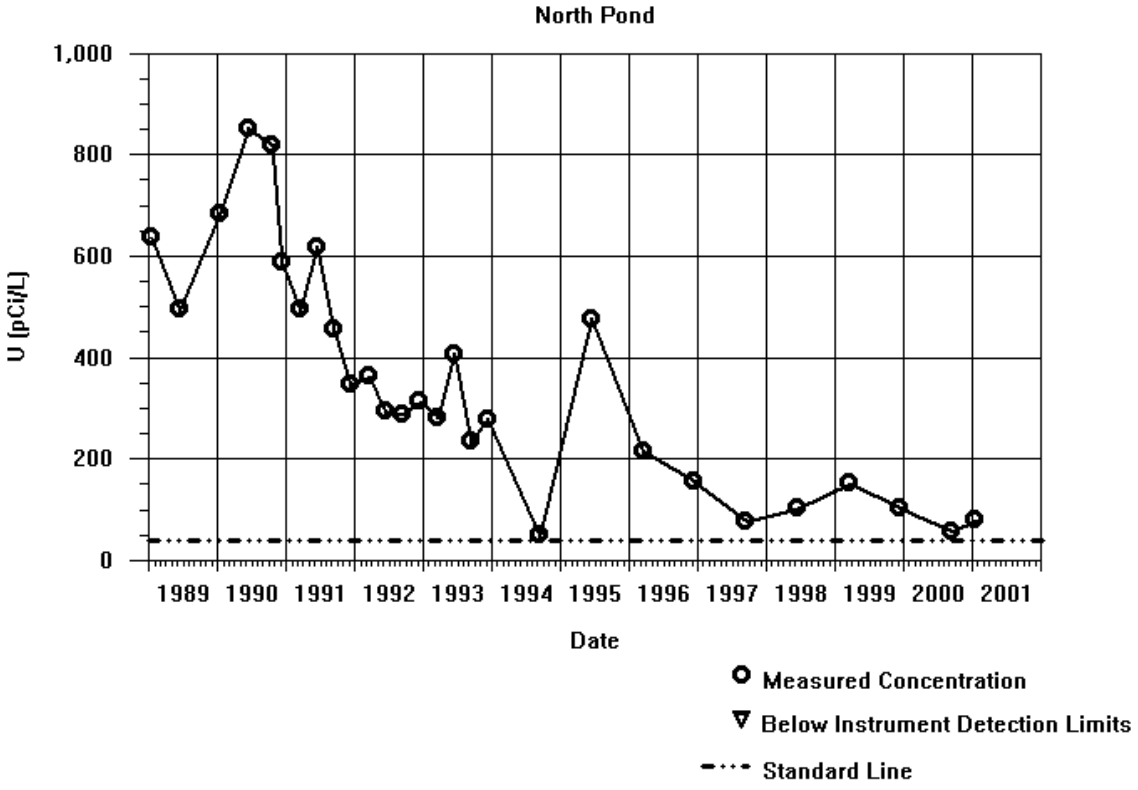

Figure B–3. Uranium Concentrations at the North Pond Sampling Location

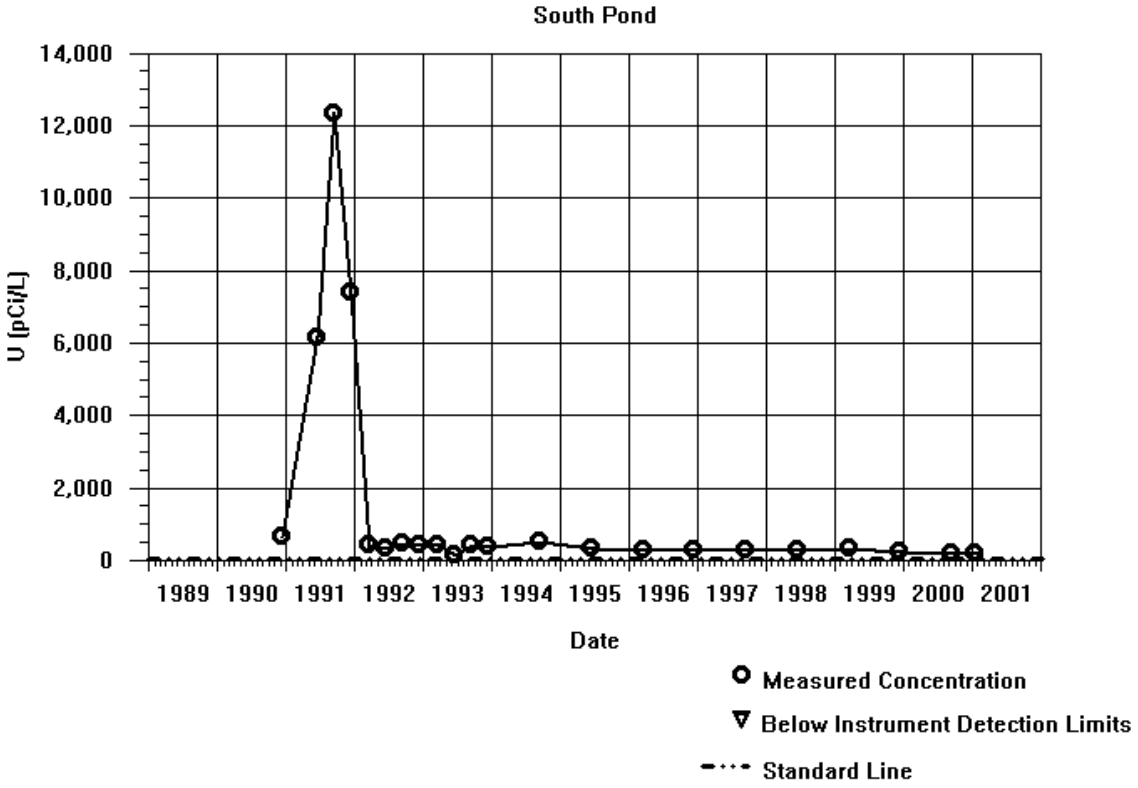

Figure B–4. Uranium Concentrations at the South Pond Sampling Location

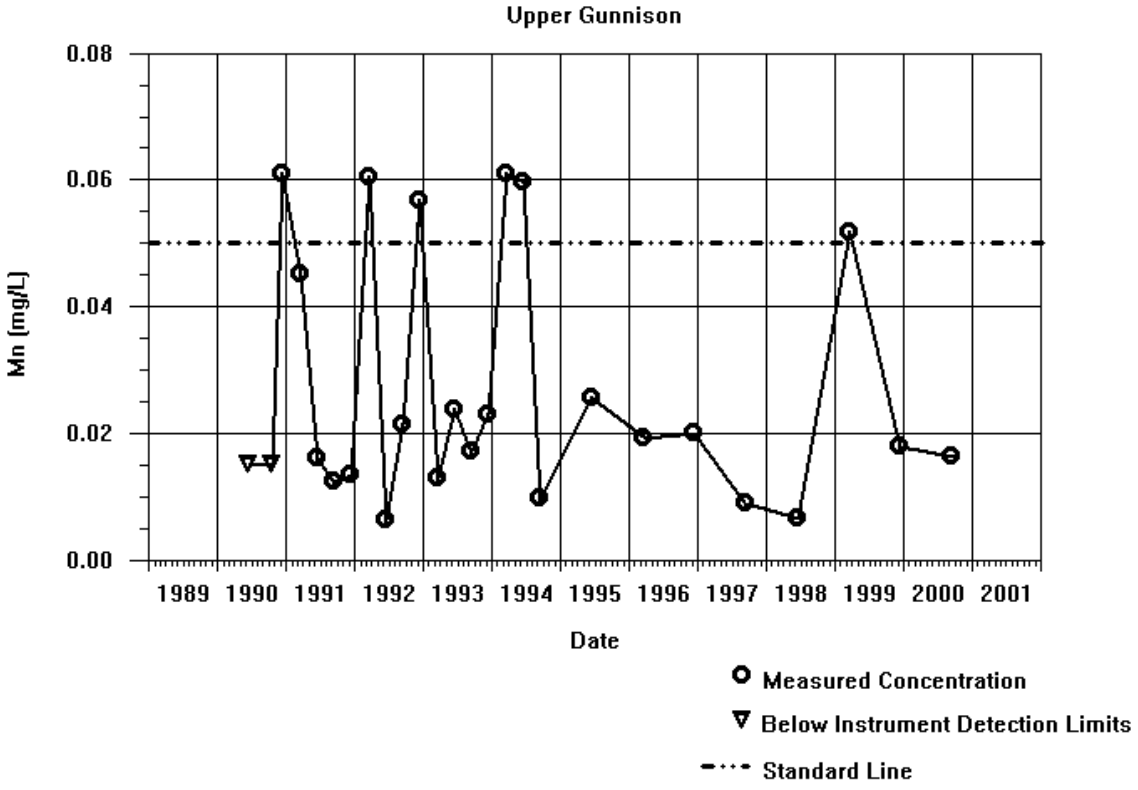

Figure B–5. Manganese Concentrations at the Upper Gunnison Sampling Location

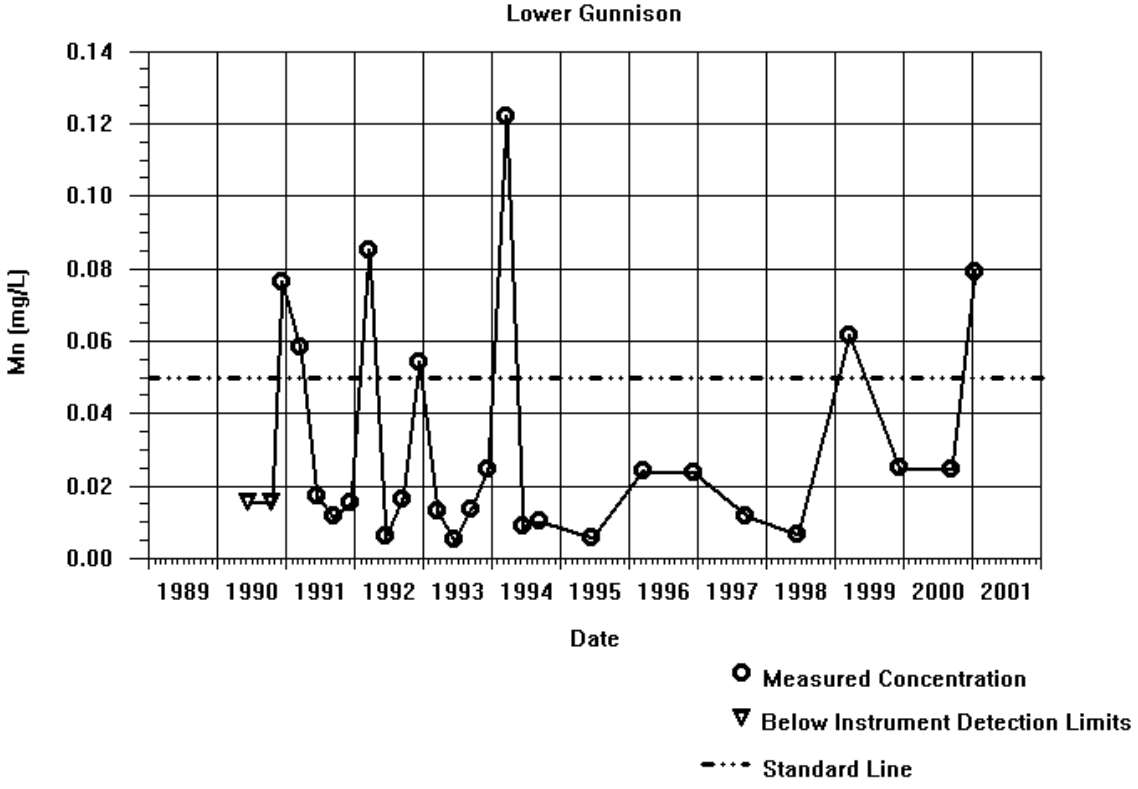

Figure B–6. Manganese Concentrations at the Lower Gunnison Sampling Location

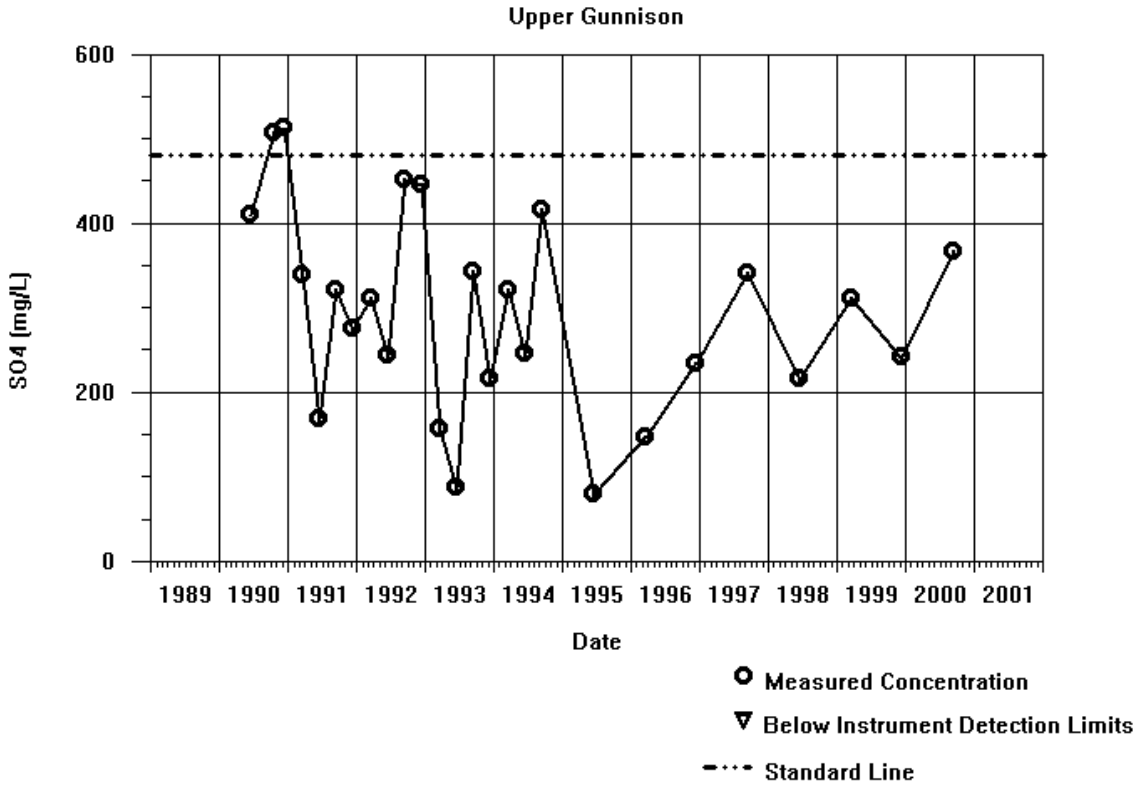

