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Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement

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Volume I
Chapters 1–11

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COVER SHEET

Lead Agency: U.S. Department of Energy

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- National Park Service
- U.S. Nuclear Regulatory Commission
- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- San Juan County
- City of Blanding
- Bureau of Land Management
- U.S. Army Corps of Engineers
- State of Utah
- Ute Mountain Ute Tribe
- Grand County
- Community of Bluff

Title: Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement (DOE/EIS–0355).

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Abstract:

The *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* provides information on the environmental impacts of the U.S. Department of Energy's (DOE's) proposal to (1) remediate approximately 11.9 million tons of contaminated materials located on the Moab site and approximately 39,700 tons located on nearby vicinity properties and (2) develop and implement a ground water compliance strategy for the Moab site using the framework of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE/EIS-0198, October 1996). The Environmental Impact Statement (EIS) informs the public of the information used by DOE in decision-making for the remediation of the Moab site. The surface remediation alternatives analyzed in the EIS include on-site disposal of the contaminated materials and off-site disposal at one of three alternative locations in Utah using one or more transportation options: truck, rail, or slurry pipeline. This EIS evaluates the environmental consequences that may result from implementing the reasonable alternatives, including health impacts to the public, impacts to ground water and surface water, traffic impacts, and impacts to other resources. The EIS also analyzes a No Action alternative, under which DOE would not implement any surface or ground water remedial actions. DOE's preferred alternatives are off-site disposal of the mill tailings at Crescent Junction, Utah, using rail transportation, and implementation of active ground water remediation at the Moab site.

Public Comments:

In preparing this final EIS, DOE considered comments received from the public and from agencies during scoping meetings, during public hearings on the draft EIS, and during a 90-day public comment period on the draft EIS that began November 12, 2004, and ended February 18, 2005. Public hearings on the draft EIS were held at four locations in Utah in January 2005.

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[*] Substantive changes made to the text of the EIS between draft and final have been marked with sidebars in the margins.

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Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AADT	annual average daily traffic
ACL	alternate concentration limit
ADT	average daily traffic
ANSI	American National Standards Institute
AWQC	ambient water quality criteria
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
cm/s	centimeters per second
dBA	A-weighted sound level (decibels)
dBV	velocity of decibels
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
ECDC	East Carbon Development Corporation
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESC	Electric Systems Consultants
ft	feet
ft^2	square feet
ft^3	cubic feet
FLPMA	Federal Land Policy and Management Act
FR	*Federal Register*
FY	fiscal year
g/m^2	grams per square meter
gpm	gallons per minute
HEW	U.S. Department of Health, Education, and Welfare
ISV	in situ vitrification
IUC	International Uranium (USA) Corporation
K_d	distribution coefficient
kVA	kilovolt-amperes
LCF	latent cancer fatality
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
MBTA	Migratory Bird Treaty Act
MCL	maximum concentration limit
MEI	maximally exposed individual
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
$\mu g/m^3$	micrograms per cubic meter
µR/h	microroentgens per hour
mph	miles per hour
mrem/yr	millirem per year
mR/h	milliroentgens per hour
mV	millivolt

NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
PCBs	polychlorinated biphenyls
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^2-s	picocuries per square meter per second
PEIS	Programmatic Environmental Impact Statement (for the UMTRA Ground Water Project)
PM_{10}	particles less than 10 micrometers in aerodynamic diameter
PMF	probable maximum flood
ppm	parts per million
PSD	prevention of significant deterioration
Qal	Quaternary alluvium
RAA	remedial action agreement
RAP	remedial action plan
RCRA	Resource Conservation and Recovery Act
R_d	distribution ratio
REA	radiological and engineering assessment
RIMS II	Regional Input-Output Modeling System II
RME	reasonable maximum exposure
rms	root mean square
ROD	Record of Decision
RRM	residual radioactive materials
SCADA	Supervisory Control and Data Acquisition
SITLA	School and Institutional Trust Lands Administration
SOWP	site observational work plan
SPA	specially planned area
TDS	total dissolved solids
TEEL	Temporary Emergency Exposure Limit
TSCA	Toxic Substances Control Act
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
UDOT	Utah Department of Transportation
UDWR	Utah Division of Wildlife Resources
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	*United States Code*
USFS	U.S. Forest Service
USF&WS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VPMIM	Vicinity Properties Management and Implementation Manual
yd^3	cubic yards

Measurements and Conversions

The following information is provided to assist the reader in understanding certain concepts in this document.

Units of Measurement

Most measurements in this report are presented in English units. Metric units are also used for measurements that are too small to be defined by English units or with data that were intended to be presented in metric units. Many metric measurements in this volume include prefixes that denote a multiplication factor that is applied to the base standard (for example, 1 centimeter = 0.01 meter). Table MC-1 presents these metric prefixes. Table MC-2 lists the mathematical values or formulas needed for conversion between metric and English units.

Table MC–1. Metric Prefixes

Prefix	Symbol	Multiplication Factor
deci	d	$0.1 = 10^{-1}$
centi	c	$0.01 = 10^{-2}$
milli	m	$0.001 = 10^{-3}$
micro	µ	$0.000\,001 = 10^{-6}$
nano	n	$0.000\,000\,001 = 10^{-9}$
pico	p	$0.000\,000\,000\,001 = 10^{-12}$

Table MC–2. Metric Conversion Chart

To Convert To Metric			To Convert From Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	0.3048	meters	meters	3.281	feet
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square feet	0.092903	square meters	square meters	10.7639	square feet
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
gallons	3.7854	liters	liters	0.26417	gallons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths then add 32	Fahrenheit
Mass					
tons (U.S.)	0.907	metric tons	metric tons	1.10	tons (U.S.)

Rounding

Some numbers have been rounded; therefore, sums and products throughout the document may not be consistent. A number was rounded only after all calculations using that number had been made. Numbers that are actual measurements were not rounded.

Scientific Notation

Scientific notation is based on the use of positive and negative powers of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 and a positive or negative power of 10.

Examples: 5,000 would be written as 5×10^{3} or 5E+3
0.005 would be written as 5×10^{-3} or 5E-3

Numbering Conventions

The following conventions were used for presenting numbers in the EIS text and tables:

- Numbers larger than 1 are expressed as whole numbers.
- Numbers between 10^{-1} and 10^{-2} are expressed in decimal form.

  Examples: 5×10^{-1} is expressed as 0.5
  5×10^{-2} is expressed as 0.05
- Numbers smaller than 10^{-3} are expressed in scientific notation.

1.0 Introduction

This chapter introduces the U.S. Department of Energy's (DOE's) proposal to remediate residual radioactive materials (RRM) at the Moab Uranium Mill Tailings Radiation Control Act (UMTRCA) site and nearby properties (known as vicinity properties) located in and near the city of Moab, Utah. It summarizes the alternatives being considered and the types and categories of materials and other waste that would be managed under the alternatives. This chapter also introduces background information, including the regulatory basis for the action, contaminants of potential concern, history of the site, and goals and standards.

DOE is proposing to clean up surface contamination and develop and implement a ground water compliance strategy to address contamination that resulted from historical uranium-ore processing at the Moab uranium mill tailings site (Moab site), Grand County, Utah. Pursuant to the National Environmental Policy Act (NEPA), 42 *United States Code* (U.S.C.) §§ 4321 et seq., DOE prepared this environmental impact statement (EIS) to assess the potential environmental impacts of remediating the Moab site and vicinity properties (properties where uranium mill tailings were used as construction or fill material before the hazard associated with this material was known). As described in more detail in subsequent chapters, DOE analyzed the potential environmental impacts of both on-site and off-site remediation and disposal alternatives involving both surface materials and ground water contamination. DOE also analyzed the No Action alternative as required by NEPA implementing regulations promulgated by the Council on Environmental Quality (Title 40 *Code of Federal Regulations* [CFR] Part 1502.14[d]).[†]

1.1 Regulatory Requirements

In 1978, Congress passed UMTRCA, 42 U.S.C. §§ 7901 et seq., in response to public concern regarding potential health hazards of long-term exposure to radiation from uranium mill tailings. Title I of UMTRCA requires DOE to establish a remedial action program and authorizes DOE to stabilize, dispose of, and control uranium mill tailings and other contaminated material at 24 uranium-ore processing sites and associated vicinity properties. UMTRCA also directed the U.S. Environmental Protection Agency (EPA) to promulgate cleanup standards (now codified at 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings") and assigned the U.S. Nuclear Regulatory Commission (NRC) to oversee the cleanup and license the completed disposal cells. Chapter 7.0 contains additional information regarding UMTRCA requirements.

In October 2000, the Floyd D. Spence National Defense Authorization Act (Floyd D. Spence Act) for fiscal year (FY) 2001 (Public Law 106-398) amended UMTRCA Title I (which expired in 1998 for all other sites except for ground water remediation and long-term radon management), giving DOE responsibility for remediation of the Moab site. That act also mandates that the Moab site be remediated in accordance with UMTRCA Title I "subject to the availability of appropriations for this purpose" and requires that DOE prepare a remediation plan to evaluate the costs, benefits, and risks associated with various remediation alternatives. The act further stipulates that the draft plan be presented to the National Academy of Sciences (NAS) for

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Substantive changes made to the text of the EIS between draft and final have been marked with sidebars in the margins.

[†] In this EIS, "contaminant" or "contamination" refers to RRM, unless specified otherwise. RRM is defined by UMTRCA and the implementing regulations in 40 CFR 192 as (1) waste that DOE determines to be radioactive in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents of the ores and (2) other wastes that DOE determines to be radioactive at a processing site which relate to such processing, including any residual stock of unprocessed ores or low-grade materials. Contaminated materials include soils, tailings, facility components, buildings or building materials, equipment, and other wastes. Contaminated ground water is ground water in the uppermost aquifer contaminated with RRM.

review. NAS is directed to provide "technical advice, assistance, and recommendations" for remediation of the Moab site. Under the act, the Secretary of Energy is required to consider NAS comments before making a final recommendation on the selected remedy. If the Secretary prepares a remediation plan that is not consistent with NAS recommendations, the Secretary must submit a report to Congress explaining the reasons for deviating from those recommendations.

DOE's *Preliminary Plan for Remediation* (DOE 2001) for the Moab site was completed in October 2001 and forwarded to NAS. After reviewing the draft plan, NAS provided a list of recommendations on June 11, 2002, for DOE to consider during its assessment of remediation alternatives for the Moab site. DOE has addressed the NAS recommendations in its internal scoping, in this EIS, and in supporting documents. Section 2.7.2 summarizes the NAS comments and provides a cross reference to sections of the EIS that address the issues raised by NAS. As published in the Notice of Intent, this EIS takes the place of a final plan for remediation for the purpose of supporting decision-making for remediation of the Moab site.

1.2 Background

As shown on Figure 1–1, the Moab site lies approximately 30 miles south of Interstate 70 (I-70) on U.S. Highway 191 (US-191) in Grand County, Utah. The 439-acre site is located about 3 miles northwest of the city of Moab (Figure 1–2) on the west bank of the Colorado River at the confluence with Moab Wash. The site is bordered on the north and southwest by steep sandstone cliffs. The Colorado River forms the eastern boundary of the site. US-191 parallels the northern site boundary, and State Road 279 (SR-279) transects the west and southwest portion of the property. The Union Pacific Railroad traverses a small section of the site just west of SR-279, then enters a tunnel and emerges about 1.5 miles to the southwest. Arches National Park has a common property boundary with the Moab site on the north side of US-191, and the park entrance is located less than 1 mile northwest of the site. Canyonlands National Park is located about 12 miles to the southwest.

1.2.1 History of the Site

The Moab site is the site of a former uranium-ore processing facility that was owned and operated by the Uranium Reduction Company and later the Atlas Minerals Corporation (Atlas) under a license issued by NRC. The mill ceased operations in 1984 and has been dismantled except for one building that DOE currently uses for maintenance and storage space. During its years of operation, the facility accumulated approximately 10.5 million tons of uranium mill tailings that are present on the site as a 130-acre tailings pile. Uranium mill tailings are naturally radioactive residue from the processing of uranium ore. Although the milling process recovered about 95 percent of the uranium, the residues, or tailings, contain several naturally occurring radioactive elements, including uranium, thorium, radium, polonium, and radon. The unreclaimed tailings at the Moab site contain contaminants at levels above the EPA standards in 40 CFR 192.

Decommissioning of the mill began in 1988, and an interim cover was placed on the tailings pile between 1989 and 1995. In 1996, Atlas submitted a reclamation plan and an application to NRC for an amendment to its existing NRC license (No. SUA-917) to allow for reclamation of the site. Under the license amendment, Atlas was required to reclaim the tailings impoundment in accordance with the October 1996 submittal to NRC titled *Final Reclamation Plan, Atlas Corporation Uranium Mill and Tailings Disposal Area* (Smith 1996).

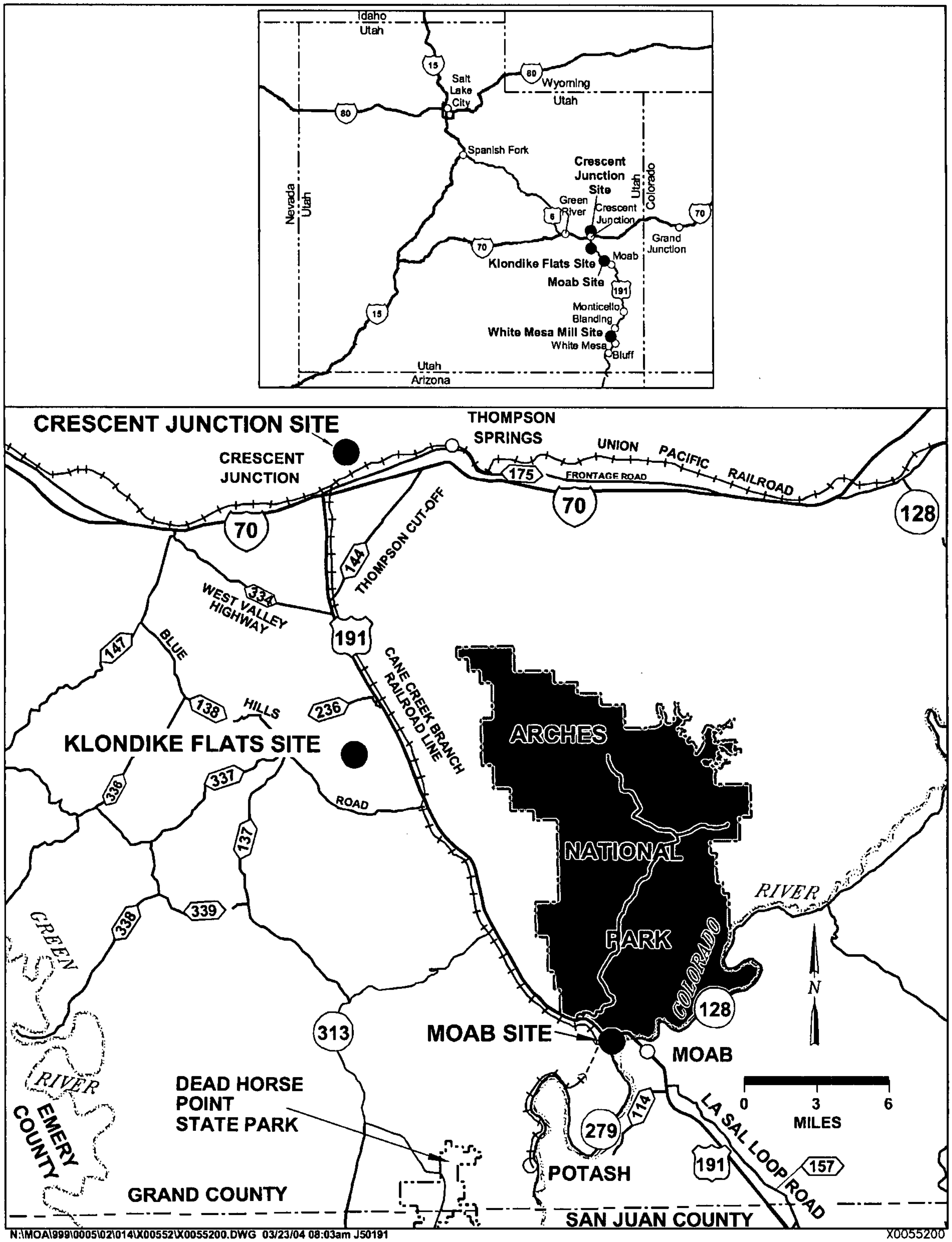

Figure 1–1. Location of the Moab Site in Grand County, Utah

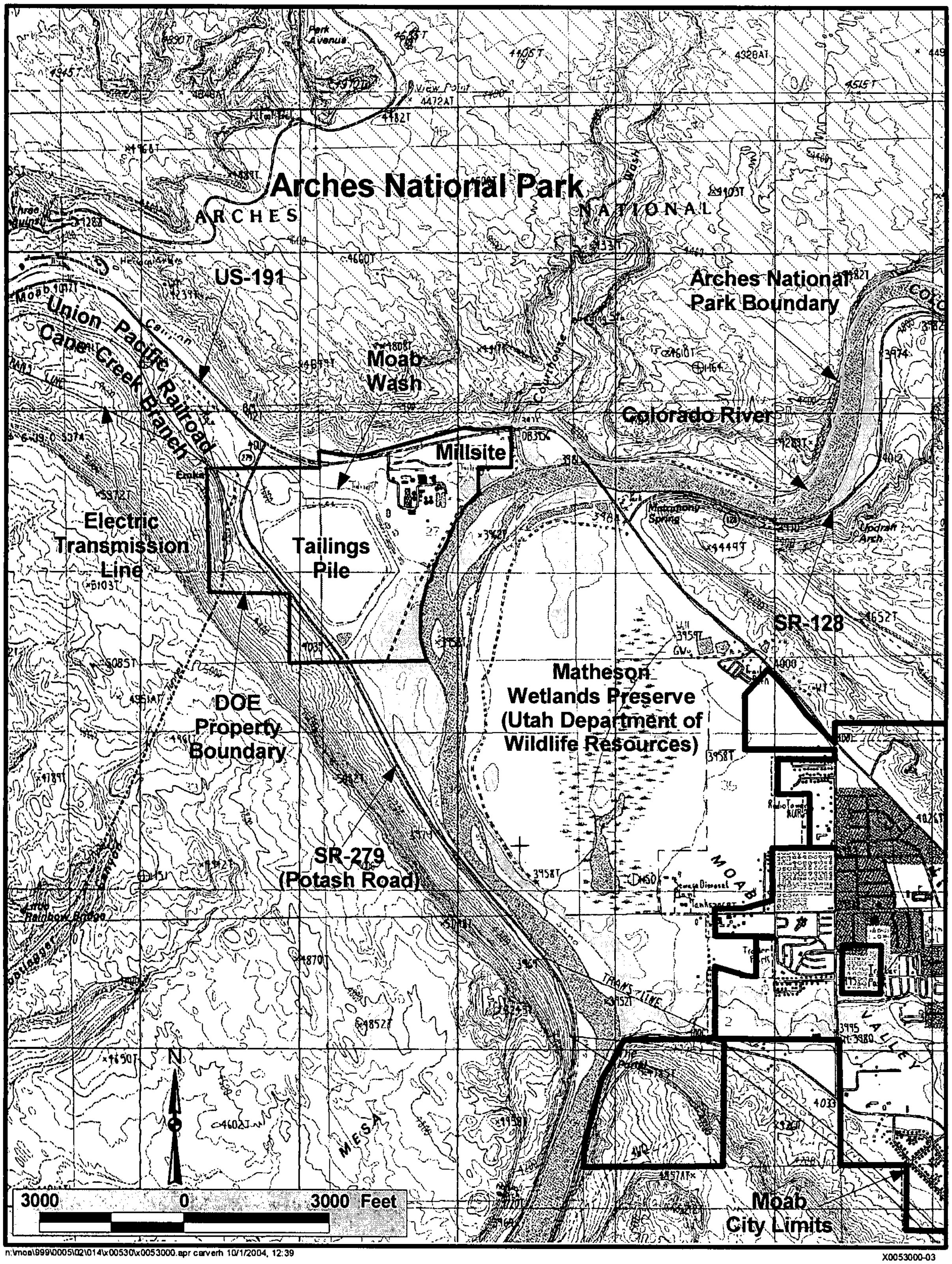

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Figure 1–2. Location of the Moab Site in Relation to the City of Moab

The amendment to the NRC license also required preparation of an EIS to assess potential impacts from the 1996 reclamation plan. However, Atlas filed for bankruptcy in September 1998, prior to completing the EIS. In March 1999, a trust was created to fund future reclamation and site closure. Atlas was released from all future liability with respect to the uranium mill facilities and tailings impoundment at the Moab site. The bankruptcy court appointed NRC and the Utah Department of Environmental Quality (UDEQ) beneficiaries of the Atlas bankruptcy trust. Later, the beneficiaries selected PricewaterhouseCoopers to serve as trustee.

In 1999, NRC completed the *Final Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah* (NRC 1999), which proposed stabilizing the tailings pile in place. The final EIS received numerous comments both in favor of and opposed to the proposed action. However, the EIS did not address ground water compliance or remediation of vicinity properties. NRC documented U.S. Fish and Wildlife Service (USF&WS) concerns regarding the effects of contaminants reaching the Colorado River; specifically, the effects on four endangered fish species and critical habitat (in 1998, USF&WS had concluded in a Final Biological Opinion that continued leaching of existing concentrations of ammonia and other constituents into the Colorado River would jeopardize the razorback sucker and Colorado pikeminnow [USF&WS 1998]).

To minimize potential adverse effects to human health and the environment in the short term, former site operators, custodians, and DOE instituted environmental controls and interim actions at the Moab site. Controls have included storm water management, dust suppression, pile dewatering activities, and placement of an interim cover on the tailings to prevent movement of contaminated windblown materials from the pile. Interim actions have included restricting site access, monitoring ground water and surface water, and managing and disposing of legacy chemicals to minimize the potential for releases to the environment. A pilot-scale ground water extraction system was implemented in summer 2003, which continues to reduce the mass of ground water contaminants discharging to the Colorado River and thereby reduce ammonia and uranium concentrations discharging to the river.

Federal and state regulatory agencies have expressed concerns about the effects of disposing of contaminated materials at the site and the effects of contaminated ground water entering the Colorado River. Stakeholders, including local and state governments, environmental interest groups, and downstream users of Colorado River water, have also expressed concerns.

1.2.2 Current Status of the Site

The tailings are located in a 130-acre unlined tailings impoundment (pile) that occupies much of the western portion of the site. The tailings pile averages 94 feet (ft) above the Colorado River floodplain (4,076 ft above mean sea level) and is about 750 ft from the Colorado River. The pile was constructed with five terraces and consists of an outer compact embankment of coarse tailings, an inner impoundment of both coarse and fine tailings, and an interim cover of soils taken from the site outside the pile area. Debris from dismantling the mill buildings and associated structures was placed in an area at the south end of the pile and covered with contaminated soils and fill. Radiation surveys indicate that some soils outside the pile also contain radioactive contaminants at concentrations above the EPA standards in 40 CFR 192.

Besides tailings and contaminated soils, other contaminated materials requiring cleanup include ponds used during ore-processing activities, disposal trenches, and other locations used for waste management during mill operations. DOE estimates the contaminated material at the Moab site and vicinity properties has a total mass of approximately 11.9 million tons and a volume of approximately 8.9 million cubic yards (yd^3). Evidence indicates that historical building materials may contain asbestos.

Ground water in the shallow alluvium at the site was also contaminated by milling operations. The Colorado River adjacent to the site has been negatively affected by site-related contamination, mostly because of ground water discharge. Concentrations of several site contaminants in ground water at the Moab site are above appropriate standards or benchmarks for aquatic organisms and may be affecting fish species protected under the Endangered Species Act. A Biological Assessment, which evaluates the effects of these contaminants and the proposed actions on protected species, and a thorough screening of contaminants are provided in Appendixes A1 and A2, respectively. Through the screening process, five contaminants of potential concern have been identified: ammonia, copper, manganese, sulfate, and uranium. However, ammonia is the key contaminant driving the proposed ground water action because of its high concentrations in the tailings seepage and ground water and its toxicity to aquatic organisms (EPA 1999). The USF&WS Biological Opinion, Appendix A3, concurred with DOE's determination that endangered species would not be jeopardized if the preferred alternative is selected in the Record of Decision (ROD).

In addition to the contaminated material at the Moab site, approximately 39,700 tons of contaminated materials are estimated to have been used as construction material or fill at homes, businesses, public buildings, and vacant lots in and near Moab (see Section 2.1.2). As a result, these vicinity properties have elevated levels of radiation. On the basis of past surveys that identified 130 potential sites, and for purposes of analysis in this EIS, DOE has assumed that 98 vicinity properties would need to be remediated. However, additional characterization would be necessary to identify the current number and locations of vicinity properties. In accordance with the requirements of UMTRCA, DOE is obligated to remediate those properties where contaminant concentrations exceed the limits in 40 CFR 192, along with the Moab site.

1.3 Purpose and Need for Agency Action

The Moab site and vicinity properties near Moab, for which DOE has been given responsibility, contain contaminated materials in concentrations that exceed 40 CFR 192 concentration limits and present a current and long-term potential source of risk to human health and the environment. DOE needs to take action to remediate the Moab site in accordance with UMTRCA Title I to fulfill its responsibilities under Public Law 106-398. Accordingly, DOE, with the assistance of its cooperating agencies (see Section 1.6), prepared this EIS to analyze the existing risks and compare and analyze reasonable alternatives available to control, reduce, or eliminate risks to the extent practicable. This EIS will be used to inform decision makers and the public prior to deciding upon a final course of action or taking any action that may represent an irreversible commitment of resources.

1.4 Alternatives

DOE is proposing (1) to remediate approximately 11.9 million tons of contaminated materials located on the Moab site and approximately 39,700 tons located on vicinity properties and (2) to develop a ground water compliance strategy for the Moab site using the framework of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE 1996). The range of reasonable surface remediation alternatives includes both on-site and off-site disposal of the contaminated materials.

For both the on-site and off-site disposal alternatives, DOE must demonstrate that the combination of engineered controls (e.g., disposal cell cover and liner systems), institutional controls, and custodial care performed as part of the long-term surveillance and maintenance activities required under UMTRCA would ensure long-term protection of public health and the environment.

Institutional Controls are used to limit or eliminate access to, or uses of, land, facilities, and other real and personal property to prevent inadvertent human and environmental exposure to residual contamination and other hazards. These controls maintain the safety and security of human health and the environment and of the site itself. Institutional controls may include legal controls such as zoning restrictions and deed annotations and physical barriers such as fences and markers. Also included are methods to preserve information and data and to inform current and future generations of the hazards and risks.

DOE Policy 454.1 (DOE 2003)

1.4.1 On-Site Disposal Alternative

The on-site disposal alternative would involve placing contaminated site materials and materials from vicinity properties on the existing tailings pile and stabilizing and capping the tailings pile in place. DOE would design the cap to meet EPA standards in 40 CFR 192 for longevity and radon releases, using DOE's experience with disposal cell covers at other uranium mill tailings disposal sites. Final design and construction would meet the requirements of disposal cells under all applicable EPA and NRC standards. Flood protection would be constructed along the base of the pile, and cover materials for radon attenuation and erosion protection would be brought to the site from suitable borrow areas.

Following completion of the on-site disposal cell, the area outside the cell would be recontoured, reclaimed, and revegetated. The disposal cell would be enclosed and protected by a security chain-link fence around its perimeter to discourage access.

Remediation of contaminated materials on the site and at vicinity properties is estimated to take 7 to 10 years to complete and to cost approximately $166 million. This cost and time estimate does not include the long-term operations and maintenance associated with ground water remediation (see Section 1.4.3). Section 2.7.3 and Table 2–35 provide a detailed characterization of the estimated costs of each alternative and transportation mode.

1.4.2 Off-Site Disposal Alternative

For this alternative, DOE would remove contaminated materials from the Moab site and transport them to another location for disposal. Approximately 11.9 million tons of contaminated material would be removed from the site. This total consists of the estimated 10.5-million-ton tailings pile; an estimated 600,000 tons of soil that was placed on top of the pile; 566,000 tons of subpile soil (assumed to be 2 ft thick); 234,000 tons of off-pile contaminated site soil; and 39,700 tons of vicinity property material that would be brought to the Moab site before shipment to an off-site location.

DOE has identified three sites in Utah as alternative off-site disposal sites: Klondike Flats site, near Moab; Crescent Junction site, near the town of Crescent Junction and 30 miles east of Green River; and the White Mesa Mill site south of Blanding and north of the town of White Mesa (see Figure 1–1 inset). The Klondike Flats and Crescent Junction sites are location alternatives where new disposal cells could be constructed; the White Mesa Mill site is an existing facility that could receive the contaminated materials.

Klondike Flats—Klondike Flats is a low-lying plateau about 18 miles northwest of the Moab site, just northwest of the Canyonlands Field Airport and south-southeast of the Grand County landfill. The Klondike Flats site consists of undeveloped lands administered by the Bureau of Land Management (BLM) and the State of Utah School and Institutional Trust Lands Administration (SITLA).

Crescent Junction—The Crescent Junction site is approximately 30 miles northwest of the Moab site and 30 miles east of Green River, just northeast of Crescent Junction. The site also consists of undeveloped land administered by BLM and interspersed with lands owned by the State of Utah.

White Mesa Mill—The White Mesa Mill site is approximately 85 miles south of the Moab site, 4 miles from the community of White Mesa and the Ute Mountain Ute Reservation and 6 miles from the city of Blanding in San Juan County, Utah. This commercial mill is owned by the International Uranium (USA) Corporation (IUC) and disposes of uranium-bearing materials on site in lined ponds. It has been in operation since 1980. Although the facility has an NRC-issued license to receive, process, and permanently dispose of uranium-bearing material, it would need a license amendment from the State of Utah before it could accept material from the Moab site. (Effective August 16, 2004, NRC transferred to the State of Utah the responsibility for licensing, including inspection, enforcement, and rule-making activities for commercial uranium and thorium milling operations, mill tailings, and other wastes at the milling sites). Also, expansion of the existing facility would be necessary. The mill has the potential to process materials from the Moab site to extract valuable constituents and then dispose of the residues on the site or to dispose of the material without processing. At this time, IUC has indicated that it may process water used for slurry transport (one of the potential transportation modes) but would not reprocess tailings. However, because the potential for wastewater processing is uncertain and the quantity and value of recoverable materials is unknown, no potentially offsetting costs were assumed for this alternative.

Under the off-site disposal alternative, three transportation modes are evaluated: truck, rail, and slurry pipeline for some or all of the off-site disposal locations.

Truck Transport—Trucks would use US-191 as the primary transportation route for hauling contaminated materials to the selected disposal site. Trucks would be used exclusively for hauling borrow materials to the selected disposal site. Construction of highway entrance and exit facilities could be required to safely accommodate the high volume of traffic currently using this highway.

Rail Transport—An existing rail line (Cane Creek Branch) runs from the Moab site north along US-191 and connects with the main east-west Union Pacific Railroad line near I-70. The Klondike Flats and Crescent Junction sites could be served with this rail line with upgrades and additional rail sidings. There is no rail access from the Moab site to the White Mesa Mill site.

Construction of a rail line from the Moab site to White Mesa Mill was not analyzed because of technical difficulties, potential impacts, and high cost.

Slurry Pipeline—This transportation mode would require the construction of a new pipeline from the Moab site to the selected disposal site and a water line to recycle the slurry water back to Moab for reuse in the pipeline.

As with the on-site disposal alternative, an off-site disposal cell would be enclosed and protected by a security chain-link fence around its perimeter to discourage access. Potential for future use outside the security fence would be evaluated after completion of remedial actions. Once the tailings were removed, the Moab site would be reclaimed by recontouring and revegetating. Future use of the site would be evaluated after completion of remedial action.

The off-site disposal of contaminated materials, including those from vicinity properties, is estimated to take up to 8 years to complete and to cost $329 million to $393 million for the closest site (Klondike Flats) and $418 million to $464 million for the farthest site (White Mesa Mill), depending upon the transportation mode selected. These cost and time estimates do not include the long-term operations and maintenance associated with ground water remediation (see Section 1.4.3). Section 2.7.3 and Table 2–35 provide a detailed characterization of the estimated costs of each alternative and transportation mode.

1.4.3 Ground Water Remediation

As part of its UMTRCA responsibilities, DOE established a Uranium Mill Tailings Remedial Action (UMTRA) Ground Water Project and prepared the UMTRA Ground Water PEIS (DOE 1996) and ROD (62 *Federal Register* [FR] 22913 [1997]). The PEIS described and the ROD adopted a ground water remediation framework that takes into consideration human health and environmental risk, stakeholder input, and cost. In applying the framework, DOE assesses ground water compliance in a step-by-step approach, beginning with consideration of a no-remediation strategy and proceeding, if necessary, to consideration of passive strategies, such as natural flushing with compliance monitoring and institutional controls, and finally to consideration of more complex, active ground water remediation methods or a combination of strategies (such as pump and treat), if needed.

Ground Water Compliance Strategies

Supplemental Standards are essentially a narrative exemption from remediating ground water to prescriptive numeric standards (background concentrations, maximum concentration limits [MCLs], or alternate concentration limits [ACLs]), if one or more of the eight criteria in 40 CFR 192.21 are met. At the Moab site, the applicable criterion is limited-use ground water, (40 CFR 192.21[g]), which means that ground water has naturally occurring total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L), and widespread TDS contamination is not related to past milling activities at the site. The PEIS (DOE 1996) also discusses supplemental standards within the context of "no ground water remediation." However, guidance in 40 CFR 192.22 directs that where the designation of limited-use ground water applies, remediation shall "assure, at a minimum, protection of human health and the environment."

No Remediation means that no ground water remediation is necessary because ground water concentrations meet acceptable standards. No remediation under the PEIS is not the same as No Action under NEPA, because actions such as site characterization would be required to demonstrate that no remediation is warranted.

Natural Flushing means allowing the natural ground water movement and geochemical processes to decrease contaminant concentrations.

Active Remediation means the use of active ground water remediation methods such as gradient manipulation, ground water extraction and treatment, or in situ ground water treatment to restore ground water quality to acceptable levels.

On the basis of this methodology and site-specific modeling, DOE's proposed action for ground water at the Moab site would involve the application of ground water supplemental standards and implementation of an active remediation system to intercept and control discharge of contaminated ground water to the Colorado River. Because of its naturally high salt content, the uppermost aquifer at the Moab site does not represent a potential source of drinking water. However, discharge of contaminated ground water has resulted in elevated concentrations of ammonia and other site-related constituents in a portion of the Colorado River near the Moab site. These concentrations pose no risk to humans, but ammonia concentrations exceed ammonia levels considered to be protective of aquatic life. Therefore, the cleanup objective of the proposed ground water action is to protect the environment, particularly endangered species of fish, which are known to use that portion of the river. Active remediation would be necessary to meet this goal.

The active remediation system would extract and treat ground water while natural processes act on the ground water system to decrease contaminant concentrations to the long-term protective goals. Active remediation would cease after long-term goals were achieved. Conceptually, the same system would be installed and operated at the Moab site regardless of whether the on-site or off-site disposal alternative was implemented. An extraction well system developed as an interim ground water remedial action in 2003 could become a part of the extraction system envisioned under the proposed ground water action.

Section 2.3.1.3 provides additional background on the ground water compliance strategy selection process and more specific cleanup objectives for the ground water. Uncertainties affecting the ability of the proposed ground water remediation to meet specific cleanup objectives are discussed in Section 2.3.3. Section 2.3.2.3 provides further details regarding construction and operation of the proposed ground water action.

It would cost approximately $10.75 million to design and construct a ground water remediation system under either the on-site or off-site disposal alternative and approximately $906,000 annually to operate and maintain it. Construction would be completed approximately 5 years after issuance of a ROD. The system would operate for 75 to 80 years. The cost and schedule for designing and constructing a ground water remediation system under an off-site disposal alternative would be the same as for the on-site disposal alternative. Section 2.7.3 and Table 2–35 provide a detailed characterization of the estimated costs of each alternative and transportation mode.

1.4.4 No Action Alternative

This alternative is analyzed to provide a basis for comparison to the action alternatives and is required by NEPA regulations (40 CFR 1502.14[d]).

Under the No Action alternative, DOE would not remediate contaminated materials either on the site or at vicinity properties. The existing tailings pile would not be covered and managed in accordance with UMTRCA standards. No short-term or long-term site controls or activities to protect human health and the environment would be continued or implemented. Public access to the site is assumed to be unrestricted. All site activities, including operation and maintenance, would cease.

Initial and interim ground water actions would not be continued or implemented. The No Action alternative would include stopping all ongoing and planned activities designed to protect endangered species and control discharge of contaminated ground water to the Colorado River. No further media sampling or characterization of the site would take place.

A compliance strategy for contaminated ground water beneath the site would not be developed in accordance with UMTRCA standards. No institutional controls would be implemented to restrict use of ground water, and no long-term stewardship and maintenance would take place. Because no activities would be budgeted or scheduled at the site, no further initial, interim, or remedial action costs would be incurred. DOE recognizes that this scenario would be highly unlikely; however, it has been included as part of the EIS analyses to provide a basis for comparison to the action alternatives in the EIS. Section 2.7.3 and Table 2–35 provide a detailed characterization of the estimated costs of each alternative and transportation mode.

1.4.5 Preferred Alternatives

On the basis of the analysis documented in the EIS, the comments received during the public comment period on the draft EIS, and other factors, DOE has determined that its preferred alternatives are the off-site disposal of the Moab uranium mill tailings pile, combined with active ground water remediation at the Moab site. The preferred off-site disposal location is the Crescent Junction site, and the preferred method of transportation is rail. The following discussion provides additional details regarding the basis for the identification of the preferred alternatives. The identification of the preferred alternatives, required by NEPA regulations in 40 CFR 1502.14(e), is not the agency's decision. Rather, DOE's decision will be reported in a ROD that will state the final decision, identify the alternatives considered by DOE in reaching its decision, specify the alternative or alternatives that were considered to be environmentally preferable, and state whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted (40 CFR 1505.2). The ROD will be issued no sooner than 30 days following publication of the EPA Notice of Availability of the final EIS.

1.4.5.1 Off-Site Disposal

DOE identified off-site disposal as one of its preferred alternatives for disposal of mill tailings primarily because of the uncertainties related to long-term performance of a capped pile at the Moab site. Issues such as the potential for river migration and severe flooding contributed to this uncertainty. Although DOE has concluded that the Colorado River will generally migrate southeastward away from the pile, DOE also acknowledges the uncertainty in this interpretation and recognizes that the State of Utah and other commentors disagree with this position. A Colorado River 100- or 500-year flood could also release additional contamination to ground water and surface water under the on-site disposal alternative, although DOE believes this contaminant release mechanism would be minimal and would not create an unacceptable risk to receptors in the Colorado River adjacent to the site. In addition, it is known that under the on-site disposal alternative, natural basin subsidence would result in permanent tailings contact with the ground water in 7,000 to 10,000 years; at that time, surface water concentrations could revert to levels that are not protective of aquatic species in the Colorado River.

Under the off-site disposal alternatives, contaminant concentrations in ground water under the Moab site would, under natural conditions, return to protective levels in approximately 75 years and to background levels after 150 years. By comparison, under the on-site disposal alternative, the tailings pile could be a continuing source of contamination that would maintain contaminant concentrations above background concentrations in the ground water.

Crescent Junction Site

The Crescent Junction site was identified as the preferred off-site disposal location because it has the longest isolation period (time in which contaminants could reach the ground water); the lowest land-use conflict potential (although DOE would need to work with holders of existing mineral leases to mitigate any possible impacts); the shortest haul distance from the rail rotary dump into the disposal cell, reducing the size of the radiological control area; and flat terrain, making operations easier and safer. In comparison, the Klondike Flats location would require the construction of a new public access road parallel to Blue Hills Road and a 1- to 4-mile truck haul road that would traverse the steep bluffs (20- to 30-percent grade) north of Blue Hills Road. The truck haul road would require radiological controls from a rail spur to the disposal cell site. These actions would be adjacent and visible to public access, could temporarily adversely affect recreational use of the local area, and could cause visual impacts to users of the northern areas of Arches National Park.

Of the three alternative off-site locations, the White Mesa Mill alternative would require the greatest distance for transportation; would have the greatest potential for adversely affecting cultural resources and traditional cultural properties at the site and along a slurry pipeline corridor; and would have the shortest isolation period. Implementation of that alternative using truck transportation would cause extensive adverse traffic impacts in the cities of Moab, Monticello, and Blanding. This off-site alternative would also be the most expensive because of its greater distance from the Moab site.

Rail Transportation

DOE identified rail as the preferred mode of transportation because compared to truck transportation, rail has a lower accident rate, lower potential impacts to wildlife (including threatened and endangered species), and lower fuel consumption. Compared to a slurry pipeline, rail transportation would have a much lower water demand and would avoid landscape scars caused by pipeline construction, which could create moderate contrasts in form, line, color, and texture with the surrounding landscape.

1.4.5.2 Active Ground Water Remediation

An active ground water remediation system would extract and dispose of contaminated ground water while natural processes act on ground water to decrease contaminant concentrations to meet long-term protective ground water cleanup goals. Active remediation would cease after long-term goals were achieved. Active ground water remediation was identified as a preferred alternative because the No Action alternative would not meet compliance goals for human health and safety and protection of the environment.

1.4.6 DOE Decision-Making

DOE will consider the results of analyses provided in this EIS; the uncertainties in those analyses, including the responsible opposing views; the relative costs of the alternatives; and other factors, such as public and agency comments on the draft EIS, in its final decision-making for remediation of the Moab site and vicinity properties. DOE's ROD will be based on these considerations and will be formally announced by DOE, published in the *Federal Register*, and distributed to all interested parties.

DOE is planning on a tiered decision-making process based on this EIS. It is anticipated that in the ROD that will be issued after publication of the final EIS, DOE will determine whether it will propose that Congress appropriate funds (1) to consolidate the mill tailings and other contaminated materials on-site and close the site with an NRC-approved cap or (2) to move the pile (including contaminated material from vicinity properties) to an off-site location for final capping and disposal. If the selected remedy is off-site disposal of contaminated material, DOE would identify the specific off-site location and the transportation mode that would be used to move the contamination to that location. As a part of its decision, DOE would also identify a strategy for remediation of the contaminated ground water under the Moab site but would defer selection of the specific remediation technologies until after a decision regarding the remediation of the Moab site.

Upon completion of this EIS and the ROD, DOE will develop a remedial action plan for remediation of contaminated materials. The remedial action plan will provide the detailed engineering reclamation design and incorporate a ground water compliance strategy and corrective actions. NRC would need to approve the remedial action plan; no additional NEPA analysis or documentation would be required for that approval.

DOE possesses sufficient information for an understanding of the potential environmental impacts of each alternative. With respect to off-site disposal sites, however, additional site-specific testing and evaluation may be required to provide data relevant to final design, although additional NEPA documentation is not expected. For example, final selection of a disposal cell location within the large areas assessed at the Klondike Flats or Crescent Junction sites would require more detailed study of geology, hydrology, engineering logistics, and other environmental factors. These evaluations could involve intrusive investigation of surface and subsurface conditions and could include site-specific cultural or archaeological surveys and other sampling. Similarly, a final selection of the soil borrow areas would require confirmatory sampling of borrow material characteristics and could also entail other site-specific environmental sampling. Should DOE select a pipeline for its transportation mode for off-site disposal, final alignment of a pipeline within the corridors assessed in this EIS would also require further route-specific characterization.

Decisions on future uses of the Moab site and a slurry pipeline (should it be selected) will not be a part of DOE's near-term decisions. For a determination on the future uses of the Moab site, a final decision on surface and subsurface remediation must be made and implemented and its success evaluated before the feasibility of future uses can be reasonably evaluated. Similarly, future uses of a slurry pipeline for water transportation would be predicated first on a decision to use a slurry pipeline and a determination, after tailings shipment was completed, that a radiological release of the pipeline for such a use would be acceptable. DOE has determined that these decisions are several years in the future and are, therefore, too speculative at this time to allow for meaningful assessment in this EIS. DOE would conduct NEPA reviews for these future decisions at the appropriate time.

In accordance with the implementing regulations for NEPA (40 CFR 1502.9[c][1] and 10 CFR 1021.314), DOE would reassess the adequacy of this EIS to support future decisions on a case-by-case basis and complete a Supplement Analysis if warranted. Because several of these future decisions would involve actions on land currently administered by BLM, a cooperating agency in the preparation of this EIS, DOE would work closely with BLM to ensure that any future NEPA documentation would meet the needs of both agencies.

1.5 Public and Agency Involvement

DOE's NEPA process includes multiple opportunities for public involvement in agency decision-making. The public scoping process allowed members of the public to suggest alternatives and issues to be analyzed in the EIS. Following issuance of the draft EIS, DOE provided a 90-day public comment period during which members of the public and agencies submitted comments regarding the EIS.

Section 1.5.1 describes the scoping process. Section 1.5.2 identifies the issues raised during scoping that helped shape the analyses of the draft EIS. Section 1.5.3 describes the process used to solicit and respond to comments on the draft EIS. Section 1.5.4 discusses the major issues raised by commentors and addressed by DOE in finalizing the EIS.

1.5.1 Scoping

In a Notice of Intent published in the *Federal Register* on December 20, 2002 (67 FR 77969), DOE sought public comment on the scope of the EIS. The public scoping process, conducted in winter of 2003, was an opportunity for the public to assist DOE in determining the alternatives and issues for analysis. As part of this process, DOE held six public scoping meetings to facilitate dialogue between DOE and the public and to provide an opportunity for individuals to provide written or oral statements, ask questions, and discuss concerns regarding the EIS with DOE officials.

DOE received 175 public scoping comment documents in the form of letters, electronic mail (e-mail) messages, facsimiles, and oral statements. Copies of the scoping presentations, scoping comments, and other project documents are available on the Internet at http://gj.em.doe.gov/moab/. In addition, copies of written comments and transcripts of oral comments are available at the following locations:

Grand County Library
25 South 100 East
Moab, UT 84532
Phone (435) 259-5421
Hours: 9–9, Mon–Fri

U.S. Department of Energy
Technical Library
2597 B ¾ Road
Grand Junction, CO 81503
Phone (970) 248-6089
Hours: 8–4, Mon–Fri

White Mesa Ute
Administrative Building
(off US-191)
White Mesa, UT 84511
Phone (435) 678-3397
Hours: 12–7, Mon–Thurs; 2–6, Fri

Blanding Branch Library
25 West 300 South
Blanding, UT 84511
Phone (435) 678-2355
Hours: 8–4:30, Mon–Fri

Public participation during the scoping period is summarized below:

- Oral comments at six public meetings (251 people signed the attendance sheets).
    - Green River, January 21, 2003 (12 people)
    - Moab, January 22, 2003 (49 people)
    - Blanding, January 23, 2003 (60 people)
    - Blanding meeting with the members of the Navajo Nation, January 23, 2003 (32 people)
    - White Mesa, January 23, 2003 (50 people)
    - East Carbon, Utah, January 28, 2003 (48 people)
- Written comments (letters, postcards, e-mail) received from 175 individuals, groups, and state, local, and tribal agencies.
- Oral comments (by telephone) received from 50 individuals, groups, and state, local, and tribal agencies.

1.5.2 Issues/Concerns Raised During Scoping

DOE has considered all the comments received during the public scoping process and has addressed the issues and concerns raised to the fullest extent possible in this EIS. The following is a summary of the scoping comments received. The reader is referred to Table 1–1 following this summary for the specific locations within the EIS where issues relevant to the scope of the EIS have been addressed.

1. DOE Decision-Making Process

Commentors stated that DOE's decision regarding the uranium mill tailings pile in Moab should be based on science and sound and impartial evidence, not emotion. Other commentors wondered what decision would be made on the basis of this EIS and whether a subsequent NEPA document would be prepared if an off-site location were selected. Some commentors questioned the value of public comments and asked how DOE would use the public comments received. Commentors also encouraged DOE to evaluate long-term effects and solutions. One commentor asked if a cleanup contract had already been signed.

2. *Public Scoping Process*

Commentors stated that there were problems with the scoping process, including lack of notice, lack of information, problems with the website and the toll-free telephone line, absence of a court reporter to transcribe comments, and absence of translators for meetings attended by members of the Ute Mountain Ute Tribe and the Navajo Nation. Commentors asked for additional reading rooms in White Mesa, Green River, Blanding, and East Carbon and asked that additional information be made available in the reading rooms and on the website (for example, regulations cited, the White Mesa Mill proposal, and NAS comments). Commentors also asked that the public scoping period be extended beyond February 14, 2003, and that DOE work with Tribal Councils. The Ute Mountain Ute Tribe requested that another informational meeting be held in White Mesa, Utah.

3. *Cooperating Agencies*

Commentors stated that Grand County and other affected local communities should be asked to be cooperating agencies. EPA, Grand County, and San Juan County also indicated interest in or asked to be cooperating agencies. One commentor disagreed with the Navajo Nation's decision not to be a cooperating agency, and another commentor asked for a list of cooperating agencies and contacts.

4. *Moab Site/On-Site Disposal Alternative*

a. Commentors stated that materials other than mill tailings (barrels, acid, and debris) may have been put on the tailings pile and that DOE needed to discuss the presence of such materials in the EIS. Some commentors stated that existing studies were not acceptable, that monitoring information should be made available, and that DOE should make a concerted effort to locate historical information about wells and quicksand. Commentors stated that the interim cover was not effective.

b. The No Action and on-site disposal alternatives were criticized for being contrary to the requirements of the Floyd D. Spence Act and were opposed because of potential impacts to the Colorado River and its users and because of the site's proximity to Arches National Park.

c. Commentors stated that the pile should remain in place because Moab had the benefits of the mill and should bear the burdens and because moving the pile would only cause additional environmental damage elsewhere.

5. *Klondike Flats and Crescent Junction Sites/Alternatives*

a. The Klondike Flats site was opposed because of its current use by mountain bikers. Other commentors stated that the Klondike Flats site might be used for other waste types, in addition to the uranium mill tailings.

b. Other commentors supported the use of the Klondike Flats site or the Crescent Junction site because these sites involved the shortest travel distance, were not near population areas, could provide jobs, or did not involve surface or ground water problems. Commentors also noted the proposed Williams Company's Crescent Junction Terminal project and its potential proximity to the Crescent Junction site.

6. *East Carbon Development Corporation Site/Alternative*

a. Commentors asked whether allowing the East Carbon Development Corporation (ECDC), an existing solid waste disposal facility in Carbon County, Utah, to dispose of the uranium mill tailings would open up the facility to the storage or disposal of other types of nuclear material or other hazardous wastes. Commentors noted that ECDC was accepted by the community for solid, nonhazardous waste disposal and presented several signed agreements between ECDC and its predecessors and the City of East Carbon documenting ECDC's plans to accept only nonhazardous waste.

b. The ECDC site was opposed primarily because of its proximity to people, potential adverse impacts to air and water quality, effect on property values, travel distance and associated traffic and dust impacts, and the contractual commitment to prohibit disposal of hazardous or radioactive materials at the site.

c. After scoping, ECDC formally requested that DOE remove its site from further consideration for Moab mill tailings (see Section 2.5.2.1).

7. *White Mesa Mill Site/Alternative*

a. Commentors stated that there was not enough information about the site, including how IUC would manage or handle the uranium mill tailings. This issue was not addressed in the EIS prepared by NRC for the White Mesa Mill (NRC 1979), which some commentors said did not accurately address the operations of the mill and overlooked the Ute Reservation and the community of White Mesa. Commentors identified potential impacts from current mill operations with alternative feed materials that have not been addressed. Commentors wanted a determination of the feasibility of remilling Moab tailings at White Mesa Mill and assurances that White Mesa Mill would bear the costs of remilling and paying DOE a percentage as required by UMTRCA Title I (Section 108 [b]). Commentors stated that because it was a Canadian company, IUC does not care about the local community; others complained that they could smell the chemicals used at the White Mesa Mill when the wind blew, that the ponds at the site were supposed to be capped but were not, that the cells leak, and that the fencing around the ponds was not adequate. Commentors stated that the cumulative effects of the mill operations and a uranium mill tailings pile should be addressed in the EIS. Commentors also asked that an epidemiological study be done for the White Mesa Mill.

b. The White Mesa Mill site was opposed primarily because of its potential impact to the Native American communities (Navajo and Ute Reservations) located near the site. Other reasons were potential adverse impacts to air and water quality, potential contamination of the San Juan River, potential impacts to tourism, and the absence of railroad access to the site.

c. Some commentors supporting the use of the White Mesa Mill site stated that any potential human health impacts could be adequately managed.

d. With respect to the White Mesa Mill site, some commentors stated that people were being asked to choose between, or balance risks to, jobs and human health.

e. Other commentors supported the use of the White Mesa Mill site because of its current use as a uranium mill, with mill tailings already on the site, and because it would provide jobs in the area.

8. Cost of Alternatives/Funding

Commentors asked what each of the alternatives would cost and whether DOE had or could obtain the funds for cleanup of the Moab site. One commentor stated that the cost of moving the Moab tailings pile could be more than $2 billion. Another commentor stated that the cost and duration of ground water cleanup would not be the same whether the tailings pile were left in place or moved, contrary to DOE's assertion. Other commentors noted the cost differential between constructing a railroad or railroad spur and a slurry pipeline for access to particular sites. Some commentors were concerned that the owner of a privately owned disposal site could go bankrupt and leave the problem for the Federal Government to clean up. Commentors also stated that the costs of legal action should be included in any cost estimate. One commentor asked if the construction contract would be a fixed-price contract.

9. Other Alternatives

Several alternatives were suggested:

- Move the pile back from the river and place in a lined bed.
- Use the Lisbon Copper Mine in San Juan County, Utah.
- Make a golf course out of the tailings pile.
- Move the tailings to old mines in the La Sal area.
- Move the tailings to an unpopulated site under DOE's control (not privately owned).
- Move the tailings to the former uranium mill tailings site near Green River, Utah.
- Move the tailings to Envirocare in Clive, Utah.
- Move the tailings to the already contaminated testing ground in Utah.
- Use the Grand County landfill.
- Allow Grand County to own and/or direct operations of the cleanup area.
- Consider in situ stabilization, perhaps using new chemical techniques for stabilization.
- Reroute the section of the Colorado River away from the Moab site.
- Use contaminated water for the slurry.

10. NRC Involvement

Commentors asked about the extent of NRC involvement with the Moab site. Commentors also stated that NRC's failure to regulate the site adequately has led to current problems there. With respect to the White Mesa Mill site, commentors stated that NRC was uncooperative and had not considered all the impacts of or alternatives to the White Mesa Mill site when it licensed that facility.

11. Extent and Impact of Contamination in the Colorado River

Commentors questioned the source and extent of contamination, including ammonia, in the Colorado River and on sandbars in the river. Commentors also questioned the impact of existing contamination on endangered species. Other commentors stated that there were 3 million downstream users, including Lake Havasu, Lake Powell, and Lake Mead. One commentor asked if any studies had been conducted regarding other wastes along the Colorado River downstream from Moab. Another commentor stated a concern that the Colorado River could migrate in the future. Commentors stated that the potential for catastrophic floods because of ice damming on the Colorado River should be addressed in the EIS.

12. Human Health Impacts

a. Commentors were concerned about possible impacts of uranium mill tailings on human (and animal) health. Commentors stated that radioactive and chemical contamination could be spread through the air (dust blowing off the pile, off-gases emanating from evaporation ponds) and through surface and ground water pathways and that radioactive contamination would be hazardous for a long time. Cancer was the primary health concern, although asthma was also noted. Some commentors stated that fears regarding the tailings material were exaggerated.

b. Some commentors noted that everyone was affected regardless of where the mill tailings were left or sent.

13. Ground Water Impacts

Commentors stated that ground water was a critical issue and that complete studies needed to be conducted; one commentor stated that earlier wells to study ground water were not deep enough. Commentors questioned whether contamination from a mill tailings pile could seep into ground water that is used as a drinking water source, thus increasing the risk of cancer. Commentors also asked, regardless of its location, what would happen if the tailings pile leaked.

14. Water Quality, Availability, and Use

Commentors stated that Colorado River water quality would be improved if the tailings pile were moved and that future river migration could threaten the pile in its current location. Commentors also noted that moving the pile to an off-site location could adversely affect other water bodies such as the San Juan River, Recapture Reservoir, Icelander Creek, Price River, Green River, Navajo Sandstone aquifer, and springs, as well as lakes downstream of Moab on the Colorado River. Commentors stated that the pile should not be located near water sources in order to protect water quality and human health. With respect to a slurry pipeline, commentors asked where the water for the slurry would come from, noting that there were water shortages in the area and could be droughts in the future. Commentors also asked how water contaminated by the tailings would be disposed of. Some stated that use of water for slurry could adversely affect Native American economic development endeavors.

15. Transportation (including slurry pipeline)

a. Commentors asked how many tons of tailings would be moved, what the time interval would be between trucks on the highways, who would drive them, and who would pay if there were an accident. Commentors also stated that truck traffic would be bad for existing roads. Commentors were concerned about the volume of truck traffic and the potential for traffic accidents and fatalities, in addition to dust. Commentors also wanted information regarding potential impacts of a loaded truck spilling on a highway. With respect to a slurry pipeline, commentors asked how such a system would operate, how much water would be required, where the water would come from, what the effect of the pipeline would be on natural and cultural resources, what the consequences would be if the pipeline carrying the uranium mill tailings slurry broke, and who would own or lease the pipeline. Commentors stated that the rail option would be the cheapest.

b. Some commentors opposed the slurry pipeline method of transporting the tailings to any site because of cost, impracticality, impacts to natural and cultural resources, and water quality and quantity issues.

c. Others supported using a slurry pipeline to avoid trucking and to minimize dust and because the pipeline could be used later to pump water to the area.

16. Socioeconomic Impacts (jobs and tourism)

Commentors stated that employment, tourism, and property values could all be affected, depending on the alternative disposal site selected.

17. Environmental Justice and Cultural Resource Considerations (impacts to Native American communities)

Many commentors noted the proximity of the White Mesa Mill site to Ute and Navajo tribal lands and stated that these Native American communities would be adversely affected by the selection of that site for the disposal of the Moab mill tailings pile and material from vicinity properties. Commentors stated that the land in that area was sacred to them and that they hunted animals and gathered herbs and willows, supporting subsistence living and medicinal uses, on the land that could become contaminated. Several commentors stated that the White Mesa Mill site was on a Ute sacred burial ground. Native American burial grounds were also said to be near the ECDC site.

18. Long-Term Surveillance and Maintenance

Commentors asked for information about long-term surveillance and maintenance activities at the sites, including whether such activities would occur at privately owned sites. Commentors asked how DOE could design a cell to last 200 to 1,000 years and whether DOE would own the land or enter into use agreements with landowners. Commentors also stated that the EIS should evaluate the potential for future human intrusion, long-term maintenance, and institutional management and controls.

19. Cumulative Effects

Commentors stated that reprocessing of uranium mill tailings and increased production at the White Mesa Mill site were reasonably foreseeable future actions that should be analyzed in the EIS. In addition, commentors stated that DOE should consider the cumulative effects of all the uranium mills and mill tailings sites in southeastern Utah. Commentors also stated that DOE should look at the cumulative effects of the disposal of the mill tailings at the White Mesa Mill site and the operations of the mill. Commentors noted that the Navajos are also affected by oil wells and electric power plants.

20. Other Issues To Be Addressed in the EIS

Commentors asked that the following issues be addressed in the EIS:

- Geologic conditions;
- Impacts to surface water (loss of surface flow, wetlands, riparian areas, and sedimentation in streambeds, seeps, and springs);
- Impacts to ground water (dewatering, process water wells, current water quality, and impacts of past and current activities);
- Impacts to cultural and historic sites, including impacts to cultural values because of the loss of pine nut gathering, and damage to springs, damage to native people's ability to use the area for cultural properties (includes nonconcrete items such as traditional cultural practices, ceremonies, and customs) or uses;
- Impacts to biological resources (native flora, threatened and endangered species, and potential for invasive species);
- Influence of tamarisk on ground water and river migration;
- Impacts to air quality (all sources of air pollution, release of dust and airborne contaminants into the atmosphere, and subsequent ground deposition);
- Noise impacts, including to visitors and employees of Arches National Park;
- Impacts to night sky (light pollution);
- Details regarding the design, construction, and operation of a slurry pipeline;
- Proposed closure and reclamation plans;
- Financial warranties and bonds;
- Short-term and long-term uses of lands and resources that could be affected by the proposed action and alternatives;
- Potential uses after pile removal, such as a restored wetland;
- A detailed economic analysis (impacts to local economy, and recreation);
- Demolition and restoration of the Moab site;
- Cleanup of areas of Arches National Park that were contaminated by windblown tailings;
- All applicable statutes, regulations, orders, policies, and guidance; and
- Homeland security.

Table 1–1 identifies specific locations in the EIS that address the scoping issues summarized in this section.

Table 1–1. Locations in the EIS That Address Public Scoping Comments

Comment	Location in Draft EIS Where Comment Is Addressed
1. DOE Decision-Making Process	Chapter 1.0, Section 1.4.5, "DOE Decision-Making"
2. Public Scoping Process	Chapter 1.0, Section 1.5, "Public and Agency Involvement"
3. Cooperating Agencies	Chapter 1.0, Section 1.6, "Cooperating Agencies"
4. Moab Site/On-Site Disposal Alternative	(a) Chapter 3.0, Section 3.1.3, "Description of Contaminated Materials at the Moab Site." (b) Potential impacts of the on-site disposal alternative are discussed in Chapter 4.0, Section 4.1, "On-Site Disposal (Moab Site)," and DOE's requirements under the Floyd D. Spence Act are described in Section 1.1, "Regulatory Requirements." (c) Impacts of off-site disposal are discussed in Chapter 4.0, Sections 4.2, 4.3, and 4.4.
5. Klondike Flats and Crescent Junction Sites/Alternatives	The Klondike Flats site is described in Chapter 3, Section 3.2, "Klondike Flats Site," and evaluated in Chapter 4.0, Section 4.2, "Off-Site Disposal (Klondike Flats Site)." The Crescent Junction site is described in Chapter 3, Section 3.3, "Crescent Junction Site," and evaluated in Chapter 4.0, Section 4.3, "Off-Site Disposal (Crescent Junction Site)." The Williams Petroleum Pipeline Project is discussed in Chapter 5, Section 5.3.
6. ECDC Site/Alternative	Chapter 2.0, Section 2.5, "Alternatives Considered But Not Analyzed," describes elimination of the ECDC from the proposed alternatives.
7. White Mesa Mill Site/Alternative	Chapter 4.0, Section 4.4, evaluates the White Mesa Mill site disposal alternative. Impacts to Native Americans are addressed in Section 4.4.18, "Environmental Justice"; other concerns are addressed in Sections 4.4.2, "Air Quality," 4.4.4, "Surface Water," and 4.4.15, "Human Health."
8. Cost of Alternatives/Funding	Costs of the proposed alternatives are discussed in Chapter 2, Section 2.7.3, "Costs," and Chapter 4.0, Sections 4.1.14, 4.2.14, 4.3.14, and 4.4.14, "Socioeconomics."
9. Other Alternatives	Chapter 2.0, Section 2.5, "Alternatives Considered But Not Analyzed," describes other alternatives.
10. NRC Involvement	NRC's involvement in cleanup at the Moab site is described in Chapter 7.0, Section 7.1, "Federal Regulatory Requirements," especially Section 7.1.2, which describes NRC's role in UMTRCA.
11. Extent and Impact of Contamination in the Colorado River	Chapter 4.0, Section 4.1.4 describes short-term and long-term effects to the Colorado River that would result from the on-site disposal alternative, and Section 4.6.4 describes the effects of the No Action alternative.
12. Human Health Impacts	Human health impacts are described in Chapter 4.0, Sections 4.1.15, 4.2.15, 4.3.15, and 4.4.15.
13. Ground Water Impacts	Ground water impacts are described in Chapter 4.0, Sections 4.1.3, 4.2.3, 4.3.3, and 4.4.3.
14. Water Quality, Availability, and Use	These resources are discussed in "Ground Water," Chapter 3.0, Section 3.1.6, Chapter 4.0, Sections 4.1.3, 4.2.3, 4.3.3, 4.4.3, 4.6.3; and "Surface Water," Chapter 3.0, Section 3.1.7, Chapter 4, Sections 4.1.4, 4.2.4, 4.3.4, 4.4.4, 4.6.4.
15. Transportation (including slurry pipeline)	Chapter 2.0, Section 2.2.4, "Transportation of Tailings Pile and Other Contaminated Material"; Chapter 3.0, Sections 3.1.17, 3.2.14, 3.3.15, 3.4.15, "Transportation"; Section 3.3.19, "Pipeline Corridor"; Chapter 4, Sections 4.1.16, 4.2.16, 4.3.16, 4.4.16, "Traffic."
16. Socioeconomic Impacts (jobs and tourism)	Chapter 4.0, Sections 4.1.14, 4.2.14, 4.3.14, 4.4.14, "Socioeconomics," and Chapter 5.0, Section 5.1, "Seasonal Tourism."
17. Environmental Justice and Cultural Resource Considerations (impacts to Native American communities)	Environmental justice is discussed in Chapter 3.0, Sections 3.1.20, 3.2.17, 3.3.18, 3.4.18; and Chapter 4.0, Sections 4.1.18, 4.2.18, 4.3.18, 4.4.18, 4.6.18. Cultural resources are discussed in Chapter 3.0, Sections 3.1.13, 3.2.10, 3.3.11, 3.4.11; and Chapter 4.0, Sections 4.1.9, 4.2.9, 4.3.9, 4.4.9, 4.6.9.
18. Long-Term Surveillance and Maintenance	Institutional controls are described in Chapter 1.0, Section 1.4, "Alternatives." Disposal cell material requirements are described in Chapter 2.0, Section 2.1.3.1, "Borrow Material Standards and Requirements." Long-term management is described in Chapter 2.0, Sections 2.1.4 and 2.2.6, "Monitoring and Maintenance."
19. Cumulative Effects	Chapter 5.0, "Cumulative Impacts."
20. Other Issues To Be Addressed in the EIS	Except for "financial warranties and bonds" and "homeland security," all issues listed in item 20 of this section appear under the same or similar section titles in Chapter 3.0, "Affected Environment" and Chapter 4.0, "Environmental Consequences." The proposed alternatives are not associated with homeland security or financial warranties and bonds and are not discussed in this EIS.

1.5.3 Public and Agency Review of the Draft Environmental Impact Statement—Process and Results

Section 1.5.3.1 documents the process DOE used to solicit public and agency comments on the draft EIS and shows the number and types of comment documents received, and Section 1.5.3.2 summarizes key issues identified in the comment documents.

1.5.3.1 Overview of Review Process

The comment period on the draft EIS began with the issuance of EPA's Notice of Availability on November 12, 2004 (69 FR 65427), and ended on February 18, 2005. DOE also issued a Notice of Availability of the EIS on December 3, 2004 (69 FR 70256). Copies of the draft EIS were distributed to members of Congress; to federal, state, and tribal agencies and governments; to local officials; and to persons and organizations who expressed an interest in the EIS. The draft EIS was made available electronically on the DOE Grand Junction website and on the DOE NEPA website. Copies of the draft EIS were also placed in the Grand County Public Library, Blanding Branch Library, the White Mesa Ute Administrative Building, and the DOE Public Reading Room in Grand Junction, Colorado.

During the public comment period, DOE held four public hearings in Utah to present information and receive oral and written comments on the draft EIS. These meetings were held in Green River (January 25, 2005), 7 attendees; Moab (January 26, 2005), 93 attendees; White Mesa (January 27, 2005), 21 attendees; and Blanding (January 27, 2005), 19 attendees. Information about the meetings was published in DOE's Notice of Availability in the *Federal Register* and in local Utah newspapers.

DOE received approximately 1,600 comment documents on the draft EIS. Comment documents were submitted by electronic mail (e-mail), voice mail, facsimile, and regular mail. Oral comments given at the public hearings were transcribed and entered into a relational database. Most comment documents were brief, raising a single issue pertaining to the draft EIS. Other comment documents were lengthy, raising multiple issues; in these cases, individual comments were extracted and a separate response was prepared for each comment.

All comment documents and their responses were tracked using a relational database. Table 1-2 shows the number of comment documents received, broken out by type of submittal.

Table 1–2. Number of Comment Documents Received

Type of Submittal	Number
Orally at Public Hearings	
Moab	30
White Mesa	13
Green River	4
Blanding	2
E-Mail	1,289
Voice Mail	146
Fax and U.S. Mail	103

1.5.3.2 Major Issues Raised in Comment Documents

DOE analyzed all comment documents to identify the major issues raised in them. About 90 percent of the approximately 1,600 comment documents shared a common sentiment: *the tailings pile should be moved from its present location adjacent to the Colorado River.* The many comment documents supporting relocation included a wide range of reasons for doing so. Among the comments that strongly supported moving the pile "somewhere," many were equally adamant about where the pile should not be moved—specifically, that it should not be moved to the White Mesa Mill alternative location. However, a few comment documents did support relocation to White Mesa Mill, especially by slurry pipeline. This section summarizes the thirteen major issues raised in the comment documents and gives a synopsis of DOE's response or position.

Catastrophic Failure—The pile should be relocated because a major earthquake or 500-year flood could result in a catastrophic failure of the disposal cell. Many comments expressed concern that a catastrophic failure of the disposal cell caused by an earthquake or a 500-year flood could spill the contents of the pile into the Colorado River and thereby pose an unacceptable downstream risk to human health, the environment, and the recreational use and value of the river.

DOE does not agree that seismic issues are a significant concern at the Moab site. The seismic characteristics of the Moab site are addressed in Section 3.1.1.4 of the EIS. In the vicinity of the site, the Moab Fault consists of two branches—the main Moab Fault and the west branch of the Moab Fault. No historical macroseismicity has been noted along the Moab Fault, and microseismicity studies have not revealed any earthquakes associated with the fault. The site area is in Uniform Building Code 1, indicating lowest potential for earthquake damage. For geologic and geophysical reasons, the Moab Fault system is not a capable fault and does not pose a significant earthquake or surface-rupture threat to the present tailings pile.

The EIS assumes that a catastrophic flood (300,000 cubic feet per second [cfs], the type of flood specified by NRC as a Probable Maximum Flood [PMF]) will occur no more than once in 500 years—twice during the 1,000-year regulatory period. The possibility of a catastrophic flood cannot be eliminated because part of the Moab site tailings impoundment is located within the 100-year floodplain of the Colorado River and within the floodplain of the PMF of both the Colorado River and Moab Wash. The 100-year floodplains for Moab Wash and the Colorado River occupy over one-third of the Moab site. However, during floods that exceed bankfull flow (that is, when water just begins to flow over a streambank's inside bend) in the Colorado River, most of the flow and flow energy are dissipated in the Matheson Wetlands Preserve away from the tailings pile.

Section 4.1.17 in the EIS addresses impacts from a catastrophic disposal cell failure. Although the likelihood of a catastrophic event would be very small over the design life of an on-site disposal cell, this type of failure was assumed to occur in order to evaluate the potential consequences, because they would differ between on-site and off-site disposal alternatives. The EIS acknowledges that if 20 to 80 percent of the tailings pile were washed into the river, it would have serious adverse impacts on riparian plant and animal life and would affect the health and safety of residents along the river and of river guides. The flood mitigation factors described in Section 2.2.2 for periodic, less severe flooding would also mitigate the impacts of a catastrophic flood.

Flooding—The pile should be relocated because episodic flooding of the site has occurred in the past, will occur in the future, and will wash contaminants into the river. DOE agrees that episodic flooding of the site has occurred in the past and will occur in the future. In Section 4.1.3.1, the EIS acknowledges the potential for episodic flooding of the tailings pile under the on-site disposal alternative, such as occurred in 1984, and quantifies the impacts that could result from such inundation. The floodplain area for the Colorado River extends the length of the eastern site boundary from the river's edge to distances ranging from 500 to 1,200 ft west and is approximately 10 ft above the average river level. On the basis of analyses in the EIS, DOE estimates that during a 100-year flood, the water level would be 3 to 4 ft above the base of the tailings pile. These impacts include additional leaching of contaminants into the ground water and subsequent migration to the river. Very conservative model results suggest that near the bank of the Colorado River, the maximum ammonia (as nitrogen) concentration in ground water could increase by just over 2 milligrams per liter (mg/L) in approximately 10 years after a 100-year flood. However, effects of the tailings inundation would decline rapidly over a period of approximately 20 years after the flood. As required in 10 CFR 1022, "Compliance with Floodplain and Wetlands Environmental Review Requirements," a floodplain and wetlands assessment of the proposed alternative actions is provided in Appendix F of the EIS.

The on-site disposal alternative includes measures to mitigate floodwater impacts. If on-site disposal were selected, an on-site disposal cell would include side slopes armored with riprap (Section 2.1.3.1) of sufficient size to mitigate erosion from floodwaters and a barrier wall (Section 2.1.4) between the river and the capped pile to deflect river encroachment. These engineered designs would further reduce the already low probability of a catastrophic failure of the disposal cell should river migration (see Section 2.2.3) begin to occur unexpectedly. The descriptions of the conceptual cell cover and barrier wall design have been expanded in the EIS (Sections 2.1.1.3 and 2.1.1.4) to state that riprap materials would be sized to withstand the maximum river forces recently identified by the U.S. Geological Survey (USGS) and that the barrier wall would be of sufficient length to deflect river encroachment. The final design specifications for the wall (including, for example, its dimensions) would be developed in a remedial action plan if the on-site alternative were selected. The estimated cost range for remediation shown in Table 2-33, item #9, of the EIS would accommodate materials consistent with the recent USGS report.

River Migration—The pile should be relocated because the river is migrating toward the pile, which will exacerbate flooding. There are responsible opposing views on the question of whether the Colorado River is migrating toward the tailings pile, which would tend to exacerbate flooding impacts, or away from the tailings pile, which would tend to mitigate flooding impacts. A new section has been added to the EIS (Section 2.6.4) to present these opposing views on river migration (and other topics) and to summarize their technical basis and implications. DOE's view is that, although a conclusive prediction of future river movement is not possible, evidence suggests that the river is migrating, and will continue to migrate, to the south and east, away from the existing tailings pile, during the 200- to 1,000-year regulatory performance period (see Section 2.6.4). The responsible opposing view is that the river channel has not migrated away from the Moab millsite in the past 80 years, and that there is no reason to suppose that it will start to do so in the immediate future.

The overall concern expressed by commentors is that the EIS has mischaracterized the available data and that the dynamic and often unpredictable nature of the river system, the site-specific conditions, and the inevitable migration of the river toward the site over geologic time make the on-site disposal alternative unacceptable because the potential impacts of river migration would pose unacceptable risks to local and downstream users and to ecological receptors of the Colorado River corridor.

Endangered Fish—The pile should be relocated because it is leaching contaminated ground water into the river, which poses a threat to endangered fish. Underlying the many comments that expressed support for relocation is the view that the on-site disposal alternative would be unable to achieve surface water quality in the Colorado River adjacent to the tailings pile that would be protective of the endangered fish species known to inhabit those waters. DOE and UDEQ have responsible opposing views regarding the ammonia surface water standard (protective criteria) for a ground water cleanup goal that was used in the EIS. The EIS has been expanded to present and discuss these views (Section 2.6.4). The basis for the ammonia surface water standard for a ground water cleanup goal is discussed in Section 2.3.1 and was developed in consultation with the USF&WS as specified in the Endangered Species Act. The USF&WS states in its Biological Opinion (Appendix A3 of the EIS):

"The FWS has considered all of UDEQ's comments in our analysis of the effects to listed species associated with ground water remediation and we agree that many warrant further study (see Incidental Take Statement). Based on our review of the available information, and with recognition that there are uncertainties in both DOE's and UDEQ's analyses, the Service has determined that DOE's premise that 3 milligrams per liter (mg/L) ammonia in ground water will result in protective concentrations in all surface water habitats presents a reasonable approach to the problem."

DOE's estimates of the duration and cost of ground water remediation are predicated on the assumption that 3 mg/L ammonia in ground water will result in protective concentrations in all surface water habitats. However, new Section 2.6.4 addresses, to the extent possible, the potential implications if the DOE and USF&WS view on this issue is in error and the UDEQ position is correct. If applicable protective criteria could not be achieved or would require longer than DOE estimates, DOE recognizes that the duration of ground water remediation, especially under the on-site disposal alternative, would be substantially longer (200 years or more) than estimated in the EIS, and that the estimated $906,000 per year cost of ground water remediation would continue beyond the currently estimated 75 to 80 years.

Subsidence—The pile should be relocated because it has no liner and will eventually come into permanent contact with ground water. Under the on-site disposal alternative, the pile would remain unlined. Over geologic time, the process of subsidence, which is caused by ground water dissolving the salt formations under the tailings pile (Section 3.1.1.4 of the EIS), will eventually cause the bottom of the tailings pile to converge with the underlying ground water at an estimated rate of approximately 1.4 ft per 1,000 years. At this rate, DOE estimates that the tailings in the disposal cell would come into permanent contact with ground water in approximately 7,000 to 10,000 years, assuming the minimum depth to ground water ranges from 5 to 7 ft.

As described in Section 2.3.2 of the EIS, active ground water remediation would result in protective levels in surface water approximately 10 years after the issuance of a ROD and implementation of active remediation. Based on the analyses in the EIS, active ground water remediation could be terminated in 75 to 80 years, when ammonia concentrations in ground water reached the target goal. DOE acknowledges uncertainties in its ground water model assumptions and responsible opposing views regarding the applicable compliance standard and recognizes that these factors could result in longer active ground water remediation. Regardless of the duration of active ground water remediation, DOE believes that under the on-site disposal alternative, protective levels in surface water could be achieved and sustained for the 200- to 1,000-year regulatory time frame despite the absence of a liner. However, DOE acknowledges that because of subsidence, under the on-site disposal alternative surface water concentrations could revert to levels that are not protective in 7,000 to 10,000 years.

