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Environmental Assessment of Ground Water Compliance at the Gunnison, Colorado, UMTRA Project Site

Final

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Prepared by
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Acronyms and Abbreviations

ACL	alternate concentration limit
BLRA	baseline risk assessment
$CaCO_3$	calcium carbonate
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
COPC	constituent of potential concern
DOE	U.S. Department of Energy
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
ft	feet
GJO	Grand Junction Office
ICs	institutional controls
MCL	maximum concentration limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
NEPA	National Environmental Policy Act
PEIS	Programmatic Environmental Impact Statement (for the UMTRA Ground Water Project)
RRM	residual radioactive material
T&E	threatened and endangered
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
USFWS	U.S. Fish and Wildlife Service

Executive Summary

This document is the Environmental Assessment (EA) for the proposed action to address residual ground water contamination at the Uranium Mill Tailings Remedial Action (UMTRA) Project site in Gunnison, Colorado. The purpose of this EA is to present the proposed action and no action alternatives and discuss their environmental effects. The EA presents a strategy for achieving compliance with requirements in the Uranium Mill Tailings Radiation Control Act (42 *United States Code* 7901 *et seq*.) and the U.S. Environmental Protection Agency's (EPAs) "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings" (Title 40 *Code of Federal Regulations* Part 192).

The compliance strategy proposed for the Gunnison site is natural flushing with institutional controls and continued monitoring for the 100-year time frame allowed in 40 CFR 192 for contaminant concentrations in the aquifer to flush to prescribed regulatory limits. This strategy was determined by using the framework in the Programmatic Environmental Impact Statement for the UMTRA Ground Water Project (DOE 1996a) that governs selection of a strategy to achieve compliance with the EPA ground water protection standards.

The Gunnison millsite is located about 0.5 mile southwest of the city of Gunnison and covers approximately 61.5 acres. The mill operated from 1958 to 1962 and produced uranium concentrate to sell to the U.S. Atomic Energy Commission. Operating capacity was 200 tons of ore per day. The ore was ground and leached with sulfuric acid and sodium chlorate. After leaching, the uranium-rich solutions and waste solids were separated by a four-stage countercurrent classifier and thickener circuit. The uranium solutions were then treated by solvent extraction to concentrate and recover the uranium, and the solids were dumped into tailings piles.

By the mid 1970s, all tailings were moved to a rectangular area of approximately 35 acres, and the mill, former ore storage area, and miscellaneous areas occupied about 16 acres. During the 1980s, the tailings pile was contoured, covered with material excavated at an adjacent gravel pit, and seeded with grasses in accordance with plans approved by the Colorado Department of Public Health and Environment. Demolition of all site buildings and structures was completed during 1991. From 1992 to 1995, most tailings and other contaminated materials were transported to a permanent disposal cell about 6 miles east of Gunnison and 0.4 mile south of the county solid waste landfill.

Ground water flow and transport modeling and the site assessments detailed in the Site Observational Work Plan (DOE 2001) indicates that natural flushing with institutional controls and continued monitoring would be protective of human health and the environment and would meet the regulatory requirements in Subpart B of 40 CFR 192.

The original Baseline Risk Assessment (BLRA, DOE 1996b) evaluated several exposure pathways—residential drinking water scenario, ingestion of garden produce irrigated with ground water, and ingestion of meat from animals watered with ground water. Through data analysis it was determined that exposure by ingestion of garden produce and meat would not produce toxic responses. Only the residential drinking water scenario posed unacceptable risks.

The constituents of potential concern were iron, manganese, sulfate, and uranium. These data were updated with more recent sampling, and two additional exposure pathways were added along with residential ground water ingestion: industrial exposure and ingestion of fish from a gravel pit pond adjacent to the site. No unacceptable risks are associated with the industrial or fish ingestion scenarios, even when the calculations are based on very conservative assumptions. Only regular use of ground water for drinking water in a residential setting would present unacceptable risks; those risks are attributed mainly to concentrations of uranium and manganese. However, U.S. Department of Energy research indicates that no one uses alluvial ground water within the plume of contaminated ground water. The Dos Rios Water and Sanitation District provides domestic water. Thus, this exposure pathway is incomplete. Uses of ground water for purposes other than drinking water (e.g., watering gardens, industrial purposes) are permissible given current contaminant levels. Current iron and sulfate concentrations are not expected to result in adverse human health effects in any exposure setting. It was concluded that ground water does not pose a risk to human health in the present or foreseeable future under current land use conditions.

A screening-level ecological risk assessment in the original BLRA concluded that cobalt, iron, and manganese concentrations in the ground water could produce detrimental effects in plant growth if only ground water is used from root uptake and irrigation. This exposure pathway does not present a significant concern because most riparian plants take water directly from the Gunnison River, Tomichi Creek, and precipitation, and pasture grasses are irrigated with water from the Gunnison River. There is no risk from ingestion of grasses and crops (e.g., gardens) by either livestock or humans. There was no evidence that site-related constituents would adversely affect surface water. Sediment data were limited and insufficient to determine if elevated concentrations in the sediments are site related. The ecological risk assessment concluded that the potential for contaminated ground water to adversely affect ecological receptors via the food chain was low.

This EA discusses the potential environmental effects of the proposed action in conjunction with institutional controls and continued monitoring, and the no action alternative. The effects of the proposed action and no action alternatives are generally similar, but the no action alternative would not provide for institutional controls or continued monitoring of constituent levels in ground water and surface water at the site.

1.0 Introduction

The U.S. Department of Energy (DOE) is in the process of selecting a ground water compliance strategy for the Gunnison, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) Project site. (Figures 1 and 2). This Environmental Assessment (EA) discusses two alternatives and the effects associated with each. The two alternatives are (1) natural flushing coupled with institutional controls and continued monitoring and (2) no action. The compliance strategy must meet U.S. Environmental Protection Agency (EPA) ground water standards defined in Title 40 *Code of Federal Regulations* Part 192, Subpart B, in areas where ground water beneath and around the site is contaminated as a result of past milling operations. It has been determined that contamination in the ground water at the Gunnison site consists of soluble residual radioactive material (RRM) as defined in the Uranium Mill Tailings Radiation Control Act (UMTRCA).

1.1 Background

UMTRCA authorized DOE to perform remedial actions at 24 inactive uranium-ore processing sites, including the Gunnison UMTRA Project site. DOE and the State of Colorado entered into a cooperative agreement (DOE 1981) that established terms and conditions for remedial action, cost sharing for remedial action, and land acquisition.

Environmental effects of surface remediation were evaluated in the *Environmental Assessment of Remedial Action at the Gunnison Uranium Mill Tailings Site Near Gunnison, Colorado* (DOE 1992).

Because final EPA ground water standards were not yet established, remedial action was designed to comply with EPA's proposed ground water standards that were published in 1987. DOE considered ground water characterization to be inadequate to fully assess compliance with existing standards and deferred formulating a ground water compliance strategy until the Gunnison site was characterized through the UMTRA Ground Water Project. Until that time, DOE did not believe that there was potential risk to human health and the environment because (1) DOE provided a domestic water supply to eliminate the need for domestic wells in the affected aquifer, and Gunnison County required all new residences and businesses to use this supply, thereby eliminating the only pathway of concern for human health risk, and (2) no complete exposure pathway existed for ecological risk from contaminated ground water. Also, no concentrations of hazardous constituents exceeded the proposed concentration limits in the Gunnison River or Tomichi Creek downstream of the site.

The UMTRA Ground Water Project was established in 1991 to further evaluate all UMTRA Project sites where the surface contamination was removed but ground water was contaminated as a result of historical uranium-ore processing. The evaluation results in a ground water compliance strategy that is protective of human health and the environment and that meets the final ground water standards EPA published in 1996 for the UMTRA Project (40 CFR 192).

In 1992, DOE began a programmatic National Environmental Policy Act (NEPA) process intended to evaluate the broad environmental impacts that were common to all UMTRA ground water sites. DOE prepared the Programmatic Environmental Impact Statement for the UMTRA

Ground Water Project (PEIS, DOE 1996a) to serve as a planning document to assess the potential programmatic effects of conducting the UMTRA Ground Water Project, to provide a method to determine site-specific ground water compliance strategies, and to provide data and information to help prepare site-specific environmental impact analyses more efficiently. This process involved public scoping meetings at the affected sites and several public comments and response periods throughout the 5-year process. The meeting in Gunnison was conducted on June 6, 1995. The programmatic approach proposed in the PEIS was approved in a Record of Decision on April 28, 1997.

The PEIS offers three programmatic alternatives, identified as strategies in the PEIS, for the proposed ground water compliance action: no ground water remediation, passive remediation (natural flushing), or active remediation. DOE also may implement any combination of the three strategies. The strategies are part of a framework that requires DOE to compare the broad cumulative effects of each strategy and to use site-specific data to move through the decision process from the least intrusive (no remediation) alternative to the most intrusive (active remediation) alternative. These alternatives provide the options for this site-specific EA. The issues discussed and the environmental effects analyzed in this EA are tiered to the PEIS. Section 1.3.1 of the PEIS discusses "tiering" and the actions required in each site-specific NEPA document. The PEIS approach allows DOE to select the least intrusive alternative that will meet the EPA standards and thereby be protective of human health and the environment. The PEIS also states that once a strategy is selected, DOE need only present that proposed alternative and the no action alternative in the site-specific NEPA documentation. As a conservative measure and a best management practice, DOE considered active alternatives and systematically eliminated them on the basis of their potential cost and risk reduction (see Section 3.3).

DOE used the concepts and decision framework in the PEIS and site-specific data to select the best strategy for the Gunnison site that would comply with EPA ground water standards and ensure protection of human health and the environment (Figure 3). The step-by-step decision process led DOE to the natural flushing strategy and is described further in Section 3.0 of this document.

1.2 Gunnison UMTRA Project Site Location and Description

The Gunnison UMTRA Project site is about 0.5 mile southwest of the city of Gunnison on a 61.5-acre tract between the Gunnison River and Tomichi Creek (Figures 1 and 2).

The site is at an elevation of 7,635 feet (ft) in a broad valley surrounded by mountains that rise above 12,000 ft. Higher elevations in the area are forested on the north and east sides, and lower elevations on the south and west are covered with brush and native grasses.

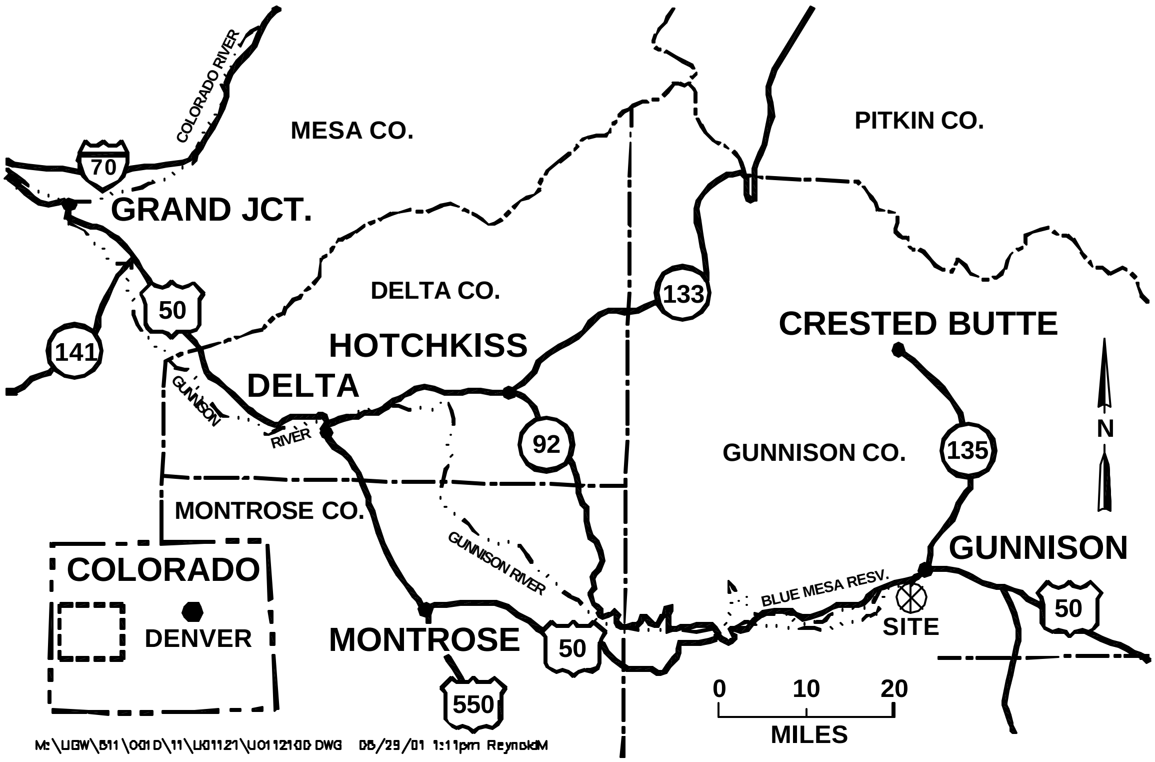

Figure 1. Location of the Gunnison Site

1.3 Site History

Uranium ore was mined from 1955 until early 1962 along Los Ochos fault near Cochetopa Pass, approximately 25 miles southeast of Gunnison. About 486,000 tons of ore were produced from this area and averaged 0.14 percent uranium oxide (U_3O_8) during the life of the mines. The Gunnison mill was constructed in 1957, mainly to mill the high-grade ore from the Los Ochos claims for sale to the Atomic Energy Commission, and operated until April 1962.