Figure B–7. Sulfate Concentrations at the Upper Gunnison Sampling Location

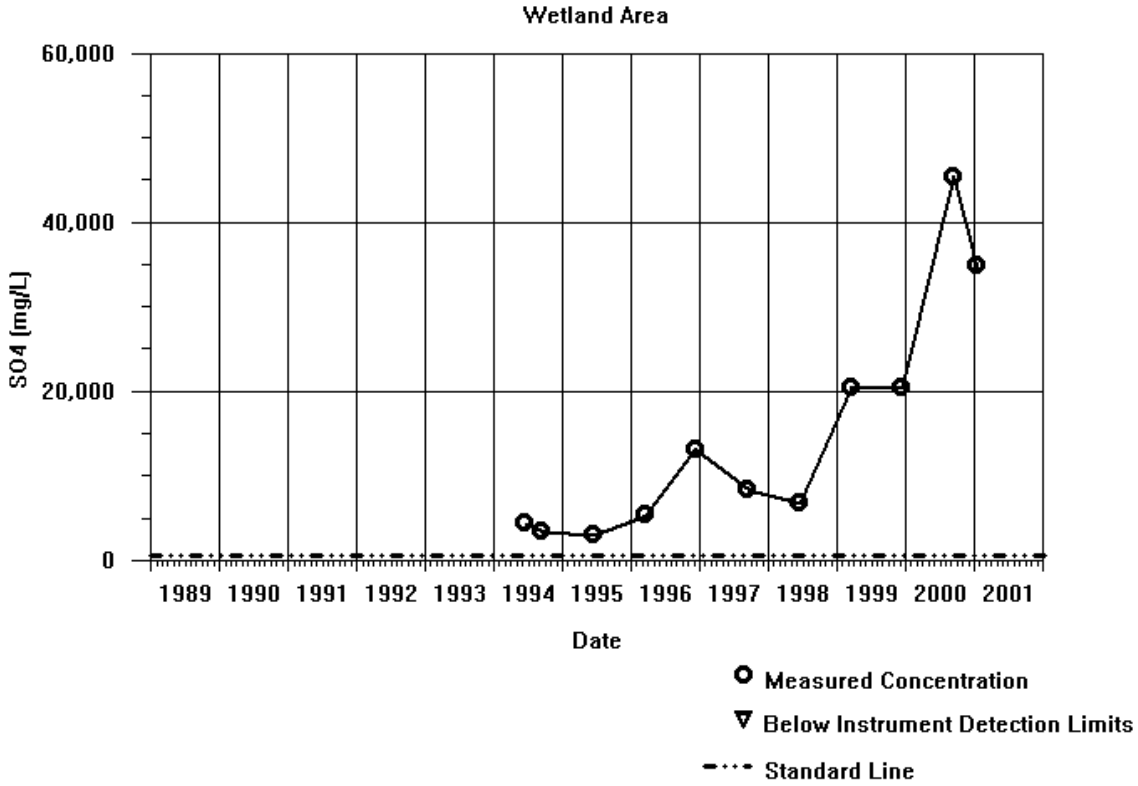

Figure B–8. Sulfate Concentrations at the Wetland Area Sampling Location

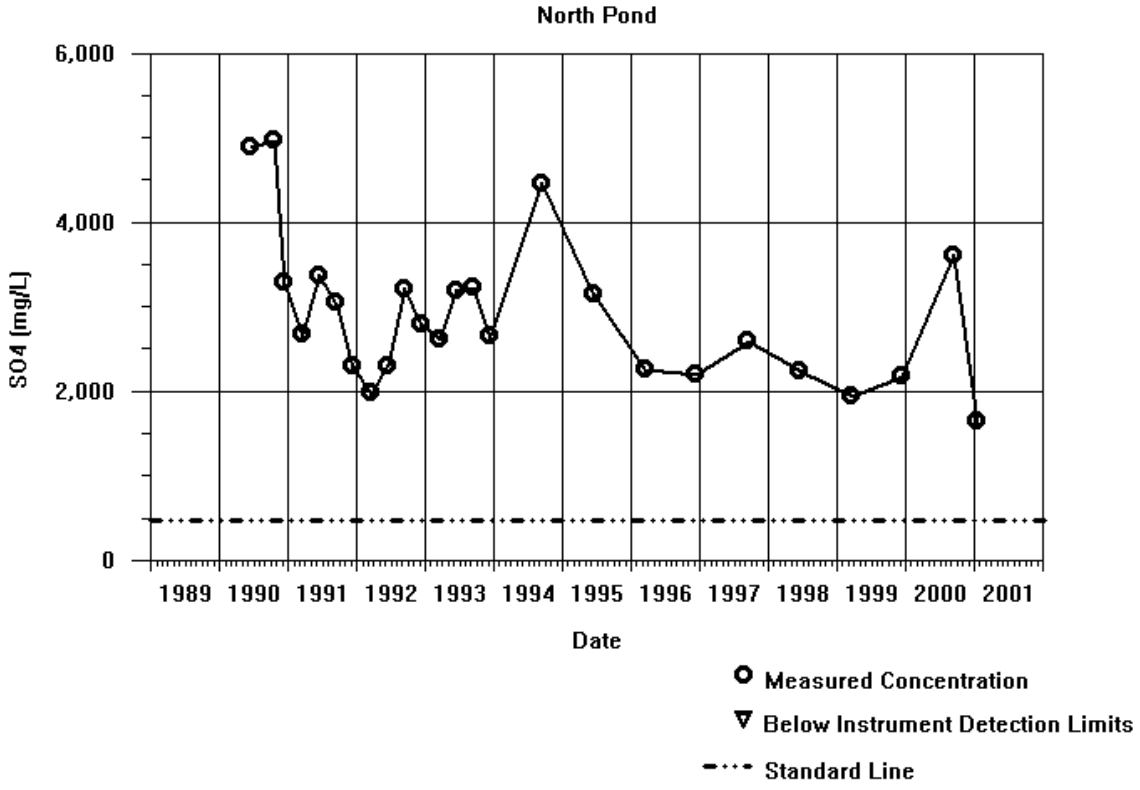

Figure B–9. Sulfate Concentrations at the North Pond Sampling Location

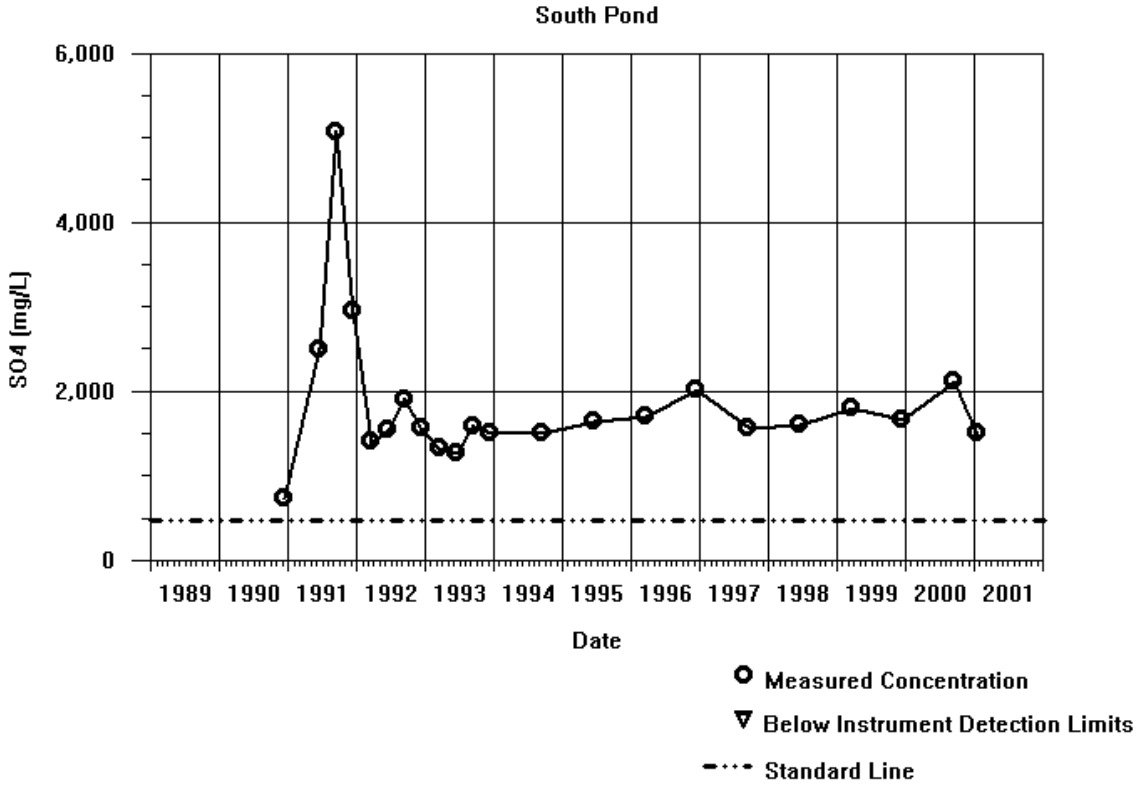

Figure B–10. Sulfate Concentrations at the South Pond Sampling Location

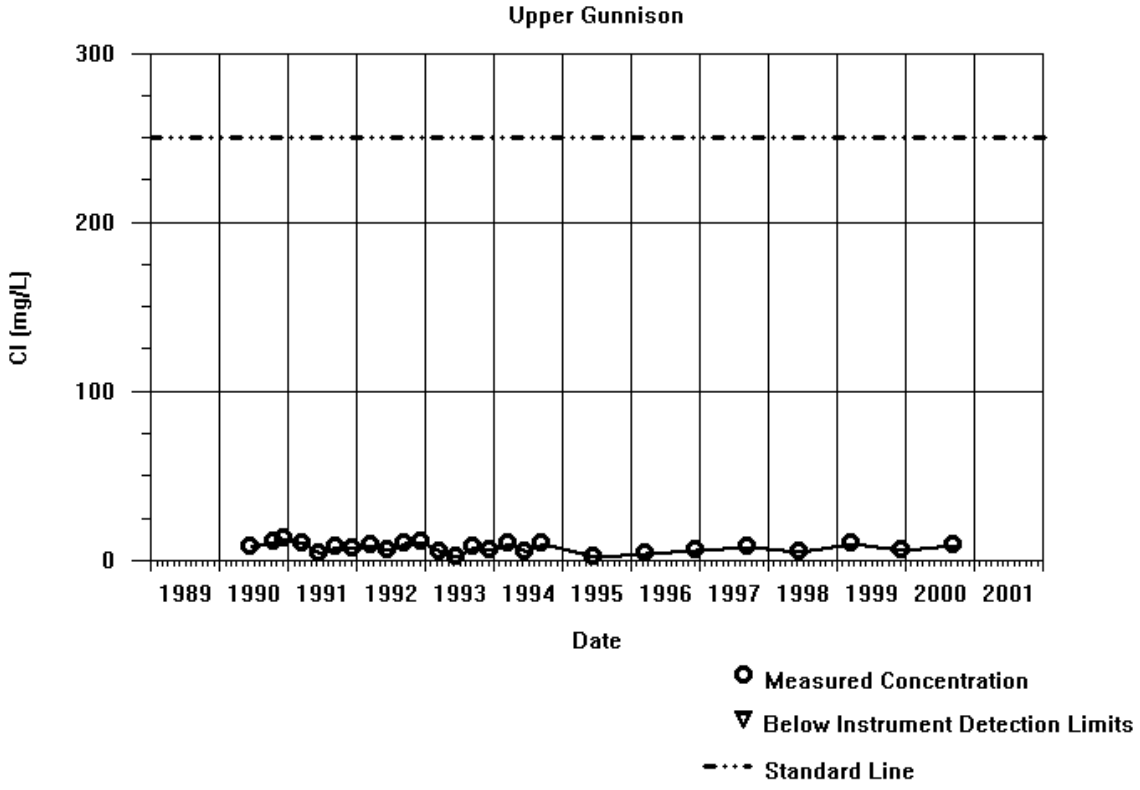

Figure B–11. Chloride Concentrations at the Upper Gunnison Sampling Location

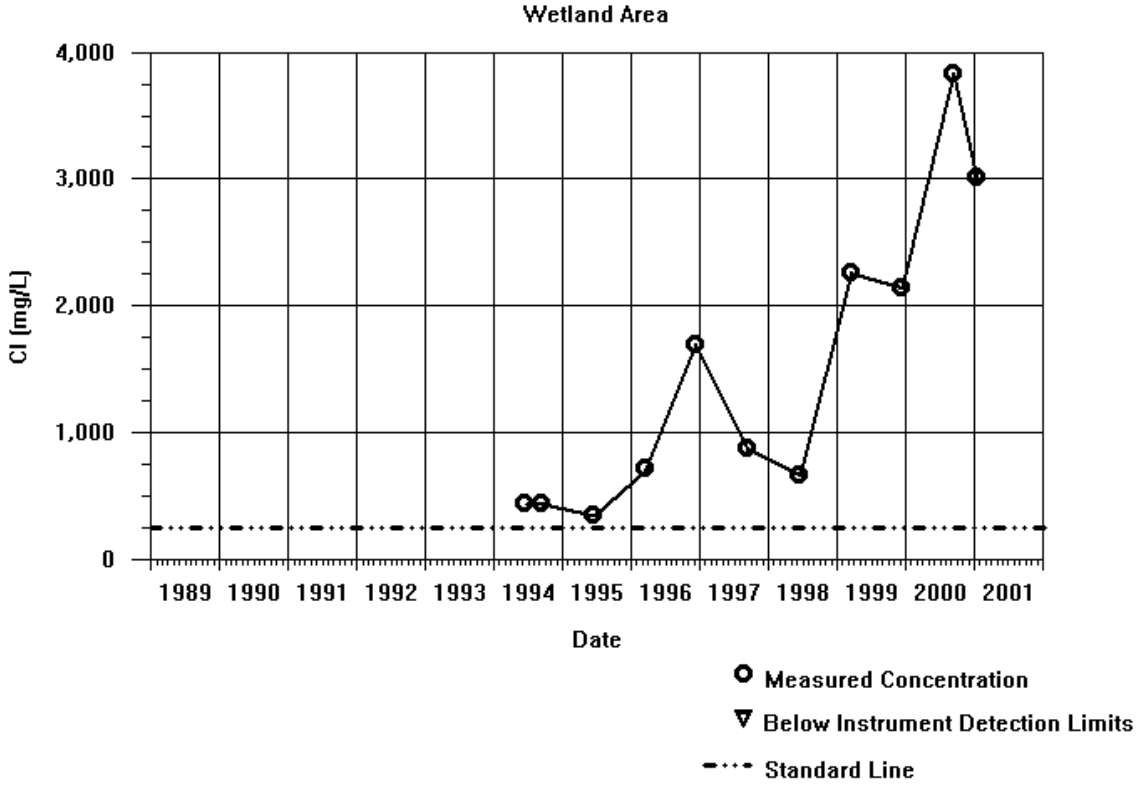