Matheson Wetlands Preserve—The pile should be relocated because contamination is migrating under the river and affecting the Matheson Wetlands Preserve. DOE's position is that contamination is not migrating under the river and affecting the Matheson Wetlands Preserve. DOE's conceptual model of ground water flow at and near the project site considers the Colorado River and perhaps a limited area just southeast of the river to be a site of both regional and local discharge for ground water. Ground water discharges to this area because the elevation of the river surface and shallow ground water to the immediate southeast is less than the flow potentials measured in ground water at the project site, in areas lying farther to the east and closer to the city of Moab, and in brine located below the river. Accordingly, ground water flow converges toward the river from all of these zones, and a ground water divide occurs either in the river itself or slightly east of the river. This flow pattern prevents water from migrating beneath the river to the Matheson Wetlands Preserve.

However, there is a responsible opposing view of the fate and transport of site-derived contaminants in ground water. This view, which was expressed in many comments, states that these contaminants have migrated, and continue to migrate, under the Colorado River toward the Matheson Wetlands Preserve and that they pose a potential hazard to public health and the environment. This view is based primarily on the interpretation of three types of information: (1) a potentiometric surface map (water table) based on calculated hydraulic heads that account for the effects of salinity on flow potential, (2) measured uranium concentrations in ground water on both sides of the Colorado River, and (3) analysis of stable isotopes of dissolved oxygen and hydrogen in ground water.

Both views on the question of contaminant migration under the river are based on differing interpretations of technical data. A new section on responsible opposing views (Section 2.6.4) has been added to the EIS. The section presents both views in detail and also discusses the implications of these opposing views.

Uncertainties with On-site Disposal—The pile should be relocated because the numerous uncertainties, especially about long-term questions, could adversely affect the cost and reliability of on-site disposal. It is possible that on-site disposal would cost much more than DOE estimates. These uncertainties could be largely eliminated if the pile were moved to a newly constructed disposal cell with better geologic confinement. DOE agrees that there are numerous uncertainties and assumptions, including long-term ones, that could increase the duration of remedial action under the on-site disposal alternative and therefore could increase the lifetime cost of the on-site disposal alternative. In the EIS, DOE described each recognized area of uncertainty and the potential consequence, including cost, where applicable (see Table 2-33 of the EIS). In addition, new Section 2.6.4 addresses areas of uncertainty about which there are responsible opposing views.

In some instances, it is not possible to quantify the potential impacts of uncertainties on cost estimates. For example, one area of uncertainty frequently cited as potentially affecting the cost of the on-site disposal alternative is the applicable compliance standard for surface water ammonia and, by extension, the length of time required for ground water treatment to achieve protective concentrations in surface water. The EIS assumes that the lower end of the range of acute criteria (3 mg/L ammonia) applies. But if the more stringent lower end of the range of chronic criteria (0.6 mg/L ammonia) applies, it could significantly extend the duration of ground water remediation. Uncertainties associated with the cost, duration, and ability to achieve protective criteria in surface water depend on multiple and potentially additive or offsetting factors. Such factors include variations in the composition of the tailings pore water, geochemical changes that occur over time, transport of contaminants to the surface water, changing regulatory criteria, and the evolving configuration of the near-bank river system. Accurately quantifying the individual and collective uncertainty of these factors would be an extremely complex exercise, and the value of the results in the decision-making process would likely be disproportionate with the required effort. Consequently, DOE acknowledges in the EIS that the estimated annual cost of ground water treatment ($906,000) and the cost of disposing of the resultant residual radioactive material could extend beyond the 80 years that DOE currently estimates for the on-site disposal alternative.

Other areas of uncertainty where DOE acknowledges the potential to increase the lifetime cost of the on-site disposal alternative include the ground water and site conceptual model assumptions and the postulated, but as yet unconfirmed, presence of a salt layer in the tailings pile. These uncertainties are discussed in Table 2–33 of the EIS.

Finally, there are also areas of short-term uncertainty that apply solely or primarily to off-site disposal and that could increase the estimated cost of this alternative. Examples include (1) the final mass and volume of contaminated material in, under, and adjacent to the tailings pile that would need to be excavated and transported, and (2) worker radiation dose rates and exposure times. These uncertainties are also discussed in Table 2–33 of the EIS.

Downstream Impacts—The pile should be relocated because of the potentially harmful impacts it poses to downstream recreational users, residents, and businesses. The public based its support for relocating the pile on a wide range of reasons, many of which reflected concerns over harmful impacts to downstream recreational users, residents, and businesses. DOE carefully considered the analyses provided in the EIS, the consequences of the uncertainties characterized in the EIS, all responsible opposing views, and the numerous public comments received on the draft EIS, including about 1,400 comment documents that supported relocating the tailings pile. Based on these considerations, in the final EIS DOE identifies off-site disposal at the Crescent Junction site using rail transportation and active ground water remediation as its preferred alternatives for the remediation of the Moab mill tailings, vicinity properties, and contaminated ground water. Section 1.4.5 further discusses the basis for DOE's identification of these preferred alternatives.

However, it is DOE's position that any of the proposed actions described in the EIS would provide long-term protection of human health and the environment within the regulatory time frame of 200 to 1,000 years. Moreover, DOE emphasizes that the final decision on which alternative will ultimately be selected and implemented will be identified in and promulgated through the ROD, which DOE expects will be issued in late 2005.

Even though our studies indicate that the on-site disposal alternative can be protective, none of the studies can eliminate all of the public concern. Further, under the on-site alternative, there is potential for additional risk to public health and safety due to the long-term disposal performance uncertainties and exposure pathways. These potential future scenarios for the Moab milling site would not exist under the off-site alternative. DOE believes that the final design of either an on-site or an off-site disposal cell would meet the requirements in 40 CFR 192 and would receive full review and concurrence from the NRC. A final disposal cell design would be developed in a remedial action plan after DOE issues its ROD.

Aesthetics and the Local Economy—The pile should be relocated because it is unattractive and discourages tourism in the Moab area. DOE agrees, and the EIS acknowledges, that the on-site disposal alternative would likely have unavoidable adverse impacts on visual resources (see Section 4.1.11.5). From key observational points, the predominantly smooth horizontal lines created by an on-site disposal cell would continue to produce a strong to moderate contrast with the adjacent sandstone cliffs. The visual contrasts that would occur under this alternative would not be compatible with the Class II objectives that the Bureau of Land Management (BLM) has assigned to the nearby landscapes. Although DOE is not required to meet the objectives of BLM's visual resource management system on the DOE-owned Moab site, the system provides a useful way to measure the effects of a proposed action on visual resources.

Since 1995, tourism-recreation employment has grown by some 20 percent and now accounts for at least 45 percent of Grand County's total employment (see Section 3.1.18.1 of the EIS). This implies that visual impacts from the tailings pile are not significantly discouraging tourism.

Public Health and Radon Risks—The pile should be relocated because it emits radon gas and poses a public health risk. For each of the proposed alternative actions, human health risks, including risks from exposure to radiation expressed as latent cancer fatalities, are analyzed and compared in the EIS (see Appendix D; Sections 4.1.15, 4.2.15, 4.3.15, 4.4.15; and the Summary). DOE agrees with the basic premise that relocating the tailings pile to a new isolated location would minimize long-term public exposure to tailings-related radiation. Based on the analyses in the EIS, while the greatest short-term risk to the public from radiation exposure at the Moab site, excluding vicinity property exposure, would be associated with the No Action alternative, there are other long-term risks that would me mitigated under the off-site alternatives.

Under any of the off-site disposal alternatives, during the period of surface remediation, there would be some increased public risk stemming from the need to disturb the existing tailings pile cover and transport the tailings. This temporary increase in public exposure and risk would not occur under the on-site disposal alternative because a fortified cap would be applied without disturbing the existing cap. Contaminated vicinity property material, which may be the greatest source of public exposure to mill-related radiation, would be removed and isolated under either the on-site or off-site disposal alternative. DOE considered public exposure in identifying an off-site location as its preferred surface remediation alternative and will continue to consider public exposure in its final decision.

Land Use—The pile should be relocated to make better use of the prime location it occupies. Several commentors expressed opinions that seemed to be based on a belief that relocating the tailings pile would quickly free up all or most of the Moab site for other uses. DOE recognizes the strategic location and potential value of the Moab site real estate. However, DOE believes that exercising caution is preferable to speculating on future land uses. Even under the off-site alternative, the land area required for ground water remediation, which could exceed 40 acres, would be unavailable for an estimated 75 years. Under any of the off-site alternatives, it would be DOE's goal to have as much as possible of the 439-acre Moab site available for unrestricted use upon completion of surface remediation. However, as stated in the EIS, it is possible that even after completion of remediation, the entire 439-acre site would remain under federal control in perpetuity. Under any action alternative, final decisions on allowable future land use at the Moab site could be made only after the success of surface and ground water remediation was determined.

Cultural Impacts to Native American Communities—The pile should not be relocated to White Mesa Mill because doing so under either of the two transportation modes proposed for the White Mesa Mill alternative, truck or slurry pipeline, would seriously (and, in some cases, irreversibly) disturb many Native American cultural sites and traditional cultural properties. The EIS analyzed the potential adverse impacts to both cultural sites and traditional cultural properties. Traditional cultural properties are those associated with traditional cultural practices, ceremonies, and customs. Although only the Moab site and the White Mesa Mill site have been field surveyed for cultural sites, some cultural sites would probably be adversely affected under any of the proposed action alternatives, including on-site disposal. Under any of the action alternatives, 4 to 11 cultural sites at the Moab site could be adversely affected. Under the off-site disposal alternative, the number of additional cultural sites potentially adversely affected varies widely among the alternative locations and modes of transportation.

Because of the proximity of the Ute Mountain Ute Tribe to the White Mesa Mill site, the White Mesa Mill disposal alternative would present unique and unavoidable potential adverse impacts to at least 10 traditional cultural properties. Based on preliminary Class I surveys to date, DOE expects that impacts to traditional cultural properties are anticipated to be far less likely at the Klondike Flats or Crescent Junction locations. Moreover, any mitigation to traditional cultural property impacts at White Mesa Mill would be extremely difficult or impossible and would involve numerous tribal entities. DOE considered adverse impacts to the Ute Mountain Ute Tribe in its identification of Crescent Junction as its preferred disposal location and will continue to consider these impacts in its final decision.

Traffic through Moab—The pile should not be relocated to White Mesa Mill by truck due to the major traffic impact on highly congested areas, especially in Moab. DOE agrees that relocating the tailings pile by truck to White Mesa Mill would necessitate traveling through the city of Moab on US-191. As seen in Figure 2-63 of the EIS, transporting the tailings to the White Mesa Mill site by truck would result in an estimated 127-percent increase in average annual daily truck traffic through Moab—a severe and unavoidable adverse impact. Moreover, the Utah Department of Transportation considers this area to be highly congested. Trucking the tailings to White Mesa Mill would also mean traveling through Monticello and Blanding.

In contrast, if the tailings were trucked to either Klondike Flats or Crescent Junction, the trucks would not have to pass through any cities or towns; however, the trucks would have to pass the entrance to Arches National Park.

1.5.4 Major Revisions to the EIS

This section lists the major revisions to the EIS. DOE made 10 major, substantive revisions and numerous minor or editorial revisions in response to comment documents received on the draft EIS. Substantive revisions to the text are marked by a sidebar in the margin. The following paragraphs summarize the 10 major revisions to the EIS and note where the revision occurs.

Preferred Alternatives. In the draft EIS, DOE did not identify a preferred alternative. In Section 1.4.5 and the Summary of the EIS, DOE identifies the combination of off-site disposal at the Crescent Junction site using rail transportation and ground water remediation at the Moab site as its preferred alternatives. DOE's bases for identifying these preferred alternatives are also discussed in Section 1.4.5.

Responsible Opposing Views. Based on continuing consultations with cooperating agencies and comment documents received on the draft EIS, DOE has identified three issues about which there are responsible opposing views: (1) river migration, (2) transport of contaminated ground water beneath the Colorado River to the Matheson Wetlands Preserve, and (3) the applicable surface water compliance standard. These opposing views, and their ramifications, are discussed in new Section 2.6.4 of the EIS.

USGS Maximum River Force Study. The descriptions of the conceptual cell cover and barrier wall design have been expanded in Sections 2.1.1.3 and 2.1.1.4 to state that riprap materials would be sized to withstand the maximum river forces recently identified by USGS and that the barrier wall would be of sufficient length to deflect river encroachment.

USF&WS Biological Opinion. Appendix A3, the USF&WS Biological Opinion, has been added. The USF&WS concurred with DOE's determination that off-site disposal at the Crescent Junction site (preferred alternative) would not jeopardize the continued existence of plant species; nor would avian or terrestrial animal species be jeopardized. USF&WS also concurred with DOE's determination that off-site disposal and active ground water remediation at Moab (preferred alternative) would not jeopardize endangered aquatic species and critical habitat in the Colorado River at Moab, subject to the provisions, terms and conditions, and conservation recommendations included in the final Biological Opinion. The USF&WS will allow the incidental take of varying numbers of the four endangered fish species in this segment of the Colorado River for a maximum 10-year period following the ROD, provided DOE

- Pays a one-time water depletion fee of approximately $3,800.
- Monitors backwater habitats near the Moab site and effects on fish.
- Evaluates the effectiveness of "initial actions."
- Addresses uncertainties by developing a surface water monitoring plan.
- Monitors and addresses potential effects on the south side of the Colorado River.

In addition, DOE would consult with the USF&WS regularly and reinitiate formal consultation if required. DOE would also consider implementing conservation recommendations as necessary.

Floodplain and Wetlands Statement of Findings. A Statement of Findings to Appendix F, "Floodplain and Wetlands Assessment for Remedial Action at the Moab Site" has been added.

Worker Radiation Dose. In the draft EIS, DOE applied an overly conservative assumption for identifying the source term of radiation to which workers would be exposed under the on-site disposal alternative (Section 4.1.15). This analysis has been revised.

State of Utah Regulatory Authority. Sections 2.2.5.2 and 7.3.4 have been revised to recognize the State's regulatory authority at the White Mesa Mill/International Uranium Corporation site.

Flood Protection at the Moab Site. Section 2.1.1.1 has been revised to state that the storm water management infrastructure at the Moab site would be designed and constructed to control a reference 100-year flood rather than a 25-year flood.

10-Fold Dilution Factor. Section 2.3.1.2 has been revised and a new reference was added to address the appropriateness of an assumed 10-fold dilution factor for ammonia as it migrates from ground water and enters surface water in the Colorado River.

Contaminants of Potential Concern. Section 2.3.1.2 has been updated with an expanded discussion of the screening process for contaminants of potential concern.

1.6 Cooperating Agencies

NEPA implementing regulations state that a federal agency with jurisdiction by law over the proposed action or alternatives must be a cooperating agency, participating in the NEPA process as requested by the lead agency (40 CFR 1501.6). In addition, an [other] agency with special expertise with respect to any environmental issue to be addressed in the EIS should be a cooperating agency. DOE has entered into agreements with 12 federal, state, tribal, county, and local agencies to be cooperating agencies in the development and preparation of this EIS:

Federal

- Bureau of Land Management
- National Park Service
- U.S. Army Corps of Engineers (Corps of Engineers)
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Nuclear Regulatory Commission

State

- State of Utah

Tribal

- Ute Mountain Ute Tribe

County

- Grand County
- San Juan County

Local

- City of Blanding
- Community of Bluff

BLM and the National Park Service (NPS) are participating as cooperating agencies because lands managed by those agencies could be affected, directly or indirectly, by the on-site and off-site disposal alternatives under consideration. As the land steward of the proposed Klondike Flats and Crescent Junction disposal sites and many of the proposed borrow areas, BLM will use this EIS to support any needed land transfers or issue permits. USF&WS is responsible for protecting threatened and endangered species and is specifically participating in this EIS process through the review and acceptance of the Biological Assessment (Appendix A1) and has provided a Biological Opinion (Appendix A3). The Corps of Engineers has regulatory authority over proposed actions within floodplains and wetlands. The purpose and need for actions by these agencies is to ensure that the alternative selected is consistent with national and local land and resource management plans and goals, floodplain and wetland regulations, and the Endangered Species Act. This EIS is intended to meet the NEPA requirements of these federal agencies and of DOE.

UMTRCA authorized NRC to be the federal regulatory oversight agency for UMTRCA Title I and II sites. Under this authority at Title I sites such as Moab, NRC provides technical and regulatory review of project documents, including remedial action plans, completion reports, long-term surveillance plans, and certification reports. Ultimately, the general license for Title I uranium mill tailings disposal sites will include the disposal site for uranium mill tailings from the Moab site and vicinity properties.

As specified in UMTRCA, EPA has established generally applicable standards for remediating and disposing of contaminated material from all uranium-ore processing sites. EPA's regulations in 40 CFR 192 establish the standards for protection of human health and the environment that form the basis for most of the impact analyses generated for this EIS.

In accordance with Section 274 of the Atomic Energy Act of 1954, as amended, NRC has recently authorized the State of Utah to regulate radioactive materials at UMTRCA Title II sites within Utah. White Mesa Mill is a Title II site now under State regulatory oversight that is being considered as an alternative off-site disposal site for contaminated materials from the Moab site. The State is also interested in ensuring that this EIS complements and satisfies environmental reporting requirements that would apply to the license amendment that would be needed should DOE select the White Mesa Mill site for off-site disposal.

The other cooperating agencies are agencies with expertise relevant to potential environmental, social, or economic impacts within their geographic regions. They provided information as requested and reviewed portions of the document as it was prepared.

1.7 EIS Contents

The remainder of this EIS consists of the following chapters and appendixes:

- *Chapter 2, Description of Proposed Alternative Actions:* This chapter describes the proposed alternatives analyzed in this EIS and those that were considered but are not analyzed in detail. It also presents summaries of the potential impacts associated with each proposed alternative and compares the potential impacts between the alternatives.
- *Chapter 3, Affected Environment:* This chapter describes the affected environment at the Moab site, at the proposed off-site disposal locations (Klondike Flats, Crescent Junction, and White Mesa Mill), at the borrow areas, and along the proposed pipeline corridors.

- *Chapter 4, Environmental Consequences:* This chapter describes the potential environmental impacts at the Moab site and off-site locations that could occur as the result of each proposed alternative. Potential environmental justice impacts associated with the proposed alternatives are also presented.
- *Chapter 5, Cumulative Impacts:* This chapter describes the cumulative impacts that would result from the proposed alternatives.
- *Chapter 6, Unavoidable Impacts, Short-Term Uses and Long-Term Productivity, and Irreversible and Irretrievable Commitment of Resources:* This chapter describes some of the additional considerations that must be analyzed as part of the NEPA EIS process.
- *Chapter 7, Regulatory Requirements:* This chapter describes the key statutory and regulatory framework and requirements that are applicable to the proposed alternatives.
- *Chapter 8, List of Preparers and Disclosure Statements:* This chapter lists the individuals who prepared the EIS and their credentials. It also provides the certification by the contractors that assisted DOE in the preparation of this EIS that they have no financial or other interest in the outcome of the project as required by the Council on Environmental Quality (40 CFR 1506.5[c]) and DOE (10 CFR 1021).
- *Chapter 9, List of Agencies, Organizations, and Individuals Receiving Copies of the EIS:* This chapter lists federal, state, local, and tribal government agencies, various organizations, and members of the public who will receive copies of the draft EIS.
- *Chapter 10, Glossary:* This chapter defines many of the technical terms used in this EIS.
- *Chapter 11, Index:* This chapter provides an index of key terms used in this EIS.
- *Appendixes:* The appendixes provide additional information to support the EIS analyses.
- *Comments and Responses:* This volume provides public and agency comments on the draft EIS and DOE's responses.

1.8 References

10 CFR 1021. U.S. Department of Energy, "National Environmental Policy Act (NEPA) Implementing Procedures," *Code of Federal Regulations*, January 1, 2005.

40 CFR 1500–1508. Council on Environmental Quality, "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," *Code of Federal Regulations*, January 1, 2004.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, January 1, 2004.

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42 U.S.C § 7901 et seq., Congressional Findings and Purposes, Uranium Mill Tailings Radiation Control Act, *United States Code*.

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Smith, 1996. *Final Reclamation Plan, Atlas Corporation Uranium Mill and Tailings Disposal Area*, prepared for the Atlas Minerals Corporation by Smith Technologies, Inc., October.

USF&WS (U.S. Fish and Wildlife Service), 1998. *Final Biological Opinion for the Proposed Reclamation of the Atlas Mill Tailings Site in Moab, Utah,* U.S. Fish and Wildlife Service, U.S. Department of the Interior, July 29.

End of current text

2.0 Description of Proposed Alternative Actions

This chapter describes the on-site disposal alternative (Section 2.1) and the off-site disposal alternative (Section 2.2). Ground water remediation is described separately (Section 2.3), although it would be common and integral to both disposal alternatives.

DOE proposes two principal alternatives for remediation of contaminated surface materials at the Moab site and vicinity properties: (1) on-site disposal and (2) off-site disposal. In addition, DOE is proposing one action to remediate contaminated ground water under the Moab site and to protect ground water and surface water quality at the Moab site and at an off-site disposal cell location if the proposed off-site disposal alternative is implemented. Ground water remediation would be an integral element of both the on-site and off-site disposal alternatives. After considering the analyses provided in the EIS, agency and public comments, and other factors relevant to the decision process, such as cost, DOE has identified (Section 1.4.5) off-site disposal at Crescent Junction using mostly rail transportation and some trucks for hauling borrow material and oversized debris, and active ground water remediation as its preferred alternatives.

Figure 2–1 shows the overall schedule for completing the proposed action assuming implementation of a single daily work shift. Detailed schedules for (1) the on-site disposal alternative, (2) the off-site disposal alternative under each of the three possible modes of transportation, and (3) ground water remediation are provided in subsequent sections where each alternative action is described in detail.

On-Site Disposal: Under the on-site disposal alternative (Section 2.1), the existing tailings pile would be converted into a permanent, engineered, disposal cell into which all on-site and vicinity property contaminated material would be encapsulated. Upon completion of excavation and placement of all contaminated material, the disposal cell would be stabilized, recontoured, and covered. This alternative is similar to that proposed by the Atlas Corporation and described in Section 2.1 of NRC's 1999 EIS (NRC 1999), with the exception of engineering design changes (for example, under the current proposed design, the cell acts as a positive drainage cover) and the introduction of the proposed ground water remediation. No on-site contaminated materials would be transported off the site. However, contaminated materials at vicinity properties would be transported to the Moab site on public roads.

Off-Site Disposal: Under the off-site disposal alternative (Section 2.2), the tailings pile, contaminated on-site soils and materials that are not yet in the pile, and contaminated materials from the vicinity properties would be transported to one of three proposed off-site disposal locations: Klondike Flats, Crescent Junction, or White Mesa Mill. Contaminated materials would be transported to the disposal sites using one of three modes of transportation: truck, rail, or slurry pipeline; however, rail transportation is not an option for transportation to the White Mesa Mill site (see Section 2.5.2 for further discussion). Figure 2–2 shows the locations of the three alternative off-site disposal locations in relation to the Moab site.

Ground Water Remediation: Regardless of whether surface remediation involved on-site or off-site disposal, active remediation is proposed for contamination remaining in ground water beneath the Moab site to prevent further degradation of surface water quality. This active remediation would be conducted in conjunction with the application of supplemental standards.

The focus of active remediation would be on preventing contaminated ground water from reaching potentially sensitive surface water areas, as opposed to accelerating the removal of contaminants from the aquifer, although it is anticipated that remediation should enhance the cleanup process. The proposed action would intercept ground water before it entered the surface water, thereby providing plume containment and contaminant mass reduction. In addition, injection and/or application of fresh water collected from the Colorado River upstream from the Moab site and pumped from the Moab site water storage ponds may provide a continuous source of uncontaminated water to the margins of the river where contaminant exposure could be the greatest.

DOE also analyzes the No Action alternative (Section 2.4), which serves as a baseline for comparing all alternatives, as required by NEPA regulation. Section 2.5 discusses alternatives that were considered but dismissed from detailed discussion in the EIS. Section 2.6 compares the impacts that would result among the five alternatives, including the No Action alternative. Other decision-making factors, such as costs and comments received from NAS, are discussed in Section 2.7.

2.1 On-Site Disposal Alternative

Figure 2–3 illustrates the major Moab site features and approximate locations of temporary on-site areas and facilities that would be utilized under the on-site disposal alternative.

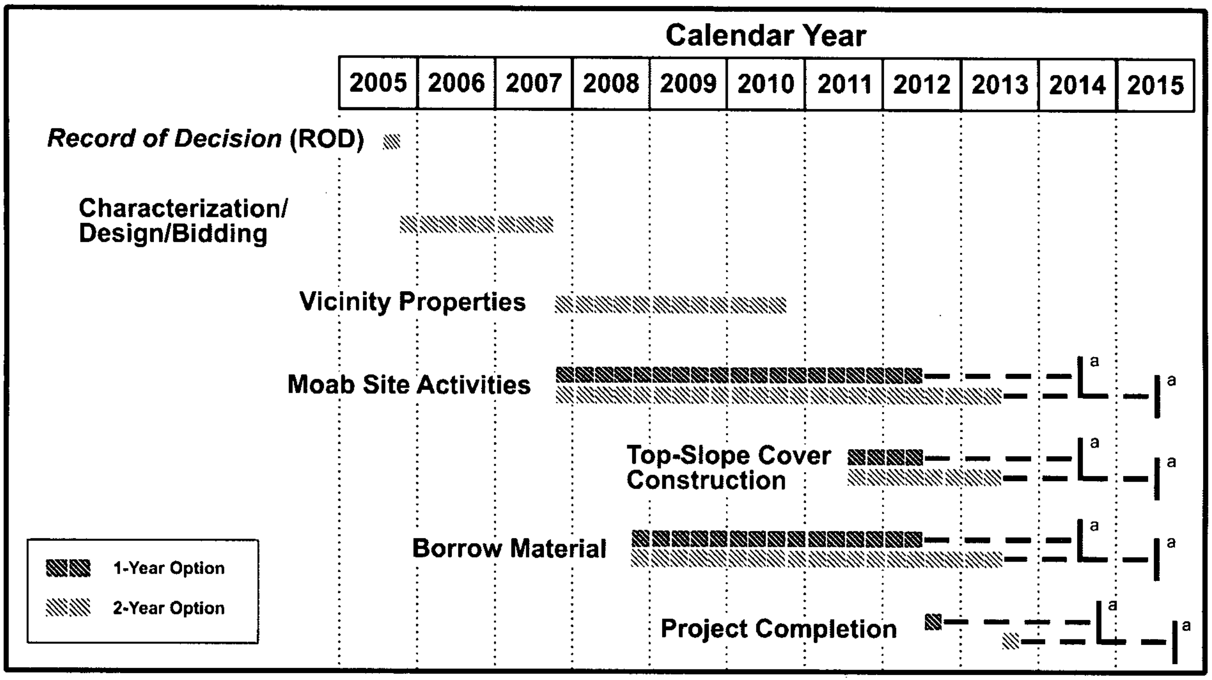
The major activities that would occur if the on-site disposal alternative were implemented would be

- Construction and operations at the Moab site (Section 2.1.1).
- Characterization and remediation of vicinity properties and disposal of contaminated materials at the Moab site (Section 2.1.2).
- Construction and operations at the borrow areas (Section 2.1.3).
- Monitoring and maintenance at the Moab site after site remediation was complete (Section 2.1.4).
- Ground water remediation at the Moab site (Section 2.3).

Resource requirements for remediation activities are discussed in Sections 2.1.5 and 2.2.7.

For the on-site disposal alternative, DOE assumed one work shift schedule for site and vicinity property remediation; that is, a single 12-hour work shift from 7:00 a.m. to 7:30 p.m., 7 days per week, 50 weeks per year. Only one work shift schedule was considered because the controlling factor determining how quickly work could progress for the on-site disposal alternative would be the rate at which the tailings pile consolidated or settled after excavated site soil and vicinity property material were placed on top of the pile. It could take 3 to 5 years for the pile to settle sufficiently to allow cap construction to begin. This consolidation process is discussed further in Section 2.1.1.2. A double work schedule for excavating soil and loading contaminated materials on the pile would not offer advantages in terms of project completion because of the need to wait for sufficient pile settling. However, to allow some flexibility in targeting a project completion date, DOE did consider a 2-year and a more aggressive 1-year time frame for completing construction of the top slope cover once settling was sufficiently under way. Both top slope cover construction schedules would employ a single work shift; the difference would be in the number of workers.

DOE estimates that all surface remediation activities under the on-site disposal alternative would be completed 7 to 8 years from the issuance of a ROD, depending on whether the 2-year or 1-year top slope cover construction schedule were implemented (Figure 2–4). However, as indicated in the figure, the schedule allows for a possible extension of approximately 2 years because of the 2-year uncertainty associated with the amount of time it would take for the tailings pile to consolidate.



[a]Uncertainty related to pile consolidation (see Section 2.1.1.2).

Figure 2–4. On-Site Disposal Alternative Surface Remediation Activity Schedule

2.1.1 Construction and Operations at the Moab Site

For the purpose of describing the on-site alternative activities, this section addresses four elements: (1) site preparation, infrastructure enhancement, and controls; (2) contaminated material remediation operations; (3) disposal cell recontouring, slope stabilization, and capping; and (4) site reclamation.

2.1.1.1 Site Preparation, Infrastructure Enhancement, and Controls

Storm Water Management System

Storm water management controls are regulated under the Utah Pollutant Discharge Elimination System General Permit for storm water discharges from construction activities. Under these regulations, the State of Utah requires development of a storm water pollution prevention plan using good engineering practices before construction can begin. The existing plan would be modified to include descriptions of additional control measures that would be implemented. A storm water management system would be implemented to prevent water, sediments, soils, and materials from the site, any of which may be contaminated, from reaching Moab Wash and the Colorado River during the construction period. The system, which would comply with all applicable federal and state regulatory requirements, would be designed to control a reference 100-year storm event throughout the construction period and would include new or improved berms, drainage ditches and basins, hay bales, sediment traps, and silt fence fabric.

The existing Moab Wash would be rechanneled to run through the former millsite area (see Figure 2–3). Rechanneling would begin before completion of the disposal cell. The reconfigured channel would discharge into the river upstream near the approximate location of the pre-operations discharge point. The channel would be designed to carry runoff that has the approximate magnitude of a 200-year flood. Flood protection along the base of the pile would protect it from more significant floods. Material excavated during construction of the reconfigured channel would be used as either cover material for the pile or backfill for other areas of the site. Any material identified as contaminated would be placed on the tailings pile before the cover was installed. DOE would also perform flood analyses of Courthouse Wash to ensure that site design requirements consider the contribution of potential flooding from Courthouse Wash.

As an element of the storm water management plan identified in Section 4.7.3, "Mitigative Measures," mountain snow pack and precipitation data would be monitored throughout the winter and spring seasons during the period of active remediation. This information would be used to track flooding potential so appropriate site management and mitigation measures could be implemented in a timely manner to ensure control of contaminants and protection of public safety and the environment.

Radiological Controls

The following radiological controls would be implemented to minimize the potential for personnel contamination or the spread of radioactive material.

Barriers

Radiation barriers would consist of signs and a system of steel "T" posts supporting standard yellow/magenta ropes to delineate radiation control areas. This action is consistent with DOE radiation safety requirements.

Personnel Screening and Decontamination

Personnel entering the site would be required to sign daily site access logs. Access to contamination areas would be controlled through a modular trailer that would be located at the site entrance (identified as the access area on Figure 2–3). A second modular trailer would be dedicated to laundering contaminated clothing. Contaminated wastewater from the laundry facility would be collected in lined ponds or sumps and eliminated using evaporation techniques, used for dust control applications during construction, or reused in equipment decontamination operations. Any excess would be distributed across the tailings surface before final covering was complete. Screening and decontamination would be performed according to appropriate DOE standards and procedures.

Vehicle and Equipment Screening and Decontamination

A vehicle and equipment decontamination facility with one bay would be constructed and located approximately as shown in Figure 2–3. Additional bays would be constructed if needed. The facility would be used to screen vehicles entering and leaving contamination areas on the site and to decontaminate any contaminated vehicles before they were released to leave the site. Similar decontamination stations used at other UMTRCA sites have used approximately 1,500 gallons of water per day. Drainage from decontamination spray-down operations would be directed to floor drains leading to a concrete sediment trap. Water would be decanted from the sediment trap into a double-lined recycle pond approximately 50 by 50 by 5 ft. Pumps installed in the recycle pond would provide recycled water to the spray hoses at the concrete pad. As needed, water to replace losses due to evaporation or overspray would be either piped below ground approximately 450 ft from the existing pump station water storage ponds (Figure 2–3) or supplied from water trucks. As construction activities involving contaminated materials decreased and as decontamination operations decreased, remaining or excess contaminated water not lost to evaporation would be sent to the tailings placement operations for use in dust control.

Dust Control

Windblown tailings and other contaminated material could create fugitive dust emissions. A dust control system would be implemented following provisions in the *Fugitive Dust Control Plan for the Moab, Utah, UMTRA Project Site* (DOE 2002a), which complies with State of Utah requirements specified in the *Utah Administrative Code* titled "Emission Standards: Fugitive Emissions and Fugitive Dust" (UAC 2000). Water for compaction and dust control would be drawn from the Colorado River. Dust suppressants such as calcium chloride, which would be stored in tanks, could also be used. Water would be stored in tanks or in the existing water storage ponds and applied only as needed, using the most economical and efficient delivery method.

Water Pumping Station Enhancements

Currently, nonpotable water from the Colorado River is pumped from an intake structure (pump house) to two connected, unlined water storage ponds located on the northeastern portion of the Moab site (Figure 2–3). This water is allocated under water rights held by DOE, which authorize 3 cubic feet per second (cfs) consumptive use and 3 cfs nonconsumptive use. Water from the pumping station would be used for all nonpotable water needs at the site. The water intake structure would be screened to ensure protection of aquatic species. In addition, the existing pumping station, piping, and storage ponds would require repairs and upgrades to supply the water demand during construction. Repairs required would include piping and pipe support structures, storage pond dredging, and general maintenance.

Temporary Field Offices

Temporary field offices would be installed to provide workspace, parking, and amenities for construction, management, or other personnel working on the site but not directly involved with field activities. The temporary field offices and other erected or emplaced facilities or structures would be painted a color similar to the background soils or vegetation to reduce visual impacts to travelers on US-191 and SR-279. The area, which would be located near existing trailers, would be graded and surfaced with a gravel base. The offices would be mobile trailers and would require setup and installation of electric utility service. The offices' sanitary sewer lines would be connected directly into a new holding tank system that would be pumped regularly by a local septic tank pumping vendor.

Vehicle Maintenance Area

The existing mill building would be converted into a vehicle maintenance area for on-site equipment. This conversion would require minor upgrades and maintenance to the building such as electrical service improvements and roofing upgrades. Spill containment areas for storage of engine oils, hydraulic fluids, and other hazardous materials associated with equipment maintenance would be constructed in the maintenance area.

Borrow Material Storage Area

Borrow materials obtained from off-site locations for use as tailings cover construction materials or clean backfill are discussed in Section 2.1.3. A borrow material storage area would be constructed for temporary storage of borrow materials. The area would occupy approximately 5 acres and would be located on top of clean (uncontaminated) soil (Figure 2–5) in an area already remediated. Off-site dump trucks delivering borrow materials to the site would dump them in the clean area and never enter the contamination zone.

Fuel Storage Area

A fuel storage and refueling area would be located within the contamination boundary to service on-site vehicles (Figure 2–5). The area would store from 5,000 to 20,000 gallons each of gasoline and diesel fuel. The area would include approved emergency containment berms around the tanks to contain spills, leaks, or ruptures and to provide adequate protection from precipitation and floodwaters resulting from a 25-year storm event as a minimum. A central delivery point for local vendors to resupply the storage tanks would be used to transfer the delivered fuel over or through contamination boundaries. Appropriate radiological and safety control practices and procedures would be followed.

Night Lighting

Grand County public land policy provides that if projects on public lands require night lighting, such lighting should be shielded and otherwise designed to prevent light pollution. DOE believes that some night lighting would be required as an occupational safety measure. However, the extent and duration of required night lighting would depend largely on the final work shift schedules that are used and the season of the year. If work activities continued after dark, night lighting would be a standard occupational safety measure. If and when required, mobile lighting would be moved from place to place as needs and work progress dictated. Either gasoline- or diesel-powered mobile lighting would be used and would have a minimum power of 500 watts. All night lighting would be shielded to reduce night sky glare that could be visible from Arches National Park.

2.1.1.2 Contaminated Material Remediation Operations

Contaminated Soil, Vegetation, and Debris

Backhoes and bulldozers would be used to excavate contaminated surface areas of the site to a depth where the concentration of radium-226 averaged over any area of 1,076 square feet (ft^2) (100 square meters) does not exceed the background level by more than 5 picocuries per gram (pCi/g) averaged over the first 6-inch-thick (15 cm) layer of soil below the surface and 15 pCi/g averaged over 6-inch-thick (15 cm) layers of soil more than 6 inches (15 cm) below the surface (40 CFR 192.12), except where the provision for the application of supplemental standards under 40 CFR 192.21 apply. Excavated areas would be cleared and grubbed prior to removal of contaminated soils, and grubbed material would be hauled with contaminated soils.

Supplemental Standards and Surface Contamination

Remedial action will generally not be necessary when (1) residual radioactive materials (RRM) occur in locations where remedial actions would pose a clear and present risk of injury to workers or the public, (2) remediation would produce health and environmental harm that is clearly excessive compared to the health or environmental benefits, or (3) the costs of remedial action are unreasonably high relative to the long-term benefits. This includes instances where site-specific factors limit the RRM hazards and locations from which they are difficult to remove or where only minor quantities of RRM are involved (40 CFR 192.21).

An estimated 234,000 tons of contaminated site materials would be excavated from the site, loaded into dump trucks, hauled to the top of the tailings pile, and deposited on top of the center of the pile above the slimes (very fine grained tailings fraction). On the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total estimated volume of contaminated site material. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the final EIS for purposes of assessing and comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing the remedial action plan.

The weight of contaminated soils and debris placed on the tailings is called "surcharge." Placing surcharge material on the slimes to accelerate settling is called "preconsolidation loading," and the process of settling that ensues is called "consolidation." DOE estimates that the consolidation loading process may require 3 to 5 years before the pile would settle sufficiently to allow final cover emplacement. To prevent cover cracking due to pile settling, final cover placement would not begin until 90 percent of the predicted consolidation settlement was complete.

Certain areas of the site are covered with vegetation, notably the tamarisk areas illustrated in Figure 2–3 and Figure 2–5. The tamarisk and materials from clearing and grubbing would be felled and chipped or

Settling, or pile consolidation, is a short-term engineering phenomenon that could affect the stability of the pile, especially the cap. It refers to the gradual compacting and lowering of the height of a tailings pile. It is caused by the weight of the pile squeezing liquids from slimes downward and out of the pile. The addition of new material or surcharge to the top of the pile results in added weight and accelerates the settling process.

It is important that settling be essentially complete (90 percent consolidation) before the final cap is put on a tailings pile; otherwise, local or differential settling could cause the cap to bow, buckle, or crack. This could result in failure of the cap, water intrusion into the interior of the disposal cell, and an increased chance for contaminants to mobilize and migrate out of the disposal cell. Under the on-site disposal alternative, DOE estimates that after surcharge loading was complete, it would take 3 to 5 years for the pile to settle sufficiently to allow final cover emplacement.

crushed prior to being hauled to and spread over the disposal cell. Miscellaneous materials, including debris from the existing mill facilities, would be deposited in an area adjacent to the pile's southeastern edges and covered with contaminated soil. This area would ultimately be stabilized under the final tailings cover.

Demolition and Disposal of Existing Mill Facilities

After DOE consulted with the State Historic Preservation Officer and agreed on mitigation measures, some or all of the remaining mill structures and features, shown on Figure 2–5, would be demolished due to varying levels of residual contamination found within the structures. The primary mill features remaining include the Uranium Reduction Company general office/warehouse/machine shop, pump house and pipeline, several sheds, scale house, and railcar loading structure. The resulting debris would be sized, loaded onto dump trucks, and hauled to and deposited in the disposal cell. The 680 ft of chain link fence would also be taken down and disposed of at the disposal cell as potentially contaminated debris.

2.1.1.3 Disposal Cell Recontouring, Stabilization, and Capping

Figure 2–6 is a conceptual cross-section of the final condition of the disposal cell. The figure also illustrates the types and approximate dimensions of the materials that would be placed on the sides and top of the pile to contain radon emissions and stabilize the cell. This is a conceptual design and diagram only. The conceptual design is strictly intended to establish a reasonable basis for evaluating environmental impacts between the alternatives associated with this component of site remediation and reclamation. This assumed design is not intended to commit DOE to any specific cover design. A detailed design would be developed in the remedial action plan following the ROD. Should the final design differ substantially from the design considered here, DOE would assess the significance of these changes as they relate to the decision-making process and the requirements of NEPA.

Section 2.2.5.2 discusses the White Mesa Mill disposal cell, for which a different cover design is addressed. The design for the White Mesa Mill site disposal cell cover is different from the design described for the other disposal alternatives because it is based on an unsolicited proposal submitted to DOE and reflects a design more typical of UMTRCA Title II uranium mill tailings reclamation. A brief description of the White Mesa Mill cover design is also included in Appendix B. By including both design approaches, DOE has attempted to support decision-making by presenting a range of potential cover design approaches and a sense of the associated impacts related to the cover component selected for the final remedy.

After all contaminated materials were relocated to the top of the tailings pile and the consolidation process was under way, final side slope grading and recontouring would begin. The side slopes would be recontoured to a 3:1 horizontal:vertical (3H:1V) slope, a downward angle of approximately 19 degrees. Final side slope cover construction would begin after the slopes were graded.

Final cover construction would start with placement of the compacted soil layer that would form the radon barrier. Clayey soil borrow material (see Section 2.1.3.1) would be transported to the site in tandem trailers, conveyed by on-site vehicles to the base of the pile, then pushed up the recontoured slopes with a dozer. These materials would be moisture-conditioned and compacted to achieve the appropriate density specifications and quality assurance/quality control criteria.

Placement of the capillary break sand/gravels and the water storage soil layer above the radon barrier would follow, using a similar procedure. Erosion control stone riprap would be the final layer placed on the side slopes. After the required thickness of riprap was placed on the side slopes, interstitial voids in the riprap would be loosely filled with soils and seeded with native or adapted plant species. A riprap-filled toe apron would provide erosion protection at the toe and prevent destabilizing of the impoundment. DOE would determine riprap sizing and durability following procedures outlined in the *Technical Approach Document* (DOE 1989). Riprap sizing requires knowledge of flow velocity, which will be obtained by verifying initial velocities identified in a recent USGS study (USGS 2005).

Construction of the remainder of the top slope cover would be similar to that of the side slope with the exception of the erosion protection layer. The top slope would use a soil/rock admixture for initial erosion protection. Rocks would be spread on the surface of water-balance soils and mixed into it. The rock admixture would provide additional erosion protection and cover vegetation growth medium.

More detailed descriptions and technical discussions of the disposal cell cover design concept and borrow materials are provided in Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction," and Section 2.1.3.1.

2.1.1.4 Site Reclamation

When the disposal cell construction is completed, recontouring and revegetating, where needed to limit erosion, would be performed to reclaim the area outside the cell. Native plant species would be used to revegetate the site. Clean reclamation soil (320,000 yd^3) would be applied to an average depth of 6 inches over the area outside the cell to meet the radium-226 subsurface soil standard of 15 pCi/g above background averaged over a 1,076-ft^2 area. The standard would apply regardless of future land use decisions.

A buried riprap diversion wall would also be constructed along the Colorado River as proposed by Atlas Corporation and approved by NRC (Figure 2–3). The buried riprap diversion wall would be constructed from relatively large riprap (12- to 36-inch diameter). Although DOE's assessment of river migration (DOE 2003a) suggests that this diversion wall would not be required, it would provide additional assurance that the design life of the cell could be met. The length and design of the wall would be addressed at the conceptual design stage.

2.1.2 Characterization and Remediation of Vicinity Properties

Because of the range of variables and uncertainty associated with Moab site vicinity properties (e.g., their exact number, size, location, and extent of contamination), the specific actions that DOE proposes to take at each property would necessarily vary. The following sections provide a general overview of the activities that DOE would undertake to survey, characterize, and remediate Moab site vicinity properties. Data obtained from characterization of the Moab site suggest that vicinity properties surrounding the site will contain contamination requiring remediation. These properties include portions of state highway and railroad rights-of-way, BLM property, and Arches National Park.

Properties in the vicinity of the Moab millsite (Figure 2–7) that can be confirmed to be contaminated with residual radioactive materials (RRM) would be eligible for inclusion in the vicinity property program. For the purposes of this program, RRM contamination is intended to be restricted to materials directly related to the milling process and is not intended to include uranium or vanadium ores or other naturally occurring radioactive materials not directly related to the milling process.

Conceptually, ores or other naturally occurring radioactive materials not directly related to the milling process would not be eligible for remediation under this program unless it could be demonstrated that these materials are inextricably mixed with RRM.

Unless specifically excluded under EPA's supplemental standards (40 CFR 192.21), contaminated materials on vicinity properties in which radium-226 concentrations averaged over any area of 1,076 ft^2 (100 square meters) exceed the background level by more than 5 pCi/g averaged over the first 6 inches (15 cm) of soil below the surface and 15 pCi/g averaged over 6-inch-thick (15 cm) layers of soil more than 6 inches (15 cm) below the surface (40 CFR 192.12) would be hauled by truck from the vicinity property to the Moab site. These materials would be unloaded in a vicinity property material stockpile area (see Figure 2–5) pending final placement in the disposal cell. DOE estimates that approximately 2,940 trips using 10-yd^3 dump trucks would be required, each averaging approximately 4 miles one way to the Moab site. The trips would generally involve using residential streets to access US-191 and established haul routes to the Moab site. If necessary, trucks would be decontaminated at both the vicinity property and at the millsite. An equivalent volume of fill material and truck traffic from the LeGrand Johnson borrow area (located in Spanish Valley) would be required.

A detailed outline of the remedial action process is provided in the *Vicinity Properties Management and Implementation Manual* (VPMIM) (DOE 1988). DOE intends to work with NRC to update the procedures in the VPMIM to reflect lessons learned from the Grand Junction, Colorado, and Monticello, Utah, vicinity property programs and amendments to UMTRCA. An example of lessons learned would be establishing the protocol for evaluating and mitigating elevated radon levels in structures after completion of remedial action. In the past, NRC did not require its approval of individual radiological and engineering assessments (REAs) as long as the VPMIM was followed, unless they involved supplemental standards. DOE intends to continue this practice.

2.1.2.1 Survey and Characterization

DOE would identify properties to be surveyed and radiologically characterized to determine their eligibility for remediation. By definition, DOE would designate the 130 properties identified in EPA's 1971 survey (EPA 1971) as vicinity properties, provided contamination on a property meets the regulatory definition of RRM. The 1971 survey used a mobile gamma scan procedure. A field team investigated gamma anomalies on a property after the property owner granted access. The survey team tried to identify the source of the contamination and whether it was from tailings, ore, or other radioactive materials.

For the purpose of identifying the scope of the vicinity property program, a specified area is proposed for DOE to perform additional gamma radiation surveys (see Figure 2–7). DOE proposes to limit surveys to the 130 designated properties and to properties within the area shown in Figure 2–7 whose owners request a survey. DOE would advertise through the newspaper and other media that a vicinity property program was being conducted and that owners should contact DOE for gamma surveys. However, DOE would also consider requests from other individuals or entities if they could demonstrate that contaminated material might be on their property and that it might be tied to Moab millsite activities. Prior to gamma survey work, DOE would obtain the consent of the property owner for access as provided under UMTRCA.

Characterizations would include gamma surveys, soil samples, and radon daughter concentration measurements. A summary of the characterization data and remediation design would be documented in an REA. Results of these characterization studies would be used to determine which properties require mitigation and remediation to meet the standards of 40 CFR 192.

2.1.2.2 Remediation

After the characterization process, remediation would involve execution of a remedial action agreement (RAA), contracting, health and safety planning, excavation, transportation, restoration, preparation of a completion report, certification, and document transfer/archiving. DOE would obtain an RAA from each property owner whose property required remedial action. Each RAA would describe a plan for remedial action based on the selected option in the final REA. It also would provide assurance that the property would be restored to its pre-remedial action condition to the extent practicable, a release of liability to DOE from the owner, and if required, provisions for dislocation and temporary relocation and reimbursement costs for the property owner or tenant. An RAA would also provide that DOE would obtain title to the RRM removed from the property.

From experience with Monticello and Grand Junction vicinity properties, DOE assumes that up to 98 of the currently identified 130 Moab vicinity properties may require remediation, and that the average Moab vicinity property remediation would involve 300 yd^3 of contaminated material and would disturb 2,500 ft^2 of surface area. Using the average remediation volume and an estimate that 98 properties would be included, DOE estimates that approximately 29,400 yd^3 (about 39,700 tons) of contaminated material would be remediated. Should additional properties in the proposed inclusion survey area be identified, it is assumed that the effort and volumes would increase proportionally.

Alternatives for remedial action would depend on the number of properties where contaminant concentrations exceed EPA standards, the complexity of the properties, the levels of congressional funding, and the length of time the disposal cell remained open. DOE estimates that remedial actions would be conducted at a rate of 33 to 98 properties per year, or for a period of about 1 to 3 years.

At 300 yd^3 per property, 30 trips per property averaging 4 miles to the Moab site would be required. Trucks would be tarped and decontaminated before leaving a property. A typical route would be one-half mile along residential streets and an average 3.5-mile trip through town on US-191. The equivalent number of trips for backfill material (sand, loam, silty loam) would also be required. Dust suppression would normally not be required due to the small size of the excavations; however, a water truck would be used as needed to control dust and supply compaction water.

DOE estimates that a typical vicinity property remediation would take 4 to 6 weeks to remove tailings, replace with backfill, and restore landscaping. A standard workweek of 10 hours per day, 4 to 5 days per week, would be used. Longer days could be used occasionally to accommodate a special need, such as a concrete pour. If remediation of all 98 vicinity properties were completed in 1 year (250 days), it could require up to 24 daily round trips on US-191 transporting vicinity property material to the Moab site and backfill material to the remediated properties.

After remediation was complete, DOE would develop the completion report documenting that the property was remediated to EPA standards in 40 CFR 192 and issue a certification to the owner if the standards were met.

2.1.2.3 Residual Radioactive Materials Combined with Other Hazardous Components

RRM combined with other hazardous components could be present on some vicinity properties. Other hazardous components on vicinity properties that are combined with RRM would not usually be considered related to the uranium milling process; therefore, these other hazardous components would not be considered RRM. Consequently, the non-RRM hazardous component of this combined waste could be subject to regulation by the Resource Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA). This type of combined vicinity property waste was historically referred to as "commingled waste" under the UMTRA Project. For the purpose of establishing a planning basis for waste management analysis in this EIS, DOE has assumed that all commingled waste would ultimately be approved for management and disposal as RRM and would be disposed of in the selected disposal cell. However, if it were determined at a later date that RCRA or TSCA provisions apply to the non-RRM hazardous component of commingled waste, such waste would not be transported directly to the Moab site. DOE would evaluate various potential disposal paths, including treating the commingled waste to render the hazardous component nonhazardous, disposing of the commingled waste in a facility licensed for radioactive mixed waste, or leaving the commingled waste on the vicinity property by implementing supplemental standards in accordance with 40 CFR 192.21.

It could take several additional weeks or months to characterize and remediate a property with commingled waste. The additional time could be required because of the need for DOE decisions regarding the most feasible, cost-effective disposal path; laboratory analyses for characterizing the commingled waste; or treatment of the commingled waste.

DOE does not expect significant quantities of commingled waste on the Moab vicinity properties. A waste management plan for characterization and remediation of commingled waste would be prepared and implemented before remediation of the vicinity properties.

2.1.2.4 Applicable Regulations

DOE anticipates that a U.S. Department of Transportation (DOT) exemption, similar to that obtained for the DOE UMTRA and Monticello Projects, would allow exemption from certain regulations pertaining to the hauling of uranium and thorium mill tailings, soils, and other materials contaminated with low levels of RRM from vicinity properties. This exemption is described in further detail in Section 2.2.4.1.

Most indoor remedial action would require local building permits. These and other local permits would be obtained as necessary. Larger remediations may require storm water control permits, which would typically result in some level of management. Any anticipated disturbance of wetlands or floodplains would follow floodplain and wetland environmental review requirements in 10 CFR 1022, applicable state stream bank alteration permit requirements, or U.S. Army Corps of Engineers 404 permit requirements. Most vicinity properties do not involve discharges of water because excavations do not generally intersect the water table.

2.1.3 Construction and Activities at Borrow Areas

Five different borrow materials obtained from off-site locations would be used to construct the disposal cell cover and to reclaim site surface areas after completion of remediation: cover (moisture storage) soils, radon/infiltration barrier soils, capillary break in the form of sand and gravel, riprap, and reclamation soils. These materials would be excavated from several potential borrow areas and transported in transport trucks to the Moab site, where they would first be stockpiled in an uncontaminated borrow material staging area, then used for cover construction or surface reclamation.

Table 2–1 lists the borrow materials and the potential source locations where they could be obtained for both the off-site and on-site disposal alternatives; the source locations are based on a review of area soil maps and commercial quarries. Figure 2–8 illustrates the potential source locations of borrow materials. The Tenmile, Courthouse Syncline, and Blue Hills Road cover soil borrow areas are near, but not on, the Klondike Flats site, which is discussed in Section 2.2. For purposes of impact analysis in this EIS, Floy Wash, as the site farthest from most alternatives, has been used as the representative soil source for transportation impact assessment for Moab, Klondike Flats, and Crescent Junction alternatives. Final selection of borrow areas would occur after a disposal site is selected in the ROD, and after further borrow area evaluations and consultations with, and permitting from the BLM.

Table 2–1. Borrow Materials and Potential Source Locations

Borrow Material	Potential Source Location
Cover Soils	Floy Wash borrow area Crescent Junction borrow area Tenmile borrow area (near Klondike Flats site) Courthouse Syncline borrow area (near Klondike Flats site) Blue Hills Road borrow area (near Klondike Flats site) White Mesa Mill borrow area
Radon/Infiltration Barrier Soils	Crescent Junction borrow area Klondike Flats site
Sand and Gravel	LeGrand Johnson borrow area
Riprap	Papoose Quarry borrow area Blanding borrow area[a]
Reclamation Soils	Floy Wash borrow area

[a] Source for White Mesa Mill only.

Section 2.1.3.1 describes standards and requirements that would apply to the borrow materials, and Section 2.1.3.2 describes the borrow material excavation procedures that would be used, including transportation routing alternatives, distances, durations, and logistics to transport the borrow materials to the Moab site.

2.1.3.1 Borrow Material Standards and Requirements

Riprap

Riprap is an outer layer of stone that would serve as an armor to protect the inner layers of water storage soil, capillary break sand and gravel, and radon barrier soil from the erosive effects of wind, precipitation, and flooding. The riprap would meet the NRC durability requirements in NUREG-1623, *Design of Erosion Protection for Long-Term Stabilization* (NRC 2002). Appendix D of NUREG-1623 notes that the principal objective in determining the riprap durability requirements for stabilized side slopes of embankments is to provide a material that meets long-term design requirements. Because the most disruptive event for these designs is likely to be gully erosion, it is important to provide a rock layer that would minimize the potential for gully erosion, which, once started, may worsen and continue unchecked. The Papoose Quarry borrow area listed in Table 2–1 has been sampled and tested by DOE for use at the Monticello disposal cell to verify that the material would meet the durability requirements of NUREG-1623. The nominal diameter of the riprap used to stabilize the disposal cell would be sized to exceed the maximum river forces recently identified by the USGS. In addition, the barrier wall would be of sufficient length and robustness to mitigate river migration into the pile.

Cover Soils

The primary function of the borrow soils used to construct the disposal cell's water storage soil layer would be to minimize infiltration of water to the underlying materials. The water absorption characteristics of these soils would result in water being retained in the soils when plants are dormant. During the growing season, vegetation in the overlying soil/rock admixture or riprap layers would extract stored water and return it to the atmosphere. Consequently, the amount of water that permeates downward would be minimized.

Types of cover soils best suited to this purpose have been selected on the basis of their water-holding and rooting characteristics. Three U.S. Department of Agriculture soil textures—loams, silt loams, and clay loams—would provide the best storage capacities (Stormont and Morris 1998). Potential soil borrow areas have been selected on the basis of availability of these soil types and on logistics and impacts considerations. These soil types would also be used as reclamation soils in all areas of land disturbances.

Sand and Gravel

The primary function of the coarse sand and gravel (capillary break) layer in the disposal cell cover would be to minimize downward movement of water under saturated conditions. The coarse sand and gravel layer would be placed under the finer-grained water storage layer and above the radon barrier soils. The capillary layer would limit downward water movement and increase the water storage capacity of the water storage layer. High tension in the small pores of the fine-grained water storage layer would impede movement of water into the larger pores of the underlying sand and gravel.

Other sand and gravel would be mixed with soil to form the disposal cell's top layer, which would control erosion and provide a matrix for plant growth. The material would meet the same NRC NUREG-1623 durability standards cited for riprap.

Radon/Infiltration Barrier

The radon barrier is a compacted soil layer of clay that would be placed directly above the tailings and contaminated materials to control radon release and limit water infiltration. Clayey soils would be derived from weathered Mancos Shale in the Klondike Flats and Crescent Junction borrow areas. The thickness of the radon barrier would be based on calculations of radon flux using the computer program RADON (NRC 1989). RADON would be applied in an iterative procedure to determine the compacted soil layer thickness that would prevent the annual average radon flux from exceeding 20 picocuries per square meter per second (pCi/m^2-s).

Moab Site Reclamation Soil

Clean, fine-grained, silty- to sandy-loam reclamation soil assumed to come from the Floy Wash borrow area would be used to backfill the entire Moab site to an average depth of 6 inches and to backfill pond areas. The reclamation soil would be used to meet the radium-226 subsurface standard of 15 pCi/g above background averaged over a 1,076-ft^2 area, which would apply regardless of any future land use.

2.1.3.2 Borrow Material Excavation and Transport Operations

Cover Soil and Radon Barrier Soil Areas

The procedures used to excavate and transport cover soils and radon barrier soils would be similar regardless of the borrow area selected. The excavation would require dozers to scrape and stockpile the soil, front-end loaders to load trucks from the stockpile, and tandem trucks to transport the material.

The general construction sequence at soil borrow areas would be as follows:

1. Access road upgrades would be required for three of the soil borrow areas: Tenmile (4.5 miles, approximately 9 days construction time), Courthouse Syncline (4.5 miles, approximately 9 days construction time), and Klondike Flats (2.0 miles, approximately 4 days construction time). The duration of road upgrade construction would depend on the extent of the required upgrade and roadbase delivery schedules. DOE estimates that 4 inches of roadbase would be required over the length of the access road and that 0.5 mile of road would be upgraded per day. For the purpose of this EIS, it has been assumed that the roadbase would be delivered from the LeGrand Johnson borrow area located in Spanish Valley.
2. A temporary office trailer and portable toilet would be located at the borrow area. DOE does not expect that utility hookups would be required. Water trucks would be used for dust suppression and would obtain the water from the Colorado River via the Moab site water storage ponds for the Moab, Klondike Flats, and Crescent Junction sites or from deep wells or Recapture Reservoir at White Mesa.
3. Approximately 1 ft of topsoil would be stripped along with clearing and grubbing debris from approximately one-third of the total area that would be disturbed, and the topsoil would be reserved in piles no more than 3 ft high. This topsoil would later be used to reclaim the borrow area.

4. Excavation and removal of borrow materials would be continuous over the course of approximately 1 to 2 years. Dozers would scrape the borrow soil into stockpiles that would subsequently be loaded onto trucks with front-end loaders. DOE estimates that local truckers would transport the materials and that a fleet of approximately 28 trucks would be used.
5. At the Moab site, the borrow soils would first be stockpiled in an uncontaminated area. As construction of the disposal cell cover proceeded and schedule dictated, soils would be taken from the uncontaminated stockpile area and deposited at the base of the disposal cell for emplacement or for interim storage. This process of excavation and transportation to the Moab site would continue until the required volume of borrow soil had been removed.
6. The disturbed borrow area would be reclaimed with the set-aside topsoil and reseeded with native vegetation.

Commercial Quarries

Riprap and sand and gravel excavation and hauling operations at commercial quarries would be governed by the quarry operator's standard operating procedures. Riprap for the on-site disposal alternative would be obtained from the Papoose Quarry borrow area in Lisbon Valley. It has been assumed that sand, gravel, and road base would be obtained from the LeGrand Johnson borrow area (Gravel Pit) in Spanish Valley. The stockpiling procedures at the Moab site for riprap, sand, and gravel would be similar to those for borrow soils.

Transport Truck Traffic Density

Assuming implementation of the 1-year top slope cover construction option, borrow material transportation would be ongoing for approximately 3.75 years (1,313 days) (Figure 2–4). DOE estimates that the transport of borrow materials would require 43 daily round-trips (shipments) from borrow areas to the Moab site. Table 2–2 shows the estimated daily round-trips, total volume, and total shipments for each of the five types of borrow material. Table 2–3 illustrates the highway segments that could be used to transport them to the Moab site. If the less aggressive 2-year top slope cover construction schedule were implemented, borrow material transport would be ongoing for approximately 4.75 years, and the daily trips shown in Table 2–2 and Table 2–3 would be reduced by approximately 25 percent. As shown in Table 2–1, there are several optional borrow areas for obtaining cover soil. Table 2–3 assumes that all cover soils would come from the Floy Wash borrow area (as would all Moab site reclamation soil) . This option would generate the most traffic on public highways.

Table 2–2. Summary Logistics for Borrow Material Transportation

Borrow Material	**Daily Round-Trips (1-year Top Slope Cover Construction Option)[a]**	**Total Volume (yd^3)**	**Total Shipments**
Cover soils	19	826,000	25,030
Radon/infiltration barrier soils	9	365,000	11,200
Sand and gravel	3	119,300	4,200
Riprap	5	140,000	6,363
Site reclamation soils	7	320,000	9,670
Total	**43**	**1,770,300**	**56,463**

[a] Assumes one shift operating 12 hours a day, 7 days a week would require approximately 3.75 years to complete transportation of the borrow materials.

Table 2–3. Borrow Material Transportation Segments and Distances

Highway	Segment	Material	Distance	Daily Round-Trips (1-year Top-Slope Cover Construction Option)[a]
Interstate 70	Floy Wash to Crescent Junction exit	Floy Wash soils[b]	7 miles	26
U.S. Highway 191	Crescent Junction exit to Moab	Floy Wash soils[b]	28 miles	26
	Klondike Flats to Moab	Radon barrier soils	18 miles	9
		Segment Total	–	35
	La Sal Junction through Moab	Papoose Quarry riprap	22 miles	5
	Spanish Valley through Moab	LeGrand Johnson sand & gravel	6 miles	3
		Segment Total	–	10
Lisbon Valley Road and Utah Route 46	Lisbon Valley to La Sal Junction	Papoose Quarry riprap	6 miles	5

[a] Assumes one shift operating 12 hours a day, 7 days a week would require approximately 3.75 years to complete transportation of the borrow materials.
[b] Includes cover soils and site reclamation soils.

2.1.4 Monitoring and Maintenance

DOE would have responsibility for long-term monitoring of the Moab site after completion of remediation and reclamation activities. Monitoring and maintenance of the Moab site after completion of site remediation would be in accordance with the site's Long-Term Surveillance and Maintenance Plan. The site is a Title I UMTRCA site and falls under NRC's general license pursuant to 10 CFR 40.27. For the license to become effective, NRC must accept the site's Long-Term Surveillance and Maintenance Plan.

As discussed in Section 1.4.5, release of portions of the site for future uses would depend on the success of site remediation. DOE's ultimate goal would be to remediate to unrestricted surface use standards. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation.

Monitoring and inspections would pay particular attention to identifying any lateral stream cutting or migration of the Colorado River. Areas around the buried riprap diversion wall and along the toe of the impoundment would be inspected for erosion. The buried riprap diversion wall would be constructed from relatively large riprap (12- to 36-inch diameter) that would fall into, and fill, voids caused by soil erosion. However, if a soil erosion problem were observed, the eroded area would be remedied by refilling the area with soil, and repairing riprap as necessary.

2.1.5 Resource Requirements

The following sections describe the major resource requirements for the on-site disposal alternative. Where appropriate, resource availability is also discussed.

2.1.5.1 Labor

The on-site disposal alternative would require work to be performed at the Moab site, including infrastructure requirements and all the activities required to physically shape the existing tailings pile, construct the cover, and reclaim the site. It would also require work at the vicinity properties and borrow areas. Table 2–4 shows the annual average labor requirements based on a 12-hour work shift option working 7 days per week (4 to 5 days per week for vicinity properties), 350 days per year.

Table 2–4. Average Annual Labor Requirements—On-Site Disposal Alternative

Worker Category	Activity Location			Total
	Moab Site	Vicinity Properties	Borrow Areas[a]	
Equipment operators	18	6	1	25
Site support	13	4	4	21
Truck drivers	4	3	41	48
General labor	12	10	4	26
Total workforce	**47**	**23**	**50**	**120**

[a] Borrow operations would require minimal equipment operators to accommodate haul trucks because of the length and duration of travel between the source and point of use.

2.1.5.2 Equipment

The on-site disposal alternative would require equipment to be operating at the Moab site, vicinity properties, and borrow areas, and truck transportation between these areas. Table 2–5 represents the annual average equipment requirements based on a 12-hour work shift option working 7 days per week (4 to 5 days per week for vicinity properties), 350 days per year.

Table 2–5. Average Annual Equipment Requirements—On-Site Disposal Alternative

Equipment Type	Activity Location			Total
	Moab Site	Vicinity Property	Borrow Area	
Tractor	1	–	–	1
Backhoe	2	1	–	3
Grader	3	–	–	3
Trackhoe	–	–	–	–
Front-end loader	1	1	1	3
Water truck	2	1	1	4
21 yd^3 scrapers	2	–	–	2
Dozer	2	–	–	2
Sheepfoot compactor	1	–	–	1
Smooth drum roller	1	–	–	1
Pickup truck	2	2	3	7
End dump truck	1	1	–	2
Skidsteer	–	2	–	2
Tandem truck	–	–	28	28
Total	**18**	**8**	**33**	**59**

2.1.5.3 Land Disturbance

Moab Site and Vicinity Properties

The on-site disposal alternative would disturb approximately 439 acres at the Moab site and 6 acres at vicinity properties.

Borrow Areas

Estimates of required volumes of borrow material are shown in Table 2–2. The range of estimated areas of land disturbance at potential borrow areas is shown in Table 2–6. This table shows all potential borrow area disturbances; however, not all these areas would be used. Final decisions would be based on additional surveys. For the purpose of assessing impacts, DOE estimates that the range of disturbed borrow area land for this alternative would be 140 to 550 acres, depending on the final selection of the borrow area source for cover and reclamation soils and on the final depth to which these soils could be excavated. This estimate excludes disturbances to privately operated commercial quarries that would provide sand/gravel and riprap.

Table 2–6. Estimated Area of Disturbed Land at Borrow Areas

Borrow Material/Area	Estimated Area of Disturbance (excavated acres or quarried volumes)	Estimated Available Area/Volume
Cover and Reclamation Soils		
Floy Wash	178–380 acres	1,035 acres
Crescent Junction	70–100 acres	4,925 acres
Tenmile	115–250 acres	1,480 acres
Courthouse Syncline	70–155 acres	4,925 acres
Blue Hills Road	70–185 acres	900 acres
Radon Barrier		
Klondike Flats	100–170 acres	10,000 acres
Crescent Junction	70–100 acres	4,925 acres
Sand and Gravel		
LeGrand Johnson	43,000–140,000 yd^3	13,000,000 yd^3
Riprap		
Papoose Quarry	185,000–257,000 yd^3	3,500,000 yd^3
Blanding	8–10 acres[a]	1,355 acres
Soils and Clay		
White Mesa Mill site	63–83 acres	300,000–400,000 yd^3

[a] Assumes rock thickness of 12 ft at borrow area.

2.1.5.4 Fuel

DOE estimates that the on-site disposal alternative would require an annual average of 820,000 to 830,000 gallons of diesel fuel, depending on the top slope cover schedule implemented, and that total fuel consumption for the project would range from 4 million to 5 million gallons.

2.1.5.5 Water

Potable water would be required for drinking, washing, toilets, contaminated clothing laundering, and other uses and would be purchased from the City of Moab. Nonpotable or construction water would be required for dust control, earth compaction, equipment decontamination, and other uses and would be derived from DOE's Colorado River water rights. DOE estimates that the total potable water requirement for the on-site disposal alternative would be 4,200 gallons per day, or approximately 30 gallons per day per worker. DOE estimates that the average annual nonpotable water requirement would be 70 acre-feet, or a project total of approximately 490 acre-feet assuming a 7-year project duration.

2.1.5.6 Solid Waste Disposal

The on-site disposal alternative would generate approximately 1,040 yd^3 of uncontaminated solid waste per year. The solid waste would be disposed of in the Grand County landfill.

2.1.5.7 Sanitary Waste Disposal

DOE estimates that the on-site disposal alternative would result in the generation of approximately 10,000 gallons of sanitary waste per week, or approximately 1,430 gallons per day, assuming a 12-hour shift. Septic holding tanks connected to bathrooms in the trailers would be placed at the Moab site along with portable toilets used to provide sanitary waste service. Both the septic tanks and the portable toilets would be pumped out routinely and disposed of at the city of Moab sewage treatment plant.

2.1.5.8 Electric Power

DOE estimates that under the on-site disposal alternative, the existing electrical service at the Moab site would be required to support an estimated maximum demand of 600 kilovolt-amperes (kVA). The primary demands for this power would be:

- Conversion of the mill building to a vehicle/equipment maintenance shop.
- Field office trailers.
- Office and parking lot security lighting.
- River pump station.
- Decontamination water sprays and recycle pumps.

2.2 Off-Site Disposal Alternative

The off-site disposal alternative would entail excavating and relocating the entire Moab site tailings pile, other contaminated on-site material, and all contaminated material from vicinity properties to one of three alternative off-site disposal cells that would be constructed specifically as a permanent repository for these materials. The three proposed off-site disposal alternatives DOE is evaluating are Klondike Flats and Crescent Junction, which are north of the Moab site, and the White Mesa Mill site to the south. Figure 2–9 shows the Moab site and the three potential disposal sites. DOE is also evaluating three alternative modes of transportation to move

2.1.5.5 Water

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- Decontamination water sprays and recycle pumps.

2.2 Off-Site Disposal Alternative

The off-site disposal alternative would entail excavating and relocating the entire Moab site tailings pile, other contaminated on-site material, and all contaminated material from vicinity properties to one of three alternative off-site disposal cells that would be constructed specifically as a permanent repository for these materials. The three proposed off-site disposal alternatives DOE is evaluating are Klondike Flats and Crescent Junction, which are north of the Moab site, and the White Mesa Mill site to the south. Figure 2–9 shows the Moab site and the three potential disposal sites. DOE is also evaluating three alternative modes of transportation to move the material to the off-site disposal cell: truck, rail, and slurry pipeline; however, as described further in Section 2.5.2, rail transport is not an option for the White Mesa Mill site. Contaminated material from vicinity properties would first be moved to the Moab site, then transported to the off-site disposal location. Contaminated ground water at the Moab site would also be remediated under the off-site disposal alternative as described in Section 2.3.

The major actions associated with implementing the off-site disposal alternative would be:

- Construction and operations at the Moab site (Section 2.2.1).
- Characterization and remediation of vicinity properties (Section 2.2.2).
- Construction and operations at the borrow areas (Section 2.2.3).
- Transportation of contaminated material from the Moab site to the off-site disposal location (Section 2.2.4).
- Construction and operations at the off-site disposal location (Section 2.2.5).
- Monitoring and maintenance of the off-site disposal cell (Section 2.2.6).
- Ground water remediation at the Moab site (Section 2.3).

Resource requirements for remediation activities are discussed in Section 2.2.7.

For the off-site disposal alternative, where pile consolidation time is not a factor, project completion dates under the truck and rail transportation options could be affected by work schedules. Consequently, for these two modes of transportation, DOE considered two work schedules. The single-shift schedule would be one 12-hour shift, 7:00 a.m. to 7:30 p.m., 50 weeks per year. The double-shift schedule would be two 10-hour shifts, 7:00 a.m. to 5:30 p.m. and 5:30 p.m. to 4:00 a.m., 50 weeks per year. These two schedules were considered to allow flexibility in targeting a project completion date. In this EIS, impacts are generally assessed assuming the more aggressive double-shift schedule is implemented. This was done to ensure that certain impacts unique to the double-shift were addressed. For example, night operations under a double shift could entail impacts to night sky vision, noise, and traffic that would not be considerations under a single-shift scenario. The NPS has expressed concern for these factors in relation to Arches National Park. The one difference in these schedules would be that for truck transportation the schedules would run 7 days per week, and for rail transportation the schedules would run only 6 days per week. This difference would be necessary to accommodate railroad requirements that stipulate 1 day per week be allowed for locomotive and track maintenance.

DOE considered only one schedule for the pipeline transportation option because once pumping operations began they would be in progress 24 hours a day. Processed slurry would be stockpiled, and the factor driving the schedule for project completion would be the diameter of the pipe rather than the number of workers excavating the pile. DOE selected the pipe diameter to allow for a schedule roughly the same as the rail and truck transportation single-shift work schedule that estimates project completion in 2012.

Figure 2–10, Figure 2–11, and Figure 2–12 illustrate the estimated schedules for completing the surface remediation activities for the off-site disposal alternative using the three transportation modes. As seen in the figures, the schedules would be similar for all three modes of transportation. Assuming that a ROD is issued in 2005 and that a single-shift work schedule is implemented for truck or rail transportation, remediation work would begin in late 2007 and would be completed in 2012 for all three modes of transportation, regardless of the off-site disposal cell location. Due to uncertainties in tailings material handling and transportation, the project completion date could extend to 2014. This is based on information developed since the draft EIS. Extending the schedule by two years to 2014 would not result in additional impacts to human health or the environment. This is similar to the schedule that would apply for the on-site disposal alternative if the more aggressive 1-year top slope cover construction schedule were used (see Figure 2–4). However, as shown in Figure 2–10 and Figure 2–11, use of a more aggressive double-shift work schedule for the truck or rail transportation modes would expedite completion of the surface remediation activities by approximately 2 years and result in completion of the surface remediation activities in late 2010 or early 2011. The 2-year schedule uncertainty for pile consolidation discussed in Section 2.1 for the on-site disposal alternative would not apply for the off-site disposal alternative.

2.2.1 Construction and Operations at the Moab Site

This section describes construction and operations at the Moab site under the off-site disposal alternative. Ground water remediation at the Moab site is discussed in Section 2.3. The following subsections address three elements: (1) site preparation, infrastructure enhancement, and control, (2) excavation and processing of tailings and other contaminated material, and (3) Moab site reclamation. Figure 2–13 is a Moab site plan illustrating the major site features and approximate locations of temporary on-site areas and facilities that would be used under the off-site disposal alternative.

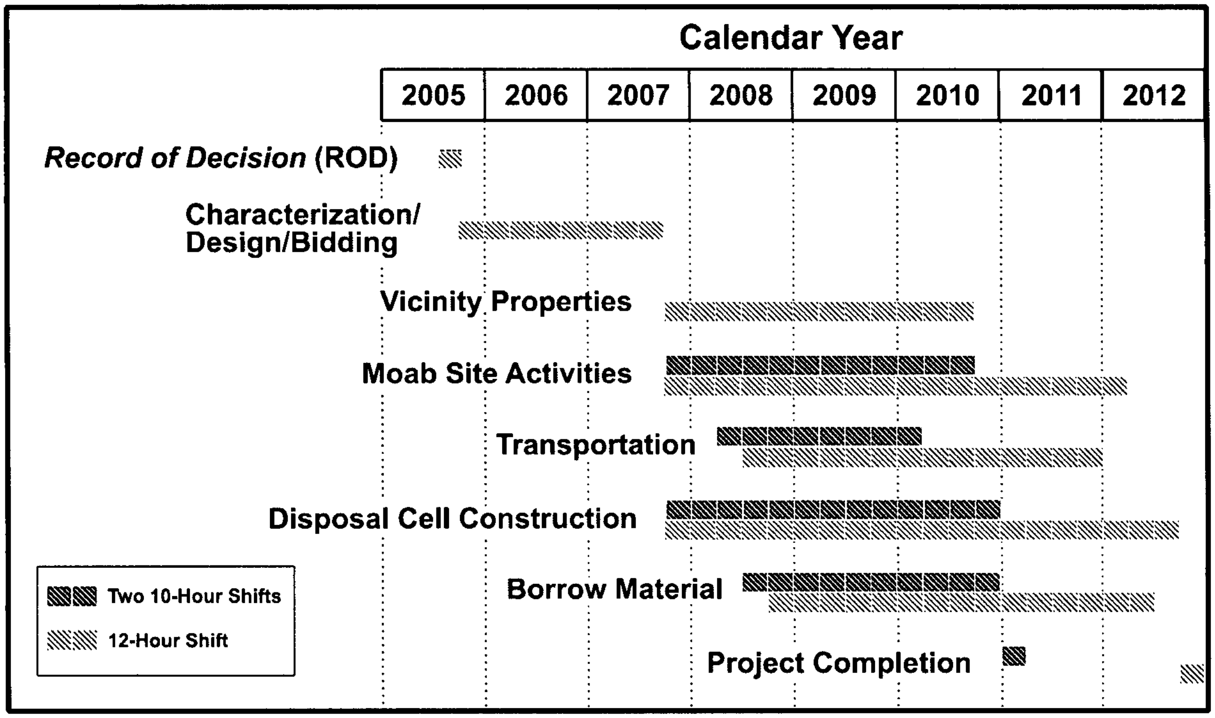


Figure 2–10. Truck Haul Off-Site Disposal Alternative, Surface Remediation Activity Schedule

2.2.1.1 Site Preparation, Infrastructure Enhancement, and Controls

Many aspects of the Moab site preparation, infrastructure enhancement, and controls would be similar to those described in Section 2.1.1.1 for the on-site disposal alternative. The major differences would be associated with the temporary transportation infrastructure, access roads, and vicinity property material storage that would be required for the off-site disposal alternative. As with the on-site disposal alternative, in all instances, new structures or other installed elements would be painted a color to match background soils and/or vegetation in order to minimize visual impacts seen from US-191 or SR-279.