The mill operated with a feed rate of 200 tons per day. Processing consisted of grinding the ore to minus 65-mesh and acid leaching with sodium chlorate and sulfuric acid for 15 hours at 25 °C. After leaching, the solution and solids were separated by a four-stage countercurrent classifier and thickener circuit. The solution was treated with ethylhexyl phosphoric acid to remove uranium from the solution, and the solids were placed in tailings piles. A sodium carbonate solution was then used to strip uranium from the solvent, and the entire slurry was passed through a filter press to strip iron residues that had precipitated. The clarified pregnant solution was acidified with sulfuric acid to decompose carbonates and precipitate uranium. Magnesium oxide was then added to complete precipitation of the uranium concentrate, or "yellow cake." During operation, the mill processed approximately 540,000 dry tons of ore.

By the 1970s, all tailings were moved and occupied a rectangular area of about 1,180 ft by 1,440 ft, or 39 acres, with a maximum height of 13 ft (FBDU 1981). The only buildings remaining were a water tower, large metal building, and office buildings. During the 1980s, the tailings pile was contoured, covered with material excavated at an adjacent gravel pit, and seeded with grasses in accordance with plans approved by the Colorado Department of Public Health and Environment (CDPHE). Vegetation was well established on the pile after a few years of irrigation.

Contaminated materials consisted of approximately 450,000 cubic yards of tailings; 214,000 cubic yards of contaminated soil from the ore storage, millsite, subpile, and other areas; 25,300 cubic yards of windblown materials; 10,500 cubic yards of rubble; and 10,000 cubic yards of contaminated materials from vicinity properties. During 1991, remaining structures at the site were demolished, and materials were stored on site for final disposition. From 1992 to 1995, most RRM and other contaminated materials were transported to a permanent disposal cell 6 miles east of Gunnison.

2.0 Need for DOE Compliance Action

DOE is required by UMTRCA to comply with EPA standards for the ground water beneath and near the Gunnison site that is contaminated as a result of historical processing of uranium ore. Ground water compliance strategies proposed for the Gunnison site are designed to achieve conditions that are protective of human health and the environment and that meet EPA's ground water standards in 40 CFR 192.

3.0 Proposed Action and No Action Alternatives

3.1 Proposed Action Alternative

On the basis of the PEIS compliance selection framework (Figure 3), DOE considered the options for a compliance strategy and determined that the natural flushing compliance strategy coupled with continued monitoring and institutional controls (ICs) that would restrict access to contaminated ground water would be protective of human health and the environment. Table 1 shows the questions posed and the responses given to arrive at the natural flushing strategy. DOE eliminated other compliance strategies on the basis of this decision process.

Natural flushing (also known as natural attenuation) is a process in which natural geochemical and biological processes and ground water movement decrease contaminant concentrations in the aquifer through time. The purpose of this approach is to ensure that risks associated with the constituents of potential concern (COPCs)—uranium and manganese—are mitigated using the proposed compliance strategy.

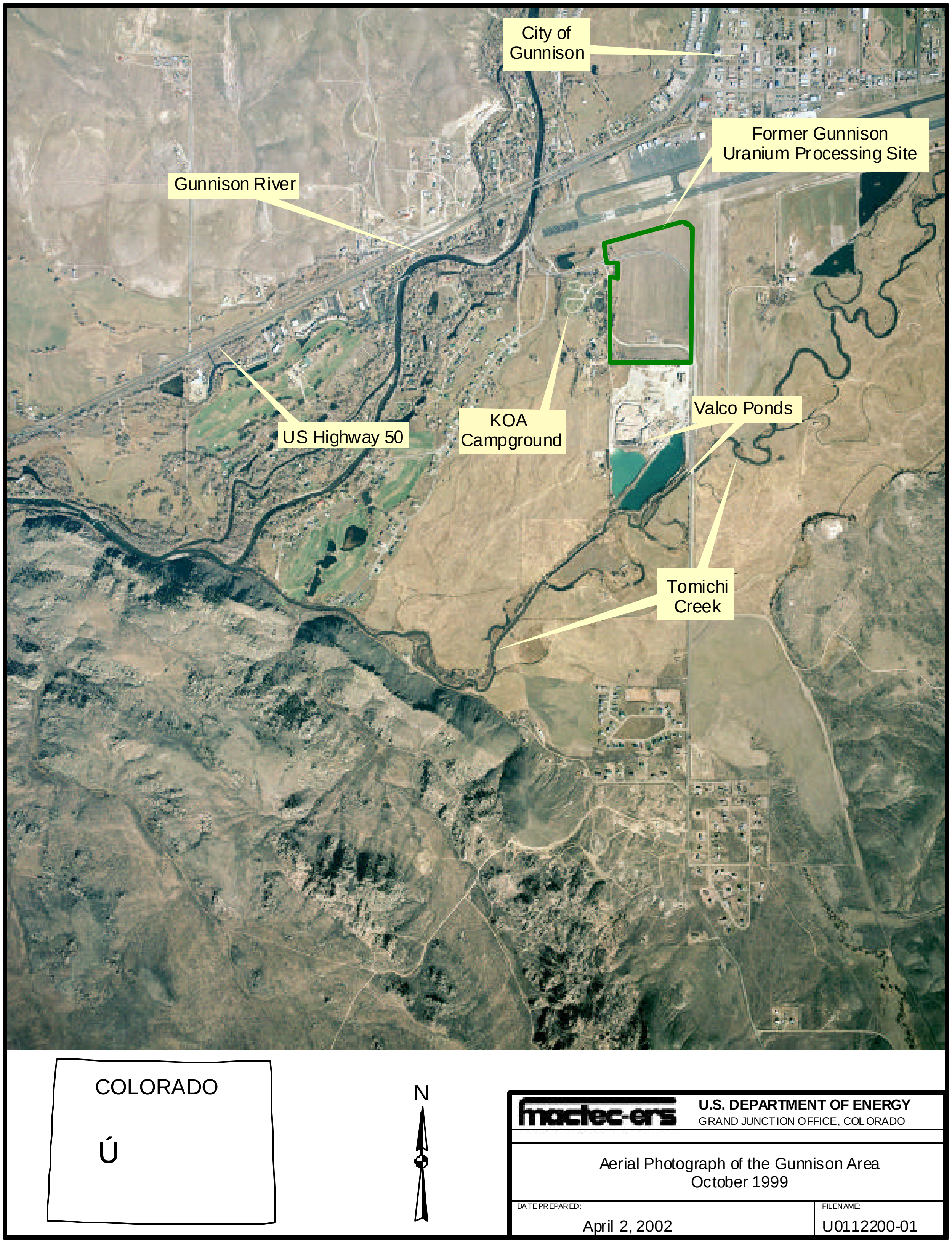

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Figure 2. Aerial Photo of the Gunnison Area, October 1999

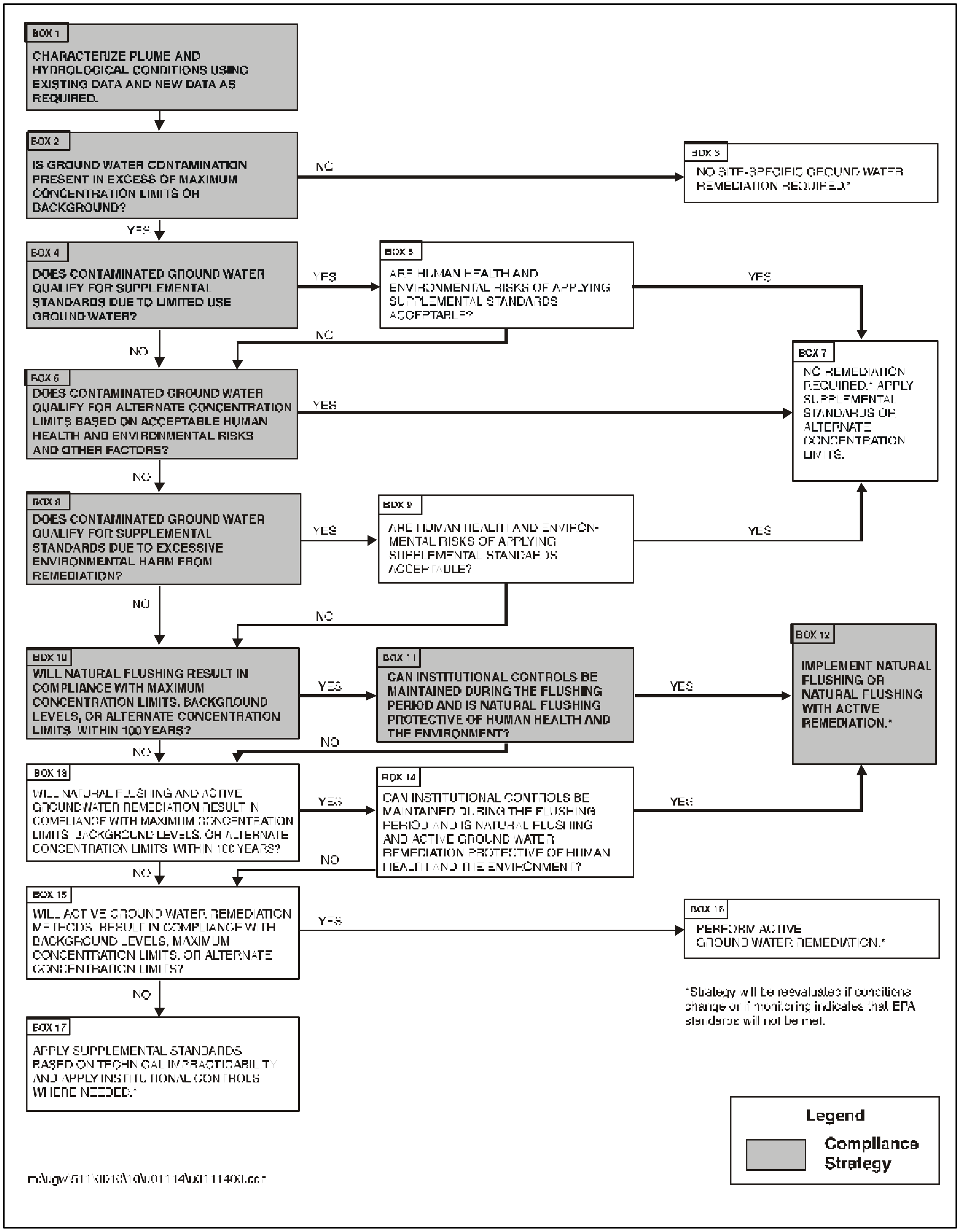

Figure 3. Compliance Selection Framework for the Gunnison Site

Table 1. Explanation of the Decision Path for the Gunnison Site Compliance Strategy

Box (Figure 3)	Action or Question	Response
1	Characterize plume and hydrologic conditions	Review historical data and identify data gaps in the Summary of Site Conditions and Work Plan. Additional field investigation conducted to address the data gaps lead to the production of the SOWP (DOE 2001). Move to Box 2.
2	Is ground water contamination present in excess of UMTRA MCLs or background?	Uranium concentration exceeds the UMTRA MCL and manganese concentration exceeds acceptable risk-based levels. Move to Box 4.
4	Does contaminated ground water qualify for supplemental standards on the basis of limited use?	The ground water does not qualify for limited use designation because the background TDS is less than 10,000 mg/L, the aquifer will yield more than 150 gallons per day, and background COPC concentrations are generally low. Move to Box 6.
6	Does contaminated ground water qualify for ACLs based on acceptable human health and environmental risks and other factors?	Ground water flow and transport modeling indicates that natural flushing will be effective and ACLs are not needed. Move to Box 8.
8	Does contaminated ground water qualify for supplemental standards due to excessive environmental harm from remediation?	Although the applicability has not been formally addressed, it is unlikely that remedial action would cause excessive harm to the environment. Move to Box 10.
10	Will natural flushing result in compliance with UMTRA MCLs, background, or ACLs within 100 years?	Ground water flow and transport modeling predicts that concentrations of uranium and manganese will reach regulatory levels within the 100-year time frame. Move to Box 11.
11	Can institutional controls be maintained during the flushing period and is the compliance strategy protective of human health and the environment?	On-site ICs in the form of a deed restriction limiting access to the ground water are already enforceable as a result of title transfer from the State to the County. DOE is working with county staff to enact an administrative restriction to define restrictions to ground water within an agreed upon boundary. Ground water off site can be used without restriction after 100 years and will be protective of human health and the environment at that time. Move to Box 12—implement natural flushing.

