IR069

P-GJO-1244

U.S. Department of Energy
Grand Junction Office

Groundwater Protection Management Program Plan

November 1996

U.S. Department of Energy

GRAND JUNCTION OFFICE

Work Performed Under DOE Contracts No. DE-AC13-95GJ87335 and No. DE-AC13-95GJ87460 for the U.S. Department of Energy

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Prepared By
U.S. Department of Energy
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Table of Contents

Page

1.0 OVERVIEW 1
1.1 Introduction 1
1.2 Summary 2

2.0 POLICY 4

3.0 EXISTING CONDITIONS 5
3.1 Grand Junction Office 5
3.2 Grand Junction Projects Office Remedial Action Project 5
3.3 Monticello Mill Tailings Site 5

4.0 OBJECTIVES 11

5.0 STRATEGY 12

6.0 IMPLEMENTATION 13
6.1 Hydrogeologic Regime Analysis 13
6.1.1 Program Overview 13
6.1.2 Regulatory Requirements 13
6.1.2.1 GJO/GJPORAP 13
6.1.2.2 MMTS 14
6.1.3 Organizational Responsibilities 14
6.1.4 GJO/GJPORAP 14
6.1.4.1 Description of the Hydrogeologic Regime 14
6.1.4.2 Nature and Extent of Contamination 17
6.1.5 MMTS 19
6.1.5.1 Description of the Hydrogeologic Regime 19
6.1.5.2 Nature and Extent of Contamination 21
6.2 Sitewide Groundwater Monitoring 22
6.2.1 Program Overview 22
6.2.2 Regulatory Requirements 22
6.2.3 Organizational Responsibilities 22
6.2.4 Program Description 22
6.2.4.1 Monitoring Well Installation, Maintenance, and Abandonment 22
6.2.4.2 Sample Collection and Analysis 23
6.2.4.2.1 GJO/GJPORAP 23
6.2.4.2.2 MMTS 23
6.2.4.3 Data Management and Reporting 23
6.3 Groundwater Consumption 27
6.4 Facilities and Operations 27
6.4.1 Drinking Water 27

6.4.1 Drinking Water 27
6.4.2 Effluent Monitoring 27
6.4.2.1 Program Overview 27
6.4.2.2 Regulatory Requirements 27
6.4.2.3 Organizational Responsibilities 28
6.4.2.4 Program Description 28
6.5 Waste Management 29
6.5.1 Program Overview 29
6.5.2 Regulatory Requirements 29
6.5.2.1 Hazardous Waste 29
6.5.2.2 Radioactive and Mixed Waste 30
6.5.3 Organizational Responsibilities 30
6.5.4 Program Description 30
6.6 Environmental Restoration Program 30
6.6.1 Program Overview 30
6.6.2 Regulatory Requirements 30
6.6.2.1 GJPORAP 30
6.6.2.2 MMTS 31
6.6.3 Organizational Responsibilities 31
6.6.4 Program Description 31
6.6.4.1 GJPO Remedial Action Project 31
6.6.4.2 MMTS Remedial Action Project 31
6.7 Contamination Prevention 32
6.7.1 Waste Minimization and Pollution Prevention Awareness 32
6.7.1.1 Program Overview 32
6.7.1.2 Regulatory Requirements 32
6.7.1.3 Organizational Responsibilities 32
6.7.1.4 Program Description 32
6.7.2 Hazardous Materials Contingency Plan and Emergency Procedures 33
6.7.3 Underground Storage Tanks 33
6.7.3.1 Program Overview 33
6.7.3.2 Regulatory Requirements 33
6.7.3.3 Organizational Responsibilities 33
6.7.3.4 Program Description 34

REFERENCES 35

Figures

Page

Figure 1. Site Location Map of the GJO 6

2. Map of the GJO Facility Showing Areas of Radiological Contamination and Remediation 7

3. Site Location Map of the MMTS 8

4. Radiological Contamination Map of the Monticello Millsite 9

5. Geological Cross Section of the Alluvial Aquifer at the GJO Facility 16

6. Typical Stratigraphic Column at the GJO Facility (compiled from well GJ87-18) 18

7. Generalized West-East Cross Section Through the Monticello Millsite 20

8. Groundwater Sampling Locations at the GJO Facility 24

9. Groundwater Sampling Locations On and Upgradient of the Monticello Millsite 25

10. Groundwater Sampling Locations Downgradient of the Monticello Millsite 26

ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
BAT	Best Available Technology
CCR	Code of Colorado Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-GJO	U.S. Department of Energy Grand Junction Office
EA	Environmental Assessment
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EPC	Environmental Procedures Catalog
FOS	Facilities and Operations Support Contractor
FSP	Field Sampling Plan
FY	Fiscal Year
GJO	Grand Junction Office
GJPORAP	Grand Junction Projects Office Remedial Action Project
GPMP	Groundwater Protection Management Program
HMCPEP	Hazardous Materials Contingency Plan and Emergency Procedures
LTSM	Long-Term Surveillance and Maintenance
MMTS	Monticello Mill Tailings Site
NEPA	National Environmental Policy Act
OU I	Operable Unit I
OU II	Operable Unit II
OU III	Operable Unit III
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RI/FS—EA	Remedial Investigation/Feasibility Study—Environmental Assessment
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
TAR	Technical Assistance and Remediation Contractor
UAC	Utah Administrative Code
UPDES	Utah Pollution Discharge Elimination System
UST	Underground Storage Tank
WMPPAP	Waste Minimization and Pollution Prevention Awareness Plan
WP	Work Plan
WWTP	Waste Water Treatment Plant

1.0 OVERVIEW

1.1 Introduction

Development of a Groundwater Protection Management Program (GPMP) for the U.S. Department of Energy Grand Junction Office (DOE-GJO) is required by the U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program," Chapter III (4)(a). This order establishes the framework necessary to protect, maintain, and restore environmental quality; minimize potential threats to the public and the environment; and comply with applicable laws, regulations, and DOE policies for the DOE-GJO. Preparation of this GPMP plan is the joint responsibility of MACTEC-ERS (the Technical Assistance and Remediation [TAR] Contractor) and *WASTREN-Grand Junction* (the Facilities and Operations Support [FOS] Contractor).

The DOE-GJO is responsible for current operations at the Grand Junction Office (GJO) facility, remedial activities at the GJO under the Grand Junctions Projects Office Remedial Action Project (GJPORAP) and remedial activities at the Monticello Mill Tailings Site (MMTS) in Monticello, Utah. The GPMP plan addresses overall groundwater protection for these operations and activities. Key documents that support the GPMP have been prepared in compliance with DOE orders, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the National Environmental Policy Act (NEPA). They include:

- *Final Remedial Investigation/Feasibility Study—Environmental Assessment for the U.S. Department of Energy Grand Junction (Colorado) Projects Office Remedial Action Project* (GJPORAP RI/FS—EA) (DOE 1989a)

- *Final Remedial Investigation/Feasibility Study—Environmental Assessment for the Monticello, Utah, Uranium Mill Tailings Site* (MMTS RI/FS—EA) (DOE 1990d)

- *Monticello Mill Tailings Site--Declaration for the Record of Decision and Record of Decision Summary* (DOE 1990e)

- *Grand Junction Projects Office Facility, Grand Junction Projects Office Remedial Action Project, and the Monticello Mill Tailings Site Environmental Monitoring Plan* (EMP) (DOE 1992b)

- *Grand Junction Projects Office Facility, Grand Junction Projects Office Remedial Action Project, Monticello Mill Tailings Site Sampling and Analysis Plan for Environmental Monitoring* (SAP) (DOE 1992c)

- *Monticello Mill Tailings Site, Operable Unit III, Surface- and Ground-Water Remedial Investigation/Feasibility Study Field Sampling Plan* (DOE 1995b)

- *Grand Junction Projects Office Site Environmental Report for Calendar Year 1995* (DOE 1996a)

- *Monticello Mill Tailings Site Environmental Summary for Calendar Year 1995* (DOE 1996b).

1.2 Summary

The hydrogeologic regimes of importance at the GJO facility and the MMTS are unconsolidated alluvial aquifers. These aquifers have been affected by the disposal of uranium mill tailings and uranium ore from past uranium milling operations. Although groundwater from the alluvial aquifers is not used, the aquifers discharge to nearby surface water. Deeper aquifers at both sites are used for domestic water supplies, but communication between these and the alluvial aquifers is inhibited by intervening aquitards.

Groundwater regimes for the GJO facility and the MMTS have been characterized by hydrogeologic and hydrochemical studies initiated under the DOE Environmental Restoration Program. Data collected from monitoring wells at the GJO facility were used to develop a predictive model for transport of contaminants resulting from past waste disposal activities. Currently, data are being collected at MMTS for use in developing a predictive model for contaminant transport. Monitoring at these sites continues at a reduced scale.

Remedial Investigation/Feasibility Studies—Environmental Assessments (RI/FS—EAs) that meet the requirements of both CERCLA and NEPA have been prepared for both the GJPORAP and the MMTS. The RI/FS—EAs and the approved Records of Decision (ROD) describe the proposed environmental restoration programs. With the majority of the mill tailings and contaminated soil removed, the environmental restoration program for GJPORAP is nearing completion; however, small quantities of contaminated soil surrounding several GJO buildings will continue to be removed through September 30, 2000. The program proposed for MMTS, Operable Unit I (OU I) (mill tailings and millsite property), commenced in FY 1996; the program proposed for MMTS, Operable Unit II (OU II) (peripheral properties), began in 1993.

Environmental restoration at both the GJO facility and the MMTS entails removal of uranium mill tailings and contaminated soil, which are the source of the groundwater contamination. Groundwater monitoring will continue during the remediation activities to assess the effectiveness of the proposed programs. Long-term surveillance and maintenance (LTSM) programs will be established for the GJO facility and the MMTS. The repository for the MMTS also will have an LTSM program to ensure that human health and the environment are not adversely affected. Passive remediation of the alluvial aquifer at the GJO facility is expected to occur within 50-80 years.

Groundwater discharges to nearby surface water during the passive remediation process at the GJO facility do not present a significant risk to downstream users. A remedial investigation of the groundwater and surface water at MMTS (referred to as Operable Unit III [OU III]) is being conducted to assess the extent of contamination, assess the human and ecological risk associated with the contamination, and develop alternatives for cleanup of groundwater and surface water.

The goal of the DOE-GJO and its contractors at the GJO facility and MMTS is to conduct day-to-day operations in an environmentally safe and responsible manner. Accordingly, operations at the GJO facility and MMTS are conducted in compliance with all regulations and legal documents, including the Federal Facilities Agreement (U.S. EPA et al. 1988) related to groundwater protection. Hazardous waste, mixed waste, radioactive uranium mill tailings, and commingled waste (uranium mill tailings mixed with hazardous constituents) are handled in a manner that protects the hydrologic regime. Waste minimization programs have been implemented at the GJO and MMTS to reduce the potential impacts of waste generation.