Activities that would be similar or identical to those described in Section 2.1.1.1 include

- Storm water management.
- Dust control.
- Water pumping station enhancements.
- Temporary field offices and staging areas.
- Vehicle maintenance and fuel storage areas.

Temporary Transportation Facilities

Temporary facilities would be necessary to support whichever transportation mode was selected. If the truck option were selected, highway access consisting of an overpass and acceleration and deceleration lanes would be required. If the rail option were selected, a railroad spur and a conveyor system to convey tailings to the railroad cars would be required. If the slurry pipeline option were selected, a pumping station with associated material preparation items would be required. More detailed descriptions of the required temporary transportation facilities that would be constructed at the Moab site are included in Section 2.2.4.

New Access Roads

The existing access road to the Moab site is adequate for only a limited volume of traffic. Construction of approximately 1,000 ft of new access roads to accommodate the added volume of traffic would be required for the off-site disposal alternative. New access roads would be 30 ft wide and gravel-surfaced; therefore, they would not require regular dust control measures. Section 2.2.4 describes the required new or upgraded access roads in greater detail.

Vicinity Property Storage Area

Vicinity property remediation is discussed in Section 2.1.2. Prior to being transported for final disposal, contaminated materials from vicinity properties would be delivered to the Moab site for sizing and processing. These materials would be stored in a vicinity property storage area until ready for processing or transportation.

Radiological Controls

The radiological controls at the Moab site would be structurally and functionally similar to those described in Section 2.1.1.1. One modular trailer would control personnel access to contamination areas. For the truck transportation option, two vehicle/equipment decontamination stations would be constructed: one for vicinity property haul trucks, and a larger one with three to four bays for decontaminating tailings haul trucks. The final size and layout of the facility would reflect the expected volume of truck traffic. For the rail or pipeline options, a single vehicle/equipment decontamination facility would be constructed.

2.2.1.2 Excavation and Preparation of Tailings for Transportation

This section describes the actions that would be necessary at the Moab site to prepare, excavate, and process contaminated material for transportation to an off-site location. This discussion addresses activities up to the time when contaminated materials are loaded into trucks for highway transportation (truck haul transportation alternative) or into the conveyor hopper (rail transportation alternative). The material preparations for truck or rail transport would differ from those for slurry pipeline transport.

Preparation for Truck and Rail Transportation

Before it could be transported by truck or rail, the material in the tailings pile would have to be excavated and dried to a specified moisture content by drying in a process bed and mixing with drier material. For the purposes of this EIS, this drying process has been assumed to bound potential impacts such as air emissions to workers and the public. Approximately 32 acres at the northwest and east base of the pile and an additional 14 acres around the top perimeter of the pile would be used as drying or processing areas. These areas (see Figure 2–13) would be accessed by temporary haul roads. There would be approximately seven separate 6- to 7-acre process beds in the areas. The system would be designed to control a reference 100-year storm event throughout the construction period and would include new or improved berms around the drying beds, drainage ditches and basins, hay bales, sediment traps, and silt fence fabric. DOE has previous experience successfully moving wet tailings, including saturated slimes, at other UMTRCA sites such as at the Riverton (Wyoming), Rifle (Colorado), Monument Valley (Arizona), and Grand Junction (Colorado) sites. The actual method of drying would be developed as part of the engineering design after the ROD and would include controls to prevent contamination of the soils and ground water. Conventional engineering solutions, including a liner for the drying bed or a mechanical system such as a press or centrifuge, would be considered.

Once the process beds and haul roads were constructed, pile excavation would begin. An excavating machine located on the perimeter of the pile would excavate from the center of the pile outward. The excavating machine would drag slimes from the center and pull them over and into the perimeter sands, providing some mixing during the excavation. The coarser tailings sands at the outer perimeter of the pile would be excavated and moved to the process beds using scrapers. This method would allow a progressive top-down excavation sequence that would maintain the stability of the perimeter tailings dike surrounding slimes and also allow continuous use of the perimeter area material for processing.

As saturated slimes were excavated from the center of the pile, the material would be loaded onto trucks and taken to the process beds for mixing and drying. A tractor would turn and dry the graded material until it reached a consistent moisture content suitable for truck or rail transport. Assuming dry tailings were available for mixing with wet tailings, the mixing and drying process for a load of excavated material would take approximately 3 days; if dry tailings were not available for mixing, the material would be processed for 7 days prior to shipment. The approximate maximum daily volume of material that could be placed for processing would be

15,500 yd^3 in each process bed of approximately 6 to 7 acres. Should tailings drying take additional time, slightly greater areas for drying would be necessary to allow sufficient inventory of tailings to be dried and transported according to the planned schedule.

Once the material was sufficiently dry, it would be loaded onto 22-ton tandem trucks (total 44 tons) for off-site shipment if the truck transportation mode were implemented. Alternatively, if rail transport were implemented, the dried material would be transported by a conveyor system and loaded onto waiting gondola cars. After excavation of the pile reached the assumed original grade, it would continue until the cleanup criterion had been met. On the basis of limited existing data, DOE estimates that subpile excavation to a depth of 2 ft would be required.

Preparation for Slurry Pipeline Transportation

Although pile excavation for the slurry pipeline transportation alternative would occur in the same manner as for truck or rail transportation, post-excavation processing would be different because the pipeline mode of transportation would require that the materials be mixed with significant amounts of water to form a slurry. As tailings were excavated, off-highway haul trucks would be loaded at the point of excavation and would deliver the material to a temporary stockpile near the slurry processing area. The material would be screened to separate greater-than-4-inch material from less-than-4-inch material. The larger material, or debris, would be stockpiled for highway truck haul to the disposal cell. Loaders would then deliver the smaller material to slurry process hoppers. Section 2.2.4.3 discusses the slurry pipeline transportation process.

Demolition and Disposal of Existing Mill Facilities

The existing mill facilities would be demolished and disposed of in a manner similar to that described in Section 2.1.1.2, with the exception that demolished material would be stockpiled, sized, and transported to the selected off-site disposal cell rather than deposited in the on-site disposal cell for permanent disposal. For the slurry pipeline and rail transportation alternatives, the demolished materials would be transported by truck.

2.2.1.3 Moab Site Closure

Site reclamation actions would be similar to those described under the on-site disposal alternative (Section 2.1.1.4). However, an additional 130 acres of reclamation would be required at the Moab site under this alternative due to removal of the tailings pile. Potential future uses of the site would be a more significant factor in determining final reclamation actions for the off-site disposal alternative because the pile would be removed. Once all contaminated material was removed from the Moab site, closure would begin and would involve two phases: (1) removal of temporary facilities, and (2) final site reclamation.

Removal of Temporary Construction Facilities

The temporary facilities described under Section 2.2.1.1, as well as concrete slabs, piping, sewage holding tanks, and pond liners, would be removed from the site in accordance with a waste management plan that complied with all applicable federal and state regulations. Wherever possible, materials would be salvaged for reuse at other sites. Unsalvageable materials would be disposed of in the off-site disposal cell, at another licensed facility, or as municipal waste, as appropriate.

Final Site Reclamation

As discussed in Section 1.4.5, release of portions of the site for future uses would depend on the success of site remediation. DOE's ultimate goal would be to remediate to unrestricted surface use standards. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation. Some fencing would be required at least for the 75 years during which ground water remediation would be ongoing. Before backfill and site reclamation and following the removal of the temporary infrastructure, structures, and controls, DOE's contractor would verify that radium-226 concentrations in soil within the Moab site boundary did not exceed EPA standards in 40 CFR 192. The entire site would then be graded and recontoured. The water storage ponds would be backfilled to original grades prior to reclamation. Approximately 425,000 yd^3 of fine-grained silty- to sandy-loam reclamation soil excavated from the Floy Wash borrow area would be imported as backfill for the Moab site. Soils would be prepared for planting by scarifying with a disk harrow. Moisture conditioning would be performed and the area seeded with native or adapted plant species.

Moab Wash would be reconstructed in its general present alignment. After removal of the tailings impoundment and contaminated soils, site topography and future land use are uncertain. Thus, to minimize costs and achieve fluvial stability, the channel would be reestablished in its current location. Additional meanders may be added to increase travel distance of the water and reduce slope to mitigate future erosion caused by higher water flow velocity. The channel would be lined with riprap and designed to carry the estimated runoff volume for a 200-year flood. Larger flows would be allowed to flood into channel overbank areas.

2.2.2 Characterization and Remediation of Vicinity Properties

Characterization and remediation of vicinity properties would be completed as described in Section 2.1.2. The primary difference between the on-site and off-site disposal alternatives with regard to vicinity properties would be the requirement to transport the stockpiled material to an off-site disposal location.

2.2.3 Construction and Operations at Borrow Areas

Descriptions of borrow material site locations, standards, and excavation procedures are the same as those described in Section 2.1.3. However, borrow material traffic density and routing would differ from those described in Section 2.1.3.2 because, with the exception of the Moab site reclamation soil, the borrow materials would be delivered to, or be available at, the selected off-site disposal location.

Transport Truck Traffic Density

As shown in Table 2–7, assuming implementation of a double work shift (for truck or rail haul) DOE estimates that the transport of borrow materials would require a total of 67 daily round-trips for the Klondike Flats off-site disposal alternative and 24 for the Crescent Junction or the White Mesa Mill alternative. (For the slurry pipeline mode, average daily round-trips would be about 30 percent less than those shown in Table 2–7 because of the longer overall schedule for borrow material activities.) Under a double work shift schedule, borrow material transportation would be ongoing for approximately 2.75 years (875 days) for the truck or rail transportation mode (see Figure 2–10 and Figure 2–11). For the slurry pipeline mode, borrow material activities would be ongoing for about 4 years (Figure 2–12). Table 2–7 also shows the total volume and total shipments for each of the five types of borrow materials.

If a single daily work shift schedule were implemented for the truck or rail transportation modes, borrow material transportation would be ongoing for approximately 3.75 years, and the estimated daily round-trips would decrease to approximately two-thirds of the numbers shown in Table 2–7. As shown in Table 2–1, there are several optional borrow areas for obtaining cover soil. Table 2–7 assumes that all cover soil would come from the Floy Wash borrow area (as would all Moab site reclamation soil). This option would generate the most traffic on public highways.

Table 2–7. Summary Logistics for Borrow Material Transport
(Truck or Rail Haul Double Work Shift)

Borrow Material	Klondike Flats Alternative			Crescent Junction Alternative			White Mesa Mill Alternative		
	Daily Round-Trips	**Total Volume (yd^3)**	**Total Ship.**	**Daily Round-Trips**	**Total Volume (yd^3)**	**Total Ship.**	**Daily Round-Trips**	**Total Volume (yd^3)**	**Total Ship.**
Cover soils	43	1,243,000	37,800	NA[a]	1,243,000	NA[a]	NA[a]	1,243,000	NA[a]
Radon barrier soils	NA[a]	294,000	NA[a]	NA[a]	294,000	NA[a]	NA[a]	294,000	NA[a]
Sand and gravel	7	215,750	6,538	7	215,750	6,300	7	215,750	6,300
Riprap	2	43,400	1,973	2	43,400	1,973	2	43,400	1,973
Moab reclam. soils	15	424,867	12,875	15	424,867	12,875	15	424,867	12,875
Total	**67**	**2,221,017**	**59,186**	**24**	**2,221,017**	**21,148**	**24**	**2,221,017**	**21,148**

[a] Material available at off-site disposal location.

2.2.4 Transportation of Tailings Pile and Other Contaminated Material

DOE evaluated the truck and pipeline modes of transportation for all three potential sites. Rail service was determined not feasible for the White Mesa Mill site because no rail service is available; therefore, this mode was evaluated only for the Klondike Flats and Crescent Junction sites. Table 2–8 shows the estimated source material quantities that would be transported under the off-site disposal alternative. On the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total estimated volume of contaminated site material. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the final EIS for purposes of assessing and comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing the remedial action plan.

Table 2–8. Source Material Quantities

Source Material	Volume (yd^3)	Weight (dry short tons)
Uranium mill tailings	7,800,000	10,500,000
Pile surcharge	445,000	600,000
Subpile soil	420,000	566,000
Off-pile contaminated site soils	173,000	234,000
Vicinity property material	29,400	39,700
Total	**8,867,400**	**11,939,700**

Figure 2–14 shows the Moab site and the proposed truck and rail routes. The proposed slurry pipeline routes are shown in Figure 2–15, and detailed maps are presented in Appendix C.

2.2.4.1 Truck Transportation

DOE analyzed highway truck transportation for all three alternative sites and two work shift scenarios. Existing highways would be used with some improvements made. In 2004, the Utah Department of Transportation (UDOT) completed the widening of US-191 to a four-lane highway from the Moab site north to SR-313. The truck fleet size would vary depending on the disposal site location. An independent trucking company using its own fleet of trucks would do the trucking.

Summary Tabulation of Truck Transportation Logistics

Table 2–9 summarizes logistics information for truck transportation from the Moab site to the three alternative off-site disposal locations.

Table 2–9. Summary Logistics for Truck Transportation from the Moab Site to Three Alternative Off-Site Disposal Locations

	Miles One-Way from the Moab Site to Alternative Disposal Cells					
	Crescent Junction		**Klondike Flats**		**White Mesa Mill**	
On highways	28		14		84	
On access roads	2		4		1	
Total miles	**30**		**18**		**85**	
Miles through community	0.5		0		9.5[a]	
	Truck Production Estimates for Alternative Disposal Cells					
	Crescent Junction		**Klondike Flats**		**White Mesa Mill**	
	1 shift	**2 shifts**	**1 shift**	**2 shifts**	**1 shift**	**2 shifts**
Daily round-trips	219	384	219	384	219	384
Trucks per fleet	36	37	24	26	78	82
Years to complete	3.5	2.0	3.5	2.0	3.5	2.0
Round-Trip Cycle Times (hours)[b]						
Crescent Junction	1.9					
Klondike Flats	1.3					
White Mesa Mill	4.2					

[a] Route to White Mesa Mill site traverses 2 miles through Monticello, 4 miles through Blanding, and 3.5 miles through Moab.

[b] Cycle times would depend primarily on the round-trip distance. However, other factors considered include highway grades, traveling through communities, nonhighway haul roads, and material handling activities such as loading, unloading, and decontamination.

Permits and Exemptions

The proposed 22-ton tandem trailer, hauling a total of 44 tons per truck, would require a special highway permit from UDOT. All work within UDOT rights-of-way would require an encroachment permit from UDOT Region 4. In addition, other federal, Utah, and local requirements would apply. As at other UMTRCA sites, DOE would apply for a DOT exemption to ship uranium mill tailings (see text box titled "DOT Exemption). Regardless of the exemption, DOT would require that each truck be surveyed for radioactivity prior to release from the site and that truck beds be covered to mitigate spills and prevent windblown contamination during transport. No loose radioactivity would be present on the outside of the truck. All transportation would be conducted under a transportation plan that included emergency provisions, manifesting, and specific information regarding any RCRA- or TSCA-regulated material, if applicable.

DOT Exemption

A DOT exemption, similar to that obtained for the DOE UMTRA and Monticello Projects, would allow exemption from specific DOT regulations, including

- 49 CFR 171.15 and 171.16.
- 49 CFR 172.202, .203(c)(1), .203(d), .302(a) and (b), .310, .331, .332, and Part 172 Subpart E and F (labeling and placarding).
- 49 CFR 173.22(a)(1), 173.403 only as it relates to the definition of closed transport vehicles, .427(a)(6) except for requirements stated in this exemption, .443(a).
- 49 CFR 177.817, and .843(a).

These exemptions would allow relief from certain transportation regulations pertaining to uranium and thorium mill tailings, soils, and other materials contaminated with radionuclides from uranium and thorium at the Moab site and vicinity properties. Some of the relief includes the use of closed vehicles and bulk containers without detailed analysis of the contents and with alternative requirements for hazard communication information and packaging. In addition, manifesting each truckload of tailings would not be required under the exemption, nor would labeling of contents or placarding of the truck. As long as the vehicles were protected by tarps or other means to prevent releases, they would not need to be monitored for each trip. A dedicated radioactive materials use statement would be required on the truck, and would have to be removed before the truck was thoroughly decontaminated and released according to DOE standards to haul any other material. A copy of the exemption would have to be carried in the cab of each truck hauling material under the exemption. Emergency reporting requirements are limited to DOE management when more than 1,500 pounds of material is spilled, and the information typically contained in a transportation plan is incorporated as part of the exemption document.

Load, Haul, and Dump Operations

After the tailings were processed and dried to the necessary moisture levels (see Section 2.2.1.2), the transport trucks would be loaded and the truck beds covered with tarps by an automatic tarping device. After the trucks were loaded, the exterior of the trucks would be decontaminated. The trucks would then be scanned for radioactivity and, if clean, released for highway transportation. At the disposal site, the trucks would drive directly into the disposal cell on dedicated haul roads and dump the tailings at designated locations in the cell for spreading, moisture conditioning as needed, and compaction. Figure 2–16 illustrates a typical disposal cell area, haul roads, and other major features.

After dumping, the haul trucks would be decontaminated, scanned for radioactivity, and released prior to leaving the disposal site. As shown in Figure 2–16, the disposal site would include a truck maintenance and fuel storage area. This area would also serve as a parking yard to store one-half of the truck fleet during the off-shift and to park any backup trucks. The other half of the fleet would be stored during the off-shift at the Moab site. An office trailer would also be located at the site to support administration for the trucking service. Fuel storage tanks would range from 5,000 to 20,000 gallons, depending on the disposal cell location, and would have spill containment berms constructed around them.

Truck Maintenance and Storage Facilities at the Disposal Sites and the Moab Site

The following sections describe the transportation-related infrastructure that would be constructed and eventually reclaimed at the Moab site and the three alternative off-site disposal locations.

Moab Site Truck Transportation Infrastructure Construction and Reclamation

Figure 2–17 shows the Moab site and anticipated temporary construction infrastructure that would be required to support a truck haul. New highway access, overpass, and acceleration/deceleration lanes would be constructed for the north haul to Klondike Flats or Crescent Junction or south haul to White Mesa Mill. A new site entrance on US-191 would be built approximately halfway between the existing site entrance and Potash Road (SR-279) on the north side of the Moab site. As seen in Figure 2–17, the proposed new truck transportation infrastructure would be located within the Moab site boundary and therefore would not constitute additional land disturbance beyond the 439-acre site area assumed to be disturbed during surface remediation.

The improvements would all be temporary and would be used only for the life of the tailings haul. Design and construction criteria would meet American Association of State Highway and Transportation Officials (AASHTO) and UDOT standards, with the design life a consideration. At the end of the tailings haulage, the acceleration/deceleration lanes and overpass would be removed and reclaimed. The current US-191 access would be reestablished as the site access.

Klondike Flats Site Truck Transportation Infrastructure Construction and Reclamation

A new overpass across US-191 with a deceleration lane entering it would be constructed for north-bound trucks to access Blue Hills Road and avoid crossing the south-bound lane. The overpass would replace the existing Blue Hills Road turnoff (Figure 2–18). (Note: In Figure 2–18 and other similar figures, the insert showing a typical cell indicates comparative size only. The final location of the cell would be within the larger hatched site area and would be decided after further investigation of surface and subsurface geologic and hydrologic conditions; investigations could also include site-specific cultural or archeological surveys or other sampling.) The existing Blue Hills Road would be paved from US-191 for approximately 2 miles to the tailings pile access exit. The haul road would continue north through the bluffs and into the disposal cell area. The exact configuration of the haul road would depend on where the disposal cell was located within the Klondike Flats site.

The haul road from the highway overpass to the disposal cell would be a private road for truck traffic and cell access only. A new Blue Hills Road access for public use would be constructed south of and parallel to the existing Blue Hills Road for 2 miles. It would reconnect to the existing Blue Hills Road west of where the new haul road would turn north. Access to the new public access Blue Hills Road would be through a new intersection with US-191 south of where the newly constructed private acceleration lane ended. The new Blue Hills Road access would be constructed to the same size and surface condition as the existing Blue Hills Road.

The acceleration lanes, deceleration lanes, and overpass would all be temporary structures to be used only for the life of the tailings haul. Design and construction criteria would meet AASHTO and UDOT standards with the design life a consideration.

At the end of the tailings haulage, the acceleration/deceleration lanes and overpass would be removed and reclaimed. The 2 miles of haul road that is currently the Blue Hills Road would remain paved, and the existing intersection with US-191 would be reconstructed, reestablishing Blue Hills Road to its former public use. The newly constructed Blue Hills Road would be regraded and reclaimed. The new haul road from the existing Blue Hills Road to the disposal cell would remain in place to provide future cell access for inspections.

Crescent Junction Site Truck Transportation Infrastructure Construction and Reclamation

The transportation trucks would use existing US-191 to transport the tailings from the Moab site to the Crescent Junction site. Road improvements would be made from the I-70 overpass to the south side of the Union Pacific rail line (Figure 2–19). A haul road would be constructed parallel to the rail line going east approximately 1 mile, where it would turn north across the railroad tracks and continue to the disposal cell. The exact configuration of the haul road would depend on where the disposal cell was located within the Crescent Junction site.

CR-175, which is the old US-50, lies north of I-70. It parallels the Union Pacific rail line and intersects US-191 north of I-70. The county road is currently paved but would have an asphalt overlay placed on it from US-191 for approximately 1,000 ft to the east. At that point, a new haul road would be constructed north on the same alignment as the current CR-223 for approximately 1,500 ft, and a new at-grade railroad crossing would be constructed. The new haul road would leave the county road alignment and continue northeast to the final disposal cell location. The entire haul road would be paved.

After completion of the tailings haul and disposal cell site reclamation, the truck haul road would continue to be used as an access road to the disposal cell for inspections. Therefore, the haul road would not be reclaimed.

White Mesa Mill Site Truck Transportation Infrastructure Construction and Reclamation

The transportation trucks would use US-191 south of the Moab site through the city of Moab. The haul route would continue on US-191 south through the cities of Monticello and Blanding to the White Mesa Mill entrance (Figure 2–20). US-191 is also the main thoroughfare in Moab, Monticello, and Blanding. A new deceleration and right turn lane would be used for entering the White Mesa Mill site, and existing haul roads on the site would also be used to access the disposal cell. A new overpass with an acceleration lane would be constructed for trucks leaving the site and accessing US-191 north-bound to avoid crossing the highway's south-bound lane. The overpass would be located within the vicinity of the existing White Mesa Mill access.

The overpass and acceleration lane would be temporary structures to be used only for the life of the tailings haul. Design and construction criteria would meet AASHTO and UDOT standards with the design life a consideration. At the end of the tailings haulage, the overpass and acceleration lanes would be removed and reclaimed. The current US-191 access would remain as the site access.

2.2.4.2 Rail Transportation

The existing rail line from Crescent Junction to the Moab site, called the Cane Creek Branch rail line, would be used to transport material from the Moab site to either the Klondike Flats or the Crescent Junction sites. This rail line continues south of the Moab site and dead-ends at the Potash Mine. The only current rail traffic on this line is one train per week to serve the Potash Mine. As shown in Table 2–10, if the off-site rail transport alternative were implemented, the line would carry 4 to 8 round-trips per day from the Moab site to the selected disposal site, depending on the implemented schedule. Tailings haulage would be scheduled for 6 days per week. The 7th day, when the Potash Mine train runs, would be used as a preventive maintenance day for the tailings train.

Table 2–10. Summary Logistics for Rail Transportation from the Moab Site to Two Alternative Off-Site Disposal Cell Sites

Distances/Cycles	**Klondike Flats**		**Crescent Junction**	
One-way distance—Moab site to off-load location (miles)	18		30	
Train cycle time (hours)[a]	5–6		10–12	
Train Production	**Klondike Flats**		**Crescent Junction**	
	1 Shift	**2 Shifts**	**1 Shift**	**2 Shifts**
Round-trips per day	4	8	4	8
Years of operation	3.3	1.6	3.3	1.6
Debris Production	**Klondike Flats**		**Crescent Junction**	
	1 Shift	**2 Shifts**	**1 Shift**	**2 Shifts**
Truck loads of debris shipped per day from Moab site	2	5	2	5
Total truck loads of debris shipped from Moab site	2,188	2,188	2,188	2,188
Years of operation	3.3	1.6	3.3	1.6

[a] Train cycle time for hauling a load of tailings from the Moab site to the disposal cell would depend primarily on the distance traveled. Other factors to be considered are rail grades, spur mileage (which would have a lower speed) switching, and other material-handling activities such as loading, unloading, and decontamination. Actual one-way travel times to the Klondike Flats and Crescent Junction sites are estimated at 1.5 and 3 hours, respectively.

An existing rail bed is located along the rail line at the Moab site near the tunnel entrance. A rail siding once existed there to provide rail service to the former Moab mill operations. A new 2,000-ft rail siding would be constructed on the existing rail bed and tied into the rail line with switches. The siding would be used to load tailings onto the rail haul trains, and the rail line would be used for stacking trains and for switching. Each train would consist of 30 standard-size gondola cars, each capable of carrying approximately 100 tons of material. Thus, each train would carry approximately 3,000 tons of material.

The trains would be loaded at the Moab site siding, driven to the disposal cell siding, and unloaded. Trains would then return to the Moab site siding for another load. They would be loaded by dumping material into the top by means of a conveyer and hopper system and unloaded at the disposal site by a rotary dump mechanism that would disconnect each car from the train and rotate it (flip it) to dump the material (Section 2.2.5 describes the process of unloading railcars in more detail). All loaded cars would be covered or treated with surfactants to suppress dust. Loaded cars would be decontaminated at the loadout station (Figure 2–21) before leaving Moab, and empty cars would be decontaminated before leaving the disposal site area.

DOE estimates that 35,000 yd^3 of debris from the Moab site would not be able to be transported by rail because of limitations on the size and shape of material that could be handled by the rail access conveyor (Figure 2–21). This material would be loaded onto highway trucks and hauled to the disposal cell in the same manner as tailings in the truck transportation option. Debris haulage would be spread out over the life of the project to minimize impacts.

Summary Tabulation of Rail Transportation Logistics

Table 2–10 summarizes logistics information for rail transportation from the Moab site to the proposed Klondike Flats and Crescent Junction sites and the estimated debris production for truck shipment.

DOT Requirements

General requirements for manifests, placards, emergency planning, railcar covers, and inspections would be similar to requirements for transport by truck. Other DOT requirements specific to rail transportation would be identified in the transportation plan.

Moab Site Rail Infrastructure Construction, Operations, and Reclamation

Rail Siding

The new 2,000-ft railroad siding would commence directly north of the tunnel entrance at an existing switch point where a new switch would be added. It would require new tracks but no new earthwork. Figure 2–21 shows the Moab site and infrastructure that would be constructed to support train haulage. At the completion of the rail haul, the railroad siding would be removed and all parts recycled. The switches on the main rail line would also be removed and replaced with straight track. As seen in Figure 2–21, all proposed new rail transportation infrastructure would be located within the Moab site boundary and therefore would not constitute additional land disturbance beyond the 439-acre site area assumed to be disturbed during surface remediation.

Conveyor System Construction

The conveyor system would consist of a truck dump bin with a belt feeder at the Moab site that would feed the tailings onto a stacking conveyor belt. As described in Section 2.2.1.2, tailings would be hauled to the conveyor truck dump bin after drying. The conveyor would be used to create a storage pile over belt feeders that would feed onto a conveyor belt. The conveyor belt would exit the millsite, cross SR-279, and continue up the hillside to the railroad siding. The conveyor belt would be vertically aligned to allow clearance over the highway for traffic and not interfere with the existing overhead electric power lines. The conveyor would feed directly into the top of the loadout hopper, which when full would load the railcars by gravity from bottom gates in the hopper. The conveyor system would be totally enclosed to minimize any dust emissions and to capture any spills should they occur. The existing dirt access road that starts at SR-279 and goes to the railroad siding would be upgraded with an all-weather surfacing to allow worker access. Once completed, the conveyor system would be operated by train loadout operators and maintenance mechanics. Figure 2–21 presents the location of the conveyor system, access road, and conveyor profile.

At the completion of the rail haul, the conveyor system would be removed. The conveyor belts, belt racks, feeders, and other components in direct contact with tailings would be treated as contaminated material and disposed of at the disposal cell. Other components such as belt housings and structural steel supports would be reclaimed and salvaged as appropriate. Concrete foundations off the millsite would be demolished and disposed of at the local solid waste landfill, if uncontaminated. Concrete foundations on the millsite would be demolished and disposed of at the disposal cell, as would any contaminated rubble found off the millsite. The access roadway from SR-279 to the rail loadout station would be left in place to be used by railroad personnel for future track and tunnel inspections.

Klondike Flats Site Rail Infrastructure Construction and Reclamation

Figure 2–22 shows a conceptual plan for one possible site configuration for the infrastructure that would be constructed to support rail transportation at the Klondike Flats site. Alternate access and egress sites are possible and may be evaluated as part of the final design if this alternative were selected.

Conceptually, a new rail spur from the Cane Creek Branch railroad line would be constructed south of the Blue Hills Road turnoff. This spur would run west parallel to the south side of Blue Hills Road for approximately 1 mile, cross to the north side of the road west of the airport, and continue west parallel to the north side of Blue Hills Road for approximately another mile to a new train/truck transfer station. The spur would extend an additional 2,000 ft to allow for car stacking and would have a 2,000-ft-long rail siding constructed parallel to the rail spur at the end to allow train changeouts during operation. Support facilities for the train, such as a locomotive inspection pit, would be constructed to provide minor preventive maintenance during operations. At the transfer station would be the rotary dump, which decouples each railcar and inverts the car into a dump station for subsequent loading into trucks for final hauling and dumping into the disposal cell.

Figure 2–23 illustrates an operational rotary dump facility similar to the one proposed. The exact configuration of the rail spur and train/truck transfer station would depend on where the disposal cell was located within the Klondike Flats site.

A total of approximately 3 miles of new railroad track spur and siding would be constructed. A new switch would be placed on the Cane Creek Branch railroad line to access the spur. The new alignment would be graded, and culverts would be placed along existing washes. The track would have an at-grade crossing at Blue Hills Road. A haul road would be constructed from the rotary dump to the disposal cell. Infrastructure construction would also include the upgrade of Blue Hills Road to be used for site access. This would consist of regrading the road and making it an all-weather road by placing additional road base and a dust surfactant.

At the completion of the rail haul, the railroad switch, spur, siding, and at-grade crossing would be removed. All rail components would be salvaged. The Blue Hills Road upgrade would remain for future cell access and public access.

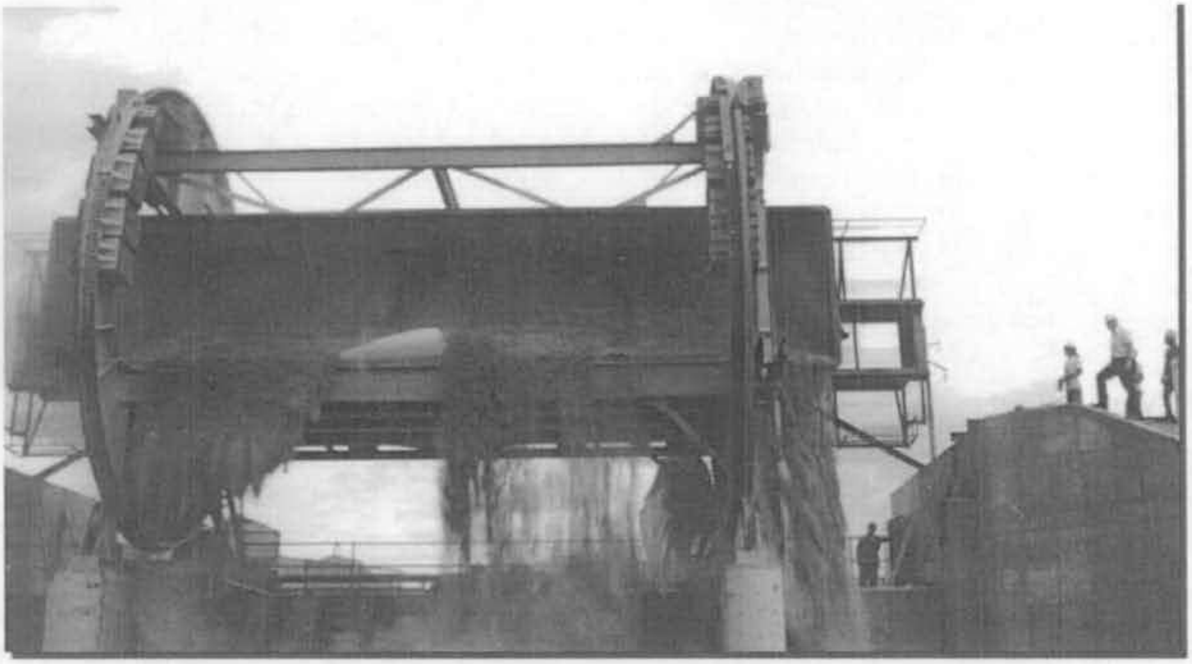


Figure 2–23. Operational Rotary Dump Facility

Crescent Junction Rail Infrastructure Construction and Reclamation

Figure 2–24 shows a conceptual plan for one possible site configuration for the infrastructure that would be constructed to support rail transportation at the Crescent Junction site. The trains would use the Cane Creek Branch railroad line from the Moab site to Crescent Junction and then use a short stretch of the Union Pacific rail line that runs from Ogden, Utah, to Grand Junction, Colorado. The trains would then proceed east along the Ogden/Grand Junction route for approximately 1 mile, where a new track switch to a siding to the north would be constructed. The siding would be approximately 1 mile long and would end at the train/truck transfer station. The support facilities would be the same as those described for Klondike Flats. Alternate access and egress sites are possible and may be evaluated as part of the final design if this alternative were selected.

A total of approximately 2.5 miles of new railroad track spur and siding would be constructed to access the disposal cell area. A new switch would be placed on the main rail line to access the spur. The new alignment would be graded, and culverts would be placed in existing washes.

Infrastructure construction would also include constructing an access road from existing CR-175 approximately 1,000 ft east of Crescent Junction. At this point, a new access road would be constructed north on the same alignment as the current CR-223 for approximately 1,500 ft, and a new at-grade railroad crossing would be constructed. The new access road would leave the county road alignment and continue north, paralleling the new rail spur to the transfer station. The entire access road would be gravel. At the completion of the rail haul, the railroad switch, spur, and siding would be removed. All rail components would be salvaged. The access road would remain in place to provide access to the cell.

2.2.4.3 Slurry Pipeline Transportation

The slurry pipeline transportation mode would require the construction of a buried pipeline from the Moab site to one of the three alternative off-site disposal locations. If this option were implemented, tailings would be mixed with water (repulped) at the Moab site to form a semiliquid slurry that would be pumped through the pipeline to the disposal site.

Slurry Pipelines

Slurry pipelines have been used for over 100 years in mining operations to transport both mineral concentrates (ores) and tailings, including coal, copper, iron, phosphates, limestone, lead, zinc, nickel, bauxite, and oil sands. Commercial long-distance transportation of slurries in buried pipelines began in 1967 when the 43-mile Savage River pipeline in Tasmania began transporting iron ore concentrate. It is still operational. Since then, numerous slurry pipelines, ranging in length from a few miles to the 246-mile SAMARCO Pipeline in Brazil, have been constructed in many countries. Most of them are still operating.

At the disposal site, the slurry would be dried by means of a vacuum filtration system, and the dried residue, or filter cake, would be placed in the disposal cell. The recovered water, or filtrate, would be clarified and returned through a second pipeline to the slurry preparation area at the Moab site for reuse. Pipeline Systems, Inc., conducted a conceptual study of a slurry pipeline transportation system for the Moab site. The study (PSI 2003) is incorporated into the EIS by reference and is the primary source document for the following synopsis of the slurry pipeline option.

In general, the slurry pipeline systems for the three alternative disposal sites would be very similar except for their lengths and routes, and for one booster pump facility (shown on Figure 2–15 and in Appendix C, Map 8) that would be required for the White Mesa Mill slurry pipeline because of its length. Also, the proposed slurry transport facility at the White Mesa Mill site would require the addition of a substation transformer at the Utah Power Blanding substation and a distribution circuit upgrade from the substation to the White Mesa Mill site, if the mill is also processing uranium ore in the conventional mill circuit. The proposed intermediate slurry pump booster station would require the addition of a substation transformer at the Utah Power La Sal substation and a new approximately 3-mile power line extension to the proposed site for the pump station. A distribution circuit upgrade of the existing line from the substation to its current ending point would also be required. The slurry pipeline systems would be constructed in accordance with American National Standards Institute (ANSI) standard B31.11, *Slurry Transportation Piping Systems* (ANSI/ASME 1989), which applies to the design, construction, inspection, quality control, and security requirements of slurry piping systems, and with other applicable codes.

Pipeline Corridors

Wherever possible, the three proposed corridors would follow existing gas or oil pipeline rights-of-way or road rights-of-way. For each of the three corridors, the slurry pipeline and return water pipeline would be buried in the same trench. Figure 2–15 illustrates the three proposed pipeline corridors, and the following subsections provide detailed descriptions of them. Figure 2–25, Figure 2–26, and Figure 2–27 illustrate the details of the pipelines' final approach to the three alternate disposal cell areas. Figure 2–28 illustrates the approximate locations of the proposed slurry pipeline facilities at the Moab site.

Moab to Klondike Flats Corridor

The slurry pipeline would leave the site south of US-191. The line would parallel the highway south of Moab Wash and cross under the highway 200 ft west of the wash. From that point near the old Arches National Park entrance, it would be buried under the old state highway. The route diverges from the existing US-191 alignment about 1.5 miles north of the existing Arches National Park entrance, then reconverges with US-191 approximately 1 mile south of the SR-313 turnoff. The route north from there could parallel either the existing highway right-of-way or the Williams Gas Pipeline, which is parallel to the highway. This corridor would need to cross under US-191 twice (by boring) and under Courthouse and Moab Washes and also cross one other unnamed wash by either boring or trenching. The route is characterized by rocky areas and sandy/clay sections. The length of the pipeline route for this option would be approximately 18.8 miles. See Maps 3 and 4 of Appendix C for more detailed route information.

Moab to Crescent Junction Corridor

The corridor to Crescent Junction would be the same as the corridor to Klondike Flats until that corridor deviates from the US-191 corridor and heads west towards the disposal site at Klondike Flats. The Crescent Junction corridor would continue north, paralleling the highway and the existing Williams Pipeline corridor. Approximately 4.5 miles south of I-70, the pipeline would parallel the Williams Pipeline, which heads northeast along the county road that is also a cutoff to the town of Thompson. After 4.2 miles, the pipeline would parallel a new pipeline segment that will be installed heading north to the new Williams Pipeline Corporation proposed loadout facility located north of I-70, east of Crescent Junction. In addition to the crossings cited above for the Klondike Flats corridor, the Crescent Junction corridor would also have to be bored under I-70 and under the Union Pacific Railroad. The length of the corridor from Moab to Crescent Junction would be approximately 33.7 miles. See Maps 1 through 4 of Appendix C for more detailed route information.

Moab to White Mesa Mill Corridor

Three operating gas pipelines currently exist along the proposed Moab to White Mesa Mill corridor: Northwest Pipeline (25-inch diameter), Rocky Mountain Pipeline (10-inch diameter) and Mid-American Pipeline (16-inch diameter). The White Mesa Mill corridor would leave the Moab site and run east for about 350 ft, then cross under the Colorado River. A directionally drilled, cased bore is proposed for passing under the river because it offers the highest degree of protection against pipeline damage or leaking. The existing gas pipelines were installed using this technique to avoid affecting the river, local wildlife habitat, and the residential areas of Moab. After crossing the river, the corridor would follow the existing gas pipeline right-of-way, passing around Moab along the base of the cliffs to the southwest of town. The topography along the route southwest of Moab is undulating. Soil and vegetation are sandy loam and sagebrush. After passing around Moab, the corridor would continue following the gas pipeline right-of-way along the west side of US-191.

Approximately 15 miles from the mainline pump station (PS1), which would be located on the Moab site, the corridor would depart from the US-191 right-of-way and head southwest cross-country to avoid steep canyons in the rolling, rocky terrain. This section of the corridor is characterized by weathered sandstones, rocky sandy loam, and sagebrush. The corridor would run cross-country along an oil pipeline right-of-way. This rocky section is approximately

15 miles long. At approximately 30 miles from PS1, the corridor would cross US-191 near Lopez Arch to the east side of the highway. At this location, the terrain changes from rocky rolling hills to relatively flat sandy loam and sagebrush terrain. The proposed booster pump station (PS2) would be located approximately 31.5 miles from PS1.

The corridor would depart from the gas pipeline right-of-way south of PS2 (see Map 8 in Appendix C) and proceed along the east side of US-191 (parallel to the gas pipelines). South of PS2, the terrain is generally flat with average slopes less than 2 percent up to the high point of the corridor, which is approximately 51 miles from the Moab site at an elevation of 6,970 ft above sea level. After reaching this high point, the corridor would proceed east off US-191 for 2 miles to join an existing gas pipeline right-of-way and would pass 2 miles east of the Monticello downtown area, approximately at pipeline milepost 58. From Monticello, the corridor would follow the Blanding gas pipeline right-of-way, a cross-country pipeline route that runs parallel to US-191. The Blanding gas pipeline route joins the US-191 right-of-way at Recapture Dam. The corridor would have to cross Recapture Creek just downstream of the dam and proceed parallel to US-191. The pipeline would diverge from the highway right-of-way just north of Blanding and head south, passing about 1 mile east of the center of Blanding. It would continue south along local unpaved roads or cross-country. The terrain in this area is flat with sandy loam soil, sagebrush, and farmland. Approximately 3 miles south of Blanding, the corridor would turn west and cross US-191 near the Blanding wastewater treatment plant and continue another 3 miles along the west side of US-191 to the White Mesa Mill terminal station. The length for this corridor would be approximately 88.7 miles, of which 60 miles, or about two-thirds, would be on existing gas pipeline rights-of-way; the remainder would use a combination of public and private road that does not currently contain pipeline right-of-way.

Table 2–11 summarizes the general and construction characteristics of the three proposed pipeline corridors.

Table 2–11. Summary of Pipeline Corridor Characteristics

	White Mesa Mill	Klondike Flats	Crescent Junction
General Characteristics	**Length in Miles**		
Total corridor length	88.7	18.8	33.7
Rock: weathered sandstone	20	7.0	26.6
Soil: sandy loam/clay and sagebrush	66.7	11.8	7.0
Crossings (roads and streams)	1	0.10	0.15
Special Construction Characteristics	**Length in Feet**		
Directional drilled crossings	3,500	300	300
Road bores (highway)	500	200	400
Aerial crossings	500	0	0
Stream crossings (buried)	900	100	100

System Specifications

Regardless of the corridor that would be selected, the slurry pipeline system would be designed to meet the operational parameters shown in Table 2–12.

Table 2–12. Slurry Pipeline System Parameters

Design Life	4 years
Facility operation hours	24 hours per day 7 days per week 365 days/year
Facility overall availability	90 percent
Dry solids throughput	373 short tons per hour
Pipeline slurry concentration	50 percent by weight
Solids specific gravity	2.78
Slurry pipeline flow rate	2,031 gallons per minute (gpm)
Slurry top size	20 mesh (0.03 inch)
Dried solids (filter cake) moisture	15–20 percent by weight
Recycled water flow rate	1,172 gpm less loss from evaporation and dust control measures.
Makeup water flow rate	409 gpm

System Descriptions, Facilities, and Operations

The slurry pipeline system would comprise four major subsystems or facilities: (1) the slurry preparation plant, (2) the mainline slurry system, (3) the terminal station, and (4) the recycle water system. Each of these would be supported by integrated control and monitoring, safety, telecommunications, and electrical systems.

Slurry Preparation Plant

The slurry preparation plant would be located in the tailings pile area of the Moab site and would be common to all three corridors. The primary function of the plant would be to repulp the tailings, regrind oversized tailings, and deliver the required 20-mesh (0.03-inch) slurry to the mainline pump station (PS1). Figure 2–29 illustrates the slurry preparation plant's process flow.

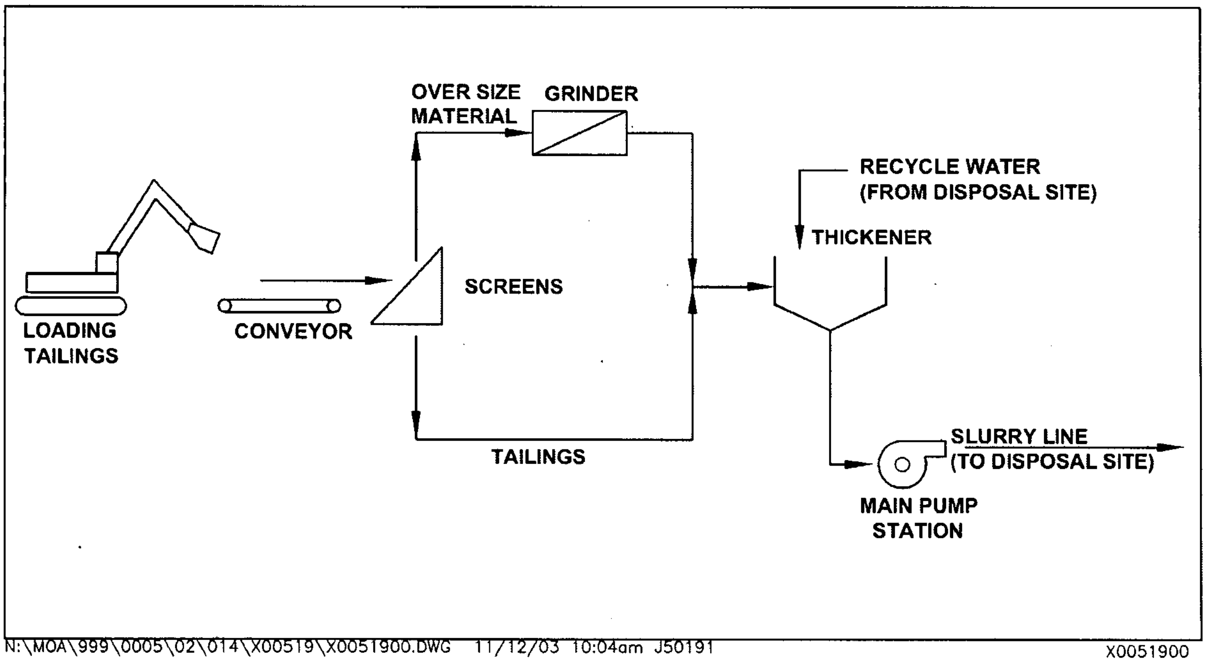


Figure 2–29. Slurry Preparation Plant Process Flow Diagram

Tailings would be excavated as described in Section 2.2.1.2 and delivered to the slurry preparation plant by conveyor, where they would be freed of debris, sized, and amended with water to form a slurry that would be thickened to a 50-percent solids concentration and pumped to the mainline slurry system. Sieved-out material would be milled and reprocessed. Large debris would be removed for truck transport.

Mainline Slurry System

The mainline slurry system would pump the slurry from the Moab site to a terminal at the off-site disposal location. It would comprise (1) a main pump station, which would be common to all three disposal terminal alternatives; (2) a booster pump station, which would be used only if the White Mesa Mill off-site disposal alternative were implemented, (3) a 12-inch-diameter steel pipeline; and (4) one or two pressure monitoring stations. Table 2–13 summarizes the mainline pump operating characteristics.

Table 2–13. Mainline Slurry Pump Characteristics

Slurry Pipeline Corridor	Maximum Mainline Pump Flow Rate (gpm)	Mainline Pump Discharge Pressure (pounds per square inch)	No. of Pump Stations	Total Horsepower
Moab site–White Mesa Mill	2,153	2,800	2	8,276
Moab site–Klondike Flats	2,153	1,200	1	1,773
Moab site–Crescent Junction	2,153	2,000	1	2,956

gpm = gallons per minute

Terminal Station

At the terminal station, the incoming slurry would be dewatered by vacuum filtration. The suction would produce a filter cake with approximately 15- to 20-percent moisture that would be disposed of in the disposal cell. The filtrate (recovered water) would be diverted to a double-lined holding pond or a wet cell, clarified, and pumped back to the slurry preparation plant through the recycle water pipeline. Even if dewatering operations were temporarily down, pipeline operations at White Mesa Mill could continue for weeks (operations at the other sites could continue for several hours) by using the station's wet cell to receive and temporarily store incoming slurry. In the event of a shutdown, the system would be able to be restarted without significant delay. The filter plant process flow diagram is illustrated in Figure 2–30.

Recycle Water System

The recycle water system would return approximately 80 percent of the slurry water to the Moab site for reuse. Due to some losses of water in the slurry preparation plant, filtering plant, and holding pond, approximately 400 gallons per minute (gpm) of additional (makeup) water would be required at the Moab site either from the Colorado River or from the terminal site, if makeup water were available at the terminal site. Makeup water would be available at the White Mesa Mill site, but the Klondike Flats and Crescent Junction sites would both require installation of new wells. Table 2–14 summarizes the mainline recycle pump operating characteristics.

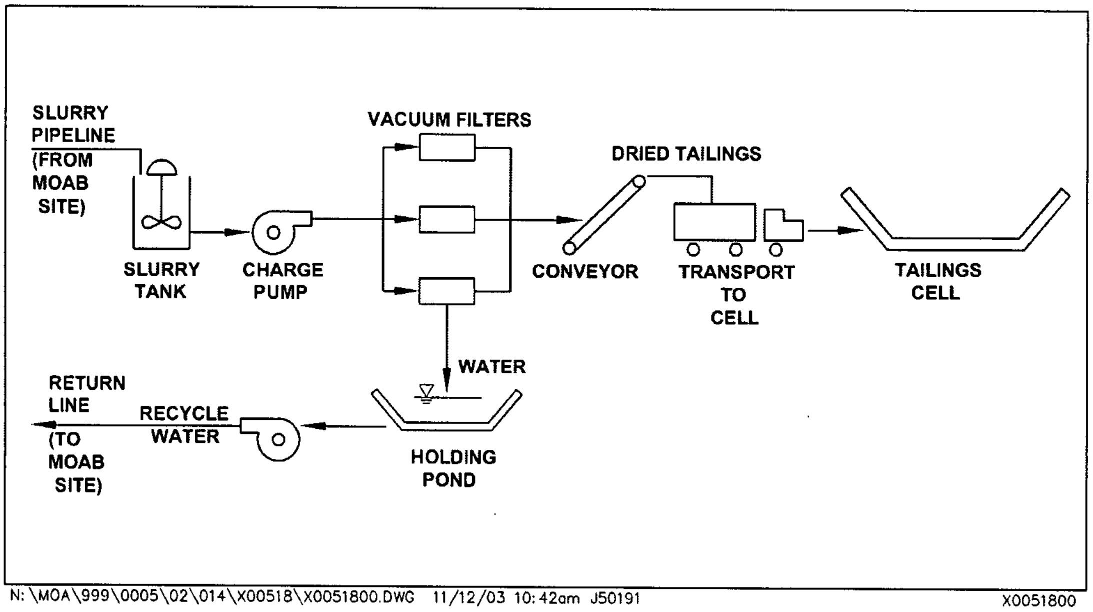


Figure 2–30. Filter Plant Process Flow Diagram

Table 2–14. Mainline Recycle Water Pump System Characteristics

Recycle Water Pipeline Corridor	Flow Rate (gpm)	Discharge Pressure (pounds per square inch)	No. of Pump Stations	Total Horsepower
Moab site–White Mesa Mill	1,172	940	1	918
Moab site–Klondike Flats	1,172	380	1	371
Moab site–Crescent Junction	1,172	640	1	625

Facility Footprints

Table 2–15 gives the estimated square footage requirements for the proposed facilities.

Table 2–15. Facility Land Use Requirements (Footprints)

Facility/Location	Footprint (ft^2)
Moab (common to all site alternatives)	67,000
Booster pump station (White Mesa Mill alternative only)	16,500
Terminal (common to all site alternatives)	40,625

Control/Monitoring and Safety Systems

Control and Monitoring

The slurry pipeline system would be controlled and monitored from a control room at the Moab site, which would be manned constantly. Control room operators/dispatchers would be alerted automatically if abnormal or emergency conditions, such as off-specification slurry, a leak, or a plug in the pipeline, were to occur. System control would be automatic in the steady-state mode. Operator intervention would be required only during process upsets, shutdowns, and restarts. For the White Mesa Mill corridor, isolation valves would be included at both sides of the Colorado River to minimize the possibility of slurry entering the river if a leak were to occur.

Safety

- *Leak Detection and Management*—The pipeline would contain only noncompressible, nonflammable, semiliquid slurry that would not pose an explosion or fire hazard. However, high-pressure slurry could be aggressively abrasive if a leak were to occur. The pipeline would be continuously monitored by a leak detection system. This system would provide operating data for the Supervisory Control and Data Acquisition (SCADA) system via a fiber optic telecommunication system. Flow rate, pressure, and density would be monitored at various points along the pipeline. A pressure monitoring station (two for the White Mesa Mill corridor) with a pressure transmitter powered by a solar panel or other power source would be installed. The objective of the leak detection system would be to detect leaks within 2 to 10 minutes of occurrence (depending on the size and the location of the leak), predict their location, and issue warnings to operators. If there were an indication of a leak, an inspection team would be dispatched. DOE's estimated theoretical spill volume for a pipeline leak is 0.65 to 1.3 yd^3 during the sensing period and 4 yd^3 after the system is shut down. The total spill volume for a leak is expected to be less than 5.2 yd^3 (PSI 2003).
- *Overpressurization Protection*—The pipeline and equipment would be protected from overpressurization by several levels of protection, including proven operating procedures, use of SCADA system software, electrical or hardware interlocks or control loops, and mechanical pressure-relieving devices.
- *Rupture Contingency Plan*—In the unlikely event of a pipeline rupture, installed systems would warn the operator with a prompt to consider activating an emergency shutdown sequence if the data appear valid. A break would result in some slurry loss. Repairs and cleanup, including lining repairs for short sections, could be made in a matter of a few days to 2 weeks.
- *Buried Pipeline*—Although the pipeline could be installed above ground and operated safely, DOE proposes to bury it in order to minimize conflicts with the public and also to prevent punctures from causes such as vehicles and gunshots.

Additional design techniques and safety factors would be applied for all special design points (e.g., thicker steel pipe wall at the river crossing). In areas of potentially severe erosion, design provisions would be based on maximum predicted flood events.

Post-Operational Activities

Post-operational activities would depend on DOE's ultimate decision on the fate of the pipeline. Some commentors have suggested that upon completion of slurry transportation activities the pipeline could be retrofitted for irrigation or other uses. However, any decision on such a future use would be predicated first on a decision that the use would be appropriate and second that a radiological release of the pipeline would be feasible and acceptable. These decisions could not be made until slurry transportation was complete. If DOE decided that other pipeline uses were not appropriate or feasible, upon completion of pipeline slurry operations, DOE would dig up the buried pipelines, compact them, and dispose of them in the disposal cell. The disturbed pipeline right-of-way would then be reclaimed and revegetated.

2.2.5 Construction and Operations at the Off-Site Disposal Locations

This section describes construction and operations at the off-site disposal locations. These activities would be essentially identical for the proposed Klondike Flats and Crescent Junction sites. Consequently, Section 2.2.5.1 describes activities for these two sites in terms of a "reference cell" that applies to both sites. The proposed cell design for the White Mesa Mill site is somewhat different because it is based on IUC's proposed design (IUC 2003). It is discussed separately in Section 2.2.5.2. For the purpose of describing these activities, the following sections address five main elements: (1) site preparation, infrastructure development, and control, (2) disposal cell construction, (3) tailings placement operations, (4) disposal cell cover construction, and (5) site reclamation.

2.2.5.1 Reference Disposal Cell

Figure 2–16 is a reference disposal cell site plan illustrating the major site features and approximate locations of temporary areas and facilities that would be used under the truck or slurry pipeline transportation alternative. Under the rail transportation alternative, the decontamination facility, worker access control, parking, fuel storage, and some stockpile areas would be located next to the train transfer point rather than adjacent to the disposal cell.

Site Preparation, Infrastructure Development, and Controls

Access Roads

The disposal cell would require new roads throughout the site to control the flow of traffic, allow access to material deliveries, and allow access to and from the contaminated haul road. DOE estimates that approximately 3,500 ft of contaminated and clean access roads combined would be required. New access roads would be 30 ft wide with a compacted gravel surface. Gravel road would be treated with dust control surfactant to reduce the need for water-consuming dust control measures.

Storm Water Control and Management

There are no major drainage channels currently entering any of the three alternative sites. Storm water management controls would be regulated under the Utah Pollutant Discharge Elimination System General Permit for storm water discharges from construction activities. Normal storm water control requirements generally are designed to control a reference storm event of a 25-year magnitude. Runoff ponds and ditches would be constructed at the transportation transfer station and the disposal cell to divert storm water away from facilities and operational areas. Hay bales and silt fences would be constructed to control sediment transport.

Radiological Controls

Radiological controls and decontamination procedures at the disposal cell would be functionally and operationally similar to those described in Section 2.1.1.1 and 2.2.1.1. One central access control location would be designated at either the disposal cell area entrance or the train/truck transfer station entrance for site radiological control as shown in Figure 2–16 (truck or pipeline transportation) and Figure 2–31 (rail transportation).

For the truck haul and slurry pipeline transportation alternatives, the contamination area boundary would encompass the disposal cell area and supporting construction facilities but would exclude the office trailer and parking lot areas. For the rail haul transportation alternative, the contamination area boundary would encompass the train/truck transfer station, the contaminated haul road from the transfer station to the disposal cell, and the disposal cell area but would exclude the office trailer and parking lot areas at the transfer station. Contamination control fencing would separate contaminated and uncontaminated areas at the transfer station and delineate the cell perimeter and both sides of the 2-mile haul road.

Water Storage Towers

Water storage towers would be placed at the disposal site and used to store water for nonpotable use such as soil compaction and dust control. Water from the Colorado River (allocated under existing water rights held by DOE, which authorize 3 cfs consumptive use) would be taken from the Moab site water storage ponds, loaded onto tanker trucks, and transported to the off-site disposal location, where it would be transferred into off-site storage towers (or possibly ponds).

Temporary Field Offices

The temporary field offices would be similar to those described in Sections 2.1.1.1 and 2.2.1.1 except that estimated discharge to the sanitary holding tank would be approximately 4,000 gallons per day. Potable water supply to the site would be locally supplied and delivered in portable, trailer-mounted water storage tanks and plumbed into the office units where appropriate. The offices would be located as illustrated in Figure 2–16 (truck or pipeline transportation) or Figure 2–31 (rail transportation).

Staging and Vehicle Maintenance Area

A staging area and a vehicle maintenance area would be constructed for storage of incidental construction materials and equipment and for on-site vehicle maintenance. Construction materials and equipment would require approximately 1 acre of open field for storage and would not require physical structures. The maintenance area would include construction of a portable structure (pole and canvas, 30 by 100 ft, dirt floor) to fully enclose excavation equipment requiring major equipment maintenance.

Fuel Storage and Refueling Area

Fuel would be supplied by local vendors and stored on the site. A central delivery point would be used to transfer the fuel to on-site 20,000-gallon fuel storage tanks. Multiple tanks would be located at both the Moab site and the off-site disposal location to accommodate fuel consumption requirements. Tank volumes would be sufficient to provide 1 week of demand. Refueling would require construction of a spill containment structure to safeguard the environment in the event of a spill. Vehicles and equipment would refuel as needed without exiting the contamination area under strict refueling plan guidelines. The areas would be located as illustrated in Figure 2–16 (truck or pipeline transportation) or Figure 2–31 (rail transportation).

Train/Truck Transfer Facility

For the rail transportation option only, a temporary train/truck transfer facility would be constructed to transfer tailings from the railcars to haul trucks. Figure 2–31 presents the overall plan for this transfer facility. It would consist of the rail spur and two sidings to allow train switchouts, a rotary bin to rotate and dump the railcars, a railcar decontamination station, a locomotive inspection pit, and a train fueling station. This area would also include support facilities for off-road haul truck maintenance and fueling and other site support facilities previously described, including field offices, equipment decontamination facilities, employee parking lots, and personnel radiological access control module.

Railcar Unloading and Decontamination

Gondola railcars delivering tailings to the train/truck transfer station would be guided into an open structure containing the rotary dump facility. The facility would consist of the rotary dump mechanism and a concrete bin directly below it to receive the dumped material. The train would approach the facility, and a car would be positioned in the center of the rotary dump. The railcar would be disconnected from the rest of the train. The rotary mechanism would connect to the car and then rotate it approximately 135 degrees to empty the car contents into the lower-level concrete bin (see Figure 2–23). The tailings would then be picked up by front-end loaders and loaded into haul trucks.

After dumping, the rotary mechanism would set the railcar upright, and the railcar would be reattached to the train. The train would pull the car forward into the decontamination area. Another full railcar would be positioned in the rotary dump, and the dumping process would be repeated. While the next car was unloaded, the previously unloaded car would be decontaminated. Its exterior would be decontaminated using high-pressure water hoses to remove visible contamination. Decontamination water would be captured below the decontamination pad in a process similar to that at the truck/equipment decontamination facility. It would flow through piping to a double-lined decontamination pond for reuse. Although most of the water would be recycled, some would be lost through evaporation. All decontamination wastewater remaining at the end of operations would be used for either moisture conditioning and compaction of cell materials or for dust control inside the cell construction area and would not be discharged to the ground water or surface water system. After decontamination, the railcar would be inspected, decontaminated again if necessary, and released. This process would be repeated for all cars until the entire train was emptied and decontaminated. It would then return to the Moab site for reloading. The unloading facility would include a rail siding adjacent to the track used for unloading. The additional siding would be used to stack a waiting train and for switching out trains to avoid track conflict.

Contaminated Haul Road to Disposal Cell

The rail transportation option would also require construction of a 30-ft-wide gravel-surfaced haul road from the transfer station to the disposal site; the length of the haul road would depend on the exact location of the disposal cell. The Crescent Junction haul road could be 1,000 to 8,000 ft long, and the Klondike Flats haul road could be 6,000 to 12,000 ft long. Haul trucks would deliver the tailings to the disposal cell. Stripping operations would remove and stockpile approximately 400 yd^3 of topsoil material strategically along the roadway alignment. The alignment would be finish-graded and would receive a 12-inch layer of compacted roadbase. Dust control surfactants would be applied.

Disposal Cell Construction

Topsoil Stripping and Stockpiling

The reference disposal cell footprint is a 3,340- by 1,670-ft rectangle on a relatively flat surface. Stripping operations would remove approximately 12 inches of topsoil from the cell footprint, haul road, stockpile areas, runoff collection pond, and runoff ditches; the estimated volume of stripped topsoil would be 234,000 yd^3. The stripped topsoil would be stockpiled for subsequent use in the final cover. Concurrently with topsoil stripping, runoff ponds and ditches would be constructed and water trucks would provide dust control as needed.

Excavation

The total volume of excavation would be approximately 3.5 million yd^3. Cell excavation would proceed sequentially in four relatively equal "subcell" areas. The cell would be excavated to a nominal depth of approximately 18 ft below grade, although the as-built dimensions could vary when the final location was chosen and actual site grade conditions were evaluated. The final cell configurations would also extend 29 ft above grade. The below-grade walls of the cell would slope inward at a 2H:1V slope. Excavated material would be hauled, dumped, and spread around the perimeter of the subcell to accommodate construction of the buttress as the excavation progressed. As material was delivered to the buttress area, soil compaction equipment would compact the buttress material.

Upon completion of subcell 1, excavation of subcell 2 would begin (Figure 2–32). A separation berm between subcells would serve as a haul route into the cell for the tailings filling operations. The excavation process would proceed in a similar manner until subcell 4 was complete. Additional cell volume above the estimated required size could be necessary to accommodate volumes of tailings that were underestimated or unaccounted for. Throughout excavation operations, a survey crew would maintain grade control, soil testing technicians would provide testing information for compaction and moisture control, and water trucks would provide dust control and soil moisture control support.

Subgrade Preparation

When excavation operations for subcell 1 were complete, subgrade preparations (that is, preparing the base of the cell to receive tailings) would commence. On the basis of past knowledge and the known geologic characteristics of the disposal site areas, DOE assumes that the subgrade materials would meet permeability requirements (see Appendix B) and that low-permeability additions to the existing soils would not be necessary. However, if testing were to prove otherwise, mitigating measures such as addition of bentonite to the subgrade soils would be employed. The subgrade surface preparation would consist of scarifying to a depth of 12 inches, moisture-conditioning to optimum moisture content (i.e., to achieve optimum compaction), processing the moisture and bentonite into the soil, and compacting the surface to its maximum density. Once subgrade grading and compaction requirements for subcell 1 were satisfactorily met, tailings placement would begin in subcell 1, and the subgrade preparation crew would move to subcell 2 to repeat the subgrade preparation operation. This sequence is illustrated in Figure 2–32.

Water from rainfall or construction activities in the individual cells would be collected in a lined sump to minimize seepage and conveyed from the cell for use in moisture conditioning or dust control. The lined sump would be removed before cell closure.

Tailings Placement and Compaction

Haul trucks would arrive at the disposal site by (1) direct haul from the Moab site, or (2) haul from the train/transfer station, or (3) haul from the slurry pipeline dewatering facility. The trucks would dump the tailings, dozers would spread the tailings to the precompaction thickness of 12 inches, and compaction equipment would compact them.

Optimum moisture content refers to the amount of moisture in the tailings that would allow the maximum control over compaction (e.g., sufficient moisture to lubricate the mineral grains). DOE assumes that the moisture content of the tailings arriving in the cell would be at or near its optimum for disposal in the cell, and that little, if any, processing would be required. However, in the event wetting or drying were needed, water trucks and tractors with disc harrow attachments would be employed to achieve the requisite moisture level.

Tailings would be loaded to an average above-grade depth of approximately 30 ft (Figure 2–33). When the loading of subcell 1 was complete, cover construction operations could commence. The tailings placement process would proceed sequentially until subcell 4 was complete to final grades.

Disposal Cell Cover Construction

The technical basis, as well as the basic types and thicknesses of cover construction materials for the reference off-site cover, would be similar to those previously described for the cover proposed for the Moab site under the on-site disposal alternative in Sections 2.1.1.3 and 2.1.3.1, and in Appendix B. However, the reference cell cover would be larger in overall area because of the configurational differences of the off-site cell and the Moab site tailings pile and because, in contrast to the Moab site cover, the off-site cover would overlie the buttress as well as the emplaced tailings. Also, only the vegetated erosion protection (riprap mixed with soil) would extend over the clean-fill buttress.

Borrow materials and excavated soil for constructing the buttress and cover would be delivered or stockpiled on the disposal cell site during the cell excavation and tailings placement operations. Cover construction would commence in subcell 1 of the disposal cell after tailings placement was complete and placement operations had moved into subcell 2. The final cover footprint would require an additional surface area of 63 acres of disturbance outside the disposal cell footprint. The total depth of the finished cover over the tailings would be 6 ft, and the total height of the completed cell would be up to 35 ft above grade. Figure 2–34 illustrates the reference cell cover and cover layer surface dimensions. The following subsections describe the amounts and placement of cover materials (see Figure 2–35).

Radon/Infiltration Barrier

Approximately 294,000 yd^3 of radon/infiltration barrier material stockpiled on the site would be transported to the cell area and emplaced on the tailings in three loose lifts, or stages, that would be sequentially compacted to a final required 1.5-ft thickness and reference density. The final placement would be graded to finish-grading specifications. If necessary, water would be added to achieve optimum moisture content for compacting.

Coarse-Sand/Fine-Gravel Capillary Break

The capillary break layer would be approximately 215,750 yd^3 of a selected blend of coarse sands and fine gravels. The material would be transported from the stockpile area to the cover placement area and dumped. It would then be spread and compacted to a depth of 6 inches. The material would be compacted in its natural moisture state and would have no moisture content or density requirements.

Fine-Grained (Water Storage) Soil Layer

The fine-grained soil layer would be approximately 1.1 million yd^3 of a borrow material that would be imported and stockpiled on site. The material would be spread to a loose depth of 3.5 ft. It would have no moisture content or maximum density placement requirements.

Soil/Rock Admixture Layer

The soil/rock admixture layer would consist of approximately 154,000 yd^3 of borrow material, of which 20 percent would be riprap no greater that 12 inches in diameter. It would be spread to a final loose depth of 6 inches and would have no moisture content or maximum density placement requirements. Once satisfactory depths and mixture ratio were achieved, a tractor and disc harrow would blend the two soil types.

Side Slope Riprap/Soil-Filled Voids Layer

The riprap/soil-filled voids layer would consist of approximately 43,000 yd^3 of borrow material, of which 20 percent would be riprap no greater that 12 inches in diameter. The riprap would be placed to a final depth of 12 inches and would have no moisture content or maximum density placement requirements. Once satisfactory depths were achieved, soil would be placed over the riprap to fill voids. A tractor and chain/blanket mat would pass over the soil to work the material into the voids. Areas that received a surplus of soil would require hand raking to achieve uniform placement.

Site Reclamation

Before the last portion of the cover was emplaced, removal of contaminated facilities and contaminated areas of temporary construction facilities would begin. Noncontaminated temporary facilities such as office trailers, access roads, and employee parking lots would remain until the end of cell cover placement.

All disturbed areas within the contaminated site boundary would be verified to meet cleanup standards prior to cell closure and backfill. Any contaminated material would be excavated and placed in the disposal cell. Areas of surface disturbance caused by construction activities outside the disposal cell final footprint and permanent drainage ditches, such as areas that supported construction of haul and access roads, construction facilities, construction materials, and cover material stockpiles, would be rough-graded and backfilled with the remaining topsoil stockpiled from stripping operations. The topsoil would be excavated from the stockpile area, transported to these areas, dumped, and graded in preparation for final reclamation. Impermeable membrane liners used in decontamination ponds, storm water control ponds, and slurry operations would be removed and disposed of in the disposal cell. The ponds would be backfilled to original grades prior to final reclamation.

All remaining structures and facilities used for cell construction and loading, including buildings, trailers, fuel storage areas, concrete slabs, water towers, and all elements of the transportation infrastructures, would be disassembled and either disposed of in the cell, salvaged, or properly disposed of in accordance with applicable federal, state, and local requirements.

The disposal cell site would be completely fenced with standard 6-ft-high chain-link security fencing with a three-strand barbed wire top and gated at the access road. The proposed fence area is illustrated in Figure 2–34. Final reclamation activities would be implemented at the cell disposal area and transportation facility area and would consist of seeding with native or adapted plant species.

2.2.5.2 White Mesa Mill Disposal Cell

The design and specifications proposed for the White Mesa Mill site are somewhat different from those proposed for the Klondike Flats and Crescent Junction sites because they are based on an unsolicited proposal submitted to DOE by IUC (IUC 2003). This cover approach reflects an alternative design that is more typical of UMTRCA Title II uranium mill tailings reclamation and is similar to that proposed in NRC's 1999 EIS (NRC 1999). A brief description of the White Mesa Mill cover design is included in Appendix B. DOE has reviewed the design and has determined it to be reasonable at the conceptual level. This section describes the activities that would occur if the IUC proposal were implemented. The conceptual design is strictly intended to establish a reasonable basis for evaluating environmental impacts associated with this component of site remediation and reclamation. This assumed design is not intended to commit DOE to any specific cover design.

IUC proposes to dispose of contaminated materials from the Moab site and vicinity properties at its White Mesa Mill site, assuming it received a license amendment from the State of Utah for its current operations there. Although the facility has an NRC-issued license to receive, process, and permanently dispose of uranium-bearing material, it would need a license amendment from the State of Utah before it could accept material from the Moab site. (Effective August 16, 2004, NRC transferred to Utah the responsibility for licensing, inspection, enforcement, and rulemaking activities for uranium and thorium milling operations, mill tailings, and other wastes.) If the IUC White Mesa Mill were selected as the final disposal site for the Moab tailings, the proposed changes to IUC disposal capacity and engineering design would require prior UDEQ approval and issuance of a State Construction Permit and possibly a modification of a State Groundwater Quality Discharge Permit. The *Utah Administrative Code* R313-24-4(1)(b) requires the White Mesa Mill site to comply with state requirements for ground water protection. Details regarding appropriate engineering design, construction requirements, operational mandates, monitoring needs, and closure stipulations would be determined by UDEQ at that time. Disposal of the Moab tailings at White Mesa Mill would be performed under a reclamation plan approved by the State of Utah. Because IUC's cells and reclamation plans would be state-approved, DOE assumes that they would meet all applicable state and federal regulations. IUC would be responsible for all material, design, and performance compliance issues concerning disposal operations, cell construction, and cover performance. Tailings placement would be performed under IUC's direction by either IUC personnel or by an outside contractor. IUC would oversee the outside contractor and would be responsible for quality assurance/quality control to ensure that all design and performance specifications were met.

Tailings would be transported approximately 85 miles to the White Mesa Mill site by either truck or slurry as described in Section 2.2.4. Under the slurry transport option, IUC would take ownership of the Moab site tailings at the entrance to the slurry pipeline system. If the tailings were trucked, DOE would retain ownership until they were received at the White Mesa Mill site.

Summary of IUC's White Mesa Mill Disposal Cell Construction and Operations Proposal

Figure 2–36 illustrates the general layout of the IUC's proposed wet and dry cell, and Figure 2–37 is a schematic cross-section. The cell would be approximately 18 ft below grade. Dimensions would depend on the final cell location and configuration, which would be based on actual site grade conditions. The interior cell sideslopes below grade would be constructed at 3H:1V. Excavation operations would remove subgrade materials to the final depth of the cell, which would have a 12-inch compacted clay liner. Excess excavated material would be delivered to the buttress area, where soil compaction equipment would compact it to form the cell buttress. The cell buttress would have 5H:1V exterior slopes. After the starter cell was filled, excavation and tailings placement would proceed sequentially as previously described for the Klondike Flats and Crescent Junction cells. Maximum cell dimensions would be approximately 3,500 by 1,800 ft, creating a disposal cell approximately 145 acres in area. Final cell size would be determined by the final quantity of tailings placed.

If the tailings were delivered by slurry pipeline, they would be processed as described in Section 2.2.4 and placed in a 30-acre "starter" dry cell that would be constructed for initial storage. Fluids not immediately repiped to Moab would be stored in a "wet" cell for later use as makeup water. The wet cell would have a geosynthetic high density polyethylene liner (Figure 2–38).

Truck-transported tailings or dried slurry materials from interim storage would be placed in the cell using conventional earth-moving construction techniques. In the case of truck-transported materials, the highway trucks would dump their loads, and front-end loaders would transfer tailings to off-highway (on-site) trucks for delivery to the dry cell. Deposited tailings would be bladed to a depth of 6 to 9 inches prior to compaction to 90 percent of maximum dry density. A water truck would provide water for dust control or for any moisture necessary for compaction. Dry cell placement would be continuous as excavation and preparation of cell capacity progressed ahead of tailings placement.

A survey crew would maintain grade control throughout the excavation operation. Soil testing technicians would provide information for compaction and moisture control. Water trucks would operate in tandem with the construction operations to provide dust control during excavation operations and soil moisture control for construction of the buttress.

Approximately 35,000 yd^3 of debris are believed to exist in the Moab site. Debris would be transported by truck to White Mesa Mill for placement in the dry cell. Before leaving the site, trucks would be scanned for radioactive contamination and decontaminated at a wash facility operated by the mill. DOE estimates that approximately 2,200 truckloads of debris would be shipped.

Summary of IUC's White Mesa Disposal Cell Cover Proposal

Figure 2–39 illustrates details (materials and thicknesses) of a typical reclamation cover that IUC proposes to construct. This proposed cover differs somewhat from the cover previously described for the reference cell but is typical of other NRC-approved covers for private licenses.

Components of the final top cover from the top down would consist of erosion protection riprap, a frost barrier, a compacted clay radon barrier, and a platform fill layer directly over the tailings. The side slope cover would consist of random fill covered by riprap. On-site borrow is available for all material except the riprap. Quarries located north of Blanding, approximately 8 miles from the White Mesa Mill site, would be used as the riprap source. Placement of these layers would be similar to that previously described for the reference cell. The materials would be stockpiled near the cell, then emplaced and compacted using standard construction equipment and techniques.

2.2.6 Monitoring and Maintenance

After completion of tailings placement and site reclamation, monitoring and maintenance of an off-site disposal cell at any of the three proposed locations would be in accordance with the Long-Term Surveillance and Maintenance Plan approved by NRC. Drainage areas and other areas susceptible to erosion would be inspected and repaired as needed.

Monitoring and maintenance procedures for the reference off-site disposal cell and the White Mesa Mill off-site disposal cell would be similar but not identical. An example of how monitoring and maintenance at the White Mesa Mill disposal cell would differ from the reference cell would be the need to manage storm water and internal infiltration drainage from upslope disposal cells at the White Mesa Mill site. There are no preexisting upslope cells with the reference cell design. Another example would be the need to operate and monitor the liner, drains, and leak detection system that would ostensibly be left in place in cell 4B at the White Mesa Mill site. This type of drainage system would not be used with the reference cell design.