The following conditions are requirements of the natural flushing compliance strategy [40 CFR 192.12(c)(2)]:

- Natural attenuation must decrease RRM concentrations to background levels, maximum concentration limits (MCLs), or alternate concentration limits (ACLs) within 100 years.

- Institutional controls must be implemented that will effectively protect public health and the environment.

- Ground water must not be used currently or in the projected future as a source of public drinking water.

A site conceptual model and ground water flow and transport model support the finding that natural ground water movement and geochemical processes will meet the regulatory requirements for natural flushing of constituents in the alluvial aquifer (DOE 2001). Application and success of the natural flushing alternative would be verified through a monitoring program as required by 40 CFR 192.12(c)(3). Figure 4 shows the 28 proposed monitoring locations, and Table 2 identifies the rationale for monitoring those locations under the proposed action alternative. To address regulatory and stakeholder concerns, two monitor wells will be added to assess potential migration of site-related contaminants in ground water and will become part of the monitoring network (Figure 4). Two surface water locations will also be added. The final monitoring network will be subject to regulatory approval.

Ground water and surface water would be monitored during the period of natural flushing to verify modeling results and to determine if concentrations of uranium and manganese are decreasing. General water quality indicators such as alkalinity, conductivity, pH, total dissolved solids (TDS), sulfate, and temperature would also be determined during sampling.

Monitoring would take place on an annual basis for the first 10 years (through 2010). At the end of the initial 10-year monitoring period, an evaluation would be made in consultation with the U.S. Nuclear Regulatory Commission and the State of Colorado to determine the monitoring requirements and frequency until completion of natural flushing. The monitoring program would continue until remediation objectives have been achieved. If it is determined that the natural flushing strategy is not progressing as predicted, the compliance strategy would be reevaluated.

Institutional controls protect public health and the environment by limiting access to a contaminated medium, in this case alluvial ground water at the Gunnison site. These controls depend on an administrative legal action, such as zoning, ordinances, and laws, to ensure that protection is effective and enforceable. For the UMTRA Ground Water Project, institutional controls would reduce exposure to contaminated ground water or reduce health risks by (1) preventing intrusion into contaminated ground water or (2) restricting access to or use of contaminated ground water for unacceptable purposes. EPA standards permit the use of institutional controls where natural flushing will result in concentrations of RRM that are below regulatory limits within 100 years.

On the basis of the known areal extent of the uranium plume, the projected path and concentrations of the plume for the 100-year time frame allowed for ICs, and the known concentrations of uranium above the background level but below regulatory levels, DOE is proposing the ICs boundary shown in Figure 5. As the contaminant plume becomes diluted and naturally flushes over time, this boundary can be adjusted, and the county may choose to adjust the language in the administrative IC to accommodate the attenuation effects of the contaminants.

Several boundaries were selected to easily define the affected area. The southeastern and southern boundaries follow the course of Tomichi Creek. The basis for choosing this boundary is that the creek is a discharge point for the uppermost aquifer. The western boundary is formed by the western section line of Section 10, Township 49 North, Range 1 West. The northern boundary runs along U.S. Highway 50 to Gold Basin Road. The areas east of the western boundary and south of the northern boundary are served by the Dos Rios water system. The eastern boundary follows Gold Basin Road to the intersection with Tomichi Creek. The proposed boundary comprises the area containing the contaminated plume and a buffer zone where uranium concentrations are known to be above background levels but below regulatory limits. In addition, the proposed boundary fully covers the area served by the Dos Rios Water and Sanitation District where DOE has previously replaced the beneficial use of the ground water by funding the existing water system.

On-site institutional controls are covered by a restriction that was placed on the deed when the former millsite was conveyed by quitclaim from the State of Colorado to Gunnison County. The deed contains the following language:

> "Grantee [Gunnison County] covenants…(ii) not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Grantor [CDPHE] and the U.S. Department of Energy."

The language is recorded with the deed and ensures that any future landowner is subject to the same restrictions. This language fulfills the requirements for degree of permanence and enforceability by government entities. The former millsite is within the service area of a municipal water line, so future users have a source of domestic water available. This availability complies with EPA's requirement to satisfy beneficial use of the ground water.

Because uranium contamination extends beyond the former millsite boundary, downgradient or off-site institutional controls are necessary. Sampling results from domestic wells within the Dos Rios subdivision immediately west of the former processing site showed levels of uranium and other metals, including manganese, that exceeded background levels. In August 1990, DOE began providing bottled water to all downgradient users. The bottled water was intended as a temporary measure until a permanent solution could be developed. In 1994, DOE and CDPHE constructed an alternate domestic water supply (Dos Rios Water and Sanitation District) using water from the Gunnison River. New users within 1,000 ft of this system are asked to tap into it for domestic water. DOE is currently working with Gunnison County officials to establish an enforceable and verifiable administrative mechanism to require new users to hook up to the municipal water supply.

3.2 No Action Alternative

Title 10 *Code of Federal Regulations* Part 1021, "National Environmental Policy Act Implementing Procedures," paragraph 321, "Requirements for Environmental Assessments" directs that DOE consider the no action alternative for comparison with the proposed action. Under the no action alternative, no further activities would be carried out at the Gunnison UMTRA Project site to comply with EPA ground water standards. Contaminated ground water would be left in place. DOE would cease collecting data to characterize ground water, and contaminated ground water would not be monitored. Any future use of alluvial ground water for human consumption would be undetected because institutional controls would not be implemented off site or monitored in any way. DOE would not perform any additional administrative or remedial activities.

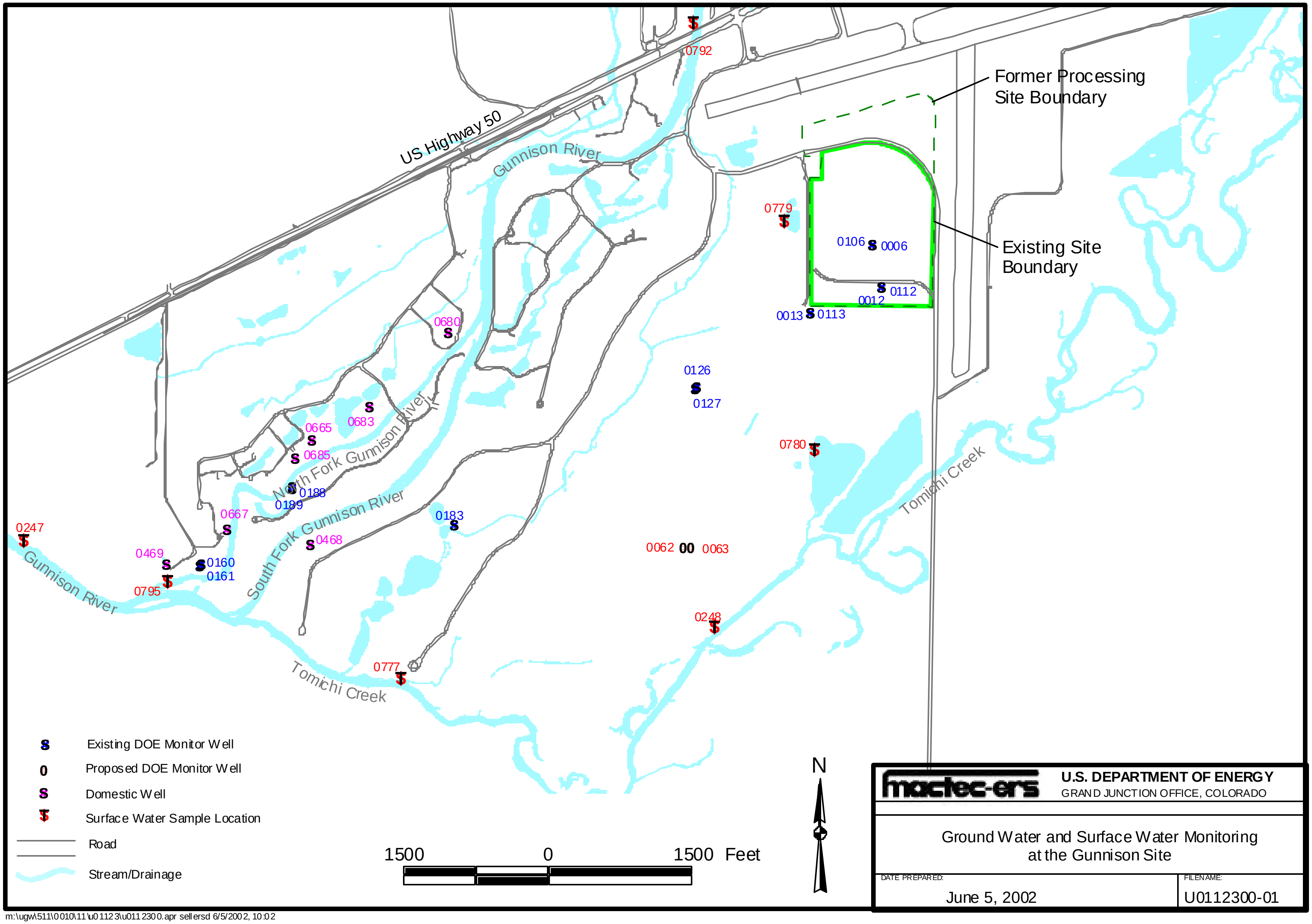

Figure 4. Ground Water and Surface Water Monitoring Locations at the Gunnison Site