Figure B–12. Chloride Concentrations at the Wetland Area Sampling Location

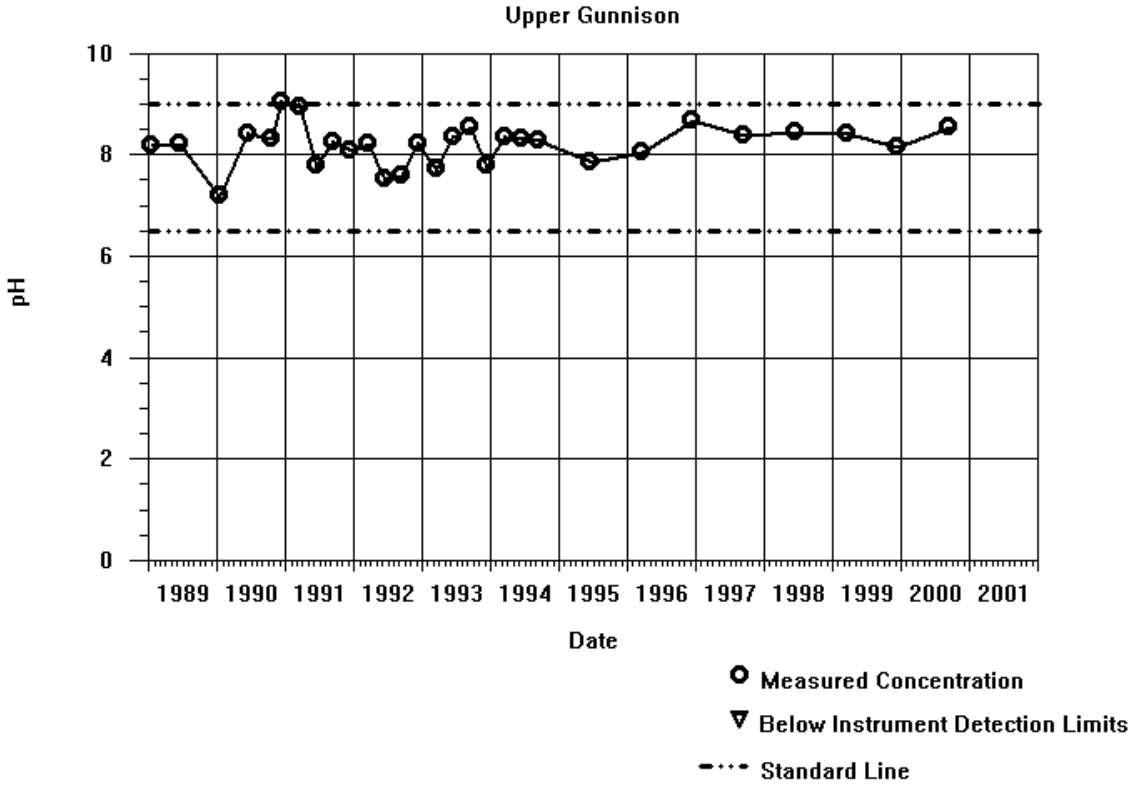

Figure B–13. pH Values at the Upper Gunnison Sampling Location

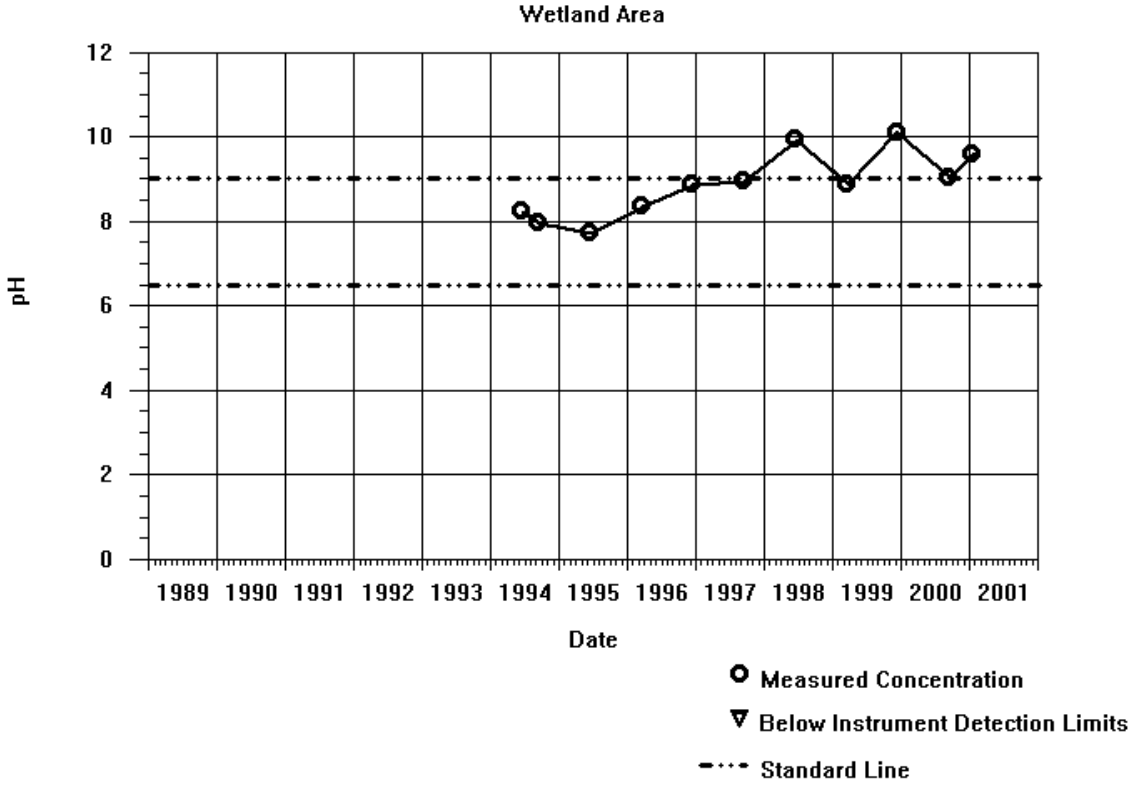

Figure B–14. pH Values at the Wetland Area Sampling Location

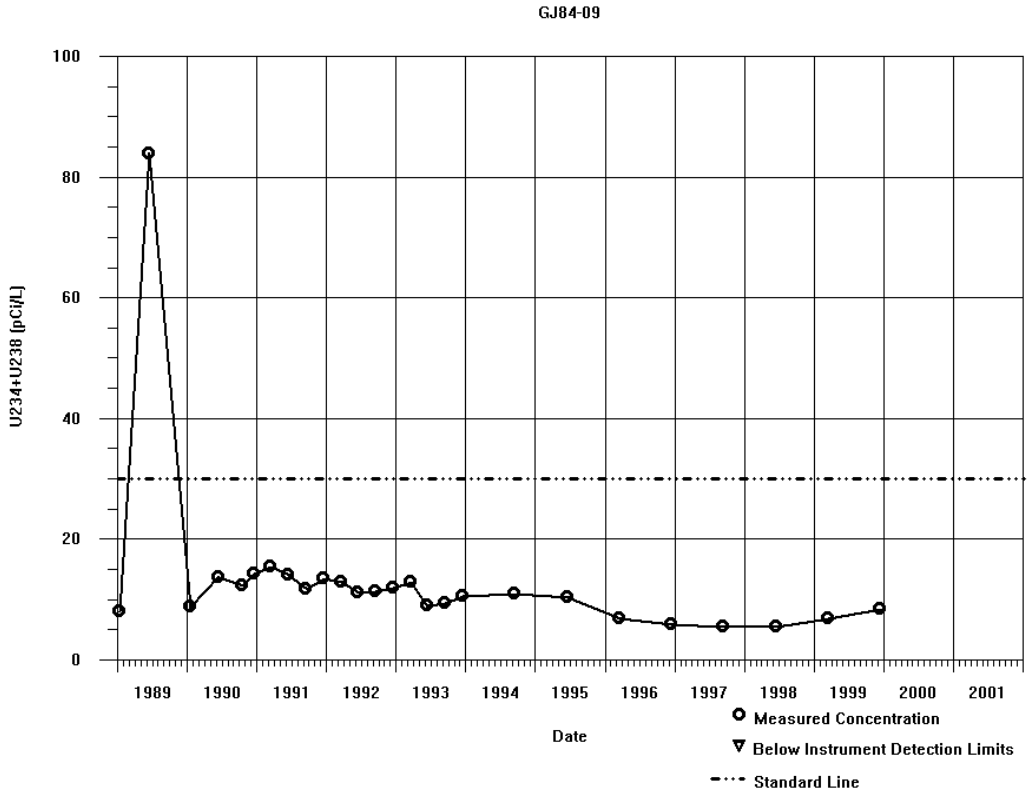

Figure B–15. Uranium Concentrations in Upgradient Well GJ84-09

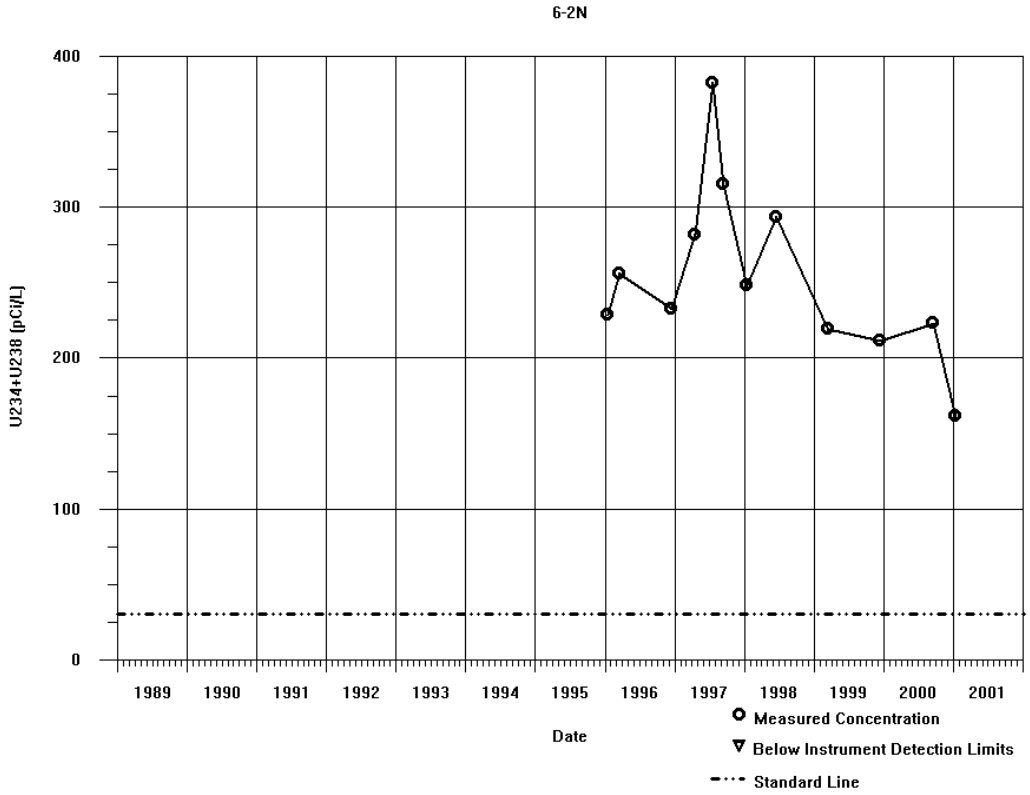

Figure B–16. Uranium Concentrations in On-Site Well 6-2N

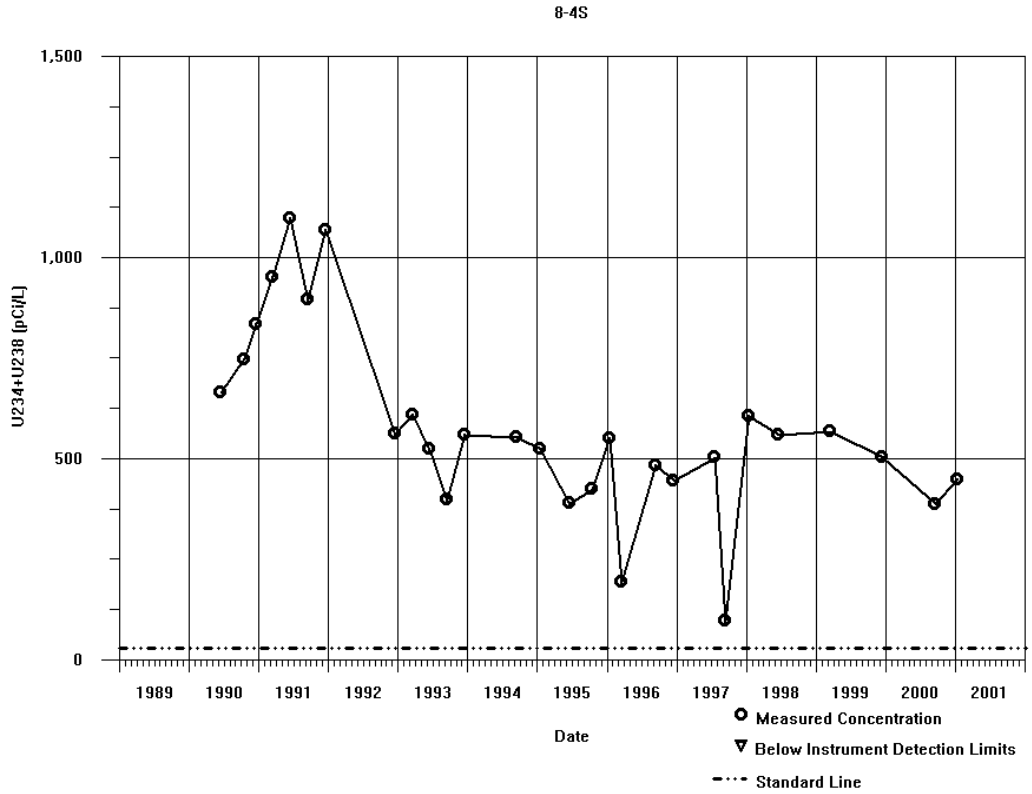