2.2.7 Resource Requirements

This section describe DOE's estimate of the major resource requirements for the off-site disposal alternative.

2.2.7.1 Labor

Table 2–16 through Table 2–18 show the estimated average annual labor requirements. In all cases, the labor category "Site Support" represents construction oversight personnel employed by the Technical Assistance Contractor for DOE.

Off-site disposal would require construction labor to be performed at the Moab site, vicinity properties, borrow areas, and the selected disposal cell site. It would also require transportation-related labor. DOE's estimates of the average annual labor requirements for construction-related activities for the Moab site, vicinity properties, borrow areas, and the selected disposal cell would be the same for all three modes of transportation. In general, single numbers in Table 2–16 through Table 2–18 indicate the labor for a single 12-hour shift working 7 days a week, 350 days a year. A double-shift schedule would require 67 to 100 percent more total work force to accomplish the same work. Where dual numbers are shown in the tables, they indicate the labor required for a single 12-hour shift (lower number) versus a double 10-hour shift schedule.

Table 2–16. Average Annual Labor Requirements—Truck Transportation

Labor Category	**Construction Labor**				**Transportation Labor**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Equipment Operators	25	6	7	28	–	–	–
Site Support	19	4	3	16	9–18	9–18	10–20
Truck Drivers	1	3	2–10	8	34–61	50–87	109–192
General Labor	22	10	10	18	–	–	–
Mechanics	–	–	–	–	3–5	4–7	8–17
Total Average Workforce	**67**	**23**	**22–30**	**70**	**46–84**	**63–112**	**127–229**

Table 2–17. Average Annual Labor Requirements—Rail Transportation

Labor Category	**Construction Labor**				**Transportation Labor**	
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**
Equipment Operators	25	6	7	28	–	–
Site Support	19	4	3	16	–	–
Truck Drivers	1	3	2–10	8	3–6	3–6
General Labor	22	10	10	18	–	–
Conveyor Operators/Crew	–	–	–	–	6–10	6–10
Train Engineer	–	–	–	–	9–14	17–28
Train Maint. Crew	–	–	–	–	1	1
Total Average Workforce	**67**	**23**	**22–30**	**70**	**19–31**	**27–45**

Table 2–18. Average Annual Labor Requirements—Slurry Pipeline Transportation

Labor Category	**Construction Labor**				**Transportation Labor**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Equipment Operators	25	6	7	28	–	–	–
Site Support	19	4	3	16	4	4	4
Truck Drivers	1	3	2–10	8	3–6	3–6	3–6
General Labor	22	10	10	18	–	–	–
System Operators	–	–	–	–	21	21	25
Pipeline Construction	–	–	–		250	330	502
	–	–	–	–	–	–	–
Total Average Workforce	**67**	**23**	**22–30**	**70**	**28–31**[a]	**28–31**[a]	**32–35**[a]

[a] Excludes pipeline construction labor. The duration of pipeline labor would be 9 months for White Mesa Mill, 7 months for Crescent Junction, and 6 months for Klondike Flats, and its labor requirements are not included in annual averages.

2.2.7.2 Equipment

Table 2–19 through Table 2–21 represent average annual equipment requirements for the off-site disposal alternative. Off-site disposal would require construction equipment at the Moab site, vicinity properties, borrow areas, and the selected disposal site. It would also require transportation-related equipment. (For the pipeline option, transportation-related equipment is considered to include pipeline construction equipment.) DOE's estimates of the average annual equipment requirements for construction-related activities for the Moab site, vicinity properties, borrow areas, and the selected disposal cell are the same for all three modes of transportation.

Table 2–21. Average Annual Equipment Requirements—Slurry Pipeline Transportation Mode

Equipment Type	**Construction Equipment**				**Transportation Equipment**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Tractor	2	–	–	1	–	–	–
Backhoe	1	1	1	2			
Grader	1	–	1	2	1	1	2
Trackhoe	1	–	–	1	2	4	10
Front-end loader	2	1	1	2	1	2	4
End dump truck	–	1	–	1	1	2	4
Water truck	1	1	1	2	1	1	1
Crane	1	–	–	–			
21 yd^3 scrapers	3	–	1	6			
Dozer	3	–	1	2	8	7	18
Sheepfoot compactor	1	–	–	2	–	–	–
Pickup truck	4	2	1	4	17	18	27
Welding rig	1	–	–	–			
Skidsteer	–	2	–	1			
16 yd^3 drag line	2	–	–	–	–	–	–
Tandum trucks	–	–	1–7 (per shift)	3	–	–	–
Tandum trucks (debris haul)	–	–	–	–	2–5	2–5	2–5
Flatbed truck	–	–	–	–	1	2	5
Crane	–	–	–	–	1	1	1
Side boom crane	–	–	–	–	2	3	8
Trencher	–	–	–	–	1	1	2
Total	**23**	**8**	**8–14**	**29**	**38–41**	**44–47**	**84–87**

2.2.7.3 Land Disturbance

Table 2–22 summarizes DOE's estimates of the acres of land that would be disturbed under the off-site disposal alternatives. These disturbances include those that would result from remediation of the Moab site and vicinity properties, disposal cell construction at off-site locations, construction of transportation infrastructures, and excavation of borrow material. Estimates of required volumes of borrow material are shown in Table 2–7. The final area of land disturbed at borrow areas would vary depending on the final selection of borrow areas (see Table 2–6) and the depth to which borrow soils could be extracted. The values shown for disturbances to borrow areas in Table 2–22 represent DOE's estimate of the maximum disturbance.

2.2.7.4 Fuel

Table 2–23 summarizes DOE's estimates of the fuel consumption for the three off-site disposal alternatives and modes of transportation.

2.2.7.5 Water

The discussion of potable and nonpotable water uses in Section 2.1.5.5 also applies to the off-site disposal alternative. Table 2–24 shows the estimated nonpotable water consumption for the three transportation modes for all three off-site disposal locations. It is assumed that DOE's Colorado River water rights would supply nonpotable water for the Klondike Flats and Crescent Junction off-site disposal alternatives and part of the White Mesa Mill site needs. The remainder of nonpotable water needed for the White Mesa Mill site would be supplied from water rights to Recapture Reservoir or deep wells at the millsite. Rail and truck transportation options show a range of usage based on one 12-hour shift or two 10-hour shifts. To the extent that Colorado River water use exceeds USF&WS protective limits, DOE would mitigate the unavoidable adverse impact with negotiated water depletion payments.

Table 2–22. Estimated Maximum Acres of Disturbed Land for the Off-Site Disposal Alternatives

Location/Activity	Alternative							
	Klondike Flats			Crescent Junction			White Mesa Mill	
	Truck	Rail	Slurry	Truck	Rail	Slurry	Truck	Slurry
Moab Site	439	439	439	439	439	439	439	439
Vicinity Properties[a]	6	6	6	6	6	6	6	6
Borrow Areas								
Cover soils	400	400	400	400	400	400	0[b]	0[b]
Moab reclamation soils	152	152	152	152	152	152	152	152
Radon barrier soil	138	138	138	138	138	138	12	12
Other	NA	NA	NA	NA	NA	NA	10[c]	10[c]
Pipeline Construction[d]	NA	NA	85	NA	NA	164	NA	430
Disposal Cell Area								
Cell Construction Area[e]	435	420	435	435	420	435	346	346
Overpass/ Haul or Access Roads for Truck Transport	40	NA	24	13	NA	11	2	NA
Rail Infrastructure[f]	NA	69	NA	NA	57	NA	NA	NA
Total	**1,610**	**1,624**	**1,679**	**1,583**	**1,612**	**1,745**	**967**	**1,395**

[a] Assumes average disturbances of 2,500 ft^2 to 98 properties.
[b] Excavated material would be used as cover soil.
[c] Blanding riprap.
[d] Assumes disturbance to a 40-foot right-of-way.
[e] New cell footprint and adjacent construction and support areas.
[f] New rail spurs, truck/train transfer station, and haul road to cell.

Table 2–23. Estimated Annual Fuel Consumption for the Off-Site Disposal Alternatives (thousands of gallons)

Alternative							
Klondike Flats			Crescent Junction			White Mesa Mill	
Truck[a]	Rail[a]	Slurry[b]	Truck[a]	Rail[a]	Slurry[b]	Truck[a]	Slurry[b]
2,336–4,314	2,053–3,232	1,798	2,712–4,873	2,187–3,657	1,798	4,032–6,827	1,469

[a] Two figures indicate annual averages for one 12-hour shift (lower value) and two 10-hour shifts (higher value).
[b] For the slurry pipeline alternative, despite its longer pipeline length, the White Mesa Mill fuel consumption is less than that for Klondike Flats or Crescent Junction because of significantly lower distances for hauling borrow materials at White Mesa Mill. Similarly, Klondike Flats and Crescent Junction consumptions are the same for the slurry pipeline alternative because differences in borrow material haul distances offset the differences in pipeline length for these two alternatives.

Table 2–24. Estimated Annual Nonpotable Water Consumption

Transportation Option	Total Project Water Consumption (acre-feet)	Average Annual Water Consumption (acre-feet)
Rail	635–710	130–235
Truck	700–775	135–240
Slurry Pipeline	3,470	730

Table 2–25 shows the estimated potable water consumption for the three transportation modes for all three off-site disposal location locations. Consumption rates are based on the 12-hour shift and use an average of the labor required for the different transportation options. If the double 10-hour shift were selected, consumption rates would increase by 67 percent but would apply for the shorter construction duration.

Table 2–25. Potable Water Consumption Rates

Transportation Option	Average Daily Water Consumption Rate (gallons)
Rail	7,500
Truck	9,000
Slurry Pipeline	6,600

2.2.7.6 Solid Waste Disposal

Approximately 2,080 yd^3 of solid waste per year would be generated at the combined Moab and Klondike Flats, Crescent Junction, or White Mesa Mill sites for the off-site disposal alternatives. The solid waste from the Moab, Klondike Flats, or Crescent Junction sites would be disposed of in the Grand County landfill. The solid waste from the White Mesa Mill site would be disposed of in tailings cells that currently exist at the site or in the new tailings disposal cell constructed for Moab site contaminated materials.

2.2.7.7 Sanitary Waste Disposal

Table 2–26 shows the estimated maximum weekly sanitary waste generation for the three transportation modes for all three off-site disposal locations. The estimated volumes are based on the 12-hour shift and use an average of the labor required for the different transportation options. If the double 10-hour shift were selected, the volume generated weekly would increase by 67 percent but would apply for the shorter construction duration. Septic holding tanks would be placed at both the Moab site and the off-site disposal location; some portable toilets would be used to provide sanitary waste service. Both the septic tanks and the portable toilets would be pumped out routinely, and the waste would be disposed of at the city of Moab sewage treatment plant for the Klondike Flats or Crescent Junction off-site disposal alternatives or at the city of Blanding sewage treatment plant for the White Mesa Mill off-site disposal alternative. White Mesa Mill also has an on-site State-approved leach field system that has adequately managed sanitary waste generated by up to 140 workers during past operations.

Table 2–26. Sanitary Waste Generated

Disposal Option	Maximum Weekly Generation (gallons)
Rail	15,000
Truck	21,000
Slurry Pipeline	15,400

2.2.7.8 Electric Power

Table 2–27 shows DOE's estimate of the power demands at the Moab site and at the three potential off-site disposal locations for the three transportation modes. In general, the major demands would be:

- Field office trailers.
- Office and parking lot security lighting.
- River pump station (at Moab).
- Decontamination water sprays and recycle pumps.
- Train transfer station (rail transportation).
- Pipeline slurry system (pipeline transportation).

Table 2–27. Estimated Maximum Average Annual Electric Power Demand (kVA) For the Off-Site Disposal Alternative

Transportation Mode	**Location**			
	Moab Site	**Klondike Flats Site**	**Crescent Junction Site**	**White Mesa Mill Site**
Truck	600	300	300	300
Rail	700	600	600	–
Pipeline	–	2,500 (terminal)	2,800 (terminal)	3,100 (terminal)
To Klondike Flats	3,400			4,800 (booster)
To Crescent Junction	4,800			
To White Mesa Mill	6,100			

2.3 Ground Water at the Moab Site

Section 2.3.1 provides background on the ground water standards, contaminants of concern, and the compliance strategy selection process. This includes remediation goals for the ground water, and the relationship with existing interim actions. Section 2.3.2 discusses the proposed ground water remediation, including remediation options and time frames, and the predicted contaminant concentrations as a result of active remediation. It also discusses the predicted outcome of the ground water No Action alternative. Section 2.3.3 discusses ground water remediation uncertainties.

2.3.1 Background

The uppermost aquifer at the Moab site occurs in unconsolidated Quaternary alluvial material deposited on older bedrock units in the basin that forms Moab Valley. Although the quality of this aquifer has been adversely affected by uranium processing activities at the site, it does not represent a potential source of drinking water. However, discharge of contaminated ground water from this aquifer has resulted in elevated concentrations of ammonia and other site-related constituents in the Colorado River. While the contaminants do not pose unacceptable risk to humans, they do exceed levels considered to be protective of aquatic life. Therefore, the objective of the proposed ground water action is to protect the environment, particularly endangered species of fish that are known to use that portion of the river.

Contamination in the ground water at the Moab site is regulated by EPA standards in 40 CFR 192. Moab site remediation must comply with Subpart A standards for ground water protection and Subpart B standards for cleanup of residual ground water contamination. Subpart C provides guidance for implementing methods and procedures to reasonably ensure that standards of Subpart B are met.

DOE's proposed action for ground water cleanup was developed using the framework described in the UMTRA Ground Water Project PEIS (DOE 1996a). This framework uses a stepwise, risk-based approach for selecting a compliance strategy and is based on site-specific characteristics. The following discussion describes the PEIS framework, identifies the overall compliance strategy using this framework, and summarizes the long-term monitoring program. A more detailed description of the PEIS compliance strategy selection process is presented in the *Site Observational Work Plan for the Moab, Utah, Site* (SOWP) (DOE 2003b).

A detailed remedial action plan would be developed following issuance of the ROD and would contain action-specific design information. However, the treatment technologies summarized in this EIS, supported by the results of site characterization studies and ground water flow and transport modeling (DOE 2003b), provide a reasonable range of scope and requirements for ground water actions to meet the requirements of 40 CFR 192. The analyses of these actions in this EIS provide sufficient information for decision-making under NEPA.

2.3.1.1 EPA Ground Water Standards

Ground water remediation actions to meet the EPA standards for inactive uranium-ore processing sites (40 CFR 192) are selected first by determining the appropriate standards for the site, then by identifying a compliance strategy that can meet the standards. Several different ground water standards could apply to the Moab site. These include background concentrations, maximum concentration limits (MCLs) (EPA ground water standards in 40 CFR 192), alternate concentration limits (ACLs), and supplemental standards (see 40 CFR 192 for definitions); applicable standards depend on site-specific cleanup objectives and conditions. Potential strategies for achieving these standards include no remediation, natural flushing with institutional controls, natural flushing with institutional controls in combination with active remediation, and active remediation alone.

At UMTRCA sites, EPA standards must be met in the uppermost aquifer, which is most likely to be affected by uranium-ore processing activities. The uppermost aquifer at the Moab site contains a highly saline (salty) water, often referred to as brine, which can be as thick as 400 ft, overlain with a thin layer of less salty water. Because ground water in the major portion of the uppermost aquifer has a TDS content exceeding 10,000 mg/L, the aquifer meets the definition of a limited-use aquifer as described in EPA's *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy* (EPA 1988).

Ground Water Compliance Strategies

No remediation means that no ground water remediation is necessary because ground water contaminant concentrations meet acceptable standards. No remediation under the PEIS is not the same as "no action" under NEPA, because actions such as site characterization would be necessary to demonstrate that no remediation is warranted.

Natural Flushing means allowing the natural ground water movement and geochemical processes to decrease contaminant concentrations.

Active Remediation means using active ground water remediation methods such as gradient manipulation, ground water extraction and treatment, or in situ ground water treatment, to restore ground water quality to acceptable levels.

Under the requirements of 40 CFR 192 Subpart C, the uppermost aquifer meets the criteria to apply supplemental standards based on limited-use ground water. Supplemental standards are regulatory standards that may be applied when the concentration of certain constituents (in this case, TDS) exceeds the normally applicable standards (e.g., MCLs; see 40 CFR 192, Subpart C for further explanation) for reasons unrelated to site contamination. The use of supplemental standards must be protective of human health and the environment. Therefore, remediation of the uppermost aquifer to meet ground water or drinking water standards is not required because a limited-use aquifer is not likely to be developed as a public drinking water source. Instead, at sites with limited-use ground water, the supplemental standards require management of contamination due to tailings in a manner that ensures protection of human health and the environment from that contamination. This means that if site-related contamination could cause an adverse effect on a drinking water aquifer or on a connected surface water body, management of contamination would be necessary to protect these resources.

Because no drinking water aquifer is affected by site-related contamination, ground water remediation focuses on protecting surface water resources for beneficial use. Risk calculations show that risks to human health would be very low for all probable uses, even using conservative assumptions (see Appendix D of this EIS). However, contaminant concentrations in surface water exceed aquatic criteria for five site-related constituents. Consequently, the compliance strategy focuses on protecting ecological receptors (i.e., endangered fish) and achieving compliance goals (i.e., surface water standards) in the surface water.

2.3.1.2 Contaminants of Potential Concern

Concentrations of some site-related contaminants in ground water at the Moab site are above appropriate standards or benchmarks for protection of aquatic organisms in surface water. A thorough screening of contaminants is provided in Appendix A2. The screening process identified five contaminants of potential concern: ammonia, copper, manganese, sulfate, and uranium. Modeling of the tailings' long-term seepage indicates that seepage rates will decrease 25-fold from the current rate of approximately 20 gpm (Figure 6–3, Table 6–3 of the SOWP [DOE 2003b]) to the predicted long-term flux of 0.8 gpm. This 25-fold decrease in volumetric and contaminant mass flux from the tailings, coupled with the 10-fold average dilution of ground water observed in surface water concentrations (DOE 2005b), is anticipated to result in decreases in contaminant surface water concentrations to levels below aquatic benchmark values and appropriate water quality standards without any geochemical transformations beyond simple dilution. For example, the maximum detected copper concentrations in surface water adjacent to the site range from 5 to 14 mg/L; while the Utah Water Quality Criterion is 12 mg/L. Similarly, maximum detected manganese concentrations in surface water (up to 11.5 mg/L) exceed the aquatic benchmark value for protection of aquatic organisms of approximately 0.01 mg/L in only five locations, and natural manganese background ground water concentrations of 19 to 38 mg/L have been observed. The maximum detected uranium surface water concentration is 5 mg/L, roughly 100 times the aquatic benchmark of 0.04 mg/L, and the maximum detected sulfate surface water concentration is approximately 14,000 mg/L, roughly 28 times the upper limit of background range (439 mg/L). Therefore, the resulting 250-fold decrease in future surface water concentrations predicted from decreased tailings seepage and ground water dilution through mixing with surface water provide a reasonable assurance that long-term concentrations will be protective of aquatic organisms.

However, ammonia is the key constituent driving the proposed ground water remedial action because of its high concentrations in the tailings seepage and ground water and its toxicity to aquatic organisms (EPA 1999). It is assumed that if ammonia target goals could be achieved that are acceptable for protection of aquatic life, concentrations of the other four contaminants of potential concern would also be protective. Even though the geochemical behavior of the other contaminants of potential concern differs from that of ammonia, it is anticipated that concentrations of these constituents would decrease to protective levels in the same time frame that it would take for ammonia to reach protective levels because their concentrations are less elevated above applicable remediation criteria (e.g., surface water standards), the contaminants are less widespread, or they occur at elevated concentrations less frequently. For this reason, ammonia is the focus of the following discussion.

National ambient water quality criteria (AWQC) for the protection of aquatic life have been established for ammonia (EPA 1999). The State of Utah is in the process of adopting these criteria as state surface water quality standards. AWQC have been identified that are protective of both acute and chronic exposures. Acute criteria vary with pH; chronic criteria are both pH- and temperature-dependent. Chronic aquatic criteria represent the low end of the potential concentration range for protection of aquatic species from ammonia toxicity; the majority of chronic values fall in the range of 0.6 to 1.2 mg/L ammonia (total as N) based on site-specific pH conditions (EPA 1999). Acute criteria represent the higher end of the concentration range; the majority of acute values fall within the range of 3 to 6 mg/L. Therefore, it is DOE's position that concentrations of ammonia (total as N) in surface water in the 0.6- to 6-mg/L range would be fully protective of aquatic life.

If ground water quality met surface water standards, then discharge of ground water to the surface should not result in exceedances of those standards unless some other process (e.g., evaporation) increased contaminant concentrations in surface water. However, establishing the low end of the protective range as the ground water target goal is probably not necessary to achieve compliance with surface water standards. Available data regarding interaction of ground water and surface water indicate that concentrations of most constituents decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease is observed on average [DOE 2003b]). In general, more recent data collected by DOE since the SOWP confirm, with a few exceptions, that a 10-

Cleanup Terminology

Ammonia Concentrations—Where concentrations of ammonia are referred to in the text, these are expressed as *total ammonia as nitrogen (N)*. The numbers represent all forms of ammonia (e.g., NH_3, NH_4) converted to reflect only the nitrogen component in them.

Federal Ambient Water Quality Criteria (AWQC) for Ammonia—Numerical concentrations of ammonia (total as N) that are protective of aquatic life in surface water. Chronic exposure concentrations vary with both temperature and pH of the waters. Acute exposure concentrations vary only with pH of the waters. AWQC are only guidelines but can be adopted by states as enforceable standards.

Utah Surface Water Standards—State standards for protection of water quality of surface waters of the state. The standard designates appropriate uses of specific surface water bodies and provides numerical and narrative standards for those designated uses. The State of Utah is in the process of adopting federal AWQC for ammonia as the numerical standards for this constituent.

Remediation Objective—The desired condition that should result when remediation of the site is completed. For the Moab site, the remediation objective would be to meet state surface water quality standards for ammonia (both chronic and acute) in surface water where appropriate. The applicable standard for a given location is dependent on temperature and pH and the presence or absence of a mixing zone, as specified in the state standards.

Target Goal—As used in this document, the target goal for ammonia in ground water is the concentration that DOE has determined would meet the remediation objective in surface water. As explained in the text, meeting a target goal of approximately 3 mg/L ammonia (total as N) in ground water would result in compliance with Utah surface water standards for ammonia in surface water.

fold dilution factor occurs where the ground water plume is discharging adjacent to the river shoreline. In background locations where elevated ammonia from the Paradox Formation is discharging to the surface water, the 10-fold dilution factor may not apply. This more recent calculation set, *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), also provides a more detailed evaluation of the transfer mechanism between ground water and backwater areas.

Consequently, there is a reasonable assurance that protective surface water concentrations could be achieved by meeting less conservative goals than chronic standards in ground water. The target goal of 3 mg/L in ground water (the low end of the reasonable acute range) is anticipated to provide adequate surface water protection. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and would be expected to result in a corresponding decrease in surface water. On the basis of sampling data presented in the SOWP (DOE 2003b), it appears that if a concentration of 3 mg/L ammonia could be achieved everywhere in surface water, approximately 99 percent of the locations sampled in the past would comply with the acute criteria, and given the 10-fold dilution factor, the chronic criteria would also be met outside the mixing zone. The 10-fold dilution factor is conservative, and a higher ground water concentration may also achieve compliance with surface water standards, although at a lower confidence level. Coupled with the average 10-fold dilution and the tendency for ammonia to volatilize, 3 mg/L in ground water is anticipated to result in compliance with both acute and chronic ammonia standards in the river adjacent to the site. Therefore, DOE proposes to use the 3-mg/L concentration of ammonia as a target goal for evaluating ground water cleanup options. However, the ultimate remediation objective would still be to meet all applicable ammonia standards in surface water.

2.3.1.3 Compliance Strategy Selection Process

Using the PEIS framework shown in Figure 2–40 and site-specific data collected through site characterization and analysis, DOE has evaluated compliance strategies for Moab site ground water. Table 2–28 summarizes the compliance strategy selection process for the Moab site, which is based on the current understanding of the site and cleanup objectives.

The PEIS framework, as presented in Figure 2–40, and the site-specific conditions of the Moab site presented in Chapter 3.0 indicate that a "no remediation" compliance strategy and the application of supplemental standards to ground water is appropriate for protection of human health. However it may not be protective of the environment (i.e., endangered species). Therefore, active remediation is proposed for both the on-site and off-site surface disposal alternatives until natural processes have reduced ground water contaminant concentrations to acceptable risk levels for discharge to surface water.

Section 2.3.2 discusses proposed active remediation approaches that may be implemented to meet the cleanup and long-term protection requirements, independent of surface reclamation. The final determination of the most appropriate technologies and method for ground water treatment would require a more detailed characterization and engineering analysis.

Table 2–28. Summary of Compliance Strategy Selection Process

Box (Figure 2–40)	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	The most recent conceptual model of the site is described in the SOWP (DOE 2003b) based on characterization activities conducted by DOE in 2002 and 2003. **Move to Box 2.**
2	Is ground water contamination present in excess of 40 CFR 192 MCLs or background concentrations?	**Yes:** Maximum ground water concentrations of arsenic, cadmium, molybdenum, nitrate, radium, selenium, uranium, and gross alpha exceed the 40 CFR 192 MCLs or Safe Drinking Water Act standards at one or more monitoring points. Levels of other constituents such as ammonia and sulfate are elevated compared with background and exceed risk-based concentrations. **Move to Box 4.**
4	Does contaminated ground water qualify for supplemental standards due to a classification of limited-use ground water?	**Yes:** The uppermost aquifer is predominantly composed of brine with concentrations of TDS in excess of 10,000 mg/L, which meets one of the criteria for limited-use ground water (40 CFR 192 and EPA 1988). EPA (1988) also indicates that "the entire ground-water unit being classified does not necessarily have to meet Class III [limited-use] untreatable criteria, but a major volume would." The major volume of the uppermost aquifer meets limited-use criteria. **Move to Box 5.**
5	Are human health and environmental risks of applying supplemental standards acceptable?	Human Health Risks: **Yes** Ground water is not reasonably considered to be a potential drinking water source because of its limited-use designation, and this use of water does not need to be considered further. Initial human health risk assessment results indicate that there are no unacceptable human health risks associated with uses of ground water other than drinking water (e.g., irrigation) and probable uses of hydraulically connected surface water (mainly recreational use). Therefore, protection of human health does not require any cleanup of ground water. For human health, no remediation required. Apply supplemental standards. **Move to Box 7.** (Note: Remainder of compliance strategy selection is focused on environmental risks.) Environmental Risks: **No** Toxicity tests conducted on fish using site-influenced ground water and surface water indicate that there is a potential for adverse effects to aquatic life (USGS 2002). Federal criteria for protection of aquatic life have been exceeded for ammonia. Concentrations of other constituents in surface water are elevated above background levels (e.g., uranium, sulfate). **Move to Box 6.**
6	Does contaminated ground water qualify for ACLs based on acceptable environmental risks and other factors?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 8.**
8	Does contaminated ground water qualify for supplemental standards due to excessive environmental harm from remediation?	**No: Move to Box 10.**

Table 2–28. Summary of Compliance Strategy Selection Process (continued)

Box (Figure 2–40)	Action or Question	Result or Decision
10	Would natural flushing result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 13.**
13	Would natural flushing and active ground water remediation result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 15.**
15	Would active ground water remediation methods result in compliance with background concentrations, MCLs, or ACLs?	**Yes:** Active remediation of ground water to control discharge to surface water can achieve surface water remediation goals until natural processes have reduced ground water concentrations to acceptable levels for discharge to surface water. **Move to Box 16.**
16	Perform active ground water remediation.	This is the compliance strategy identified by the PEIS framework.

2.3.1.4 Initial and Interim Actions Related to the Proposed Action

DOE, upon accepting responsibility for the Moab site, initiated consultations with USF&WS. On the basis of these consultations, and after reviewing historical surface water quality studies and data, DOE and USF&WS agreed that an elevated concentration of site-related ground water contaminants (primarily ammonia) reaching the Colorado River posed immediate risk to endangered fish and designated critical habitat.

On April 30, 2002, USF&WS concurred with DOE's decision to implement an initial action, followed by an interim action. The goal of the initial action was to dilute ammonia concentrations at the ground water–surface water interface in areas that presented the greatest potential for fish to be present, when backwater habitat has developed. It was estimated that backwater habitat would most likely be present from June through August at flows of 5,000 to 15,000 cfs. The action focused on the segment of the Colorado River from Moab Wash extending approximately 800 ft downriver, which contributes the highest concentrations of contaminants to the river. The system was designed to withdraw fresh water upstream of the site and pump it through a distribution system to backwater areas. Because of low flows, the system was not installed in 2003. The system was installed and tested in 2004, but because of low river flows caused by a continuing drought, the targeted backwater areas never held water, and the system could not be fully implemented.

The goal of the interim action is to extract contaminated ground water near the Colorado River, thereby reducing the amount of contamination reaching the river. DOE funded, designed, and implemented the system (Phase I) in 2003, which included 10 extraction wells aligned parallel to the Colorado River. The system is designed to withdraw ground water at the rate of approximately 30 gpm and pump it to an evaporation pond on top of the existing tailings pile. On April 4, 2004, USF&WS concurred with DOE's decision to construct a land-applied sprinkler system designed to increase evaporation rates. The system was installed in the existing evaporation pond area. In July 2004, DOE installed an additional 10 extraction wells (Phase II) near the first 10 wells to increase the rate of ground water extraction and to test the effects of freshwater injection on surface water concentrations. If the interim actions are successful, a reduction in contaminant concentrations in surface water could be observed significantly sooner than the 10-year maximum time frame predicted under the proposed action.

2.3.2 Proposed Ground Water Action

This section presents the potential ground water actions for both the on-site and off-site tailings disposal alternatives and provides the basis for assessing the impacts of these actions. This section also discusses ground water remediation objectives. Section 2.3.2.1 discusses ground water remediation options. Section 2.3.2.2 discusses time frames for implementation (i.e., pre-remediation period) of active remediation. Section 2.3.2.3 discusses construction and operational requirements. Section 2.3.2.4 discusses the active remediation target goals and time frames for remediation and compares the proposed ground water action to the No Action alternative.

The focus of active remediation would be on preventing ground water discharge to potentially sensitive surface water areas, as opposed to accelerating mass removal from the aquifer, though it is expected that the remediation should enhance the cleanup process. DOE's proposed action for ground water at the Moab site would be to design and implement an active remediation system and also apply ground water supplemental standards. These actions would be in addition to the initial and interim actions (described above) that have already been implemented. Ground water remediation would be implemented under both the on-site and off-site tailings disposal alternatives. It would be designed to intercept contaminated ground water that is currently discharging into the nearshore area of the Colorado River, which is designated critical habitat for endangered fish species. The proposed action would, at a minimum, meet the protective surface water criteria. It is possible that effects of the interim action and the proposed action may achieve background surface water quality conditions in less than the estimated 10 years after the ROD. The system would be operated until ground water contaminant concentrations have decreased to levels that would no longer present a risk to aquatic species. The duration of active remediation is predicted to be 75 years for the off-site disposal alternative and 80 years for the on-site disposal alternative (DOE 2003b).

Because selection and design of the actual extraction and treatment system have not yet begun, the proposed action cannot be described precisely. Therefore, the following descriptions address the scope of ground water extraction, treatment, and associated effluent discharge alternatives as if the remediation action were the one with the greatest potential for impact. In this way, DOE intends to bound the range of potential forms the proposed action could take and, consequently, the range of potential impacts from their implementation. These estimates are based on experience at other UMTRCA sites. Estimates based on those sites have been scaled up to accommodate the larger scope of the Moab site remediation. Where appropriate, distinctions are made between the construction/implementation phase of the proposed action and the operation/maintenance phase, because the scope, activities, and potential impacts from these two distinct periods would be substantially different.

2.3.2.1 Ground Water Remediation Options

Potential technologies for ground water treatment were prescreened to determine which remediation methods would be most feasible (DOE 2003b). In situ as well as ex situ methods were considered.

Active ground water remediation would be accomplished using one of, or a combination of, the options described below. All proposed remediation options would occur within the area of historical millsite activities and areas requiring surface remediation. Figure 2–41 shows the area of proposed ground water remediation.

Remediation would include the following options:

- Ground water extraction, treatment, and disposal
- Ground water extraction and deep well injection (without treatment)
- In situ ground water treatment
- Clean water application

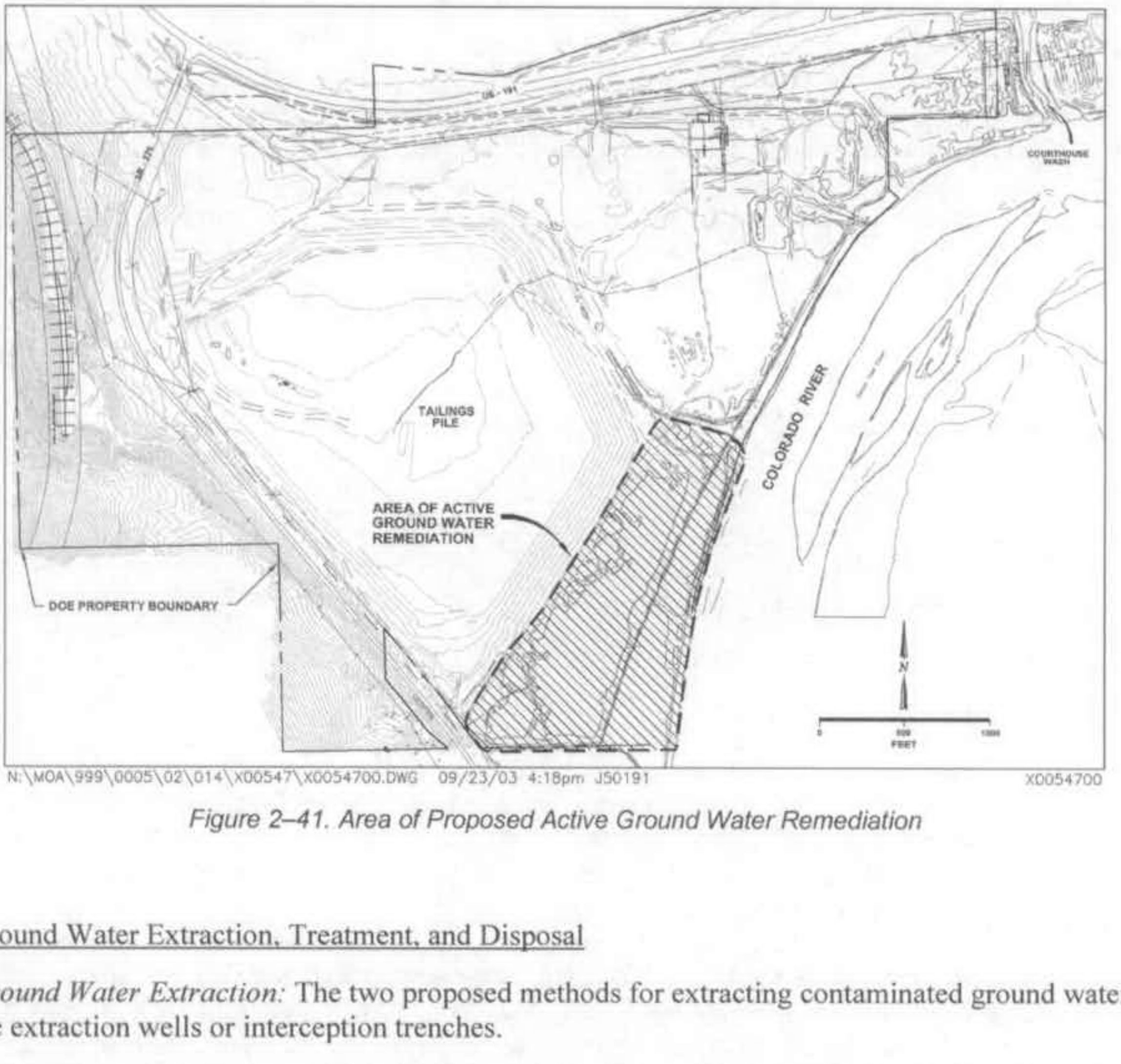


Figure 2–41. Area of Proposed Active Ground Water Remediation

Ground Water Extraction, Treatment, and Disposal

Ground Water Extraction: The two proposed methods for extracting contaminated ground water are extraction wells or interception trenches.

If extraction wells were used, between 50 and 150 wells would be installed to depths of up to 50 ft using conventional drilling equipment. This design would allow for extracting up to 150 gpm of contaminated ground water. The water would be pumped from the wells to a treatment collection point (e.g., evaporation pond) via subsurface piping. The system would be installed between the current tailings pile location and the Colorado River to intercept the plume before it discharged to the river and would require up to 50 acres of land for the duration of ground water remediation. The proposed locations (Figure 2–41) are within the area of historical site disturbances and areas requiring remediation of contaminated soils. It is expected that the system would be installed after any remediation of surface soils required in these areas. It is possible that some extraction wells would need to be installed adjacent to the river in areas northeast of the tailings pile in the vicinity of the old millsite.

If shallow trenches were used, they would be constructed to intercept shallow ground water, which would be piped via shallow subsurface piping to a collection point for treatment (e.g., evaporation pond). This design would allow for extracting up to 150 gpm of contaminated ground water. It is estimated that the system would require from 1,500 to 2,000 lineal ft of trenches and could affect up to 50 acres of land for the duration of ground water remediation. The proposed locations are within the area of historical site disturbances, and areas requiring remediation of contaminated soils.

Treatment Options: DOE has screened potential treatment technologies that would be applicable for treatment of ammonia and other contaminants of concern (DOE 2003b). The treatment options and technologies described below are meant to bound the range of viable possibilities. All treatment options would require construction of infrastructure. The level of treatment would depend largely on the selected method of effluent discharge. Therefore, specific treatment goals could not be established until the specific discharge method(s) were selected. The treatment goals would have to consider risk analysis and regulatory requirements.

Additional testing, characterization, or pilot studies may be required before the optimum system could be selected and designed. This level of design would be developed in the remedial action mentioned in Section 2.3.1, following publication of the ROD. The SOWP (DOE 2003b) presents more detailed descriptions of the processes and discusses the screening process for the following treatment options.

- Standard evaporation
- Enhanced evaporation
- Distillation
- Ammonia stripping
- Ammonia recovery
- Chemical oxidation
- Zero-valent iron
- Ion exchange
- Membrane separation
- Sulfate coagulation

Because evaporation is a primary treatment consideration and is also considered a disposal option, it is included in more detail. Evaporation treats extracted ground water by allowing the water to evaporate due to the dry conditions of the site and warm temperatures during part of the year. Influent rates to the ponds would match the rate of natural evaporation. Nonvolatile contaminants would be contained and allowed to concentrate, which would require provisions for disposal of the accumulated solids. Evaporation could also be used to treat concentrated wastewater from treatment processes such as distillation and ion-exchange that produce a wastewater stream. Passive evaporation would not require any mixing after disposal in the ponds. If it were determined that concentrations would present a risk to avian or terrestrial species, a wildlife management plan would be submitted to USF&WS, as further discussed in Appendix A1 (the Biological Assessment).

Solar evaporation would consist of putting the water into large, double-lined ponds built into the floodplain and designed to withstand a 100-year flood. Without enhanced methods, the pond or ponds would need to be of sufficient size that evaporation rates could keep up with extraction rates and complete remediation in a reasonable time frame. Pond areas could range up to 40 acres and include a total of 60 acres of land that would need to be disturbed. This would also require some type of small support facility. Devices such as spray nozzles could enhance evaporation rates considerably.

Disposal Options: If ground water were treated by a method other than evaporation, the treated water would require disposal by one of the following methods:

- Discharge to surface water
- Shallow injection
- Deep well injection

The Colorado River is a boundary to the Moab site, and it would be the natural repository of the site ground water if effluent were discharged to surface water. Because of water quality standards and designation as critical habitat for endangered fish, it is likely that this option would require extensive water treatment for all contaminants of concern. If discharge to the river was considered a viable alternative for dealing with treatment effluent, appropriate permits would need to be obtained from the State, and compliance with conditions such as discharge rates and effluent composition would be required.

If shallow injection were selected, injection wells would be used to return the treated ground water directly back into the alluvial aquifer. Treated ground water could potentially be used to recharge the aquifer at different points to allow manipulation of hydraulic gradients. This could facilitate extraction of the lower quality water and accelerate removal of the contaminant source. This option would require treatment of ammonia.

If deep well injection were selected, treated ground water would be disposed of by deep well injection into the Leadville Formation, Paradox Formation, or deep brine aquifer. Ground water hydrology beneath the site includes a deep salt formation called the Paradox Formation overlain by a deep aquifer with a high salt concentration (brine water). This method would likely require an underground injection control permit from the State of Utah.

Ground Water Extraction and Deep Well Injection (without treatment)

If this option were selected, ground water would be extracted using a system and infrastructure similar to that described above, and untreated water would be pumped into a geologically isolated zone. This option would likely require an underground injection control permit from the State of Utah and concurrence from NRC.

In Situ Remediation

If this option were selected, it would include some form of bioremediation, including phytoremediation (use of deep-rooted plants that extract certain contaminants from ground water through root uptake). This option would require minimal infrastructure and could require state or federal permits, depending on the method of bioremediation.

Clean Water Application

Another aspect of the active remediation system could involve some form of application of clean water to dilute ammonia concentrations in the backwater areas along the Colorado River that may have potentially suitable habitat for endangered fish. This would likely take either or both of two configurations. The first configuration would consist of diverting uncontaminated water from the Colorado River through a screened intake at the nearest location just upstream of Moab Wash. A water delivery system consisting of a pump and aboveground piping would redistribute the water to the backwater areas along a section of the sandbar of up to 1,200 ft beginning just south of Moab Wash. Flow meters and valves would be used to measure and control the rate of upstream river water released at each distribution point to minimize turbidity and velocities. The components and operation would be similar to the 1,360-gpm system originally planned as an initial action for the sandbar area adjacent to the site (DOE 2002b) or some alternative system design.

A variation of the clean water application could consist of using injection wells or an infiltration trench to deliver uncontaminated river water indirectly to the backwater areas. For this second configuration, clean water would be collected from the Colorado River and pumped to the site water storage ponds to control suspended sediment and prevent system clogging. The storage pond water would then be introduced to the shallow ground water system by a series of injection wells or infiltration trenches located along the bank adjacent to the backwater areas. The clean water would enter the backwater areas by bank discharge of ground water to provide dilution of ammonia concentrations. This clean water application system could also be combined with the extraction wells discussed earlier to control drawdown and minimize the potential for brine upconing. For this case, up to 150 gpm of uncontaminated river water would be needed to balance the amount of plume water extracted.

2.3.2.2 Implementation of Ground Water Remediation

DOE estimates that design, procurement, testing, construction, and implementation of an active ground water remediation system would be complete within 5 years of issuance of the ROD (Figure 2–42). Design criteria and specifications would depend upon whether the on-site or off-site alternative was selected for tailings disposal.

Following the start of system operation, DOE estimates that as much as an additional 5 years (Figure 2–42) could be required to reduce concentrations of contaminants in the surface water to levels that are protective of aquatic species in the Colorado River, if protective levels were not already achieved as a result of interim actions. However, it is possible that considerably less time could be required to reach protective levels. The period of construction and implementation is considered the pre-remediation period.

2.3.2.3 Construction and Operational Requirements

Number of Workers and Duration of Work

The greatest numbers of workers would be required during the initial construction of the remediation system. Construction of the system would include installing an extraction system and constructing a treatment system. Construction of a distillation system would probably be the most labor-intensive water treatment option and require the greatest diversity of workers because

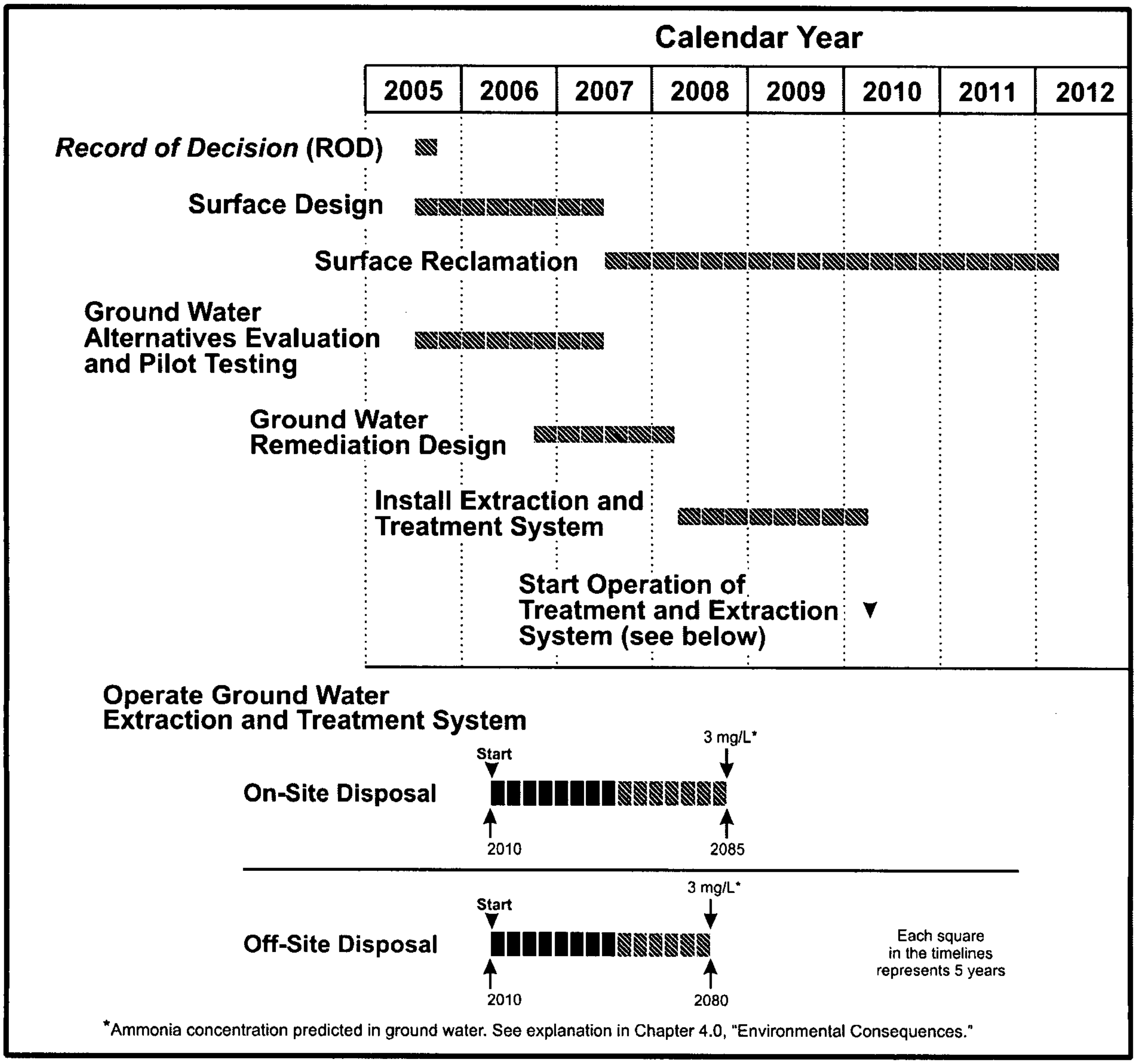


Figure 2–42. Estimated Ground Water Remediation Schedule

of the complexity of the system. After the system construction was complete, routine operation and periodic maintenance and monitoring would be required until remediation goals were met. If the treatment process produced a solid waste stream, such as a sludge produced from residual brines generated during distillation, transportation to an off-site disposal facility could be required.

Required workers would include construction workers, operators, engineers, electricians, plumbers, and administrative support.

- Number of workers for construction: 25 to 50; duration: 12 months
- Number of workers for operation: 2 to 6; duration: 80 years (on-site disposal) and 75 years (off-site disposal)

If the initial action discussed in Section 2.3.1.4 were needed to dilute river water during installation of the active system, it could be started almost immediately. Construction of the active system would not start until surface remediation was completed in the location where the system would be installed.

Number and Types of Equipment

Installation of an extraction system would require either conventional drill rigs for the wells or heavy equipment (e.g., backhoes) for construction of trenches. If ground water treatment were required, a treatment plant would need to be constructed with infrastructure to meet the operational requirements of the treatment system. The technology requiring the greatest amount of equipment for construction would be installation of an evaporation pond system because of the large amount of excavation required. Typical construction and earth-moving equipment would be required. Additional considerations include air emission controls, holding tanks, water lines, electrical lines, chemical storage areas, and pumps. After construction, the only equipment required for continued operations would likely be pickup trucks.

Equipment estimates are based on construction of an evaporation pond at a similar UMTRCA site near Tuba City, Arizona. Table 2–29 provides estimated equipment requirements for a scaled-up 40-acre evaporation pond at the Moab site to manage the estimated 150-gpm ground water extraction rate.

Table 2–29. Estimated Equipment Requirements

Equipment	No. of Equipment
Tractor	2
Drill rig for wells	1
Trackhoe for trenches	1
Backhoe	2
Grader	2
Front-end loader	1
End dump truck	1
Water truck	2
Scrapers (21 yd^3)	4
Dozer	2
Sheepfoot compactors	2
Smooth drum roller	1
Pickup	2
Skidsteer	1

Wastes Generated and Waste Management Requirements

Depending on the way extracted ground water would be treated and managed, different waste streams could be generated. Some of these waste streams would require some form of additional management, whereas others would be lost naturally to the atmosphere or subsurface. For example, if evaporation were the selected method for addressing ground water remediation, contaminated ground water would be discharged to an evaporation pond. Some constituents, such as ammonia, would volatilize to the atmosphere in the form of air emissions. The water in the pond would evaporate, and dissolved solids would eventually accumulate and be left as a residual sludge that would require waste management. Depending on combinations of technologies selected, different combinations of wastes would be generated, requiring different management techniques. Minimization of liquid wastes would result in more solids to manage. Different treatment options would result in varying amounts of secondary solids.

Regardless of the active method selected, is it assumed that any remediation system would need to accommodate a feed rate of 150 gpm of contaminated water. The average influent stream water composition would be roughly 1,000 mg/L ammonia, 7 mg/L uranium, and 20,000 mg/L TDS. Because ammonia is volatile, its release could result in air emissions; the dissolved solids would end up in solid form by removal of water through the remediation process.

Air Emissions. Operation of an evaporation pond, particularly spray evaporation, or an ammonia-stripping treatment technology would probably be the alternatives with the highest air emissions. Emission control devices on treatment plants could probably control emissions for some treatment methods. Residuals from these control systems would then require subsequent disposal. Control of emissions from an evaporation pond would not be feasible. However, the pond could be designed and operated to minimize impacts on surrounding areas.

Water Effluents. It is assumed that the same volume of extracted ground water would need to be handled regardless of the remedial system selected. However, resulting water effluents from that system would be of varying quality and would require different methods of handling. For deep injection and evaporation, extracted ground water would go directly to its final disposal with no intermediate steps. Water effluents produced as a result of some treatment process could require no special handling, as in the case of treated water that is produced through distillation, or may require some additional management method (such as the residual brine from distillation). Additional studies could be required if water effluents would be used for land application so that soils were not adversely affected.

Waste Solids. Solids generated from ground water remediation would mostly include sludges derived from processes employing precipitation and evaporation, or RRM or filters used in flow-through media processes. Both distillation and evaporation would concentrate dissolved solids and would probably produce the most concentrated waste solids. Larger volumes of lower-concentration wastes could be produced by use of flow-through processes. An estimated 6,600 tons per year of RRM waste would be generated, assuming all of the 20,000 mg/L TDS in the treatment stream would be recovered at a treatment capacity of 150 gpm. These RRM wastes would need to be disposed of at a low-level waste disposal site or at an UMTRCA disposal cell.

Land Use Requirements

The greatest requirements for land use would probably be associated with the evaporation alternative. A sufficiently large pond would need to be constructed to achieve evaporation rates that could keep up with extraction rates and complete remediation in a reasonable time frame. Estimated pond areas range up to 40 acres, and a total of 60 acres of land would need to be disturbed. Any active remediation alternative would require some type of support facility, but this would be expected to be minor and would probably be located in already disturbed areas. If land application of treated water were selected as the preferred effluent disposal alternative, sufficient land would need to be reserved for this purpose with a delivery system installed to transport and deliver the effluents (piping and sprinkler heads). A similar land farming alternative for an UMTRCA site in Monument Valley, Arizona, was estimated to require approximately 30 acres to handle 80 gpm of water; extraction rates at the Moab site are estimated to be a maximum of 150 gpm. If treated effluents resulted in a proportional volume of water requiring land application, land use requirements would probably be less than 60 acres. However, unlike under the evaporation alternative, this land could serve other beneficial purposes.

Natural Resource Requirements

Power consumption needs for a distillation unit would be the highest required for ground water remediation. Based on operation of a distillation unit at Tuba City, Arizona, an UMTRCA site similar to the Moab site, it is estimated that the maximum electrical power demand would be approximately 600 kVA. The capacity of the existing distribution system circuit at the Moab site would support this demand. An estimate of diesel fuel consumption for construction of an evaporation pond is shown in Table 2–30.

Table 2–30. Estimated Diesel Fuel Consumption for Evaporation Pond Construction (12-month period)

Equipment Type	Number of Equipment Total Project	Consumption (gallons per hour)	Consumption (gallons per year per piece)
CAT Ag. tractor (Challenger 55)	2	9	54,000
CAT 420D backhoe	2	3	18,000
CAT 140H grader	2	6	36,000
CAT 9880G front-end loader	1	13	39,000
12 yd^3 end dump	1	3	9,000
4000 gal. capacity water truck	2	3	18,000
CAT 621G 21 yd^3 scrapers	4	11	132,000
CAT D8R dozer	2	9	54,000
CAT 825G soil compactors	2	15	90,000
CAT CS533D drum roller	1	4	12,000
Pickup truck	2	1	6,000
CAT 248 skidsteer loader	1	3	9,000
Total Diesel Fuel Consumption			477,000

Construction Materials (e.g., building materials, piping, pumps)

For an evaporation pond for ground water remediation, construction materials for a berm would come from clean, on-site materials. If the decision were made to implement some form of interim action in the potential habitat areas of the river before the active remediation system was fully operational, water could be extracted using the existing pumping system upgradient of the site and discharged to the potential habitat areas adjacent to the site. If application of fresh river water were implemented as an interim measure, DOE estimates that 50 to 500 gpm of river water would be withdrawn and used for this purpose. Almost all the water withdrawn would be returned to the river in fish habitat areas. The interim action would continue only until active ground water remediation began–that is, for a period of 4 to 5 years or less after issuance of the ROD.

2.3.2.4 Active Remediation Operations

The active remediation system would begin to extract and treat ground water within 10 years of the ROD and would continue for 75 to 80 years (depending on whether an off-site or on-site surface remediation alternative were implemented) to maintain surface water quality goals. This is the predicted time to allow natural processes to diminish the contaminant sources to the point that maximum ground water concentrations adjacent to the river meet the target goals (Figure 2–43). Contaminant concentrations in the ground water are thus predicted to be at acceptable risk levels prior to entry into the Colorado River within 10 years of the ROD. Active remediation would cease only after ground water and surface water monitoring confirmed that long-term remediation goals were achieved. The 3-mg/L target goal is a reasonably conservative ground water goal that should result in ammonia compliance in surface water given the uncertainties involved in predicting contaminant behavior. These uncertainties associated with the success of active remediation are discussed further in Section 2.3.3. Ground water and surface water would be monitored for any alternative that is selected to assess the progress of the active remediation system in achieving long-term remediation objectives and verifying predicted concentrations.

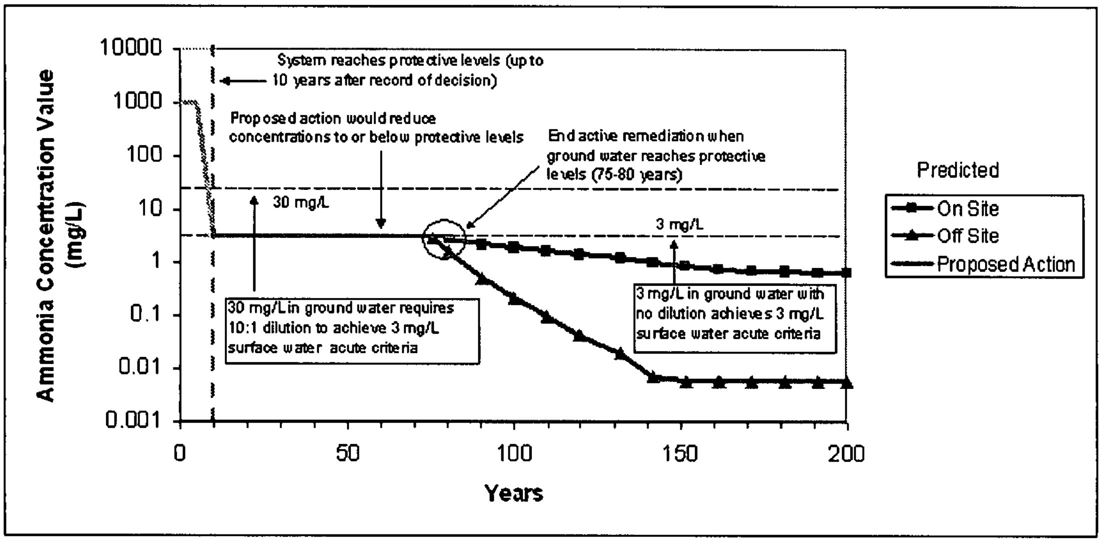


Figure 2–43. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation

Table 2–31 summarizes the predicted schedule for meeting the target goal of 3-mg/L *in ground water* based on ground water modeling results (using base case assumptions). Ground water modeling results indicate that ground water ammonia concentrations would slowly decline through time under all remedial scenarios and under the No Action alternative. The on-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 80 years. The off-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 75 years. According to modeling results for the on-site disposal alternative, the lowest achievable ground water concentrations of ammonia would be less than 0.7 mg/L in 200 years at steady-state. For the off-site disposal alternative, the ground water concentrations of ammonia would reach the most stringent calculated chronic ammonia State of Utah standard for the site (0.2 mg/L) in 100 years and eventually decline to background levels in 150 years.

Table 2–31. Schedule for Meeting Ground Water Target Remediation Goals

Post-ROD Project Phase	**Remediation Target Goals Achieved**	
	On-site Alternative	**Off-site Alternatives**
Pre-remediation (within 10 years of the ROD)	No	No
Remediation—on-site disposal (within 80 years of the ROD)	Yes	NA
Remediation—off-site disposal (within 75 years of the ROD)	NA	Yes
Post-remediation	Yes	Yes

Higher ground water concentrations, such as those resulting from the No Action alternative, could comply with surface water standards, albeit at a lower confidence level.

The lowest concentration achievable under the No Action alternative is 6 mg/L; therefore, this alternative would not meet the 3-mg/L target goal. Figure 2–44 shows the ammonia concentrations over time for the No Action alternative.

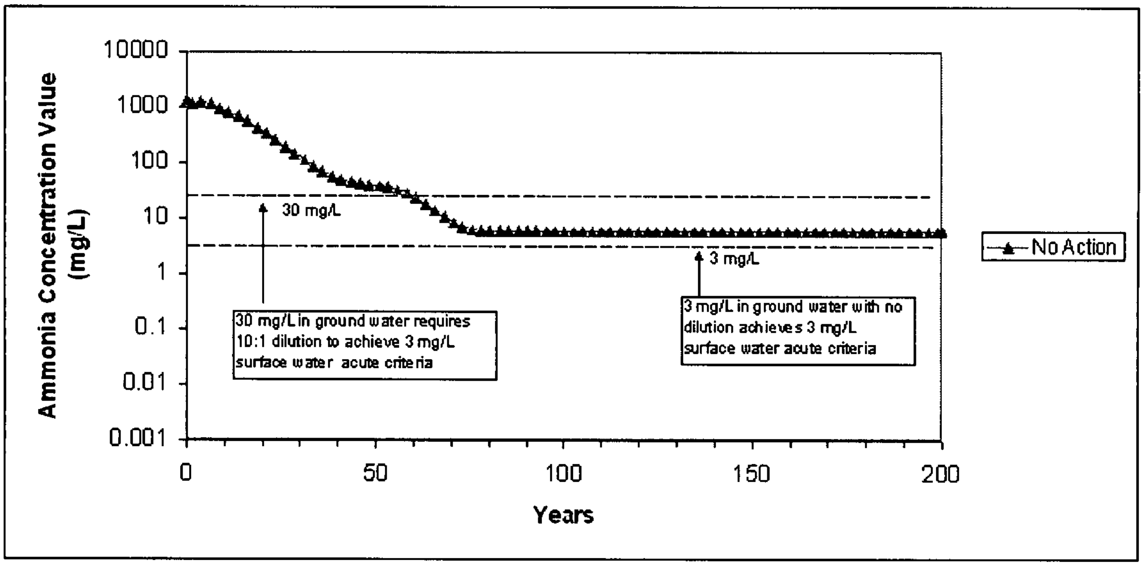


Figure 2–44. Predicted Maximum Ammonia Concentrations in Ground Water for No Action

2.3.3 Uncertainties

DOE does not have a quantitative estimate of uncertainty associated with modeling predictions estimating the time for ground water concentrations to reach target goals that are protective of aquatic species. The uncertainties can be grouped into the following general categories:

- Future changes in the status of threatened and endangered species.
- Future changes in AWQC.
- Uncertainties in concentrations predicted by the ground water model.

- Uncertainties in the time to achieve the target goal predicted by the ground water model.
- Change in concentrations of contaminants associated with ground water discharge to surface water (i.e., application of a dilution factor).

This analysis of uncertainties focuses on the goal of achieving concentrations of contaminants in the river that are protective of threatened and endangered fish species. According to the recovery plan for the Colorado pikeminnow (USF&WS 2002), downlisting could be achieved by 2006 and delisting by 2013. The razorback sucker could be delisted by as early as 2023 (USF&WS 2002). At that time, protection of threatened and endangered fish and critical habitat could have less significance, and less conservative remediation objectives could be applicable. Conversely, ambient water quality standards (federal or state) could be revised that affect target remediation goals.

Sections 7.3, 7.6, and 7.8 of the SOWP (DOE 2003b) discuss the sensitivity of the ground water flow and transport model to specific modeling input parameters as well as modeling uncertainty. Specifically, transport parameters (e.g., tailings seepage concentration and the natural degradation of ammonia in the subsurface) were found to have a much greater impact on predicted concentrations than did flow parameters (e.g., hydraulic conductivity and effective porosity). The sensitivity analysis performed indicates that perturbing the key transport parameters from the calibrated values could result in either significantly higher or significantly lower contaminant concentrations in the ground water adjacent to the river; it did not indicate the probability or likelihood of any one outcome.

The variables affecting prediction accuracy are many, and the system of contaminant transport and the interaction between ground water and surface are complex, largely due to the dynamic nature of river stage and backwater area morphology. To compensate for the inherent uncertainties, DOE has assumed a conservative protective water quality goal of meeting the lowest possible acute aquatic standard (based on the range of observed pH and temperature conditions in the river) in the ground water with no consideration of dilution.

<u>On-Site Disposal</u>

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (0.7 mg/L ammonia for the on-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

Because seepage from the tailings pile represents a long-term source of ground water loading, an on-site disposal decision could result in longer-term active ground water remediation; higher concentrations of residual ground water contamination also would be expected to remain at the conclusion of the remediation time period (see Figure 2–43). The longer operational time period would also result in a corresponding increase in operational costs of the system.

Some acceleration of cleanup could be realized under the on-site disposal alternative by focused ground water remediation of the legacy plume and the ammonia flux from the brine interface. However, after the legacy plume and ammonia flux from the brine interface were depleted, the continued presence of the tailings pile source would limit the degree to which concentrations could ultimately be reduced. Uncertainties associated with model predictions for the on-site disposal alternative involve both time required to meet steady-state conditions and the question of whether the target goals (i.e., concentrations) could be met.

Off-Site Disposal

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (background concentrations for the off-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

No Action Alternative

It is possible that the No Action alternative would meet the target goal considering the number of uncertainties involved. For example, a factor-of-2 decrease in the 6-mg/L ammonia concentration in ground water predicted at steady state would result in meeting the 3-mg/L target goal. A factor-of-2 decrease in predicted concentrations is within the lower range of uncertainty.

It is clear that if ground water concentrations comply with remediation objectives, surface water concentrations should comply as well. Therefore, on the basis of site-specific data and a study of the site conditions, DOE has a reasonable degree of confidence that protective conditions would be met and maintained both during the operation of the remedial action (75 to 80 years) and following achievement of water quality goals. Monitoring would confirm performance to meet target concentrations.

2.4 No Action Alternative

Although DOE would not remediate contaminated materials or ground water under this alternative, DOE would likely complete tasks necessary to secure the site to minimize the potential for accidents. For example, power would be turned off and equipment would be removed. This alternative is analyzed to provide a basis for comparison to the action alternatives and is required by NEPA regulations (40 CFR 1502.14[d]).

Under the No Action alternative, DOE would not remediate on-site surface contamination, which includes the existing tailings pile, contaminated materials and buildings, and unconsolidated soils. The existing tailings pile with its interim cover would not be capped and managed in accordance with 40 CFR 192 standards; this consequence of the No Action alternative would conflict with the requirements of the Floyd D. Spence Act. In addition, no site controls or activities to protect human health or the environment would be continued or implemented. Public access to the site would be unrestricted. All site activities, including operation and maintenance activities, would cease. Vicinity properties located close to the site and near the town of Moab, including residences, commercial and industrial properties, and vacant land, would also not be remediated.

Initial and interim ground water actions would not be continued or implemented. DOE would abandon all ongoing and planned activities designed to protect endangered species and prevent discharge of contaminated ground water to the Colorado River. No further media sampling or characterization of the site would take place.

A compliance strategy for contaminated ground water beneath the site would not be developed in accordance with standards in 40 CFR 192. Contaminated ground water would discharge indefinitely to the backwater areas of the Colorado River, and ammonia concentrations would continue to exceed protective levels. No institutional controls would be implemented to restrict the use of ground water, and no long-term surveillance and maintenance would take place. Because no activities would be budgeted or scheduled at the site, no further initial, interim, or remedial action costs would be incurred.

2.5 Alternatives Considered But Not Analyzed

This section addresses on-site and off-site alternatives, including locations, that were initially considered on the basis of preliminary assessment. However, they were eliminated from detailed evaluation for the EIS.

2.5.1 On-Site Alternatives

On-site alternatives for surface remediation that were initially considered included (1) stabilize-in-place, (2) solidification, (3) soil washing, and (4) vitrification. All but stabilize-in-place were eliminated from detailed evaluation. The rationale for elimination is discussed below. Ground water compliance alternatives were evaluated in the SOWP (DOE 2003b), which evaluates the compliance strategies and serves as the basis for the strategy proposed in Section 2.3.

2.5.1.1 Solidification

This alternative involves adding a stabilizing reagent to a soil or sediment. The reagent fills the interstitial spaces, blocking the flow of water and other fluids into these spaces and reducing contact and leaching of contaminants. A study of polyethylene macroencapsulation conducted by DOE and Envirocare at the Envirocare site near Salt Lake City showed that this technology could be applied to reduce leachate from radioactively contaminated lead bricks.

However, a study of seven solidification/stabilization reagents for treatment of contaminated sediments at the New Bedford Harbor Superfund site in Massachusetts did not give encouraging results. Concentrations of RCRA Toxicity Characteristic Leachate Procedure metals, particularly barium, copper, and zinc, actually increased in leachate generated from a number of post-treatment samples (EPA 2001).

The current cost of the treatment system used at Envirocare (excluding the costs of the initial treatability studies that resulted in a viable technology) was estimated at \$90 to \$100 per cubic foot (ft^3) based on a demonstration performed on waste streams from 23 DOE sites (FRTR 2001). The estimated total volume of contaminated tailings and soils at the Moab site is approximately 8.9 million yd^3, or 240 million ft^3. Thus, the cost of remediating the Moab site using Envirocare macroencapsulation would be \$22 billion to \$24 billion. Macroencapsulation is inherently an ex situ process; therefore, this cost would be in addition to the cost of excavating the entire volume of contaminated tailings and soil. Because the solidified material would remain classified as RRM, it would still have to be disposed of as a radioactive waste. Additional disposal costs were not estimated because of the excessive costs associated with the treatment. Therefore, this alternative was eliminated from further assessment under this EIS.

2.5.1.2 Soil Washing

Notwithstanding the name, most soil-washing processes do not actually wash soils. Rather, they use water, sometimes combined with chemical additives, to separate contaminated soils into contaminated and clean constituents. Contaminants tend to bind to silt and clay. Soil-washing processes separate silt and clay from sand and gravel particles that constitute the bulk of most contaminated soils. The silts and clays, which contain the contaminants, must then be treated by other means before disposal. The sand and gravel can be disposed of as nonhazardous material. Soil washing, then, is a waste volume-reduction technology. It can be effective, resulting in volume reductions of as much as 90 percent.

Soil washing has been used at a number of Superfund sites, notably at the King of Prussia Technical Corporation site in 1993, where 19,200 tons of metal-contaminated soil and sludge were treated. The treated soil (sand and gravel) from the King of Prussia site met or exceeded all the treatment standards (EPA 1995).

Ashtabula, Ohio, is a DOE site where soil washing was used to treat 40,000 tons of soils commingled with depleted uranium. This application more nearly approximated true "soil washing" because it used a chemical extraction to leach the uranium from the soil. The results of this deployment appear to be mixed, although the volume reduction was nearly 98 percent (DOE 2001a).

Technical feasibility may be a serious obstacle to the use of soil washing at the Moab site. The uranium at the Moab site is chemically bound to the tailings because it occurs naturally in the ore, and the tailings are the by-product of the milling process. The uranium remaining in the tailings is that which remained bound to the substrate after the leaching process was used at the mill. It would likely be difficult to remove the uranium in a second stage of processing. Furthermore, a significant portion of the Moab tailings consists of slimes, which are difficult to handle in physical processes and do not disperse readily. The soil-washing systems used to date have relatively low capacities. The King of Prussia system operated at 25 tons per hour, so it would require 54 years to treat the Moab pile, assuming continuous operation. The Ashtabula system operated at 10 tons per hour, a rate that would require 136 years to treat the Moab pile. Pulse Technology, a private firm marketing a soil-washing technology developed with Russian aid, offers a stationary system that can process up to 90 tons per hour. This would treat the Moab pile in 15 years with no allowance for downtime. Because residual contamination would remain after soil washing, the resulting waste would still have to be managed and disposed of as radioactive waste.

Soil washing is an expensive technology. The project cost at the King of Prussia site was $7.7 million, or $401 per ton of soil (EPA 1995). The unit treatment cost at Ashtabula was estimated at $370 per ton (DOE 2001a). Either of these figures, if extrapolated to the total volume of more than 11 million tons of contaminated tailings and soils at the Moab site, results in a total treatment cost of more than $4 billion. The lowest cost suggested by EPA for soil washing is $90 per ton (DOE 2001a), equivalent to $1 billion for the Moab site. To make soil washing economically feasible at the site, the unit costs would have to be an order of magnitude lower than those reported at the other sites where that technology has been used. There is no indication that such a reduction could be achieved.

2.5.1.3 Vitrification

This treatment alternative uses electricity to heat contaminated soils to their melting points in place, then allows the melted soils to cool as glass. The high temperatures required for vitrification (quartz melts at 1,610 °C [2,930 °F]) destroys many contaminants, and contaminants that are not destroyed are encapsulated in the glass.

Vitrification has been used at a number of DOE and other sites to treat small quantities of high-level radioactive waste. It is particularly useful for treatment of high-level liquid wastes. The Savannah River (Pickett et al. 2000) and Hanford Sites (62 FR 8693–8704 [1997]) are using vitrification for this purpose. An in situ vitrification (ISV) treatment system was successfully used to treat contaminated soils and sediment at the Parsons Chemical/ETM Enterprises Superfund site (EPA 1997). Oak Ridge National Laboratory (ORNL) has successfully demonstrated a transportable vitrification system for ex situ treatment of contaminated soils (DOE 1998). An in situ pilot test at Brookhaven National Laboratory in 1996 was less successful and, as stated in the report on that test, "raised concerns about the effectiveness of ISV" (DOE 1996b).

The quantities of wastes treated by vitrification have been small compared with the volume of contaminated tailings and soils at the Moab site. The ORNL ex situ demonstration (DOE 1998) treated about 8 tons of mixed waste, and the Parsons Chemical/ETM project (EPA 1997) treated approximately 3,000 yd^3 of soils and sediment. The estimated volume of solid material at the Moab site is 8.9 million yd^3.

Partly because of the relatively small volumes treated, the reported unit costs of ISV projects have been high.

- The ISV project at the Parsons Chemical/ETM Enterprises Superfund site in Grand Ledge, Michigan, which treated approximately 3,000 yd^3 of contaminated soils and sediments in 1993 and 1994, reported a cost of $270 per cubic meter (equivalent to $353 per cubic yard).
- DOE's report on ISV reported average costs of $375 to $425 per ton for projects at Parsons, ORNL, Wasatch, and a private Superfund site.
- "High Temperature Plasma Vitrification of Geomaterials" (Mayne and Beaver 1996) reported a range of operating costs of $308 to $695 per cubic meter (equivalent to $403 to $909 per cubic yard).

The total treatment cost of the ORNL ex situ transportable vitrification system was calculated at $8 to $15 per kilogram ($18 to $33 per pound).

Applying the average of the costs of the in situ processes (excluding the ORNL ex situ transportable vitrification system) to the total volume of the tailings and contaminated soils at the Moab site yields an estimated total cost of more than $4 billion for remediation of the site using ISV. Some economy of scale would be realized in a project the size of Moab. However, the most significant cost element in a vitrification process is electricity. DOE used an estimated unit cost of $0.05 per kilowatt hour to derive the cost range for vitrification projects, and it is highly unlikely that the cost of electricity for the Moab project would be significantly lower than this value. To make vitrification economically feasible at Moab, the unit costs would have to be more than an order of magnitude lower than those reported at the other sites where that technology has been used. The consistency between the reported unit costs for the various ISV projects suggests that an order of magnitude reduction is unlikely. In addition, as with other treatment alternatives, this waste would still need to be managed and disposed of as a radioactive waste.

2.5.1.4 On-Site Relocation

Moving the pile to another location on the Moab site was considered but dismissed as an alternative. DOE is already analyzing an on-site disposal alternative and there do not appear to be any advantages offered by relocating the tailings elsewhere on the site. Any alternate locations on the Moab site would result in more of the tailings pile/disposal cell lying in the 100-year floodplain of either the Colorado River or Moab Wash, thereby increasing the risk of flooding and decreasing cell integrity. One of the major objections to the existing pile is its proximity to the residents of Moab, to the Colorado River, and to Arches National Park. Moving the cell to a different location on the Moab site would not remedy these concerns and is likely to result in the relocated cell being closer to one of these three receptors. Although a relocated on-site disposal cell could be designed with a liner, it would continue to be located directly over an aquifer that feeds the Colorado River. Potential liner failure would pose a threat of contamination of the ground water and thus the Colorado River.

2.5.1.5 Removal of Top of the Pile

Because ammonia is the primary contaminant of concern and because it appears to be concentrated in the top of the pile due to the presence of a salt layer, some commentors have suggested that an alternative disposal strategy might be to remove the top portion of the pile (for example, the top 10 ft) for off-site disposal and cap the rest of the pile in place. However, DOE does not believe such a strategy offers potential advantages sufficient to warrant full analysis. While acknowledging that a salt layer may exist in the upper part of the pile and that leaching of ammonia from this layer could result in a temporary resumption of nonprotective surface water quality, modeling suggests that the potential impacts to surface water and aquatic species from salt layer leaching would not occur for at least 1,000 years. Moreover, partial removal of the pile would be the worst alternative in terms of proliferation of sites requiring long-term monitoring and stewardship. To some degree, removal and transportation of just the top of the pile would entail all of the unavoidable adverse impacts associated with full off-site disposal but would not result in any of the benefits to be accrued at the Moab site through full off-site disposal. DOE does not believe the alternative offers any compelling benefits in terms of impact or cost.

2.5.2 Off-Site Alternatives

2.5.2.1 Off-Site Surface Locations

Several off-site locations were considered for surface disposal of contaminated materials. All sites are within the state of Utah and included the following:

- Envirocare
- ECDC
- Green River
- Box Canyon
- Rio Algom
- Cisco site
- Whipsaw Flats
- Summo Minerals Lisbon Valley

These alternate locations for surface disposal were eliminated from further consideration on the basis of the following factors:

The licensed capacity of the Envirocare site is only half of the volume of tailings at the Moab site that would require disposal. Additional capacity for the tailings would require an amendment to the existing license from the State of Utah and an environmental evaluation. In August 2004, NRC transferred licensing authority to the State of Utah for the regulation of the possession of by-product material by persons. The tailings-transport distance to the Envirocare site would be over 200 miles (170 miles farther than the Crescent Junction site). Transportation costs associated with disposal of the tailings at Envirocare would be prohibitive.

ECDC formally withdrew its site from consideration shortly after the Notice of Intent To Prepare an EIS was published. At the Green River site, the location of the Green River floodplain in the northern portion of the site would limit placement of a disposal cell to the area south of the Probable Maximum Flood (PMF [see definition in Chapter 1.0]) boundary. The site is also bounded by I-70, which would severely restrict the space available for cell construction and disposal. The Box Canyon site would be limited by several small washes formed by surface runoff at the site, and the space is limited for a tailings pile. In addition, the Box Canyon site is located in an area frequented by tourists and outdoor recreationists, making it incompatible with a tailings disposal facility.