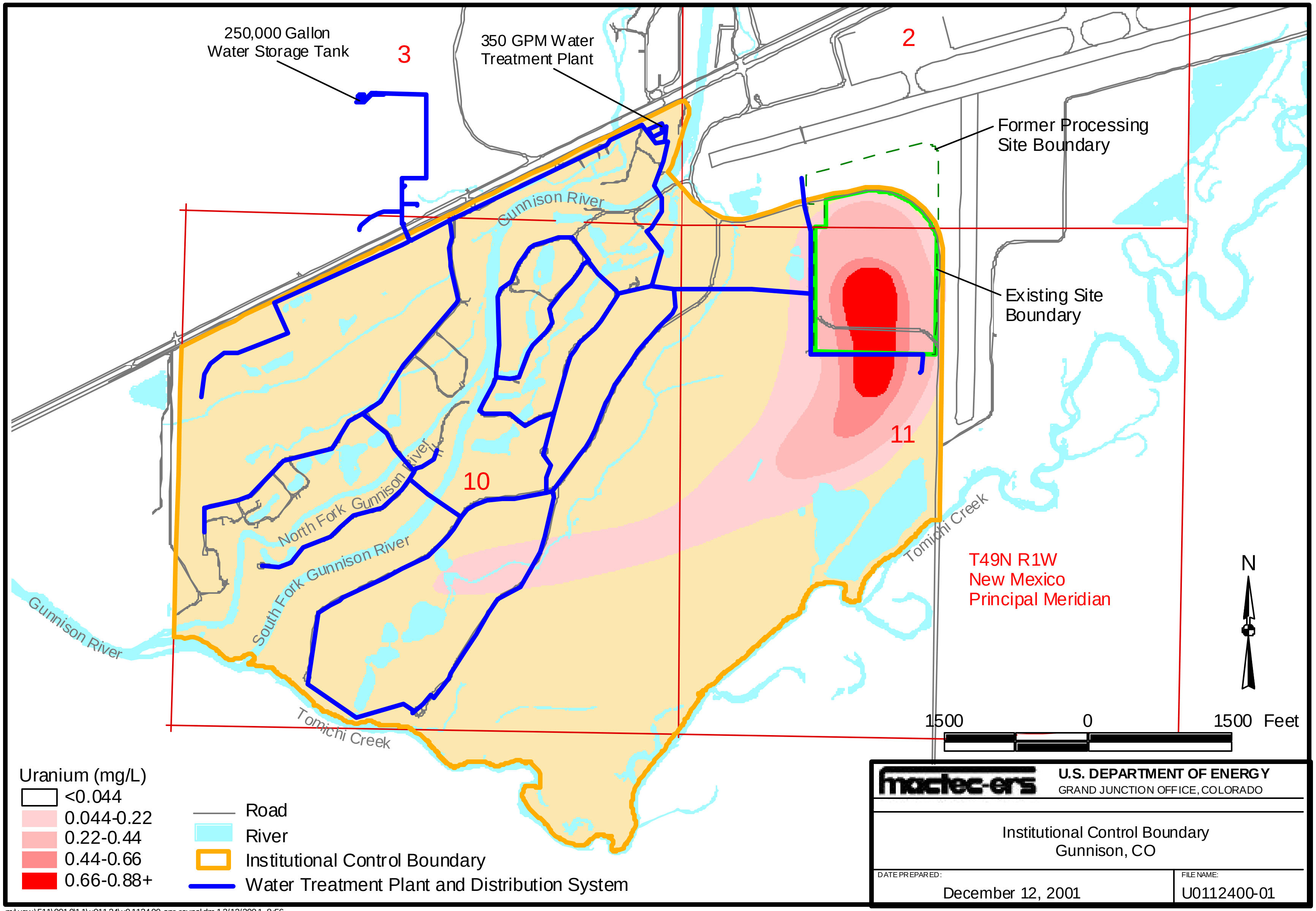

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Figure 5. Institutional Controls Boundary at the Gunnison Site

Table 2. Ground Water and Surface Water Monitoring at the Gunnison Site

Monitor Well	Aquifer Zone	Screened Interval (ft)	Location	Rationale (Uranium)
Ground Water				
GUN-006	Shallow	10–15	On site	Hot spot
GUN-106	Intermediate	34–39	On site	Background
GUN-012	Shallow	10–15	On site	Hot spot
GUN-112	Intermediate	40–45	On site	Background
GUN-013	Shallow	11–16	Just off site	Above MCL
GUN-113	Intermediate	41–46	Just off site	Above MCL
GUN-126	Intermediate	54–59	Downgradient	Below MCL
GUN-127	Deep	94–99	Downgradient	Below MCL
GUN-062	Intermediate	50–55	Downgradient	South edge of plume
GUN-063	Deep	95–100	Downgradient	South edge of plume
GUN-183	Deep	93–98	Beneath golf course	Above MCL
GUN-188	Intermediate	53–58	West of Gunnison River	Above background
GUN-189	Deep	93–98	West of Gunnison River	Above background
GUN-160	Intermediate	51–56	West of Gunnison River	Above background
GUN-161	Deep	93–98	West of Gunnison River	Above background
Surface Water				
GUN-247			Gunnison River	Downstream
GUN-248			Tomichi Creek	Near Valco gravel pit
GUN-777			Tomichi Creek	Downstream
GUN-780			Valco gravel pit	Above MCL
GUN-792			Gunnison River	Upstream
GUN-795			Gunnison River	Downstream
Domestic Wells				
GUN-468	Shallow	Unknown	East of Gunnison River	Buffer zone
GUN-469	Shallow	Unknown	West of Gunnison River	Buffer zone
GUN-665	Shallow	Unknown	West of Gunnison River	Buffer zone
GUN-667	Shallow	Unknown	West of Gunnison River	Buffer zone
GUN-680	Shallow	Unknown	West of Gunnison River	Buffer zone
GUN-683	Shallow	Unknown	West of Gunnison River	Buffer zone
GUN-685	Shallow	Unknown	West of Gunnison River	Buffer zone

3.3 Consideration of Active Remediation Alternatives

To compare cleanup alternatives, DOE performed a preliminary assessment of potential active remediation alternatives for the Gunnison site. The purpose of this assessment was to determine whether the ground water contaminant plume that remains beneath and downgradient from the site could be cleaned up more quickly and effectively using active remediation methods rather than by relying on natural processes alone. Active remediation would possibly allow the natural flushing processes to act more quickly by decreasing the amount of contamination in ground water that would be available to migrate downgradient. The active remediation alternatives considered included pumping ground water to the surface for treatment (pump and treat), a permeable reactive barrier, and engineered bioremediation. Detailed cost estimates for the different alternatives have not been prepared; however, the estimated costs provided here are based on experience at other sites.

3.3.1 Pump-and-Treat

A widely used ground water remediation technology is the pump-and-treat method, which can be used for hydraulic containment and reduction of dissolved contaminant concentrations in ground water (EPA 1996). Conventional pump-and-treat methods involve pumping contaminated ground water to the surface for treatment. A series of wells is installed in the aquifer to pump out contaminated ground water, which is then run through some form of treatment system on the surface, then injected back into the aquifer, discharged to surface water, or used for some purpose. Overall, this type of system consists of an extraction well field, collection piping, treatment plant facilities, evaporation pond, and infiltration trenches or injection wells. Combining the pump-and-treat approach with in situ chemical and biological enhancements provides further opportunities for improving the effectiveness of ground water cleanup. Although the effectiveness and performance of pump and treat has been questioned, it can be used for both restoration and containment of ground water when conditions are favorable (EPA 1996, Travis and Doty 1990).

Much of the contaminant plume has already escaped from beneath the site and is present at lower concentrations in ground water downgradient from the site. Also, the plume has migrated deeper in the aquifer as it has moved downgradient. This results in a large volume of contaminated ground water of variable concentrations dispersed through large areas of the aquifer. An estimated 1.1 billion gallons of contaminated ground water is in the plume associated with the Gunnison site (DOE 2002). A comprehensive pump-and-treat system would be needed to recover and treat all ground water with uranium concentrations greater than the standard beneath and downgradient from the site. This system would include the extraction well field installed on the county-owned site and on private property, and having an extensive collection system to convey the contaminated water to the treatment plant that would be constructed on the former site.

Design of the extraction system would involve capture zone analysis, optimization modeling, assessment of monitoring data to help determine extraction well locations, and consideration of a phased approach to maximize capture of the contaminant plume. An array of conventional vertical wells to a maximum depth of 80 ft would be required to effectively capture the contaminant plume. The estimated volume of contaminated ground water to be removed and the rate of extraction would be determined on the basis of (1) the configuration of the plume and magnitude of contamination within the plume, (2) lack of uniformity of aquifer materials and effect on ground water flow paths, (3) geochemical characteristics of the aquifer materials and interactions with ground water and contaminants, (4) capacity of the treatment plant, (5) the operational period (seasonal or construction of a winterized system), (6) means of discharge of the treated water (through injection wells or infiltration trenches back into the aquifer or into adjacent streams), (7) effect of depletion of ground water in the aquifer on the normal use of ground water (for irrigation or domestic use) or natural discharge into adjacent streams, and (8) restrictions on consumptive use of ground water and water rights issues. During the pump-and-treat process, the large volume of ground water pumped out usually includes a large volume of clean water along with the contaminated water, resulting in a greater volume that must be treated and discharged. The amount of ground water that would need to be extracted for treatment and the duration of the pump-and-treat activities would depend on the number of pore volumes required to reduce contaminant concentrations in ground water to acceptable levels. The time period could range from 20 to 50 years depending on factors mentioned above.

Ground water extracted from the well field would be piped to the surface treatment plant. The treatment method and capacity of the facility would be determined from characteristics of the contaminated ground water. The period of operation would be based on the degree of winterization of the overall system. Two treatment methods commonly in use include distillation and ion exchange. The distillation method treats contaminated ground water by boiling it, recovering vapors as a clean water stream, and concentrating the contaminants in a brine/waste stream. The brine is then purged from the distillation unit and evaporated to dryness in a solar evaporation pond, and finally disposed of. The ion exchange method treats contaminated water by passing it through columns containing synthetic resins that selectively remove specific ions. Ion exchange beds require periodic regeneration with concentrated acid or alkaline solutions. The regeneration process produces a wastewater stream that is evaporated in a solar evaporation pond and disposed of. Any residual radioactive waste would require special disposal treatment. After the contaminated ground water is treated, the clean, treated water would have to be discharged either back into the aquifer through injection wells or an infiltration gallery, or discharged directly into adjacent streams. Another option would be to use the treated water for irrigation or domestic use. The well field and treatment facility would cover much of the Gunnison site and would greatly restrict any planned use of the property for the duration of the cleanup operation.

Many factors are involved in the effectiveness and applicability of a pump-and-treat system. Pump-and-treat operations have been successful for cleanup of plumes of limited extent, such as gas station cleanups, and at sites where aquifer properties are favorable. Overall, the pump-and-treat method has not proven to be a technically effective or economical process for cleaning up ground water contamination in complex aquifer systems, such as at the Gunnison site. Specifically, factors at the Gunnison site not conducive to application of this method would include (1) the large volume of ground water to be treated, (2) the wide dispersion of the contaminant plume, (3) the complexity of the materials and geochemistry of the aquifer, (4) the logistics of establishing and maintaining a sizable cleanup operation in this area, and (5) authorization of substantial funding when there would be no significant risk-reduction benefit and no economic gain because an alternative drinking water source is already available. Another factor that limits the effectiveness of the pump and treat method is related to the phenomena of "tailing" and "rebound" (EPA 1996). Tailing is the progressively slower rate of decline in dissolved contaminant concentrations with continued operation of the pump-and-treat system, which results in a longer treatment time and residual concentrations in excess of cleanup standards. Rebound is the rapid increase in contaminant concentrations that can occur after pumping has been discontinued. This is possibly followed by stabilization of the contaminant concentration at a somewhat lower level. Thus, the standard is attained, and then the system gets out of compliance again. These phenomena are common, and the degree to which tailing and rebound complicate remediation efforts is a function of the physical and chemical characteristics of contaminant being treated, subsurface solids, and ground water chemistry.

The estimated cost for this method, including capital cost, operation, and maintenance, would be a minimum of $25 million over a 20-year period and could exceed this amount if a longer period of remediation was required.

3.3.2 Permeable Reactive Barrier

A permeable reactive barrier is a zone of reactive material placed in the subsurface so that contaminated ground water flows through and contamination is either contained or destroyed in the process (Gavaskar et al. 1998). This prevents downgradient migration of dissolved ground water contaminants. Use of this method at the Gunnison site would be difficult if the entire 100-ft thickness of the alluvial aquifer beneath the site were to be treated. Construction of a barrier is limited to reasonable depths and is more effective when tied into impermeable bedrock. Reaching bedrock would be difficult at the Gunnison site and would complicate managing the movement of ground water through the reactive material. Since a permeable reactive barrier would have to be built on site, this method would only treat site-related contamination in ground water that is still beneath the site and would have no immediate effect on cleaning up the portion of the contaminant plume that is already downgradient from the site boundary. Application of this method would decrease the amount of contaminated ground water that migrates off site over time and would result in concentrations in the downgradient plume decreasing to below the MCL in a somewhat shorter period of time. However, because of the technical problems associated with implementing this technology at the Gunnison site, it is uncertain whether this decrease in time frame could be achieved.

The estimated cost of this method may be 2 to 5 million dollars for 20 years.