Figure B–17. Uranium Concentrations in On-Site Well 8-4S

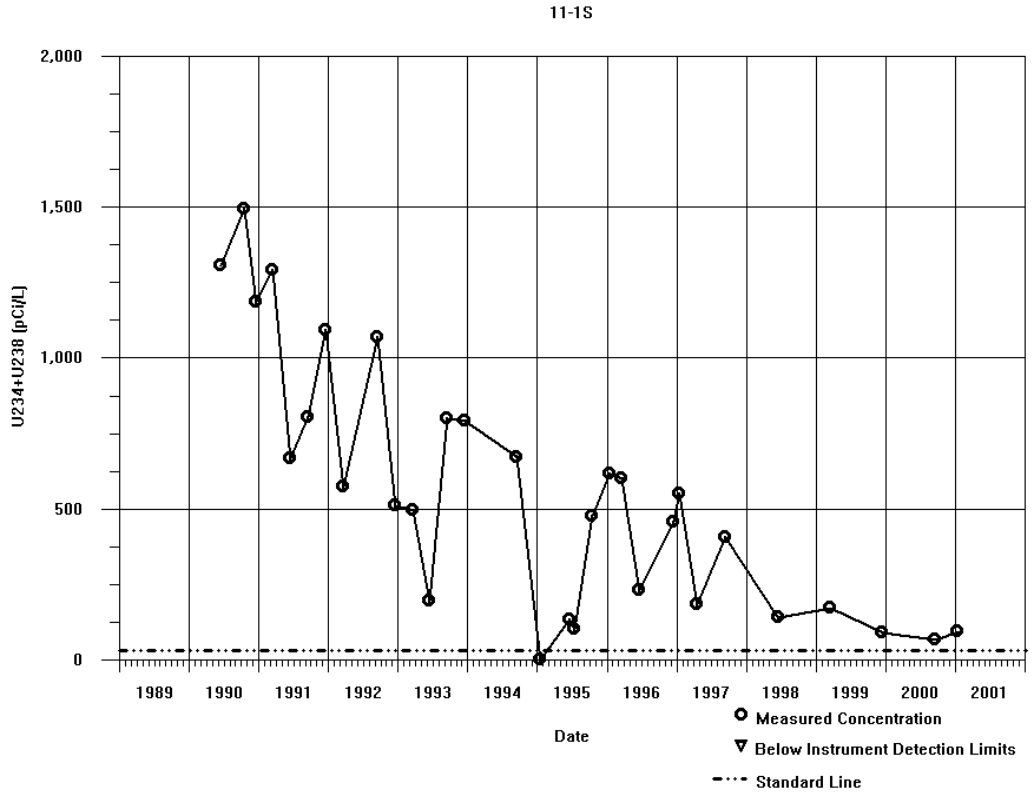

Figure B–18. Uranium Concentrations in On-Site Well 11-1S

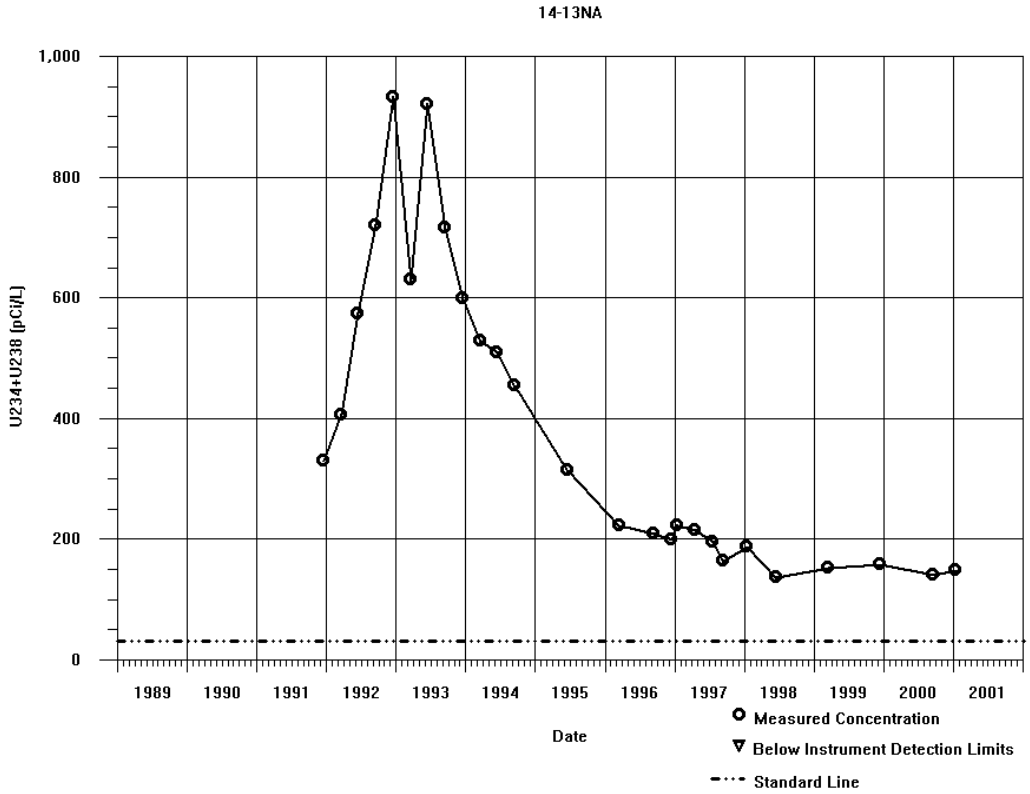

Figure B–19. Uranium Concentrations in On-Site Well 14-13NA

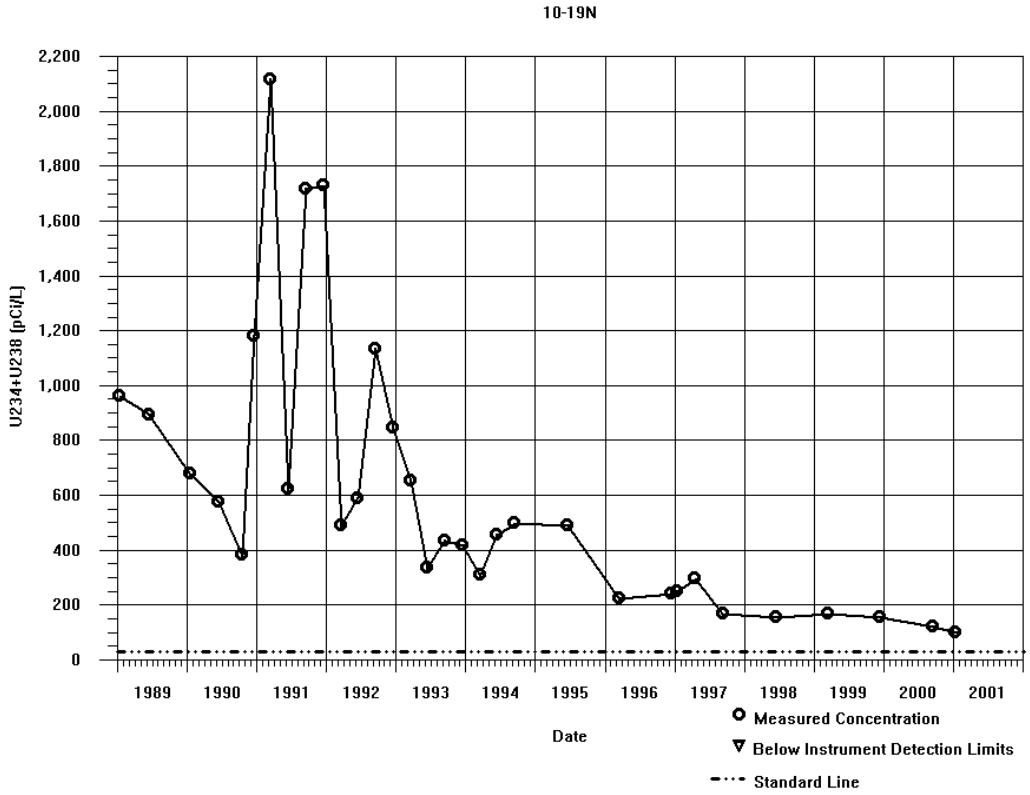

Figure B–20. Uranium Concentrations in On-Site Well 10-19N

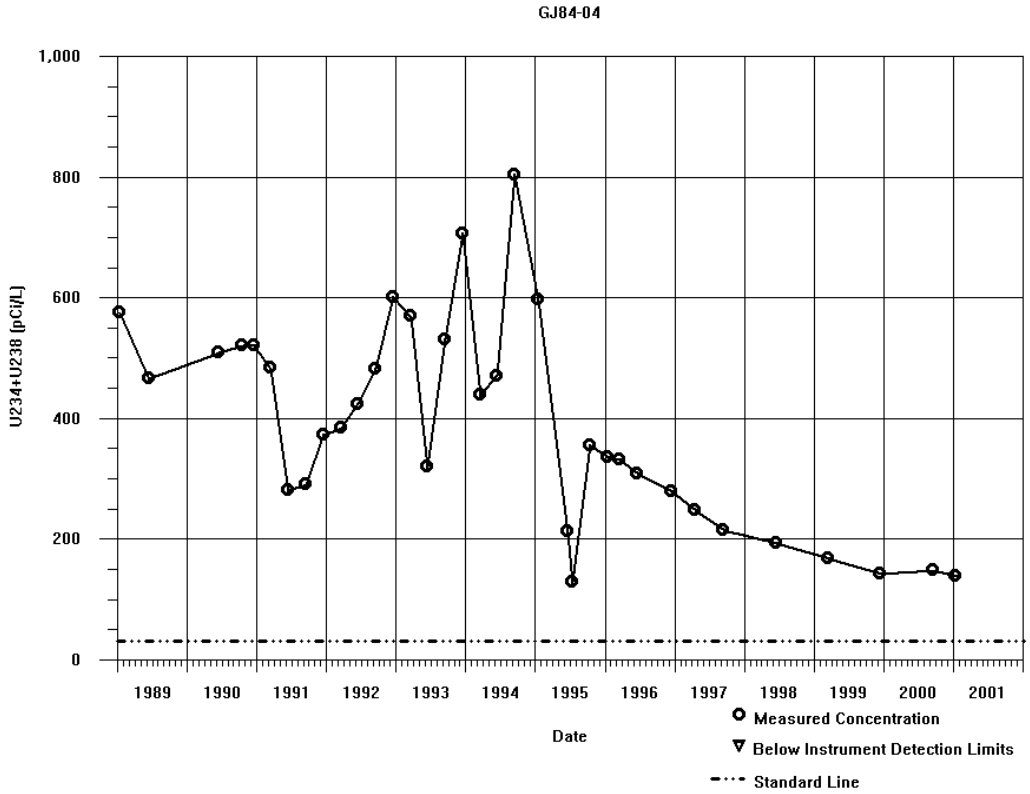

Figure B–21. Uranium Concentrations in Downgradient Well GJ84-04

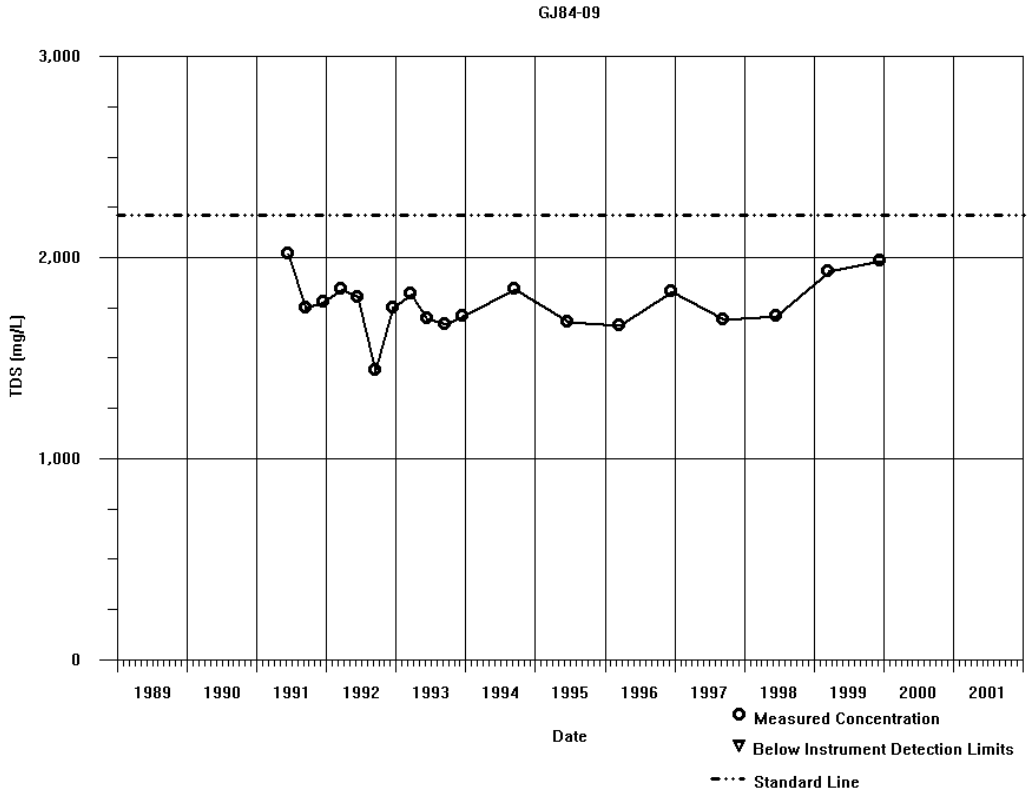

Figure B–22. TDS Concentrations in Upgradient Well GJ84-09