The Rio Algom facility was not considered a viable disposal site because (1) shallow, contaminated ground water exists in the Burro Canyon aquifer, (2) the ACL application has already been submitted to NRC for approval and termination of the license, contingent on existing conditions, and (3) adjacent property has already been acquired to provide an institutional control over the site-related contamination in ground water, and it may be impractical to expand farther.

The Cisco site is located 30 miles farther from Moab than the Crescent Junction site, and transportation costs would be higher compared to those for the Klondike Flats or Crescent Junction sites. Also, the Cisco site does not offer disposal criteria that are better than those at the Klondike Flats site. The Whipsaw Flats site is close to Arches National Park, and NPS personnel have opposed this location because the disposal site would be visible from portions of Arches National Park. In addition, this site would not offer any advantages over the Klondike Flats or Crescent Junction sites and would be more difficult to access than either the Klondike Flats or Crescent Junction sites.

The Summo Minerals Lisbon Valley site was proposed by a private copper mining company who suggested that the Moab tailings could be co-deposited with copper ore heap-leach residues. The Lisbon Valley site is located roughly the same distance from Moab as the Klondike Flats site, but the hydrogeology is less favorable.

Comments received in scoping meetings suggested several other off-site alternatives or related actions. These were considered but dismissed as described in the following discussions.

Railroad to White Mesa Mill Site—DOE considered but dismissed construction of a new railroad line from the Moab site to White Mesa Mill as an alternative because of the potential for extensive environmental impacts, technical difficulty, and cost. Minimum construction costs for a new rail line are typically in the range of $1 million to $3 million per mile, depending on terrain. In areas where the grade exceeds 1 to 2 percent, the line would have to be routed to avoid these grades, thereby adding to the total mileage, or the railbed would have to be graded to 1 to 2 percent, which would add to the cost and terrestrial impacts. A railroad bridge crossing the Colorado River would be a major additional expense and would require extensive and unforeseeably complex and lengthy permitting issues and potential delays in completing the construction. Acquisition or leasing of undisturbed land, much of it privately held, would be an additional expense, as would the necessary land surveys and road crossings, and there would be no guarantees that the required land could be secured without condemnation proceedings. DOE estimates that capital construction costs of a new 90- to 100-mile railroad from the Moab site to the White Mesa Mill site would exceed $150 million, including land surveys/acquisition and track, bridge, and road crossings construction. This is almost twice the projected capital construction costs for building a pipeline. Based on these higher capital construction costs, uncertainties surrounding the permitting process, and the likelihood of significant environmental impacts, this alternative was dismissed from further consideration.

Old Mines—Disposing of the contaminated tailings in old mines was dismissed from consideration because (1) no single mine in the region had sufficient volume to contain the contaminated material from the Moab site, (2), mines are typically excavated by blasting, and consequently can be structurally and geologically unstable, and (3) old mine shafts could also be susceptible to explosions, poisonous gas, and cave-ins. The use of mines under these conditions would pose serious logistical and worker occupational safety and health concerns.

Grand County Landfill—Using the Grand County landfill or allowing Grand County to own or direct operations of the cleanup area was dismissed because the landfill is neither permitted for nor technically designed for radioactive waste.

River Rerouting—Rerouting the Colorado River away from the Moab site was dismissed as an alternative because of the broad range of adverse and irreversible environmental impacts to the Matheson Wetlands Preserve that such an undertaking would entail.

Land Use—Converting the site into a golf course was suggested but is not considered an alternative remediation action. Rather, it is a potential future land use suggestion that will be considered at a later time.

Use of Contaminated Water—Contaminated ground water could possibly be used to augment the slurry pipeline recycle makeup water requirements or, depending on schedule, to augment the nonpotable requirements for the initial pipeline slurry. However, the anticipated 150 gpm of pumped contaminated ground water would be less than 40 percent of the required 409 gpm of makeup water (see Table 2–12). If the pipeline option were implemented, the effluent discharge options discussed in Section 2.3.3 would be evaluated, and a preferred option or combination of options would be selected for more detailed technical and engineering review. Use of contaminated water to augment the slurry water requirements would be evaluated at that time.

2.5.2.2 Disposal in Mined Salt Caverns

In late 2003, DOE considered an option to dispose of the Moab mill tailings in solution-mined salt caverns either at the Moab site or off site at two potential locations. Conceptually, disposal caverns would be created by solution mining in the salt beds of the Paradox Formation beneath the Moab site or at other possible locations, such as the commercial potash mine site approximately 6 air miles downstream from Moab. This option would involve withdrawing Colorado River water for the solution mining process; the water would become saturated with salt, generating brine that would have to be disposed of by deep well injection or solar evaporation or perhaps by use in the potash mining operations. Appendix E presents DOE's evaluation of this alternative approach.

Disposal in mined salt caverns is an unproven approach to uranium mill tailings disposal that would require immense amounts of Colorado River water (approximately 1,700 gpm of fresh water, roughly 880 million gallons per year or 73 million gallons per month) for a 20-year period to perform solution mining activities. DOE does not currently own the rights to withdraw this much water, and if they could be purchased, DOE would be required to pay water depletion fees associated with compensation of existing water right holders because of impairment.

DOE's programmatic experience with the complexity of implementing a first-of-a-kind unproven disposal technique for radioactive waste indicates that implementation of this option could be 3 or 4 times as long as all other alternatives (up to a few decades to go operational, a 20-year operations time frame, and a project life cycle range of multiple decades). Technical, geological, hydrological, seismological, legal, economic, and operational uncertainties present a real potential for substantial schedule and cost growth over current estimates. More specifically, these technical and operational uncertainties include (1) the location of favorable geologic strata that could be used for disposal of the brine by deep well injection and the rate and extent that brine could be injected; (2) the location, depth, and configuration of the caverns to be solution mined in the Paradox Formation; (3) the long-term performance of salt caverns in isolating the mill tailings; (4) the private/government business model that could allow use of the salt or brine, (5) the consumption of significant quantities of Colorado River water, which may be more than is available under DOE's water rights and possibly more than what would be acceptable under the recovery program for endangered fish; (6) the high potential cost (approximately $892 million to $1.3 billion); and (7) high potential for cost growth well beyond the range identified for other alternatives.

Resolving these uncertainties sufficiently to determine whether this alternative would be technically feasible and cost-effective would require a significant investment in additional studies. Such studies would include injection well testing, subsurface characterization, salt cavern performance modeling, an assessment of legalities, and an overall system performance assessment. The studies could require several to tens of millions of dollars and many years to complete, with no guarantee that the investment would demonstrate that this alternative is technically viable or offers substantive advantages to DOE or the public relative to the other alternatives being considered. Because the available data are not sufficient to provide the basis for a decision of this magnitude, DOE would need to delay the EIS to obtain this information.

An advantage of the solution-mixed salt cavern approach is the potential for longer-term isolation and more protection than that offered by other alternatives. Other advantages are that (1) salt cavern disposal would produce the least long-term environmental impact because no surface footprint would remain at the conclusion of the disposal period, and (2) this approach provides another disposal option for contaminated ground water for 50 of the 75 to 80 years required for active ground water remediation.

However, on the basis of the evaluation of this option and review by the 12 cooperating agencies and given the technical, legal, and economic uncertainties associated with this unproven technical approach, DOE's past experience, and the potential advantages with respect to the existing alternatives and the disadvantages, DOE has concluded that this option is not "practical or feasible" and has therefore decided not to include salt cavern disposal as a reasonable alternative in the EIS.

2.6 Description and Comparison of Alternatives and Environmental Consequences

Section 2.6.1 summarizes the potential impacts (both adverse and beneficial) to the physical, biological, socioeconomic, cultural, and infrastructure environment that could occur under the on-site disposal alternative, the off-site disposal alternative, and the No Action alternative. Human health impacts are also summarized. This section also compares the major differences in impacts among the alternatives and the differences among transportation modes under the off-site disposal alternative. It is based on the consequences, including assumptions and uncertainties, identified in detail in Chapter 4.0 of the EIS. Section 2.6.2 summarizes the potential impacts (both adverse and beneficial) to the physical, biological, socioeconomic, cultural, and infrastructure environment that could occur at the potential borrow areas. Section 2.6.3 identifies areas of uncertainty in DOE's analyses and the potential ramification of those uncertainties on decision-making. Section 2.6.4 recognizes that there are opposing views on a few issues, characterizes those opposing views, presents DOE's position on the issues, and discusses the implications of these issues to decision-making.

2.6.1 Impacts Affecting the Moab Site and Vicinity Properties, Transportation Corridors, and Off-Site Disposal Locations

Geology and Soils. Under either the on-site disposal alternative or the No Action alternative, the combination of the processes of subsidence and incision would slowly affect the tailings pile by lowering it in relation to the Colorado River. This impact would not occur under the off-site disposal alternative because the pile would be removed. There is also the potential for minor geologic instabilities in areas surrounding the White Mesa Mill site. Sand and gravel resources beneath the Moab site would be unavailable for commercial exploitation under all the alternatives due to residual contamination, even after surface and ground water remediation was complete. There are no known geologic resources beneath any of the alternative off-site disposal cell locations that would be affected by the proposed actions. Under any of the action alternatives, approximately 234,000 tons of contaminated site soil would be excavated and disposed of with the tailings.

Air Quality. Under the on-site and off-site disposal alternatives, emissions of particulate matter would occur during construction and excavation operations and would require dust control measures. Operation of vehicles and construction equipment would result in emissions of criteria air pollutants. Air pollutant emissions would be greater under the off-site disposal alternative as compared to the on-site disposal alternative, primarily because of the need to transport the tailings. Among the alternative off-site locations, transporting the tailings to the White Mesa Mill site would result in the largest volume of air pollutants because of the longer distance to be traveled. With respect to the alternative modes of transportation under the off-site disposal alternative, transportation of the tailings by slurry pipeline would involve less air pollution than would either truck or rail transportation due to the lower level of exhaust emissions. Such emissions would be greater for truck versus rail transportation. However, none of the proposed action alternatives would result in air emissions that exceed National Ambient Air Quality Standards or Prevention of Significant Deterioration increment limits.

A detailed human health analysis that includes health impacts associated with air quality is provided in Appendix D of the EIS. The design and construction of the disposal cell cover at all disposal sites would ensure that radon emissions would be below applicable health standards. Under any of the proposed action alternatives, long-term air emissions at the Moab site from technologies evaluated for active ground water remediation would not exceed health standards for workers or the public.

Ground Water. Ground water remediation would be implemented under both the on-site and off-site disposal alternatives. Under the on-site and off-site disposal alternatives, supplemental standards would be applied to protect human health. The supplemental standards would include institutional controls to prohibit the use of ground water for drinking water. Under the on-site disposal alternative, the tailings pile would be a continuing source of contamination that would maintain contaminant concentrations at levels above background concentrations in the ground water and, therefore, potentially require the application of supplemental standards (institutional controls) in perpetuity to protect human health. Under the off-site disposal alternatives, contaminant concentrations in the ground water under the Moab site would return to background levels after 150 years, by which time active ground water remediation would have been complete and supplemental standards would no longer be needed. The tailings pile would not be a continuing source of contamination to ground water under the off-site disposal alternative.

DOE estimates that meeting its target ground water remediation goal of 3 mg/L of ammonia in ground water would require active ground water remediation at the Moab site for 80 years under the on-site disposal alternative and for 75 years under the off-site disposal alternative (Figure 2–45). DOE has determined that this duration of treatment would ensure that water quality in the Colorado River would remain protective after ground water treatment was terminated.

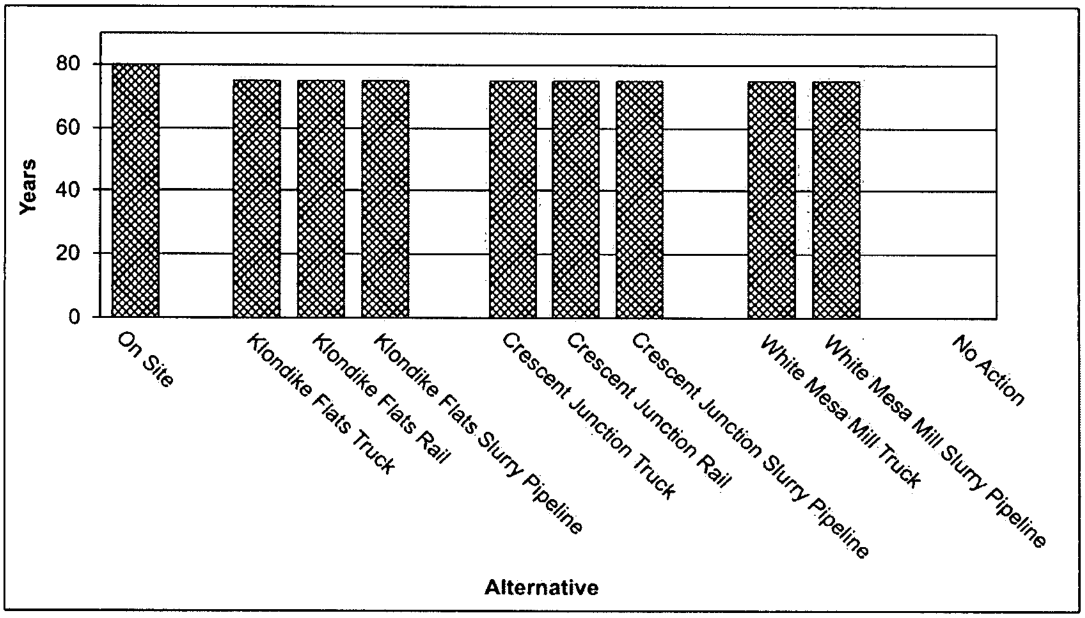


Figure 2–45. Estimated Duration of Ground Water Remediation

In the near term, DOE estimates that the proposed ground water remediation system would result in surface water quality that is protective of aquatic species in the Colorado River within 5 years after the system was implemented.

DOE also anticipates that contaminant concentrations in ground water and surface water that are protective of aquatic species in the Colorado River could be maintained, under all action alternatives, for the 200- to 1,000-year time frame specified in EPA's regulations (40 CFR 192.32[b][1][i]) promulgated under UMTRCA. However, under the on-site disposal and No Action alternatives, natural basin subsidence would result in permanent tailings contact with the ground water in 7,000 to 10,000 years, at which time surface water concentrations would temporarily revert to levels that are not protective of aquatic species in the Colorado River.

In addition, under the No Action alternative, the ground water beneath the Moab site would remain contaminated, would pose an increased risk to human health, and would continue in perpetuity to discharge contaminants to the surface water at concentrations that would not be protective of aquatic species. Cursory characterization indicates a potential for a salt layer in the upper zone of the tailings pile (see Table S–1). Modeling results indicate that under the on-site disposal alternative, contaminants from such a salt layer if present in the tailings pile would reach ground water in approximately 1,100 years and would affect ground water and surface water for approximately 440 years. Because ground water treatment would have been discontinued after an estimated 80 years, surface water concentrations could revert to nonprotective levels.

Surface Water. Under the No Action alternative, ground water and surface water contamination and nonprotective river water quality would continue in perpetuity. As stated in the discussion of ground water impacts, DOE estimates that under all action alternatives, contamination of the Colorado River from ground water discharge would be reduced to levels that would be protective of aquatic species within 5 years after implementation of ground water remediation because of the interception and containment of the contaminated ground water plume. Under the off-site disposal alternative, the removal of the pile coupled with the estimated 75 years of active ground water remediation would result in permanent protective surface water quality. Under the on-site disposal alternative, active ground water remediation would continue for an estimated 80 years.

In addition to natural subsidence described in the discussion of ground water impacts, a Colorado River 100- or 500-year flood could release additional contamination to ground water and surface water under the on-site disposal or No Action alternatives. However, under the on-site disposal alternative, the increase in ground water and river water ammonia concentrations due to floodwaters inundating the disposal cell would be minor, and the impact on river water quality would rapidly decline over a 20-year period. Under the No Action alternative, lesser flood events could also result in the release of contaminated soils to the Colorado River as sediment runoff. In contrast to the on-site disposal and No Action alternatives, the off-site disposal alternative presents no risk of these recurrences of surface water contamination at the Moab site because the tailings pile would be removed.

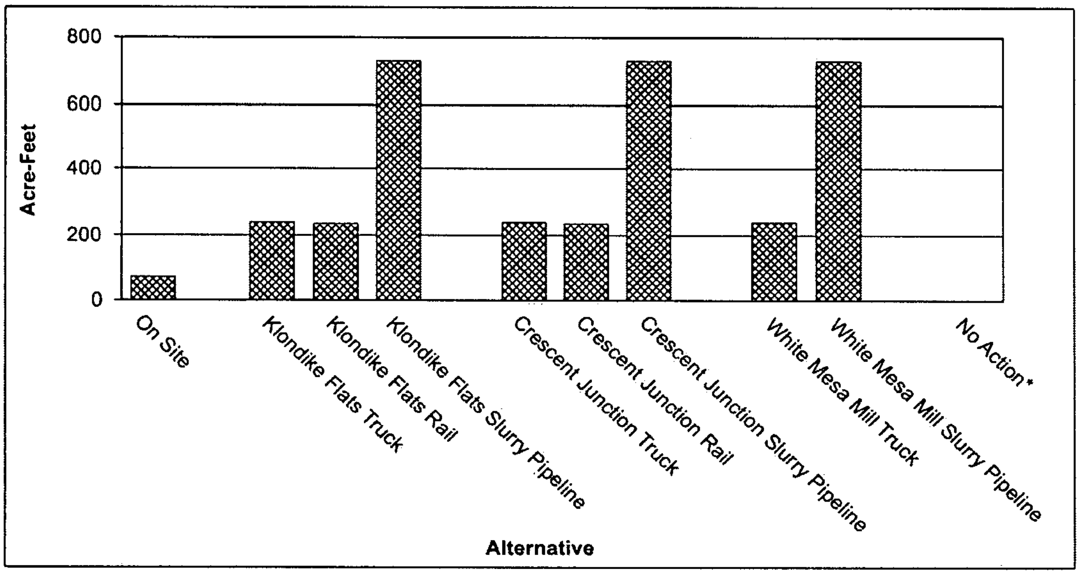
With the exception of ephemeral streams and impoundments, no surface water exists on or near any of the three off-site disposal locations.

Floodplains and Wetlands. As noted, 100- and 500-year flood events could partially inundate the disposal cell or pile under the on-site disposal alternative or No Action alternative. In addition, approximately 4.7 acres of wetlands could be contaminated in the long term under either of these alternatives. There are no known wetlands on or near the Klondike Flats or Crescent Junction sites, although potential wetlands exist near these sites and on the White Mesa Mill site. Under all the action alternatives, wetland areas on and adjacent to the Moab site could be adversely affected by surface remediation at the site, and for all action alternatives, activities would be necessary within the floodplain at the Moab site. Under the White Mesa Mill off-site disposal alternative, transportation of the tailings by slurry pipeline would require crossing the Colorado River, the Matheson Wetlands Preserve, and a number of perennial and intermittent streams. Potential wetlands near some borrow areas could be affected.

In accordance with its regulations (10 CFR 1022), DOE has prepared the *Floodplain and Wetlands Assessment and Floodplain Statement of Findings for Remedial Action at the Moab Site* and is included in the EIS as Appendix F.

Aquatic Ecology. Under the No Action alternative, the current adverse impacts to the Colorado River and to endangered aquatic species caused by contaminated ground water would continue in perpetuity. In comparison, under either the on-site or the off-site disposal alternative, these adverse impacts would cease within 5 years of the implementation of active ground water remediation, thereby eliminating the potential for impacts to aquatic organisms for the regulatory time frame of 200 to 1,000 years. Under the on-site disposal alternative and the No Action alternative, potential future releases of contaminants from natural subsidence (see the discussion of ground water) would cause adverse impacts to aquatic species in the Colorado River, but these impacts would not occur for at least 7,000 years. Under the off-site disposal alternative, the potential for future contamination from natural subsidence would be eliminated. Under all action alternatives, surface remediation activities at the Moab site would result in temporary disturbance to approximately 1.5 miles (8,100 ft) of Colorado River shoreline.

Annual withdrawals of Colorado River water (nonpotable water) are illustrated in Figure 2–46. All of these withdrawals are within DOE's authorized water rights. In addition, under the on-site disposal alternative, the required 70-acre-foot annual withdrawal would not exceed the 100-acre-foot annual limit that the USF&WS considers to be protective of aquatic species. However, this limit would be exceeded under the off-site disposal alternative.



*Impact would not occur under this alternative.

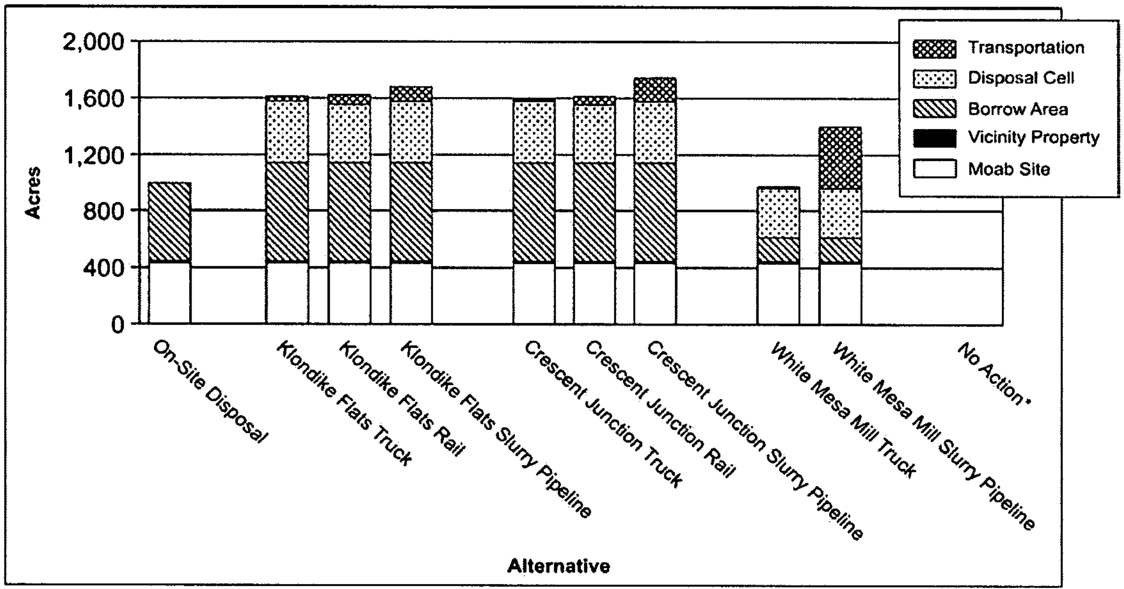
Figure 2–46. Annual Withdrawals of Colorado River Water

The truck or rail transportation modes would require annual withdrawals of 235 to 240 acre-feet, and the slurry pipeline mode would require annual withdrawals of up to 730 acre-feet, assuming all required slurry makeup and recycle water was drawn from the river. Exceeding the 100-acre-foot limit deemed protective for endangered fish species would be an unavoidable adverse impact. Mitigation would be accomplished in accordance with the cooperative agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin." The recovery program requires that all Section 7 consultations address water depletion impacts, and a financial contribution (adjusted annually for inflation) be paid to USF&WS to offset the impacts of water depletion. The contribution collected by USF&WS would be used to fund activities necessary to recover the endangered fish as specified in the recovery plan.

Terrestrial Ecology. All action alternatives would result in the temporary loss of 50 acres of vegetation and habitat at the Moab site. This would also be an adverse impact to some aquatic species given the proximity of the Colorado River. For any of the action alternatives, effects of human presence could reduce the overall habitat value of the area and could adversely affect two to four threatened terrestrial species if they are present at the site. Impacts of physical disturbance could be avoided or minimized by conducting site-specific investigations prior to any development to determine the presence of any species of concern.

All action alternatives would produce short-term land disturbance to the entire Moab site, to vicinity properties, and to one or more borrow areas. Disposal at any of the three off-site locations would result in land disturbance associated with construction of the off-site disposal cell and the requisite transportation infrastructure.

In general, the vegetation that would be disturbed is sparse and provides only poor habitat for wildlife; however, under the White Mesa Mill slurry pipeline transportation option, much of the land disturbance would occur in previously undisturbed areas. Figure 2–47 depicts the total acres of disturbed land for all alternatives and the relative contribution to the total associated with five activities or facilities.



*Impact would not occur under this alternative.

Figure 2–47. Maximum Land Disturbance

Revegetation would minimize land disturbance impacts over the longer term. Under the No Action alternative, animal intrusion into the tailings pile could result in acute or chronic toxic effects to wildlife. Transportation of the tailings by truck to an off-site disposal location would result in an increase in wildlife traffic kills due to the increase in traffic.

Land Use. Under any of the disposal alternatives, the land dedicated to the disposal cell would be unavailable for any other uses in perpetuity. Under off-site disposal at the Klondike Flats and Crescent Junction locations, up to 435 acres of undisturbed BLM rangeland would be dedicated to the disposal cell and therefore would be permanently unavailable for grazing rights; although there are no known resources beneath the off-site locations, the potential for oil and gas and mineral extraction would be lost in perpetuity. Under off-site disposal at the White Mesa Mill location, up to 346 acres would be dedicated to the disposal cell and therefore would be permanently unavailable for any other uses. However, at the White Mesa Mill site, the land that would be dedicated to the disposal cell has already been committed to the disposal of radioactive material. Under the on-site disposal alternative, the entire 130-acre recontoured disposal cell would be permanently unavailable for any other uses.

Under either the on-site or any off-site disposal alternative, the land at the Moab site required for ground water remediation infrastructure would be unavailable for any other use for the 75 to 80 years needed to complete ground water remediation. If an evaporation ground water treatment technology were implemented, the evaporation ponds could require up to 40 acres, and support facilities would require additional land.

As mentioned, under the on-site disposal alternative, the entire 130-acre recontoured disposal cell would be permanently unavailable for any other uses. Under either the on-site or the off-site disposal alternative, DOE's goal would be to have as much of the 439-acre Moab site available for unrestricted use upon completion of surface remediation as would be possible. However, it is possible that even after completion of remediation, the entire 439-acre Moab site would remain under federal control permanently. Under any action alternative, final decisions on allowable future land use at the Moab site could be made only after the success of surface and ground water remediation was determined.

Cultural Resources. Only the Moab site and White Mesa Mill site have been field-surveyed; however, cultural resources would probably be adversely affected under all the action alternatives. The numbers of potentially affected cultural resources would vary significantly among the action alternatives (Figure 2–48). The on-site disposal alternative would have the least effect on cultural resources, potentially affecting 4 to 11 sites eligible for inclusion in the National Register of Historic Places. The White Mesa Mill slurry pipeline alternative would have the greatest adverse effect on cultural resources, potentially affecting up to 121 eligible cultural sites. The Klondike Flats alternative could adversely affect a maximum of 35 to 53 eligible sites (depending upon transportation mode), and the Crescent Junction alternative could adversely affect a maximum of 11 to 36 eligible sites (depending upon transportation mode).

A minimum of 10 to 11 traditional cultural properties would be potentially affected under the White Mesa Mill truck or slurry pipeline alternatives (Figure 2–49). (The term "traditional cultural properties" can include traditional cultural practices, ceremonies, and customs.) Mitigation of the potential impacts to cultural sites and traditional cultural properties under the White Mesa Mill alternative would be extremely difficult given the density and variety of these resources, the importance attached to them by tribal members, and the number of tribal entities that would be involved in consultations.

Noise and Vibration. Noise generated by construction and operations under any of the action alternatives would not exceed 65 A-weighted decibels (dBA) at any permanent receptor location. The 65 dBA level is the City of Moab's nighttime limit for residential areas. Remediation activities at vicinity properties under any of the action alternatives would cause temporary increases in local noise levels, and the City of Moab noise standard could be violated. Small vibrations from activities at the Moab site could be felt near the boundary of Arches National Park under any of the action alternatives. Under the Klondike Flats or Crescent Junction truck alternatives, truck noise could disturb temporary residents of Arches National Park seasonal housing complex. Under the Crescent Junction truck or rail alternative, residents of Crescent Junction at the intersection of I-70 and US-191 would likely be disturbed by the noise from trucks or trains passing through to the Crescent Junction site. Under the White Mesa Mill truck alternative, residents of Moab, La Sal Junction, Monticello, and Blanding would also probably be disturbed by the increase in truck noise.

Visual Resources. Under the on-site disposal alternative, adverse impacts to visual resources would occur during the short and long terms. Contrasts between the surrounding natural landscape and the newly constructed disposal cell would be strong and would attract the attention of casual observers. Although these contrasts would lessen slightly over time when the side slopes become vegetated, the disposal cell would continue to remain an anomalous feature in perpetuity. Under the No Action alternative, leaving the existing tailings pile in place would result in adverse visual impacts in perpetuity as well. The predominantly smooth, horizontal lines created by the tailings pile contrast moderately and would continue to contrast moderately with the adjacent vertical sandstone cliffs. Visual impacts under both of these alternatives would not be compatible with visual objectives assigned by BLM to nearby landscapes.

Visual Resource Contrast Rating

DOE rated the degree of contrast between natural landscapes and the proposed alternatives as follows:

None: the contrast is not visible or perceived.
Weak: the contrast can be seen but does not attract attention.
Moderate: the contrast begins to attract attention and begins to dominate the landscape.
Strong: the contrast demands attention, will not be overlooked, and is dominant in the landscape.

Implementation of the off-site disposal alternative would result in beneficial visual impacts at the Moab site because the pile would be removed and would have negligible to adverse visual impacts at the off-site disposal locations, depending upon viewing location. Disposal at the Klondike Flats site would have mostly negligible impacts over the long term, as the cell would not be visible to most observers. Disposal at the Crescent Junction site would have mostly negligible impacts over the long term, as the cell would create only weak contrasts with the surrounding landscape for most observers (those traveling I-70). One exception would be for travelers at the I-70 scenic overlook. The higher viewing angle at this elevated location would allow observers to view the top and side slopes of the cell. The simple, rectangular form of the cell would contrast strongly with the surrounding landscape during the short term, and moderately with the surrounding landscape in the long term. Disposal at the White Mesa Mill site would have mostly negligible impacts over the long term, as the cell would not be visible to most observers. The most adverse short-term impact to visual resources under the off-site disposal alternative would occur if the slurry pipeline transportation option were selected. The landscape scars created by the pipeline would be visible to travelers on US-191 and would create moderate contrasts in form, line, color, and texture with the surrounding landscape.

Infrastructure and Resource Requirements. Under all action alternatives, demand for electricity, potable and nonpotable water, and sewage treatment would not exceed local capacity or DOE's withdrawal rights to Colorado River water. However, under the White Mesa Mill slurry pipeline transportation option, a booster pump station on the pipeline approximately 30 miles beyond the Moab site would be required. Powering the new pump station would require (1) adding a substation transformer at the Utah Power La Sal substation, (2) installing approximately 3 miles of new distribution line to service the booster pump station, and (3) upgrading the existing line from the La Sal substation to its current endpoint in Lisbon Valley. The required upgrade would entail modifications to line and pole configurations and capacities as necessary to accommodate the increased electric load represented by the booster pump station. A slurry pipeline to White Mesa Mill may also require a new substation transformer at Utah Power's Blanding substation and upgrades to the existing distribution line from the Blanding substation to the White Mesa Mill site. Exact upgrade requirements would be determined by the requisite detailed electrical engineering study if slurry pipeline transportation to White Mesa Mill were implemented.

Total diesel fuel consumption under the on-site disposal alternative would be 4 million to 5 million gallons. Total fuel consumption under the off-site disposal alternative would range from 12 million to 20 million gallons for truck transportation, from 10 million to 11 million gallons for rail transportation, and from 7 million to 9 million gallons for slurry pipeline transportation.

Weekly generation of sanitary sewage during surface remediation activities would range from 10,000 gallons (on-site disposal alternative) to 21,000 gallons (truck transportation option).

Figure 2–50 through Figure 2–54 compare the major resource and infrastructure requirements among the alternatives. These figures show that power and nonpotable water requirements would be significantly higher for the slurry pipeline alternative than for other alternatives. Fuel requirements for the White Mesa Mill truck alternative would be noticeably greater than for other alternatives because of the greater trucking distance. Sanitary waste generation would be greater for off-site disposal (15,000 to 21,000 gallons per week) than for on-site disposal (10,000 gallons per week), reflecting the larger work force and multiple work locations.

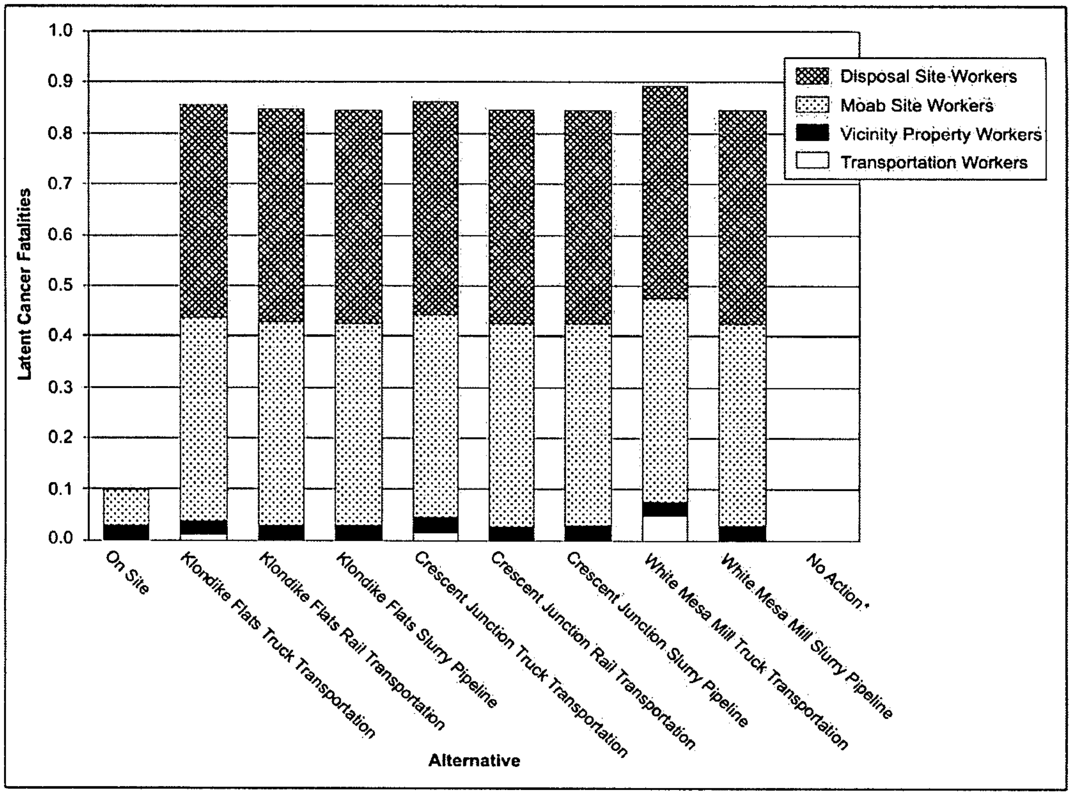
Waste Management. All action alternatives would generate identical amounts of RRM from treatment of contaminated ground water (Figure 2–55). Assuming ground water treatment would entail an evaporation technology, DOE estimates that this waste stream would consist of approximately 6,600 tons of RRM annually for 75 to 80 years and would be disposed of in the disposal cell or at another licensed facility. Surface remediation at the Moab site would generate approximately 1,040 yd^3 of solid waste annually under all action alternatives. Under any off-site disposal alternative, another 1,040 yd^3 of solid waste would be generated annually. These solid waste streams would be disposed of in the disposal cell or in local landfills. Landfills at Moab and Blanding could accommodate this volume of solid waste.

Socioeconomics. Figure 2–56 and Figure 2–57 compare socioeconomic costs and benefits (annual cost, output of goods and services, labor earnings, and job generation) among the alternatives. Of the action alternatives, on-site disposal would be the least expensive ($20.7 million annual average), assuming an 8-year period for surface remediation. The off-site disposal alternative would average between $41.3 million (Klondike Flats site) to $52.5 million (White Mesa Mill site) annually, using truck transportation. Rail transportation to Klondike Flats or Crescent Junction would average approximately $49 million annually. Slurry pipeline transportation would average between $49.4 million (Klondike Flats site) and $58.2 million (White Mesa Mill site) annually. The annual cost of each alternative would be directly proportional to the number of jobs that would be created regionally and the annual output of goods and services for each alternative.

The largest number of new direct and indirect jobs (778) would occur during the first year only of the White Mesa Mill pipeline alternative. For all pipeline alternatives, during the first year, the labor force would be higher due to pipeline construction; during years 2 through 8, the number of new jobs would be lower. On a sustained basis (years 2 through 8), the largest number of new direct and indirect jobs, 598, would occur under the White Mesa Mill truck transportation alternative (Figure 2–57). The smallest number of new direct and indirect jobs, 171, would occur under the on-site disposal alternative. Under both the on-site and off-site disposal alternatives, the increased work force would tend to cause some crowding-out impacts in hotels, apartments, and campgrounds in the Moab area during the peak tourism season, but lower vacancy rates would be expected during the off-season as workers took up temporary accommodation in the two-county region of influence. Crowding-out impacts would not be expected to occur in the White Mesa Mill area because of the availability of housing and accommodations.

The potential socioeconomic impacts from the No Action alternative would relate to potential longer-term damages that would result from leaving the pile and contaminated materials at vicinity properties where they are in their present form. These damages would include potential adverse impacts to human health, diminished quality of land and water resources, and potential losses in future economic development opportunities. In addition, implementation of the No Action alternative would result in loss of employment for the three to four individuals currently employed at the Moab site.

Human Health. No construction-related fatalities from industrial accidents are predicted to occur under any of the alternatives. However, construction and operations activities under all of the action alternatives would result in the exposure of workers and the public to very small amounts of radiation, which would present a risk of latent cancer fatalities among the workers and the public. Figure 2–58 shows total latent cancer fatalities for all workers by alternative and indicates the relative contribution to this impact for Moab site workers, disposal site workers, vicinity property workers, and transportation workers. The figure illustrates that latent cancer fatality risk to vicinity property and transportation workers would be very low compared to workers at the Moab site or at off-site locations. Site worker risk under the on-site disposal alternative would be less than half that under the off-site disposal alternative. Disposal at any of the three off-site locations would result in about 1 latent cancer fatality among the total worker population. The No Action alternative would result in no worker fatalities.



*Impact would not occur under this alternative.

Figure 2–58. Latent Cancer Fatalities Among Workers

Figure 2–59 illustrates the latent cancer fatalities predicted for members of the public from exposure to all sources of project-related radiation except for exposure to radiation at vicinity properties, which is presented in Figure 2–60. Estimates of latent cancer fatalities shown for the action alternatives in Figure 2–59 assume public exposure during the course of remediation activities and for 30 years thereafter. Approximately 1 latent cancer fatality would occur under the off-site disposal alternative from exposure to radiation (excluding exposures to vicinity property material), and this fatality would be almost entirely associated with exposure to radiation from remediation activities at the Moab site as opposed to off-site locations (Figure 2–59). Among the three transportation modes, the slurry pipeline mode represents the lowest public risk (0.75 latent cancer fatality) compared to 1.0 latent cancer fatality for truck or rail transportation. In contrast, the on-site disposal alternative represents a risk of about one-quarter of a latent cancer fatality among the public, and the No Action alternative represents just over 5 latent cancer fatalities among the public over a 30-year time period.

Figure 2–60 illustrates the potential latent cancer fatalities among members of the public due to exposure to radiation at vicinity properties based on the conservative assumptions used for analyses. For the action alternatives, this figure shows the relative contribution to the aggregate risk for 5 years before and for 30 years after remediation. DOE estimates that there would potentially be 12 latent cancer fatalities among the public under any action alternative and 26 latent cancer fatalities if the No Action alternative were implemented. These risks reflect ongoing long-term exposure dating back to the beginning of mill operations.

The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the decay of the radionuclides in the uranium mill tailings. In the time frame of 200 to 1,000 years, the major route of exposure of people would be through the inhalation of radon progeny from the disposal cell. Even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible, and DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 picocuries per square meter per second (pCi/m^2-s), under EPA's regulations (40 CFR 192).

On the basis of this emission rate, after the disposal cell cover was installed the annual latent cancer fatality risk from radon for a nearby resident at any of the disposal sites is estimated to be 8.9×10^{-5} per year of exposure. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time. Therefore, the annual latent cancer fatality risk for a nearby resident would be about the same immediately after the cover was installed as it would be 1,000 years after the cover was installed.

Long-term population risk assessment for this 1,000-year period would be greatly influenced by changing demographics. For comparison among the on-site and off-site alternatives, assuming no changes in population numbers or geographic distribution yields the following population risks over 1,000 years: the population around the Moab site would incur 6 latent cancer fatalities; the population around the Klondike Flats site would have a latent cancer fatality risk of 0.09; the population around the Crescent Junction site would have a latent cancer fatality risk of 0.07; and the population around the White Mesa Mill site would have a latent cancer fatality risk of 0.1.

Release of uranium mill tailings in a truck or rail transportation accident would not be expected to result in any latent cancer fatalities to either the exposed population or the maximally exposed individual.

Figure 2–61 compares nonradiological fatalities predicted among members of the public due to project-related traffic accidents and to exposure to project-related nonradiological pollutants during surface remediation activities. There would be less than one-tenth of one fatality due to exposure to nonradiological pollutants (for example, exhaust emissions) under any action alternative (Figure 2–61). Traffic fatalities would be directly proportional to truck shipment miles; fewer than one traffic fatality is predicted to occur under any action alternative except the White Mesa Mill truck alternative, where 1.3 traffic fatalities are predicted.

Traffic. Figure 2–62 through Figure 2–64 depict traffic impacts among the alternatives. All the proposed action alternatives would result in increased traffic on local roads and US-191. Among the three off-site disposal locations, truck transportation to the White Mesa Mill site would represent the most severe impact to traffic in central Moab, an area that UDOT currently considers to be highly congested. Transportation of contaminated materials from the Moab site to the White Mesa Mill site would result in a 127-percent increase in average annual daily truck traffic through Moab. In contrast, if the tailings were trucked to the Klondike Flats or Crescent Junction sites, or if either the rail or slurry pipeline transportation modes were implemented for any of the off-site disposal locations, there would be only a 7-percent increase in truck traffic through central Moab from shipments of vicinity property materials under all action alternatives, and only a 2- to 3-percent increase from shipments of borrow materials for the on-site disposal alternative or for off-site disposal at the Klondike Flats or Crescent Junction locations. All alternatives would also result in an overall increase in the average annual daily truck traffic on US-191, both north and south of Moab, from shipments of contaminated materials and borrow materials. These impacts would be most severe with the off-site truck transportation mode, which would increase average annual daily truck traffic on US-191 by 95 percent for the Klondike Flats or the Crescent Junction alternative and by 65 to 186 percent for the White Mesa Mill alternative, depending on the segment of US-191.

In comparison, the on-site disposal alternative and the rail or pipeline off-site alternatives would increase average annual daily truck traffic on US-191 only by 7 percent. Assuming conservatively that each worker would commute through Moab, the increase in all traffic through central Moab due to commuting workers would be minor for all alternatives, ranging from a 1- to 5-percent increase. As shown in Figure 2–61, DOE estimates that less than one traffic fatality would occur for all alternatives and transportation modes with the exception of truck transportation to White Mesa Mill, for which modeling predicts that 1.3 traffic fatalities would occur.

Environmental Justice. Disproportionately high and adverse impacts to minority and low-income populations would occur under the White Mesa Mill off-site disposal alternative (truck or slurry pipeline transportation) as a result of unavoidable adverse impacts to at least 10 to 11 potential traditional cultural properties located on and near the White Mesa Mill site, the proposed White Mesa Mill pipeline route, the White Mesa Mill borrow area, and the Blanding borrow area. Moreover, if the White Mesa Mill alternative were implemented, it is likely that additional traditional cultural properties would be located and identified during cultural studies. DOE would address the potential for adverse impacts to these properties once they were discovered.

The sacred, religious, and ceremonial sites already identified as traditional cultural properties are associated with the Ute, Navajo, and Hopi cultures and people. Currently, there are no known traditional cultural properties at any other site, although the potential for their being identified during cultural studies and consultations ranges from low to high, depending on the site and mode of transportation. The impacts to all other resource areas analyzed in the EIS (for example, transportation or human health) would not represent a disproportionate adverse impact to minority and low-income populations under any alternative.

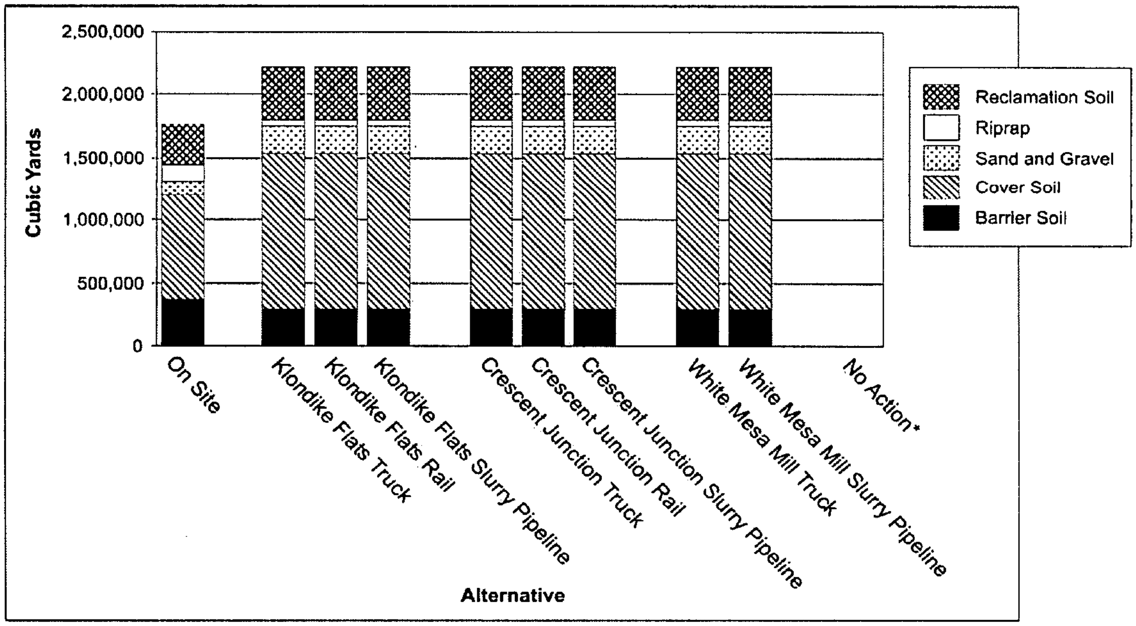
Disposal Cell or Tailings Pile Failure. Under the on-site remediation alternative and No Action alternative, a disposal cell or tailings pile failure could pose a risk under the residential scenario and could result in adverse impacts to aquatic receptors from uranium and ammonia concentrations in the Colorado River. The risk would be much lower for the off-site disposal locations because the sites are not located near a river, do not have historical seismic activity, are not prone to subsidence attributed to salt dissolution below the alluvial basin, and are located away from population centers and sensitive habitats. The possibility and consequences of a tailings pile failure are greatest under the No Action alternative because it would not include the use of engineering controls to mitigate impacts from floods and other natural events as would occur under the on-site disposal alternative.

Table 2–32 compares the impacts analyzed in the EIS. In general, the information in Table 2–32 is the same as that provided in this section. The information is repeated in tabular form as an aid to readers who may wish to rapidly compare a specific impact across all alternatives.

2.6.2 Impacts Affecting Potential Borrow Areas

Although impacts to borrow areas would occur under any of the alternative actions, these impacts are discussed separately in this section in response to a request by BLM, one of the cooperating agencies. BLM indicated that analyzing impacts to borrow areas as a stand-alone topic would facilitate subsequent analyses necessary to authorize DOE to use borrow material at BLM-managed borrow areas.

All of the off-site disposal locations would require approximately the same amount of borrow material (2.2 million yd^3), about 20 percent more than the 1.8 million yd^3 that would be needed for the on-site alternative (Figure 2–65). The relative amounts of the five types of borrow material would be very similar for all alternatives, and approximately 90 percent of the required borrow material would be excavated soil (Figure 2–65). Further description of impacts at borrow areas is provided in Section 4.5 and Table 4–52.



*Impact would not occur under this alternative.

Figure 2–65. Borrow Material Requirements

2.6.3 Consequences of Uncertainty

The purpose of this EIS is to assess and compare the potential environmental impacts associated with reasonable alternative actions to remediate the uranium mill tailings pile at Moab and contaminated ground water beneath the site. The EIS describes these impacts as accurately as possible given the available data and certain assumptions as required in the Council on Environmental Quality's NEPA regulations (40 CFR 1502.22). However, DOE recognizes that uncertainties are associated with these assumptions and that some of the assumptions could turn out to be inaccurate. Other areas of uncertainty have developed between DOE and one or more of its cooperating agencies on issues regarding regulatory or scientific interpretation. These uncertainties are relevant to decision-making, because if any of the assumptions underlying the EIS change significantly, the impacts as described could also change. It is important that decision-makers are cognizant not only of the nature and range of uncertainties inherent in the EIS but also of the potential consequences of these uncertainties. Many of the uncertainties have been identified and acknowledged in the EIS. This section delineates the major uncertainties and, to the extent possible, describes the potential consequences of them.

The uncertainties in the EIS include areas as diverse as the future regulatory environment, the duration of worker exposure to radiation, ground water modeling assumptions, and the timing of congressional appropriations. Some of these uncertainties (for example, congressional appropriations) would be "alternative neutral" in that the consequence of the uncertainty would be expected to affect all alternatives in the same way and to the same degree, with the exception of the No Action alternative. Other uncertainties would be irrelevant to some alternatives but of significant potential consequence to others. For example, the uncertainties surrounding the speed and direction of river migration are relevant to the on-site or No Action alternatives but are of no consequence to the off-site disposal alternative because the pile would have been removed.

The majority of these uncertainties relate to the intrinsic variability and heterogeneity of the natural media to which DOE is applying engineering solutions. The types and degrees of uncertainty identified in this section are typical of those that have been encountered during the characterization and remediation of the previous 22 sites designated under Title I of UMTRCA and are similarly typical of the uncertainties associated with this stage of decision-making for remedial action projects. Based on DOE's extensive history with the remediation of uranium mill tailings sites, reasonable conservatism has been employed in characterizing the costs, resources, and impacts associated with meeting the statutory requirements of UMTRCA and NEPA. Consistent with the Council on Environmental Quality requirements for incomplete or unavailable information (40 CFR 1502.22), within this EIS DOE has explicitly identified its assumptions where information may be limited, clearly indicated the methods and models used in its analyses, and evaluated the potential relevance of incomplete or unavailable information to decision-making.

Table 2–33 identifies the major areas of uncertainty, characterizes the changes that might occur in the predicted impacts, and establishes the relative effect that such changes in impacts might have on the alternatives evaluated in this EIS.

2.6.4 Responsible Opposing Views

As a result of input developed in the public comment process and consultations with the 12 cooperating agencies, DOE has identified three general topics on which there exist responsible opposing views to DOE's position regarding the remediation alternatives for the Moab site: river migration, contaminated ground water flow under the river to the Matheson Wetlands Preserve, and the appropriate compliance standard for aquatic species in the river. Sections 2.6.4.1 through 2.6.4.3 summarize the responsible opposing views on these topics, DOE's positions on these topics, and the implications for the alternatives should DOE's views prove to be incorrect.

2.6.4.1 Responsible Opposing Views on River Migration

Several commentors, including state and federal agencies, presented their views regarding the EIS's characterization that the dominant direction of river migration over the next 200 to 1,000 years will be away from the site and that, should the tailings and associated wastes be remediated on the site, the infrastructure proposed under this alternative could be built and maintained in a manner protective of public safety and the environment. Specifically, commentors based their views on different interpretations of data addressed in the EIS.

- *USGS Study*. In a recent study (USGS 2005), the USGS used a multidimensional hydrodynamic model to explore the hydraulic conditions of the existing channel geometry and three hypothetical channel scouring geometries under 100-year (97,600 cfs), 500-year (120,000 cfs), and PMF (300,000 cfs) discharge conditions. Water surface elevations, velocity distributions, and shear-stress distributions were predicted for each discharge and each channel geometry. The report states that "...predicted main-channel bed stress values indicate substantial transport of medium-sized gravels for the simulations conducted with the existing channel geometry. Transport of coarse sands was predicted near the tailings for the 100-year discharge, and fine gravel transport was predicted in this region for the PMF discharge." Overbank shear stresses are greatest for the hypothetical 25-ft scour channel geometry. The State of Utah and others have interpreted the results of this study to indicate that substantial potential for erosion of the riverbank adjacent to the tailings pile exists and that this potential poses a sufficient threat and uncertainty to warrant relocation of the tailings to a more geologically stable location.
- *Interpretation of Historical Documents*. Dr. John Dohrenwend questioned DOE's interpretation of the 80-year history documented by historical maps and aerial photographs. A particular concern was that the photographs were not properly registered or interpreted. Dr. Dohrenwend's interpretation was that if the images were properly registered or evaluated, they would show that the Colorado River is not migrating south and east away from the tailings pile, but rather to the north and west, toward the pile. Comment 429 in EIS Volume III, "Comment Responses," presents the complete text of Dr. Dohrenwend's opposing view.
- *Significance of Flows into the River*. Dr. John Dohrenwend raised the issue of the significance of Courthouse Wash and Moab Wash on the movement of the Colorado River. Dr. Dohrenwend and others suggested that flows from Courthouse Wash have deposited sediments on the south side of the Colorado River channel and, therefore, have actively contributed to the northward migration of the river channel, not southward and eastward as indicated in the EIS.

- *Interpretation of Data.* DOE's interpretation of available well log and borehole data was called into question. Dr. John Dohrenwend and the State of Utah interpreted the available data to indicate that the valley fill is not thickest and deepest south of the present location of the river channel, but rather beneath or perhaps as much as several hundred feet north of the present river channel. Therefore, the commentors maintained, there is no reason to suppose that continuing subsidence of the valley floor would cause the river channel to migrate away from the tailings pile. The opposing interpretation is that if the thickest and deepest valley fill deposits mark the position of maximum valley subsidence, there would instead be strong reason to suppose that continuing subsidence could cause the river to move closer to the pile.

  Dr. Dohrenwend also challenged DOE's interpretation of available subsurface data. He interpreted these data to show that conditions directly beneath the tailings pile are much more complex than presented in the EIS. The opposing interpretation is that the data indicate localized subsidence of the valley floor and that the subsidence must be considered as a possible and potentially serious geologic hazard. Moreover, a comparison of surface and subsurface data along the northern margin of Moab Valley between Courthouse Wash and the millsite suggests the possibility that localized subsidence or extremely deep channel scour has occurred in this area sometime during the past 45,000 years.

- *Dissolution of Salt Layers.* Dr. John Dohrenwend raised the issue of the dissolution of the salt layers (Paradox Formation) beneath Moab Valley. Dr. Dohrenwend maintains that dissolution of the salt layers is causing slow subsidence of the alluvial fill within the valley. In his interpretation, the Colorado River and its local tributaries deliver far more sediment to the valley floor than could ever be accommodated by the valley's slow subsidence. Therefore, ongoing deposition by the Colorado River and by Mill Creek and Pack Creek are the principal processes controlling the surficial geology and geomorphology of Moab Valley.

Commentors agreed with the EIS characterization that the geometry and position of ancient Colorado River gravels buried beneath the surface of Moab Valley clearly show that the Colorado River has shifted back and forth across the mill and tailings site in the recent geologic past. However, they interpret these data to mean that the river is therefore likely to traverse the site again in the near future.

The issue of recent flooding in the St. George and Santa Clara regions of Utah was also presented. The commentors interpreted these recent flood events on other drainages in Utah as demonstrations of the swift and immense force of floodwater in the desert. Some commentors have indicated that the unanticipated results of these occurrences demonstrate mankind's inability to adequately predict or engineer and plan for such impacts and that this potential poses a sufficient threat and uncertainty to warrant relocation of the tailings to a more geologically stable location.

In summary, commentors suggested that scientific evidence exists indicating flaws in DOE's interpretation concerning the suitability of the Moab millsite for the long-term disposal of the uranium mill tailings and associated waste. They maintain that the Colorado River channel has migrated both toward and away from the Moab millsite in the past 80 years and that it could do so in the future. The overall concern expressed by commentors is that the EIS has mischaracterized the available data and that the dynamic and often unpredictable nature of the river system and the inevitable migration of the river toward the site over geologic time make on-site disposal an inappropriate alternative. Their view is that under this alternative the potential impacts of river migration would pose unacceptable risks to a multitude of local and downstream users, as well as the ecological receptors of the Colorado River corridor.

DOE's Position on River Migration

DOE's position concerning lateral migration potential of the Colorado River is stated in a 2003 river migration report (DOE 2003a): "Although a conclusive prediction of future river movement is not possible, evidence suggests that the river is and will continue migrating to the south and east away from the existing tailings pile." The basis for this claim is supported by the following technical arguments:

- Historical evidence of river migration (e.g., aerial photographs, historical topographic and property survey maps) indicates that the river has remained stable to moderately stable for the last 120 years, suggesting that catastrophic rapid channel migration is unlikely and indicating that all floods have dissipated by overflow into the Matheson Wetlands Preserve. Significant movement of the right bank (tailings side) has not occurred in the historical time frame.

- Sediment input from Courthouse Wash and Moab Wash has created an alluvial fan upon which the tailings impoundment is constructed. Both washes have delivered significant quantities of sediment in the past and will continue to do so into the future unless profound changes occur in the watersheds. Sediment deposition has pushed the river channel south into Moab Valley.

- The current location of the Colorado River is approximately 1,100 ft south of the terrace formed at the confluence of Courthouse Wash and the Colorado River, suggesting that the river has moved south since the time the terrace gravels were deposited. Geologic mapping by the Utah Geologic Survey has dated this terrace as late Pleistocene, and this date is supported by correlation of soil profiles. The terrace age provides an indication of the length of time in the past the river channel was at that location and was flowing with a velocity high enough to transport and erode gravels. This finding indicates that the right riverbank has been stable for the last 30,000 years.

- The thickness and distribution of basin-fill sediments in Moab Valley indicate past and continuing salt dissolution of the valley. Subsidence creates a zone of accommodation for alluvial fill material transported by the Colorado River.

- The rate and character of salt dissolution in the Moab Valley area indicate that significant dissolution has occurred in the past and has trapped large quantities of sediment.

The absence of a cobble-gravel bedload downstream of the Portal (the location where the river exits Moab Valley and enters a canyon) suggests current salt dissolution of Moab Valley. Ongoing dissolution will tend to control the position of the Colorado River, and based on geologic evidence, subsidence is occurring beneath the Matheson Wetlands Preserve.

Implications of Opposing Views on River Migration

If the river migrates gradually to the north and west toward the disposal cell, annual inspections would afford the long-term steward, required under UMTRCA, the opportunity to implement additional mitigation measures beyond the disposal cell riprap side slopes and engineered buried riprap barrier wall already included in the conceptual design to ensure long-term protection. This could potentially involve additional bank armoring and stabilization and enhancement of the disposal cell riprap side slopes and engineered buried riprap wall. These efforts could involve additional temporary impacts at riprap borrow sources, temporary disturbances in the floodplain and riverbank areas associated with implementation of these enhancements, and additional transportation impacts associated with transporting the riprap or stabilization materials to the site. The cost of these measures could run to several million dollars.

The impacts to public health and the environment, should the river migrate toward the disposal cell catastrophically, is addressed in Section 4.1.17 of the EIS.

2.6.4.2 Responsible Opposing Views on Contaminant Flow Under the River

Dr. Kip Solomon and Phil Gardner of the University of Utah and commentors from the State of Utah, which commissioned Dr. Solomon's study, opposed DOE's view regarding the fate and transport of site-derived contaminants in ground water. This view states that these contaminants have migrated, and continue to migrate, under the Colorado River toward the Matheson Wetlands Preserve and that they pose a potential hazard to public health and the environment. This view is based primarily on the interpretation of three types of information: (1) a ground water flow gradient map based on calculated hydraulic heads that account for the effects of salinity on flow potential, (2) measured uranium concentrations in ground water on both sides of the Colorado River, and (3) analysis of stable isotopes of dissolved oxygen and hydrogen in ground water.

Values of equivalent freshwater head (EFH) were calculated by Gardner and Solomon (2003) at nine wells screened in brine at a common elevation of 3,904 ft above mean sea level. The calculations were performed using measured water levels at the wells and estimated TDS concentrations in the well columns at the common elevation. The resulting EFH values were plotted on a map of the area and contoured using a 1.6-ft contour interval. Contours of equal potential indicated ground water movement to the south-southeast; Gardner and Solomon infer that ground water on the project side of the river has the capacity to flow under the river toward the Matheson Wetlands Preserve. They also concluded that the sub-riverbed flow occurs within highly permeable basin fill consisting of very coarse sands and gravels, which are commonly observed on both sides of the river at a depth of about 16 to 23 ft below ground surface.

A map of posted uranium concentrations in ground water at five wells on the project side of the river and 14 wells southeast of the river (Gardner and Solomon 2003) suggested that uranium concentrations in wells along the river's east bank and in and near the Matheson Wetlands Preserve were derived from contaminated ground water on the Moab site. The explanation given for this connection was that ground water flows below the riverbed from the project site to the wetlands area in the very coarse basin fill sediments found in both areas. The study presented two cross-sections showing measured uranium levels in selected monitor wells on either side of the river as support for the possible transport of uranium from one area to the other.

Two cross-sections by Gardner and Solomon (2003) containing measured oxygen isotope ($\delta^{18}O$) ratios did not conform to DOE's conceptual model of ground water flow at the Colorado River, which hypothesizes that the river itself or an area close to its east bank acts as a ground water divide. Such a divide would likely result in more negative $\delta^{18}O$ ratios (compared to standard mean ocean water ratios) with depth in the ground water system near the river. However, Gardner and Solomon pointed out that less negative $\delta^{18}O$ ratios are observed below more negative ratios just to the southeast of the river. From this observation, the authors concluded that ground water from the project site with less negative $\delta^{18}O$ ratios migrates to deeper ground water below the Matheson Wetlands Preserve.

The Gardner and Solomon study also used dissolved ammonia concentrations on either side of the Colorado River as additional evidence to support a sub-riverbed hydraulic connection between the project site and the wetlands. Tailings-related, high ammonia contamination on the site is obvious, and the authors suggest that slightly elevated ammonia concentrations in ground water on the east side of the river are probably caused by subsurface transport from the site.

DOE's Position on Contaminant Flow Under the River

DOE's conceptual model of ground water flow at and near the project site considers the Colorado River and a limited area located just to the southeast of the river to be a site of both regional and local discharge for subsurface water. Ground water discharges to this area because the elevation of the river surface and shallow ground water to the immediate southeast is less than the flow potentials measured in ground water at the project site, in areas lying farther to the east and closer to the city of Moab, and in brine located beneath the river. Ground water flow converges toward the river from all of these zones, and a ground water divide occurs either in the river itself or slightly east of the river. This flow pattern prevents water from migrating beneath the river to the Matheson Wetlands Preserve.

The unique salinity conditions observed in ground water in the study area are attributed to the river's natural tendency to act as a site of regional discharge. Very saline water to brine is observed on both banks of the river at about the elevation of the riverbed. DOE views this phenomenon as a form of saltwater upconing that is similar to the upconing that would occur below a well that withdraws relatively fresh ground water above a saline zone. A natural source for the brine in the Moab study area is the dissolution of evaporite sediments that make up the Paradox Formation, which appears to subcrop hundreds of feet below the riverbed.

Information supporting this conceptual model includes flow potential data on both sides of and near the river. A significant upward component of flow was observed in these types of data collected at the project site for the SOWP (DOE 2003b). Steep upward gradients are also indicated in the data collected from three deep boreholes drilled just east of the river for the Gardner and Solomon (2003) study. From prominent studies of regional ground water flow over brine sources, it can be deduced that such upward gradients are expected in the vicinity of a site of ground water discharge. These studies also demonstrate that ground water velocities in the brine are very small and explain how relatively fast-moving fresh water above the brine moves mostly laterally to the site of discharge (e.g., a river). In effect, the brine at the discharge site acts as a barrier to ground water flow, thus limiting flow from one of its sides to the other. In a similar manner, DOE's conceptual model of ground water flow envisions shallow water converging toward the Colorado River from both the northwest and southeast and postulates that brine does not flow below the river from one side to the other.

From the available data and corresponding flow assessments, DOE concludes that ground water contamination does not migrate under the river from the project site to the Matheson Wetlands Preserve. The occurrence of ammonia (as nitrogen) concentrations in the 3- to 5-mg/L range measured just to the southeast of the river can be explained by the natural upconing of briny water in the vicinity of the river, not the result of sub-riverbed flow. Accordingly, DOE believes that the project site poses no potential human health risk on the east side of the river and that the site does not affect ecological receptors east of the river.

A review of measured ammonia concentrations in wells located close to the river but on its east side indicates that these ammonia levels have a high probability of being naturally caused. Ammonia levels in wells screened within uncontaminated brine near the river are typically in the 3- to 4.5-mg/L range, which is the same range observed in ground water on the river's east side. In addition, oil and gas wells drilled into the Paradox Formation in the vicinity of Moab Valley have encountered brine with ammonia concentrations as high as 1,330 mg/L.

Implications of Opposing Views on Contaminant Flow Under the River

If significant contaminant mass has flowed and continues to flow beneath the river eastward toward the Matheson Wetlands Preserve, contaminant concentrations would increase in the ground water in these areas. The existing concentrations of ammonia, uranium, sulfate, and chloride on the east side of the river are all within the range of natural background. It is not clear that future contaminant migration to the east side of the river would cause a significant health risk to the public or the environment. Because of the naturally high concentrations of TDS, chloride, and sulfate in all but the shallowest waters on the east side of the river (TDS below 3 to 14 feet is between 40,000 and 124,000 mg/L), the incremental addition of contaminants from the Moab site would not reasonably result in a significant increase in risk to receptors, given the poor ambient water quality and lack of exposure pathway. However, in the extreme case, additional ground water remedial action could be required to address the deeper contamination on both sides of the river. This could involve installing additional ground water monitor and extraction wells and implementing additional ground water treatment capabilities for many decades. Should this be required, implementation of these measures could cause (1) additional temporary surface disturbance on the tailings side and on the east side of the river within the floodplain, (2) additional water treatment waste generation for decades, and (3) the consumption of additional utilities. Consumption of water in the treatment process may have depletion impacts on recharge to the river commensurate with the extraction and treatment requirements of the system.

However, the current water quality of all but the upper few feet of the several-hundred-foot-thick aquifer on the east side of the river, like that on the west (tailings) side of the river, is an order of magnitude worse than any potential use criteria (more than 80,000 mg/L TDS—more than twice the salinity of sea water). Due to the naturally high salinity of the ground water on the east side of the river it is not used for drinking water, irrigation, or livestock watering. Therefore, there is no limited use of the aquifer on the east side of the river.

2.6.4.3 Responsible Opposing Views on the Appropriate Compliance Standard

The State of Utah and others presented opposing views regarding DOE's target cleanup goal for ground water of 3 mg/L ammonia (as nitrogen). The opposing view is that the ground water cleanup goal for ammonia should be the chronic AWQC for ammonia rather than the acute standard. These criteria vary depending on pH and temperature, but a value of 0.6 mg/L was shown in the SOWP (DOE 2003b) to be applicable for the vast majority of surface water conditions. The commentors maintain that the 0.6-mg/L ammonia goal must be met in ground water to ensure that it can also be met in quiet backwater areas that serve as endangered fish habitat. Their interpretation disagrees with DOE's interpretation that ground water discharging to the surface will undergo dilution by a factor of 10 or more. The high standard deviation associated with the average dilution factor is cited as evidence that there is no statistical basis for DOE's assumed dilution factor. Their view contends that DOE's analysis was based on data collected for purposes other than estimation of a dilution factor and that a much more rigorous sampling is required before a defensible dilution factor can be established. Commentors further argued that unless DOE better understands the geochemical behavior of ammonia as it is transferred from ground water to surface water, DOE has no choice but to apply the 0.6-mg/L criterion as a conservative interim cleanup goal.

Finally, the State of Utah questions DOE's conclusion that only 80 years of active ground water remediation would be required to meet remediation goals. This view is predicated on doubts that DOE's application of a 3-mg/L ammonia cleanup goal would be protective because of dilution of ground water as it discharges to the surface. The opposing view indicates that at least 200 years would be required to achieve the 0.6-mg/L level based on DOE's contaminant transport model. Also, the State of Utah maintains that the State can enforce the appropriate protective criteria in ground water.

DOE's Position on the Appropriate Compliance Standard

DOE has established the target cleanup goal for ammonia in ground water based on the national AWQC, considerable study of ground water and surface water data, and direct consultation with the USF&WS. These data were collected expressly to determine the validity of the conceptual site model presented in the SOWP and to better understand ground water-surface water interactions and the effect of discharge of ground water to the Colorado River. Results of these evaluations were presented in the SOWP (DOE 2003b), the *Fall 2004 Performance Assessment of the Ground Water Interim Action Well Fields* (DOE 2005a), the *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), and the *Performance of the Ground Water Interim Action Injection System at the Configuration 2 Well Field* (DOE 2005c). Also, the USF&WS has since prepared a Biological Opinion, which concurs that the target cleanup goal for ammonia in ground water is reasonable. In its Biological Opinion, the USF&WS indicates that additional studies are required as a reasonable and prudent measure to increase confidence for this target goal.

Specifically, DOE's use of the 3.0-mg/L acute ammonia-nitrogen standard as a ground water cleanup goal is based on the national AWQC. The acute criterion is a function of water pH, and the chronic criterion is a function of water temperature and pH. The national criteria documentation does not recommend using an average temperature and pH to calculate a single applicable value for the standards, but rather a range of standards that may apply under observed pH and temperature conditions. Chronic aquatic criteria represent the low end of the potential concentration range for protection of aquatic species from ammonia toxicity. The majority of chronic values measured in the surface water at the Moab site range from 0.6 to 1.2 mg/L ammonia (total as N) based on site-specific pH conditions. Acute criteria represent the higher end of the concentration range; the majority of acute values measured in the surface water range from 3 to 6 mg/L based on site-specific temperature and pH conditions. Therefore, it is DOE's position that ammonia concentrations (total as N) in surface water in the 0.6- to 6-mg/L range would be fully protective of aquatic life.

As discussed in Section 2.3.1.2, if ammonia concentrations in the ground water met the surface water standards, then discharge of ground water to the surface should not result in exceedances of those standards unless some other process (e.g., evaporation) increased contaminant concentrations in surface water. However, establishing the lowest end of the protective range as the ground water cleanup goal is not considered necessary to achieve compliance with surface water standards. Available data regarding interaction of ground water and surface water indicate that concentrations of constituents generally decrease significantly as ground water discharges to and mixes with surface water (at least a 10-fold decrease was noted [DOE 2003b, Section 5.6.6]). In general, more recent data collected by DOE since the SOWP confirm, with a few exceptions, that a 10-fold dilution factor occurs where the ground water plume is discharging adjacent to the river shoreline. In background locations where elevated ammonia from the Paradox Formation is discharging to the surface water, the 10-fold dilution factor may not apply. This more recent calculation set, *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), also provides a more detailed evaluation of the transfer mechanism between ground water and backwater areas.

Implications of Opposing Views on the Appropriate Compliance Standard

If the State's view prevailed, the proposed action for ground water remediation would change only in the duration for which the system would be operated. It is expected that the proposed ground water action would mitigate all impacts to the river within 10 years of implementation and would be operated for 75 years to meet the 3-mg/L ammonia target cleanup goal. Should the target cleanup goal be 0.6 mg/L, the proposed ground water action may need to be operated for at least 200 years. If this were the case, a commensurate increase in annual operation and maintenance costs, generated wastes, and water resource impacts would result for the additional period of operation. Although DOE would commit to completing its cleanup responsibilities in this case, DOE cannot now reasonably assure continued maintenance of active ground water remediation for a time period of 200 years or more. Section 2.6.3 discusses the uncertainty regarding achieving these cleanup goals.

2.7 Other Decision-Making Factors

2.7.1 Areas of Controversy

Several areas of continuing controversy have emerged as a result of DOE's discussions and consultations with cooperating and other agencies or as a result of public comments. Some of these issues and controversies derive directly from technical or regulatory uncertainties. Nontechnical issues and controversies have their origins in policies, perspectives, or positions endorsed by specific agencies or members of the public.

One area of controversy involves the ground water remediation standard to be applied. Based on its calculations, DOE has concluded that protection for aquatic species would be achieved at total ammonia concentrations in surface water of 3 mg/L (acute criteria) and 0.6 mg/L (chronic criteria that assumes dilution within a mixing zone). The USF&WS agrees with DOE that the target goal of 3 mg/L (acute criteria) in ground water that DOE has selected would be protective of aquatic species in the Colorado River.

However, UDEQ disagrees with DOE's selection of the acute standard and has stated that the chronic standard (0.6 mg/L) should be applied to ground water. The consequences of the State's position could lengthen the duration of ground water remediation and are discussed in more detail in Section 2.6.3, "Consequences of Uncertainty," and Section 2.6.4, "Responsible Opposing Views."

There are also some areas of technical disagreement regarding long-term site risks. These risks are associated with uncertainties in processes potentially occurring over hundreds or thousands of years that are not amenable to short-term resolution. For example, professional differences of opinion with the State of Utah on river migration and transport of contaminants under the Colorado River to the Matheson Wetlands Preserve can be resolved with certainty only through long-term monitoring. The potential consequences of these differing opinions with regard to environmental impacts are discussed in Sections 2.6.3 and 2.6.4. While acknowledging these as areas of scientific controversy, DOE does not believe that it is necessary to conclusively resolve these technical controversies before making informed site remediation decisions. DOE will, however, incorporate protocols into its ROD, which will be elaborated on in a subsequent remedial action plan, to require long-term processes to be monitored in a manner that would allow timely remedial action to be taken if DOE's assumptions were subsequently shown to be in error.

DOE recognizes each of these perspectives and, as appropriate, has incorporated them into the analysis of impacts. DOE will take these views into account when it makes its decision on the ultimate disposition of the tailings pile following the issuance of the final EIS.

The primary issue to be resolved is whether to dispose of the Moab uranium mill tailings pile on-site or off-site. If the off-site disposal alternative were selected, DOE must decide which of the three off-site disposal locations should be selected and which mode of transportation (truck, rail, or slurry pipeline) should be used. Ground water remediation would occur under any of the action alternatives. Selection of the No Action alternative for either surface or ground water remediation would not fulfill DOE's obligations under federal law to protect human health and the environment.

2.7.2 National Academy of Sciences Review

The Floyd D. Spence Act required that a remediation plan be prepared to evaluate the costs, benefits, and risks associated with various remediation alternatives, including "removal or treatment of radioactive or other hazardous materials at the site, ground water restoration, and long-term management of residual contaminants." The Act further stipulated that the draft plan be presented to NAS for review. NAS was directed to provide "technical advice, assistance, and recommendations" for remediation of the Moab site. Under the Act, the Secretary of Energy is required to consider NAS comments before making a final recommendation on the remedy. If the Secretary prepares a remediation plan that is not consistent with the recommendations of the NAS, the Secretary must submit to Congress a report explaining the reasons for deviating from the NAS recommendations.

The *Preliminary Plan for Remediation* (DOE 2001b) was completed in October 2001 and forwarded to NAS. The National Research Council, the chief operating arm of NAS, formed a committee of expert volunteers to review the draft plan and provide technical advice and recommendations for a remedy at the Moab site. The committee held a fact-gathering meeting in Moab on January 14–15, 2002; this meeting included a session for public input. The committee completed its report on June 11, 2002, and conducted a public meeting in Moab and released the report on the same date.

The NAS report concluded that existing scientific and technical data were insufficient to support a decision. Specifically, the committee provided four principal reasons for not selecting a remedial action alternative at the time the report was issued.

The first reason stated that "The pile, the Moab site, and alternative sites for a relocated disposal cell have not been characterized adequately." Since preparation of the *Preliminary Plan for Remediation*, additional characterization of the tailings pile and the Moab site, which was not available at the time of the NAS review, has been completed and is presented in the SOWP (DOE 2003b). In addition, numerous other reports have been acquired or generated by DOE that are cited as references throughout this EIS and that provide sufficient characterization of the three off-site alternatives to support the analyses in this EIS and future DOE decision-making.

The second reason stated that "Options for implementing the two primary remediation alternatives have not all been identified or sufficiently well defined." More detailed and complete options for implementing the two primary remediation alternatives, stabilize-in-place or off-site disposal, have been identified and defined in the EIS. For example, three off-site alternatives have been added to the scope of this EIS where, in contrast, the *Preliminary Plan for Remediation* only considered one off-site alternative in any detail. Pre-conceptual facilities configurations, transportation scenarios, and labor and resource requirements have all been defined and presented to support comparative impacts analysis. DOE is confident that the configuration and definition of all the alternatives is much more robust that originally presented in the *Preliminary Plan for Remediation* and sufficient to support sound decision-making. For this reason, the final EIS also serves as the final PFR.

The third reason stated that "Risks, costs, and benefits of the major alternatives have not been adequately characterized and estimated." Human and ecological risks, long- and short-term environmental impacts, costs, and benefits of the major alternatives, which were not completely developed in the *Preliminary Plan for Remediation*, have been fully developed and evaluated in the EIS. These include assessment of potential impacts of catastrophic failure of the disposal cell for the on-site stabilization alternative should DOE's conclusions regarding river migration prove to be incorrect.