2.0 POLICY

The DOE-GJO GPMP requires that facility operations and remedial actions be conducted in a manner that protects, maintains, and restores environmental quality to the groundwater; minimizes potential threats to the public and the environment; and complies with applicable laws, regulations, and DOE policies.

The DOE-GJO and the TAR and FOS contractors are committed to protecting the public health and the environment in a manner consistent with all DOE orders, particularly DOE Orders 5400.1 and 5400.5. DOE Order 5400.1 provides comprehensive direction for programs designed to ensure compliance with internal DOE policies and federal, state, and local environmental laws and regulations. DOE Order 5400.5, "Radiation Protection of the Public and the Environment," establishes standards and requirements for operations at DOE facilities to protect the environment and members of the public from undue risks associated with radiation.

3.0 EXISTING CONDITIONS

3.1 Grand Junction Office

The GJO facility is located in Mesa County, western Colorado, immediately south and west of the Grand Junction city limits (Figure 1). Contractor personnel provide technical and administrative support for various DOE, U.S. Department of Defense, and U.S. Environmental Protection Agency (EPA) programs and provide laboratory and construction-related services for a variety of remedial programs.

Operations at the GJO facility are conducted in an environmentally safe and responsible manner. Waste disposal operations are conducted in compliance with applicable regulations. The GJO facility is considered a conditionally exempt small-quantity generator of hazardous waste. Before off-site disposal, hazardous wastes are stored in a designated area in a manner that prevents groundwater contamination. Facility sanitary wastewater is discharged to the local publicly owned treatment works (POTWs) in accordance with the conditions established in the Industrial Pretreatment Permit. Solid, nonhazardous waste is transported to local landfills.

3.2 Grand Junction Projects Office Remedial Action Project

The GJPORAP manages the removal of environmental hazards associated with the uranium mill tailings generated by earlier milling operations at the GJO facility (Figure 2). On-site remedial activities began in 1989 and are ongoing. Documentation of the decisions leading to remedial action is in the GJPORAP RI/FS—EA (DOE 1989a), the *Grand Junction Projects Office Remedial Action Project Finding of No Significant Impact* (DOE 1989d), and the *Declaration for the Record of Decision and Record of Decision Summary—Grand Junction Projects Office Remedial Action Project* (DOE 1990a).

3.3 Monticello Mill Tailings Site

Activities at the MMTS include the removal of approximately 2,000,000 cubic yards of uranium mill tailings and tailings-contaminated soil from the millsite. The millsite is located along Montezuma Creek south of the City of Monticello, San Juan County, Utah, as illustrated in Figure 3. The objective of remedial action is to restore the government-owned millsite to safe levels of radioactivity and metals concentrations and to stabilize the tailings in an environmentally safe manner in the on-site repository south of the millsite. Figure 4 shows the extent of contamination on the millsite and parts of OU III. Documentation of the decisions leading to the proposed remedial action is in

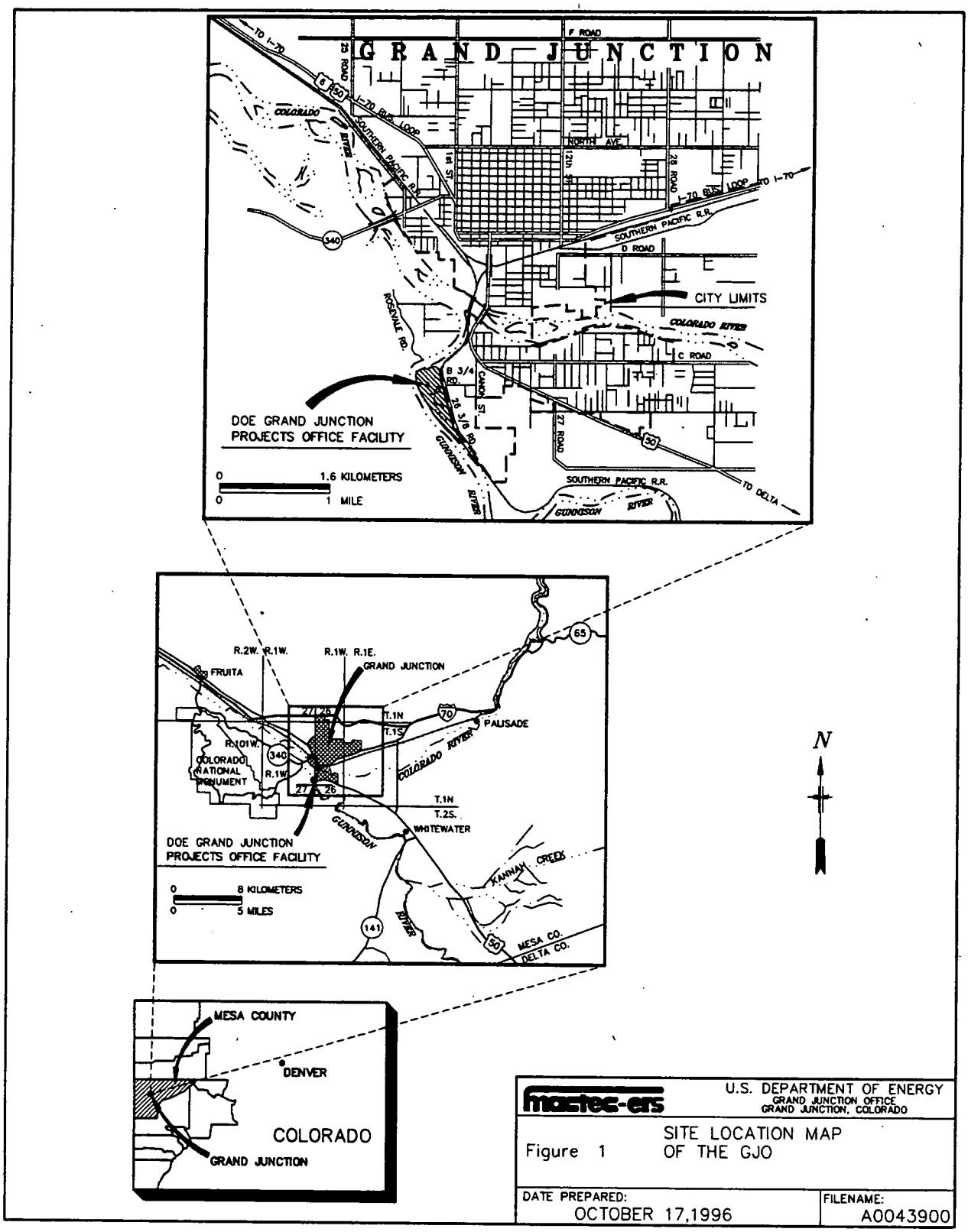

Figure 1. Site Location Map of the GJO

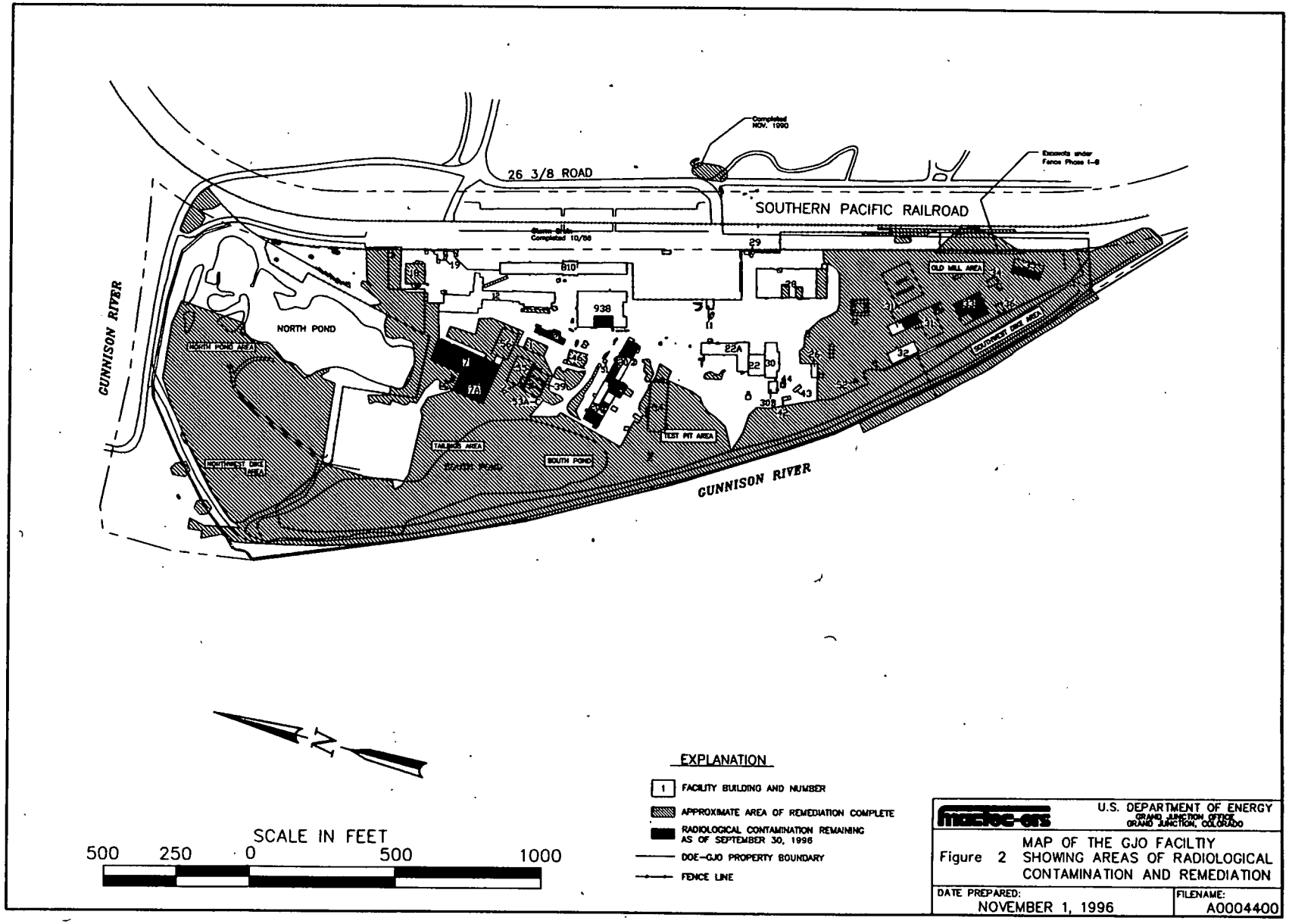

Figure 2. Map of the GJO Facility Showing Areas of Radiological Contamination and Remediation