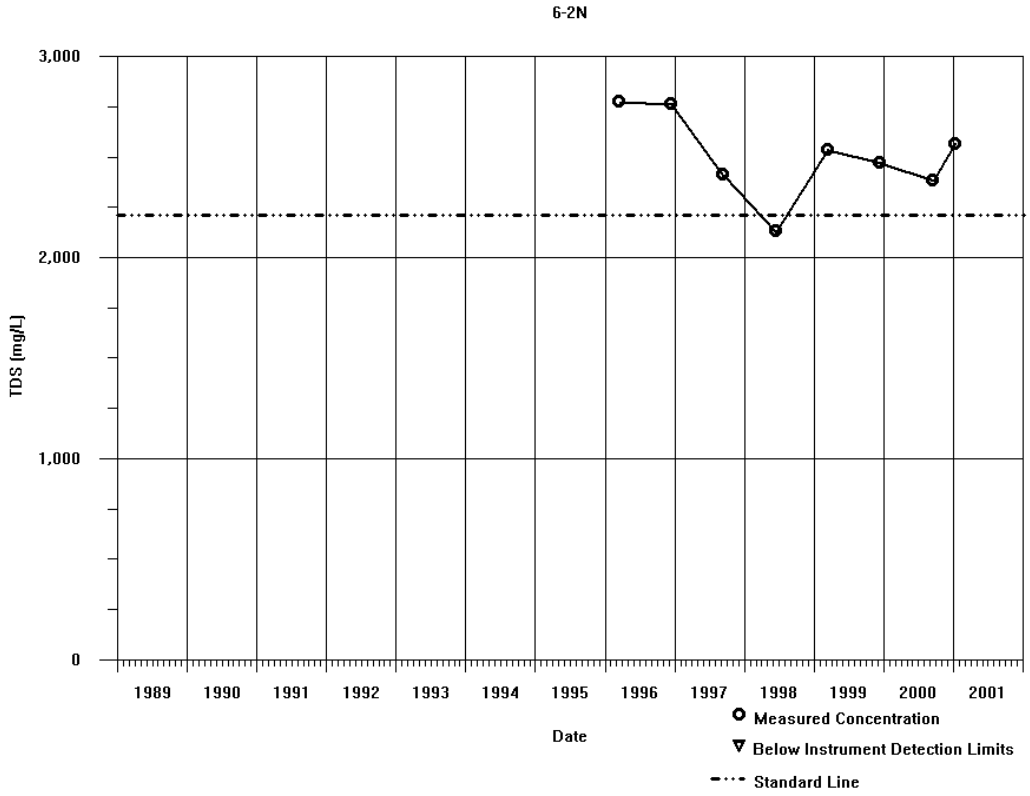

Figure B–23. TDS Concentrations in On-Site Well 6-2N

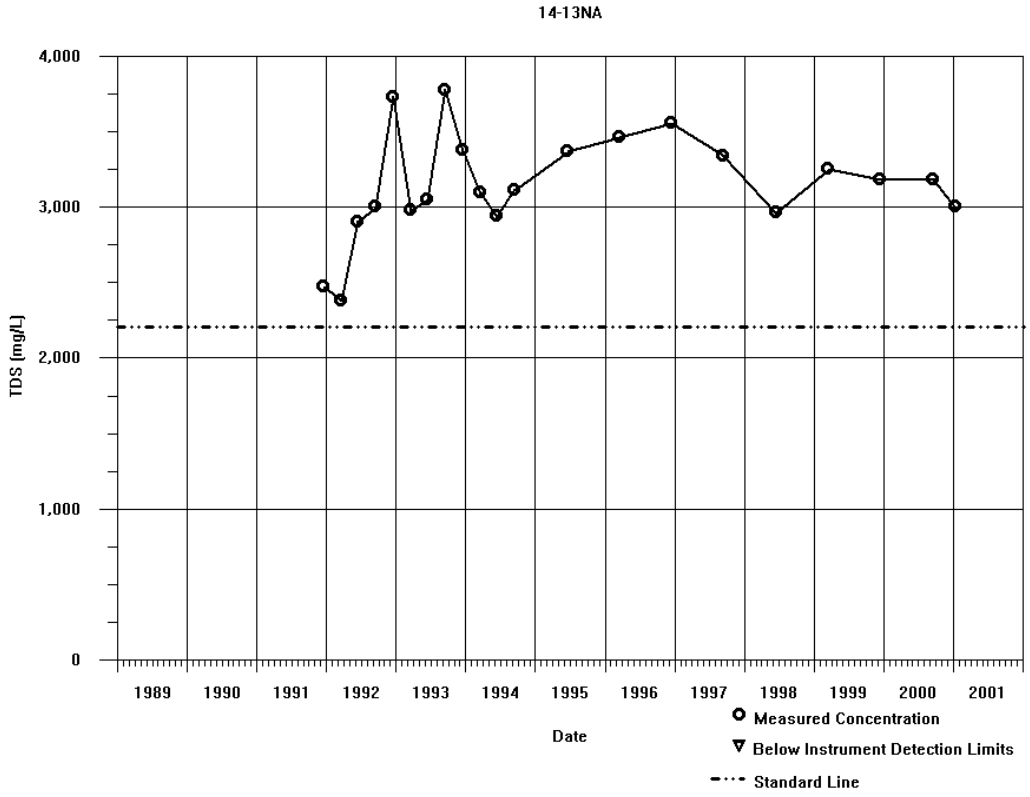

Figure B–24. TDS Concentrations in On-Site Well 14-13NA

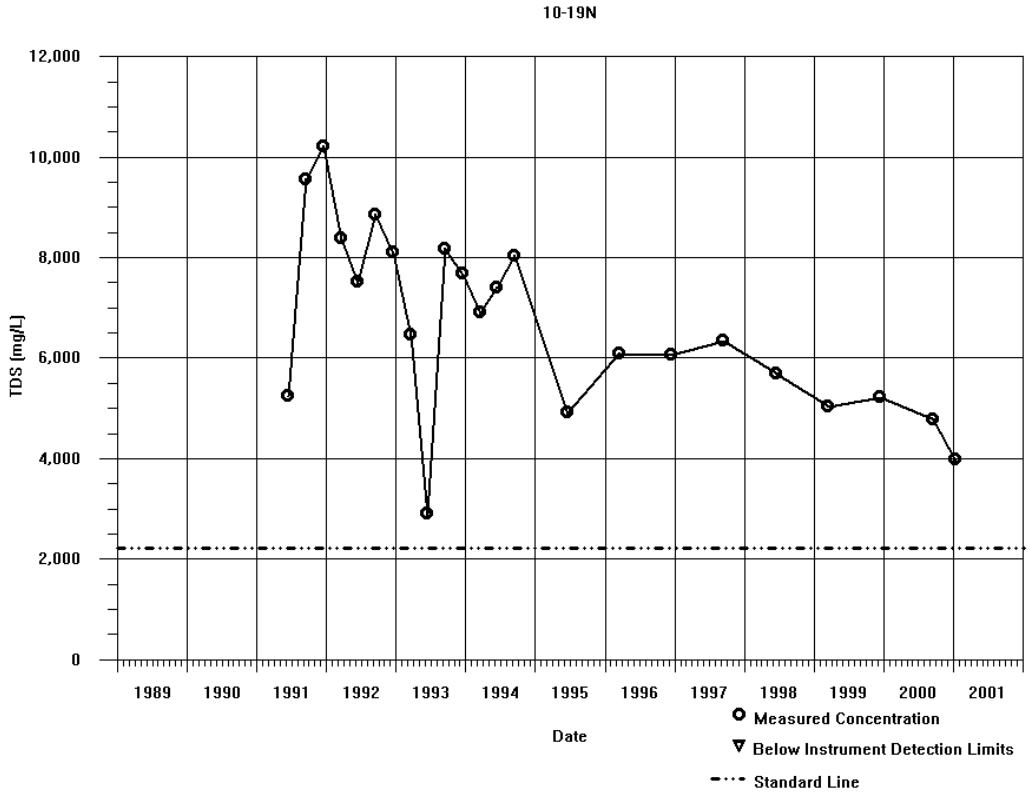

Figure B–25. TDS Concentrations in On-Site Well 10-19N

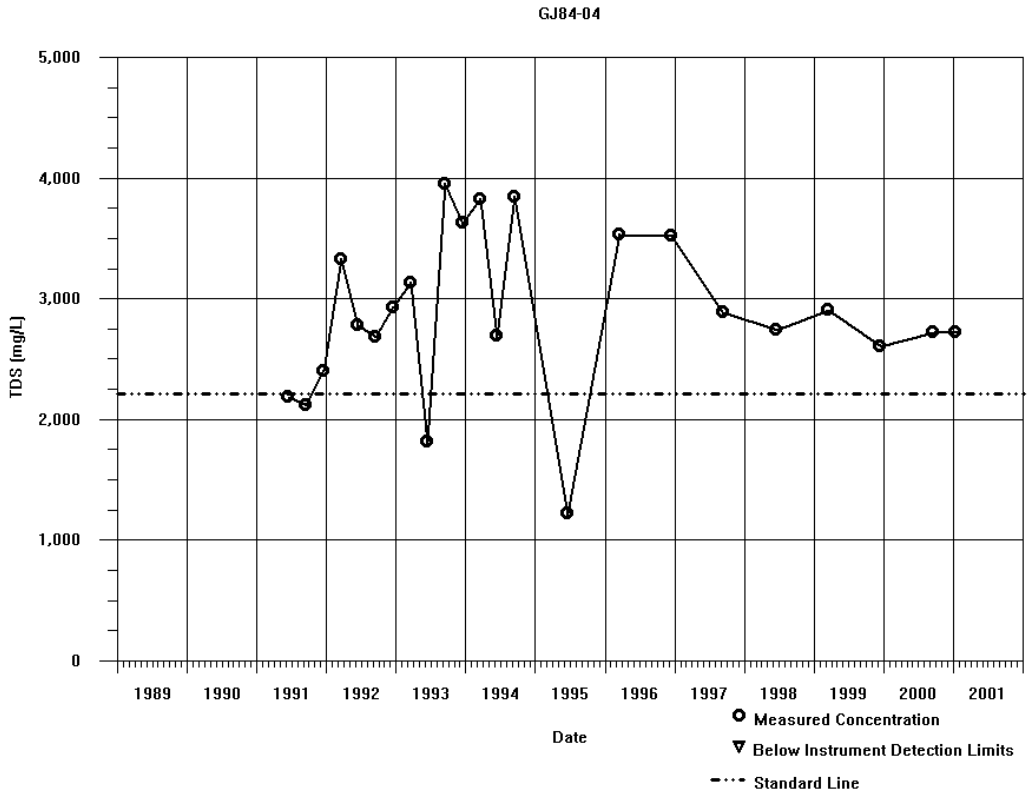

Figure B–26. TDS Concentrations in Downgradient Well GJ84-04

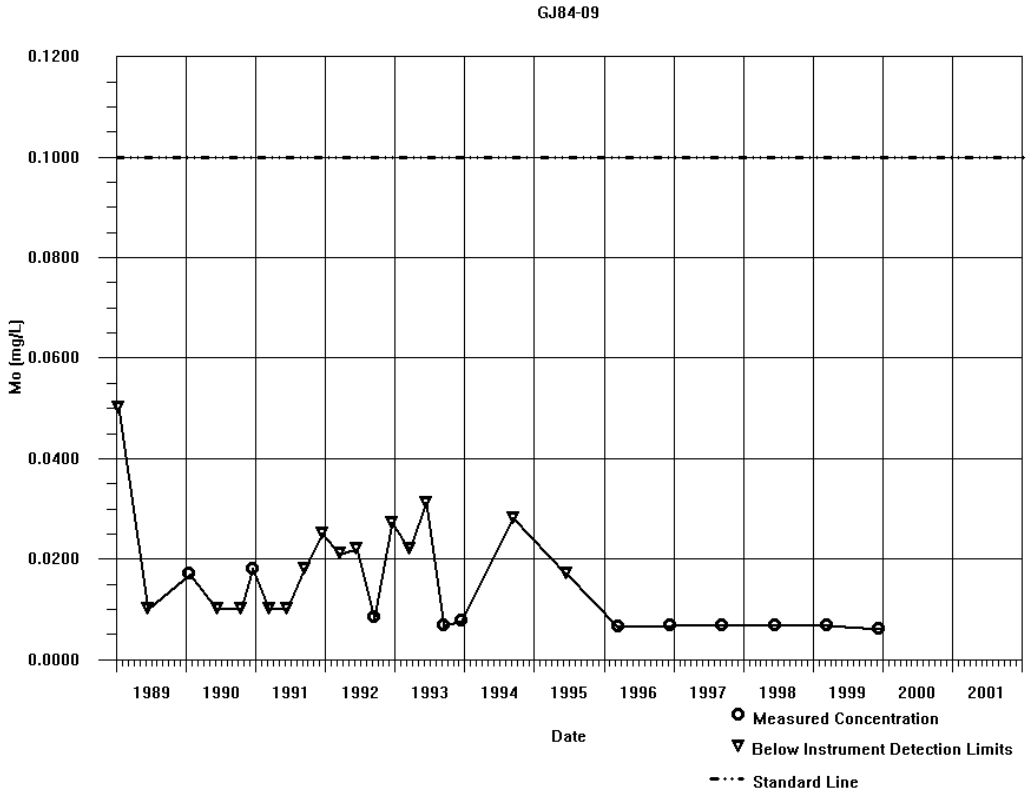

Figure B–27. Molybdenum Concentrations in Upgradient Well GJ84-09