3.3.3 Bioremediation

Bioremediation involves the use of microorganisms to reduce or eliminate concentrations of metals and radionuclides in soils and ground water or contain them at environmentally safe levels (McCullough et al. 1999). Microorganisms can interact with metals and radionuclides and transform them from one chemical form to another by changing their oxidation state. This can either increase the solubility of the altered contaminant, allowing it to be more easily flushed from the environment, or the opposite—decrease the solubility, and the contaminant will be immobilized in the ground, thus reducing the risk to humans and the environment by containment. Use of this process would affect land use because a well field and surface facilities would have to be constructed. As with the permeable reactive barrier, this method would have no effect on the contaminant plume that has already migrated from the site, but would only decrease the amount of contamination currently leaving the site and would allow natural flushing to occur more rapidly downgradient from the site.

Since this method is still in the experimental stage and has not been implemented at a field scale, estimated costs, time involved, and relative effectiveness of the technology are not available.

3.3.4 Summary of Active Remediation Alternatives

Based on this preliminary assessment, it was determined that using an active remediation alternative would not significantly enhance the technical feasibility of cleaning up contaminated ground water and would not provide significant risk reduction or economic benefits. The only potential gain by implementing some form of active remediation may be that ground water cleanup would occur in a shorter period of time, but at much greater expense and with no risk reduction benefit, since the main pathway for human health risk has been mitigated by installation of the water distribution system in 1994. Because contaminated ground water exists, implementing any active remediation alternative would not eliminate the need for institutional controls. Restrictions to ground water access would still be required until ground water cleanup goals were met. Also, in the pump-and-treat scenario, land use would be affected both on site and off site during the active remediation period.

Therefore, natural flushing coupled with effective institutional controls and performance monitoring has been determined to be the most technically feasible and economical compliance strategy for the Gunnison site that is protective of human health and the environment. Since none of the active remediation alternatives appear to provide a viable solution or enhancement to cleanup of contaminated ground water, the "Affected Environment" and "Environmental Consequences" discussions in Section 4.0 will only considered the proposed action alternative (natural flushing) and the no action alternative, as required by the NEPA process and outlined in the PEIS (DOE 1996a).

4.0 Affected Environment and Environmental Consequences

This section describes the environmental issues and resources that are associated with the compliance strategy proposed for the alluvial aquifer at the Gunnison site and the effects that the proposed action and no action alternatives may have on them. DOE has determined that some environmental resources are not present at the site or, if present, would not be affected by the alternatives. Resources that will not be affected or issues that are not relevant to the proposed action include air quality, noise, cultural resources, socioeconomics, transportation, wetlands, and visual and recreational resources. Therefore, these are not discussed further. Sections 4.2 through 4.11 discuss the resources or issues that are relevant to the alternatives.

4.1 Physical Setting and Climate

The Gunnison site is located on the northern margin of the San Juan Mountains (formed during the Laramide orogeny) and in the eastern edge of the West Elk volcanic field of Tertiary age. The elevation at the site is 7,635 ft, and surrounding mountains rise above 12,000 ft. Higher elevations in the area are forested on the north and east sides, and lower elevations on the south and west sides are covered with scattered trees, forbs, and grasses. The area surrounding the site is characterized as rural to remote, with a moderately dense population typical of a mountain community.

Widespread recent alluvial floodplain and terrace deposits associated with the Gunnison River and Tomichi Creek underlie the Gunnison site and surrounding area. The alluvium is composed of poorly sorted sediments ranging from clay-sized material to gravel with cobbles. The thickness of the alluvium ranges from 70 ft to 130 ft. Underlying the alluvium is a discontinuous unit of unknown extent and thickness identified as the Brushy Basin Member of the Jurassic Morrison Formation. The formation is composed of low-permeability shale that separates the overlying alluvium from the deeper units.

Gunnison receives an average annual precipitation of 10.5 inches (maximum precipitation in July and August) and an annual average snowfall of 54 inches. Winds blow predominately from the west and northwest. Average monthly temperatures range from 9 °F in January to 62 °F in July.

4.2 Subpile Soils

Because supplemental standards were applied for thorium during the surface remediation, subpile soils at the site were analyzed to determine if there is a continuing source for uranium in the ground water. Uranium concentrations as high as 86.2 milligrams per kilogram (mg/kg) were detected in the subpile soils beneath the former millsite. Leaching from the tailings pile and precipitation of manganese or ferric oxyhydroxides might have adsorbed uranium onto the sediments. However, no correlation between uranium content and manganese or iron concentration in soils was observed. Column studies showed that natural ground water from the site could leach uranium from the subpile soils. Effluents from the columns contained up to 1.6 milligrams per liter (mg/L) uranium. These concentrations are comparable to the uranium concentrations currently detected in the ground water on site.

4.3 Ground Water

4.3.1 Affected Environment

Regulations governing ground water remediation are primarily concerned with the uppermost aquifer. A detailed description of the alluvial (uppermost) aquifer at the Gunnison site is provided in Section 5.1.2 of the SOWP (DOE 2001). This aquifer consists of a sandy gravel deposit underlain by shales of the Brushy Basin Member of the Jurassic Morrison Formation. The aquifer is unconfined and extends well north of the site and underlies the entire area between Tomichi Creek and the Gunnison River. Near the site, the saturated thickness ranges from 70 to 130 ft.

Alluvial ground water flows southwest at an average horizontal gradient of 0.005. There appears to be minimal difference between the various depths within the aquifer; the deeper zones have a similar ground water flow direction and gradient. Vertical ground water gradients within the aquifer are generally downward. At various times during the year, the vertical gradients in the past have changed from downward to upward. Hydraulic conductivity estimates range from 103 to 171 ft/day. Based on a ground water gradient of 0.005 and an estimated effective porosity of 0.27, the average linear ground water velocity ranges from 1.9 to 3.2 ft/day.

Several surface water sources affect recharge to, and discharge from, the alluvial aquifer. Tomichi Creek and the South Fork of the Gunnison River are the main recharge sources during spring and summer. Daily mean stream-flow data are available from the U.S. Geological Survey (USGS) gauging stations located on the Gunnison River north of the site and on Tomichi Creek south of the site. Other sources of recharge include flood irrigation during late spring to late summer on the pasture area southwest (downgradient) of the site, and irrigation of the golf course, which applies up to 200,000 gallons per day during the spring and summer months to the area west of the site. Snowmelt and precipitation recharge the alluvial aquifer to a lesser extent.

Alluvial ground water discharges from the shallow zone (less than 20 ft below ground surface) to the Gunnison River and Tomichi Creek at various times of the year, primarily in summer and fall. Transpiration from the irrigated pasture downgradient of the site also provides significant discharge from the aquifer. The Valco gravel pit operation to the south also contributes to discharge of ground water in the immediate vicinity of the site. From mid-May through August the excavation is dewatered by pumping 2,000 to 4,000 gallons per minute continuously; all water is discharged into an adjacent pond. This dewatering creates a steeper ground water gradient in the vicinity of the excavation and creates a ground water mound to the south.

Ground water pH at the Gunnison site averages 7.3 and ranges between 5.2 and 8.5. TDS concentrations range from 110 to 2,280 mg/L. Highest concentrations were detected in ground water beneath the millsite. The geochemical conditions are intermediate to oxidizing, and the oxidation-reduction potential ranges from –214 to +276 millivolts. Major cations in the ground water are calcium and magnesium. The alkalinity averages 200 mg/L as $CaCO_3$ but can be as high as 1,075 mg/L on the west side of the Gunnison River. The ground water chemistry beneath and downgradient of the millsite is dominated by sulfate.

Background Ground Water Quality

Background ground water quality is defined as the quality of water in portions of the aquifer that were unaffected by milling activity. The MCL is defined as the maximum concentration of a constituent that is allowed in drinking water. Table 3 lists key geochemical parameters as well as constituents anticipated to be present at uranium mill tailings sites.

Table 3. Ground Water Quality Parameters at the Gunnison Site

Analyte	UMTRA Project MCL	Background[a]	Range in the Ground Water Plume[b]
Cadmium (mg/L)	0.01	< 0.001	< 0.001–0.002
Iron (mg/L)		0.18	0.006–10.3
Magnesium (mg/L)		15.7	5.58–59.3
Manganese (mg/L)		0.03	< 0.001–18.6
Nitrate (mg/L)	44	4.4	< 0.01–6.38
Radium-226+228 (picocuries per liter)		0.92	0.52–3.03
Selenium (mg/L)	0.01	< 0.001	< 0.001–0.004
Sulfate (mg/L)		20.0	11.6–1,810
Uranium (mg/L)	0.044	0.003	< 0.001–0.95
pH		7.3	5.2–11.3
Alkalinity as $CaCO_3$ (mg/L)		215	
Oxidation-Reduction Potential (millivolts)		14	-214–276
Total Dissolved Solids (mg/L)		312	110–2,280

[a]Average from wells 001, 101, 002, 102
[b]Data: Average May/October 1999

Nature and Extent of Contamination

Ground water beneath and downgradient from the former millsite was contaminated by uranium-ore processing activities. RRM was removed to just below the water table, although some contaminated material was left in place during the surface remediation.

Uranium is the primary COPC in ground water because concentrations exceed 1.0 mg/L beneath the former millsite and because they exceed the MCL of 0.044 mg/L at a distance of 1,000 ft downgradient from the site boundary beneath the adjacent gravel mining operation (Figure 6 and Figure 7). Concentrations of uranium in ground water that are below the MCL but above background extend approximately 7,000 ft downgradient from the site boundary and have migrated under the Gunnison River just beyond the confluence with Tomichi Creek. The zone of contamination attenuates and migrates downward as it progresses laterally. Manganese does not appear to be widespread in the aquifer, and concentrations beneath the site are decreasing (Figure 8).

CDPHE established an action level for uranium in ground water of 0.020 mg/L in 10 domestic buffer zone wells and 0.20 mg/L in the domestic irrigation wells downgradient from the millsite. There have been no notable concentration trends or variations in samples from the domestic buffer zone wells that would suggest the potential for significant changes in ground water quality.

Ground Water Use

There is no current use of alluvial ground water beneath the former processing site. Historically, ground water from the shallow alluvial aquifer downgradient of the site between the Gunnison River and Tomichi Creek was the principal source for drinking, irrigation, and livestock water. Residents in the Dos Rios subdivision and local businesses obtained ground water from private domestic wells that were generally completed less than 30 ft in depth in the alluvial aquifer.

Results of ground water sampling in 1990 from domestic wells downgradient from the site indicated concentrations of uranium in excess of background levels (DOE 2001). In an effort to ensure a long-term source of clean water, DOE, CDPHE, and Colorado Department of Local Affairs funded a $6.8 million water supply system. Gunnison County completed construction in 1994, and the system was turned over to the Gunnison County Public Works Department as the Dos Rios Water and Sanitation District. There are currently 231 hookups to the system, which includes most of the residences and businesses in the area. The fourteen residences that are not tapped into the system and still use ground water from domestic wells are located northwest of the Gunnison River in an area where shallow alluvial ground water has not been, and is not expected to be, affected by site-related contamination. The water system has the capacity for expansion to cover any anticipated growth in the vicinity. Any potential future use of ground water both at the former processing site and in the surrounding area would be subject to Gunnison County institutional controls. Continued use of ground water from wells designated for irrigation use is permissible. Domestic wells permitted for "household use only" should not be used for any other purpose.