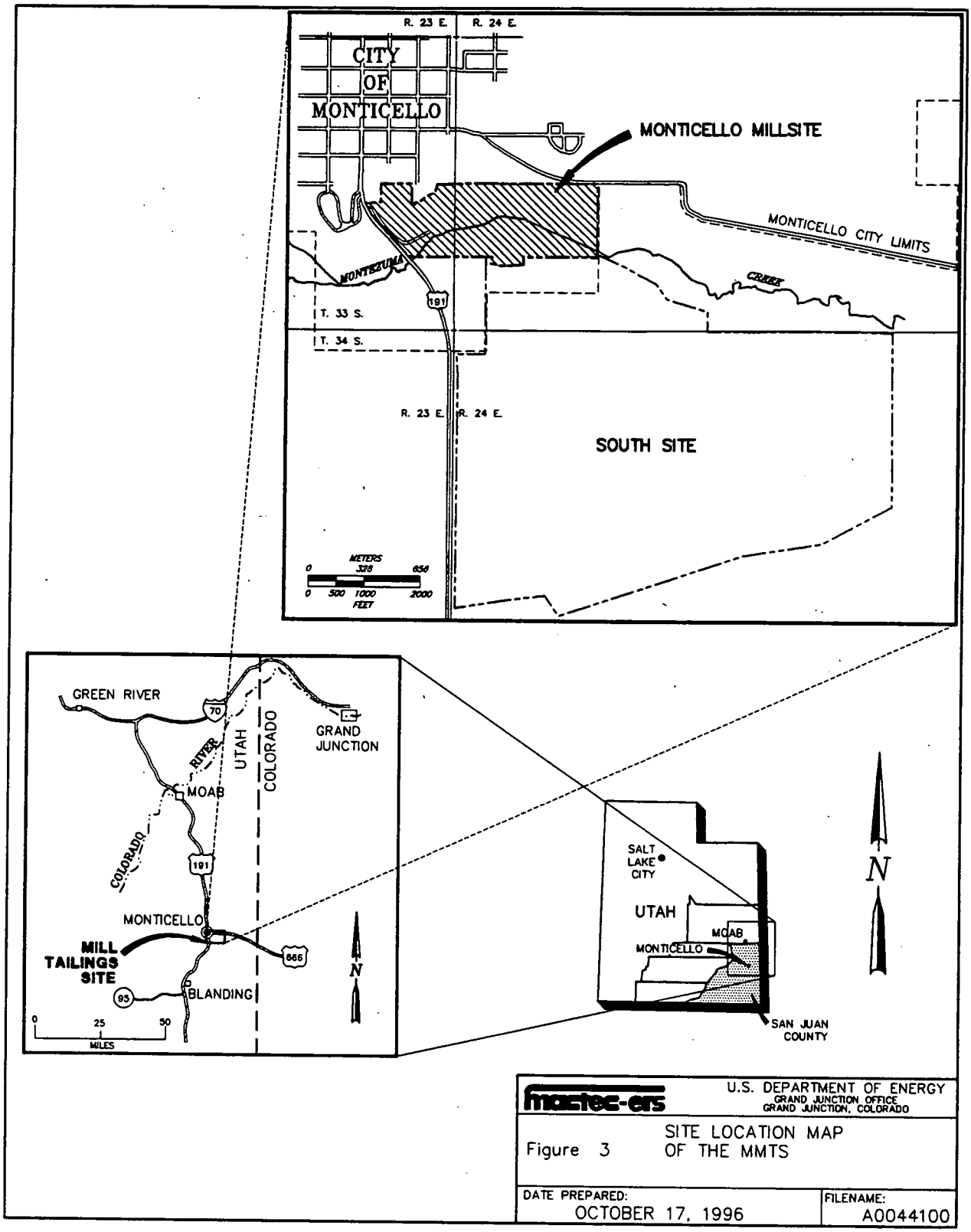

Figure 3. Site Location Map of the MMTS

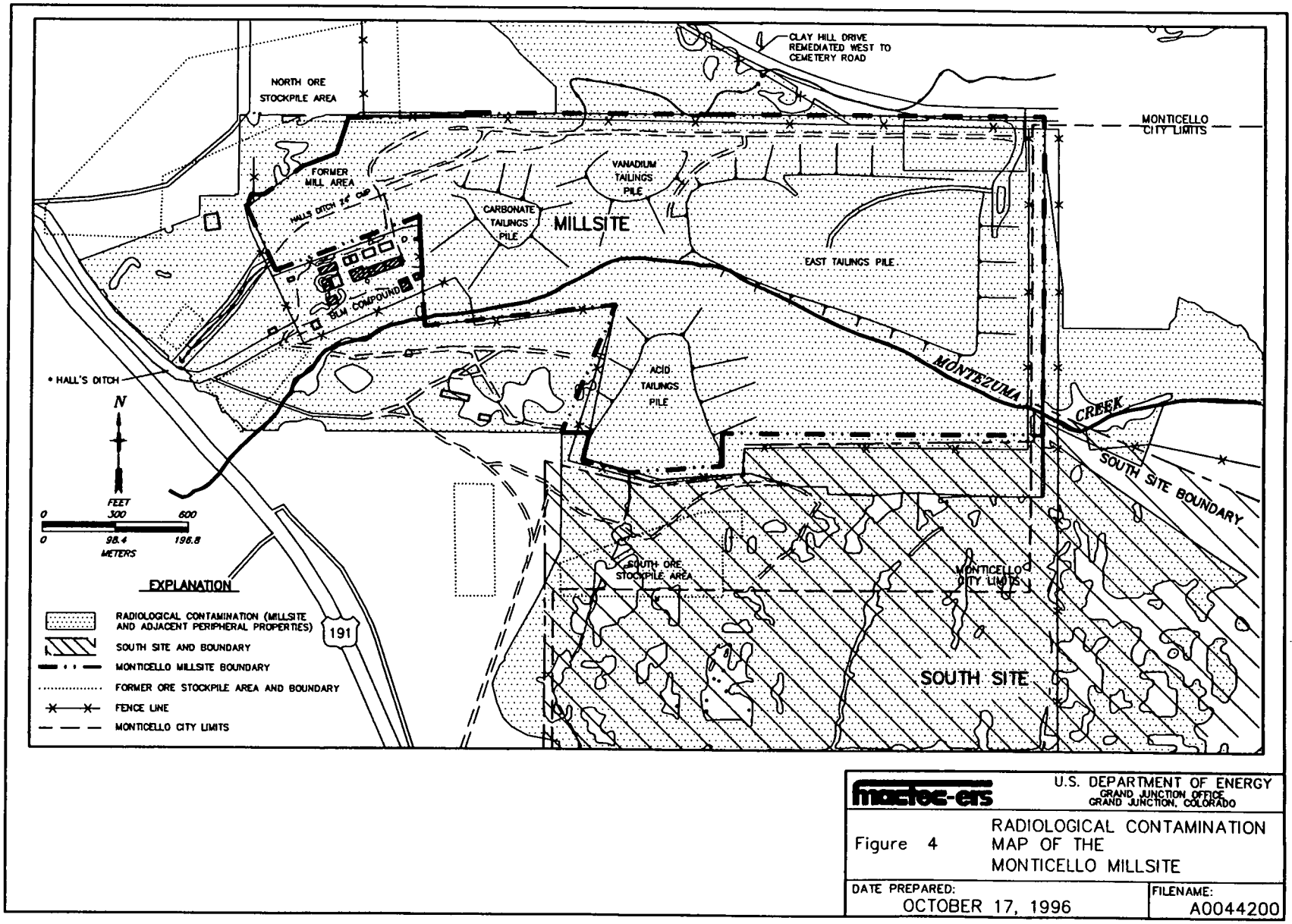

Figure 4. Radiological Contamination Map of the Monticello Millsite

the MMTS RI/FS—EA (DOE 1990d), the *Monticello Mill Tailings Site Finding of No Significant Impact* (DOE 1989e), the *Monticello Mill Tailings Site—Declaration for the Record of Decision and Record of Decision Summary* (DOE 1990e). Remedial design activity for the repository is complete. Millsite restoration design continues.

4.0 OBJECTIVES

The objectives of the GPMP are

- To operate the GJO facility and MMTS in a manner that protects groundwater quality.
- To return groundwater contaminated by past waste disposal operations at the GJO facility and the MMTS to an environmentally acceptable quality.
- To assess existing groundwater conditions and verify the current understanding of hydrogeologic conditions.
- To evaluate the adequacy of proposed remedial action programs.
- To comply with all waste disposal requirements related to groundwater protection.

5.0 STRATEGY

The strategy for reaching the objectives of the GPMP for the current activities at the GJO facility includes

- Identification of regulatory and other groundwater protection requirements.
- Identification of areas of operation where current activities may affect groundwater quality.
- Development of operating procedures that will protect the hydrogeologic regime.
- Assessment of the need to redesign current facilities to protect groundwater quality and, where necessary, implementation of design changes.
- Development and implementation of administrative controls to ensure continued protection of the hydrogeologic regime.

The strategy for reaching the objectives of the GPMP for the GJPORAP and the MMTS includes

- Identification of regulatory and other groundwater protection requirements.
- Identification of the nature and extent of past waste disposal operations that have affected groundwater quality.
- Design and implementation of remedial action(s) to reduce the contaminant concentrations in the hydrogeologic regime to acceptable levels.
- Development of a groundwater monitoring plan to evaluate the effectiveness of the remedial action.
- Development and implementation of administrative controls to ensure the continued protection of the hydrogeologic regime.

6.0 IMPLEMENTATION

The seven principal elements of the GPMP are listed below.

- Hydrogeologic Regime Analysis: characterization of the groundwater systems at the GJO facility and MMTS (Section 6.1).
- Sitewide Groundwater Monitoring: monitoring of the groundwater system to characterize the hydrogeologic regime and evaluate the effectiveness of the protective measures implemented by the GPMP (Section 6.2).
- Groundwater Consumption: management of groundwater use to ensure protection of the hydrogeologic regime (Section 6.3).
- Facilities and Operations: monitoring of liquid waste discharges from operating facilities that could affect the hydrogeologic regime (Section 6.4).
- Waste Management: management of the disposal of all waste streams in a manner that protects the hydrogeologic regime (Section 6.5).
- Environmental Restoration Program: passive remediation of the hydrogeologic regime where there has been significant degradation of the groundwater system (Section 6.6).
- Contamination Prevention: minimization of waste, prevention of spills, and development of an underground storage tank program to provide control over facility operations that could affect the hydrogeologic regime (Section 6.7).