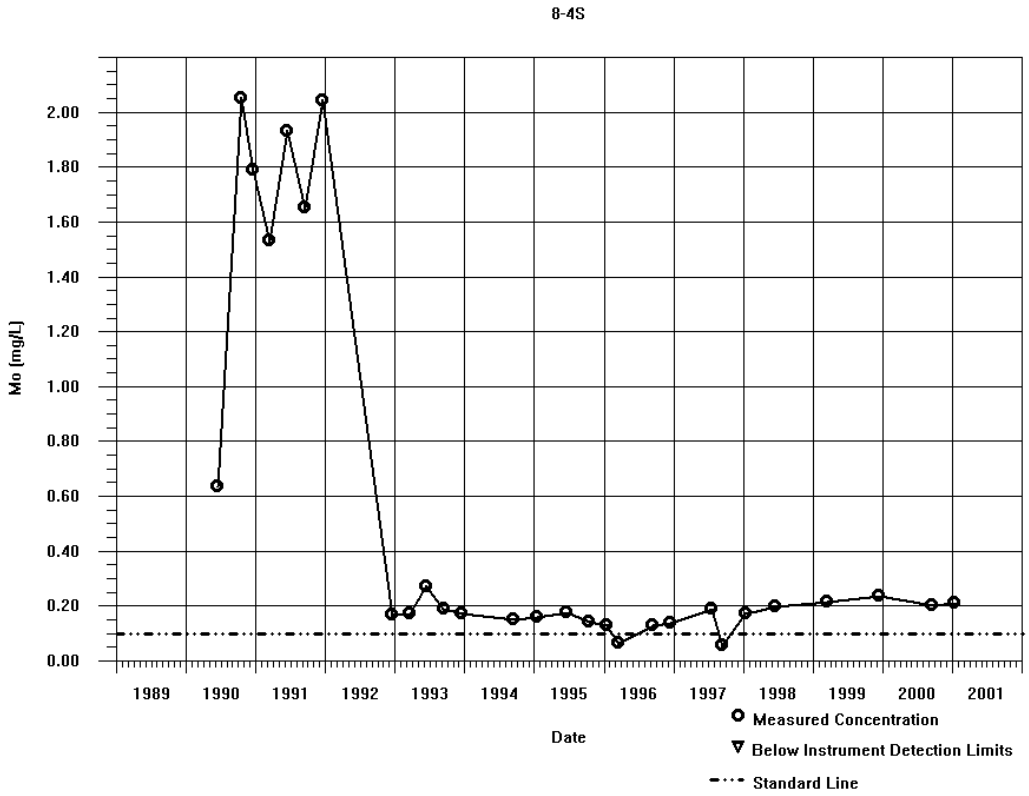

Figure B–28. Molybdenum Concentrations in On-Site Well 8-4S

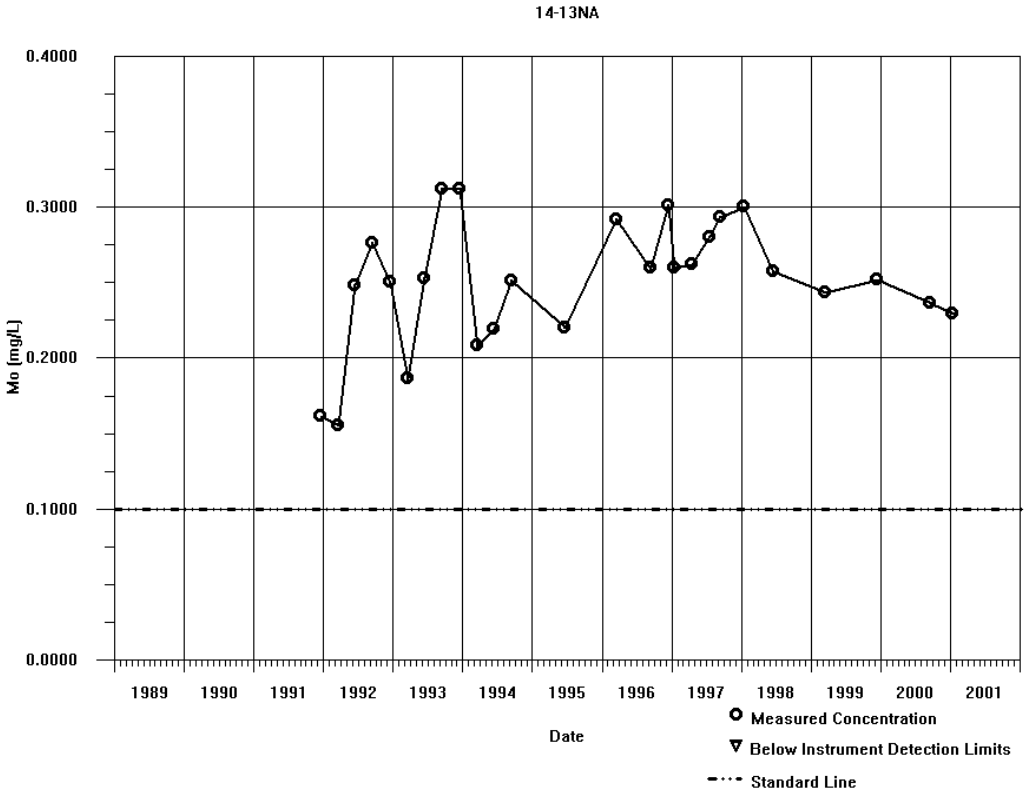

Figure B–29. Molybdenum Concentrations in On-Site Well 14-13NA

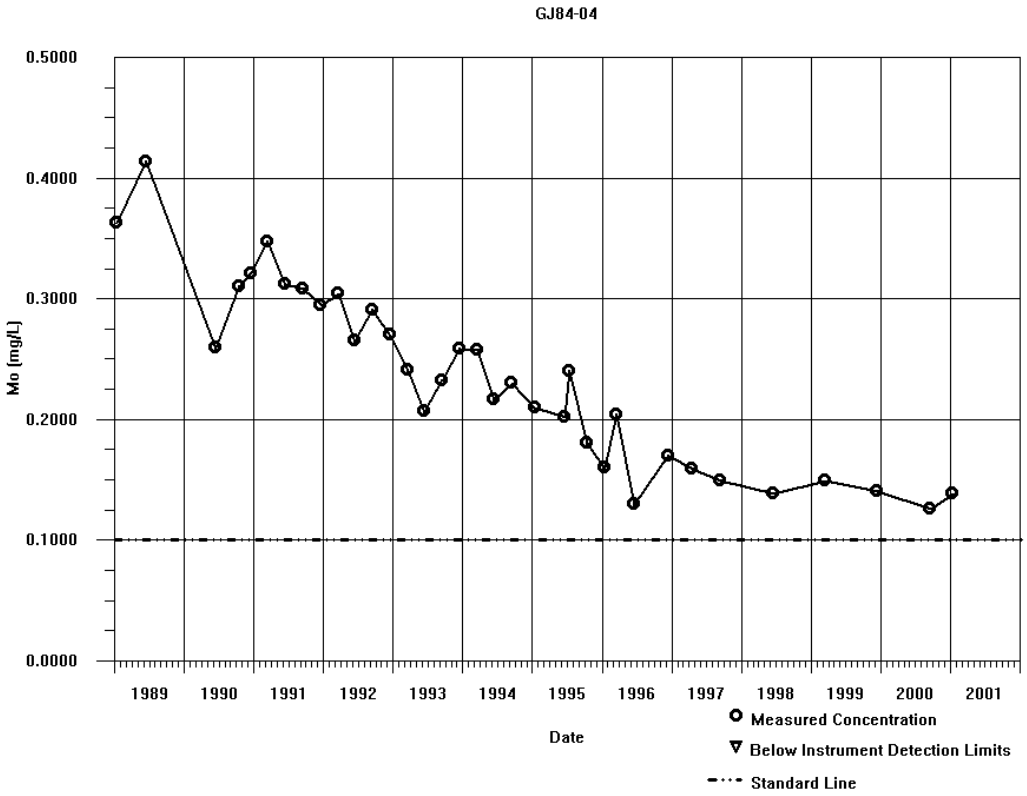

Figure B–30. Molybdenum Concentrations in Downgradient Well GJ84-04

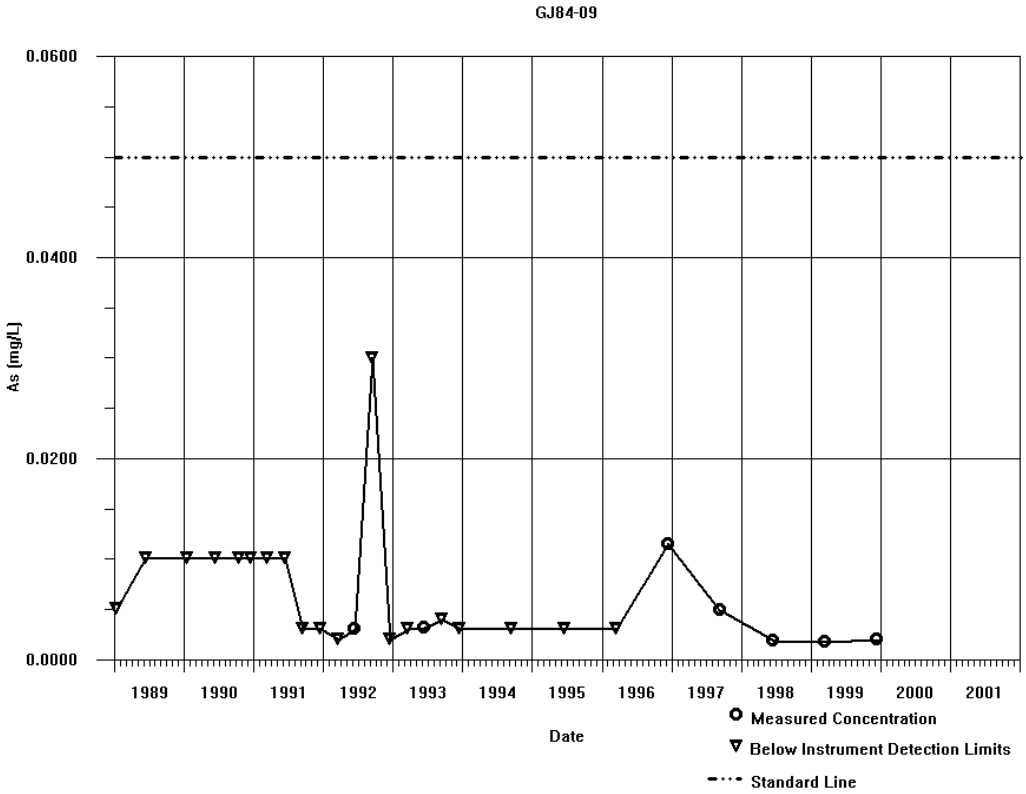

Figure B–31. Arsenic Concentrations in Upgradient Well GJ84-09

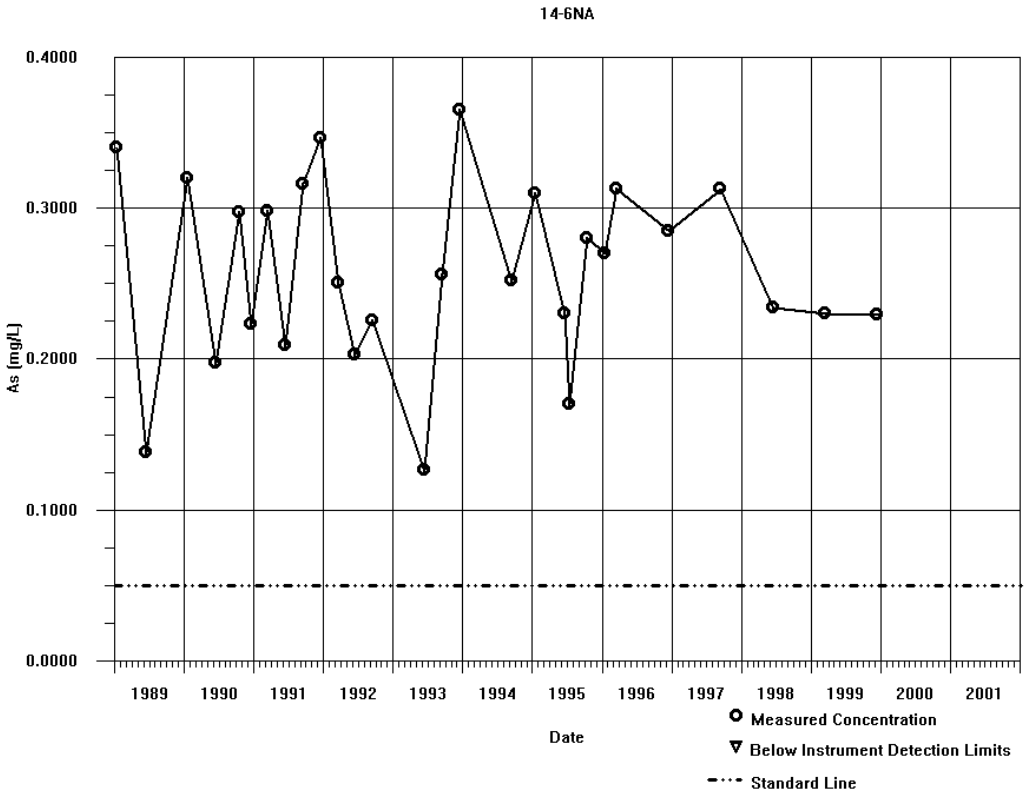

Figure B–32. Arsenic Concentrations in On-Site Well 14-6NA

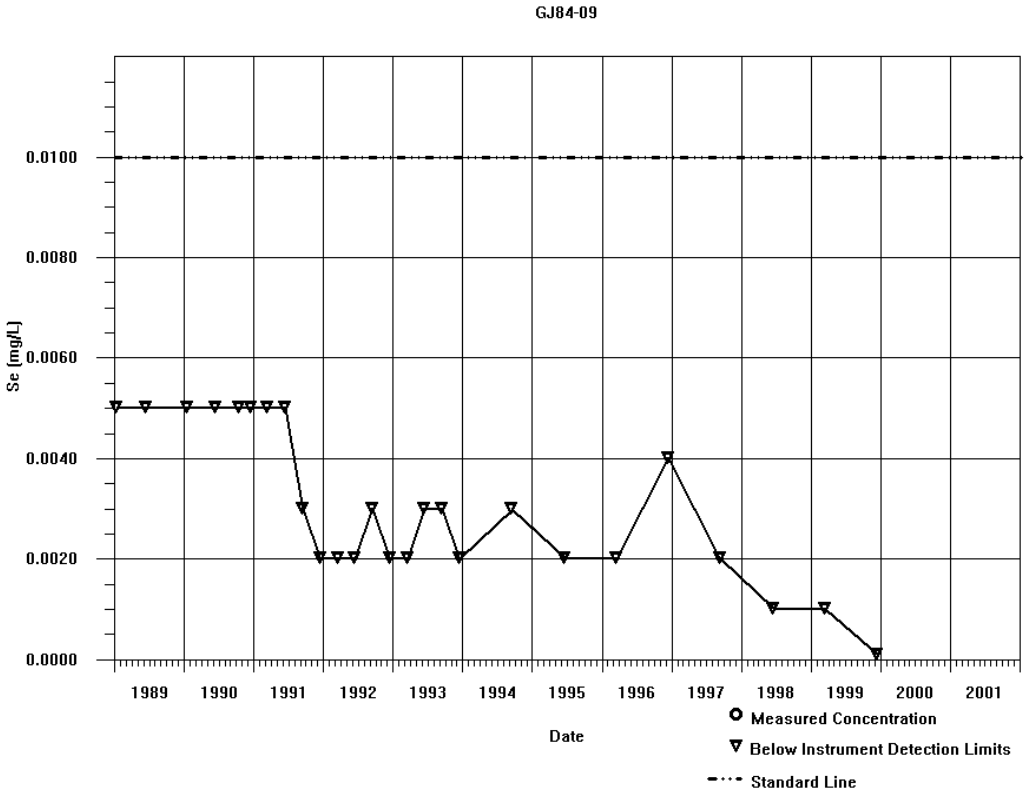