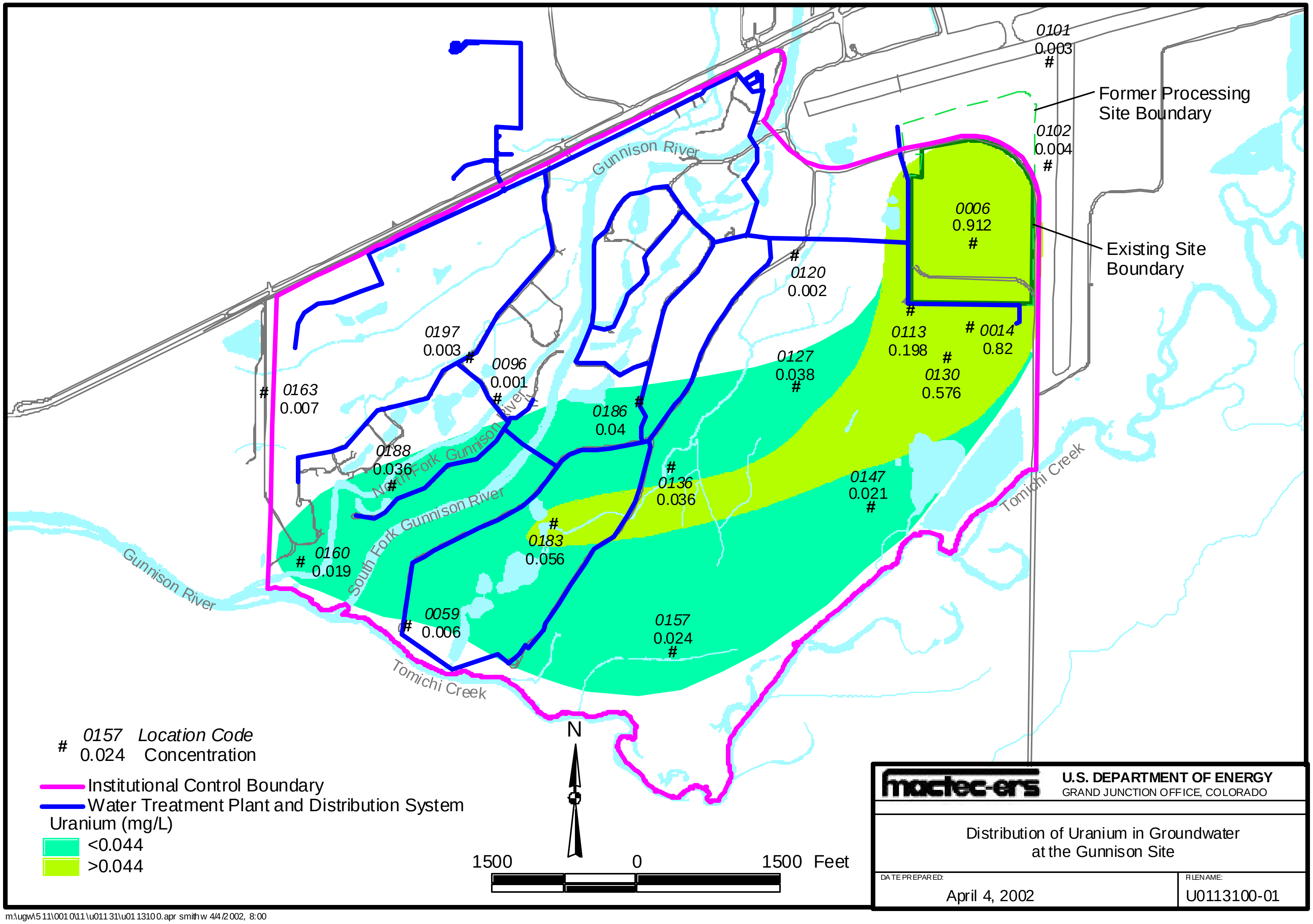

Figure 6. Distribution of Uranium in Ground Water at the Gunnison Site (1999 data)

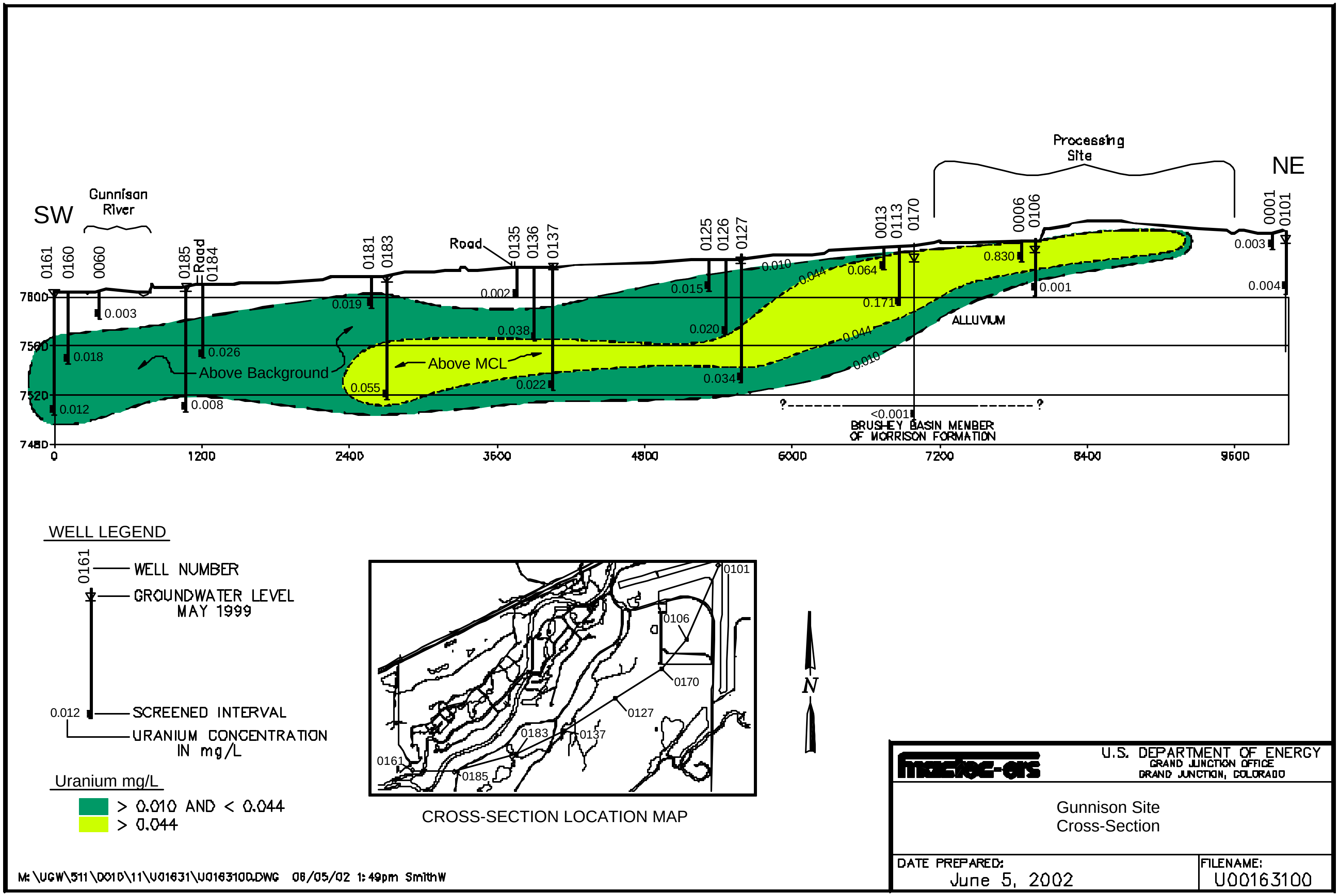

Figure 7. Cross Section of Uranium Contamination at the Gunnison Site

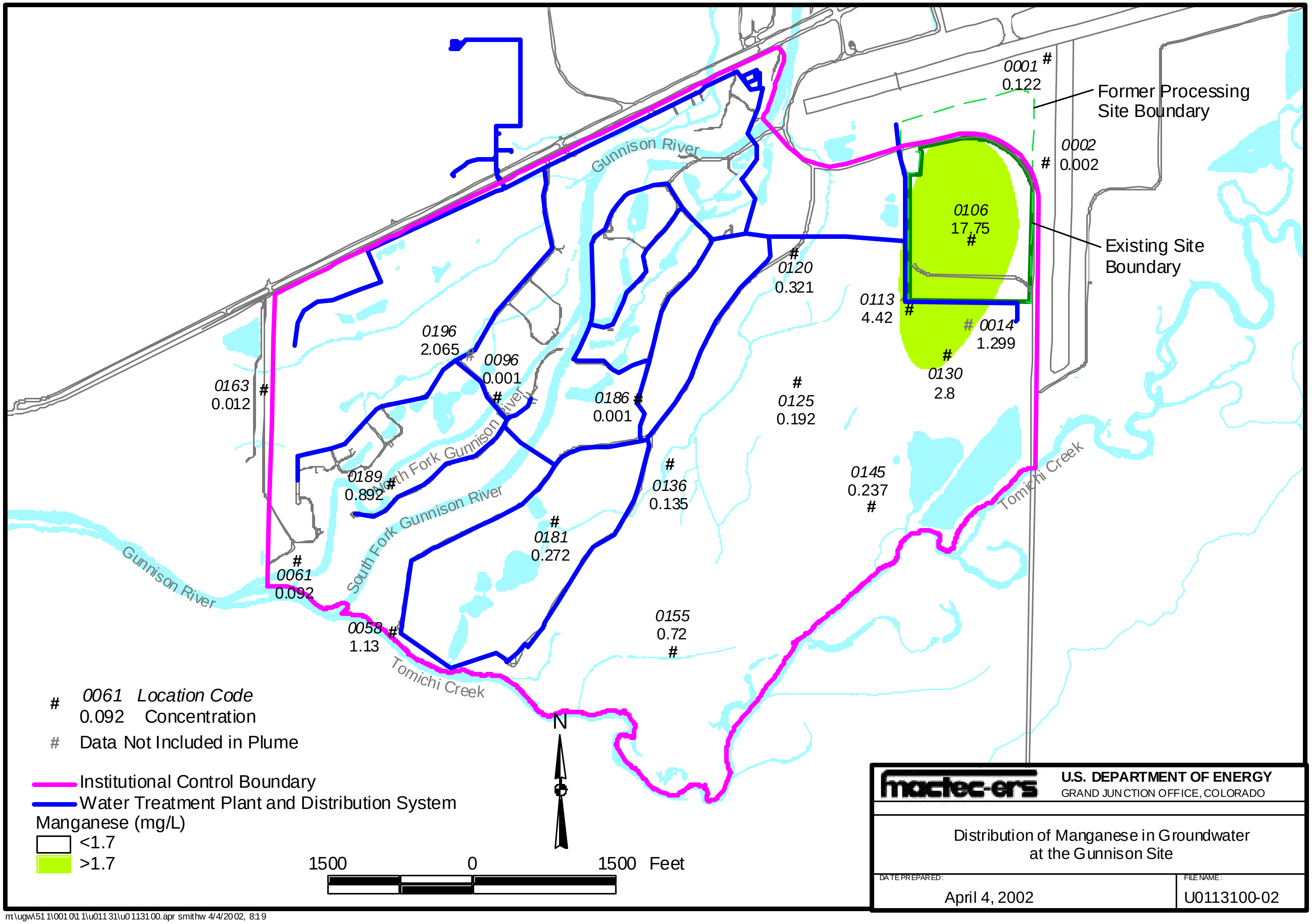

Figure 8. Distribution of Manganese in Ground Water at the Gunnison Site (1999 data)

The city of Gunnison obtains potable water from nine wells in the alluvial aquifer east of the Gunnison River from 0.5 to 1.5 miles north (upgradient) of the former processing site.

4.3.2 Environmental Consequences

Proposed Action Alternative

Over time, natural flushing would decrease contaminant concentrations in ground water beneath and near the Gunnison site to levels below EPA standards in 40 CFR 192. Ground water flow and transport modeling (DOE 2001) indicates that uranium concentrations would likely be below the standard of 0.044 mg/L in less than 100 years in areas where concentrations currently exceed the standard. Likewise, manganese concentrations are also expected to decrease within that time frame. Until contaminant concentrations are within acceptable levels, enforceable institutional controls would be in place to ensure protection of human health and the environment.

No Action Alternative

The environmental consequences under the no action alternative are similar to those under the proposed action. Under the no action alternative, uranium and manganese levels would continue to naturally attenuate. The primary difference under this alternative is that DOE would not be required to comply with monitoring and administrative requirements or to comply with certain provisions of the PEIS. ICs would not be implemented to prevent access to contaminated ground water, which could result in humans and ecological receptors being exposed to ground water contaminants.

4.4 Surface Water

4.4.1 Affected Environment

Background surface water quality is generally good. The average pH in the Gunnison River is 7.5; average TDS concentration is 105 mg/L; and alkalinity as $CaCO_3$ averages 75 mg/L. Concentrations of uranium and metals in the river water are low.

No surface water is present on the former processing site. The only surface water near the site is the Gunnison River, Tomichi Creek, ponds at the Valco gravel pit (south of the millsite), and the pond at the KOA campground (west of the millsite). Section 5.2.1 of the SOWP summarizes the surface water quality for the Gunnison site for selected constituents.

The primary concern was the possibility that contaminated ground water may be hydraulically connected to surface water, thereby creating the potential to contaminate adjacent streams, rivers, or ponds. Because the Gunnison River, Tomichi Creek, a campground pond, and Valco ponds are close to the ground water contamination, surface water sampling locations were established in all four areas. Constituents selected for analysis in surface water were those that exceeded background concentrations in ground water. Table 4 summarizes the analytical results.