6.1 Hydrogeologic Regime Analysis

6.1.1 Program Overview

Characterization of the hydrogeologic regime is necessary to evaluate potential impacts to the groundwater resource and to determine measures necessary for the protection and remediation of that resource. This section combines the description of the hydrogeologic regime for ongoing GJO operations and GJPORAP because they involve the same area.

6.1.2 Regulatory Requirements

6.1.2.1 GJO/GJPORAP

The regulatory requirements implementing hydrogeologic regime characterization are in the GJPORAP RI/FS—EA (DOE 1989a). The regulatory requirements implementing

groundwater protection are listed as applicable or relevant and appropriate requirements (ARARs) in the GJPORAP ROD (DOE 1990a).

6.1.2.2 MMTS

As outlined in the Federal Facilities Agreement (U.S. EPA et al. 1988) for the MMTS, the state of Utah provided a proposed list of state ARARs to DOE and EPA in February 1989. DOE then conducted a detailed ARARs analysis to establish cleanup standards at the site, taking into account both federal and state ARARs. This list is summarized in the Final RI/FS—EA (DOE 1990d). The ARARs for OU I and OU II are identified in the MMTS ROD (DOE 1990e) and the potential ARARs for OU III are listed in the *Monticello Mill Tailings Site, Operable Unit III, Remedial Investigation/Feasibility Study Work Plan, Draft Final* (DOE 1995c).

6.1.3 Organizational Responsibilities

Analysis of the hydrogeologic regimes at the GJO facility and the MMTS has been conducted under the direction of the respective DOE Project Managers. The FOS/TAR Program Manager(s) direct the FOS/TAR Project Manager(s) with appropriate expertise to complete various aspects of the hydrogeologic regime analysis.

6.1.4 GJO/GJPORAP

6.1.4.1 Description of the Hydrogeologic Regime

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 are the controlling factors in groundwater flow and discharge into the river.

The alluvial aquifer underlying the GJO facility occupies about 22.8 hectares (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. Recharge is mainly from fluctuations in the river and, to a much lesser extent, precipitation. Groundwater is discharged into the Gunnison River along the north and west boundaries of the facility. Aquifer pump tests show the hydraulic conductivity of the alluvium to be approximately 9 meters (30 feet) per day and the specific yield to be on the order of 0.05. Generally, depth to groundwater ranges from 1.5 to 3 meters (5 to 10 feet). Currently, the alluvial groundwater is not used for any purpose.

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 5). Drill-hole logs from 1984 well installations indicate that both units are laterally continuous throughout the GJO site.

Field observations suggest that a simple depositional model is adequate to represent the alluvial unit. The basal unit was deposited as the 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 resulted in a continuous layer of gravel, sand, and silt. Periodic flood events deposited sand and silt on top of the gravel to produce the alluvial stratigraphy shown in Figure 5. Such a depositional model is similar to the fluvial-floodplain facies model of Allen (1970), the primary difference between the two being that the alluvium at the GJO facility was deposited in a laterally more restricted and much higher energy environment. The result is a thicker and more consistent basal gravel unit.

This high-energy floodplain environment does not allow for significant soil development. Soil accumulations at the GJO facility range from a few inches to several feet thick that become increasingly coarse with depth and eventually grade into porous sandy gravel. The Mesa County soil survey (Spears and Kleven 1978) classifies on-site soils as well drained, typic torrifluvents, which are young, undeveloped soils formed in alluvial deposits.

Generally, groundwater enters the alluvial aquifer as recharge from the Gunnison River along the southern perimeter of the GJO facility. The upgradient groundwater tends to exhibit water quality characteristics similar to those of the river, although major ion concentrations increase slightly as the groundwater residence time within the alluvium increases. Before uranium mill tailings were removed from the facility, groundwater beneath the facility became contaminated with the leached products of uranium mill tailings: uranium, arsenic, selenium, and molybdenum. Only uranium and molybdenum, however, were mobile enough to migrate to the northern discharge boundary of the aquifer.

Surface water sources at or near the GJO facility include the North Pond, South Pond, Wetland Area, and Gunnison River, all of which contain water perennially. The North Pond, South Pond, and Wetland Area are located on the GJO facility, and the Gunnison River is contiguous to the facility's western and northern boundaries. The Wetland Area was formed in the spring of 1994 from excavation of contaminated soils during remediation of the GJO facility. This area was not backfilled after excavation, and the result was a depression that is recharged by groundwater. Although a majority of the Wetland Area is dry during low groundwater periods (September through February), a portion of the area (in the vicinity of former monitoring well 13-16NA) was designed to contain water year round for monitoring purposes. The North Pond, South Pond, and the Wetland Area are recharged by the shallow alluvial aquifer and exhibit the same characteristics as the groundwater. Like the groundwater, the North Pond, South Pond,

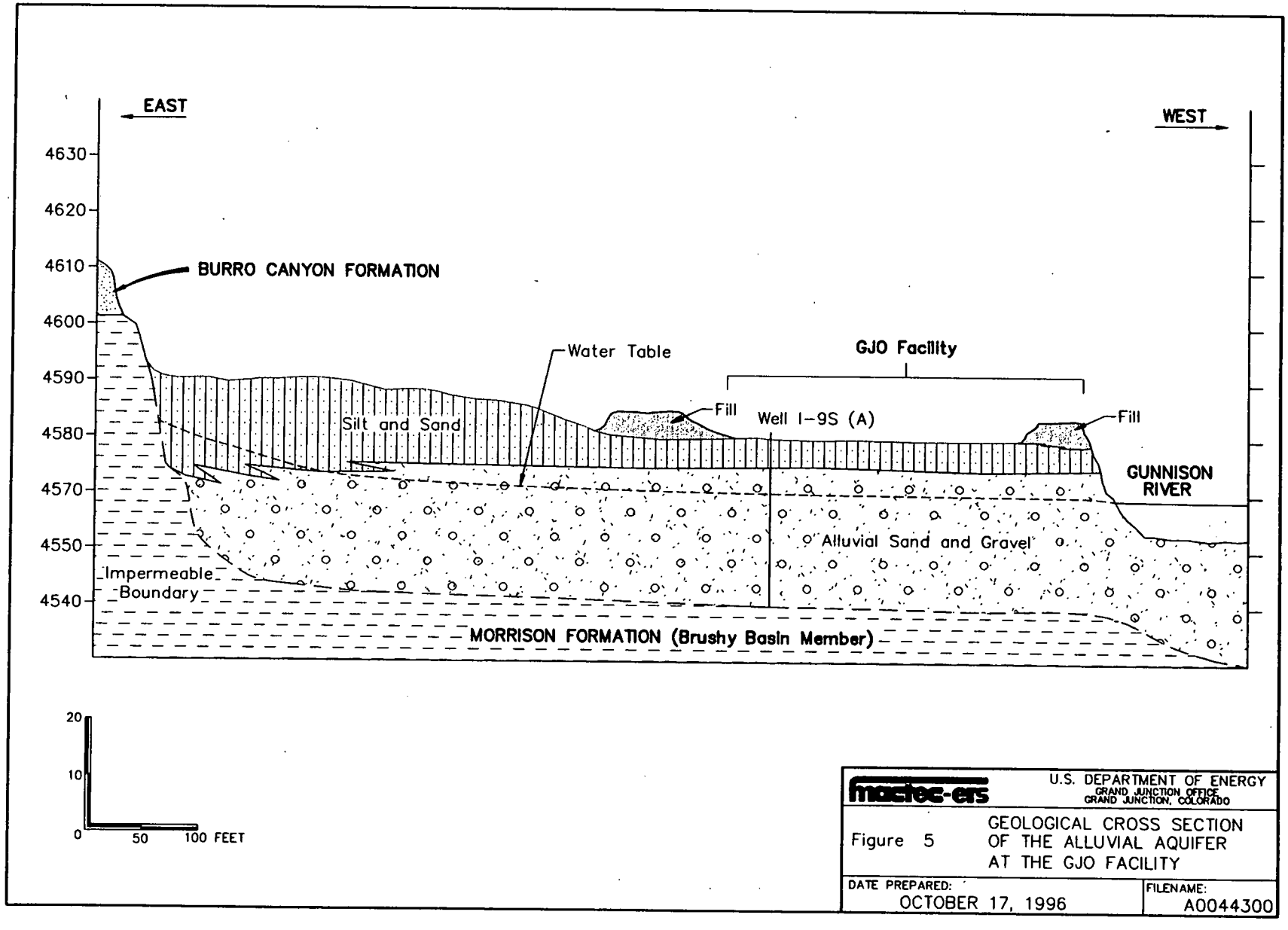

Figure 5. Geological Cross Section of the Alluvial Aquifer at the GJO Facility

and the Wetland Area are contaminated by the leached products of uranium mill tailings. The Gunnison River, which also receives discharge from the alluvial aquifer is not measurably affected by the mill tailings contaminants except for uranium. Uranium concentrations within the Gunnison River may have been affected by alluvial groundwater discharges but not to the extent that state water-quality standards were exceeded.

Underlying the alluvial aquifer at the GJO facility is the Morrison Formation, which, in the Grand Junction area, comprises the Brushy Basin and Salt Wash Members. The formation is composed primarily of red, green, and gray shale, although minor lenticular sandstones are present in the upper Brushy Basin, and increasing sandstone facies occur in the Salt Wash. The Morrison serves as an aquitard beneath the facility, as it inhibits downward groundwater flow and prevents communication between the overlying alluvial aquifer and the underlying Entrada Sandstone aquifer.

Regionally, the upper Brushy Basin Member is approximately 104 meters (340 feet) thick; however, about 12 meters (40 feet) of this unit has been removed from the GJO site by the Gunnison River. Core samples from the facility show the Brushy Basin Member to contain mudstone (36 percent), siltstone (28 percent), shale (25 percent), and sandstone lenses (11 percent); a typical stratigraphic column is presented in Figure 6. Lohman (1965) reported that no known wells have been developed in the sandstones of the Brushy Basin, although some of the sandstone lenses bear small amounts of water.

At the base of the Brushy Basin is a conglomeratic sandstone that grades laterally into shale. The underlying Salt Wash Member is approximately 94 meters (310 feet) thick and contains lenticular sandstone units that produce minor amounts of water. Transmissivities measured in two producing wells in the Salt Wash range in value from 0.44 to 0.58 square meters (4.8 to 6.28 square feet) per day (Lohman 1965).

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 groundwater in the alluvial aquifer because Brushy Basin shales act as a relatively impermeable boundary beneath the aquifer and along the valley margins.