The fourth reason stated that "Long-term management implications for each option have not been described." The scope and costs of the long-term stewardship requirements associated with each option have been more fully developed and evaluated in the EIS. Included in this evaluation are the long-term ground water remedial action costs and long-term stewardship costs for annual surveillance and maintenance. The impacts of catastrophic failure should long-term surveillance and engineering controls fail are also included in the EIS to support informed decision-making.

NAS also advised that decisions involving risk management should involve stakeholders from the earliest phases of defining the problem through the final decision. NAS noted that involving the public has particular value at Moab because of the anticipated long duration of the cleanup. To date, DOE's efforts toward public involvement have included public scoping meetings, periodic project update public briefings, publication of project documents on a project website, and presentations to city council meetings. DOE has also included federal and state agencies along with cities, towns, counties, and tribes as cooperating agencies in the development of the EIS through briefings, data submittals to cooperating agencies, and reviews of preliminary drafts. Section 1.6 presents a discussion of these activities and the differing opinions expressed by the cooperating agencies.

In addition, the National Research Council committee recommended further study and evaluation of a wide range of technical areas before DOE makes decisions on the remediation of the Moab site. Table 2–34 presents a summary of these recommendations. NAS did not provide a recommendation on a disposal alternative. Since the issuance of the NAS report, DOE has integrated the NAS recommendations for further study into ongoing site investigations and has used this new knowledge in the analyses performed for this EIS.

NAS has confirmed that its role in the Moab project ended with the issuance of its report, that NAS met its responsibilities under the Act, and that unless directed by Congress, NAS will not be reviewing the EIS (NAS 2004). DOE has considered NAS findings and recommendations in developing this EIS. Specifically, Table 2–34 lists key NAS recommendations, DOE's proposed resolution to findings and recommendations, and the chapter and section of the EIS in which they are addressed.

Table 2–34. Key NAS Recommendations for Assessing Remedial Action Alternatives for the Moab Site

Recommendation	Proposed Resolution	EIS Chapter/Section
Use bounding analysis to frame the major issues.	Incorporate bounding analysis throughout the EIS.	All sections
Evaluate the impacts of a potential failure of the tailings pile.	Include an evaluation of catastrophic failure of a disposal cell at the Moab site.	Chapter 4.0, Section 4.1.17, "Disposal Cell Failure from Natural Phenomena"
Rely on the experience gained from previous DOE projects and the UMTRA Project.	Use overall experience and lessons learned from DOE's uranium mill tailings cleanup programs, especially construction of uranium mill tailings disposal cells, annual inspections of disposal cells, and cleanup of UMTRA Project vicinity properties.	Chapter 2.0, Sections 2.1.1, "Construction and Operations at the Moab Site," 2.1.2, "Characterization and Remediation of Vicinity Properties," 2.1.5, "Resource Requirements"; Chapter 4.0, sections titled "Construction and Operations Impacts at the Moab Site," "Impacts from Characterization and Remediation of Vicinity Properties," "Monitoring and Maintenance Impacts"; and Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction."
Improve the understanding of the potential performance of the disposal cell.	Conduct a more detailed evaluation of physical conditions at the proposed disposal sites with respect to geology, soils, climate and meteorology, ground water, and surface water; design a disposal cell that would perform satisfactorily under worst-case conditions at the proposed sites.	Chapter 3.0, Geology—Sections 3.1.1, 3.2.1, 3.3.1, 3.4.1; Soils—Sections 3.1.2, 3.2.2, 3.3.2, 3.4.2; Climate and Meteorology—Sections 3.1.5, 3.2.3, 3.3.4, 3.4.4; Ground Water—Sections 3.1.6, 3.2.4, 3.3.5, 3.4.5; Surface Water—Sections 3.1.7, 3.2.5, 3.3.6, 3.4.6; Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction."
Evaluate impacts from institutional controls, including failure.	Evaluate institutional controls with respect to risk to workers and members of the public exposed to contaminants at the proposed disposal sites.	Chapter 4.0, "Human Health"—Sections 4.1.15, 4.2.15, 4.3.15, 4.4.15, 4.1.17, "Disposal Cell Failure from Natural Phenomena"; Appendix D, "Human Health."
Refine the initial cost estimates for the major alternatives.	Provide more detailed cost estimates in 2003 dollars.	Chapter 2.0, Section 2.7.3, "Costs"; Chapter 4.0, "Socioeconomics"—Sections 4.1.14, 4.2.14, 4.3.14, 4.4.14.
Examine the effectiveness of long-term management.	Prepare a risk assessment to evaluate several aspects of the two major alternatives—cap in place and off-site disposal.	Chapter 4.0, "Human Health"—Sections 4.1.15, 4.2.15, 4.3.15, 4.4.15, 4.1.17, "Disposal Cell Failure from Natural Phenomena"; Appendix D, "Human Health."

2.7.3 Costs

To support future decision-making, DOE has estimated the costs of the alternatives analyzed in the EIS (Table 2–35). The estimates, which are in 2003 dollars, include the total costs for surface remediation, ground water remediation, and long-term surveillance and monitoring of the disposal cell. The estimates assume that ground water remediation and long-term surveillance and monitoring would continue for 80 years under the on-site disposal alternative and for 75 years under the off-site disposal alternative, although DOE acknowledges that up to $35,000 in annual costs for disposal cell surveillance and monitoring could continue in perpetuity. The estimates assume implementation of a single work shift schedule; however, the estimates would be essentially the same if a double work shift were implemented because a double shift would not involve overtime costs, but only a compressed schedule for completing the same work. The cost estimate accuracy, as defined by ANSI and the Association for the Advancement of Cost Engineering, is a budget estimate and is expected to fall within the range of –15 percent to +30 percent. However, DOE acknowledges that additional uncertainties, such as land acquisition and impact mitigation costs, are inherent in these estimates. Since the draft EIS, DOE has refined the cost estimates for the Crescent Junction rail alternative. The expected value (mid-range) is now $578 million.

2.7.3.1 *On-Site Versus Off-Site Disposal Alternative Comparison*

Depending on the off-site disposal cell location and mode of transportation, off-site disposal would cost approximately 63 to 118 percent more than on-site disposal. In absolute terms, off-site disposal would cost approximately $158 million to $294 million more than on-site disposal, depending on the off-site disposal location and mode of transportation.

2.7.3.2 *Off-Site Transportation Options Comparison*

Among the three transportation options, truck haul would be the least expensive and slurry pipeline the most expensive. The cost difference between rail and slurry pipeline would be less than 2 percent. Truck transportation would cost approximately 10 to 15 percent less than either rail or slurry pipeline.

2.7.3.3 *Off-Site Disposal Cell Locations Comparison*

The costs for off-site disposal at the Klondike Flats and Crescent Junction sites would be comparable, differing less than 2 percent regardless of the mode of transportation. Consistent with this, the estimates indicate that transport distance is not a key factor in cost for the off-site disposal alternatives. The approximate ratio of the distances of the Klondike Flats, Crescent Junction, and White Mesa Mill sites from the Moab site is 1:1.7:4.7. However, despite the almost 5 times longer distance to White Mesa Mill, truck transportation would cost only 22 percent more for the White Mesa Mill site than for the Klondike Flats site, and slurry transportation would cost only 15 percent more. Nonetheless, the absolute increase in cost under the White Mesa Mill off-site disposal alternative would be substantial. Compared to the cost to ship to the Klondike Flats site, shipping to the White Mesa Mill site would cost $90 million more for truck transport and $71 million more for pipeline transport. In contrast, the absolute increase in cost for the Crescent Junction site over the Klondike Flats site would be only about $3 million to $7 million, depending on the mode of transportation.

2.8 References

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40 CFR 1500–1508. Council on Environmental Quality, "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act."

49 CFR 171. Research and Special Programs Administration, Department of Transportation, "General Information, Regulations, and Definitions."

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3.0 Affected Environment

This chapter provides information on the physical, biological, chemical, social, and infrastructure characteristics of the environment that could be affected by the proposed action and alternatives discussed in this EIS. This information is necessary to evaluate individual and interactive impacts that could result from the activities described in Chapter 2.0. Impacts are discussed in Chapter 4.0.

For the purposes of this EIS, the affected environment encompasses the Moab site, the three alternative off-site disposal locations (Klondike Flats, Crescent Junction, and White Mesa Mill), the transportation (rail and truck) and slurry pipeline corridors leading to the off-site disposal locations, and the borrow areas that may provide borrow materials for the proposed action. Where appropriate, a specific region of influence has been defined. The region of influence is the area that could be affected by activities associated with each alternative; this region varies depending upon the aspect being assessed. Section 3.1 describes the affected environment of the Moab site. Sections 3.2 through 3.4 describe the affected environment of the three alternative off-site disposal locations.

Although both the Klondike Flats and Crescent Junction sites are located north of the Moab site, some environmental, cultural, and social aspects at these alternative sites have important differences; these differences are discussed for each site. When resources and aspects are the same as or similar to those discussed under the Moab site description, the appropriate section under the Moab site is referenced when the resources are first discussed, or a brief summary of the resources is provided at the beginning of the section on alternative disposal sites.

The slurry pipeline route is discussed in the appropriate major section. For example, the pipeline route segments north of the Moab site are described in Section 3.2, Klondike Flats site, or Section 3.3, Crescent Junction site. The pipeline route segments south of the Moab site are discussed in Section 3.4, White Mesa Mill site.

Borrow areas are described in Section 3.5. Many borrow areas are within or near the boundary of a proposed disposal site; because of this proximity, either the general resources present at the borrow area are summarized, or a specific resource section is referenced. More detailed site-specific information could be researched and evaluated once specific borrow sources were selected.

3.1 Moab Site

The Moab millsite lies in eastern Utah in an area characterized by low precipitation, high summer temperatures, and moderate winter temperatures. Unique desert scenery in this area has attracted increasing numbers of tourists and new residents who like the moderate climate and variety of outdoor activities readily available. The focal point for the area is the city of Moab, which is about 3 miles southeast of the millsite on the opposite side of the Colorado River. Much of the surrounding area is open country administered by federal agencies, primarily BLM and NPS.

3.1.1 Geology

The Moab site is at the northwest end of Moab-Spanish Valley along the axis of the Moab Valley salt-cored anticline (Figure 3–1). The northwest part of the valley is Moab Valley; the site is located at the mouth of Moab Canyon. The steep slope southwest of the site flanking Moab Valley rises 1,200 to 1,400 ft to the top of sandstone-capped Poison Spider Mesa. Just north of the site, north of US-191, and at the north end of Moab Valley is a steep slope rising approximately 600 ft that is composed of highly fractured and faulted sandstones.

3.1.1.1 Stratigraphy

Rocks exposed and in subcrop in the area range in age from Middle Pennsylvanian to Middle Jurassic. These bedrock formations and their ranges of thickness are shown in Figure 3–2. This section briefly describes the geologic formations in relation to the site. More detailed geologic descriptions are provided by Doelling et al. (2002) and are summarized in the SOWP (DOE 2003).

Bedrock Formations

The Paradox Formation was deposited in a periodically restricted part of the Paradox Basin. However, no outcrops of Paradox Formation are present in the immediate site area. No boreholes are known to have penetrated the Paradox Formation beneath the site.

The Honaker Trail Formation crops out as ledges on a steep slope west and south of the tailings pile. Up to 600 ft of Cutler Formation is exposed south and west of the site.

The Moenkopi Formation, also west of the tailings pile, consists of mostly red interbedded siltstone, fine-grained sandstone, and mudstone.

Outcrops of the Chinle Formation are located south of the tailings pile.

The Wingate Sandstone forms a prominent gray-pink to red-brown smooth cliff south and west of the tailings pile and forms a wall along the northeast side of Moab Valley and at the mouth of Courthouse Wash. The Wingate is faulted and highly fractured near the Moab anticlinal axis as it plunges southeastward into Moab Valley.

The Kayenta Formation caps Poison Spider Mesa to the south; north of the site, the formation crops out along the edge of Moab Valley near the mouth of Courthouse Wash.

Exposed at the site north of US-191, the Navajo Sandstone forms the northwest end of Moab Valley and dips moderately (about 50 degrees) southwest along the southwest flank of the Moab anticline.

One member of the Carmel Formation and one member of the Entrada Sandstone are present in the northwest end of the site area in the subsurface just north of the Moab Fault (Figure 3–3) in the lower end of Moab Canyon. The Dewey Bridge Member of the Carmel Formation overlies the Navajo Sandstone. The Slick Rock Member, which is the only member of the Entrada Sandstone in the vicinity of the site, is well-fractured in the subsurface along the Moab Fault zone.

Quaternary Deposits

Except for the alluvial deposits, most Quaternary deposits are relatively thin. Because of the subsidence caused by removal of salt from the underlying Moab Valley salt-cored anticline, alluvium deposited mainly from the ancestral Colorado River has accumulated to a thickness of 450 to 500 ft beneath the site in Moab Valley. The subsiding Moab Valley has acted as a sump to catch Colorado River alluvium for much of Pleistocene time since erosion has begun "opening up" the Moab Valley salt-cored anticline and exposing the salt to dissolution by ground and surface waters.

The thick valley-fill alluvial deposits consist mainly of coarse gravelly sand, with minor silt and clay. Boulders as large as 1 to 2 ft in diameter, composed of resistant igneous and metamorphic rock types representing the upper Colorado River drainage, are common in the alluvium. At the mouth of Moab Canyon, the Colorado River alluvial deposits are mixed with and interlayered with generally fine-grained alluvium and detritus that has traveled down Moab Wash. Overlying the coarse alluvial deposits in the immediate site area in Moab Valley adjacent to the Colorado River is finer-grained alluvium of Holocene age composed mainly of sand, silt, clay, and minor lenses of gravel; this modern alluvium of the Colorado River covers much of the site area outside the tailings pile and is approximately 20 ft thick.

3.1.1.2 Structure

The Moab site is in the northern part of the ancestral Paradox Basin (see Figure 3–1). The salts deposited in this basin flowed toward northwest-striking faults in the basin floor, where they became thicker and formed northwest-striking elongate salt diapirs. Basins, called rim synclines, formed between the salt diapirs. Regional compression in Late Cretaceous to early Tertiary time formed broad northwest-striking anticlines and synclines, resulting in the Moab Valley salt-cored anticline (where the Moab site is located), the Courthouse syncline to the northeast of the site, and the Kings Bottom syncline to the southwest (see Figure 3–3). The northwest-striking Moab Fault (Figure 3–3) formed near the crest of the Moab Valley salt-cored anticline in mid-Tertiary time during a period of extensional faulting after regional compression.

Late Tertiary erosion allowed ground water to locally reach the upper parts of the salt diapirs through fractures and joints in the anticlinal folds. The resulting dissolution during late Tertiary and Quaternary time (and to the present) caused local areas of collapse, tilting, faulting, and subsidence of the overlying strata along the salt-cored anticlines. The degree of breaching (or opening up) of the salt-cored anticlines in this part of the Colorado Plateau largely reflects the amount of ground water that has been available for dissolution of the underlying salt and subsequent collapse. Ground water dissolves the salt and carries it away, leaving the insoluble part of the Paradox Formation as residue, called cap rock, on top of the leached salt diapirs.

3.1.1.3 Geologic Resources

In the site area, potash- and magnesium-bearing sylvite and carnallite are probably present in the salt wall, estimated to be at least 9,000 ft high and composed of the Paradox Formation in Moab Valley and adjacent Spanish Valley (Doelling et al. 2002). Similar deposits about 8 miles southeast of the site on the Cane Creek anticline (Figure 3–3) have been commercially extracted. Information is not sufficient to assess the extractability or value of the saline deposits.

Brine has also been produced from salt beds in the Paradox Formation about 2.5 miles southeast of the site. No oil or gas resources are known to exist beneath the site on the basis of oil and gas test holes drilled within 1 mile of the site.

The modern and older alluvium along the Colorado River, covering much of the site outside the tailings pile, contains sand and gravel suitable for highway and other construction. The considerable thickness of alluvial basin fill (up to 500 ft) beneath the site may also contain significant sand and gravel resources. A sand and gravel pit adjacent to the west edge of the site near the junction of US-191 and SR-279 was used by UDOT for highway construction and maintenance. This pit, UDOT 19076 (McDonald 1999) appears to be inactive.

Uranium and vanadium prospects occur south of SR-279 along the lower slopes of Poison Spider Mesa. No significant uranium-vanadium deposits are known to occur on the site; however, uranium and copper deposits have been identified in the lowermost part of the Chinle Formation about 8 miles northwest of the site.

3.1.1.4 Geologic Hazards

Swelling clay (montmorillonite) is present in the Moenkopi and Chinle Formations along the west edge of the site. These bentonite-derived clays are capable of absorbing large amounts of water, accounting for the shrinking and swelling character of the formations and their derived soils.

Piping and rapid erosion may occur in fine-grained soils and unconsolidated fine-grained sediments at the site along the ephemeral stream channel of Moab Wash. The piping can occur when water from storms flows into permeable, noncohesive layers, removes fine sediments, and exits where the layer reaches the surface (Doelling et al. 2002). The void space created is a "pipe" that promotes accelerated erosion.

Active rock-fall areas are along the top of the slope of Poison Spider Mesa, which have the potential to reach the southwest border of the site.

Seismic and salt dissolution hazards associated with the Moab Fault were evaluated by Woodward-Clyde Federal Services (1996a). These hazards consist of the capability of the fault to rupture the surface of the site, the potential for salt dissolution and collapse at the site, and the potential of a microearthquake trend along the Colorado River.

In the vicinity of the site, the Moab Fault consists of two branches—the main Moab Fault and the west branch of the Moab Fault, which is exposed in places west and southwest of the site on the slopes of Poison Spider Mesa. The inferred trace of the main fault before salt dissolution passes through the site approximately across the northeast corner of the tailings pile (Doelling et al. 2002). No historical macroseismicity has been noted along the Moab Fault, and microseismicity studies have not revealed any earthquakes associated with the fault. The site area is in Uniform Building Code 1, indicating lowest potential for earthquake damage (Doelling et al. 2002). A concentration of seismicity was evaluated in a probabilistic seismic hazard analysis by Woodward-Clyde Federal Services (1996b). On the basis of that analysis, the recommended design-peak horizontal acceleration was 0.18g. For a 10,000-year return period for a strong earthquake, this value provides the level of protection equivalent to the extent practicable as specified in 10 CFR 100, "Reactor Site Criteria." For these geologic and geophysical reasons, the

Moab Fault system is not a capable fault and does not pose a significant earthquake or surface-rupture threat to the present tailings pile.

Vertical subsidence rates in the northwest end of Moab Valley in the site area provide an estimate of the amount of collapse that could be expected from continued salt dissolution beneath the site. Rates of subsidence evaluated by Woodward-Clyde Federal Services (1996b) yield maximum estimates of 1 to 3 ft over 1,000 years. This deformation is expected to occur as a process of slow incremental displacements over time.

Radiocarbon dating of a wood fragment found deep in Colorado River alluvial deposits on the Moab millsite during monitor well drilling in summer 2002 provides another estimate of subsidence for the site. The carbonized wood fragment was in core from alluvial deposits at a depth of 116.5 ft in the boring for well MOA-435. The fragment was 89.5 ft below the top of gravel deposited by the Colorado River. A radiocarbon date of 45,340 years was determined for this wood fragment. Details of this wood occurrence and its radiocarbon dating are in the SOWP, Appendix D (DOE 2003). On the basis of this radiocarbon dating, a subsidence rate of approximately 2 ft per 1,000 years is indicated for the site; this rate is in the middle of the range (1 to 3 ft per 1,000 years) estimated by Woodward-Clyde Federal Services (1996b).

The rate of incision (downcutting) of the Colorado River where it has cut through sandstone bedrock upstream and downstream from the Moab site is much less than the estimated subsidence rate for the Moab Valley. The incision rate for this area has been estimated as 0.6 ft per 1,000 years by Willis (1992), using a dated volcanic ash bed preserved in a terrace at a known vertical elevation above the Colorado River. These subsidence and incision rates indicate that the tailings pile would become approximately 1.4 ft lower during the next 1,000 years in relation to the Colorado River.

Subsidence refers to the geologic process that is lowering the elevation of the entire tailings pile and the Earth's surface at the Moab site because ground water is dissolving the Paradox Formation salt deposits underlying the Moab-Spanish Valley. The rate of subsidence of the Moab-Spanish Valley is approximately 2 ft per 1,000 years. This gradual downward sinking of the tailings pile is partially offset by the gradual regional uplift of the Colorado Plateau.

River incision refers to the geologic process by which the Colorado River cuts down through the bedrock sandstone outcroppings located upstream and downstream of the Moab site. The rate of river incision in this area has been estimated as 0.6 ft per 1,000 years, much less than the estimated subsidence rate for the Moab Valley.

Over geologic time, the combined processes of subsidence and river incision will change the position of the tailings pile in relation to the underlying ground water and the Colorado River. As for ground water, these processes will eventually cause the bottom of the tailings pile to converge with the underlying ground water at an estimated rate of approximately 1.4 ft per 1,000 years. At this rate, DOE estimates that the tailings in the disposal cell would come into permanent contact with ground water in approximately 7,000 to 10,000 years, assuming the minimum depth to ground water ranges from 5 to 7 ft. As for the Colorado River, these processes will eventually lower the disposal cell by approximately 1.4 ft in relation to the river over the 1,000-year regulatory design period. This would place the 100-year floodplain of the river about 1.4 ft higher on the east toe of the cell, creating a higher probability for flooding over time. This potential impact would be very long term, and the potential hazard would be reduced by the proposed buried riprap diversion wall.

3.1.2 Soils

Surface soils in disturbed areas of the site are predominantly sands mixed with clays, silts, and gravels and are saturated within 16 ft of the surface most of the year (NRC 1999). Remaining native soils surrounding the site are predominantly sands mixed with clays, silts, and gravels and are classified as Nakai fine sandy loams (Table 3–1). Soils include sandy loams to loamy fine sands. Soils are generally deep (depths greater than 36 inches), are well-drained, and have a minimal water-erosion potential, a moderate hazard of blowing potential, and an estimated erosion rate of 3 tons per acre per year. Additional information is available in the *Soil Survey of Grand County, Utah, Central Part* (SCS 1989).

Table 3–1. Properties of the Nakai Soil Type

Soil Name	Taxonomy	Depth (inches)	pH	Salinity (mmho/cm)
Nakai	Coarse-loamy, mixed, mesic Typic Calciorthids	40–>60	7.4–8.4	< 2
Permeability (inches/hour)	**Available Water (percent)**	**Textural Class**	**Clay (percent)**	**Erodibility Factors[a]**
2.0–6.0	10–16	Fine sandy loam to loamy fine sand	10–18	K = 0.28 T = 3 Wind = 3

[a] Erodibility factors: "K," used in the Universal Soil Loss Equation, is an indicator of the susceptibility of a soil to sheet and rill erosion by water. Values range from 0.02 to 0.69; the higher the value, the more susceptible the soil is to sheet and rill erosion. "T" is an estimate of the maximum average annual rate of water or wind erosion in tons per acre per year.
Wind erosion factors range from 1 to 8; the lower the value, the more susceptible the soil is to wind erosion.
mmho/cm = millimhos per centimeter.
Source: SCS 1989.

3.1.3 Description of Contaminated Materials at the Moab Site

3.1.3.1 Millsite Contamination

In 2001, DOE began radiometric characterization of soils on the millsite. To date, the area north and northeast of the tailings pile have been assessed. Most of the site has soil contamination exceeding EPA standards for radium-226 except for small areas north of the tailings pile and one larger area northwest of the pile where a borrow pit was excavated and soils were used for pile surcharge (i.e., weight on the pile to squeeze out moisture) and for the interim cover. Shallow contamination was also identified north of US-191 on DOE property extending to the property line with Arches National Park.

Depths of contamination range from 6 to 120 inches. The area outside the tailings pile (i.e., the area of windblown contamination) is estimated to contain 71,000 yd^3 of contaminated soils. Measuring the depth of contamination with surface scanning and downhole logging instruments has inherent uncertainties; experience at other UMTRCA sites suggests that the final volume could exceed the volume characterized by a range of 50 to 100 percent.

Additional data collected also suggest that contamination occurs elsewhere on the site. Preliminary surface scans by DOE show contamination between the railroad and SR-279 and also near the abandoned ore-loading station adjacent to the rail tracks. Preliminary scans also show elevated gamma levels southeast of the tailings pile in the tamarisk. However, statistical sampling performed to minimize cutting of the tamarisk between the property fence and the Colorado River indicates that radium-226 concentrations in the area may not exceed EPA standards. A 1980 survey performed for Atlas Corporation (Ford, Bacon & Davis 1979) suggests that contamination does not extend across SR-279 to the southwest and up the steep hillside. A 1982 aerial survey performed by a DOE contractor (EG&G) did not provide any additional data on millsite contamination.

On the basis of site knowledge and past UMTRCA site experience, DOE estimates that 11.9 million tons (8.9 million yd^3) of contaminated materials exist at the Moab site and vicinity properties. However, on the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total estimated volume of contaminated site material. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the EIS for purposes of assessing and comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing the remedial action plan.

Table 3–2 presents a summary of the contaminated materials and quantities present at the Moab site and nearby vicinity properties. On the basis of sampling results, Table 3–3 shows the percentages of tailings by type believed to be present in the Moab tailings pile. Additional investigations confirmed that most of the slimes are located in the center of the pile and are surrounded by sandy tailings.

Table 3–2. Contaminated Material Quantities

Source Material	Volume (yd^3)	Weight (dry short tons)
Uranium mill tailings	7,800,000	10,500,000
Pile surcharge	445,000	600,000
Subpile soil	420,000	566,000
Off-pile contaminated site soils	173,000	234,000
Vicinity property material	29,400	39,700
Total	**8,867,400**	**11,939,700**

Table 3–3. Percent of Tailing Types in the Moab Impoundment

Material	% Passing No. 200 Sieve	Percentage of Total Tailings
Sand	Less than 30	7
Slimey-sands	Greater than 30; less than 50	20
Sandy-slimes	Greater than 50; less than 70	23
Slimes	Greater than 70	49

The tailings pile at the site contains the waste residuals from the milling operation. Milling involved both acid and carbonate processing methods (i.e., circuits). Lime was added to the tailings to neutralize the acid-milled tailings. Chemicals used in the processing, including acids, ammonia, and solvents, are incorporated with the silicate grains. Many other minerals, including sulfates and sulfides, are also present in lesser amounts. It is difficult to determine the residence time of the contaminants, although there is evidence that some exist as siliceous mixtures, and others may exist as sulfides, selenides, molybdates, and uranium minerals. Contaminants are also likely to be adsorbed to minerals, especially iron oxyhydroxides.

Bulk chemical analysis of the tailings solids indicates that high concentrations of ammonia, uranium, and radium-226 are present. The mean radium-226, ammonia (as N), and uranium concentrations for the tailings are 516 pCi/g, 423 milligrams per kilogram (mg/kg), and 84 mg/kg, respectively. The finer grained (slimes and silt) fractions have more radium-226 and uranium but less ammonia as (N) than the sand fraction. Other constituents, including iron, manganese, copper, lead, molybdenum, and vanadium, are present in lesser amounts. The pH values of the tailings are near neutral but have zones of pH values as low as 2.5 and as high as 10. The tailings have a small amount of acid-generating capacity in the form of sulfide minerals. The oxidation-reduction potential is not well defined by existing data, and conditions may vary spatially from relatively oxidizing to relatively reducing.

Mean tailings pore water concentrations for radium-226 and uranium are 61.1 picocuries per liter (pCi/L) and 15.1 mg/L, respectively. The average tailings pore water concentration for ammonia (as N) is 1,100 mg/L. Pore water is a mixture of residual milling fluids and water that infiltrated later into the tailings. The pore water appears to be relatively oxidized, although few data are available to assess oxidation-reduction potential. The pH value of the pore water is near neutral, and the mean TDS concentration is 23,500 mg/L. Values of pH, oxidation state, and availability of soluble minerals in the tailings are the main parameters that affect the composition of pore water. Concentrations of organic constituents used in the mill processing circuit are negligible in the pore water. Concentrations of all constituents are much higher in samples of water collected in a shallow-depth sump fed by pore water extracted from the tailings through wick drains than in any of the pore water samples collected from deeper SRK (2000) wells. Analysis of samples collected from the sump indicate the presence of a salt layer in the upper portion of the pile (DOE 2003).

Two underground septic tanks (size unknown) that supported past operations but are no longer used are located inside the radioactively contaminated portion of the site northeast of the historical warehouse. It is unknown if there are buried leach fields associated with these tanks. Organic contamination in soil and ground water samples was not detected by DOE in an analysis performed as part of the site characterization for the SOWP (DOE 2003).

3.1.4 Air Quality

EPA has established National Ambient Air Water Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter (particles less than 10 micrometers [μm] in aerodynamic diameter, designated PM_{10}) small enough to move easily into the lower respiratory tract. NAAQS are expressed as concentrations of particular pollutants that are not to be exceeded in the ambient or outdoor air to which the general public has access (40 CFR 50.1[e]). Primary NAAQS are designated to protect human health; secondary NAAQS are designated to protect human welfare by safeguarding environmental resources (such as soils, water, plants, and animals) (Table 3–4). Utah has adopted NAAQS as the air quality standards for the state.

Table 3–4. Air Quality Standards

Pollutant	Averaging Period	National and State Ambient Air Quality Standard (μg/m^3)[a]		Allowable Increment for Prevention of Significant Deterioration (PSD)[a] (μg/m^3)	
		Primary	Secondary	Class I	Class II
Sulfur dioxide	Annual	80	–	2	20
	24-hour[b]	365	–	5	91
	3-hour[b]	–	1,300	25	512
Nitrogen dioxide	Annual	100	100	2.5	2.5
Carbon monoxide	8-hour[b]	10,000	–	–	–
	1-hour[b]	40,000	–	–	–
Ozone	1-hour[b]	235	235	–	–
PM_{10}[c]	Annual	50	50	4	17
	24-hour[b]	150	150	8	30
Lead	3-month[d]	1.5	1.5	–	–

[a] μg/m^3 = micrograms per cubic meter; where no value is listed, there is no corresponding standard.
[b] Not to be exceeded more than once per year (for ozone and PM_{10}, on more than 1 day per year on the average over 3 years).
[c] Particulate matter less than 10 μm in diameter.
[d] Calendar quarter.

The air quality in the Moab area is generally good. The current median visual range for the Moab region is about 81 miles (Trijonis 1990). Grand and San Juan Counties are designated as being in attainment with NAAQS for sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone (40 CFR 81.345). Not enough data are available to support a classification for PM$_{10}$, so a designation of "unclassifiable" is given for that pollutant (40 CFR 81.345). The PM$_{10}$ data for the Moab region (Table 3–5) show one exceedance during the 4-year period of 1991–1994; an average of one exceedance per year over a 3-year period is allowed. No designation (attainment, nonattainment, or unclassifiable) is published for Utah for lead, although data from Utah metropolitan areas indicate that levels of lead are less than 10 percent of NAAQS (Table 3–4 and Table 3–5). Lead concentrations in the atmosphere have decreased markedly in recent years, largely because of the substitution of unleaded gasoline for leaded gasoline. Monitoring locations in Table 3–5 are those that are closest to the Moab site, including those in Colorado.

Table 3–5. Air Quality in the Moab Region

Pollutant	Monitor location[a]	Year	Averaging period	Maximum (µg/m^3)[b]	Annual mean (µg/m^3)
Sulfur dioxide	Mesa County, Colorado	1991	3 hours	28	4
	Mesa County, Colorado	1992	3 hours	13	4
	Salt Lake City[c]	1993	3 hours	776	34
	Salt Lake City	1994	3 hours	509	29
	Mesa County, Colorado	1991	24 hours	9	4
	Mesa County, Colorado	1992	24 hours	12	4
	Salt Lake City[c]	1993	24 hours	176	34
Nitrogen dioxide	Salt Lake City	1991	Annual		55
	Salt Lake City	1992	Annual		49
	Provo[c]	1993	Annual		49
	Provo[c]	1994	Annual		45
Carbon monoxide	Grand Junction, Colorado	1991	1 hour	14,375	
	Grand Junction, Colorado	1992	1 hour	13,685	
	Grand Junction, Colorado	1993	1 hour	13,800	
	Grand Junction, Colorado	1994	1 hour	13,340	
	Grand Junction, Colorado	1991	8 hours	8,970	
	Grand Junction, Colorado	1992	8 hours	7,705	
	Grand Junction, Colorado	1993	8 hours	7,935	
	Grand Junction, Colorado	1994	8 hours	8,625	
Ozone	Arches National Park	1991	1 hour	141	
	Arches National Park	1992	1 hour	135	
	Canyonlands National Park[c]	1993	1 hour	147	
	Canyonlands National Park[c]	1994	1 hour	143	
PM$_{10}$	Moab	1991	24 hours	181[d]	34
	Moab	1992	24 hours	65	33
	Grand Junction, Colorado[c]	1993	24 hours	67	25
	Grand Junction, Colorado[c]	1994	24 hours	63	24
Lead	Salt Lake City	1991	3 months[e]	0.09	
	Salt Lake City	1992	3 months[e]	0.05	
	Salt Lake City	1993	3 months[e]	0.05	
	Salt Lake City	1994	3 months[e]	0.05	

[a] With the exception of PM$_{10}$, few site-specific data are available for Moab. The following monitor locations provide the closest available data.

[b] µg/m^3 = micrograms per cubic meter. Values reported are from the nearest monitoring station.

[c] A different station was used for 1993 because reporting at the previous nearest station had been discontinued. For sulfur dioxide, the 1991 and 1992 values are believed to be more representative of current conditions at Moab than are the more recent values at the more distant station.

[d] One exceedance per year is allowed; the second highest value during 1991 was 111 µg/m^3, which is below the 24-hour standard.

[e] Calendar quarter.

In addition to ambient air quality standards, which represent an upper bound for allowable pollutant concentrations, there are standards to prevent the significant deterioration of air quality. The prevention of significant deterioration (PSD) standards differ from the NAAQS in that the NAAQS provide maximum allowable *concentrations* of pollutants, and PSD requirements provide maximum allowable *increases in concentrations* of pollutants for areas in compliance with the NAAQS. PSD standards are, therefore, expressed as allowable *increments* in the atmospheric concentrations of specific pollutants. Allowable PSD increments currently exist for nitrogen dioxide, sulfur dioxide, and PM_{10}. PSD increments are particularly relevant when a major proposed action (involving a new source or a major modification to an existing source) may degrade air quality without exceeding the NAAQS (as would be the case, for example, in an area where the ambient air is very clean). One set of allowable increments exists for Class II areas, which cover most of the United States, and a much more stringent set of allowable increments exists for Class I areas, which are specifically designated areas where the degradation of ambient air quality is severely restricted. Class I areas include certain national parks and monuments, wilderness areas, and other areas as described in 40 CFR 51.166 and 40 CFR 81.400–437. Maximum allowable PSD increments for Class I and Class II areas are given in Table 3–4. The PSD Class I area nearest the Moab site is Arches National Park, immediately to the north of the Moab site and about 1,000 ft from the north edge of the tailings pile. Arches National Park has been designated as a mandatory Class I federal area where visibility is an important value (40 CFR 81.430).

3.1.4.1 Conformity Review

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable state implementation plans for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., volatile organic compounds and nitrogen oxide) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a state implementation plan. For there to be a conformity, a federal action must not contribute to new violations of air quality standards, increase the frequency or severity of existing violations, or delay timely attainment of standards in the area of concern.

The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels to occur in locations designated as nonattainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted the required conformity review and determined that all the proposed alternative actions would result in emissions of one or more criteria air pollutants. These emissions are described further in the air quality sections of Chapter 4.0. However, because none of the proposed action alternatives (on-site or off-site disposal) would occur in or potentially affect a nonattainment or maintenance area, further conformity determination under the conformity rule is not required.

3.1.5 Climate and Meteorology

The desert climate of Moab is characterized by hot summers and mild to cold winters. Weather data summarized by the Utah Climate Center for the town of Moab are presented in the following discussion (Pope and Brough 1996). January and July are the coldest and hottest months, with their respective average temperatures of about 30 °F and 81 °F. The average annual temperature is about 56 °F. Temperature extremes have ranged from –24 °F in January 1930 to 114 °F in July 1989. Temperatures of 32 °F or lower occur about 130 days a year; approximately 90 percent of those occur during November through March. Temperatures of 90 °F or higher occur about 95 days a year; approximately 25 of those days have temperatures of 100 °F or higher. The effects of temperatures higher than 90 °F on human comfort are somewhat moderated by the low relative humidity, which is typically less than 20 percent during daytime.

Average annual precipitation at Moab is 9 inches. The driest months are February and June, which have average precipitation slightly less than 0.5 inch; the wettest months are October and April, which have average precipitation of about 1.15 and 1.00 inch, respectively. Annual precipitation is greatly exceeded by potential evapotranspiration (about 50 inches annually), potential or pan evaporation (about 60 inches annually), and lake evaporation (about 38 inches annually).

The greatest precipitation amount reported at Moab in a single day was 3.99 inches on September 23, 1896, and the most precipitation in a single month was 6.63 inches in July 1918. In a 7-day period in late August and early September 1969, Moab received 6.25 inches of precipitation (Pope and Brough 1996). These large precipitation amounts are examples of high rainfall that sometimes occur in association with the late summer-early fall southwest monsoon period. For shorter-term precipitation events, the greatest expected 30-minute precipitation in 100 years is about 1.3 inches, and the greatest expected 1-hour precipitation in 100 years is about 1.6 inches (Hershfield 1961).

Snowfall is light and averages only about 10 inches per year, occurring mostly from December through February. The greatest amount of snow recorded in a single day was 33 inches on December 31, 1915; that month also had the highest single-month snowfall of 46 inches (Pope and Brough 1996). These snowfalls are highly unusual; a single snowfall of greater than 6 inches is rare and occurs only about once every 3 years.

Low humidity in the region limits fog occurrences (visibility less than 0.3 mile) to fewer than 10 days per year. Thunderstorms occur about 40 days per year. Hail occurs about 3 days per year.

Prevailing winds in the Moab area are from the west-southwest (Figure 3–4). Wind speeds are less than 1 mile per hour (mph) 75 percent of the time; wind speeds are 1 to 7 mph 95 percent of the time (Figure 3–5). The highest wind speed recorded at Moab was 80 mph (Pope and Brough 1996). One tornado with wind speeds of at least 100 mph would be expected once in about 100,000 years (ANS 1983). Cold air drainage at the Moab site can occur from the northwest under stable conditions, creating a temperature inversion. These inversions typically occur in the winter months of December and January at times when snow covers the valley floor and can persist for several weeks.

3.1.6 Ground Water

3.1.6.1 Hydrostratigraphy

Rush et al. (1982), Weir, Maxfield, and Hart (1983), and Weir, Maxfield, and Zimmerman (1983) grouped the aquifers in the northern part of the Paradox Basin into lower and upper hydrologic systems. The upper ground water system consists of unconsolidated and bedrock formations above the impermeable salt beds of the Paradox Formation. Confining salt beds of the Paradox Formation underlie most of the site and locally contribute to high levels of salinity in the overlying unconsolidated basin-fill aquifer. The lower ground water system includes all the stratigraphic units below the Paradox Formation. Site-related ground water contamination occurs in the unconsolidated basin-fill aquifer in the upper hydrologic system. Water-bearing characteristics of major stratigraphic units from the Paradox Formation and above are presented in Figure 3–6.

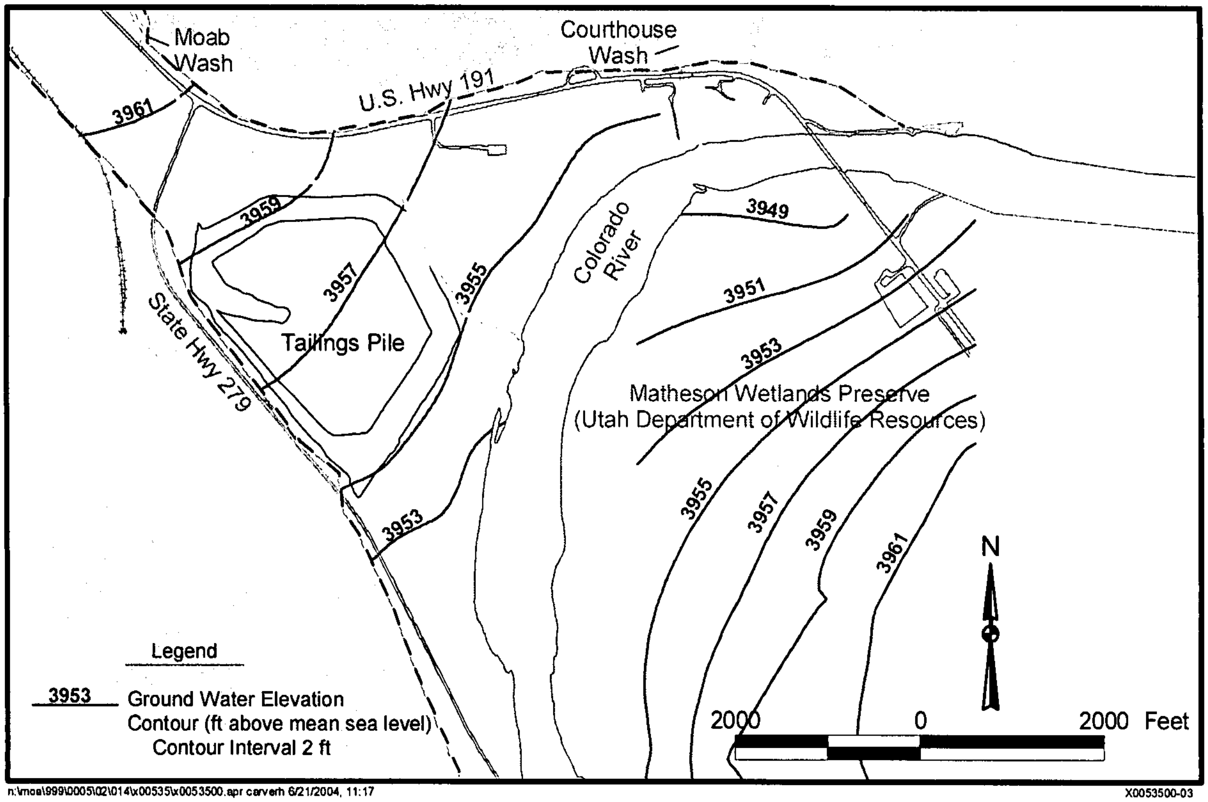
3.1.6.2 Ground Water Occurrence

Ground water occurs in the bedrock formations and unconsolidated Quaternary material deposited on the floor of Moab and Spanish Valleys. The Navajo Sandstone, Kayenta Formation, and Wingate Sandstone of the Glen Canyon Group contain the principal bedrock aquifer in the region and locally are present only upgradient at the northern boundary of the site. The Navajo Sandstone of the Glen Canyon aquifer ranges in thickness from 300 to 700 ft (Doelling et al. 2002) and is the shallowest and most permeable formation in the Glen Canyon Group. Wells located 7 to 8 miles southeast of the site produce in excess of 1,000 gpm of high-quality water from the Navajo Sandstone for the city of Moab water supply.

Estimated transmissivity for the Navajo Sandstone ranges from near 0 to 700 ft^2/day, and estimated hydraulic conductivity ranges from 0.4 to 1 ft/day (Blanchard 1990). Specific capacities of two water-supply wells at the entrance to Arches National Park, completed in the Navajo Sandstone, were 1.7 and 14.5 gpm per foot (Blanchard 1990). Average saturated thickness of the gravelly sand that constitutes the unconsolidated basin-fill aquifer is approximately 70 ft (Sumsion 1971). This basin fill material may be as much as 450 to 500 ft thick in Moab Valley.

Most of the fresh water in the basin-fill aquifer enters the site from Moab Wash and along geologic contacts between the alluvium and the Glen Canyon Group bedrock present at the north boundary of the site. The bedrock in this area is highly fractured and faulted from incipient collapse of the Moab anticline caused by dissolution of the underlying Paradox Formation salt core of the anticline.

Ground water elevation of the fresh water in the basin fill alluvium is shown in Figure 3–7. West of the Colorado River, these shallow water-table contours are based on average water elevations measured in 2001 and 2002. Contours east of the Colorado River in the Matheson Wetlands Preserve are based on March 2003 water elevation measurements and indicate ground water flow toward the river. The elevation contours indicate that fresh water entering the site at the northern boundary flows south toward the river over the top of a deeper natural brine zone.



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X0053500-03

Figure 3–7. Ground Water Elevation Contours on the Upper Freshwater Surface

The deeper brine water results mostly from dissolution of the underlying salt beds of the Paradox Formation present beneath most of the site. Figure 3–8 presents a conceptual model of the subsurface hydrogeology along a representative streamline showing the interface between the deeper saltwater system and the overlying freshwater system. The saltwater interface is defined at the 35,000-mg/L TDS boundary. The transition from the saltwater to the freshwater system occurs over a short vertical distance and is, therefore, referred to as being "sharp." The vertical position of the interface is in equilibrium because the buoyant force exerted by the brine is balanced by the weight of the overlying fresh water. In natural systems, little, if any, fresh water penetrates salt water at the interface. The fresh water can be thought of as a liquid that "floats" upon a buoyant saltwater liquid. At the Moab site, the interface extends across the site in a wedge shape, in which the deepest part of the interface is near the northwest boundary, and the shallowest depth is near the river. The position of the interface near the river is in dynamic equilibrium and probably shifts laterally and vertically in response to evapotranspiration by the tamarisk plant communities and the stage of the Colorado River. The interface may also shift vertically upward as a result of pumping from the shallow fresh water (e.g., during a pump-and-treat remediation) and cause the salt water to rise to a higher elevation and intrude the fresh water. Saltwater intrusion would result in degradation of the overlying fresh water, which could adversely affect the tamarisk plant communities that are providing some beneficial phytoremediation at the site.

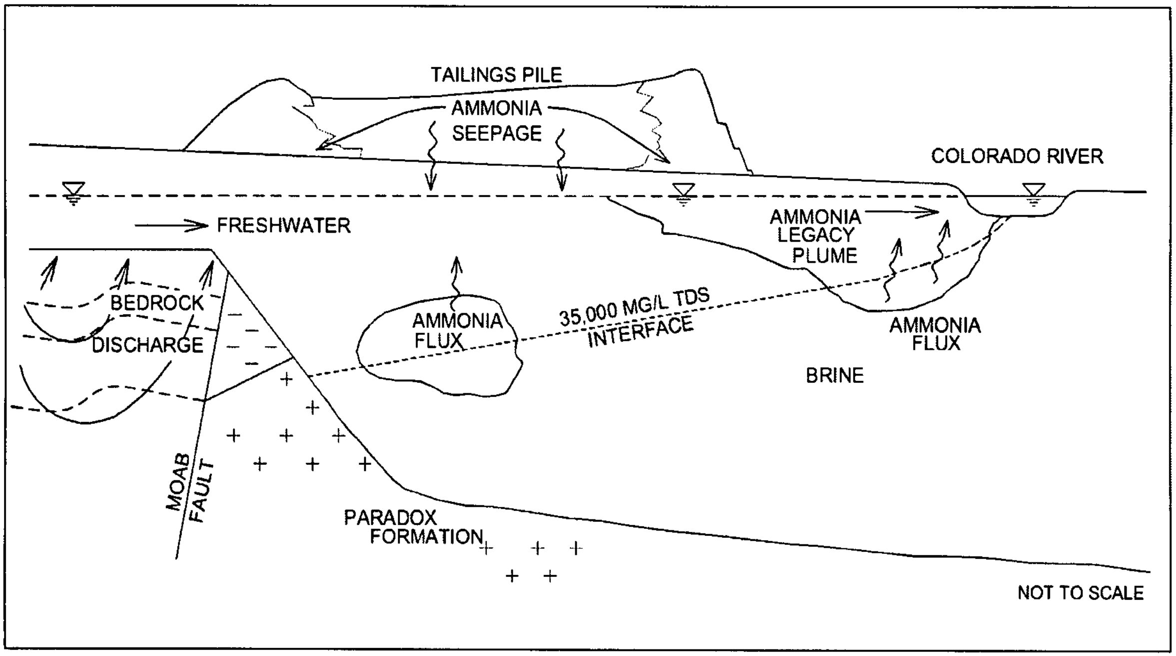

Figure 3–8. Conceptual Model, Saltwater/Freshwater Interface

Rising salt water may also bring higher ammonia and salt concentrations to the surface and cause added contamination flux to the river. Low pumping rates and proper extraction well construction and pump location may prevent saltwater intrusion. Additional information on the hydrogeology of the site is presented in the SOWP (DOE 2003).

Additional recharge to the site occurs through precipitation. The Paradox Formation is believed to be an impermeable boundary (bedrock aquitard) and does not contribute to the site water budget. An estimate of the annual steady-state water budget for each hydrologic component of the system is presented in Table 3–6. Short-term transient effects such as the small positive contribution to bank storage by recharge from the Colorado River during periods of high flow are not included. The estimates are represented with a large range of individual values, and the ranges of the total inflow and total outflow do not overlap, reflecting the uncertainty of the values and suggesting that the true water budget might lie between the two ranges. The SOWP (DOE 2003) provides additional discussion of the ground water hydrology and water budget of the site.

Table 3–6. Estimated Annual Water Budget for the Moab Site

Flow Component	Inflow (gpm)	Outflow (gpm)
Areal Precipitation	16–65	N/A
Moab Wash	0.5–33	N/A
Glen Canyon Group	28–280	N/A
Tailings Pile	20	N/A
Evapotranspiration	N/A	200–500
Colorado River	N/A	300–600
Total	**65–400**	**500–1,100 (rounded)**

N/A = not applicable.

3.1.6.3 Ground Water Quality

The basin-fill aquifer underlying the site is divided into three hydrochemical facies: (1) an upper fresh to moderately saline facies (fresh Quaternary alluvium [Qal]) that has concentrations of TDS up to 10,000 mg/L, (2) an intermediate facies of very saline water (saline Qal), having TDS concentrations between 10,000 and 35,000 mg/L, and (3) a lower briny facies (brine Qal) that has TDS concentrations greater than 35,000 mg/L. All three facies existed beneath the site prior to milling activities. The SOWP (DOE 2003) provides additional discussion of ground water geochemistry and water quality at the site.

A cross-sectional view of contoured TDS concentrations beginning at Moab Wash and extending southeast to the Colorado River is shown in Figure 3–9. The interface between the upper fresh water with the deeper saline water is shown by the 35,000-mg/L contour line. Sixty percent of the alluvial aquifer is contained in the lower briny facies. More than 80 percent of the basin-fill aquifer contains TDS concentrations that are greater than 10,000 mg/L. The upper hydrochemical facies contains limited fresh water with less than 3,000 mg/L TDS that could provide potable water (Figure 3–9). The volume of ground water containing 3,000 mg/L or less TDS represents less than 3 percent of the total volume in the basin-fill aquifer beneath the site. All the fresh water with TDS concentrations less than 3,000 mg/L that could provide potable water occurs upgradient of the tailings pile near Moab Wash. Though some of the TDS in the freshwater system is from recent contamination, the percentage of the aquifer that would return to TDS concentrations of less than 3,000 after remediation would be minimal.

The fresh water quickly becomes mixed with more saline water in the basin-fill aquifer as it enters the site from Moab Wash and flows toward the Colorado River. Salinity naturally increases with depth and distance from the freshwater source contribution from Moab Wash. Mixing of the two background water types (fresh upgradient water with the deeper depth saline water) influences the background water quality at the site. The result is a background water quality in the basin-fill aquifer that is highly variable both vertically and horizontally across the site.

Background conditions in the upper fresh Qal facies are characterized by low concentrations of uranium and other trace metals that are all below the EPA standards in 40 CFR 192 (Table 3–7). TDS concentrations range from 677 to 7,820 mg/L, which classifies the water quality as fresh to slightly saline. Background alkalinity as calcium carbonate ranges from 137 to 189 mg/L. There is no EPA standard for ammonia in 40 CFR 192. Ammonia–N concentrations are less than 1 mg/L. Sulfate concentrations range from 180 to 1,140 mg/L. Calcium concentrations range from 47 to 294 mg/L. Magnesium concentrations range from 31 to 188 mg/L. On average, the pH value of the upper fresh Qal facies is near neutral (7.7), and the redox condition is slightly oxidizing (oxidation-reduction potential is 186 millivolts [mV]).

Table 3–7. Standards for Inorganic Constituents in Ground Water at UMTRCA Sites

Constituent	Standards[a]		Background[a]	
	EPA (40 CFR 192)[b]	**SDWA[c]**	**Fresh Qal Facies Range**	**Brine Qal Facies Range**
Arsenic	0.05	0.01	0.00018–0.0015	0.00015–0.11
Barium	1.0	2.0	0.0222–0.033	0.031–0.121
Cadmium	0.01	0.005	<0.0001–<0.0017	<0.0001–0.014
Chromium	0.05	0.1	<0.0005–<0.011	<0.003–<0.01
Lead	0.05	N/A	<0.0001–<0.0055	0.00054–0.184
Mercury	0.002	0.002	<0.0001–<0.0002	<0.0002–<0.0002
Molybdenum	0.1	N/A	<0.0018–0.01	<0.004–<0.009
Nitrate (as N)	10[d]	10[d]	1.22–15.9	<0.02–0.075
Selenium	0.01	0.05	0.0091–0.0266	<0.0001–0.009
Silver	0.05	N/A	<0.0001–<0.0055	<0.0001–<0.004
Radium (combined radium-226 and radium-228)	5 pCi/L	5 pCi/L	N/A	N/A
Radium-226	N/A	N/A	0.07–0.16 pCi/L	<0.29–9.26 pCi/L
Radium-228	N/A	N/A	<0.5–1 pCi/L	2.6–6.09 pCi/L
Uranium (combined uranium-234 and uranium-238)	0.044[e]	0.03	0.0042–0.0259	0.0007–0.0269
Gross alpha-particle activity (excluding radon and uranium)	15 pCi/L	15 pCi/L	<6.73–<73.92 pCi/L	<356.33–<473.08 pCi/L

[a] Concentrations reported in milligrams per liter (mg/L) unless noted otherwise; pCi/L = picocuries per liter.
[b] Maximum concentration limits, 40 CFR 192, Table 1, Subpart A.
[c] Maximum contaminant levels, Safe Drinking Water Act, 40 CFR 141.23 and 141.62.
[d] Equivalent to 44 mg/L nitrate as NO_3.
[e] Equivalent to 30 pCi/L, assuming secular equilibrium of uranium-234 and uranium-238.
N/A = not applicable

Background conditions in the lower brine Qal facies are characterized by a poor water quality resulting from the dissolution of gypsum and salt beds in the underlying bedrock formations. The water is a sodium-chloride type with TDS concentrations up to 97,000 mg/L, which classifies the water quality as briny. Maximum detected concentrations of arsenic (0.11 mg/L), cadmium (0.014 mg/L), and lead (0.184 mg/L) are all slightly higher than EPA standards in 40 CFR 192. Maximum concentrations of uranium (0.027 mg/L) are less than the EPA standard. Ammonia background concentrations range from 0.03 to 3.0 mg/L. Safe Drinking Water Act secondardy standards are exceeded for sulfate (250 mg/L), chloride (250 mg/L), manganese (0.05 mg/L), and iron (0.3 mg/L), demonstrating the poor quality of the brine Qal background ground water. Secondary standards are unenforceable.

Site-related constituents have contaminated the basin-fill aquifer beneath the tailings pile and beneath the former millsite. Ammonia, nitrate, sulfate, molybdenum, uranium, gross alpha, and gross beta are the site-related constituents most prevalent in the basin-fill aquifer. The relatively low distribution ratios (R_ds) measured for uranium and ammonia explain the higher prevalence of these site-related constituents, which are conserved in the ground water and are more easily dispersed from the source area. Similarly, molybdenum and nitrate are geochemically conservative and tend to be highly mobile in ground water under almost all conditions.

Concentrations of magnesium, cobalt, manganese, and strontium exceed the upper limit of the range in natural background for the fresh Qal facies in more than 50 percent of the samples but do not exceed the upper limit of natural background for the brine Qal facies in any of the samples. Similarly, cadmium and nickel concentrations exceed the upper limit of natural background for the fresh Qal facies in more than 50 percent of the samples but exceed the upper limit in natural background for the brine Qal facies in only 3 percent or less of the samples. This low frequency reflects the relatively high concentrations that occur naturally in the Paradox Formation brine.

Other site-related constituents are present at concentrations above the upper limit of natural background; however, concentrations exceed background less frequently. For example, arsenic concentrations exceed the upper limit in approximately 35 percent of the samples when compared to the fresh Qal background but in only 3 percent of the samples when compared to the brine Qal background. Selenium concentrations exceed the upper limit in approximately 29 percent of the samples when compared to the fresh Qal background and in 54 percent of the samples when compared to the brine Qal background. Vanadium concentrations exceed the upper limit in approximately 19 percent of the samples when compared to the fresh Qal background and in 10 percent of the samples when compared to the brine Qal background. Antimony, barium, chromium, lead, mercury, silver, and zinc concentrations exceed the upper limit of natural background for either the fresh or brine Qal facies in only 10 percent or less of the samples.

Ground water concentration limits for arsenic, barium, cadmium, chromium, lead, mercury, molybdenum, nitrate, selenium, silver, uranium (combined U-234 and U-238), gross alpha (excluding radon and uranium), and radium (combined radium-226 and radium-228) are regulated by EPA standards (see Table 3–7). Of these constituents, the maximum concentrations detected for arsenic, cadmium, uranium, radium, gross alpha, nitrate, selenium, and molybdenum exceed EPA standards. The remaining regulated constituents (barium, chromium, lead, mercury, and silver) are all present at relatively low concentrations below EPA standards.

The areal distribution of uranium concentrations greater than 0.044 mg/L, interpolated and contoured on the upper surface of the ground water, is presented in Figure 3–10. The highest uranium concentrations are in the shallow ground water in the former millsite area. Cross-sectional views of the uranium plume and additional isoconcentration maps of uranium as a function of depth are provided in the SOWP (DOE 2003). SMI (2001) suggested that the high uranium concentrations beneath the millsite are caused by waste leaking from the former wood chip disposal areas. Although the uranium plume is in an area where wood chip disposal was likely to have occurred, lithologic logs of borings installed in this area of the site do not indicate that they penetrated through the wood chip pits. Another possible source of the high uranium concentrations is the uranium ore stockpiles; however, samples collected from monitor wells nearest the largest known ore stockpiles have lower uranium concentrations. Whether the source of the high uranium concentrations in ground water samples is the wood chip pits, the ore stockpiles, or some other millsite-related release, it seems that some of the ground water contamination originates in the millsite area, independently of the tailings pile.

Although ammonia has no EPA standard in 40 CFR 192, it occurs at concentrations significantly greater than natural background, is one of the most prevalent contaminants in the ground water, and is the constituent of greatest ecological concern that is discharging to the Colorado River in backwater areas adjacent to the site. The areal distribution of ammonia concentrations greater than 50 mg/L, interpolated and contoured on the upper surface of the ground water, is presented in Figure 3–11. The highest concentrations in the shallow ground water, greater than 500 mg/L, appear near the downgradient edge of the pile and extend to and discharge to the Colorado River. The highest ammonia concentrations in surface water samples are detected in samples collected closest to the riverbank adjacent to the tailings pile and immediately downstream of Moab Wash. A comparison of ground water data with surface water data shows that, with few exceptions, concentrations of site-related constituents are much lower in the surface water than in the ground water. Ammonia concentrations in the river are approximately 2 orders of magnitude lower than in the ground water. Available data (DOE 2005b) suggest that at least order-of-magnitude decreases in constituent concentrations can be expected as ground water discharges to the river. For further discussions see Section 2.3.1.2. Isolated pools or very shallow areas may be exceptions to this; however, those locations are temporary and are unlikely to represent important aquatic habitat.

Relatively high ammonia concentrations in ground water also occur at depth beneath the tailings pile (Figure 3–12). During milling operations, the tailings pond contained fluids with TDS concentrations ranging from 50,000 to 150,000 mg/L. Because these salinities exceed 35,000 mg/L, they had sufficient density to migrate vertically downward through the freshwater system and into the brine. This downward migration of the tailings pond fluids into the saltwater system is believed to have created a reservoir of ammonia that now resides below the saltwater interface. This ammonia plume below the interface probably came to rest at an elevation where it was buoyed by brine having a similar density. Under present conditions, the ammonia plume beneath the saltwater interface represents a potential long-term source of ammonia to the freshwater system. The conceptual model presented in Figure 3–8 illustrates the ammonia source at the saltwater interface (basal flux), the legacy plume, and seepage of ammonia from tailings pore fluids.

3.1.6.4 Ground Water Use

Historical records indicate that two water supply wells were present at the site before milling operations began in 1956 (DOE 2003). Both wells were located near the northwest area of the tailings pile. Records indicate that the first well, designated as well C, was installed to a depth of 67 ft by the U.S. Department of the Interior Grazing Service in 1940 and provided approximately 20 gpm from the basin-fill aquifer, presumably used for livestock watering. The second well, designated as well B, was installed to a depth of 114 ft by the U.S. Atomic Energy Commission in 1954 just prior to mill construction. The zone of completion for well B is unknown. This well produced approximately 11 gpm through a perforated casing and was presumably used to supply process water for the mill. In both cases, the quality of the water is unknown, and the wells have subsequently been decommissioned. No other water wells are known to have existed at the site prior to milling.

The Navajo Sandstone of the Glen Canyon aquifer, which ranges in thickness from 300 to 700 ft (Doelling et al. 2002), is the shallowest and most permeable formation in the Glen Canyon Group. Consequently, it is the primary target for most bedrock wells drilled in the area (Eisinger and Lowe 1999). The city of Moab derives most of its drinking water from a well field that is completed in the Glen Canyon aquifer near the northeast canyon wall of Spanish Valley (Blanchard 1990). Two water-supply wells located near the entrance to Arches National Park are completed in the Navajo Sandstone.

Numerous springs flow from the Navajo Sandstone. Flux from these springs is limited to less than 10 gpm but is sufficient to provide water for a few cattle (Doelling et al. 2002). Other consolidated formations in the Spanish Valley, such as the Entrada Sandstone, are capable of transmitting and yielding small quantities of water but are not important as a water resource (Sumsion 1971).

Unconsolidated basin-fill deposits make up a secondary aquifer used mostly for irrigation and some domestic water supply in Spanish Valley (Steiger and Susong 1997). More than 200 wells completed in the unconsolidated material in the Moab-Spanish Valley area (Sumsion 1971) range in depth from 30 to 300 ft (Eisinger and Lowe 1999). Water in the unconsolidated aquifer is generally of poorer quality than that of the Glen Canyon and Entrada aquifers. Near the Colorado River, TDS and trace metals concentrations in the basin-fill aquifer increase as a result of dissolution of the underlying Paradox Formation salt beds (Cooper and Severn 1994).

3.1.7 Surface Water

3.1.7.1 Surface Water Resources

The Moab site is located within the Southeast Colorado Watershed Management Unit as designated by UDEQ's Division of Water Quality (UDEQ 2000). This watershed unit includes the Colorado River in the vicinity of the Moab site and all its tributaries and other water bodies between the Colorado River and the Colorado/Utah state line.

The principal surface water resource in the area, the Colorado River, lies 500 to 700 ft from the easternmost extent of the tailings pile, which is located on alluvial material deposited by the river. It flows south along the east edge of the site, and flows in deeply incised bedrock canyons cut by the river at the northeast and southwest borders of Moab Valley. The Colorado River flows south out of Moab Valley through The Portal, 1,000-ft sandstone cliffs flanking the entrance to the river canyon. The river drains one of the most arid sections of the North American continent. The rugged mountains, broad basins, and high plateaus in the Upper Colorado Basin (above Lees Ferry, Arizona) have been deeply entrenched and dissected (Price and Arnow 1974).

Courthouse Wash empties into the Colorado River 0.5 mile upstream from the tailings pile, and Moab Wash crosses the site along the north and east sides of the tailings pile. The channel of Moab Wash was rerouted east of the mill during operations to mitigate flooding potential during peak flows. Courthouse Wash drains 102 square miles, has an average discharge of 2.12 cfs, and produces peak flows reaching 12,300 cfs. Courthouse and Moab Washes are ephemeral and are dry much of the year. Courthouse Wash sustains flows for longer durations than Moab Wash, which drains an area of only 5 square miles (Smith Technology Corporation 1996). Moab Wash is an ungaged stream.

The Dolores River and the Green River empty into the Colorado River upstream and downstream, respectively, from Moab and the tailings pile. The Scott M. Matheson Wetlands Preserve (Matheson Wetlands Preserve), a shallow wetland open to the public and managed jointly by the Nature Conservancy and the Utah Division of Wildlife Resources (UDWR), is located across the river from the pile.

Natural streamflow of the Colorado River has been affected by many diversions and dams. The dams above the Moab area are not large in comparison to other dams in the Upper Colorado drainage system, such as the Flaming Gorge or Glen Canyon dams. The reservoirs along the Colorado River tributaries upstream of the Moab area store only about 10 percent of the total volume of water stored in Lake Powell (Van Steeter and Pitlick 1998), which is located 150 miles downstream from Moab. However, the presence of these dams has altered streamflow significantly by controlling the extreme high and low flows experienced prior to dam construction. These controlled flows have resulted in changes of river morphology and other characteristics such as sediment load (Van Steeter and Pitlick 1998).

The Cisco, Utah, gaging station (the closest station upstream of the site) is located 1 mile below the confluence of the Colorado and Dolores Rivers, and 31 miles upstream from the Moab site (NRC 1979). The drainage area above the gage is 24,100 square miles. The average discharge for 59 years of record (1911 to 1970) was 7,711 cfs, and maximum and minimum daily mean flows measured 73,200 cfs and 640 cfs, respectively. The complete period of record for the Cisco gaging station extends from January 1895 through 2003. The first 15 years consist of calendar-year rather than water-year discharge statistics. The maximum discharge for the complete period of record was 76,800 cfs.

3.1.7.2 Surface Water Quality

The Colorado River Basin Water Quality Control Project was established in 1960 (U.S. Department of Health, Education, and Welfare [HEW] 1961), and much of the early monitoring of the river was conducted in support of that project. A study conducted to determine the potential effects of the Moab site identified several constituents in the Colorado River in the study area that had concentrations above recommended limits, including sulfate, chloride, TDS, and manganese (HEW 1961). The presence of these constituents was attributed to natural causes. Highest levels of some analytes were detected in samples collected at the confluence of the Dolores River with the Colorado River. Studies of Colorado River water quality were undertaken in 1966 mainly to study the effects, if any, of uranium milling operations on the river. Radionuclides, particularly radium, were of main concern in these studies (HEW 1966).

In the 1970s, much of the focus on the Colorado River Basin concerned salinity control, pursuant to passage of the Colorado River Basin Salinity Control Act (Public Law 93-320). A major source of salinity load to the Colorado River, particularly in the Southeast Colorado Watershed Management Unit, is the Dolores River. As the Dolores River crosses the Paradox Valley in southwestern Colorado, highly saline ground water (brine) discharges to the river (Chafin 2003). The source of the brine is a collapsed salt anticline, similar to that in Moab Valley. Surface waters in the vicinity of the Moab site are influenced by discharge of ground water containing dissolved salts from the Paradox Formation that is found in the cores of salt anticlines characteristic of this region (DOE 2003). Highly saline ground water is known to occur beneath the Moab site as well as at the Matheson Wetlands Preserve across the river from the site. Near the confluence of the Dolores River and the Colorado River, the salinity of the Dolores River limits the use of river water for irrigation of some crops (UDEQ 2000). Onion Creek, another high-salinity tributary to the Colorado River, has been designated as an impaired water body because of elevated levels of TDS from both natural and agricultural sources (UDEQ 2000).

Several other water bodies in the Southeast Colorado Watershed Management Unit have been designated as impaired because of high TDS levels, including Mill Creek, which is a source of recharge to the alluvial aquifer across the Colorado River from the Moab site.

Selenium is also cause for regional concern. Although selenium levels have received greater attention in the Upper Colorado River Basin in Colorado, where concentrations have been detected up to 2 orders of magnitude above the National Ambient Water Quality Criteria of 0.005 mg/L (Spahr et al. 2000), concentrations in the vicinity of the Moab site are also relatively high. Concentrations of other constituents are known to be elevated in the Upper Colorado River Basin and the Southeast Colorado Watershed Management Unit as a result of the extractive industries; these effects tend to be more localized (Spahr et al. 2000; UDEQ 2000).

More recently, surface water monitoring of the Colorado River Basin, which includes the Moab site, has been conducted as required by the Clean Water Act. An intensive monitoring program took place between July 1997 and June 1998 to assess streams against state water quality standards and pollution indicators to determine if their designated beneficial uses were being met (UDEQ 2000).

Water quality of the Colorado River has declined over the years as human activities in the basin have expanded. Dams and water-diversion projects have greatly accelerated water loss through evaporation and consumption, resulting in higher salinities (i.e., higher TDS), altered temperature and flow regimes, and altered nutrient and suspended solids transport (NRC 1999). Industrial development (mining and milling in particular) and rapid urbanization have introduced wastewaters containing a variety of contaminants into the river, including suspended sediments, acid mine drainage, heavy metals, radionuclides, and organic wastes.

Despite the different factors that impair the surface water quality of the Colorado River, the portion of the river belonging to the Southeast Colorado Watershed Management Unit was assessed as fully supporting all its beneficial uses, according to results of the intensive monitoring conducted from July 1997 to June 1998. Therefore, the overall river water quality is considered to be good. Of the 981 stream miles within the Southeast Colorado Watershed Management Unit, 27 sampling sites were used in the assessment. Four of the 27 sampling sites were located on the Colorado River (UDEQ 2000).

3.1.7.3 Site-Related Surface Water Contamination

In addition to previous characterization, DOE conducted a baseline round of surface water sampling in the Colorado River near the site in summer 2002. Analytical results of samples collected adjacent to the site were compared to background concentrations and aquatic benchmarks to develop a list of contaminants of potential concern. The analytical results confirmed that ground water discharge from the Moab site has caused localized degradation of surface water quality. As a result of that evaluation, ammonia, copper, manganese, sulfate, and uranium are considered contaminants of concern.

Additional sampling conducted in 2004 focused on understanding the effects of ground water discharge on surface water quality in backwater areas that may provide preferred habitat for endangered fish. The sampling results (DOE 2005a) confirmed both historical and the 2002 sampling results.

Concentrations of contaminants of potential concern in surface water samples vary widely, depending on sampling locations and river flow conditions. Concentrations are highest immediately adjacent to the riverbank in areas where water is shallow, slow moving, or pooled where it is cut off from the main channel of the river. Concentrations are most likely to be elevated during average to low river stages. The constituents with concentrations that are most consistently elevated in samples from the Colorado River are ammonia and uranium. The highest ammonia concentrations have been detected in samples from areas next to the riverbank immediately downstream of Moab Wash. DOE conducted field mapping of the most distinctive features in the river adjacent to the site in November 2001 (DOE 2003). Those mapped features are shown on Figure 3–13. The distribution of maximum uranium concentrations detected in the surface water samples since 2000 is shown in Figure 3–14. The distribution of maximum ammonia concentrations detected in surface water samples since 2000 is shown in Figure 3–15. However, samples collected in the main river channel show minimal or no impact to water quality. Sampling has shown that concentrations of contaminants decrease to natural background levels within 0.5 mile downstream of the Moab site.

Low river flows expose greater portions of the Moab Wash sandbar, creating increased backwater areas that allow for higher concentrations of ammonia in the surface water. However, a study completed in 2000 (SMI 2001) determined that during high flows, backwater areas are eliminated near the site, and ammonia concentrations near the shore are diluted to protective levels (within EPA's recommended total ammonia protection criteria), or loading is temporarily stopped by river water flowing into the aquifer because of the seasonally high river stage. This finding suggests that snowmelt runoff periods (May and June) may effectively reduce the ammonia concentration in the Colorado River.

Because ground water gradients on both sides flow toward the river, it is likely that the presence of the ground water brine affects surface water quality. However, because process fluids disposed of in the former tailings pond contained some of the same constituents that occur in natural brines, distinguishing between naturally occurring constituents and site-related constituents in surface water is not straightforward. Increases in sodium, chloride, or dissolved solids content of river water (among other constituents) in the vicinity of the site, compared to background concentrations, could be a result of discharge of either site-related contaminated ground water or natural brines.

3.1.7.4 Surface Water Use

The Colorado River Compact of 1922 established water allocations to the Upper and Lower Colorado River Basins, which encompass seven states (Chrisman et al. 1976). The 1944 Treaty with Mexico established a Colorado River water reserve that must cross the international boundary. Glen Canyon Dam defines the point of compliance for water allocations between the Upper and Lower Colorado River Basins. Numerous diversions occur for irrigation. Phoenix and Tucson, Arizona, as well as the Mexican border towns of Mexicali and Tijuana, obtain drinking water from the Colorado River. No discharge occurs into the Gulf of California because the Colorado River is completely diverted by the United States and Mexico.

Surface water consumption from the Colorado River watershed is less than 25 million gallons per day (39 cfs) in Grand County, Utah. This water is used almost exclusively for agricultural irrigation. Industry, mining, and thermoelectric power plant cooling account for less than 10 percent of this consumption. DOE's water right (previously Atlas' water right) allows for 3 cfs consumptive and an additional 3 cfs nonconsumptive (6 cfs total). The Colorado River is not currently used as a drinking water supply for the city of Moab.

Water from the Colorado River was not diverted for use in Moab-Spanish Valley prior to 1971, other than for the Atlas mill (Sumsion 1971). Domestic and public drinking water supplies are obtained from ground water, streams, and springs. In Utah, use of Colorado River water for purposes other than recreation is limited. In Grand County downstream from Moab, water is withdrawn from the river for irrigation of about 100 to 150 acres of hay and small grains, and a water right for consumptive use of 3 cfs is held for operations at Potash. No additional water withdrawals are believed to occur in Utah, including Canyonlands National Park and Lake Powell (NRC 1999). The Colorado River in the vicinity of Moab is used for swimming, rafting, boating, and fishing as well as other forms of recreation and is a recognized scenic waterway. The stretch of the river adjacent to the site is within the area designated as critical habitat for four endangered species of fish. For further details, see Section 3.1.10, "Aquatic Ecology."

3.1.7.5 Surface Water Quality Criteria

Five contaminants of concern in the surface water have been identified, as described in Section 3.1.7.3 (Site-Related Surface Water Contamination) and Appendix A2. There are no EPA surface water standards in 40 CFR 192. However, UMTRCA requires DOE to determine applicable regulations in consultation with the State of Utah. Surface water quality criteria for the protection of aquatic species have been developed in Appendix A2 for these contaminants of concern. The criteria for ammonia and copper are consistent with the standards currently specified in the Utah Administrative Code R317-2. In the case of ammonia, the State of Utah is in the process of updating its standards to be consistent with the current Ambient Water Quality Criteria published by EPA. Suter and Tsao (1996) were used where state and federal standards were not available. There are no federal or State of Utah standards for uranium or sulfate. Suter and Tsao developed estimated lowest chronic uranium values for fish extrapolated from laboratory studies. The lowest chronic value is considered conservative in comparison to results of studies on swim-up fry and juvenile Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and bonytail (*Gila elegans*) (Hamilton 1995). Sulfate was retained as a contaminant of concern because concentrations are elevated when levels of other contaminants of concern are also elevated. Table 3–8 summarizes the protective criteria for each contaminant of concern.

3.1.8 Floodplains

The 100-year floodplains for Moab Wash and the Colorado River and the 500-year floodplain of the Colorado River occupy more than one-third of the Moab site (Figure 3–16). The Colorado River floodplains extend the length of the eastern site boundary from the river's edge to distances ranging from 500 to 1,200 ft west and are approximately 10 ft above the average river level. The tailings impoundment is located within the 100- and 500-year floodplains of the Colorado River and within the floodplain of the PMF. Two dams upstream of the Moab site affect the flow of the Colorado River: Blue Mesa Dam on the Gunnison River and McPhee Dam on the Dolores River.

Table 3–8. Summary of Surface Water Quality Criteria for Aquatic Species

Contaminant of Concern	Protective Acute Criteria (mg/L)	Protective Chronic Criteria (mg/L)	Source of Criteria
Ammonia	1.5 – 41.7[a]	0.17 – 4.13[b]	NRWQC; EPA 1999[c]
Copper	0.013[d,e]	0.009[d,e]	NRWQC; EPA 2002[f]
Manganese	2.3	1.78	Suter and Tsao 1996
Sulfate	N/A	N/A	No published criteria
Uranium	0.142	0.142	Suter and Tsao 1996

[a] Criteria are pH and life-stage dependent; early life stages are assumed to be present, and salmonids are assumed to be absent; range represents calculated criteria based on measured range of surface water pH values at the Moab site from 2000 to 2002 (Appendix D, SOWP; DOE 2003).

[b] Criteria are pH, temperature, and life-stage dependent; early life stages are assumed to be present and salmonids are assumed to be absent; range of values represents calculated criteria based on measured range of surface water pH values and temperature at the Moab site from 2000 to 2002 (Appendix D, SOWP; DOE 2003).

[c] National Recommended Water Quality Criteria (NRWQC) are based on EPA's ambient water quality criteria (EPA 1999).

[d] Criteria for metals are expressed in terms of dissolved metals in the water column.

[e] Criteria are expressed as a function of hardness (milligrams per liter) in the water column. The value listed corresponds to a hardness of 100 mg/L.

[f] National Recommended Water Quality Criteria are based on EPA's criteria (EPA 2002).

N/A = not available; no published criteria available. Note: measured background sulfate concentrations in the surface water range from 84 to 439 mg/L.