Table 4. Constituents Exceeding Background Concentrations at Surface Water Sampling Locations[a]

Constituent	Location				
	0776[b]	0777[c]	0779[d]	0780[e]	0795[f]
Ammonium					
Calcium		X		X	
Cadmium					
Cobalt				X	
Iron			X		
Lead-210					
Magnesium		X		X	
Manganese				X	
Nickel					
Polonium-210					
Potassium				X	
Silica	X[g]				NA
Sodium				X	
Strontium					
Sulfate		X		X	
Thorium-230					
Uranium				X	
Zinc			X		

Notes: If no X appears in a box, the contaminant concentration did not exceed background concentrations.
NA = Not analyzed at this location.

[a]Sampling locations are shown on Figure 4.
[b]Gunnison River (downstream)—results compared to background at location 775.
[c]Tomichi Creek (downstream)—results compared to background at location 778.
[d]KOA campground pond—results compared to background at location 775 and 778.
[e]Valco Pond—results compared to background at location 792.
[f]Confluence of Tomichi Creek and Gunnison River—results compared to background at location 792.
[g]Silica is not a site-related constituent.

There is some evidence that mill-related constituents have historically influenced surface waters. A comparison of surface water data from Gunnison River samples collected at upstream and downstream locations indicated that most constituents did not exceed background concentrations.

Sulfate concentration in Tomichi Creek downgradient of the millsite was about 30 percent higher than the upstream concentration. Because of the limited data available, the significance of this increase above background is not known. Calcium and magnesium concentrations only slightly exceeded background and are not considered site-related constituents.

Iron and zinc concentrations exceeded background in water collected from the campground pond. A comparison of the surface water data with available water quality values indicated that the concentrations of iron and zinc are below the state standards.

There is evidence that contaminated ground water is influencing the Valco pond. The eight constituents identified as exceeding background in the Valco Pond are calcium, cobalt, magnesium, manganese, potassium, sodium, sulfate, and uranium. Of these, calcium, magnesium, potassium, and sodium were eliminated because they are not believed to be site-related constituents. Manganese concentration is below the Colorado aquatic-life water quality value of 1.0 mg/L. The average sulfate concentration of 107 mg/L is well below the secondary drinking water standard (250 mg/L) considered protective of human health. Although there is no surface water standard for uranium, the average concentration of 0.038 mg/L is below the UMTRA Project ground water standard of 0.044 mg/L (equivalent to 30 picocuries per liter), which is considered protective of human health in drinking water.

Surface Water Quality and Use

Surface water from the nearby Gunnison River and Tomichi Creek is used for irrigation, stock watering, and recreational uses such as boating and fishing. Water from the Gunnison River is diverted to flood-irrigate the pasture southwest of the site from May through September. Irrigation water for the Dos Rios golf course west and southwest of site is withdrawn from the Gunnison River. The KOA campground pond and the Valco pond are used primarily for recreational fishing.

4.4.2 Environmental Consequences

Proposed Action Alternative

There is evidence that mill-related constituents have influenced surface water in the vicinity of the millsite. The two constituents of concern, uranium and manganese, do not appear to be influencing the Gunnison River, Tomichi Creek, or the KOA campground pond. There is evidence that both constituents are influencing the Valco pond; concentrations are within accepted standards and are expected to decrease over time. This scenario is not expected to change as a result of the proposed action. Monitoring of the surface water will be conducted to confirm that this is the case (see Table 2). Sections 4.0 and 6.0 of the SOWP provide the rationale for this conclusion.

No Action Alternative

The environmental consequences under the no action alternative are similar to those under the proposed action. Under the no action alternative, uranium and manganese concentrations would continue to attenuate naturally and influence surface water to some extent. The primary difference under this alternative is that DOE would not be required to comply with monitoring and administrative requirements required by regulations and provisions of the PEIS. No sampling would be conducted to monitor the influence of contaminant concentrations on surface waters.

4.5 Floodplain and Wetlands

4.5.1 Affected Environment

The Gunnison site is adjacent to 100-year and 500-year floodplains of the Gunnison River and Tomichi Creek. Computer modeling (DOE 1992) using Probable Maximum Flood and Probable Maximum Precipitation flow rates indicated that the site and the floodplain between the surface water bodies would be inundated under these conditions. However, historical stream flow data indicate that these flow rates are extremely unlikely. For example, the flow rates used for

Tomichi Creek in the modeling are 121 times the maximum recorded flow of the creek, and the Gunnison River flow rate used in the study was 291,000 cubic feet per second, which is 1.4 times the regional maximum flood discharge (DOE 1992).

Before remediation, several jurisdictional wetlands were within and adjacent to the site boundary. These wetlands were removed during surface remediation and replaced by mitigation wetlands outside the site. Currently, no delineated wetlands are known to be present on the site or within the area influenced by contamination.

4.5.2 Environmental Consequences

Proposed Action Alternative

The proposed action would have no effect on floodplains. Seasonal water table variation and intermittent flood irrigation will affect mobilization of contaminants at the site or within the area influenced by contamination and most likely will enhance natural flushing. The potential enhancement to natural flushing will have no effects on the floodplain.

No Action Alternative

The effects of the no action alternative would be the same as those of the proposed action alternative.

4.6 Sediment

4.6.1 Affected Environment

Sediment samples were collected in 1993 at locations 775 through 779. The BLRA states that only manganese, molybdenum, uranium, and zinc were analyzed. It is assumed these metals were identified as a potential concern. Table 5 summarizes the sediment sample results.

The BLRA stated that there were no state or federal sediment quality criteria at that time. However, the U.S. National Oceanic and Atmospheric Administration (NOAA) does have an effects-based sediment quality value of 120 mg/kg for zinc. Zinc concentrations in the Gunnison River upstream and downstream of the site were below the NOAA value.

Table 5. Summary of Locations Where Constituent Concentrations Exceeded Background Sediment Concentrations

Constituent	Gunnison River (776)	Tomichi Creek (777)	Campground Pond (779)
Manganese		X	
Molybdenum			
Uranium		X	
Zinc	X	X	

X = concentration exceeded background.

The Gunnison River sediment data suggest that the site is not a notable source of contaminants in river sediments. In Tomichi Creek, manganese, uranium, and zinc concentrations in sediment were all higher at the downstream location than at the upstream location. The concentrations of zinc, both upstream and downstream, are below the NOAA effects-based concentration of 120 mg/kg. The manganese concentration is also below the NOAA benchmark. Only uranium concentrations represent potential risks because they are elevated above background levels. However, no benchmark exists to quantify the risk.

The concentrations of all four constituents in sediment samples from the campground pond were less than the concentrations detected at the upstream locations in both the Gunnison River and Tomichi Creek. Site-related contamination has not affected the sediment quality in the campground pond.

4.6.2 Environmental Consequences

Proposed Action Alternative

Although mill-related constituents have influenced sediments in the vicinity of the millsite, zinc and manganese concentrations have not affected sediment quality. Due to lack of sediment benchmark criteria for uranium, no conclusions are possible. However, it is believed that risks are low compared to risks from other stressors, and remediation of contaminated surface soil has removed the potential for future sediment contamination from storm water runoff. In areas where ground water is hydraulically connected to surface water, contaminant concentrations in sediments are negligible. Therefore, sediments are not expected to be affected as a result of the proposed action. Because of the lack of a continuing source, concentrations of contaminants in sediments are expected to decrease, particularly during high-volume flows associated with spring runoff.

No Action Alternative

The environmental consequences of the no action alternative would be similar to those of the proposed action. The primary difference under the no action alternative is that DOE would discontinue all monitoring. Under the proposed action alternative, any changes in contaminant concentrations in surface water and ground water would be detected through the monitoring program, and DOE would have the option of conducting additional sediment sampling if data indicated the need. Under the no action alternative, this option would be unavailable.

4.7 Land Use

4.7.1 Affected Environment

The former uranium-ore processing site was previously owned by the State of Colorado and was deeded to Gunnison County in December 1999. A fence surrounds most of the site, except in the southeast corner, where it is readily accessible to the public. Eleven DOE monitor wells remain on the site. The site is not currently being used except as storage in a small fenced yard near the south end maintained by Gunnison County. The existing fenced area does not include all the original site. The north part of the site has already been deeded to Gunnison County for expansion of the airport and is behind the airport fence.

Gold Basin Road (County Road 38) and the Gunnison County Airport border the site on the north and east. The Valco gravel-mining operation bounds the site to the south. Commercial and residential property bounds the site to the west. Valco also owns most of the large pasture area southwest of the site, which is currently being used for livestock grazing and crops. This property will eventually be mined for gravel or developed as a residential area. The Dos Rios subdivision and golf course is west and southwest of the site and began development approximately 20 years ago along the North and South Forks of the Gunnison River. The subdivision is still under development.

Future uses for the former processing site are under consideration. The deed restriction prohibits use of contaminated ground water for any purpose and controls excavation of soil beneath the site (on the millsite only). The Gunnison County land use planning procedures and zoning regulations would control potential development of the site and adjacent land.

4.7.2 Environmental Consequences

Proposed Action Alternative

The proposed action alternative would have no effect on land use. Current land use would be unchanged, and land would still be available for most future residential, agricultural, commercial, recreational, and industrial uses. ICs, in the form of an administrative legal action such as restrictive zoning or an ordinance, would be required to limit access to ground water contaminated by previous milling activities. Although ICs would prohibit the use of ground water as a potable water supply, domestic water is available through municipal services and the water line funded by DOE.

No Action Alternative

The environmental consequences of the no action alternative would be similar to those of the proposed action. Access to ground water would be prohibited on the millsite in accordance with deed restrictions already in place. The primary difference under this alternative is that no restrictions would be placed on the ground water beneath privately owned land in areas adjacent to the millsite. Because no institutional controls would be implemented, use of ground water as a domestic water supply would be undetected.

4.8 Human Health

4.8.1 Affected Environment

Appendix B of the PEIS (DOE 1996a) describes the methods used to assess the human health risk at UMTRA Ground Water Project sites. A screening-level human health risk analysis was performed for the Gunnison site in 1996 (DOE 1996b) and updated in the SOWP (DOE 2001).

Table 6 provides a summary of alluvial ground water quality based on historical and recent sampling data.

Table 6. Gunnison Site Data Summary

Constituent	Frequency of Detection	Minimum mg/L	Maximum mg/L	Mean mg/L	MCL mg/L	RBC mg/L
Iron						11
Background	2/16	0.004	0.869	n/a		
Current Plume	18/30	0.003	4.73	0.581		
Historical Plume	4/4	49	91	66		
Manganese						1.7
Background	3/16	0.001	0.457	n/a		
Current Plume	20/30	0.0008	19.1	3.51		
Historical Plume	15/15	0.05	7	3.5		
Sulfate					n/a	n/a
Background	16/16	16.4	25.8	20.8		
Current Plume	30/30	19.2	1,390	539		
Historical Plume	4/4	1,470	1,590	1,540		
Uranium					0.044	
Background	16/16	0.0022	0.0058	0.00358		
Current Plume	26/30	0.0002	1.22	0.296		
Historical Plume	4/4	1.2	1.6	1.4		

[a]Benchmark = MCL, if available; risk-based concentration (RBC) used if no MCL

Notes:
Alluvial background wells: 001, 002, 101, 102, 140, 141, 142 (1998–99 data)
Current plume wells: 006, 013, 014, 106, 113, 130, 132, 170 (1998–99 data)
Historical plume wells: 133 and 134 for Fe, SO4, U (1989–93 data); 106, 109, 110–112 for Mn (1989–93 data)
For mean calculations, values for samples below detection were set at one-half the detection limit.
Risk-based concentrations (RBCs) represent noncarcinogenic risk.

Risks were calculated for the worst-case scenario of using a well on the former millsite as a primary drinking water source, for dermal exposure in an occupational setting (e.g., workers at the Valco pond), and for ingestion of fish obtained from the Valco pond. The only unacceptable risks were associated with ingestion of ground water in a residential setting. Uranium and manganese were the major risk contributors for noncarcinogenic risks; uranium concentrations also resulted in unacceptable carcinogenic risks. These risks are potential risks only; alluvial ground water near the site is not currently being used as a source of drinking water, and local residents receive drinking water from a municipal water supply.