6.1.4.2 Nature and Extent of Contamination

On-site personnel purchased and sampled uranium concentrate, tested and processed uranium ores, and operated uranium mill pilot plants at the GJO facility between 1947 and 1970. Wastes generated by these activities consisted of uranium mill tailings, ore, byproduct material, and related process equipment. Groundwater contamination resulting from these activities was first identified in 1980. Since then, 64 wells have been installed on and around the GJO facility to characterize the physical groundwater flow regime and to monitor the effects of ongoing remediation. Currently, 12 wells are sampled periodically as part of the GJO groundwater monitoring program

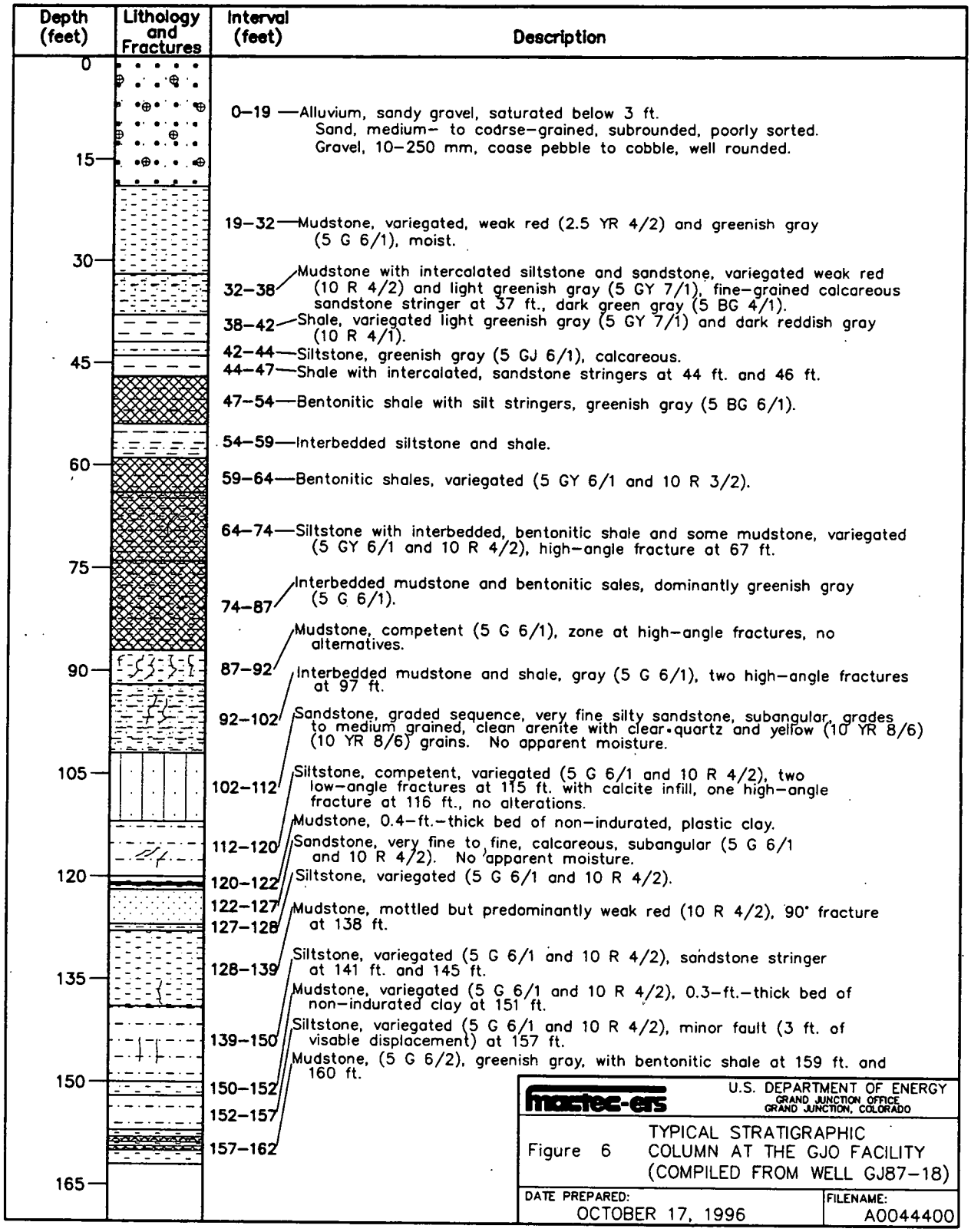

Figure 6. Typical Stratigraphic Column at the GJO Facility (Compiled From Well GJ87-18)

(Section 6.2.4.2). Results of monitoring through the years are presented and discussed in annual site environmental reports, cited in the reference section at the end of this document.

During preparation of the GJPORAP RI/FS—EA, a transient finite-difference groundwater flow model, published by the Illinois State Water Survey (Prickett and Lonnquist 1971), was used to assess contaminant transport within the alluvial aquifer. The model predicted that alluvial groundwater beneath the facility would be cleaned to below applicable standards within 50 to 80 years after the uranium mill tailings source was removed. Remediation of exterior soils known to be contaminated at the GJO facility was essentially completed in 1994 with only minor cleanups occurring at this time.

6.1.5 MMTS

6.1.5.1 Description of the Hydrogeologic Regime

There are two aquifers underlying the Monticello millsite and surrounding area. Unconsolidated materials deposited by Montezuma Creek constitute an alluvial aquifer along the valley bottom. An underlying sandstone aquifer, the Burro Canyon Formation, is separated from the alluvial aquifer by the Mancos Shale Formation (in places) and/or by fine-grained units of the Dakota Sandstone Formation, both of which act as aquitards in the MMTS area (Figure 7).

The alluvial aquifer is approximately 5 meters (16 feet) thick near Montezuma Creek in the vicinity of the carbonate tailings pile and thins gradually upgradient and downgradient from this location and toward the valley sides. Montezuma Creek is in communication with the alluvial aquifer throughout the MMTS (Figure 4).

In addition to alluvium, unconsolidated deposits at the millsite include wind-blown loess, pediment gravel, residual soil, and fill/tailings material. Soils are variable at the site, depending on landscape position and type of human disturbance. Soil types range from shallow, clayey soils formed over Mancos shale, to deep soils composed of loess and pediment gravel, to very deep, undeveloped soils formed in alluvial deposits. On the upland areas, soils are well drained; along Montezuma Creek, soils are poorly drained and saturated to near the surface. Recharge of the alluvial aquifer is from infiltration of precipitation and surface water. Like the local surface waters, water levels within the aquifer fluctuate seasonally. The alluvial aquifer discharges contaminated groundwater into Montezuma Creek. Hydraulic conductivity for the alluvial aquifer underlying the MMTS, estimated from 46 slug tests, ranges from 5.2×10^{-5} to 1.5×10^{-1} centimeters per second (DOE 1995a). As alluvial groundwater moves across the site, it is degraded by constituents such as arsenic, uranium, vanadium, radium, sulfate, selenium, and molybdenum, which are leached from the mill tailings. Generally, groundwater flow direction is to the east. Water from the alluvial aquifer currently is not used in the vicinity of the millsite.

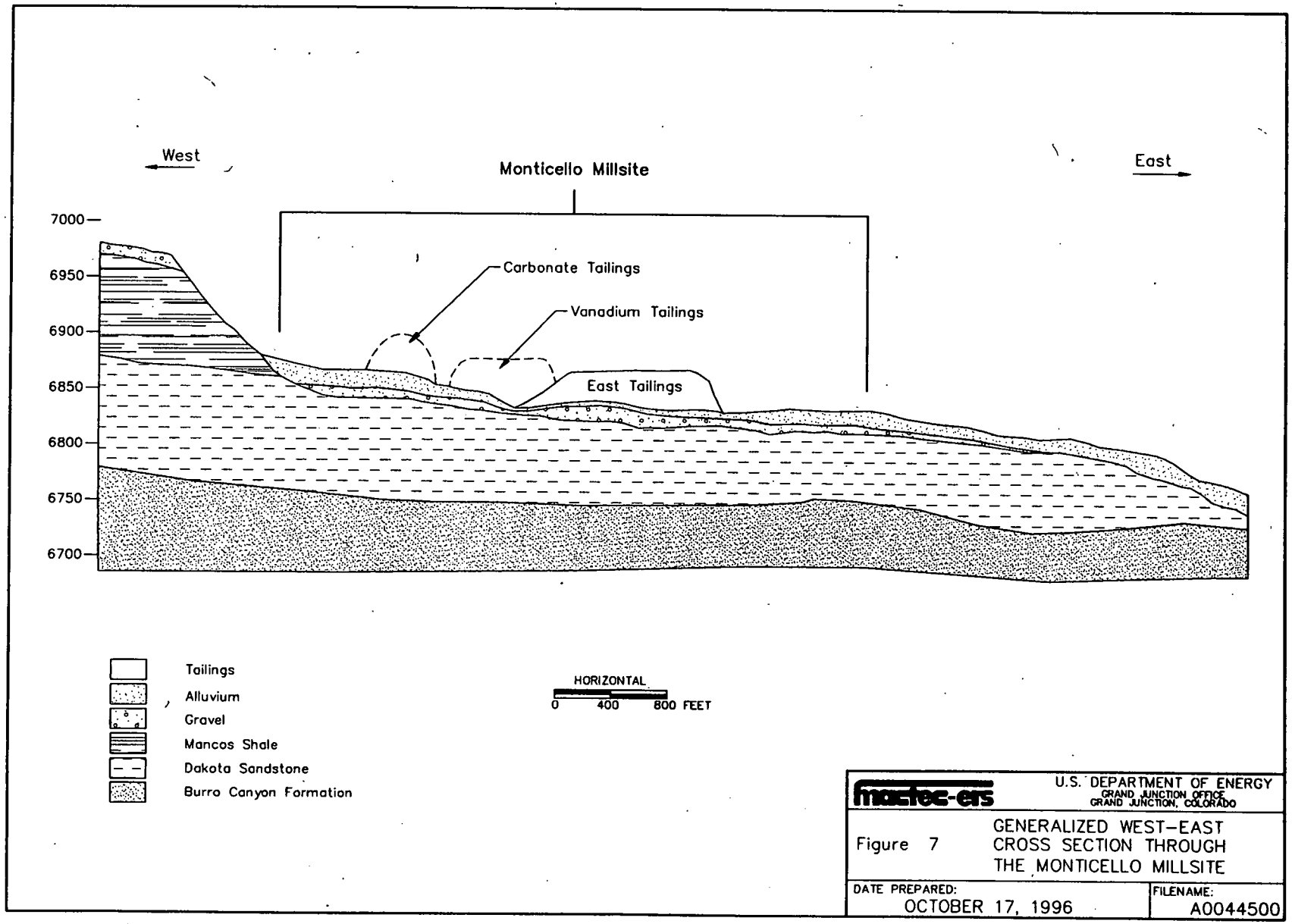

Figure 7. Generalized West-East Cross Section Through the Monticello Millsite

The Burro Canyon aquifer is generally confined under the millsite and is separated from the alluvial aquifer by an aquitard consisting of the Mancos Shale Formation, where it has not eroded, and fine-grained units of the Dakota Sandstone Formation. The Burro Canyon aquifer is recharged through the tilted, exposed area of the formation located along the margin of the Abajo Dome west of the millsite. Discharge from the aquifer occurs across the Great Sage Plain, along erosional margins, and in areas where canyons dissect the formation. Numerous stock ponds and marshy areas are created as a result of spring-fed discharge from the aquifer. To date, analysis of groundwater samples indicates that the Burro Canyon aquifer is not being degraded by the tailings piles. Water in the Burro Canyon aquifer is used as a domestic water supply source in the Monticello area.