Figure B–33. Selenium Concentrations in Upgradient Well GJ84-09

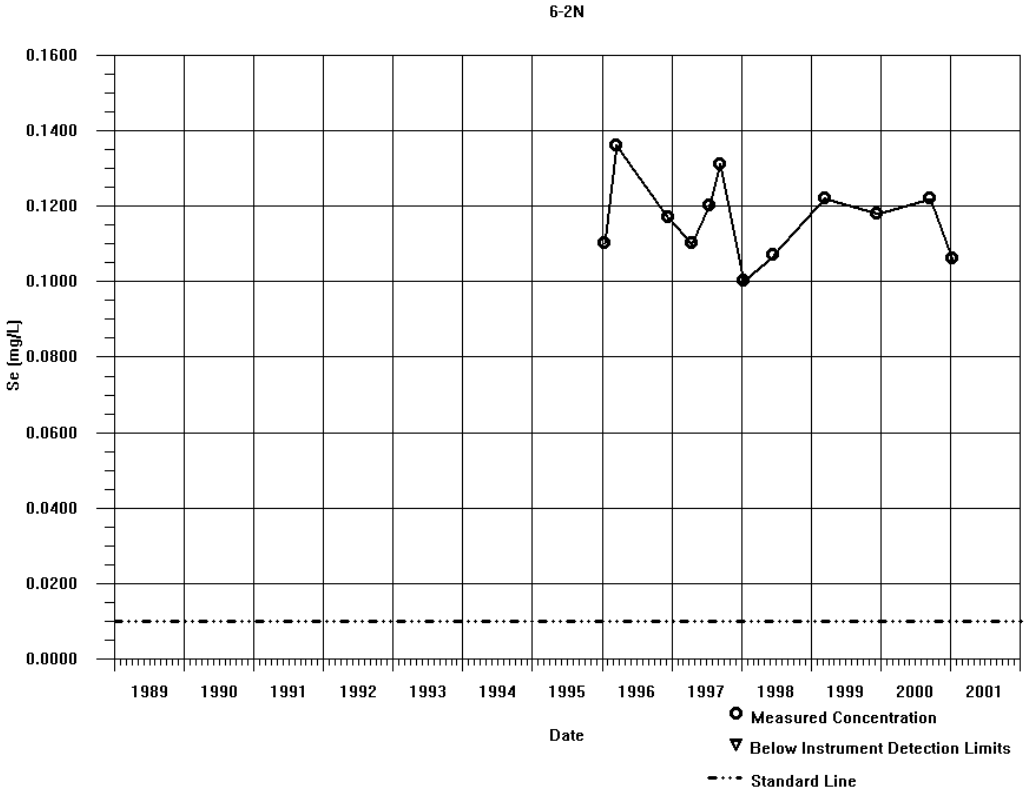

Figure B–34. Selenium Concentrations in On-Site Well 6-2N

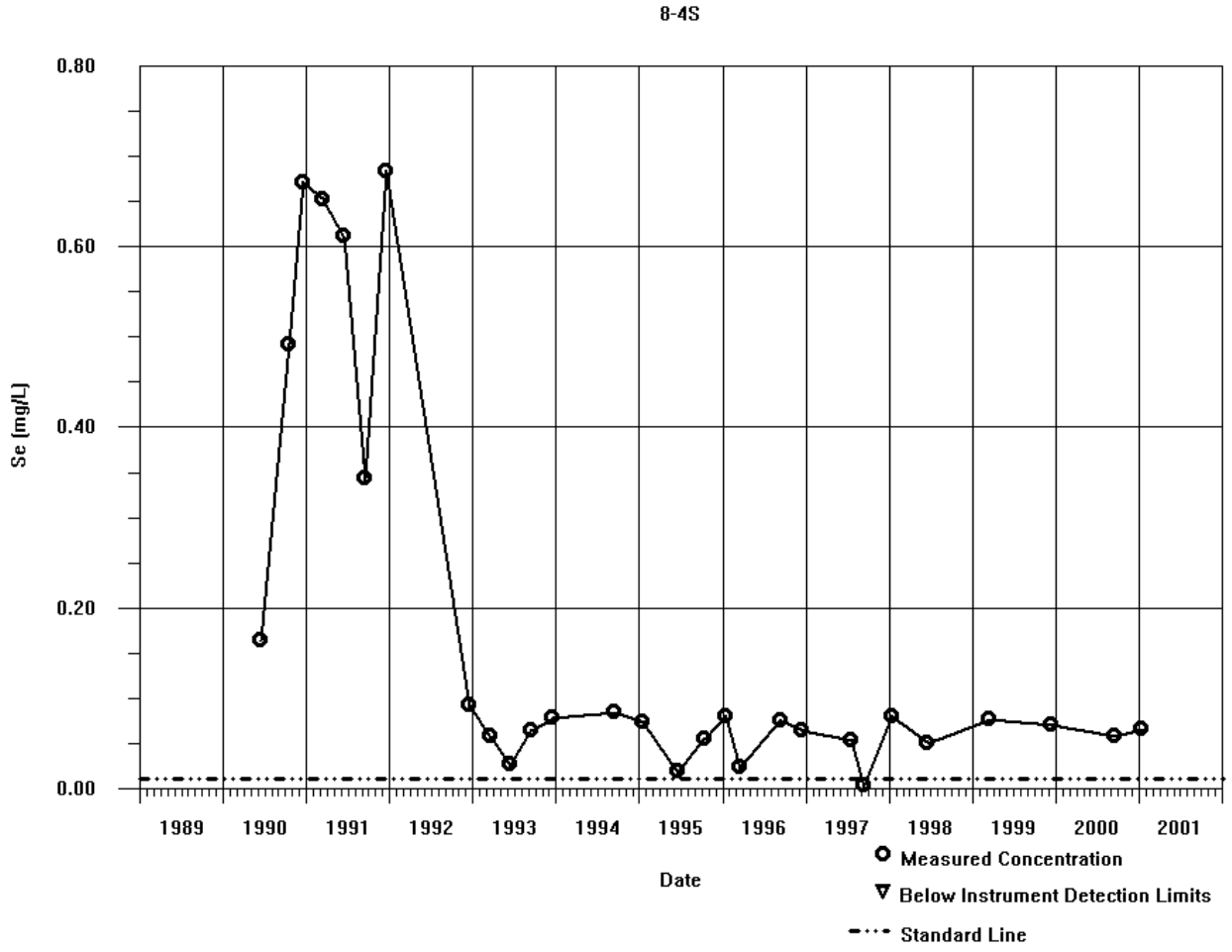

Figure B–35. Selenium Concentrations in On-Site Well 8-4S

Appendix C

GJO Ground Water Sampling and Analytical Design Schedule

Table C–1. GJO Ground Water Sampling and Analytical Design Schedule

Month	Contractor	Wells Sampled	Analytes Measured
January	*MACTEC-ERS, LLC (LTSM Program)*	10–19N, 11–1S, 14–13NA, 6–2N, 8–4S, GJ84–04	As, Cl, Cr, Fe, Mg, Mn, Mo, NO_3, SO_4, Se, U, and V; alkalinity, conductivity, gross alpha/beta, pH, total dissolved solids, temperature and turbidity

Table C–2. GJO Surface Water Sampling and Analytical Design Schedule

Month	Contractor	Locations Sampled	Analytes Measured
January	*MACTEC-ERS, LLC (LTSM Program)*	Upper-middle Gunnison, Lower Gunnison, North Pond, South Pond, Wetlands	As, Cl, Cr, Fe, Mg, Mn, Mo, NO_3, SO_4, Se, U, and V; alkalinity, conductivity, gross alpha/beta, pH, total dissolved solids, temperature and turbidity