4.8.2 Environmental Consequences

Proposed Action Alternative

The proposed action would be protective of human health. Contaminant concentrations in ground water and surface water would be monitored at 28 locations (Table 2) to verify that concentrations are decreasing according to ground water model predictions. Enforceable institutional controls would be in place to prohibit inappropriate use of ground water. The institutional controls would most likely be in the form of a county ordinance; work is currently underway to get the controls in place. The effectiveness of the institutional controls would be evaluated through inspection of the restricted areas. When concentrations of manganese and uranium have decreased to acceptable levels, ICs would be lifted, and ground water would be available for unrestricted use. If results of monitoring indicate that contaminant concentrations are not declining as predicted, DOE would reevaluate the compliance strategy and may select another compliance strategy. If selection of a different compliance strategy were necessary, separate NEPA documentation would be prepared at that time.

Exposure to contaminated ground water during the natural flushing period is possible at the Valco pond and during monitor well sampling. Risks associated with occupational exposure and with fishing in the Valco pond were determined to be acceptable. Routine health and safety measures taken during monitor well sampling would ensure worker protection.

No Action Alternative

Effects of the no action alternative would be the same as those of the proposed action alternative under current circumstances. However, no monitoring of ground water would take place, and it would not be possible to verify that natural flushing is resulting in lower contaminant levels. Because no institutional controls would be in place requiring current or future residents to use the municipal water supply, ground water could be withdrawn from areas that pose unacceptable risks to human health. Therefore, potential future risks would be greater from the no action alternative than from the proposed alternative.

4.9 Wildlife

4.9.1 Affected Environment

The BLRA (DOE 1996b) and surface remediation EA (DOE 1992) provide a detailed list of wildlife species likely to be found in the site area. Several species of birds and mammals were identified as likely to occur in the area depending upon seasonal habitat needs. Species diversity is somewhat limited due to limited vegetation (primarily sagebrush and grasses) and habitat diversity near the site. The limited vegetation is a result of livestock grazing, moderate density residential and recreational development, and nearby industrial operations such as the Valco gravel plant. Some riparian areas along the Gunnison River and Tomichi creek provide suitable temporary habitat for amphibians, birds, and mammals. Mammals anticipated to frequent the area include the masked shrew, desert cottontail, striped skunk, western jumping mouse, and muskrat. Muskrat sign was observed in the areas close to the site. Prairie dogs were observed in 1990. The area also serves as winter range for larger mammals such as mule deer.

No reptiles or amphibians were observed during previous wildlife surveys; however, seven species, including short-horned lizard, eastern fence lizard, and bull snake would be expected at the site. Lizard species such as the short-horned lizard and the sagebrush lizard may inhabit the sagebrush and dry rocky areas (DOE 1992).

Bird species, including the western meadowlark, red-wing blackbird, yellow warbler, and robin, are common nesting species at and near the site. Wetland species such as red-wing blackbirds, waterfowl, and shorebirds frequent the irrigated pastures. The sage thrasher, sage grouse, green-tailed towhee, and various species of sparrows are common nesting species in the sagebrush habitat. Fish species in the Gunnison River and Tomichi Creek include brown, brook, and rainbow trout, and several species of suckers (DOE 1996b).

Threatened and Endangered Species

Consultation with the U.S. Fish and Wildlife Service (USFWS) to determine potential effects on threatened and endangered (T&E) species began in 1985. A biological assessment was conducted as part of the surface remediation EA in 1991 and 1992. At that time, six T&E species were identified; one proposed species and five federal candidate species were identified as potential inhabitants of the area. In June 2000, follow-up communications with USFWS (letter dated June 28, 2000) identified several T&E species as potentially occurring in the Gunnison area. Although the bald eagle was not identified, it is known to roost in the area. No nesting sites have been confirmed near the site. T&E bird species identified by USFWS were the southwestern willow flycatcher, Gunnison sage grouse, and the whooping crane; fish species were the humpback chub, bonytail chub, Colorado pikeminnow, and razorback sucker. Of the species identified, only the whooping crane has been sighted (1 to 2 weeks each year).

4.9.2 Environmental Consequences

Proposed Action Alternative

Both physical and chemical effects are relevant to potential effects on wildlife. Physical effects such as noise and disturbances related to monitoring activities would be minimal. Some temporary displacement of wildlife would be expected once or twice a year during these activities.

Key receptors typically spend only a fraction of their time in riparian or aquatic areas that could be affected by site-related contaminants, and most have home ranges that extend well outside those areas. Provided that there is no surface expression of ground water and that disturbances are minimal, the proposed action would not affect habitat or abundance, distribution, and diversity of wildlife species, including T&E species, at the Gunnison site.

The potential for wildlife to be exposed to contamination is minimal. Terrestrial receptors, such as herbivores, grazing on vegetation could be exposed to contaminants in areas where plant roots tap into contaminated water, resulting in subsequent exposure to animals that ingest exposed vegetation. This scenario is unlikely because plants with deep root structures do not grow in the most contaminated areas of the millsite. Larger herbivores prefer to browse on leafy material; smaller mammals and birds seek plant seeds and roots. Because most of the area is irrigated with water taken directly from the Gunnison River, exposure from plant consumption is unlikely.

Terrestrial and avian receptors would also likely use the riparian corridor for food items and for a drinking water source. Consequently, there is a potential to be exposed to contaminated sediments and surface waters. Aquatic receptors such as fish, reptiles, and amphibians whose habitat includes areas influenced by site-related contaminants have the potential to ingest contaminated sediment, surface water, and riparian vegetation. Aquatic wildlife species such as fish, muskrat, and beaver have the potential for the greatest exposures. Higher trophic receptors such as coyotes, eagles, and hawks may in turn feed on small mammals or birds that have ingested contaminated food items. Aquatic avian species, including the bald eagle, whooping crane, ducks, and geese, are frequent visitors to the area surface waters and represent ecological receptors with exposure potential. Aquatic invertebrates, amphibians, reptiles, and fish are also in direct contact with potentially contaminated sediment and surface water. These receptors can also serve as prey for eagles, whooping cranes, and other wildlife. However, as noted in Sections 4.4 ("Surface Water") and 4.6 ("Sediment"), contaminant levels in those media are not anticipated to affect wildlife receptors.

No Action Alternative

The environmental consequences under the no action alternative are similar to those under the proposed action. Provided that there is no surface expression of ground water, the abundance, distribution, and diversity of wildlife species and habitat at the Gunnison site would be similar to those under the proposed action alternative. Contaminant concentrations would continue to decrease over time. Section 6.2 of the SOWP (DOE 2001) presents a detailed evaluation of ecological risk and potential effects to wildlife at the Gunnison site.

4.10 Vegetation

4.10.1 Affected Environment

Moderate annual precipitation, a rural setting, and irrigated pasture land influence the terrestrial ecology of the Gunnison site. Tree cover in the area is limited and occurs primarily in riparian areas near the Gunnison River and Tomichi Creek. Most of the undeveloped land is used as irrigated pasture for cattle.

Plant communities in the area potentially affected by contaminated ground water are predominantly desert shrub and grasses associated with irrigated pasture lands. Some riparian vegetation exists along the banks of the Gunnison River and Tomichi Creek. Big sagebrush is the most common shrub species in the desert shrub community and grows scattered or in clumps. Rabbitbrush is present with grasses and herbs dominating the understory. Small narrowleaf cottonwood is also common to the area. Only grasses currently grow within the boundaries of the former millsite. The surface remediation EA (DOE 1992) describes plant types and ecology in detail. No known threatened or endangered plant species are on or near the millsite.

4.10.2 Environmental Consequences

Proposed Action Alternative

As with wildlife, both physical and chemical effects have the potential to affect vegetation. Activities associated with monitor well sampling and abandonment could result in short-term loss or disturbance of vegetation in isolated areas. Total surface disturbances under the proposed action are estimated at less than 5 acres during the period of natural flushing. No threatened or endangered plants are known to exist on the millsite or in adjacent areas. Therefore no effects are anticipated. Any surface areas disturbed by ground water sampling during the natural flushing period would be reseeded upon completion of activities, and vegetation should reestablish within 1 to 3 years. Currently, no evidence indicates that plant species are affected by ground water in contaminated areas. There is also no evidence that vegetation associated with the Gunnison River and Tomichi Creek is influenced by millsite contaminants. If future changes in the diversity of plant species produce plants that could potentially tap into contaminated ground water, adverse effects to plant species are possible. However, on the basis of current risk assessment methodology, the potential for effects to plants is minimal.

No Action Alternative

The environmental consequences under the no action alternative are similar to those under the proposed action, except that no ground water sampling would take place to produce short-term, minor disturbance of vegetation.

4.11 Environmental Justice

4.11.1 Affected Environment

Executive Order 12898, *Federal Actions to Address Environmental justice in Minority Populations and Low-Income Populations*, states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…" The following activities have taken place and are planned to ensure that concerns from minority and low-income populations either have been or will be addressed:

- Comments from the public were solicited during development of the PEIS.
- A Public Involvement Plan (DOE 2000) was written to define how DOE will involve stakeholders in the decision-making process.
- The proposed action alternative was presented and discussed at a meeting with the Gunnison County Commissioners during 2001.
- Information will be sent to property owners adjacent to the site so that they have the opportunity to receive information on the proposed strategy and institutional controls.

4.11.2 Environmental Consequences

Proposed Action Alternative

There are no identified populations subject to environmental considerations in the vicinity of the former millsite and the contaminated ground water. Because the proposed action is protective of human health and the environment, there would be no adverse effects on any environmental resource such as ground water, surface water, current or future land use, ecological resources, or wetlands.

No Action Alternative

No identified populations subject to environmental justice considerations are in the vicinity of the former millsite and the contaminated ground water. However, since contaminants in the alluvial ground water render it unfit for domestic use, and there are currently no regulations or ordinances to prevent residents from using the ground water, the possibility exists that ingestion could pose a risk to human health. A municipal water supply is available, but in the absence of enforceable institutional controls, any population using the alluvial aquifer as a domestic water supply is exposed to risk.

5.0 Persons and Agencies Consulted

Information for this document was compiled from other sources, such as the Surface EA (DOE 1992), the Baseline Risk Assessment (DOE 1996b), the PEIS (DOE 1996a), and the SOWP (DOE 2001). During preparation of those documents, DOE held several public meetings and solicited input from affected stakeholders. In addition, notices were published in local newspapers and in the *Federal Register*.

Following the issuance of the draft PEIS for the UMTRA Ground Water Project in 1995, a public meeting was held at the Gunnison County Courthouse on June 21, 1995. The comments received from that meeting are documented in Volume II of the PEIS (comments 144 through 159).

DOE has maintained ongoing discussions and meetings with CDPHE relative to issues at the Gunnison site. On June 27, 2000, DOE met with CDPHE in Denver to present the results of the sampling program, the ground water modeling and methodology, and the proposed compliance strategy.

On June 26, 2000, DOE met with Mr. Terry Ireland, Grand Junction Office of the USFWS, to identify T&E species potentially present at the Gunnison site. That consultation directly supports the ecological risk assessment and the determination of the proposed compliance strategy.

To introduce the concept of institutional controls and to begin discussions, many conversations were conducted with Ms. Marlene Crosby, Public Works Director for Gunnison County, John DeVore, Gunnison County Manager, and the Gunnison County Commissioners. A public information meeting was conducted on March 5, 2002, to discuss the UMTRA Ground Water Project with affected stakeholders, to discuss the proposed strategy for compliance with ground water standards, and to propose ICs needed to restrict access to contaminated ground water. This meeting also served as a forum for public input to this document.

DOE consulted Mr. Wayne Lovelis, Dos Rios Water and Sanitation District Manager, to obtain information on the extent and capacity of the municipal water system that provides domestic water to the institutional controls area. Mr. Lovelis also described the process by which users hook up to the system.

Comments submitted to DOE for consideration and DOE's responses are presented in Appendix A.

6.0 References

10 CFR 1021, "National Environmental Policy Act Implementing Procedures," *Code of Federal Regulations*, January 1, 1997.

40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, July 1, 1996.

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Appendix A

Public Comment and Responses

This appendix is not available in electronic format.
Please e-mail lm.records@lm.doe.gov to request the appendix.