Montezuma Creek is the main surface-water body on the MMTS and flows through the middle of the millsite from west to east. Although flow is generally perennial, the creek can be quite low or dry during the late summer. Creek water is stored and withdrawn for irrigation purposes about 1.6 kilometers (1 mile) upstream of the millsite. Downstream of the millsite, the creek is used primarily for livestock watering.

Concentrations of molybdenum, selenium, and uranium and gross alpha activity increase within Montezuma Creek as it flows across the millsite. Seeps from the shallow alluvial aquifer are visible along the creek downstream of the eastern millsite boundary, and creek discharge increases throughout this section for approximately 2 kilometers (1.25 miles). Historical assessments of water-quality data (DOE 1990c) indicate that the highest concentrations of mill-tailings-related constituents occur between 0.5 and 1.6 kilometers (0.3 and 1.0 mile) downstream of the millsite.

6.1.5.2 Nature and Extent of Contamination

From 1940 through 1960 the Monticello millsite facility produced vanadium and/or uranium through the following processes: raw ore carbonate leach, low-temperature roast/hot carbonate leach, salt roast/hot carbonate leach, and acid leach resin-in-pulp. Approximately 2,000,000 cubic yards of tailings and tailings-contaminated soil resulted from these activities and were deposited on the alluvium of Montezuma Creek and on Mancos Shale outcrops adjacent to the mill.

Site characterization activities at the MMTS began in 1981. Approximately 78 wells were installed in the early 1980s to characterize the physical groundwater flow regime. Analyses of samples collected from these wells confirmed elevated levels of arsenic, uranium, vanadium, radium, sulfate, selenium, and molybdenum in the shallow aquifer (Abramiuk et al. 1984). Since 1984, additional wells have been installed to further characterize the contamination in this regime. Results of monitoring activities through the years are presented and discussed in annual site environmental reports, cited in the reference section at the end of this document.

6.2 Sitewide Groundwater Monitoring

6.2.1 Program Overview

The goals of the groundwater monitoring programs at the GJO facility and the MMTS are to determine the background conditions at the sites, characterize contamination plumes, detect any changes in groundwater quality because of activities at the sites, and provide LTSM of the groundwater system following completion of environmental restoration programs.

6.2.2 Regulatory Requirements

Groundwater monitoring conducted at the GJO facility and the MMTS supports the hydrogeologic regime analysis discussed in Section 6.1 and the environmental restoration program discussed in Section 6.6. The groundwater protection regulatory requirements include the ARARs identified in the respective site RODs (DOE 1990a; DOE 1990e).

6.2.3 Organizational Responsibilities

It is the responsibility of the DOE Project Manager to direct the groundwater monitoring effort. The FOS/TAR Program Managers designate the Managers of environmental services to implement the groundwater monitoring program. The Managers of environmental services, or their designates, are responsible for planning and budgeting groundwater projects, monitoring groundwater project activities, conducting data evaluation, and preparing reports. To accomplish these tasks, the Mangers of environmental services, or their designates, assign groundwater projects to contract personnel who possess the technical expertise to perform the required activities, or the work is subcontracted to outside organizations.

6.2.4 Program Description

The groundwater monitoring program has three components: (1) well installation, maintenance, and abandonment; (2) sample collection and analysis; and (3) data management and reporting.

6.2.4.1 Monitoring Well Installation, Maintenance, and Abandonment

Procedures for surveying, installing, inspecting, maintaining, and abandoning monitoring wells are compiled in the *Environmental Procedures Catalog* (EPC) (Chem-Nuclear Geotech, Inc. 1992d).

6.2.4.2 Sample Collection and Analysis

An accurate and defensible hydrogeologic investigation is dependent upon proper collection and analysis of groundwater samples. Protocol, procedures, and quality assurance for water sampling are detailed in the EPC (Chem-Nuclear Geotech, Inc. 1992d). Groundwater samples are analyzed by the Analytical Laboratory or subcontracted to a qualifying laboratory using analytical procedures outlined in the *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures* (Chem-Nuclear Geotech, Inc. 1992a) or methods and detection limits prescribed by the EPA in *Test Methods for Evaluating Solid Waste* (U.S. EPA 1986). Quality assurance and quality control measures are implemented for all sampling/analysis activities in accordance with the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (Chem-Nuclear Geotech, Inc. 1992b).

6.2.4.2.1 GJO/GJPORAP

Groundwater sampling at the GJO facility currently is conducted on 12 monitoring wells every 9 months (Figure 8). Sampling every 9 months allows seasonal fluctuations in contaminant concentrations to be monitored over a 3-year period. Analytes include general water-quality indicators, metals associated with uranium mill tailings and radionuclides associated with uranium mill tailings. Specific constituents measured, sample collection protocol, and quality assurance procedures are prescribed in the EMP (DOE 1992b) and SAP (DOE 1992c).

6.2.4.2.2 MMTS

Remedial investigation activities to characterize the groundwater regime at the MMTS was initiated in the fall of 1992. An RI/FS will be written to describe the groundwater investigation, and to examine the remedial alternatives. Groundwater sampling at the MMTS currently is conducted semiannually. Samples are collected from 13 wells in April and 28 wells in October (Figures 9 and 10). Analytes include general water-quality indicators, metals, radionuclides, and major anions and cations. Specific constituents measured, sample collection protocol, and quality assurance procedures are prescribed in the MMTS OU III FSP (DOE 1992g).

6.2.4.3 Data Management and Reporting

The update and maintenance of a computerized database, the storage of data records in a permanent project file within FOS/TAR Records Management departments, and quarterly data reporting requirements are described in the EMP (DOE 1992b).