Because of terracing and lack of river access during regular high-flow events (less than 5-year occurrence), the floodplain is not considered an "active" floodplain. Most of the surface has been disturbed in the past by milling and soil borrow operations. Some areas are sparsely vegetated, and other areas are dominated by tamarisk. A small patch of mature cottonwoods exists in the northeastern portion of the site.

Courthouse Wash drains 102 square miles and empties into the Colorado River immediately upstream of the Moab site. Moab Wash, which drains approximately 5 square miles, runs through the middle of the site to the Colorado River.

Appendix F, "Floodplain and Wetlands Assessment and Floodplain Statement of Findings for Remedial Action at the Moab Site," includes a more detailed description of floodplains at the Moab site.

3.1.9 Wetlands

Several areas below the tamarisk next to the Colorado River were investigated in February 2002 and were found to contain wetland plants and soils. Although their boundaries have not been formally delineated, these areas are jurisdictional wetlands. Neither the tamarisk areas nor the vegetated margin of a holding pond for irrigation water qualify as wetlands.

The Matheson Wetlands Preserve, across the river from the Moab site, has a variety of wetland types that include emergent wetlands, shrub wetlands, cottonwood stands, and ponds. This 875-acre preserve contains the only sizable wetland remaining on the Colorado River in Utah. Appendix F includes a more detailed description of wetlands at the Moab site.

No wetlands are known to exist at any vicinity properties, but because desert environments often contain small, isolated wetlands, these properties would be examined for wetlands prior to construction.

3.1.10 Aquatic Ecology

The aquatic resources within the vicinity of the Moab tailings pile are associated with the Colorado River. The river has historically had seasonal variations in flow and temperature that are based on natural flow cycles. Aquatic species in the river have adapted to physical and chemical conditions that fluctuate naturally, both seasonally and daily. These variable conditions include river flow, bottom scouring by sand and silt, temperature, sediment loading, chemical composition, and salinity (NRC 1999).

The Moab site is near river mile 64 on the Colorado River in a transition zone between two geomorphically distinct reaches. River miles on the Colorado River have been designated for use in research programs; the beginning of the designation (mile 0) is at the confluence of the Green River and the Colorado River (Belknap and Belknap 1991; Osmundson et al. 1997). The Colorado River upstream of the site is predominantly sand bedded with a few cobble bars. Downstream of the site, the river is sand bedded with sandbars and stabilized islands. Much of the shoreline near the site has been stabilized by tamarisk, an invasive species, or stabilized with riprap. The tamarisk can form cutbanks that erode to some degree with each large flood. The shoreline at the Matheson Wetlands Preserve opposite the site has been diked and is heavily colonized by tamarisk (NPS 2003).

The State of Utah has classified the river segment adjacent to the Moab site as protected for warm-water species of game fish and other warm-water aquatic life, including necessary aquatic organisms in their food chains. This river segment has also been designated as critical habitat (50 CFR 17.95) for four federal endangered fish species. Detailed information concerning habitat for these species is addressed in Appendix A1, "Biological Assessment."

Macroinvertebrates (i.e., chironomids and oligochaetes) are thought to dominate the benthic community of the main channel of the Colorado River near the Moab site (NRC 1999, USGS 2002). Backwater areas, such as the wetlands formed by periodic inundation of the floodplain just downstream and across the river from the Moab site, may support a much more diverse and more productive benthos. Similarly, rooted macrophytes (i.e., plants), along with algae and zooplankton, flourish in the backwaters that may provide suitable habitat but are almost nonexistent in the main channel (NRC 1999). The backwaters and inundated floodplains often serve as important nurseries and forage suppliers for fish, including the endangered Colorado pikeminnow (Valdez and Wick 1983). Fish species known or believed to be present in this reach are listed in Table 3–9. This list includes four federal endangered species, one state threatened species, and two state species of special concern.

Many components of the upper Colorado River ecosystem have undergone dramatic changes during the last several decades. An additional important force for change has been the sometimes accidental, but often deliberate, introduction of nonnative fish species into the river, including carp, channel catfish, various minnow species, and largemouth bass (NRC 1999). These introductions, in concert with the physical and chemical alterations of the river, may have contributed to the decline of the native fish populations (Trammell and Chart 1999; NRC 1999; Muth et al. 2000).

Table 3–9. Fish That May Occur in the Colorado River Near the Tailings Pile

Common Name	Scientific Name	Status
Roundtail chub	*Gila robusta*	N, ST
Humpback chub	*Gila cypha*	N, FE, SE
Bonytail	*Gila elegans*	N, FE, SE
Colorado pikeminnow	*Ptychocheilus lucius*	N, FE, SE
Longnose dace	*Rhinichthys cataractae*	I
Speckled dace	*Rhinichthys osculus*	N
Fathead minnow	*Pimephales promelas*	I
Carp	*Cyprinus carpio*	I
Red shiner	*Notropis lutrensis*	I
Sand shiner	*Notropis stramineus*	I
Flannelmouth sucker	*Catostomus latipinnis*	N, SP
Bluehead sucker	*Catostomus discobolus*	N, SP
Razorback sucker	*Xyrauchen texanus*	N, FE, SE
Channel catfish	*Ictalurus punctatus*	I
Black bullhead	*Ictalurus melas*	I
Rio Grande killifish	*Fundulus zebrinus*	I
Largemouth bass	*Micropterus salmoides*	I
Green sunfish	*Lepomis cyanellus*	I

Sources: NRC 1999; Trammell and Chart 1999.
N = native to upper Colorado River; ST = State listed threatened species; FE = federally listed endangered species; SE = State listed endangered species; I = introduced species; and SP = State species of special concern

As reflected in the list of species in Table 3–9, as least as many exotic species as native species of fish are now established in the Colorado River.

The roundtail chub, *Gila robusta*, a Utah state-listed threatened species, is a large minnow native to the Colorado River system. It is most often found in pools and eddies near strong currents in the Colorado River and its large tributaries. These chubs eat terrestrial and aquatic insects, mollusks, other invertebrates, fish, and algae. The species spawns over areas with gravel substrate during the spring and summer. Eggs are fertilized in the water, then drop to the bottom where they adhere to the substrate until hatching about 4 to 7 days later (UDWR 2003a).

The flannelmouth sucker, *Catostomus latipinnis*, and the bluehead sucker, *Catostomus discobolus*, are considered Utah state species of concern because of recent population reductions. Both species are benthic fish that primarily eat algae. The flannelmouth sucker spawns in streams over gravelly areas during the spring and early summer and is often found in deep pools of slow-flowing, low-gradient reaches. The bluehead sucker spawns in streams during the spring and summer. Fast-flowing water in high-gradient reaches of mountain rivers has been identified as important habitat for the bluehead sucker (UDWR 2003a).

3.1.10.1 Aquatic Species Listed in the Endangered Species Act

Four endangered fish species—the Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus)*, humpback chub (*Gila cypha)*, and bonytail (*Gila elegans)*—are endemic to the Colorado River basin. The Colorado River near the Moab site has been designated as critical habitat (50 CFR 17.95) for all four federal endangered fish species. Detailed information concerning habitat and critical life-history phases for these species is presented in Appendix A1, "Biological Assessment."

Colorado Pikeminnow

The Colorado pikeminnow, a large fish-eating fish belonging to the minnow family, was once abundant and widely distributed in the Colorado River basin. Pikeminnow less than 2 inches in total length prey on small aquatic invertebrates in side channels and backwaters; juveniles between 2 and 8 inches total length, still in the backwater nursery habitat, eat invertebrates and other fish; pikeminnow greater than 8 inches total length prey mainly on other fish (Muth and Snyder 1995).

Adult pikeminnow use a variety of habitats after spawning, including eddies, backwaters, and shorelines. In the spring and early summer, the adults use shorelines, floodplain habitats, flooded tributary mouths, and lowlands inundated during spring floods (Tyus 1990; USF&WS 2002a). The pikeminnow spawn on gravel beds in whitewater canyons during the period of declining flows in June, July, or August (Tyus and Haines 1991; Muth et al. 2000; Tyus 1990). During the spawning season, adults have been reported to migrate up to 200 miles upstream or downstream to reach spawning areas (Tyus 1990). After hatching, larvae drift downstream, where they are entrained in backwater nursery habitats (Tyus and Haines 1991). Young Colorado pikeminnow remain near the nursery areas for the first 2 to 4 years of life, then move upstream and establish home ranges (Osmundson et al. 1998). Larval pikeminnow (0 to 1 year) show a preference for secondary channel habitats (Trammell and Chart 1998; Rakowski and Schmidt 1996; Day et al. 1999), and they are primarily found in low-velocity waters, which include backwaters (Tyus and Haines 1991; Trammell and Chart 1998). In the fall, they use backwater habitats that are deeper and more persistent than other habitats (Trammell and Chart 1998; Day et al. 1999). These backwaters are created when a secondary channel is cut off at the upper end but remains connected to the river at the downstream end. These areas are considered crucial for overwinter survival of the larval and juvenile fish (Trammell and Chart 1998).

There are 600 to 900 adults in the upper Colorado River (USF&WS 2002a). The two known spawning areas in this reach of the river are near Grand Junction, Colorado, and in the lower Gunnison River (USF&WS 2002a). Fish and juveniles aged 0 to 1 year are found in the upper Colorado River downstream of Palisade, Colorado, to Lake Powell, Utah (USF&WS 2002a). The Moab site is located on river mile 64 and is within the habitats documented to contain current populations of Colorado pikeminnow. Low numbers of Colorado pikeminnow (between 1 and 28 fish) were consistently collected from 1986 to 1996 between river miles 68 and 49 (USGS 2002). Both adults and subadults were collected in Moab Wash and directly below the tailings pile (USGS 2002). As many as 53 young-of-the-year pikeminnow were captured between river miles 48 and 84 (Osmundson et al. 1997). In a mark-recapture study of adult pikeminnow in this reach, 21 of 51 fish (41 percent) were caught between river miles 57 and 65 (Osmundson et al. 1997). Surveys in 1992 to 1996 by Trammell and Chart (1998) found adult and larval pikeminnow between river miles 55 and 65. In addition, pikeminnow are known to use the main channel for spawning migrations and the backwater area of the Matheson Wetlands Preserve as important nursery habitat (NRC 1999). During periods of inundations, the lower Moab Wash and the riparian woodland near the toe of the pile potentially provide habitat for pikeminnow and razorback suckers (NRC 1999). Other backwaters and eddies occur in this reach during periods of relatively low flow and also serve as nurseries (NRC 1999).

As part of the Interagency Standardized Monitoring Program[1], pikeminnow nursery habitat was sampled each fall (1986–2002) between river miles 53.5 and 63.5. The area surveyed began at or near the Moab site (river mile 64) and continued downstream about 10 miles. The purpose of this sampling was to determine relative abundance and distribution of young-of-the-year Colorado pikeminnow. The sampling protocol required sampling two habitats every 5 miles. Sixty backwater locations were sampled between 1986 and 2002, of which 13 were between river miles 61 and 63.5. Five of the 13 backwater areas sampled contained a total of 83 young-of-the-year pikeminnow, composing 24 percent of the total pikeminnow captured in this reach (river miles 53.5 to 63.5) during the sampling (UDWR 2003b).

From 1992 to 1996, 13 flyovers were conducted to determine backwater habitat in this reach (river miles 53.5 to 63.5).

A field visit with UDWR on December 19, 2001, identified areas that may serve as preferred habitat when backwaters are present. These areas begin at the mouth of Moab Wash and extend approximately 1,200 ft south (Hudson 2001). Within this area, three locations (Figure 3–17) extending about 600 to 800 ft south of the wash were tentatively identified as having the greatest potential for habitat preferred by young-of-the-year fishes. Because natural processes can physically alter the characteristics of river channels, the exact location of preferred habitat can change seasonally or annually. Part of the channel to the west is completely inundated during an average spring runoff in April and May when the river flow is greater than approximately 15,000 cfs. Preferred habitat for young-of-the-year fishes develops in the channel as the river recedes below 15,000 cfs in May and June and the sandbar area becomes exposed. As the river level further declines in the fall, the backwaters in the channel become isolated from the river at approximately 5,000 cfs and evaporate to dryness. Habitat availability and quality depend upon the time of year, changes in river structure, and water level.

USF&WS has defined physical characteristics of preferred habitat to include (1) warmer backwater and slow-moving eddies, (2) a sandy/silty substrate, and (3) water depths of less than 2 ft. However, habitat criteria can be less than optimal if other factors, such as food supply, are attractive. Preference parameters can vary significantly and are not prescriptive.

Razorback Sucker

The endangered razorback sucker is one of the most imperiled fish in the basin. It exists naturally as only a few disjunct populations or scattered individuals (Minckley et al. 1991; Muth et al. 2000). Lack of recruitment sufficient to sustain populations has been mainly attributed to the cumulative effects of habitat loss and modification caused by water and land development and predation on early life stages by nonnative fishes (Hamilton 1998; USF&WS 1998; Muth et al. 2000).

Razorback suckers are known to spawn on gravel bars and may also spawn in backwaters (NRC 1999). In the past, they have been observed spawning in early and mid-summer within 2 miles upstream of the tailings pile (NRC 1999). This type of preferred habitat develops in the channel as the river recedes below 15,000 cfs in May and June and the sandbar area becomes exposed. The razorback sucker may be found almost anywhere in the river, including slow runs

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[1] This program is a consortium among the U.S. Fish and Wildlife Service; Bureau of Reclamation; Western Area Power Administration; the states of Utah, Colorado and Wyoming; the water user community; and environmental interests (http://www.desertfishes.org/na/catostom/xyrauche/xtexanus/xtexanus.html).

in the main channel, inundated floodplains and tributaries, eddies and backwaters, sandy bottom riffles, and gravel pits (USF&WS 1998). Young razorback suckers require nursery habitat with warm, shallow water such as tributary mouths, backwaters, or inundated floodplains (Modde 1996; Muth et al. 2000). During periods of inundation, the lower Moab Wash and the riparian woodland near the toe of the pile potentially provide habitat for pikeminnow and razorback suckers (NRC 1999). The Matheson Wetlands Preserve area is also potential nursery habitat for the razorback sucker (NPS 2003). For purposes of this EIS, it is assumed that the razorback sucker may be present in the project area.

A limited number of adults have been found in the upper Colorado River since 1974 (USF&WS 2002b). Many of the adults captured during studies have been found in two abandoned gravel pits in Grand Valley, Colorado, just upstream and downstream of the confluence with the Gunnison River (USF&WS 2002b). No young razorback suckers have been captured anywhere in the upper Colorado River since the mid-1960s (USF&WS 2002b; USGS 2002; NPS 2003).

The diet of all life stages is varied and includes invertebrates, zooplankton, phytoplankton, algae, and detritus (Behnke and Benson 1983; Marsh 1987; Muth et al. 1998, 2000).

Humpback Chub

The humpback chub, a large cyprinid fish, prefers deep canyons with swift water and rapids (USF&WS 2002c; Muth et al. 2000). Adults require eddies and sheltered shoreline habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, and form gravel and cobble deposits used during spawning. Young require low-velocity shoreline habitats, including eddies and backwaters, that are more prevalent under base-flow conditions (USF&WS 2002c).

Historical abundance of the humpback chub is unknown, and knowledge of historical distribution is incomplete (Muth et al. 2000; USF&WS 2002c). The species exists primarily in relatively inaccessible canyons of the Colorado River Basin and was rare in early collections (USF&WS 2002c).

Humpback chub move substantially less than other native Colorado River fish. Radiotelemetry and tagging studies consistently show that respective humpback chub populations remain in specific river locations.

Five individuals were collected from a reach about 19 river miles downstream of the Moab site, possibly associated with populations upstream of the Moab site in Westwater Canyon and Black Rocks (NRC 1999; Valdez and Williams 1993).

Six extant wild populations are known in the Upper Colorado Basin: (1) Black Rocks, Colorado River, Colorado; (2) Westwater Canyon, Colorado River, Utah; (3) Yampa Canyon, Yampa River, Colorado; (4) Desolation/Gray Canyons, Green River, Utah; (5) Cataract Canyon, Colorado River, Utah; and (6) Colorado River in Marble and Grand Canyons and the little Colorado River, Arizona (USF&WS 2002c). The nearest downstream population occurs in Cataract Canyon (43 miles downstream of the Moab site) (USF&WS 2002c). UDWR, in cooperation with USF&WS, plans to reintroduce the humpback chub into its historical range upstream of the site in the near future.

Bonytail

The bonytail uses mainstem river channels as well as inundated riparian areas. Currently, no self-sustaining populations of bonytail exist in the wild, and few individuals have been caught throughout the Upper Colorado Basin (USF&WS 2002d). Bonytail have been stocked in this reach since 1996; however, these populations have not thrived, and there has been no recruitment (NPS 2003). Only five individuals, all from Cataract Canyon, were collected during surveys by Valdez and Williams from 1985 to 1988 (NRC 1999). The presence of this rare fish near the Moab site has not been confirmed (NRC 1999).

3.1.10.2 Environmental Tolerances

The aquatic environment in the reach of the Colorado River bordering the Moab site is potentially affected by activities at the site. Ground water flow from the pile has introduced chemical and radioactive contaminants into the surface water (see Section 3.1.7.3). Tolerance of the aquatic biota to the contaminants is dependent on their life-stage, location, and duration of exposure. Appendix A1, "Biological Assessment," provides further information on contaminants and their effects on the aquatic biota.

3.1.11 Terrestrial Ecology

Historically, the entire site has been disturbed from natural events such as floods or from milling operations. At present, the relatively barren terrain of the site limits the potential for terrestrial wildlife habitat, with the exception of the southeasternmost portion of the site, where tamarisk are dominant. Approximately 380 acres of the site do not currently support vegetation. Mature tamarisk, with minimal understory, covers approximately 50 acres of the site east of the tailings pile on the Colorado River floodplain. This area provides some habitat for birds and small mammals. Steep rock mesas dominate the area just west of the site. Low-growing desert shrub communities and low-density piñon-juniper forest are the predominant vegetation types west and north of the site along the transportation routes.

3.1.11.1 Terrestrial Vegetation and Wildlife

The existing vegetation reflects a history of disturbance. Plants observed in April 2003 include spike dropseed (*Sporobolus contractus*), sand dropseed (*Sporobolus cryptandrus*), tamarisk (*Tamarix ramosissima*), black greasewood (*Sarcobatus vermiculatus*), gray rabbitbrush (*Ericameria nauseosa*), Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), big sagebrush (*Artemisia tridentata*), and galleta (*Pleuraphis jamesii*). The presence of tamarisk and low-density black greasewood indicates that ground water occurs within 20 to 50 ft of the surface.

Vegetation across the Colorado River, including the Matheson Wetlands Preserve, provides more attractive habitat and consists of riparian woodland, grassland, and shadscale (saltbush) communities. Woodland, dominated by native tree species such as black willow (*Salix nigra*) and Fremont cottonwood (*Populus fremontii*), is present in the preserve. Other plants include tamarisk, sedges (*Carex* spp.), bulrush (*Scirpus* spp.), and cattail (*Typha* spp.) (NRC 1999). More than 175 species of birds have been observed at the preserve, and a great blue heron (*Ardea herodias*) rookery is present in its lower end (NRC 1999).

Without the current disturbance, the potential natural vegetation (i.e., vegetation that would occur in the absence of disturbance) and habitat of the upland soils at the site, Nakai sandy loam (see Section 3.1.2), would include grasses such as Indian ricegrass (*Achnatherum hymenoides*) and galleta and the desert shrubs fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), and winterfat (*Krascheninnikovia lanata*). Because of a relatively high composition and productivity of palatable grasses and shrubs in the potential vegetation (Table 3–10), these plant species would normally be of value as forage for livestock. This relative diversity of the potential vegetation could also provide habitat for a variety of small mammals, including white-tailed prairie dog (*Cynomys leucurus*), desert cottontail (*Sylvilagus audubonii*), and black-tailed jackrabbit (*Lepus californicus*). Fourwing saltbush, shadscale, and galleta may be used to some extent by mule deer (*Odocoileus hemionus*) as forage. Coyote (*Canis latrans*), bobcat (*Lynx rufus*), and badger (*Taxidea taxus*) could frequent this area to prey on the small mammals. Raptors, including golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), and rough-legged hawk (*Buteo lagopus*), could also use this area as hunting ground.

Table 3–10. Characteristics of the Potential Vegetation on the Nakai Soil Type

Soil Name	Range Site	Characteristic Potential Vegetation	(percent)	Productivity (pounds/acre)	Rooting Depth (inches)
Nakai	Desert Sandy Loam	Fourwing saltbush (*Atriplex canescens*)	10	350–700	40 to >60 depending on depth to bedrock
		Shadscale (*Atriplex confertifolia*)	10		
		Winterfat (*Krascheninnikovia lanata*)	5		
		Torrey Mormon tea (*Ephedra torreyana*)	5		
		Indian ricegrass (*Achnatherum hymenoides*)	20		
		Galleta (*Pleuraphis jamesii*)	10		
		Sand dropseed (*Sporobolus cryptandrus*)	5		
		Globemallow (*Sphaeralcea* spp.)	10		
		Locoweed (*Astragalus* spp.)	5		

Source: NRCS (2002); SCS (1989).

3.1.11.2 Threatened and Endangered Species

This section describes the terrestrial (plant and wildlife) threatened and endangered species that are, or may be, present in the project area. Threatened and endangered plant and wildlife species are those species listed in 50 CFR 17 as threatened, endangered, or candidate species and are subject to USF&WS Section 7 consultation under the Endangered Species Act (ESA). USF&WS (2003) lists 19 threatened and endangered animal species and 24 threatened and endangered plant species for the state of Utah. In March 2003, DOE requested an updated list of threatened and endangered species from USF&WS that may be present or affected by DOE's proposed alternatives. USF&WS responded in April 2003 with a list for Grand County that included one threatened plant, five threatened and endangered animal species, and two animal species that are candidates for protection under the ESA. These are listed in Table 3–11. UDWR (2003a) has identified the white-tailed prairie dog as being considered for candidate status. The status of each of these species in the vicinity of the Moab site is briefly discussed below. Appendix A1, "Biological Assessment," provides more detailed information concerning these federally listed species that may be in the vicinity of the site or could be affected by activities or contaminants at the site.

<u>Jones' Cycladenia</u>

The federally threatened Jones' cycladenia is known to occur relatively near the Moab site. However, USF&WS has determined that this plant species would likely not be located in the proposed project areas. Jones' cycladenia grows in gypsiferous soils that are derived from the

Summerville, Cutler, and Chinle Formations; they are shallow, fine textured, and intermixed with rock fragments. The species can be found in Eriogonum-ephedra, mixed desert shrub, and scattered piñon-juniper communities at elevations ranging from about 4,000 to 6,800 ft. It is restricted to the canyonlands of the Colorado Plateau in Emery, Garfield, Grand, and Kane Counties, Utah, as well as in immediately adjacent Coconino County, Arizona (UDWR 2003a).

Table 3–11. Federally Listed Terrestrial Threatened and Endangered Species Potentially Occurring at the Moab Site

Common Name	Scientific Name	Habitat Present and Affected	Species Present	Status	Comments
Jones' cycladenia	*Cycladenia humilis* var. *jonesii*	Possible	No	Threatened	None
Southwestern willow flycatcher	*Empidonax traillii extimus*	Possible	Unknown	Endangered	Likely migrate through area
Bald eagle	*Haliaeetus leucocephalus*	Possible	Yes	Threatened	Proposed for delisting
Mexican spotted owl	*Strix occidentalis lucida*	Possible	No	Threatened	None
California condor	*Gymnogyps californianus*	No	No	Endangered	None
Black-footed ferret	*Mustela nigripes*	No	No	Endangered	None
Yellow-billed cuckoo	*Coccyzus americanus*	Possible	Unknown	Candidate	None
Gunnison sage grouse	*Centrocercus minimus*	No	No	Candidate	None

Southwestern Willow Flycatcher

Southwestern willow flycatchers (*Empidonax trailii extimus*) are among the few bird species known to nest in habitat dominated by exotic species such as tamarisk and Russian olive (*Eleagnus angustifolia*), invasive species that are prevalent along much of the Colorado River corridor. However, it appears that higher quality habitat exists where tamarisk is intermixed with other trees and shrubs, along with the presence of natural flood regimes, ample water, and beaver activity (USGS 2001). The southwestern willow flycatcher typically nests in riparian areas with dense thickets of trees and shrubs that are on average 13 to 23 ft in height, with dense foliage from 0 to 13 ft above ground. The percent canopy cover is generally high (50 CFR 17).

The southwestern willow flycatcher has been identified as potentially occurring in the Matheson Wetlands Preserve and also several miles downstream of the Moab site. No nesting activity was observed in these areas, and the species has not been observed on the Moab site proper (NRC 1999). Surveys of potentially suitable habitat were conducted along the Colorado River, approximately 6 river miles south of the site in 2002. Willow flycatchers (subspecies not specified) were present during one survey in May (USGS 2002). The survey report concluded that willow flycatchers in this area were migrating and were not using the area for breeding. These results reflected conclusions of a 3-year study (1999 to 2001). However, the study recommended continued monitoring. No designated critical habitat for this species exists within the site area or along transportation corridors.

It appears that the Moab site is at or beyond the northern extent of the range for the southwestern willow flycatcher. According to UDWR (2003a), the known distribution for the southwestern willow flycatcher in Utah is limited to the southern parts of the state. USF&WS (2002e) identifies southern Utah as the north-central limit of the flycatcher's breeding range. However, a similar subspecies, *E.t. adastus*, occurs at higher elevations in central and northern Utah, and the subspecific identity of these two subspecies in the vicinity of the Moab site remains unresolved (USF&WS 2002e).

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) ranges over much of North America, and wintering grounds include many areas in Utah (National Geographic Society 1987). The population throughout the lower 48 states has increased significantly during the last several decades, to the point that USF&WS has submitted a proposal to remove the bald eagle from the list of threatened species (64 FR 36453–36464 [1999]). Bald eagles generally avoid areas with nearby human activity and development. Only four nest sites were known in Utah as of 2000 (UDWR 2003a), and none of these are near the Moab site or any of the other sites considered in this analysis. Nesting habitat for this species is limited in the vicinity of the Moab site and does not exist along the proposed transportation corridors between the Moab site and the proposed borrow locations. The BLM Grand Resource Area Management Plan/Environmental Impact Statement (BLM 1985) identified the threatened bald eagle as potentially occurring in the Moab area. Suitable habitats along the Colorado River in the vicinity of the Moab site are likely wintering areas. The Utah Gap Analysis Program indicates that wintering habitat occurs in the Moab vicinity (UDWR 1999).

Mexican Spotted Owl

The Mexican spotted owl (*Strix occidentalis lucida*) occupies a variety of habitats, including thickly wooded canyons and humid forests (National Geographic Society 1987) to steep rocky canyons, which is the primary habitat used in Utah. These owls do not build their own nests, but utilize nests built by other animals or suitable naturally occurring sites. Preferred nesting sites are in trees with broken tops but are also in trunk cavities or on cliffs. Spotted owls are nonmigratory.

According to UDWR (2003a), the spotted owl's current range in Utah includes most of the southern part of the state, including much of San Juan County. Small patches of known distribution occur in the southernmost part of Grand County and parts of Uinta and Carbon Counties. Many of these areas are also designated by USF&WS as critical habitat (66 FR 85–308553). Within these critical habitat areas are protected and restricted habitat areas. Protected habitat "includes all Mexican spotted owl protected activity centers, all areas in mixed-conifer and pine-oak types with slope greater than 40 percent where timber harvest has not occurred in the past 20 years" (UDWR 2003a). Restricted habitat has a similar, but more general, definition and is not tied to specific protected activity centers (i.e., not tied to known nest sites). BLM has identified potentially suitable habitat (Cresto 2003) within 0.5 mile west of the site on the basis of models developed at Northern Arizona University.

California Condor

California condor (*Gymnogyps californianus*) sightings were historically rare in Utah, noted only twice by pioneers in the 1800s. A nonessential experimental population of California condors was established in northern Arizona in 1996 (61 FR 54043–54060 [1996]). Sightings of the birds that were released in northern Arizona were made nearly statewide in Utah in the late 1990s. The known distribution of the California condor in Utah currently consists of the southern third of the state, including most of San Juan County (UDWR 2003a). Individuals may occasionally pass through the Moab area, but they are not likely to land or use habitat in the vicinity of the Moab site or any of the alternative off-site disposal sites or borrow areas.

Black-Footed Ferret

The range of the black-footed ferret (*Mustela nigripes*) historically covered much of the Great Plains and extended west into eastern Utah. Thought to be extinct until 1981, all individuals now in the wild are thought to be the result of a successful captive breeding and reintroduction program. Unconfirmed sightings of naturally occurring ferrets persist throughout eastern Utah (UDWR 2003a).

Black-footed ferrets depend almost exclusively on prairie dog colonies for food, shelter, and denning. The range of the ferret coincides with that of prairie dogs, and ferrets with young have been documented only in the vicinity of active prairie dog colonies. It has been estimated that about 100 to 150 acres of prairie dog colony are needed to support one ferret (USF&WS 1988). Black-footed ferrets were released in Uinta County, Utah, in late 1999, and UDWR now considers much of the central part of Grand County as Critical Value Habitat. Although there may be a few small prairie dog colonies in the vicinity of the Moab site, the Moab region is not considered high-quality habitat for white-tailed prairie dogs (UDWR 2003a), and it is unlikely that colonies of sufficient size to support ferrets occur near enough to the Moab site to be affected by site operations.

Yellow-Billed Cuckoo

The yellow-billed cuckoo (*Coccyzus americanus*) was listed on October 30, 2001 (66 FR 54807), as a candidate species. Nesting habitat is classified as dense lowland riparian areas characterized by a dense subcanopy or shrub layer (regenerating canopy trees, willows, or other riparian shrubs) within about 300 ft of water. Overstory in these habitats may be either large, gallery-forming trees (33 to 90 ft) or developing trees (10 to 27 ft), usually cottonwoods. Nesting habitat is found at low to mid-elevations (2,500 to 6,000 ft) in Utah. Cuckoos may require large tracts (100 to 200 acres) of contiguous riparian nesting habitat. The yellow-billed cuckoo is thus considered a riparian obligate (UDWR 2003a).

Potentially suitable habitat is located south of the Moab site along the Colorado River and possibly across the river in the Matheson Wetlands Preserve. Surveys conducted from 1999 to 2001 south of the Moab site showed few sightings. Sightings that were documented indicated that this species is using potentially suitable habitat as a migrant and is not using the area as breeding habitat (USGS 2001). However, according to USF&WS, there was a breeding record from the Matheson Wetlands Preserve in 1994 (66 FR 38611–38626 [2001]), located across the Colorado River from the Moab site.

Gunnison Sage Grouse

Although the Gunnison sage grouse (*Centrocercus minimus*) may range into southeastern Grand County, it appears that populations of this species in Utah are essentially restricted to San Juan County (UDWR 2003a). It is unlikely that this species would be present at the Moab site. The Gunnison sage grouse was recognized as a species distinct from the greater sage grouse (*Centrocercus urophasianus)* in 2000 (AOU 2000) and was added to the list of ESA candidate species in 2002 (67 FR 40657–40679 [2002]).

White-Tailed Prairie Dog

A petition to list the white-tailed prairie dog as threatened or endangered under the ESA was submitted by a group of environmental organizations in July 2002 (Center for Native

Ecosystems 2002). USF&WS is currently evaluating this petition and is considering adding this species to the list of candidates for ESA protection. As previously stated, the Moab site is not considered to be quality habitat for this species (UDWR 2003a), and it is unlikely to occur at or near the site in substantial numbers.

3.1.11.3 Other Special Status Species

For this EIS, special status species are those that are protected under federal and state regulations other than the ESA, which include the Migratory Bird Treaty Act (MBTA), Executive Order 13186, and Birds of Conservation Concern (USF&WS 2002f). The State of Utah maintains a list of species that it considers threatened, endangered, or otherwise of concern; other federal agencies such as BLM and the U.S. Forest Service (USFS) maintain lists of species considered to be sensitive. However, only those listed by the USF&WS under the ESA are included in Section 7 consultations or in the Biological Assessment. Although special status species are not covered by the ESA and are, therefore, not subject to Section 7 consultations, USF&WS encourages protection of these species.

Table 3–12 lists sensitive plant species considered by state and federal resource agencies to be of concern that may occur in the site region, including transportation routes and borrow areas. A number of the species listed by the State of Utah, or considered sensitive by BLM, are potentially present in the vicinity of the Moab site.

Table 3–13 includes animal species listed by the State of Utah as endangered, threatened, or otherwise of concern that may be present in the project region. The list includes all species identified by UDWR as potentially occurring in Grand County; in some cases, the known population or suitable habitat is well removed from the Moab site. The species listed as endangered or threatened by UDWR are discussed below.

Peregrine Falcon

Peregrine falcons inhabit mountain ranges, river valleys, and coastlines (USF&WS 1999). They prefer to nest on high cliff ledges (National Geographic Society 1987). Peregrine falcons were one of the first species listed as endangered in 1970 (predating the ESA). After a successful recovery program, they are now much more abundant throughout their range, and the species was ultimately removed from the list of threatened and endangered species in 1999 (64 FR 46541–46558). In Utah, the bird is still rare, but primary breeding habitat exists in small, scattered areas throughout the state. The peregrine falcon is believed to be a year-round resident in the vicinity of the Moab site (BLM 1985).

Ferruginous Hawk

Ferruginous hawks (*Buteo regalis*) are found in grasslands, agricultural lands, sagebrush/ saltbush/greasewood shrub lands, and at the edges of piñon-juniper forests. They tend to avoid high elevations, forests, and narrow canyons. Flat and rolling terrain in grassland or shrub steppe are most often used during breeding season. In winter, they use open, arid areas where rabbits, prairie dogs, and other major prey are found. Nest locations show great flexibility, including trees and shrubs, cliffs, creek banks, utility structures, and abandoned buildings; however, they have a preference for elevated nest sites. Ferruginous hawks are widespread throughout the western United States. In Utah, primary breeding grounds are in northern Grand County and in areas of northern and western Utah.

Table 3–14 lists sensitive bird species, including migratory birds, that may occur in the vicinity of the site, although on-site habitat limits typical nesting and breeding activities. Most of these species are protected under the MBTA, which prohibits take or destruction of birds, nests, or eggs of listed migratory birds.

Table 3–14. Sensitive Bird Species Protected Under the Fish and Wildlife Conservation Act and Migratory Bird Treaty Act That May Occur Near the Moab Site

Species	Potential to Occur in Project Area
Order Gaviiformes—Open-water birds	
Common loon *(Gavia immer)*	Low
Order Ciconiiformes—Long-legged waders	
American bittern *(Botaurus lentiginosus)*	Moderate
White-faced ibis *(Plegadis chihi)*	Moderate
Order Falconiformes—Birds of prey	
Golden eagle *(Aquila chrysaetos)*	High
Northern harrier *(Circus cyaneous)*	Moderate
Prairie falcon *(Falco mexicanus)*	Moderate
Red-tailed hawk (*Buteo jamaicensis*)	High
Turkey vulture (*Cathartes aura)*	High
Order Gruiformes—Marsh and open country birds	
Black rail *(Laterallus jamaicensis)*	Moderate
Yellow rail *(Coturnicops noveboracensis)*	Low
Order Charadriiformes—Shorebirds	
Black tern *(Chlidonias niger)*	Moderate
Long-billed curlew *(Numenius americanus)*	Moderate
Marbled godwit *(Limosa fedoa)*	Moderate
Snowy plover *(Charadrius alexandrinus)*	Moderate
Solitary sandpiper *(Tringa solitaria)*	Moderate
Upland sandpiper *(Bartramia longicauda)*	Low
Wilson's phalarope *(Phalaropus tricolor)*	Moderate
Order Strigiformes—Nocturnal birds of prey	
Barn owl *(Tyto alba)*	Low
Flammulated owl *(Otus flammeolus)*	Low
Short-eared owl *(Asio flammeus)*	Low
Order Apodiformes—Small swallowlike birds	
Black swift *(Cypseloides niger)*	Low
Vaux's swift *(Chaetura vauxi)*	Low
Order Piciformes—Wood-boring birds	
Red-headed woodpecker *(Melanerpes erythrocephalus)*	Low
Williamson's sapsucker *(Sphyrapicus thyroideus)*	Low
Order Passeriformes—Perching birds	
Olive-sided flycatcher *(Contopus borealis)*	Low
Gray flycatcher *(Empidonax wrightii)*	Moderate
Pinyon jay *(Gymnorhinus cyaneocephalus)*	Low
Bendire's thrasher *(Toxostoma bendirei)*	High
Crissal thrasher *(Toxostoma dorsale)*	High
Bewick's wren *(Thryomanes bewickii)*	Moderate
Sedge wren *(Cistothorus platensis)*	Low
Verry *(Catharus fuscenscens)*	Moderate
Sprague's pipit *(Anthus spragueii)*	Low
Loggerhead shrike *(Lanius ludovicianus)*	Moderate

Note: Birds listed in the table are protected under the Fish and Wildlife Conservation Act (Birds of Conservation Concern [2000] [USF&WS 2002f] and the MBTA [50 CFR 10], Executive Order 13186). Species listed as threatened or endangered under the ESA or considered endangered, threatened, or rare by the State of Utah are not included here.

3.1.12 Land Use

Federal, state, city, or county entities administer approximately 90 percent of the land in Grand County. Among federal agencies, BLM administers the greatest percentage of land. Several national parks are in the vicinity of the Moab site. Arches National Park is adjacent to the north border of the site, and Canyonlands National Park is approximately 12 miles (see Figure 2–2) southwest of the site (in San Juan and Wayne Counties). The closest boundary to the Uinta and Ouray Indian Reservation is located approximately 44 air miles north-northwest of the site; however, the closest populated area within the reservation is considerably farther at Duchesne, about 120 air miles north of Moab.

Most of the land in this area is open to recreational uses, and tourism is an important part of the Moab economy. Favorable weather allows off-road access for hikers, bikers, and off-highway vehicles in virtually all seasons. The Colorado River adjacent to the site is a source of extensive recreational use for spring and summer water sports. Because the land directly south of the site adjoins the river and access is not limited, it is often used by campers and hikers throughout the summer months. The entrance to Arches National Park is within 1 mile of the site boundary. It is the northern end of a crescent of national parks and recreation areas that curve southwesterly to the Grand Canyon in Arizona. Most of the visitors to Arches National Park are there for the day only. During 2002, 765,000 visitor days were recorded at the park, of which 41,524 included at least one overnight stay. This park includes exceptional viewpoints and is known for its many spectacular arches.

Grand County has little land suitable for farming. Areas that are suitable for cultivation are limited to Moab Valley and Spanish Valley. Grand County has no prime or unique farmlands. Residential and commercial development has been increasing since 1979, and agricultural use has declined. Grazing occurs throughout the region, including on the plateaus. However, low rainfall and sparse vegetation limit livestock numbers. Except where irrigation is present, federal grazing allotments cover large areas.

Land use in the vicinity of the Moab site is largely commercial, with few residents in the immediate area. The nearest full-time residence is at the northeast corner of the site between Courthouse Wash and the easternmost site boundary. A river tours and gift shop business is located adjacent to the east side of Courthouse Wash. A restaurant, a residence, and two commercial parks for recreational vehicles, motor homes, and trailers are along US-191 approximately 0.75 to 1.5 miles east of the site. Area land use between the Moab and Crescent Junction sites is shown on Figure 3–18.

Land directly south of the site is privately owned and is vacant. The northwest edge of the main residential and commercial area of the city of Moab is across the Colorado River, approximately 1.8 miles southeast of the site.

The land directly across and adjoining the Colorado River to the east is designated as the Matheson Wetlands Preserve. It is jointly owned and managed by UDWR and the Nature Conservancy. The 875-acre preserve includes a trail system, educational kiosks, wildlife viewing platforms, and a water delivery system. Land uses farther downstream along the Colorado River include residences for about 15 families, 100 to 150 acres of forage crops, grazing, and a potash facility (NRC 1999).

The headquarters and staff residences for Arches National Park are located about 1.2 miles northwest of the Moab site. No residences or residential areas, other than those identified above, are known to be located within 2 miles of the site.

3.1.13 Cultural Resources

3.1.13.1 Cultural History of Southeastern Utah

The earliest known humans to inhabit southeastern Utah were believed to have arrived around 10,000 B.C. These paleoindian people were nomadic hunters of large game animals, which at that time included the mammoth, horse, camel, bison, and giant sloth. Stone weapon points from this period have been found in southeastern Utah. These hunters were believed to have migrated out of the area soon after the end of the Pleistocene (Berry 2003).

From 7800 to approximately 500 B.C., Archaic people inhabited southeastern Utah. These were hunter-gatherers who depended more on small game and plants for subsistence. Sometime after 2000 B.C., agriculture was adopted by many of the Archaic people, and a more sedentary, group-oriented lifestyle began. A number of archaeological sites containing evidence of Archaic-age tools, weapons, and structures have been discovered throughout southeastern Utah.

With the advent of horticulture, populations of tribal groups within the southeastern Utah area expanded and diversified. Between A.D. 1 and 1300, several distinct cultural groups inhabited the area, the best known of which were the Anasazi and Fremont. Grand County is thought to have been the northern limit of Anasazi habitation, although some rock art and pottery remains have been found in the Moab and Arches National Park areas. The Fremont group is believed to have inhabited areas primarily north of Moab. Numerous lithic sites, granaries, and storage pits have been found in the area between Arches National Park and the Book Cliffs. The abundant pictographs and petroglyphs discovered throughout southeastern Utah derive from the Anasazi and Fremont people. Both of these groups abandoned the Four Corners region between A.D. 1250 and 1400.

The ancestors of the present-day Ute and Southern Paiute tribes entered southeastern Utah about A.D. 1200. They were mainly hunter-gatherers who hunted and traveled in small bands composed of two to two dozen individuals. By the time Anglo-Americans arrived in southeastern Utah, the San Juan Southern Paiutes and several bands of Utes were well established in the area.

The Ute people were closely tied to the land, not so much through agriculture but through hunting and gathering; thus, their survival depended heavily upon having complete access to the land (Cuch 2000).

In the late 1800s and early 1900s, their free-roaming lifestyle ended when the Utes were removed from their ancestral lands and forced onto reservations. Today, the Ute bands that once roamed the lands of southeastern Utah are concentrated in reservations in a number of areas: the White Mesa Ute community 9 miles south of Blanding, Utah; the Ute Mountain Utes in Towaoc, Colorado; the Southern Utes in Ignacio, Colorado; and the Northern Utes in White Rocks, Fort Duchesne, and Randlett, Utah.

The Navajos migrated into the Four Corners region sometime between A.D. 900 and 1400. In San Juan County, the earliest known Navajo site, discovered in White Canyon (adjacent to the

Colorado River and west of Blanding), is estimated to be 380 years old. Several Spanish maps dating from the 1660s pictured Navajo territory as far north as the present-day town of Green River, Utah (Cuch 2000). However, the primary homeland of the early Navajos was in a large area known as Dinétah, located southeast of present-day Farmington, New Mexico.

In 1868, a treaty was signed between the Navajos and President Andrew Johnson that allowed the Navajos to return to their homeland. Today, 110 chapters of the Navajo Nation are located in northern Arizona, northwestern New Mexico, and southeastern Utah. The Aneth and Red Mesa Chapters in southeastern Utah are approximately 30 and 45 miles, respectively, southeast of the White Mesa Mill site.

Spanish explorers and traders traveled through southeastern Utah from the late 1600s to about 1848, when Mexico ceded to the United States the tract of land south of the forty-second parallel, including the state of Utah. The best known of the explorers were Juan María Antonio de Rivera, who traveled the area in 1765, and Francisco Atansio Domínguez and Francisco Silvestre Vélez de Escalante, who traveled the area in 1776. During this period, the Old Spanish Trail was developed as a major trade route between California and Santa Fe, New Mexico Highway. I-70 to Denver and the Union Pacific Railroad line follow the northern branch of this route, and US-191 from Crescent Junction to Blanding follows the historic main branch of the trail (Berry 2003).

The first Anglo-Americans to settle the southeastern Utah area were Mormon missionaries. They came in 1855 to convert the Utes to Mormonism and teach them farming. During their brief stay at the Elk Mountain Mission, which they constructed north of present-day Moab, they raised cattle and grew crops. Their efforts were soon thwarted by conflicts with the Utes, and they departed the area "in haste" about 4 months after their arrival. Mormon farmers and ranchers did not permanently settle southeastern Utah until 1877, when the United States signed a peace treaty with the Ute Tribe and established reservations in eastern Utah and southwestern Colorado (Firmage 1996).

Prospectors settled in the Moab area between the 1880s and 1920s to mine gold, copper, uranium, and radium. Moab, Grand County, and southeastern Utah were forever changed by a uraninite discovery on July 6, 1952, by Texas prospector Charles A. Steen. His strike was the richest single lode of uranium ore discovered anywhere to that date and led to Moab becoming the "Uranium Capital of the World." Steen built his own $8 million processing mill on the north side of the Colorado River 3 miles north of Moab in 1956. In 1962, the Atlas Corporation purchased Steen's mill for $25 million and operated it until it closed in April 1984. This mill operation generated the tailings pile that is the subject of this document (NRC 1999).

3.1.13.2 Cultural Resource Inventories of Potentially Affected Areas

DOE contracted two professional archaeological consultants to conduct Class I cultural resource inventories of areas that could be affected by the proposed alternatives (Berry 2003; Davis et al. 2003). Class I inventories are inventories of existing cultural resource data. Archaeologists study published and unpublished documents, records, files, and other sources to determine if previous cultural resource investigations have been conducted within an area. If cultural resources have been identified, the federal agency conducting the action, in consultation with the State Historic Preservation Officer and affected Native American tribes, determine whether the cultural resources are included or are eligible for inclusion in the National Register of Historic Places. DOE is required by the National Historic Preservation Act to consider the effects of its actions on any "district, site, building, structure, or object" that is included or eligible for inclusion in the National Register of Historic Places. If DOE's action would have an adverse effect on an eligible cultural resource, DOE would be required to implement a process called the Section 106 consultation process. This process would require DOE to consult with the State Historic Preservation Officer and others in an effort to find ways to make the action less harmful. Others who would be consulted might include Native American tribes, BLM, NPS, UDOT, Bureau of Indian Affairs, and other federal and state agencies, organizations, and private individuals.

The National Historic Preservation Act also requires DOE to inventory surface and subsurface cultural resource sites in areas before they are disturbed. These on-the-ground "Class III" surveys would be conducted by professional archaeologists before DOE implemented any of the proposed alternatives. A Class III survey is "a continuous, intensive survey of an entire target area, aimed at locating and recording all archaeological properties that have surface indications, by walking close-interval parallel transects until the area has been thoroughly examined" (BLM 2003a).

Some culturally significant properties or places may be eligible for inclusion in the National Register of Historic Places but may not be readily identifiable by archaeologists during a Class I inventory or Class III survey. These "traditional cultural properties" may be associated with the cultural practices or beliefs of a community and may be significant to the community's history or may be important in maintaining the community's cultural identity. The National Historic Preservation Act requires that these properties or places be considered by federal agencies in the same manner as other eligible cultural resources through the Section 106 consultation process. To identify traditional cultural properties that may be affected by its proposed actions, DOE contracted a cultural anthropologist to assist in communicating with tribal members who may have knowledge of such properties. Because Class III cultural resource surveys have not yet been completed in many portions of the project area, all potential traditional cultural properties cannot yet be identified. Information contained in this EIS concerning traditional cultural properties is preliminary and not complete. Once a preferred alternative is selected, site-specific studies and additional interviews would be conducted in conjunction with the Class III surveys to identify all potential traditional cultural properties.

3.1.13.3 Section 106 Consultation Process

In April 2003, DOE initiated the Section 106 consultation process by notifying potentially interested stakeholders that DOE was preparing this EIS. DOE contacted federally recognized Native American tribes that resided in or had cultural ties to the project area to inform them of DOE's proposed alternatives and to solicit their concerns or comments. A total of 38 representatives from 14 Native American tribes and the Navajo Utah Commission were contacted by mail and telephone. To date, the Ute Mountain Ute Tribe (including White Mesa Ute Tribe), Southern Ute Tribe, Uintah-Ouray Ute Tribe, Navajo Nation (including Aneth Chapter, Red Mesa Chapter, and Oljato Chapter), Navajo Utah Commission, and Hopi Tribe have expressed interest in or concerns with DOE's proposed alternatives.

DOE also contacted potentially affected federal agencies, including BLM, NPS, Bureau of Indian Affairs, and UDOT about the proposed alternatives. BLM and NPS are cooperating agencies for the EIS.

3.1.13.4 Moab Site Inventory Results

DOE contracted a Class III cultural resource survey of the Moab site in January and March 2004 (Christensen 2004; Christensen and Lindsay 2004 [in progress]). As a result of that survey, DOE determined that five cultural sites eligible for inclusion in the National Register of Historic Places are present on DOE property. The eligible sites include (1) a prehistoric site, (2) a section of the historic US-160 that parallels and pre-dates the present-day US-191, (3) a sign identifying the historic livestock driveway from Moab to Crescent Junction, (4) a collapsed farmstead dating from the Depression era, and (5) the remaining structures associated with the uranium mill. The primary contributing features associated with the historic millsite include the Uranium Reduction Company general office/warehouse/machine shop, Colorado River pump station and pipeline, ore loadout structure on the railroad spur, and scale house. Although the millsite features are less than 50 years old, DOE determined that they are eligible for nomination to the National Register of Historic Places, primarily because of their association with the "greatest mining boom in American history" (Christensen 2004), a boom that facilitated the Unites States' dominance as a nuclear superpower. The features also are "representative of the uranium milling industry that brought many jobs to Grand County, contributing to the current community structure of Moab to a degree far greater than any other single mechanism in regional history" (Christensen 2004).

One recorded traditional cultural property associated with the Ute Tribe is present near the Moab site (Berry 2003).

3.1.14 Noise and Vibration

Noise is technically defined as sound waves that are unwanted and perceived as a nuisance by humans. Sound waves are characterized by frequency and measured in hertz (Hz); sound pressure is expressed as decibels (dB). Humans have a perceptible hearing range of 31 to 20,000 Hz. The threshold of audibility ranges from about 60 dB at a frequency of 31 Hz to less than about 1 dB between 900 and 8,000 Hz. For regulatory purposes, noise levels for perceptible frequencies are weighted to provide an A-weighted sound level [dBA] that correlates highly with individual community response to noise. Sound pressure levels outside the range of human hearing are not considered noise in a regulatory sense, even though wildlife may be able to hear at those frequencies. A better understanding of noise impacts is facilitated by associating noise levels with common activities or sources (Figure 3–19).

Noise levels are often reported as the equivalent sound level (L_{eq}). The L_{eq} is expressed in dBA over a specified period of time, usually 1 or 24 hours. The L_{eq} is the equivalent steady sound level that, if continuous during

Noise Measurement

What are *sound* and *noise*?

When an object vibrates it possesses energy, some of which transfers to the air, causing the air molecules to vibrate. The disturbance in the air travels to the eardrum, causing it to vibrate at the same frequency. The ear and brain translate the vibration of the eardrum to what we call *sound. Noise* is simply unwanted sound.

How is sound measured?

The human ear responds to sound pressures over an extremely wide range of values. The range of sounds people normally experience extends from low to high pressures by a factor of 1 million. Accordingly, scientists have devised a special scale to measure sound. The term decibel (abbreviated dB), borrowed from electrical engineering, is the unit commonly used.

Another common sound measurement is the A-weighted sound level, denoted as dBA. The A-weighting accounts for the fact that the human ear responds more effectively to some frequencies than others. Higher frequencies receive less weighting than lower ones. Most of the sound levels provided in this report are A-weighted; however, some are in decibels because of lack of information on the frequency spectrum of the sound. Figure 3–19 shows common references to sound on the A-weighted sound-level scale.

SOUND SOURCE	SOUND LEVEL (dBA)	RESPONSE
Carrier deck jet operation	140	
Civil defense siren (at 100 ft)	130	Painfully loud
Jet takeoff (at 200 ft)	120	Threshold of feeling and pain
Riveting machine (at 1 ft)	110	
Ambulance siren (at 100 ft)	100	Very loud
Heavy truck (at 50 ft)	90	
Freight train cars (at 50 ft)	80	
Vacuum cleaner (at 10 ft)	70	Moderately loud
Air conditioning unit (at 20 ft)	60	
Speech in normal voice (at 15 ft)	50	
Residence, no TV or radio	40	Quiet
Soft whisper (at 5 ft)	30	
Recording studio	20	
	10	
	0	Threshold of hearing

Figure 3–19. Comparison of A-Weighted Sound Pressure Levels Associated With Different Sources of Noise

a specified time period, would contain the same total energy as the actual time-varying sound over the monitored or modeled time period. Another expression of noise levels is the day-night sound level (L_{dn}). This is the average of the day and nighttime A-weighted sound level with a built-in penalty of 10 dB at night. The L_{dn} is particularly useful for evaluating community-level noise effects.

The Moab site is located in a quiet, open desert environment where natural phenomena such as wind, rain, and wildlife account for most natural background noise. At times, insect activity and birds may account for significant portions of environmental noise. The Arches National Park is a potential sensitive site located close to the Moab site. The park maintains two housing complexes near the park entrance. The housing complex that is closer to US-191 provides temporary housing for seasonal employees, students, and official visitors but does not have any permanent residents. The permanent housing complex is located farther from US-191 and consists of three permanent residences for park employees and families. Sources of man-made background noise near the Moab site may include automobile traffic on US-191, trains on the Union Pacific Railroad, aircraft flying overhead, and outdoor recreational activities in adjacent areas.

The city of Moab is located about 3 miles southeast of the Moab site and is outside the influence of noise originating at the site. Expected noise levels in and around the city of Moab likely range from 45 to 55 dBA, with levels approaching 65 dBA around busy roads. The city of Moab has a noise ordinance specifying that noise levels not exceed 65 dBA (Moab City Ordinance 17.74.080, "Noise Levels"). This applies to residential zones from 10:00 p.m. to 7:00 a.m. Monday through Saturday and not before 9:00 a.m. on Sunday. For commercial zones, the standard applies to the time interval between 10:00 p.m. and 6:00 a.m. the following day. The acoustic environment in open desert in Utah is typical of other desert environments where average L_{dn} values range from 22 dB on calm days to 38 dB on windy days (Brattstrom and Bondello 1983).

Ground vibration is generally not perceived as a characteristic of the environment because background ground vibration is not perceptible to humans. Ground vibration is expressed as the average vibration root mean square (rms) velocity in decibels (expressed as dBV) with a reference to 10^{-6} inch per second. The highest mean value of rms velocity over a given event is called the maximum rms velocity. It is a more suitable expression of ground vibration energy for addressing human annoyance because of the response time for humans to respond to ground vibration stimuli. The human threshold for the perception of ground vibration is 62 to 65 dBV. A large truck or bus can produce ground vibration levels of about 62 dBV. About 70 dBV will result in notable human response.

Natural sources of ground vibration include wave action, strong winds striking natural or man-made structures, and, infrequently, seismic activity. Human activities that can create perceptible levels of ground vibration (such as blasting, pile driving, operation of heavy earth-moving equipment, or rail traffic) are important when sensitive sites, structures, or activities may be affected. The most significant background component of ground vibration in the Moab area is railroad traffic.

No background noise or ground vibration data are available for the Moab site. A single residence is located to the northeast of the site; otherwise, there are no residences located close to the site.

3.1.15 Visual Resources

Visual resources are the visible physical features of a landscape that impart scenic value. Southeastern Utah is known worldwide for its unique scenic qualities and unusual landscape features. It is a land of deep canyons, rock arches, towering rock formations, badlands, and expansive panoramas. Many of the more spectacular features are preserved in national and state parks or monuments, three of which—Arches and Canyonlands National Parks and Deadhorse Point State Park—are located near Moab, and one of which—Natural Bridges National Monument—is located west of Blanding.

BLM has developed a Visual Resource Management system that helps federal agencies classify and manage landscapes and their associated scenic values. The system allows landscapes to be ranked and placed into one of four classes. Each class has a management objective that is related to the value placed on the scenic characteristics of the landscape (BLM 2003b).

Class I Objective: Preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

Class II Objective: Retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Changes must repeat the basic elements of form, line, color, and texture of the predominant natural features of the characteristic landscape.

Class III Objective: Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements of the predominant natural features of the characteristic landscape.

Class IV Objective: Provide for management activities that require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of basic elements.

BLM classifies BLM-managed lands surrounding the Moab site as Class II, primarily because of the nearness of the Colorado River, Arches National Park, and stunning landform features in the area (BLM 2003b).

The Moab site is on the floodplain of the Colorado River and is immediately adjacent to US-191 and Potash Road SR-279. Depending on the viewing location, the backdrop to the site may be the steep, red sandstone cliffs that define the western edge of Moab valley; The Portal, where the Colorado River re-enters its steep, narrow canyon; or the towering and often snow-covered La Sal Mountains. In any direction, the contrasts in the green-patchwork valley floor and vertical red cliffs impart a spectacular quality to the views.

The Moab site tailings pile can be viewed by northbound and southbound travelers on US-191 and Potash Road and by tourists from two unmarked scenic turnouts on the Arches National Park road. The tailings pile is a relatively large, flat, geometrically shaped landform that has smooth steep side slopes on the south and east sides and terraced, step-like side slopes on the north and west sides. The predominant horizontal lines created by the pile provide a moderate contrast to the adjacent vertical sandstone cliffs; however, the red color of the soils currently covering the tailings blends with the reds of the surrounding cliffs, allowing the pile to go unnoticed by many first-time visitors to the area. Because of its size, the tailings pile moderately to strongly dominates the view from most of the viewing locations. It can be seen from one residence located directly northeast of the site and a residence at The Portal RV and Park across the river from the site. Figure 3–20 shows the current view of the tailings pile from southbound US-191.

Figure 3–20. View of the Moab Site Tailings Pile from Southbound US-191
[Before UDOT widened US-191]

3.1.16 Infrastructure

3.1.16.1 Waste Management

Nonradioactive solid waste at the Moab site is disposed of by a commercial contractor in the Grand County landfill, which has a remaining projected lifespan of 64 years at a disposal rate of 30,000 to 35,000 yd^3 per year.

Currently, two portable toilets are on the site for managing nonradioactive sanitary waste. Each portable toilet can support up to 25 workers. The sanitary waste is emptied from the portable toilet one or two times per week, depending on the size of the on-site workforce and is disposed of by a commercial contractor in the Moab sewage treatment plant, which has a capacity of 1.5 million gallons per day. The treatment plant currently treats an average of 800,000 to 900,000 gallons per day; it restricts discharge of concentrated sewage from portable toilets to 9,000 gallons per day and limits receipts to 3 days per week.

3.1.16.2 Electrical Power Supplies

A three-phase overhead power line runs along the north boundary of the property, and an electrical substation on the property feeds power to the site. The electrical utility servicing the site is Utah Power, a subsidiary of PacifiCorp.

3.1.16.3 Water

The Moab site has its own pump station that can pump nonpotable water from the Colorado River. DOE currently has a water right for consumptive use of Colorado River water at the Moab site of 3.3 cfs (approximately 2,366 acre-feet per year). This right includes an additional 3.03 cfs (about 2,194 acre-feet per year) for nonconsumptive use. Potable water is available in the city of Moab. The city's potable water supply system is provided by the Glen Canyon aquifer (see Section 3.1.6.4) and can produce 3 million to 5 million gallons per day.

3.1.17 Transportation

3.1.17.1 Vehicular Traffic

US-191 provides highway access to the Moab site. It is generally two lanes wide but does have occasional passing lanes. Originating at the Arizona-Utah border and terminating at the Crescent Junction and I-70 intersection, US-191 provides north-south travel access in eastern Utah and also carries significant truck traffic. As much as 30 percent of the total vehicle volume consists of trucks.

Table 3–15 presents a summary of annual average daily traffic (AADT) counts, degree of congestion, percentage of truck traffic, number of accidents, and accident rates for US-191 between the White Mesa Mill site and Crescent Junction where it intersects with I-70. AADT volume is based on vehicle counts from continuously operating automatic traffic counters that do not discern direction of travel. The reported AADT is a combination of vehicles traveling in both directions for a specific route segment. Congestion is a reflection of the actual number of vehicles on a highway segment in relation to how many the road can safely handle. Various other factors, such as the geometry of the roadway and number of lanes, are also considered in determining whether a road is congested. Truck traffic is defined as single-unit delivery trucks or larger sized vehicles. Truck traffic is shown as a percent of the AADT. Accident rates are determined by comparing actual recorded crashes to expected accident rates for a specific road segment and per 1 million miles of vehicle travel. Expected accident rates are a 5-year average of accidents that occur on similar highway segments and include all types of vehicles. The rates provided in Table 3–15 are based on the 1997–2001 time period (Ames 2003).

As shown in Table 3–15, central Moab is considered congested and had a high accident rate of 3.5 accidents per 1 million miles of vehicular travel in 2001. Based on accident averages, it was expected to have an accident rate of 1.77. US-191 increases to four lanes in the downtown area to accommodate the increase in traffic. Within 1,400 ft of the north city limits, US-191 reduces to two lanes, congestion is no longer a problem, and the accident rate reduces to low, which is characteristic of most sections of US-191 (Ames 2003). It is assumed that the large increase in traffic volume in the downtown area reflects downtown business activity and cross traffic that stays within the city. No state or federal routes converge with US-191 in Moab.

The city of Moab is concerned about traffic congestion within the central area, which continues to get progressively worse as the city grows and attracts increasing tourism and tourism-related commerce and recreation. The city has considered a bypass to relieve traffic congestion; however, it has not yet begun a feasibility study (Vaughn 2003).

Table 3–16. Average Monthly Vehicle Traffic Near the North Boundary of Moab

Month	2000		2001		2002	
	Traffic Count	**Percent Change From Previous Month**	**Traffic Count**	**Percent Change From Previous Month**	**Traffic Count**	**Percent Change From Previous Month**
January	2,902		2,847	–12	2,938	–9
February	3,324	15	3,251	14	3,638	24
March	5,257	58	5,312	63	6,443	77
April	7,212	37	7,235	36	6,915	7
May	7,646	6	7,627	5	7,913	14
June	7,722	1	6,897	–10	7,136	–10
July	7,601	–2	6,519	–5	6,715	–6
August	6,052	–20	6,542	0.4	6,400	–5
September	6,703	11	6,433	–2	6,590	3
October	6,068	–9	5,866	–9	6,357	–4
November	3,554	–41	4,340	–26	4,146	–35
December	3,252	–8	3,216	–26	3,582	–14
Year Totals	**67,293**		**66,085**		**68,773**	

Reference: UDOT 2002a.

Numerous county roads in the area (see Figure 3–21) are used for recreational travel by off-highway vehicles, motorcycles, or mountain bikes to backcountry areas. Some of the roads are former highway routes that pre-date I-70 construction and some are the result of seismic exploration activities.

CR-138, 1 mile south of the Canyonlands Field Airport, is locally known as Blue Hills Road. This is a dirt surface, two-lane road that carries heavy off-highway vehicle traffic to backcountry areas. The road surface is wider than the typical two-lane road. During the peak summer use season, 100 vehicles per day may travel the road (Vaughn 2003). BLM recorded 53,000 vehicle counts on CR-138 during a 12-month period in 2002. Although there are many connecting road choices, it is believed that the majority of the vehicles also return to US-191 by using CR-138 (Von Koch 2003).

CR-236 provides access to the Grand County landfill, locally known as the Klondike landfill, and to a radio tower. The landfill is about 1 mile west of US-191 and is operated by the Grand County Solid Waste District. The amount of daily traffic accessing the landfill on this road is unknown. CR-236 continues as a dirt track past the landfill.

Another former highway alignment out of use since about 1911 is CR-144, also known as the Thompson Cut-Off Road. This road has a gravel surface and is locally used to access I-70 at Thompson Springs.

CR-175 is north of I-70 at Crescent Junction. This road also predates I-70 and still carries local or frontage road traffic from Crescent Junction to Thompson Springs or farther to a point near Cisco. It is a two-lane road from Crescent Junction to the bridge over Thompson Wash, where it narrows to one lane because of the condition of the bridge. It continues as a two-lane road east of Thompson Springs. Although there may be occasional local use of this frontage road, most of the asphalt pavement is deteriorating and would need resurfacing for any sustained increase in use.

The stretch of US-191 area between the Canyonlands Field Airport (Blue Hills Road) and CR-334 to the north is locally considered a potentially dangerous section of the highway. The combination of terrain, slower moving vehicles, and the two-lane limitation can create dangerous passing situations (Vaughn 2003). In addition, according to UDOT highway statistics, a 2-mile stretch of US-191 south of Blue Hills Road sustains more accidents than expected (Ames 2003).

To relieve congestion associated with traffic in the Arches National Park entrance area, a new entrance road has been constructed within the park that will connect with US-191 approximately three-quarters of a mile south of the existing entrance to the park.

In 2004, UDOT upgraded US-191 to four lanes from the area just north of SR-128 to the area just north of SR-313; adding two turn lanes at the entrance to Arches National Park, at Gemini Bridges, and at SR-313; adding a 2-mile-long bicycle lane on the northeast side of US-191; and adding center divides along some stretches of US-191.

3.1.17.2 Rail Transport

The Union Pacific Railroad parallels I-70 and offers predominantly freight rail service. On a daily basis, there is usually one Burlington Northern train carrying 75 to 100 cars of mixed manifest; two to three freight trains of 105 to 134 empty coal cars; one to two loaded coal trains of 105 cars; and an east-bound passenger train and a west-bound passenger train. The California Zephyr passenger train stops in Green River, Utah, and Grand Junction, Colorado (Legg 2003).

The Cane Creek Branch of the Union Pacific Railroad parallels US-191 and provides weekly freight service to the Moab Potash and Salt Mine. It carries potash and salt to Crescent Junction and continues on the Union Pacific Railroad to Grand Junction for distribution to points east and west. This train consists of between 40 and 50 cars. It does not stop between the Moab Potash and Salt Mine and Crescent Junction but does cross several county roads with unguarded and unmarked rail crossings. As shown on Figure 3–21, just north of Blue Hills Road (CR-138), the railroad crosses under US-191 from the east to the west side, where it continues south toward the Moab Potash and Salt Mine. At the Blue Hills Road crossing, there is a stop sign but no rail guard arms or signal. After traversing a tunnel, the railroad emerges several miles from the Moab Potash and Salt Mine and continues on the north side of SR-279. The Moab Potash and Salt Mine is located 16 miles from the intersection of US-191 and SR-279.

There was one recorded fatality on the Cane Creek Branch during the period of 1974 or 1975 to 2003. Injuries of all kinds for all travel on the Union Pacific Railroad are reported as averaging 2.9 per 100,000 man-hours of work. Derailments are reported per ton-mile and were estimated at possibly 0.009 percent (Legg 2003).

3.1.18 Socioeconomics

This section describes the socioeconomic environment of Grand and San Juan counties, Utah, in terms of their demographic, economic, and natural resource features.

3.1.18.1 Population, Workforce, and Job Base

Grand County covers 3,689 square miles and had a 2000 census population of 8,485. Its population has grown 28.2 percent since 1990. Prior to 1990, the population declined by 19.7 percent relative to 1980 levels, coinciding with the closure of the Atlas mill in 1984. The recent trends in population growth mark a turnaround; tourism-recreation now forms the basis of economic activity and growth in the regional economy. This fundamental change reflects that the minerals industry (uranium, potash, oil, and gas), which in 1980 directly and indirectly generated 62 percent of all income of Grand County residents, now contributes only 2 percent to the overall labor income. Table 3–17 provides population information for Grand and San Juan Counties.

Table 3–17. Population and Labor Force Information for Grand and San Juan Counties, Utah

Demographic Features	Grand County	San Juan County
2000 population	8,485	14,413
1990–2000 percent change	28.2	14.2
1980–1990 percent change	−19.7	3.0
2000 population per square mile	2.3	1.8
2000 civilian labor force	5,164	4,593
1999–2000 percent change	−4.5	−6.0
2000 unemployment rate	6.5	9.2
Government employment		
Federal	245	285
State-local	545	1,313
Total	**790**	**1,598**

From 2000 Census
Source: U.S. Census Bureau, County and City Data Book: 2000

Population effects from tourism and recreation are most notable in Moab, the Grand County seat. Moab is the largest town in southeastern Utah, and in the 2000 census had a permanent population of 4,779. At the time of the 2000 census, more than half of Grand County's population resided in Moab. By comparison, San Juan County covers 8,103 square miles and had a reported population of 14,412 during the same census period. This county also experienced accelerated population growth during the last 2 decades. It grew 3 percent between 1980 and 1990 and 14.2 percent between 1990 and 2000. According to the 2000 census, the population density in San Juan County is lower than in Grand County, averaging 1.8 individuals per square mile, compared to Grand County's density of 2.3 individuals per square mile. The population density of both counties is well below the statewide average of 27.2 persons per square mile.

Table 3–17 also provides labor force information for Grand and San Juan Counties. The civilian component of the labor force is similar in size for the two counties, numbering 5,164 in Grand County and 4,593 in San Juan County. This labor force is primarily employed by a service economy founded on tourism-recreation, especially in Grand County. The combination of federal, state, and local government employment is nearly twice as high in San Juan County relative to Grand County, mostly because of the state and local components. Despite the larger number of government jobs in San Juan County, its local unemployment rate was 9.2 percent, compared to 6.5 percent in Grand County. Both counties had significantly higher unemployment rates during the first half of 2000 compared to the state average of 3.7 percent. These indicators of human resource availability vary because of the seasonal nature of employment opportunities and job turnover rates in the tourism-recreation job base. For example, seasonal unemployment in Grand County has ranged from 6.2 percent to 7.3 percent (GPU 2003).

Meanwhile, over the longer term (since 1995), tourism-recreation employment has grown by some 20 percent, now accounting for at least 45 percent of Grand County's total employment (GPU 2003). An estimated 1,878 jobs are now tourism-related (GPU 2003). By comparison, mining has decreased from a 16-percent share of total area employment in 1995 to a 2-percent share in 2000, and government employment has increased from 10 to 19 percent (GPU 2003). Federal land management agencies are among the major employers in the regional economy. At the center of this activity is the city of Moab, which acts as a gateway to Arches and Canyonlands National Parks, as well as Dead Horse Point State Park and the famous Slickrock Bike Trail. In the year 2000, Arches National Park attracted some 790,000 visitors, and Canyonlands National Park received 400,000 visitors.

3.1.18.2 Housing and Income Characteristics

Census data for 2000 show significant increases in both the number of housing units and the number of households in the study region. In Grand County, the number of housing units increased by more than 35 percent compared to 1990 levels, and the number of households increased by 38 percent relative to 1990 levels. Although the growth rates for San Juan County tended to be half as large as those of Grand County, the residents of San Juan County had a larger percentage of owner-occupied dwellings (79.3 percent compared to 71 percent). Table 3–18 provides information on housing and income characteristics in Grand and San Juan counties.

Table 3–18. Housing and Income Information for Grand and San Juan Counties, Utah

Housing and Income	Grand County	San Juan County
2000 housing units	4,062	5,449
1990–2000 percent change	35.8	17.2
Percent owner occupied	71.0	79.3
Number of households	3,434	4,089
1990–2000 percent change	38.0	21.2
1997 median household income (1997 dollars)	$28,881	$26,723
1989–1997 percent change	33.1	54.6
1998 per capita income	$19,505	$12,685
Percent of national average	71.7	46.6
Percent of Utah average	87.7 (71.7/81.8)	56.9 (46.6/81.8)

Source: U.S. Census Bureau, County and City Data Book: 2000. Percentage of Utah average is calculated by dividing the county per capita income as a percentage of national average (71.7 percent and 46.6 percent, respectively) by the state per capita income as percentage of national average (81.8 percent).

Temporary housing and accommodations in Moab are available for the large influx of tourist and recreational visitors in various forms, including motels and hotels (1,583 rooms); bed and breakfasts, apartment units, condominiums, and guest houses (278 rooms); and numerous campsites (GPU 2003). Additional temporary housing and accommodations are available in the towns of Monticello and Green River. For example, Monticello (55 miles south of Moab) has more than 200 motel and hotel rooms, 2 bed and breakfasts, and 5 campsite-RV parks. Temporary housing accommodations in Green River include 650 hotel and motel rooms, 1 bed and breakfast, and 3 camp parks.

The vacancy rates for temporary housing in Moab tend to follow the pattern of the seasonal tourist economy. The availability of apartment rental units, as well as mobile homes and trailers, is greatest between November and mid-February. By early spring, most rental units are occupied by seasonal employees staffing motels, restaurants, shops, and other tourist service businesses (e.g., bike shops, raft tour companies). Outside of Moab, temporary housing is also limited to a few motels, trailers, and campgrounds in towns such as Green River (52 miles northwest of Moab), Monticello (54 miles south of Moab), and Blanding (78 miles south of Moab).

Table 3–18 also reports median household incomes (1997) and per capita incomes (1998) for the two counties. These statistics suggest that the typical resident of Grand County had a slightly larger median household income and a relatively larger per capita income than the typical resident in San Juan County. The similarity of values for median household incomes is attributable to relatively faster income growth in San Juan County during 1989 to 1997 (54.6 percent compared to Grand County's 33.1 percent). Per capita income in San Juan County is less than that of Grand County ($12,685 compared to $19,505) and makes up only 56.9 percent of the average per capita income in Utah and only 46.6 percent of the average per capita income in the United States. By comparison, Grand County's per capita income is closer to the state and national averages (87.7 percent and 71.7 percent, respectively).

3.1.18.3 Commercial Business and Farm-Based Enterprise

In 1998, there were an estimated 360 private nonfarm businesses in Grand County, many supporting the expanding tourism-recreation sector. The number of private businesses in Grand County grew by 67.4 percent between 1990 and 1998, reflecting a period of relative prosperity in the local and regional economy. In 2000, tourists spent an estimated $99.2 million in Grand County, making it the seventh highest county for tourist dollars spent in Utah (GPU 2003). By comparison, San Juan County had an estimated 242 private nonfarm businesses in 1998, an increase of 22.2 percent over 1990. Table 3–19 provides information on the number and growth of private commercial businesses and farm-based enterprise in the two-county region.

Table 3–19. Commercial and Farm-Based Enterprise in Grand and San Juan Counties

Enterprise	Grand County	San Juan County
Private nonfarm businesses, 1998	360	242
1990–1998 percent change	67.4	22.2
1998 annual payroll per worker	$15,188	$16,464
Percent of national average	49.6	53.8
Percent of Utah average	59.3 (49.6/83.7)	64.3 (53.8/83.7)
1997 accommodation and food service firms	82	38
Paid employees	1,141	382
1997 number of farms	85	231
Land in farms (acres × 1,000)	76	1,673
1997 value of farm products, average per farm	$26,929	$39,381

Source: U.S. Census Bureau, County and City Data Book: 2000. Percentage of Utah average is calculated by dividing the county annual payroll per employee as a percentage of national average (49.6 percent, 53.8 percent) by the state annual payroll per employee as percentage of national average (83.7 percent).

Signs of a new growth economy are apparent in the service sector, particularly in the number of accommodation and food service firms located in Grand County. In 1997, this sector had 82 firms (mostly located in Moab), supporting 1,141 paid employees. Taxable retail sales, services, and business equipment purchases for Grand County amounted to $159.6 million in 2000 (GPU 2003). Grand County and the city of Moab have experienced significant accommodations growth; lodging capacity increased from 612 rooms to 1,861 rooms (GPU 2003). As a result, the local tax base is heavily dependent on the level of tourism-recreation activity.

By contrast, San Juan County has a much smaller service sector supporting the tourism-recreation-based economy; in 1997, 38 firms provided accommodation and food services and employed 382 workers.

The annual payroll per worker for both Grand County and San Juan County ($15,188 and $16,464, respectively) remained well below state and national averages despite growth and development in the tourism-recreation economy. In Grand County, for example, the annual payroll per worker is only 59.3 percent of the state average and 49.6 percent of the national average. The percentages for San Juan County are somewhat higher than those for Grand County (64.3 percent and 53.8 percent), possibly because its service sector and underlying labor force are less dependent on tourism- and recreation-based activities.

Table 3–19 also provides information on farm-based enterprise in the two-county region. San Juan County had 231 farms in 1997 occupying over 1.6 million acres of land. On average, each farm contributed $39,381 worth of farm products to the local economy, signifying the relative importance of farm-based activity in San Juan's local economy. Farm-based activity in Grand County plays a relatively minor role in its local economy. In 1997, Grand County had 85 farms covering 76,000 acres of land and producing an average value of $26,929 worth of farm products per farm.

The availability of land in Grand County for expanding economic activity is restricted, given the predominant role of state and federal governments in managing nearly 94 percent of Grand County's total land area. For example, only 4.3 percent of the land in Grand County is privately owned; most of the remaining land is managed by the federal government (71.7 percent), owned by the state (15.5 percent), or held in trust as American Indian tribal land (4.4 percent). Other land stakeholders in Grand County include the USFS (1.2 percent) and the U.S. Department of Defense (0.08 percent) (GPU 2003).

3.1.19 Human Health

Human health at and near the Moab site is influenced by the radiation sources in the environment and the contaminants associated with the mill tailings at the site. Exposures occur to occupational workers and members of the public that may live near or recreate adjacent to the site. This section evaluates the potential risks to human health at the Moab site. Appendix D presents a detailed evaluation of the risk to the public.

3.1.19.1 Natural Radiation Environment

Everyone is exposed to three types of ionizing radiation: (1) natural sources unaffected by human activities, (2) those of a natural origin that are affected by human activities, and (3) man-made sources. Natural sources include cosmic radiation from space and naturally occurring radionuclides in soils and rocks. The tailings pile at the Moab site is an example of radiation from a natural origin that has been affected (concentrated) by human activities. Man-made sources include nuclear medicine, medical x-rays, nuclear fallout, and consumer products.