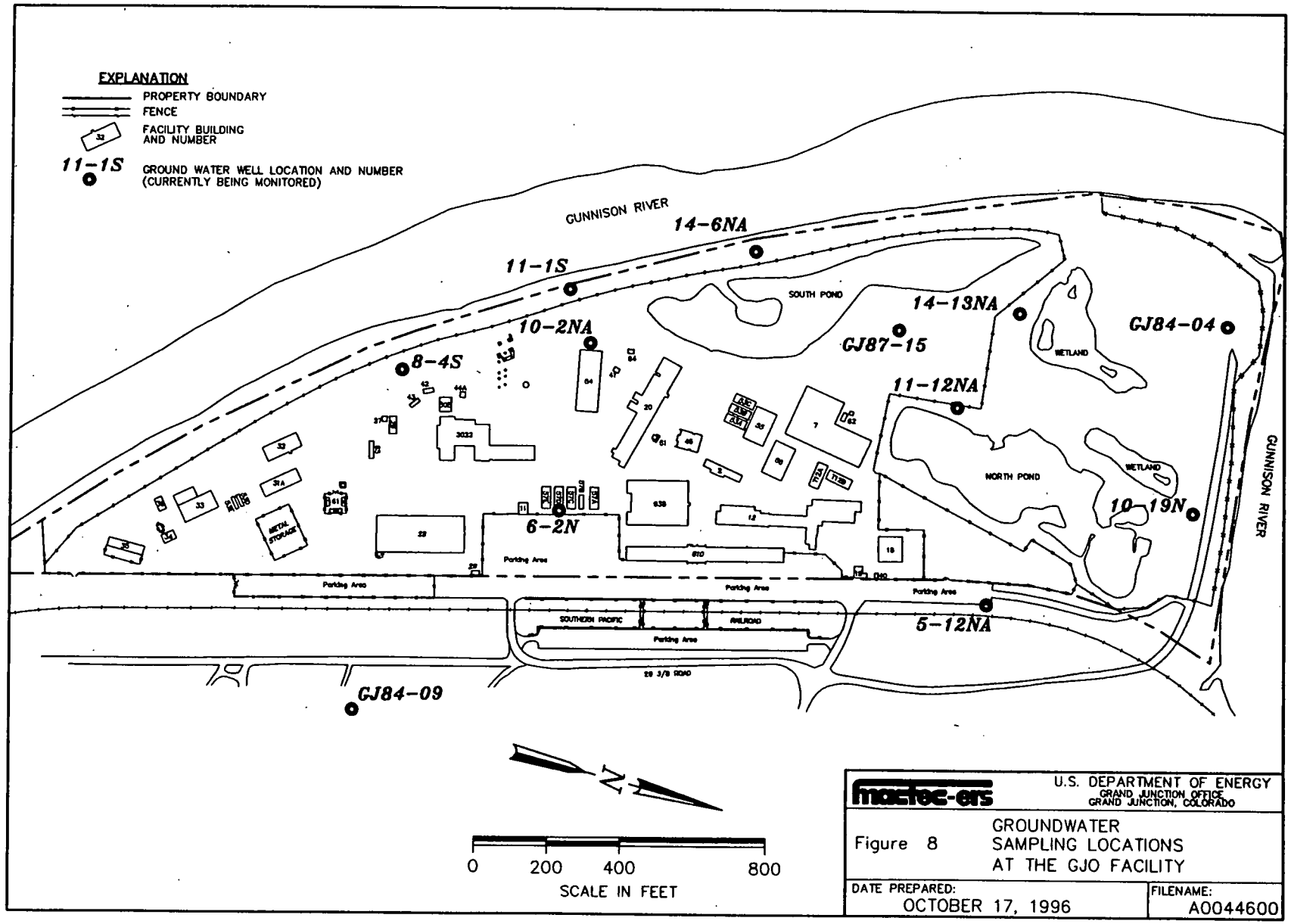

Figure 8. Groundwater Sampling Locations at the GJO Facility

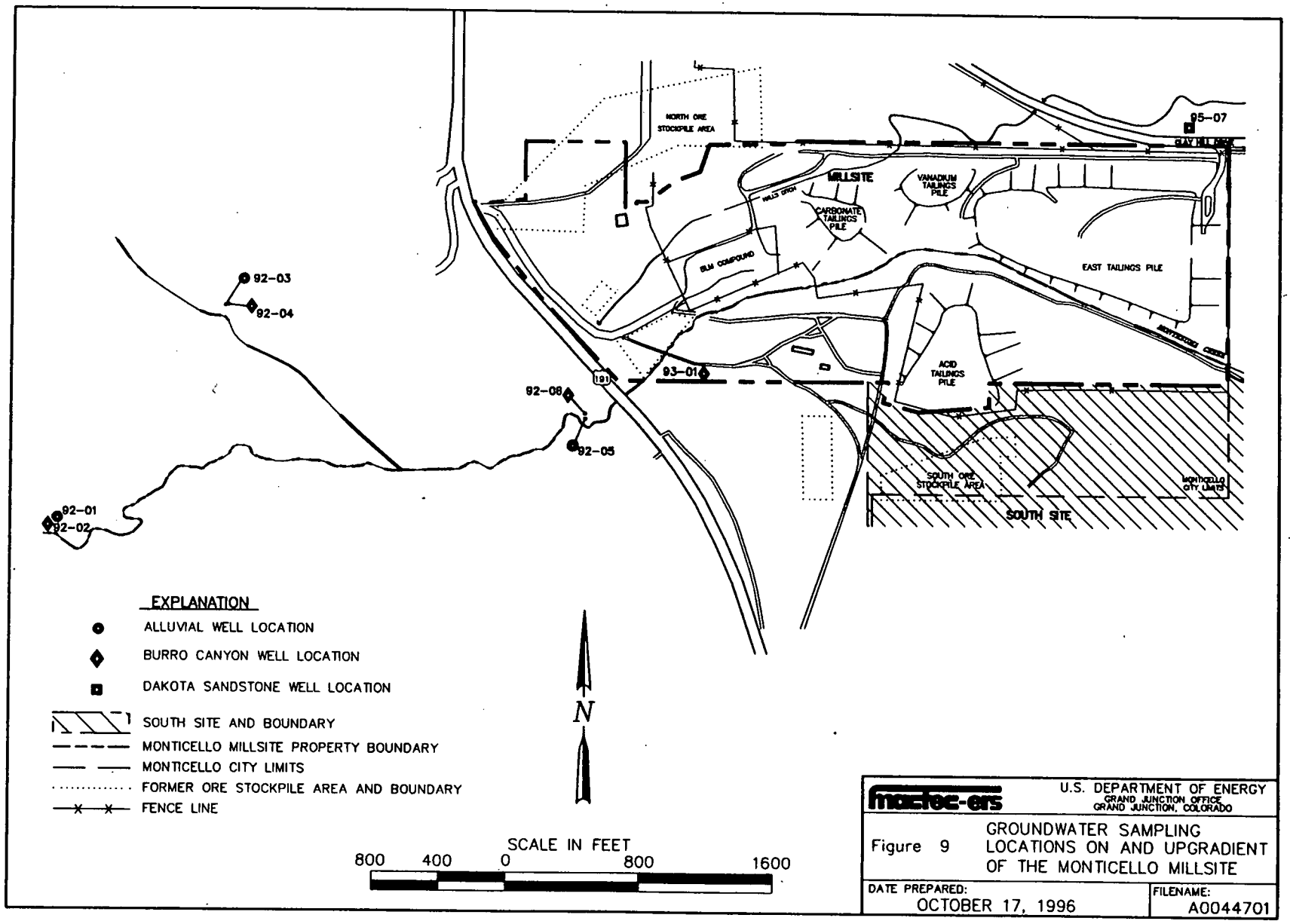

Figure 9. Groundwater Sampling Locations On and Upgradient of the Monticello Millsite

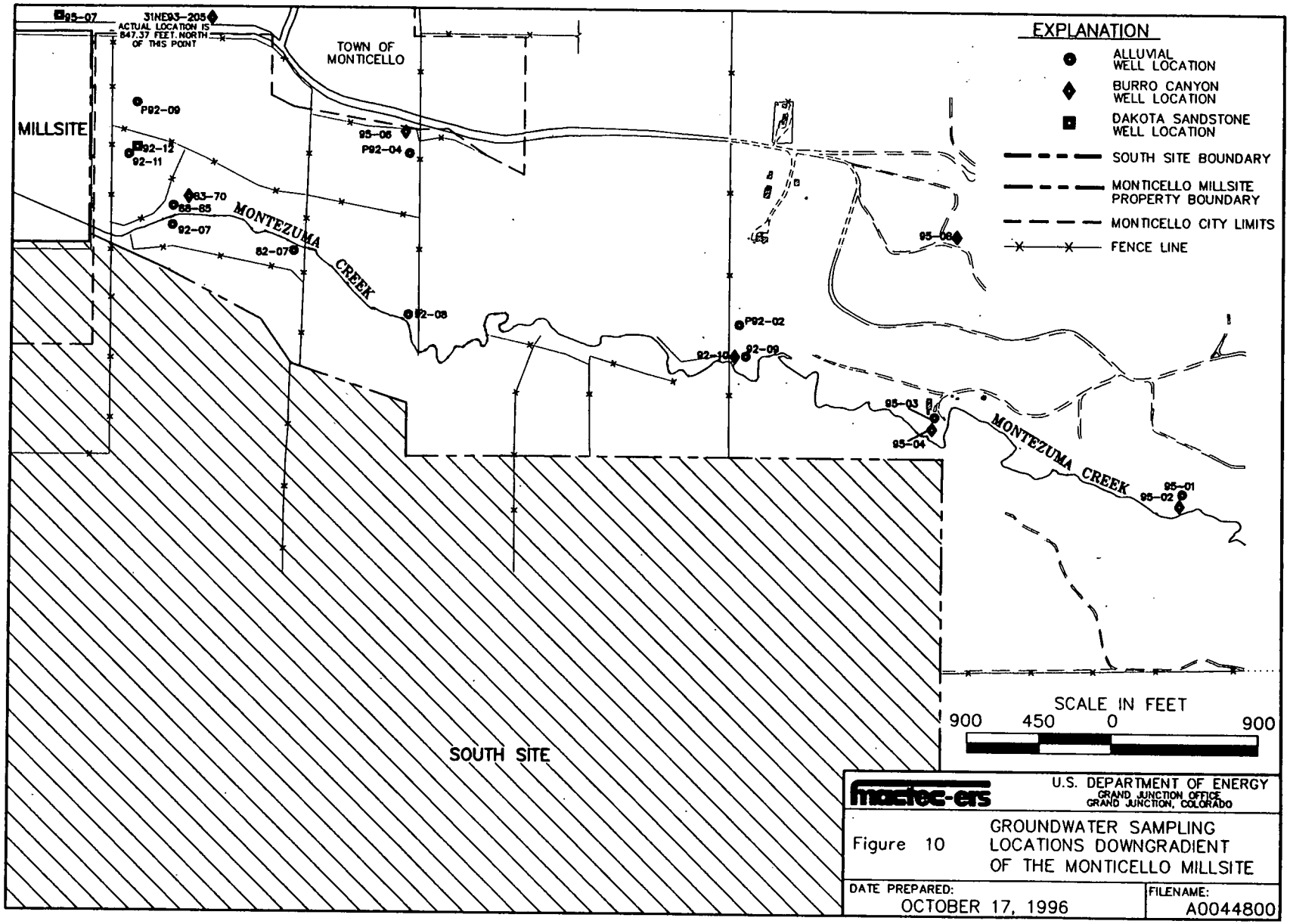

Figure 10. Groundwater Sampling Locations Downgradient of the Monticello Millsite

6.3 Groundwater Consumption

Groundwater is not extracted for consumption at the GJO facility because water is supplied by the city of Grand Junction. There is no consumption of groundwater at the MMTS.

6.4 Facilities and Operations

Activities discussed in this section apply both to the GJO facility and the MMTS.

6.4.1 Drinking Water

The GJO facility receives all drinking water from the city of Grand Junction. No extraction of groundwater for use occurs at this facility.

6.4.2 Effluent Monitoring

6.4.2.1 Program Overview

Discharge of liquid wastes from the GJO facility is limited to the discharge to the sanitary sewer system. This is the only liquid waste stream that could affect groundwater quality on the facility, and it is monitored routinely.

Discharge of liquid wastes from MMTS is limited to storm-water runoff and dewatering fluids from remedial activities in the surface aquifer. Both effluents are collected and treated before discharge to Montezuma Creek.

6.4.2.2 Regulatory Requirements

GJO Nonradiologic—In June 1996, a new Class II Industrial Pretreatment Permit (No. 023) was issued for the GJO facility by the city of Grand Junction in accordance with provisions of the Clean Water Act of 1977, 40 CFR Part 403, "General Pretreatment Regulations for Existing and New Sources of Pollution," the Colorado Water Quality Control Act, and Article 10 of Chapter 25, Code of Ordinance for the city of Grand Junction. Article 10 sets forth uniform requirements for users of city and county publicly owned wastewater treatment works and requires monitoring, enforcement activities, and user reporting.

GJO Radiologic—Liquid effluent discharge from the GJO facility to the city sewer system is sampled monthly for gross alpha and gross beta. If the sum of gross alpha and gross beta is equal to or greater than 150 picocuries (pCi) per liter, analyses are performed for those isotopes and elements that are expected to be the principal contributors to the elevated gross alpha and gross beta concentrations. Gross alpha and gross beta values exceeded 150 pCi/L four times in 1995. Isotopic and elemental analysis was performed

on the first two of these samples and revealed that natural uranium was the principal contributor to the high gross values. Because uranium was the principal contributor to the first two exceedances, the subsequent two exceedances were analyzed for only uranium.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, states that if the total of the fractions of the average concentrations for each radionuclide to its respective Derived Concentration Guide value exceeds 5, then the best available technology (BAT) to control discharges must be implemented. Analysis of the data revealed that the GJO radiological discharge was below the threshold requiring BAT implementation.

MMTS—Utah Pollution Discharge Elimination System (UPDES) permit rules establish an analyte list, 30-day average effluent limits, and maximum discharge levels for discharges into waters of the State. Although the MMTS is a CERCLA site and therefore exempt from obtaining a discharge permit, the intent of a discharge permit will be met at the site.

6.4.2.3 Organizational Responsibilities

The DOE Project Manager is responsible for ensuring compliance with the Industrial Pretreatment Permit and UPDES rules. Routine sample collection and data evaluation are delegated to DOE's contractors for the GJO facility and the waste-water treatment plant (WWTP) at MMTS.

6.4.2.4 Program Description

Domestic sewage from the GJO facility, including discharges from the Analytical Laboratory, is directed to the sanitary sewer system and subsequently to the city of Grand Junction's POTWs. The industrial pretreatment permit was revised (No. 0023 REV) by the city in February 1993. Prior to permit to No. 0023 REV expiring on May 30 , 1996, the GJO recharacterized its effluent in order to obtain a new permit. The new permit (No. 023) became effective on July 1, 1996 and will expire on May 31, 1999. Analytical results are forwarded to the city in April, July, October, and January and are reported to DOE in annual Radioactive Effluent and On-Site Data Discharge Reports. The new permit required measurement of biological oxygen demand, total suspended solids, total dissolved solids, ammonia, temperature, pH, oil and grease, silver, and polychlorinated biphenyls. Threshold limits were established only for temperature, pH, silver, and polychlorinated biphenyls.

Maintenance, inspection, and repair of the sewer system at the GJO facility is required for protection of groundwater. A program for maintenance and inspection of sewer lines adjacent to and downstream of the laboratory buildings is prescribed in *Preventative Maintenance Procedures Manual, Volume 2* (Chem-Nuclear Geotech, Inc. 1991). The program involves flushing the sewer lines annually to clear line blockages and trapped

materials that may not have washed through the lines under normal flow. In addition, visual inspection of the sewerlines using a remote camera to detect damage is conducted every 5 years.

Two types of liquid effluent are generated on the Monticello millsite—storm-water runoff and liquid from dewatering of the surface aquifer during remediation activities. Both types of effluent are routed through interceptor trenches and discharge lines to Holding Pond No. 3. The collected water is then pumped to the WWTP for treatment and eventual discharge to Montezuma Creek. When the WWTP is operating, the treated outflow is sampled and tested weekly for compliance with UPDES rules.

6.5 Waste Management

6.5.1 Program Overview

The GJO facility is a conditionally exempt small-quantity generator of hazardous and mixed waste. Except for small quantities of characteristic hazardous waste that have been treated periodically on-site, most hazardous wastes are removed from the facility by a private hazardous waste contractor. Before their disposal, wastes are stored in a manner that prevents groundwater contamination. The GJO facility generates very small quantities of mixed and radioactive wastes, which are primarily associated with the activities of the Analytical Laboratory. In addition, commingled wastes have been identified at the GJO facility. By-product materials contaminated with nonradiological hazardous substances may be identified during remediation of the MMTS.

6.5.2 Regulatory Requirements

6.5.2.1 Hazardous Waste

The Resource Conservation and Recovery Act (RCRA) of 1976, as amended by the Hazardous and Solid Waste amendments of 1984, provide a comprehensive Federal regulatory program for hazardous waste management. DOE Order 5400.1 establishes environmental protection requirements to ensure compliance with applicable Federal, State, and local laws and regulations. The Colorado Department of Health and the Environment has been granted authority by the EPA to conduct the RCRA hazardous waste program in Colorado. The requirements for the management of hazardous waste, from generation to final disposal, are established in the Colorado Hazardous Waste Regulations, 6 CCR 1007-3, and the Utah Hazardous Waste Management Rules, UAC, (R315-1 to R315-9, R315-12 to R315-14, R315-50, and R315-101). Additionally, the Toxic Substances Control Act provides the regulatory framework for the management of toxic substances, which include polychlorinated biphenyls and asbestos.

6.5.2.2 Radioactive and Mixed Waste

A variety of regulatory documents guide and support the GJO facility's mixed and radioactive waste management activities. These documents include DOE Order 5820.2A, *Radioactive Waste Management*; DOE Order 5400.3, *Hazardous and Radioactive Mixed Waste Program*; and the DOE Albuquerque Operations Office guidance document, *Performance Objective for the Waste Moratorium* (DOE 1994a). These orders incorporate, by reference, federal hazardous waste regulations contained in 40 CFR 260-280.

6.5.3 Organizational Responsibilities

The operation of the GJO facility is the responsibility of the DOE Project Manager. The Contractor(s) Site Manager delegates the authority for environmental protection activities to line management.

6.5.4 Program Description

The GJO facility adheres to the practices outlined in the *Conditionally Exempt Small Quantity Generator Management Plan* (DOE 1992a) and the *Waste Minimization and Pollution Prevention Awareness Plan* (WMPPAP) (DOE 1994c). All waste management activities are conducted to safeguard the groundwater regime.

6.6 Environmental Restoration Program

6.6.1 Program Overview

Disposal of uranium mill tailings from past milling operations has resulted in radiological contamination of groundwater in the shallow alluvial aquifers underlying the GJO facility and MMTS. A remedial action plan for environmental restoration of the GJO facility has been approved, and one is being developed for the MMTS.

6.6.2 Regulatory Requirements

6.6.2.1 GJPORAP

The implementing regulatory requirements are found in the GJPORAP RI/FS—EA (DOE 1989a). The groundwater protection regulatory requirements include the ARARs identified in the ROD (DOE 1990a).

6.6.2.2 MMTS

As outlined in the Federal Facilities Agreement (U.S. EPA et al. 1988) for the MMTS, the state of Utah provided a proposed list of ARARs to DOE and EPA in February 1989. DOE then conducted a detailed ARARs analysis to establish cleanup standards at the site, taking into account both federal and state ARARs. This list is summarized in the MMTS RI/FS—EA (DOE 1990d). The final ARARs for OU I and OU II are identified in the MMTS ROD (DOE 1990e), and the potential ARARs for OU III are identified in the MMTS OU III WP (DOE 1995c). An RI/FS and subsequent ROD for groundwater and surface water at the MMTS are in the development stages.

6.6.3 Organizational Responsibilities

The DOE Project Manager is responsible for remediation of the GJO facility and the MMTS. The appropriate Contractor(s) Program Manager is the primary interface with DOE and assumes overall responsibility for the success of the program activities. The scope and overall schedule are determined by the Program Manager in consultation with the DOE. The Program Manager maintains oversight responsibilities, measures overall program progress, monitors budgets, and reports to the DOE. In addition, the Program Manager contracts with the Contractor(s) Project Manager for implementation of site characterization/environmental restoration activities.

6.6.4 Program Description

6.6.4.1 GJPO Remedial Action Project

The DOE developed a remedial action plan, in consultation with the Colorado Department of Health, to stabilize and control uranium mill tailings and related contaminated material at the GJO facility. Implementation of the selected remedy, defined in the GJPORAP ROD (DOE 1990a), resulted in the removal of all known tailings and soil contamination from the facility. Affected areas of the facility were recontoured, reconstructed, resurfaced, and revegetated, as appropriate. Passive remediation of the groundwater is expected to occur within 50 to 80 years. Ultimately, there will be no remaining tailings-related environmental hazard associated with the facility, and use of the entire 56.4-acre site will be unrestricted. Groundwater monitoring will continue to be conducted under the LTSM program to verify passive groundwater restoration.

6.6.4.2 MMTS Remedial Action Project

Remediation of the MMTS is conducted by agreement among the EPA, state of Utah, and DOE. A remedy for OU III will be proposed by DOE following completion of the OU III RI/FS. Mill tailings remediation (OU I) will begin after the disposal cell has

been lined, which is scheduled to be completed in FY 1997. Once the mill tailings remediation is completed, an LTSM program will be implemented to ensure that the final repository performs as designed and that human health and the environment are not threatened. Pursuant to CERCLA Section 121(c), as amended, periodic reviews will be made at least once every 5 years after the initiation of the final response action by the EPA and the state of Utah to ensure that design standards are being met.

6.7 Contamination Prevention

6.7.1 Waste Minimization and Pollution Prevention Awareness

6.7.1.1 Program Overview

The waste minimization and pollution prevention awareness program for the DOE-GJO is implemented through the Waste Minimization and Pollution Prevention Awareness Plan (WMPPAP) (DOE 1994c) as required by DOE Order 5400.1. The WMPPAP encompasses all ongoing operations at the GJO facility.

6.7.1.2 Regulatory Requirements

The regulatory requirements that apply to waste generation at the GJO facility with respect to waste minimization include DOE Order 5400.1, "General Environmental Protection Program"; DOE Order 5400.3, "Hazardous and Radioactive Mixed Waste Program"; 40 CFR Parts 260-279; 40 CFR 82, "Protection of Stratospheric Ozone"; the DOE's "Performance Objective for the Waste Moratorium"; and DOE Order 5820.2A, "Radioactive Waste Management."

6.7.1.3 Organizational Responsibilities

The DOE Project Manager is responsible for ensuring compliance with the WMPPAP. Development and management of the WMPPAP is delegated to the FOS and TAR Managers of environmental services. Implementation of the plan is the responsibility of the site or specific program managers.

6.7.1.4 Program Description

The DOE-GJO is a conditionally exempt small-quantity generator. As such, the DOE-GJO generates no more than 100 kilograms (kg) of hazardous waste per month, and total on-site accumulation does not exceed 1000 kg of hazardous waste, or 1 kg of acutely hazardous waste, at any time. The GJO facility also generates small amounts of radioactive and mixed wastes, primarily from the on-site Analytical Laboratory. Nonhazardous solid waste generated on the facility as routine trash is placed in

dumpster-type receptacles for daily pickup; office papers and corrugated cardboard are recycled.

The DOE-GJO has incorporated waste minimization and pollution prevention awareness into job performance at the appropriate levels. This is accomplished by routinely integrating waste minimization ideas, methods, and philosophies into both the management culture and employee operating procedures, process design considerations, and training in a manner similar to that established for promoting safety and quality assurance/quality control concepts and awareness.

6.7.2 Hazardous Materials Contingency Plan and Emergency Procedures

The Hazardous Materials Contingency Plan and Emergency Procedures, Chapter 12 of the *GJPO Emergency Preparedness and Response Plan* (DOE 1992i), provides procedures for minimizing hazards to groundwater from accidental releases of hazardous materials on the site as required by 6 Code of Colorado Regulations 1007-3, Part 265, Subpart D ("Contingency Plan and Emergency Procedures"). The DOE Project Manager is responsible for ensuring compliance with the Hazardous Materials Contingency Plan and Emergency Procedures (HMCPEP). The development and management of the HMCPEP is delegated to the FOS Manager of Compliance Management; implementation of the HMCPEP is the responsibility of the FOS and specific program managers.

6.7.3 Underground Storage Tanks

6.7.3.1 Program Overview

All underground storage tanks (USTs) have been removed from the GJO facility. Three USTs were removed from the Monticello millsite in 1995. If USTs are encountered during remediation, the USTs will be removed and abandoned in accordance with 40 CFR 280, Subtitle I.

6.7.3.2 Regulatory Requirements

Removal of USTs was conducted per the requirements of 40 CFR 280, Subtitle I, and Utah Administrative Code R311-204 and R311-205.

6.7.3.3 Organizational Responsibilities

The DOE Project Manager is responsible for ensuring compliance with UST regulations. At the GJO facility, this responsibility is delegated to the Contractor Site Manager. At MMTS, the TAR Program Manager is delegated the responsibility for ensuring compliance with UST regulations.

6.7.3.4 Program Description

All known USTs were removed from the GJO facility during May and June 1988. This work is documented in the *Grand Junction Projects Office Underground Storage Tanks Notification and Removal* (DOE 1988c). USTs were removed from MMTS in August 1995. An UST closure document currently is being prepared for the Utah Department of Environmental Quality.

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