For most of the population, natural background radiation is the largest contributor to their overall radiation dose. The natural occurrence of cosmic radiation and radionuclides at the earth's surface varies throughout the world and depends mostly on the altitude where the exposure occurs and the nearby geology. Cosmic radiation consists of charged particles (primarily extraterrestrial) that generate secondary particles that have direct and indirect ionizing properties. The main radionuclide contributors to external terrestrial gamma radiation are potassium-40 and the members of the thorium and uranium decay series. Impacts (terrestrial gamma and radon gas and its decay products) are mostly from the top several inches of soil.

3.1.19.2 Current Risk to Members of the Public

To evaluate current risk to members of the public, the region of influence is considered to be a 50-mile radius of the Moab site (Figure 3–22). The estimated population in this region is approximately 11,000; most of this population lives within 10 miles of the Moab site.

The majority of the affected population lives in Moab, which is approximately 3 miles from the site. According to the 2000 census, the population of Moab was 4,779. The primary individuals exposed to contaminants at the Moab site are the nearby residents (the closest residents live adjacent to the site approximately 2,200 ft from the tailings pile) and recreational users of land adjacent to the site. Recreational users include Moab residents and tourists. The major recreational activities near the site are rafting on the Colorado River and camping on adjacent lands. Although some minor trespassing has occurred since DOE began managing the Moab site, no members of the public are receiving prolonged exposure to on-site contaminants.

The site contaminants consist of both radioactive and nonradioactive components (e.g., heavy metals). Because members of the public do not have access to the site, essentially all the risks are associated with the radioactive contaminants through exposure to gamma radiation and inhalation of radon gas.

Table 3–20 summarizes the potential dose to members of the public from the radioactive contaminants at the Moab site and from other sources (natural and man-made). This table provides three types of risk numbers. Two sets of numbers are site-related, and the third is an average radiation risk for the U.S. population from natural radiation sources. Site-related risk information is provided for the types of activities that currently occur near the site (rafting and camping) and for the individual who lives closest to the Moab site (the maximally exposed individual). Table 3–20 indicates that the most significant contribution to total dose comes from background sources, not from the Moab site.

Table 3–20. Annual Doses From Background Radiation (Millirem per Year) Compared to Doses From Radon and Gamma Associated With Tailings at the Moab Site

Scenario	Central Tendency[a] (site related)		Background (U.S. average)	Total	RME[b] (site-related)		Background (U.S. average)	Total
	Radon	Gamma			Radon	Gamma		
Camping	15.0	4.0	300	319.0	30.0	7.9	300	337.9
Rafting	7.4	1.6	300	309.0	11.1	2.4	300	313.4
MEI[c]	105.7	16.0	300	421.7	132.3	20.0	300	452.3

Notes: The backup assumptions and calculation sheets are presented in Appendix D.

[a] Central tendency risks are based on more typical exposure assumptions that are still somewhat conservative. Exposure assumptions include the time spent in contaminated areas and the amounts of contaminated material ingested that have a direct impact on the estimated risks.

[b] RME = reasonable maximum exposure.

[c] MEI = maximally exposed individual (the resident closest to the site).

The two types of site-related risks are based on (1) typical exposure assumptions (called central tendency exposures [e.g., amount of contaminated soil accidentally ingested, number of days camping next to the site]), and (2) exposure assumptions that tend to reflect the worst case and result in high-end risks (called reasonable maximum exposures [RMEs]). These high-end risks are based on conservative exposure assumptions resulting in high-end risk estimates. Exposure assumptions include factors such as the number of days spent camping at a site. The site-related exposure doses are based on time spent near the site-related contamination. Details on the assumptions and the calculation approach are presented in Appendix D.

Table 3–20 shows the radiation levels that occur from natural sources such as cosmic rays and natural radioactive materials in the earth. Actual background radiation doses vary with location. In the case of the Moab site, data for Blanding, Utah, were used. The natural background doses assume exposure for an entire year. The *Final Environmental Impact Statement for Remedial Action Standards at Uranium Processing Sites* (EPA 1982) provides more information on the radiation standards.

3.1.19.3 Existing Occupational Risks

DOE contract personnel are on the site Monday through Thursday, except on holidays. On-site personnel conduct maintenance and environmental characterization activities. Maintenance activities include controlling dust using calcium chloride or water spraying, repairing the tailings pile after major precipitation events, and removing process-related material from the site.

Environmental characterization includes collecting samples of soil, ground water, and surface water; conducting gamma surveys of the surface soils; installing ground water monitor wells; conducting land surveys; and conducting vegetation surveys.

Table 3–21 summarizes the 2002 annual personnel exposure report for those employees with a measurable dose.

Table 3–21. 2002 Annual Personnel Exposure Summary Report

Employees with Measured Dose	External Dose (gamma) (mrem/yr)	Internal Dose (whole body from radon) (mrem/yr)	Total Effective Dose Equivalent (mrem/yr)
1	0	31	31
2	0	145	145
3	0	150	150
4	13	60	73
5	10	160	170
6	0	115	116
7	0	567	567
8	13	40	53
9	0	216	216
10	0	186	186
11	13	122	135
Average	**4.5**	**163**	**167**

Eleven other employees that participated in the personnel dose monitors did not have any measurable doses. This table indicates that the most significant dose contribution is from the ingestion of radon gas and that doses to workers vary considerably. All doses are below DOE benchmarks of up to 5,000 millirem per year (mrem/yr).

3.1.20 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), directs federal agencies to identify and address, as appropriate, any activities that may affect minority and low-income populations. A minority has been defined as individual(s) who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. A minority population has been identified where the minority population of the affected area exceeds 50 percent of the population. Low-income populations are groups with an annual income below the poverty threshold.

Table 3–22 presents the minority and low-income populations in Grand and San Juan Counties. A portion of the Uinta and Ouray Indian Reservation is located in northern Grand County. The Ute Mountain (White Mesa Utes) and the Navajo Reservations are situated along the southern border of San Juan County, and American Indians make up the majority of the population in San Juan County: 57 percent of the 14,413 population base. The Hispanic population in Grand County represents the next largest minority population in either of the two counties (5.6 percent).

Table 3–22 also presents the percentage of persons below the poverty line as defined by the U.S. Department of Commerce. San Juan County has a relatively large percentage of individuals below the poverty line (30 percent) compared to Grand County (18 percent). The county poverty trends from 1989 through 1997 show that the percentage of the population falling below the poverty level increased by 34 percent in Grand County and decreased by 10 percent in San Juan County during that time.

Table 3–22. Minority and Low-Income Populations in Grand and San Juan Counties

Population Group	Grand County	San Juan County
2000 population	8,485	14,413
Percent Hispanic or Latino	5.6	3.7
2000 population by race	8,373	14,195
White Non-Hispanic (percent)	7,861 (94%)	5,876 (41%)
Black or African American (percent)	21 (0.3%)	18 (0.1%)
American Indian (percent)	327 (4%)	8,026 (57%)
Some other race (percent)	164 (2%)	275 (2%)
Percent of people below 1997 poverty level	18	30
Percent change 1989–1997	34	–10

Source: 2000 Census

Demographic information obtained from the U.S. Census Bureau was used to identify low-income and minority populations within 50 miles of the Moab site and the proposed off-site alternatives (Klondike Flats, Crescent Junction, and the White Mesa Mill). This radius is consistent with that used to evaluate collective dose for human health effects from the proposed on-site and off-site disposal of the Moab mill tailings and contaminated material from vicinity properties. Census data are compiled at a variety of levels corresponding to geographic areas. In order of decreasing size, the areas used are states, counties, census tracts, block groups, and blocks. A "block" is geographically the smallest census area; it is usually bounded by visible features such as streets or streams or by invisible boundaries such as city limits, township lines, or property boundaries and offers the finest spatial resolution. Block data were used to characterize minority distribution. Because block data are so specific to the individuals within a block (for example, sometimes only one family may live in a block), income data are available only at the block group level and above. For this reason, block group data were used to identify low-income populations.

Demographic maps were prepared using 2000 census data for minority populations and for low-income populations. Figure 3–23 shows census blocks with minority populations that are more than 50 percent within 50 miles. The nearest block occurs about 20 miles south of Moab.

The poverty level established by the Census Bureau for 2000 for a family of four is $18,244. Figure 3–24 shows average household income for the year 2000. Assessment of the census data determined that within the 50-mile area, less than 1 percent of the population had a household income below the poverty level.

3.2 Klondike Flats Site

The proposed Klondike Flats disposal site (Klondike Flats site) is located about 18 miles northwest of the Moab site and just west of US-191. It is remote from populations and behind a low bluff such that the Klondike Flats site is not visible from the highway.

Air quality in this area would be considered similar to and likely better than air quality at the Moab site. There are no major sources of pollutants and no developed industries; regular vehicle use does not occur in the area under consideration. The Moab region is classified as an attainment area under the NAAQS; therefore, the Klondike Flats site is also considered to be an attainment area according to these standards, and air quality is not considered further.

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There are no perennial streams in or near this area; therefore, aquatic ecology is not considered further. Ephemeral streams are present throughout the region; the washes in the Klondike Flats site area may carry heavy flows after significant storm events. The course of these ephemeral water bodies is well established, and these washes are unlikely to migrate in a different direction or pattern; therefore, the potential for river migration is not considered further.

Any future use as a disposal site would require importing potable water and exporting nonradioactive solid and sanitary waste. An existing three-phase distribution line parallels US-191 adjacent to the site that is within the service territory of Utah Power.

3.2.1 Geology

The Klondike Flats site is in the north part of the Canyonlands section in the north-central part of the Colorado Plateau physiographic province. The surface of the site slopes gently westward, and the elevation ranges from about 4,600 to 4,750 ft. The site is in the northwest part of the ancestral Paradox Basin, which is discussed in Section 3.1.1 (Figure 3–1).

3.2.1.1 Stratigraphy

Bedrock exposed at the site is the lower part of the Mancos Shale (Figure 3–25). Approximately 300 to 700 ft (estimated) of Mancos Shale is present in the Klondike Flats site area. Just west of the site, an old oil test well (Klondike well) penetrated about 700 ft of Mancos Shale at its total depth (Doelling 1997; Lupton 1914).

The following members (in descending order) represent the lower part of the Mancos Shale in this area: Blue Gate Shale, Ferron Sandstone, and Tununk Shale. Approximately 100 to 200 ft of the lowermost part of the Blue Gate Shale Member is present in the western part of the site.

The Ferron Sandstone Member is exposed in the eastern and southern parts of the site. The lowermost member of the Mancos, the Tununk Shale, is exposed in the slope below the Ferron Sandstone cuesta around the east and south margins of the site area. The Dakota Sandstone of Early Cretaceous age underlies the Mancos Shale and consists of 50 to 100 ft of resistant sandstone, conglomeratic sandstone, and conglomerate. This formation likely represents the shallowest bedrock unit containing ground water. The Cedar Mountain Formation of Early Cretaceous age underlies the Dakota Sandstone and consists of one or two beds up to 30 ft thick of sandstone, conglomeratic sandstone, and conglomerate separated by thick, gray-green and lavender mudstone. The total thickness of the formation is 100 to 200 ft.

Bedrock (Mancos Shale) exposures are covered in some of the western part of the site by alluvial mud (Doelling 1997). These deposits fill swales in poorly developed drainages between bedrock ridges of Blue Gate Shale. Mostly residual, these deposits of mud, silt, and clay formed as the shale weathered; thickness is up to 20 ft.

3.2.1.2 Structure

The site is in a prominently exposed structural feature known as the Courthouse syncline. The surface expression of the syncline is hyperbolic and is well-defined by the Ferron Sandstone double cuesta. The site area roughly straddles the syncline axis, which runs approximately across Section 36, from its northwest to southeast corners. The southwest flank of the syncline terminates along the Moab Fault system and its northwest extension, the Moab splay faults (Figure 3–3).

Age	Formation and Member	Thickness (ft)
Late Cretaceous	Mancos Shale, Blue Gate Shale Member	Up to 3,000 preserved at Crescent Junction Site
	Mancos Shale, Ferron Sandstone Member	60
	Mancos Shale, Tununk Shale Member	250–300
Early Cretaceous	Dakota Sandstone	50–100
	Cedar Mountain Formation	100–200
Jurassic	Morrison Formation, Brushy Basin Member	200–400
	Morrison Formation, Salt Wash Member	150–250
	Curtis Formation, Moab Member	80–110
	Entrada Sandstone, Slick Rock Member	200–300
	Carmel Formation, Dewey Bridge Member	100–200
	Navajo Sandstone	300–500
	Kayenta Formation	150–300
	Wingate Sandstone	200–300
Triassic	Chinle Formation	200–800
	Moenkopi Formation	Up to 1,500
Permian	Cutler Formation	Up to 1,500
Pennsylvanian	Honaker Trail Formation	Up to 2,000
	Paradox Formation	Up to 12,000

Figure 3–25. Generalized Stratigraphic Column for the Klondike Flats and Crescent Junction Alternative Disposal Sites

No faults are obvious in the Klondike Flats site area. A minor northeast-striking normal fault, inferred by Doelling (1997), extends northeast and ends in Section 35.

3.2.1.3 Geologic Resources

There are no known oil and gas resources in this area. Evaporite deposits, such as potash and rock salt, occur in the Paradox Formation in the Salt Valley salt-cored anticline about 8 miles northeast of the Klondike Flats site area. However, no commercially viable deposits are present at the site.

Some minor uranium and vanadium deposits are known to occur in this area at a depth of 1,500 to 3,000 ft; however, this depth makes further exploration of such deposits uneconomical. No sand and gravel deposits are present at the site.

3.2.1.4 Geologic Hazards

Montmorillonite, a clay that is characterized by its ability to swell and shrink, is found in the Mancos Shale that is exposed over most of the area (Mulvey 1992). Changes in water content cause the shrinking and swelling, which leads to subsidence and is known to be the cause of highway road damage because of heave of concrete slab structures present over the Mancos Shale. Wetting of the shale surface from rainstorms often causes unimproved roads to be impassable for several days. No hazard exists at the site for landslides, slumping, or rock falls because of the low slopes and homogeneity of the Mancos Shale bedrock.

Earthquake risk and seismic activity in this area are low. The site is in Uniform Building Code 1, indicating lowest potential for earthquake damage (Olig 1991). The nearest faults with Quaternary movement are about 1 to 1.5 miles to the west and southwest of the site and are associated with the Moab splay faults (Hecker 1993).

The site has a high radon-hazard potential for occurrence of indoor radon because of the naturally occurring geologic factors of uranium concentration, soil permeability, and ground water depth (Black 1993). The high rating stems from the relatively high concentration of naturally occurring uranium in Mancos Shale, the relatively high soil permeability caused by shrinking and swelling of the Mancos-derived soil, and the relatively deep depth to ground water (shallow water retards radon migration to the atmosphere).

3.2.2 Soils

The more widespread soil classification units at the site are the Chipeta Complex in upland areas and the Toddler, Ravola, Glenton families in alluvial fans, drainages, and floodplains.

The surface is covered with less than 18 inches of Chipeta silty clay loam or Chipeta Complex soils. These soils have low infiltration characteristics (0.06 to 0.2 inch per hour) and are highly erodible (SCS 1989). These strongly saline, strongly alkaline, relatively well-drained clayey soils are generally shallow; weathered shale is often within 5 to 20 inches of the surface. Slopes vary from 0 to 10 percent. Hydrocollapse and subsidence potential are low. Liquefaction potential is also low because no liquefiable materials or conditions are present.

Grouped together, the Ravola, Toddler, and Glenton soil families occur on the floodplains of the major drainages to the north and west of the marine shale slopes that dominate the landscape. Some of the drainages are deeply incised. Soils of all three families are very deep and well-drained. The soil families grade one into another across the landscape and vary primarily in the origin of the alluvium within which they formed.

Water erosion hazard is moderate; however, the soils are subject to gully formation and piping where runoff is concentrated. Toddler family soils formed in alluvium derived from a mixture of marine shale to the north and east and sandstone to the south and west and are moderately to strongly saline. Runoff is slow and the erosion hazard is moderate. The Glenton soils, formed in alluvium derived mainly from sandstone, are very deep, are well-drained, and exhibit fairly rapid permeability. Runoff is moderate to slow and erosion hazard is relatively low; however, deep gullies have formed in areas where runoff is concentrated.

Cryptobiotic soil crusts and associated pedestal soil are found within the Klondike Flats site area. The cryptobiotic soil crusts reduce soil loss and are evidence of light to moderate grazing. A rock veneer also occurs over much of the site. Lag layers of surface rock can form by winnowing, frost heaving, and movement of soil gases during and after rain. Large and small burrows are common on the site, possibly dug by kangaroo rats, ground squirrels, and badgers. Burrowing is evidence that soils are being churned and that the Klondike Flats site is an active habitat.

Table 3–23 identifies soil properties associated with the Chipeta Complex and Ravola, Toddler, and Glenton soil families.

3.2.3 Climate and Meteorology

The closest available weather statistics are from the National Weather Service Canyonlands Field Airport meteorological station, located 2 to 4 miles southeast of the site. Weather information is available for only a short period from June 1998 to January 2002. Mean annual temperature is 55.6 °F; temperatures have ranged from –2 °F in January to 107 °F in August.

Average annual precipitation is 9.2 inches; frequency for precipitation events greater than 0.125 inch is less than 10 percent of the time. Most of the precipitation occurs during the southwest monsoon season, July to September. Most surface water flow in the Klondike Flats site area is from infrequent large thunderstorm events that occur in the late summer part of the monsoon season. The potential annual evaporation is 55 to 60 inches, which greatly exceeds annual precipitation (Robson and Banta 1995).

Average wind direction is from the north most of the time, as shown on Figure 3–26. Wind speed monitored at Canyonlands Field Airport indicated that 24 percent of the time the wind blows less than 1 mph, and 5 percent of the time the wind blows greater than 9 mph (Figure 3–27).

3.2.4 Ground Water

3.2.4.1 Hydrostratigraphy

Ground water in the Klondike Flats area occurs in several aquifers ranging from the Dakota Sandstone and Cedar Mountain Formation of Cretaceous age to the Navajo Sandstone of Jurassic age. Few data exist to evaluate ground water resources in the Courthouse syncline area; bedrock aquifers are largely untested, and only a few water wells are present in the area. The near-surface hydrostratigraphic unit (all geologic units younger than the Moenkopi Formation of Triassic age) includes aquifers consisting of sandstone and coarse unconsolidated units. This hydrostratigraphic unit is characterized by many perched zones and local systems with short flow paths. Local precipitation is the source of recharge, which occurs when winter snows melt and during the infrequent summer and early fall thundershowers (generally restricted to small areas).

Water percolates downward through fractures and weathered rock into the sandstone units. Water generally moves a short distance through the aquifer and is then lost through intermittently flowing springs and seeps. Discharge rates are low; many springs and seeps flow during the spring and are dry during other seasons.

3.2.4.2 Ground Water Occurrence

In 1994, Grand County Solid Waste Management drilled a well (Landfill No. 1) to a depth of 500 ft through the Ferron Sandstone Member and into the base of the Mancos Shale near the county landfill north-northwest of the site (Figure 3–28). The hole was dry and was abandoned. The Ferron Sandstone Member consists of a relatively thin set of resistant sandstone beds approximately 250 to 300 ft above the base of the Mancos Shale and is not a water-bearing unit. During earlier minerals exploration drilling, most or all of the Mancos Shale drilled was dry. It was concluded that the Mancos Shale does not yield ground water and that it forms an aquitard that inhibits ground water migration to deeper stratigraphic units (Blanchard 1990).

Limited data are available to assess ground water quality in the Dakota Sandstone or Cedar Mountain Formations at the site. Three wells have been drilled in which ground water was present at depths between 400 and 500 ft. Ground water may be present in these formations, but additional investigation would be necessary to determine if the quantities and yield are significant.

Ground water is present in the Brushy Basin and Salt Wash Members of the Morrison Formation at depths from 600 to 2,500 ft (Blanchard 1990). The Brushy Basin Member is composed largely of bentonitic shale that has a tendency to seal itself if it becomes fractured. This unit acts mainly as an aquitard. The Salt Wash Member forms an aquifer that is composed of lenticular fluvial sandstone deposits interbedded with siltstone and shale. The Salt Wash Member is not recognized as a regional aquifer and probably has limited production compared to eolian sandstone units below it.

The Moab Member of the Curtis Formation and the Slick Rock Member of the Entrada Sandstone are sandstone beds in the site area that have a high potential for containing usable ground water. However, no local well data are available to determine the water resource potential of the Curtis or Entrada Formations in the Klondike Flats site area.

The Navajo Sandstone, approximately 1,500 to 2,000 ft beneath the land surface, is the first significant water-producing aquifer in the area beneath the proposed site and is a major ground water resource throughout the region. Specific capacities of two water-supply wells at the entrance to Arches National Park, completed in the Navajo Sandstone, were 1.7 and 14.5 gpm per foot (Blanchard 1990).

3.2.4.3 Ground Water Quality

Ground water quality from potential aquifers in the Dakota Sandstone and Cedar Mountain Formation beneath the Klondike Flats site has not been determined. Ground water collected from a flowing well south of Cisco and from a spring east of the Klondike Flats area had TDS concentrations of 1,470 and 1,020 mg/L, respectively (Blanchard 1990). This would be classified as drinking water under the Utah Ground Water Quality Protection Regulations (UAC 2003a).

Ground water in the Salt Wash and Brushy Basin Members of the Morrison Formation has highly variable TDS concentrations ranging from 1,020 to 25,700 mg/L (Blanchard 1990). No data are available to evaluate local ground water quality in the Salt Wash Member.

Ground water in the Entrada Sandstone is generally good quality, with TDS concentrations typically less than 220 mg/L (Doelling and Morgan 2000). Ground water sampled from an Entrada Sandstone well approximately 1 mile south of the Klondike Flats area has a TDS concentration of 300 mg/L (Blanchard 1990). The Entrada Sandstone contains much higher concentrations of TDS in the deep subsurface. TDS concentrations in nine deep wells (depths of 900 to 5,300 ft) in the Entrada Sandstone north of I-70 between Crescent Junction and Cisco range from 9,470 to 104,000 mg/L (Blanchard 1990). One of these wells is approximately 5 miles north of the Klondike Flats area and contains a TDS concentration of 10,300 mg/L at 1,750 ft.

Ground water quality in the Navajo Sandstone is generally good; concentrations of TDS average less than 220 mg/L (Blanchard 1990). The water type is calcium bicarbonate or calcium magnesium bicarbonate, and the water is moderately hard to hard.

3.2.4.4 Ground Water Use

The Navajo Sandstone is the most important source of drinking water in Moab Valley, about 20 miles southeast of the Klondike Flats area (Eisinger and Lowe 1999). Wells in the Navajo Sandstone produce more than 1,000 gpm of high-quality water for the city of Moab water supply (Sumsion 1971). Numerous springs flow from the Navajo Sandstone where it is exposed about 5 miles south of the site. Flow from these springs is less than 10 gpm but is sufficient to provide water for a few cattle (Doelling and Morgan 2000).

The Hagen No. 1 Tenmile Wash (also known as Queen) well, approximately 4 miles west of the site, was drilled to 920 ft. Fresh water is present in white sandstone at a depth of 425 ft, and the well was converted to a water well (McKnight 1940; Doelling 1997). Salty water issued from another aquifer at a depth of 600 ft. The specific water-bearing units were not identified (McKnight 1940), but the depths and the location on the geologic map by Doelling (1997) indicate that the water is likely from the Dakota Sandstone and Cedar Mountain Formation.

Ground water use from two wells approximately 1 mile southeast and 1 mile north of the site reportedly completed in the Dakota Sandstone or Cedar Mountain Formation (Airport Well No. 2 and MIC-1, respectively) has not been confirmed and is under investigation.

Four water wells were drilled on state sections in the vicinity of Dalton Wells (approximately 4 miles southeast of the airport) (Utah Division of Water Rights 2004). No information is provided in the files, but a preliminary field check indicates that these wells are providing water for crop irrigation. The size of drilling equipment observed on the site in March 2002 suggests that the likely target would be the Navajo Sandstone. Figure 3–28 provides the locations of domestic wells in the Klondike Flats area.

3.2.5 Surface Water

3.2.5.1 Surface Water Resources

The Klondike Flats site is located near a surface water divide between the Colorado and Green Rivers. Tenmile Wash flows southwestward from Klondike Flats to the Green River. Another unnamed wash drains southeastward from the site toward Canyonlands Field Airport, and it eventually joins Bartlett and Klondike Washes, which discharge to Courthouse Wash and the Colorado River. Headwaters emanating from the Klondike Flats site area drain small areas. All of these washes are ephemeral, are dry much of the year, and are ungaged. Extreme floodwater surface elevations or the effects of these storm events are unknown.

3.2.5.2 Surface Water Quality

Water bodies in the Klondike Flats site area consist primarily of ephemeral washes that are dry most of the year. Flow occurs in these washes primarily after significant storm events. No information is available on water quality during these events; however, it is expected that the water would be heavily loaded with sediment from surface water collection coming off Mancos Shale. Soils associated with Mancos Shale are alkaline and may have high concentrations of selenium. It would be expected that the water quality of flows through these washes would be characterized as saline, very turbid, having considerable hardness, and having elevated levels of sulfate and selenium. Surface water use is limited to a few stock-watering dams.

3.2.5.3 Water Quality Standards

All ephemeral water bodies in the Klondike Flats site area eventually flow into either the Green River or the Colorado River; therefore, they are subject to the classifications specified in Utah Administrative Code R317-2-13 for the affected segments of both the Green and the Colorado Rivers and their tributaries (see Chapter 7.0).

3.2.6 Floodplains

No perennial rivers or streams and no floodplains are present at the Klondike Flats site. The site contains numerous ephemeral washes where surface flooding occurs, but these areas are not floodplains.

3.2.7 Wetlands

No wetlands are known to exist at the site, but because riparian vegetation is present in places, the area would be investigated for any small, isolated wetlands prior to construction. Appendix F includes a more detailed description of floodplains and wetlands at the Klondike Flats site.

3.2.8 Terrestrial Ecology

This section discusses the existing vegetation and wildlife, including threatened and endangered species and sensitive species, at the Klondike Flats site. The Klondike Flats site is within an area designated by the BLM as moderate to heavy use. The presence of human-related features, such as Canyonlands Field Airport to the south and the Grand County landfill to the northwest, may serve as limiting factors in the density and diversity of wildlife species present, such as larger mammals with large home ranges. The presence of human activity (primarily recreation) in this area further limits wildlife diversity and densities.

3.2.8.1 Terrestrial Vegetation and Wildlife

The vegetation on Chipeta soil (see Section 3.2.2) within the Klondike Flats site area is close to the potential natural vegetation as described in the Grand County Soil Survey (SCS 1989). In upland areas, vegetation is dominated by low saltbushes (mat and Gardner saltbush [*Atriplex corrugata* and *Atriplex gardneri*]) with scattered plants of bud sagebrush (*Picrothamnus desertorum*), galleta, Indian ricegrass, and desert trumpet (*Eriogonum inflatum*). Prickly pear cactus, a grazing increaser in upland areas, is a potential indicator of past overgrazing. A few hedgehog cacti (*Echinocereus* spp.) were also observed in upland areas. At the confluence of drainages where greater amounts of moisture occur seasonally, vegetation consists of abundant rubber rabbitbrush with a relatively dense understory of galleta. This is evidence that a slight increase in moisture can significantly increase plant abundance.

Plant abundance and diversity are very low, even for arid rangeland, because the low-permeability soils promote rapid runoff, have low available water capacity, and are often highly saline. Rooting depths vary from 5 to 20 inches. The plant community consists primarily of low shrubs, which includes mat saltbush and Gardner saltbush with occasional shadscale and bud sagebrush. A desert shadscale/saltbush community dominates habitat in this area. The existing low-growing vegetative cover is limited and sparse (about 50 percent cover), which reflects the low rainfall characteristic of the desert ecosystem and possibly overgrazing by cattle. Vegetation growing on Chipeta Complex soils has limited value for grazing because of the low productivity and poor palatability of dominant species.

Table 3–24 provides vegetation characteristics associated with soil types in the proposed Klondike Flats site area. Russian thistle, rabbitbrush, prickly pear cactus, and snakeweed are known to occur in the area. As shown in Table 3–24, the potential vegetation of the Ravola-Toddler-Glenton soils may consist of greater than 50 percent grasses that are palatable to livestock, such as Indian ricegrass and galleta, and these soils, therefore, have a somewhat higher value for grazing than Chipeta soils on nearby marine shale hills. The ephemeral washes support greasewood and tamarisk and also provide valuable cover for wildlife (BLM 1995).

Wildlife population diversity and densities are limited by sparse vegetation and poor habitat. This area is also likely to support fewer and less diverse wildlife populations than the Moab site because of the lack of water. However, large mammals adapted to a desert environment, such as the pronghorn antelope (*Antilocapra americana*), may inhabit the area to the north of the Klondike Flats site area. Smaller wildlife populations adapted to a desert environment, including mammal, bird, and reptile populations, are also present. Upland areas have poor forage and cover for wildlife. Nearby pockets of black greasewood provide cover for some birds and smaller mammals such as white-tailed prairie dog and black-tailed jackrabbit.

No critical winter or summer range has been identified for wildlife for the Klondike Flats site area.

3.2.8.2 Threatened and Endangered Species

This section describes federally listed terrestrial threatened and endangered, proposed, or candidate species that are or may be present in the Klondike Flats site area. In March 2003, DOE requested an updated list of such species from USF&WS that may be present or affected by DOE's proposed alternatives. USF&WS responded in April 2003 with a list for Grand County. Table 3–25 lists a subset of those species that may occur in the vicinity of the Klondike Flats site.

Table 3–25. Federally Listed Threatened and Endangered Species Potentially Occurring in the Vicinity of the Klondike Flats Site

Common Name	Scientific Name	Habitat Present and Affected	Species Present	Status	Comments
Jones' cycladenia	*Cycladenia humilis* var. *jonesii*	Possible	Possible	Threatened	
Black-footed ferret	*Mustela nigripes*	No	No	Endangered	
California condor	*Gymnogyps californianus*	No	No	Endangered	
Mexican spotted owl	*Strix occidentalis lucida*	Possible	Possible	Threatened	
Bald eagle	*Haliaeetus leucocephalus*	Possible	Possible	Threatened	Proposed for Delisting

Spatial data for the species listed in Table 3–25 were obtained from the Utah Conservation Data Center (UCDC). This data set was compiled by the Utah Natural Heritage Program (UNHP) of UDWR, in which species occurrences are depicted as points at a scale of 1:24,000 on 7.5-minute topographic quad maps. Spatial data depicting the Klondike Flats site were overlaid on the species of concern spatial data to evaluate known species occurrences in the area.

The status of each of these species in the vicinity of the Klondike Flats site is briefly discussed below. Appendix A1, "Biological Assessment," provides more detailed information concerning these federally listed species that may be in the vicinity of the Klondike Flats site or could be affected by activities at the site.

There is a cluster of known populations of Jones' cycladenia on BLM land in Grand County approximately 11 to 17 miles northeast of Moab (UDWR 2003b). However, there are no known occurrences of the species on the Klondike Flats site.

UDWR (2003b) reported an unconfirmed ferret sighting in the vicinity of the Klondike Flats site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Klondike Flats site.

Surveys for white-tailed prairie dogs (currently in review for federal listing) have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

A UDOT environmental study (UDOT 2002b) included the California condor as potentially occurring in the Klondike Flats area in sparsely inhabited mountain ranges, mesas, and open rangeland. However, based on habitat needs, it is unlikely that this species exists in the vicinity of the site.

Data provided by UDWR (2003a) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, habitat models (BLM 2003b) indicate that potential habitat areas may exist in the canyons near US-191 over the first 7 miles north from the Moab tailings pile. Nonetheless, these models are primarily based on physical and topographic features and do not consider vegetation requirements. Mexican spotted owls nest, roost, and forage in an array of different community types, but mixed-conifer forests dominated by Douglas fir and/or white fir are most common (USF&WS 2001). However, they may also nest, but less frequently so, in arid, rocky, mostly unvegetated canyons (Romin 2004). Although there are no forested areas in the vicinity of US-191 north of Moab, there are arid canyons that largely or altogether lack forest-type vegetation. Thus, it is unlikely but possible that spotted owls occur in the canyons near US-191 over the first 7 miles north of the Moab site. It is, thus, even more unlikely that spotted owls occur at the Klondike Flats site.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. However, it is not known to nest or night roost nor is it known to have been observed in the vicinity of the Klondike Flats site.

There is no designated or proposed critical habitat for any of the above federally protected species in the vicinity of the Klondike Flats site.

DOE, in consultation with USF&WS and BLM, would determine the need for additional habitat evaluations and surveys for species that may be affected by the proposed action should this alternative be selected.

3.2.8.3 Other Special Status Species

Special status species are those that are protected under federal and state regulations other than the ESA, which include the MBTA, Executive Order 13186, and Birds of Conservation Concern (USF&WS 2002f). The State of Utah maintains a list of species that it considers threatened, endangered, or otherwise of concern; other federal agencies such as BLM and USFS also maintain lists of species considered to be sensitive. UDWR notified DOE of species that should be considered under this EIS (UDWR 2003b). Although the special status species are not covered by the ESA and are therefore not subject to Section 7 consultation, USF&WS encourages protection of these species.

Table 3–26 lists sensitive plant species that may occur in the site region and are considered by state and federal resource management agencies to be of concern. A number of species listed by the State of Utah or considered sensitive by BLM are potentially present in the vicinity of the Klondike Flats site.

Table 3–27 includes animal species listed by the state to be of concern and may be present in the project region. The list includes all species identified by UDWR as potentially occurring in Grand County; in some cases, the known populations or suitable habitat are not close to the Klondike Flats site. Some species have been eliminated from the site list because of site-specific habitat.

Table 3–28 lists sensitive bird species, including birds protected under the MBTA, that may occur in the vicinity of the site, although current on-site habitat may limit typical nesting and breeding activities. Most of these species are protected under the MBTA, which prohibits take or destruction of birds, nests, or eggs of listed migratory birds.

Birds of primary concern are the burrowing owl (*Athene cunicularia*), Swainson's hawk, ferruginous hawk, and peregrine falcon. Although these species are not federally listed species, they are included on the state list and are also protected under the MBTA. Because of previous sightings, it can be assumed that the peregrine falcon and ferruginous hawk may be present.

Table 3–28. Sensitive Bird Species Protected Under the Fish and Wildlife Conservation Act and Migratory Bird Treaty Act That May Occur Near the Klondike Flats Site

Species	Potential To Occur in Project Area
Order Falconiformes—Birds of prey	
Golden eagle *(Aquila chrysaetos)*	High
Northern harrier *(Circus cyaneous)*	Moderate
Prairie falcon *(Falco mexicanus)*	Moderate
Red-tailed hawk (*Buteo jamaicensis*)	High
Turkey vulture (*Cathartes aura)*	High
Order Gruiformes—Marsh and open country birds	
Black rail *(Laterallus jamaicensis)*	Moderate
Yellow rail *(Coturnicops noveboracensis)*	Low
Order Strigiformes—Nocturnal birds of prey	
Barn owl *(Tyto alba)*	Low
Flammulated owl *(Otus flammeolus)*	Low
Short-eared owl *(Asio flammeus)*	Low
Order Apodiformes—Small swallowlike birds	
Black swift *(Cypseloides niger)*	Low
Vaux's swift *(Chaetura vauxi)*	Low
Order Passeriformes—Perching birds	
Olive-sided flycatcher *(Contopus borealis)*	Low
Gray flycatcher *(Empidonax wrightii)*	Moderate
Pinyon jay *(Gymnorhinus cyaneocephalus)*	Low
Bendire's thrasher *(Toxostoma bendirei)*	High
Crissal thrasher *(Toxostoma dorsale)*	High
Bewick's wren *(Thryomanes bewickii)*	Moderate
Sedge wren *(Cistothorus platensis)*	Low
Verry *(Catharus fuscenscens)*	Moderate
Sprague's pipit *(Anthus spragueii)*	Low
Loggerhead shrike *(Lanius ludovicianus)*	Moderate
Gray vireo *(Vireo vicinior)*	Moderate
Virginia's warbler *(Vermivora virginiae)*	Moderate
Black-throated warbler *(Dendroica nigrescens)*	Low
Grace's warbler *(Dendroica graciae)*	Low
Blackpoll warbler *(Dendroica striata)*	Low
Dickcissell *(Spiza americana)*	Low
Sage sparrow *(Amphispiza belli)*	Low
Cassin's sparrow *(Aimophila cassinii)*	Low
Brewer's sparrow (*Spizella breweri)*	Moderate
Lark bunting *(Calamospiza melanocorys)*	High
Baird's sparrow *(Ammodramus bairdii)*	Low
Grasshopper sparrow *(Ammodramus savannarum)*	Low
McCown's longspur *(Calcarius mccownii)*	Low
Chestnut-collared longspur *(Calcarius ornatus)*	Low

Note: Birds listed in the table are protected under the Fish and Wildlife Conservation Act (Birds of Conservation Concern [2000] [USF&WS 2002f] and the MBTA [50 CFR 10], Executive Order 13186). Species listed as threatened or endangered under the ESA or considered endangered, threatened, or rare by the State of Utah are not included here.

Burrowing owl habitat may exist in the vicinity of white-tailed prairie dog colonies. Although burrowing owls have not been documented as occurring in the vicinity of the Klondike Flats site, prairie dog burrows may provide suitable habitat for nesting.

3.2.9 Land Use

The Klondike Flats site area is located in Grand County, Utah, on land administered by BLM. The area under consideration is approximately 18 miles northwest of the city of Moab and west of US-191 and the Union Pacific Railroad. Arches National Park is approximately 3.5 miles east of US-191 (see Figure 3–18).

The general area is undeveloped land administered by BLM. A portion of the site area under consideration is designated for disposal in BLM's resource management plan (BLM 1983). The Grand County landfill is located adjacent to the area identified for disposal. BLM has stated that it would pursue necessary real estate actions to have adjacent areas available for a disposal site.

The nearest commercial property is the Canyonlands Field Airport, which is immediately southeast of the Klondike Flats site area. Four employees live at the airfield year-round, and up to seven employees live at the airport during peak season (Albrecht 2003). There are no other nearby residents. Access to the Grand County landfill is approximately 1 mile north of the Klondike Flats site area and 1 mile west of US-191 on CR-236. Crescent Junction and the I-70 interchange are approximately 10 miles north along US-191.

The area surrounding and including the Klondike Flats site is available for recreation and other uses; existing roadways limit access. However, several dirt roads are used for recreational access. Favorable weather allows recreational access for hikers, campers, mountain bikers, and off-highway vehicles during most of the year. Most of the recreational activities occur south and west of the Klondike Flats site along CR-138, also known as the Blue Hills Road. This road provides access to desirable areas to the west that are used mainly for mountain biking and all-terrain vehicles. Although the amount of recreational use west of the site is unknown, it is possible that as many as 53,000 recreational use visits occurred in 2002. This estimate is based on vehicle counts on Blue Hills Road. An off-highway vehicle play area is located southwest of Canyonlands Field Airport. The track was established in the 1970s and fell into disuse; however, in recent years it has had renewed interest and use because of the popularity of all-terrain vehicles and motorcycles. An estimated 1,000 user-days per year occur at this track. Peak use occurs during the spring and fall.

In addition to recreation, BLM allows grazing, oil and gas leasing, and mining claims. The Klondike Flats site area is part of the Big Flat grazing allotment, which is currently under a grazing permit until 2013. There are no mineral, oil, or gas leases in effect for the potential site, and BLM has closed this area to any new leases.

Two sections of land to the south and southeast of the site are administered by the State of Utah SITLA. SITLA administers sections of land throughout the state with the express mandate of maximizing the value of the holdings for use by the state's educational institutions. SITLA contains provisions for easements or rights-of-way crossings.

3.2.10 Cultural Resources

The cultural history of the Klondike Flats site is included in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for this site is described in Section 3.1.13.2.

Results of the Class I inventory indicate that Class III cultural resource surveys have not been conducted on most of the Klondike Flats site. Two sites have been recorded within the boundaries of the site, but neither has been recommended as eligible for inclusion in the National Register of Historic Places. Both are located on the site margin adjacent to US-191, where numerous linear surveys have been conducted. An additional seven sites have been recorded immediately adjacent to the eastern boundary of the site, again, where linear surveys associated with projects that parallel US-191 have been conducted.

The potential for cultural resources to occur in unsurveyed portions of the site is high on the basis of soil types and adjacent surveys. Cultural site densities of 22.4 to 27.4 sites per square mile are predicted for the soil types and landforms found on the site (Berry 2003). Class III cultural resource surveys from areas approximately 1 to 10 miles to the west and southwest of the site indicate densities of 20 or more cultural sites per square mile in some instances. The surveys indicate the presence of Paleoindian, Archaic, Formative (represented by Anasazi), and historic sites (Berry 2003).

No data exist concerning the presence of potential traditional cultural properties on the Klondike Flats site. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of their occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high) for traditional cultural properties associated with the Ute Mountain Ute Tribe, White Mesa Ute Tribe, Southern Ute Tribe, and Navajo Nation. The likelihood of occurrence and their estimated density on the site are medium for traditional cultural properties associated with the Uintah-Ouray Ute Tribe and Hopi Tribe (Fritz 2004).

3.2.11 Noise and Vibration

The Klondike Flats site is located in a quiet desert environment where natural phenomena such as wind, rain, and wildlife account for most natural background noise. The acoustic environment in open desert in Utah is typical of other desert environments where average L_{dn} range from 22 dB on calm days to 38 dB on windy days (Brattstrom and Bondello 1983). Sources of man-made background noise may include automobile traffic on US-191 (about 1 mile away), trains on the Union Pacific Railroad, aircraft flying overhead, a landfill located near the site, and outdoor recreational activity.

Neither background noise nor ground vibration data are available for the Klondike Flats site. Estimated average background noise for the site from natural and man-made sources is about 45 dBA, but could exceed 55 dBA within 1,300 ft of US-191. No residences are in the immediate surrounding areas, and the land is used for outdoor recreation.

3.2.12 Visual Resources

The Klondike Flats site is remotely located on the back slopes of the bluffs that border the western side of US-191. It is characterized by gently rolling, buff-colored hills that are dotted with prickly pear cactus and low-growing shrubs (Figure 3–29). From a distance, the horizontal and diagonal lines of the landscape features are smooth and unbroken except for an occasional drainage. From most viewing locations on the site, the background scenery is composed of red-rock cliffs and sandstone mesas. Most of the site is not visible to travelers on Blue Hills Road or US-191 because it is shielded by the steep bluff side slopes that parallel both of these roads.

Figure 3–29. View Northeast of the Klondike Flats Site

Although no roads or trails currently cross the Klondike Flats site, it may be viewed occasionally by off-road recreationists who stray from existing roads and trails. BLM (2003b) classifies visual resources in this area as Class III (see Section 3.1.15 for an explanation of visual resource classes).

3.2.13 Infrastructure

With few exceptions, the infrastructure that currently supports the Moab site (see Section 3.1.16) is the same for the Klondike Flats site area. Nonpotable water is obtained from the Moab site at the river water pump station and transported to the Klondike Flats site. Potable water is obtained from the city of Moab and transported to the Klondike Flats site. A Utah Power three-phase overhead distribution line runs along US-191, approximately 3 miles from the disposal cell area.

3.2.14 Transportation

Section 3.1.17 provides details related to area federal, state, and county road use. Table 3–15 in Section 3.1.17 provides AADT, level of congestion, truck percent, and accident rates for US-191 from Moab to Crescent Junction. Table 3–16 in Section 3.1.17 provides monthly traffic at the junction of SR-279 and US-191. Figure 3–21 illustrates area access possibilities.

AADT on US-191 in the Klondike Flats area is low and contains high percentages (30 percent) of truck traffic. Of the AADT of 2,855 vehicles, an estimated 856 vehicles would be trucks. Between Blue Hills Road (CR-138) and SR-313, accident rates increase above expected rates but are still close to expected rates identified for similar highways (Ames 2003).

As shown on Figure 3–21, the Union Pacific Cane Creek Branch Railroad parallels US-191 between Crescent Junction and Moab. However, just south of CR-138 (Blue Hills Road), the railroad track goes under US-191 and continues south on the west side of US-191. As discussed in Section 3.1.17, current rail usage on the segment between Moab and the main line at Crescent Junction is limited to one train per week that hauls freight from the Moab Potash and Salt Mine on SR-279.

The Canyonlands Field Airport (see Figure 3–21) provides commuter and scenic air tour services. A local aviation company operates the airport and services 22 fixed-wing flights a day year-round. There are three daily commercial flights by an airline carrier; the remaining flights are a combination of charter and scenic flying services. An average of one helicopter flight per day year-round provides mostly fuel service (Albrecht 2003).

3.2.15 Socioeconomics

The Klondike Flats site is situated 18 miles north of the Moab site in Grand County, Utah. Section 3.1.18 discusses Grand County socioeconomic characteristics. The Canyonlands Field Airport is the only commercial employer in the site area. It employs 11 full-time employees year-round; of that number, four people live at the airport year-round and seven employees live there during the peak season. There are no other commercial businesses or residences in the site area.

3.2.16 Human Health

3.2.16.1 Background Radon/Natural Radiation

Nationwide, people are exposed to an average of about 300 mrem/yr of natural background radiation (NCRP 1987). Table 3–29 summarizes the radiation doses from natural background, assuming residential exposure is occurring at the Klondike Flats site.

Table 3–29. United States and the Klondike Flats Site Natural Background Radiation Doses

Source	U.S. Average Natural Background Radiation Dose (millirem/yr)	Klondike Flats Natural Background Radiation Dose (millirem/yr)
Cosmic and cosmogenic radioactivity	28	68
Terrestrial radioactivity	28	74
Internal radioactivity	40	40
Inhaled radioactivity	200	260
Rounded Total	**300**	**440**

The largest natural source is inhaled radioactivity, mostly from radon-222 and its radioactive decay products in homes and buildings, which accounts for about 200 mrem/yr. Additional natural sources include radioactive material in the earth (primarily external radiation from the uranium and thorium decay series), radioactive material in the body (primarily potassium-40), and cosmic rays from space filtered by the atmosphere.

The actual radiation dose from natural background radiation varies with location. According to data for Blanding, the radiation dose from cosmic and cosmogenic radioactivity is about 68 mrem/yr at the Klondike Flats site; the dose from external terrestrial radioactivity is about 74 mrem/yr; and the dose from radon-222 and its radioactive decay products is about 260 mrem/yr (IUC 2003). The total natural background radiation dose at the Klondike Flats site would be about 440 mrem/yr, considerably higher than the national average.

No one currently resides at the Klondike Flats site, and only 15 people live within 10 miles of the site. According to 2000 census data, the population within 50 miles of the Klondike Flats site was about 10,500 (Figure 3–30). Assuming that all residents were exposed to 440 mrem/yr, the population dose would be about 4,600 person-rem per year.

3.2.17 Environmental Justice

Several small pockets of minority populations greater than 50 percent of the total population within a census block are found south and east of the Klondike Flats site within 50 miles from the site. As shown in Figure 3–31, there are no areas with minority populations greater than 50 percent of the total population closer than 20 miles to the site. Approximately 94 percent of Grand County was identified by the census as white, non-Hispanic. One census group block area with a reported annual household income less than $18,244 is identified about 30 miles north of the site (Figure 3–32).

3.2.18 Pipeline Corridor

3.2.18.1 Geology

Seismicity (and seismic risk) is low in this part of the northern Paradox Basin and has a low rate of occurrence with small- to moderate-magnitude earthquakes (Wong and Humphrey 1989). The proposed slurry pipeline route is in Uniform Building Code 1, indicating the lowest potential for earthquake damage (Olig 1991).

Geologic conditions for subsidence and landslides were evaluated in the EIS for the Questar, Williams, and Kern River pipeline route, which closely follows the proposed pipeline route from the Moab site to Klondike Flats (DOI 2001). In that EIS, no risks for landslides, soil liquefaction, or collapsible soils were noted for the Moab site to Klondike Flats portion of the pipeline route.

The northernmost 3 miles of the proposed pipeline route crosses over the lower part of the Mancos Shale, which contains expansive clay (montmorillonite) that can potentially cause engineering geologic problems. Changes in water content cause the clay to shrink and swell, leading to subsidence or heave of concrete slab structures.

3.2.18.2 Soils

Soils within the proposed pipeline corridor between the Moab site and the Klondike Flats site are formed primarily on marine shale uplands and pediments and on alluvial fans and drainages consisting of sediments derived from nearby shale and sandstone uplands. Three general soil map units occur along this segment of the proposed pipeline corridor from south to north: Rock Outcrop-Nakai-Moenkopi, Chipeta-Killpack-Blueflat, and Toddler-Ravola-Glenton (SCS 1989).

3.2.18.3 Ground Water

Depths to ground water vary widely along the length of the proposed pipeline corridor from the Moab site to the Klondike Flats site. For the first mile of the pipeline corridor northwest of the Moab site, ground water is in Quaternary alluvium and detritus in Moab Wash at depths less than 100 ft. For the next 6 to 7 miles through Moab Canyon to about Sevenmile Canyon, the pipeline corridor is on the southwest (upthrown) side of the Moab Fault, where ground water is several hundred feet deep in sandstone of the Cutler or Honaker Trail Formations. North of Sevenmile Canyon, where the proposed pipeline corridor is on the northeast (downthrown) side of the Moab Fault, ground water would be in the Entrada Sandstone at estimated depths of 200 to 500 ft. About 4 miles north of Sevenmile Canyon along the pipeline route are seeps at the base of the Cedar Mountain Formation, and ground water is shallow in the Cedar Mountain Formation or Dakota Sandstone for about the next 2 miles to where Bartlett Wash comes in from the west. For the last 3 to 4 miles, where the pipeline corridor turns to the west and passes over increasing thicknesses of Mancos Shale, ground water depths to the Dakota Sandstone increase from 200 to about 700 ft.

3.2.18.4 Surface Water

No perennial surface waters are present within the pipeline corridor. The proposed slurry pipeline corridor extending north from the Moab site to the Klondike Flats site would cross several streams and washes (Moab Wash, Sevenmile Wash, Klondike Wash, and Tusher Canyon Wash) and numerous other smaller, unnamed drainage features, all of which are ephemeral. Storm water runoff in the local ephemeral streams is characterized by a rapid rise in flow rates, followed by rapid recession, primarily because of the small storage capacity of the surface soils in the area. The flows in these drainage features occur primarily in response to local heavy rainfall and occasionally to snowmelt runoff.

Water Quality and Existing Surface Water Contamination

When storm water flows through washes within this proposed pipeline corridor, the water is laden with sediment, and water quality is anticipated to be poor. These ephemeral washes collect surface water runoff from areas composed predominantly of the Mancos Shale Formation, which are highly alkaline and may have high concentrations of selenium. As a result, surface water quality from these drainage features would likely be characterized as having high salinity, turbidity, and hardness and having elevated levels of sulfate and selenium.

Relevant Water Quality Standards

All ephemeral water bodies in this proposed pipeline corridor are eventually tributaries to either the Green River or the Colorado River; therefore, they are subject to the water quality classifications specified in Utah Administrative Code R317-2-13 (see Chapter 7.0).

3.2.18.5 Floodplains and Wetlands

No known floodplain or wetland areas would be affected by the pipeline corridor.

3.2.18.6 Terrestrial Ecology

Section 3.2.8 describes the affected environment for terrestrial ecology on a regional basis between the Moab site and the Klondike Flats site (Maps 2–4, Appendix C). This section addresses only the areas, wildlife, and habitat that would be affected by the proposed pipeline corridor. General information applicable to the regional descriptions as described in Section 3.2.8 is not repeated in this section. Although vegetation is sparse and habitat is limited, large mammals adapted to a desert environment, such as the pronghorn antelope, coyote, and black-tailed jackrabbit, are anticipated to be present intermittently in the proposed corridor.

Recreational activities (e.g., motorized off-highway vehicles) on the west side of US-191 and highway traffic from Moab limit wildlife diversity and densities. However, the desert bighorn sheep is a Utah species of high interest and is known to frequent area transportation corridors (US-191 and the Union Pacific Railroad) from the Moab site as far north as 14 miles toward the Klondike Flats site (Maps 3 and 4, Appendix C). The desert bighorn prefers rocky, relatively steep slopes characteristic of the area between Moab and the Klondike Flats site. Road traffic has resulted in mortality to this species.

Table 3–25 in Section 3.2.8.2 presents a list of federally listed threatened and endangered species that may occur in the vicinity of the Klondike Flats site. Appendix A1, "Biological Assessment," provides more detailed information concerning these species. Of these species, the black-footed ferret, Mexican spotted owl, and bald eagle, as described in Section 3.2.8.2, are the primary federally listed species of concern in the vicinity of the pipeline corridor. In addition, the white-tailed prairie dog, currently in review for federal listing, is also of concern.

UDWR (2003b) reported an unconfirmed sighting of black-footed ferrets in the vicinity of the Klondike Flats site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur along the pipeline corridor between the Moab site and the Klondike Flats site. The black-footed ferret is of concern particularly along the northernmost sections of the pipeline route. However, the route's proximity to US-191 and its limited potential for suitable habitat for more than 80 percent of the area likely limit the potential for the ferret's presence. An environmental assessment conducted for the Grand County Landfill (BLM 1995), which is located within 3 miles of the Klondike Flats site, concluded that there is no present or historical evidence of black-footed ferrets.

However, white-tailed prairie dog colonies, upon which the ferret depends, may be located in the vicinity of this segment of the proposed pipeline corridor just south of the Klondike Flats site. Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

Data provided by UDWR (2003a) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, habitat models (BLM 2003b) indicate that potential habitat areas may exist in the canyons near US-191 over the first 7 miles north from the Moab site. Nonetheless, these models are primarily based on physical and topographic features and do not consider vegetation requirements. Mexican spotted owls nest, roost, and forage in an array of different community types, but mixed-conifer forests dominated by Douglas fir and/or white fir are most common (USF&WS 2001). However, they may also nest, but less frequently so, in arid, rocky, mostly unvegetated canyons (Romin 2004). Although there are no forested areas in the vicinity of US-191 north of Moab, there are arid canyons that largely or altogether lack forest-type vegetation. Thus, it is unlikely but possible that spotted owls occur in the canyons near US-191 over the first 7 miles north of the Moab site.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. However, it is not known to nest or night roost nor is it known to have been observed in the vicinity of the proposed pipeline corridor between the Moab site and the Klondike Flats site.

There is no designated or proposed critical habitat for any of the above federally protected species in the vicinity of the proposed pipeline corridor between the Moab site and the Klondike Flats site.

DOE, in consultation with USF&WS and BLM, would determine the need for additional habitat evaluations and surveys for species that may be affected by the proposed action should this transportation mode be selected.

The burrowing owl (Cresto 2003), ferruginous hawk, peregrine falcon, and Swainson's hawk are not federally listed species, but they are included on the state list of sensitive species and are also protected under the MBTA. On the basis of previous sightings, it can be assumed that the peregrine falcon and ferruginous hawk may be present. Studies conducted for the Grand County landfill (BLM 1995) identified ferruginous hawk sightings in the vicinity of the pipeline corridor.

3.2.18.7 Land Use

The slurry line route from the Moab site to the Klondike Flats site is approximately 18 miles. Where possible, the pipeline would be located in an existing right-of-way permitted across federal lands administered by BLM, which constitutes approximately 37 percent of the entire route. Approximately 7 percent of the route would be located on national park lands, 16 percent on private lands, and the remaining 40 percent on state and sovereign lands. If co-location of the proposed slurry line is not feasible or practical, DOE would obtain a new permit from BLM, and the pipeline would parallel the existing right-of-way. Proposed pipeline corridors are shown on Maps 2 through 4 in Appendix C.

3.2.18.8 Cultural Resources

The cultural history of the proposed Klondike Flats pipeline route is discussed in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for this corridor is described in Section 3.1.13.2.

Results of the Class I inventory indicate that a number of linear Class III cultural resource surveys associated with existing pipelines and US-191 have been conducted along the proposed pipeline corridor between the Moab and Klondike Flats sites. On the basis of these surveys, 25 sites have been identified that are either eligible for inclusion in the National Register of Historic Places or have been recommended as eligible. An additional site, the Dalton Wells Civilian Conservation Corps/Japanese-American Internment Camp (Map 3, Appendix C), is listed on the National Register. The 25 sites include historic sites associated with transportation, mining, ranching, and agriculture; prehistoric lithic scatters of unknown affiliation; a small number of Formative and Archaic period sites; small rock art sites; and possibly protohistoric (immediately preceding recorded history) sites. No Paleoindian sites have been recorded along the corridor, and it is not likely that they would occur.

No data exist concerning the presence of potential traditional cultural properties along the proposed Klondike Flats pipeline route. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of their occurrence and estimated density on the site are low (on a scale of low-medium-high-extremely high) for traditional cultural properties associated with the Navajo Nation and medium for properties associated with the Ute Mountain Ute Tribe, White Mesa Ute Tribe, Southern Ute Tribe, and Hopi Tribe. The likelihood of their occurrence and estimated density are medium to high for properties associated with the Uintah-Ouray Ute Tribe (Fritz 2004).

3.2.18.9 Visual Resources

The proposed pipeline route between the Moab and Klondike Flats sites passes through narrow Moab Canyon, just north of the Moab site (Map 4, Appendix C), and the gently rolling desert plains north of Moab Canyon to the Klondike Flats site (Maps 2 and 3, Appendix C). Moab Canyon, characterized by steep, rugged, red sandstone cliffs, has a visual resource designation of Class II (BLM 2003b) (see Section 3.1.15 for an explanation of visual resource classes). The natural environment in the canyon has been altered somewhat by a number of cultural modifications, such as US-191, the Cane Creek Branch rail line, an overhead transmission line, and several buried pipelines. For the most part, however, the dominant features within the canyon are not the cultural modifications but the imposing sandstone cliffs. North of the canyon, the rolling desert plains are designated Class III (approximately 70 percent of the route) and Class IV (approximately 10 percent of the route) (Map 4, Appendix C).

The desert plains are characterized by undulating topography that is scattered with small desert shrubs and grasses. The background scenery along the pipeline corridor in these Class III and IV areas is composed of moderately rugged red and beige sandstone mesas and cliffs containing predominantly horizontal and diagonal features. Near the Klondike Flats site, background scenery changes to the smooth, rounded, buff-colored bluffs of the Mancos Shale.

The route proposed for the pipeline is visible to travelers on US-191 for most of its length. An approximately 4-mile stretch of the route is not entirely visible from the highway but is visible to recreationists and other travelers on the county road (historic US-160) that parallels US-191 along Moab Canyon. The proposed south access portion of the pipeline route is visible to recreationists and other travelers on Blue Hills Road (CR-138).

3.3 Crescent Junction Site

The proposed Crescent Junction disposal site (Crescent Junction site) is located about 2 miles north of the Crescent Junction interchange on I-70 and US-191. The site is about 31 miles north of the Moab site and covers several square miles of largely desert terrain that is bordered on the north by the prominent Book Cliffs. All drainage to the Green River, which ultimately flows to the Colorado River, is located several miles west of the site. Because no perennial streams or rivers are on the Crescent Junction site, aquatic ecology and surface water contamination and use are not discussed.

The Crescent Junction area is within the service territory of Utah Power, a subsidiary of PacifiCorp. The corporation maintains an existing three-phase distribution line that parallels CR-175, a frontage road between Crescent Junction and Cisco.

3.3.1 Geology

The Crescent Junction site is along the south edge of the Uinta Basin, and rocks dip gently to the north toward the basin axis. The site also overlies the northwestern part of the ancestral Paradox Basin (Figure 3–1). Nearby to the north is an erosional escarpment that rises about 600 ft; this escarpment is known as the Book Cliffs.

3.3.1.1 Stratigraphy

Mancos Shale bedrock is exposed in several places at the site. The site is underlain by 3,000 ft of Mancos Shale; the remaining 1,000 ft was removed by erosion. The Ferron Sandstone Member is about 60 ft thick and occurs in the lower 300 to 350 ft of Mancos Shale. Below the Ferron is the lowermost member of the Mancos, the Tununk Shale (see Figure 3–25).

The Dakota Sandstone underlies the Mancos Shale and is less than 100 ft thick in the Crescent Junction site area. It is likely the shallowest bedrock unit containing ground water. The Cedar Mountain Formation underlies the Dakota Sandstone.

Mancos Shale bedrock exposures are covered over much of the Crescent Junction site area by alluvial mud (Doelling 2001). This unconsolidated gray material, less than 20 ft thick, fills swales in the softest parts of the Mancos Shale and consists of silt, clay, sand, and minor fragments of sandstone. Along the west side of the site area, Quaternary stream alluvium, up to 20 ft thick deriving from Crescent Wash, covers the Mancos Shale (Doelling 2001). This material consists of sand, silt, clay, pebbles, and sparse cobbles adjacent to the Crescent Wash stream course, which heads in the Book Cliffs just to the north.

3.3.1.2 Structure

The site is in the Paradox fold and fault belt of the ancestral Paradox Basin (see Figure 3–1). The geologic structure of the Paradox Basin is discussed in Section 3.1.1. The Book Cliffs, less than 1 mile north of the site, is an erosional escarpment on the south flank of the Uinta Basin. Mancos Shale at the site dips gently (less than 10 degrees) northward (from north-northeast to north-northwest) toward the axis of the subtle, northwest-striking Whipsaw Flat syncline. Northwest-striking normal faults defining a graben of the northwest extension of the Salt Valley salt-cored anticline are about 1 to 2 miles southwest of the Crescent Junction site. These faults are not exposed on the surface and reportedly have as much as 1,000 ft of displacement, as determined by oil test wells drilled in the area in the 1920s and 1930s (Fisher 1936).

A fault mapped in 1924 during oil exploration (Harrison 1927; Fischer 1936) is believed to extend into the southwest quarter of Section 27 in the Crescent Junction site area. More recent studies do not show this fault as having surface expression (Woodward-Clyde Consultants 1984; Doelling 2001). It is unclear what geologic features were used as evidence of the fault. Surface fieldwork and an additional search for well data in the area would be necessary to confirm the existence of the fault. No other lineaments or geologic structures were noted in the Crescent Junction site area from northern Paradox Basin mapping by Friedman and Simpson (1980).

3.3.1.3 Geologic Resources

No oil and gas resources have been found in the Crescent Junction site area. The nearest known petroleum accumulation is in the Morrison Formation about 3 miles south-southwest of the Crescent Junction site. Exploratory drilling for gas is currently under way 1 to 2 miles west of the Crescent Junction site; results of this exploration are unknown. Historical drilling in the vicinity of the site indicates that the potential for oil and gas accumulations at the site is low.

Although potash resources are associated with the Paradox Formation about 3 miles south of the Crescent Junction site, the site is northeast of the Salt Valley salt-cored anticline, and thick saline deposits are not present.

Uranium and vanadium deposits, which are associated with the Morrison and Chinle Formations, have been found in scattered locations in the region. However, because of the depth of these formations (3,000 to 4,000 ft) in the Crescent Junction site area, exploration for such deposits is not economical. Copper and silver mineralization is known to occur in a few locations in the region in fault-related deposits in the Morrison Formation (Woodward-Clyde Consultants 1984). Exploration for these deposits would be uneconomical because of their great depth. Coal resources occur in the Book Cliffs just north of the site; however, they are in stratigraphically younger rocks (Mesaverde Group of Late Cretaceous age) than are present at the Crescent Junction site.

Black shales, such as the Mancos, are naturally enriched to above background concentrations in metals such as uranium, copper, silver, vanadium, mercury, arsenic, and gold. These metals likely originated in volcanic ash material that was deposited (and became bentonite) during deposition of the Mancos Shale. In a study by Marlatt (1991), sampling of Mancos Shale generally in the area between Salt Valley and the Book Cliffs found that gold content ranged from 30 to 100 micrograms per kilogram (parts per billion). These values are about 10 times the background levels but are much too low for economic extraction.

No sand and gravel deposits are present in the Crescent Junction site area. Potential deposits of such material are present just south of the Crescent Junction site area and also about 0.5 mile west of Crescent Wash (McDonald 1999). This material occurs as pediment-mantle deposits that cover Mancos Shale bedrock surfaces.

3.3.1.4 Geologic Hazards

Montmorillonite clay is found in the Mancos Shale underlying the Crescent Junction site area. Changes in water content cause the clay to shrink and swell, which can lead to subsidence (Mulvey 1992). An example of current problems associated with this clay may be seen along I-70, just south of the Crescent Junction site. Portions of the highway that cross Mancos Shale require constant maintenance because of heaving of the concrete slab structures.

The low angle of slopes and homogeneity of the Mancos Shale bedrock preclude hazardous landslides, slumping, or rock falls. The site is sufficiently distant from the Book Cliffs that hazards from rock falls are not an issue.

Earthquake risk and seismic activity in the site area are low. The nearest faults with Quaternary movement that also have surface expression are about 2 to 4 miles southwest of the site and are related to the northwest extension of the Salt Valley salt-cored anticline (Hecker 1993). These faults are associated with salt structures in the northern part of the Paradox Basin and salt-dissolution collapse that has occurred (Wong et al. 1996). The faults are considered to be unrelated to earthquake-generating tectonic forces and not seismogenic. Seismicity in this part of the northern Paradox Basin has a low rate of occurrence, with small- to moderate-magnitude earthquakes (Wong and Humphrey 1989). The site area is in Uniform Building Code 1, indicating lowest potential for earthquake damage (Olig 1991).

The site area has a moderate-to-high radon-hazard potential for occurrence of naturally occurring indoor radon based on the geologic factors of uranium concentration, soil permeability, and ground water depth (Black 1993). The moderate-to-high rating stems from the relatively high concentration of naturally occurring uranium in Mancos Shale, the relatively high soil permeability caused by shrinking and swelling of the Mancos-derived soil, and the relatively deep depth to ground water (shallow water retards radon migration).

3.3.2 Soils

The soils at the Crescent Junction site are on the alluvial valley flats immediately south of the Book Cliffs. The area is dominated by the Toddler-Ravola-Glenton complex of soils. Because the Book Cliffs are composed mainly of shale and topped by sandstone, the Ravola family soils, which are strongly influenced by shale sediment, are probably the predominant family in the area. Table 3–30 provides characteristics of these soils.

The Ravola family is derived from shale from the Book Cliffs and is therefore moderately to strongly saline. These soils are typically very deep and well-drained. The hazard of water erosion is moderate; however, the soils are subject to gully formation and piping where runoff is concentrated.

Also occurring within the soil complex is the Toddler family of soils, which formed from a mixture of marine shale and sandstone and is also very deep and well-drained. They are moderately to strongly saline. Runoff is slow, and the erosion hazard is moderate.

Formation of the Glenton soils is strongly influenced by sandstone sediment. These soils are very deep, are well-drained, and exhibit fairly rapid permeability. Runoff is moderate to slow and erosion hazard is relatively low; however, deep gullies have formed in areas where runoff is concentrated.

Mack loam soils, associated with 2- to 6-percent slopes, are formed similarly to Toddler-Ravola-Glenton soils from alluvium derived from sandstone and shale from the Book Cliffs. They are also similar in that they are very deep and well-drained. However, these soils are composed of more loam-textured soils and therefore support a different plant community. They also have a slight, rather than moderate, water erosion hazard.

Soil materials consist of more than 60 inches of the Toddler-Rovola-Glenton family soil. This series consists of low plasticity sandy clay and silts with good infiltration characteristics. These soils are grouped into the Hydrological Group B characterized by moderately high infiltration rate with a low erosion potential (SCS 1989).

Hydrocollapse potential for these soils is low, and no subsidence areas are known to exist in the area. Conditions for liquefaction (that is, loose soils, soils with a high moisture content, and a source of vibration) do not occur, so liquefaction potential is considered low.

3.3.3 Air Quality

3.3.3.1 Ambient Air Quality

Air quality information specific to the Crescent Junction site is unavailable; however, it is expected to be similar to, or better than, that described for the Moab site because of its more remote location and lack of area development. Limited air quality data are available for the Green River, Utah, area approximately 20 miles west of the Crescent Junction site. Air quality data collected from this site are considered to be representative of the Crescent Junction site because of geologic and physiographic similarities.

Criteria pollutants (Table 3–4 and Table 3–5 in Section 3.1.4) routinely measured at the Green River station include total suspended particulates, sulfur dioxide, and nitrogen dioxide; pollutants not monitored are carbon monoxide, ozone, and lead. Measurements of pollutants at the Green River station from 1980 through 1985 were below applicable standards except for total suspended particulates, which exceeded state secondary standards (DOE 1985). There are no major sources of pollutants at the Crescent Junction site; therefore, pollutant concentrations are likely similar to those recorded at the Green River station.

The Green River area is classified as an attainment area under the NAAQS. No site-specific information is available for the Crescent Junction site. However, based on its proximity to Green River, the Crescent Junction site is also considered to be an attainment area according to these same standards.

3.3.3.2 Visibility

Visibility information specific to the Crescent Junction site is unavailable; however, it is expected to be similar to that described for the Moab site. Because the Crescent Junction site is on a plateau, the range of visibility is expected to be greater in most locations than at the Moab site where visibility is impeded by natural geologic features. However, low areas and hills are present and could impede visibility.

3.3.4 Climate and Meteorology

Climate statistics for the Crescent Junction site were obtained from Thompson Springs, Utah (5 miles east). This arid area is characterized by maximum average temperatures that range from 88 °F in summer (the maximum recorded summer temperature is 105 °F) to 46 °F in winter. Minimum average temperatures range from 60 °F in summer to 22 °F in winter (the minimum recorded winter temperature is –23 °F). The overall mean annual temperature is 52.8 °F, the annual average maximum temperature is 66 °F, and the annual average minimum is 39.7 °F (Ashcroft et al. 1992).

Mean annual precipitation is 9.2 inches, and the frequency of precipitation events greater than 0.125 inch is less than 10 percent. Most of the precipitation occurs as rainfall during the southwest monsoon season, July through September. Maximum daily precipitation of 2.00 inches and maximum monthly precipitation of 3.99 inches have occurred in August. The potential annual evaporation is approximately 55 inches, which greatly exceeds annual precipitation (Robson and Banta 1995).

Wind speed and direction data are currently unavailable for this site. For the purposes of this EIS, the data compiled from the Canyonlands Field Airport for the Klondike Flats site have been used (see Section 3.2.3).

3.3.5 Ground Water

3.3.5.1 Hydrostratigraphy

Unconsolidated alluvial material that is less than 20 ft thick along Crescent Wash consists of silt, clay, and minor fragments of sandstone. This material occurs just west of the site and overlies the Mancos Shale bedrock.

Bedrock at the Crescent Junction site is the upper part of the Mancos Shale; approximately 3,000 ft of the formation underlies the site. The Mancos Shale in the area consists of thin siltstone, fine-grained sandstone, and bentonitic interbeds widely spaced in the thick calcareous mudstone (Chitwood 1994). The Ferron Sandstone Member is about 60 ft thick and occurs in the lower 300 to 350 ft of the Mancos Shale (Blanchard 1990).

The Dakota Sandstone of the Late Cretaceous age underlies the Mancos Shale and consists of less than 100 ft of sandstone, conglomeratic sandstone, and shale. The Dakota Sandstone is deeper than 3,000 ft beneath the surface. The Cedar Mountain Formation of Early Cretaceous age underlies the Dakota Sandstone and consists of several sandstone and conglomeratic sandstone beds along with thick mudstone layers.

3.3.5.2 Ground Water Occurrence

No usable ground water is available in the thin alluvial deposits of Crescent Wash just west of the Crescent Junction site area.

The Ferron Sandstone Member of the Mancos Shale is not a water-bearing unit. The Mancos Shale overall does not yield ground water and forms an aquitard that inhibits ground water migration to deeper stratigraphic units (Blanchard 1990).

The Dakota Sandstone likely represents the shallowest bedrock unit containing ground water beneath the Crescent Junction site. Ground water is also present in the sandstone and conglomeratic sandstone beds of the Cedar Mountain Formation. Water in the Dakota Sandstone and Cedar Mountain Formation may be under slight artesian head from recharge to the north along the north edge of the Uinta Basin. Additional studies may be necessary to identify quantity yields from these formations.

3.3.5.3 Ground Water Quality

Inferred ground water quality for the Dakota Sandstone in this area is based on information from a well approximately 5 miles northeast of the proposed site, which had a TDS content of 1,800 mg/L (Blanchard 1990). This represents drinking water quality based on the Utah Ground Water Quality Protection program (Class II aquifer) (UAC 2003a).

3.3.5.4 Ground Water Use

The current known source of water used by residents in the Crescent Junction area is from Thompson Spring, near the town of Thompson Springs. Additional studies may be necessary to confirm uses.

3.3.6 Surface Water

3.3.6.1 Surface Water Resources

No perennial water bodies are present within the Crescent Junction site area. Surface water resources within this area are limited to storm water runoff flows within the various ephemeral washes that transect the area. The courses of the ephemeral water bodies in this area are well-established and are unlikely to migrate in a different direction or pattern. Two washes just west of the site are Crooked Wash and Crescent Wash. Several smaller washes are present in the east part of the site that are tributaries of Thompson Wash. All of these washes flow south to southwest and are tributaries of the Green River. The ephemeral washes located on the Crescent Junction site are ungaged. Extreme floodwater surface elevations or the effects of extreme storm events are not currently known.

3.3.6.2 Surface Water Quality

Soils associated with the Mancos Shale are alkaline and may have high concentrations of selenium. As a result, surface water in these ephemeral washes likely has high salinity, high turbidity, considerable hardness, and elevated levels of sulfate and selenium.

3.3.6.3 Relevant Water Quality Standards

All ephemeral water bodies within the Crescent Junction site area are tributaries of the Green River; therefore, they are subject to the water quality classifications specified in Utah Administrative Code R317-2, "Standards of Quality for Waters of the State" (UAC 2003b) (see Chapter 7.0).

3.3.7 Floodplains

Crescent Wash, an ephemeral stream, runs east of the Crescent Junction site and drains an area of 18 square miles. No floodplains exist at the Crescent Junction site, but it is prone to extreme surface flooding during precipitation events. The disposal cell would be located outside flood-prone areas of Crescent Wash.

3.3.8 Wetlands

No known wetlands exist in or near the Crescent Junction site, but because riparian vegetation is present in places, the area would be investigated for any small, isolated wetlands prior to construction. Appendix F includes a further description of floodplains and wetlands at the Crescent Junction site.

3.3.9 Terrestrial Ecology

This section describes the vegetation and wildlife aspects, including protected and sensitive species, for the Crescent Junction site. Although natural habitat is limited, it does exist for wildlife adapted to a desert environment, including some species of birds, mammals, and reptiles. The site topography is relatively flat, although steep rock mesas dominate the area to the north of the site, which also influences available habitat.

3.3.9.1 Terrestrial Vegetation and Wildlife

In most areas of the site, vegetation is indicative of a disturbed site and varies from the potential native vegetation. About 50 percent of the Crescent Junction site area is covered by low-growing vegetation. The northern part of the site is covered with a gray veneer of debris from a recent outwash originating in the nearby Mancos Shale hills. The outwash area is mostly bare with some prickly pear cactus, cheatgrass, and Russian thistle. Vegetation in the south-central and southeast areas of the site also consists primarily of species such as Russian thistle, cheatgrass, and prickly pear with a few native shrubs and perennial grasses, including Gardner saltbush, galleta, and Indian ricegrass. The range condition of this area would probably rate as poor to fair.

Shrubs include black greasewood, shadscale, and Gardner saltbush; an understory consists primarily of annual weeds such as cheatgrass and Russian thistle with a few perennial grasses (galleta and Indian ricegrass). Table 3–31 lists characteristics of the potential natural vegetation.

Black greasewood, an obligate phreatophyte, dominates the plant community in this area and accounts for the relatively high productivity. Occasional saltcedar (tamarisk) occurs in the drainages. Toddler family soils provide the structure to support Gardner and mat saltbush vegetation.

Wildlife population diversity and densities are limited in the Crescent Junction site area by the vegetation and habitat types present. However, large mammals such as the coyote and pronghorn antelope, adapted to a desert environment, likely occur in the vicinity of the Crescent Junction site. Smaller wildlife species adapted to a desert environment, including mammal, bird, and reptile, are also present. Coyote, mule deer, and bobcat may use the deep gullies as protection while traveling. Crescent Wash is near the site and may provide enough water near the surface to support low-density cottonwood trees that can serve as nesting and roosting sites for raptors, horned lark, sparrows, and other birds. The deep gullies are used as nesting sites for swallows. Coyote, white-tailed prairie dog, desert cottontail, and black-tailed jackrabbit may also use this habitat for food and cover. Raptors such as red-tailed hawks, golden eagles, and harriers use the area as a hunting ground. The presence of human activities close to I-70 may serve as a limiting factor in the density of wildlife species in this area. No critical habitat has been identified for wildlife at this site.

3.3.9.2 Species Listed Under the Endangered Species Act

This section describes federally listed terrestrial threatened and endangered, proposed, or candidate species that are or may be present in the Crescent Junction disposal site area. In March 2003, DOE requested an updated list of such species from USF&WS that may be present or affected by DOE's proposed alternatives. USF&WS responded in April 2003 with a list for Grand County. Table 3–32 lists a subset of those species that may occur in the vicinity of the Crescent Junction site.

Spatial data for the species listed in Table 3–32 were obtained from the Utah Conservation Data Center (UCDC). This data set was compiled by the Utah Natural Heritage Program (UNHP) of UDWR, in which species occurrences are depicted as points at a scale of 1:24,000 on 7.5-minute topographic quad maps. Spatial data depicting the Crescent Junction site were overlaid on the species of concern spatial data to evaluate known species occurrences in the area.

The status of each of these species in the vicinity of the Crescent Junction site is briefly discussed below. Appendix A1, "Biological Assessment," provides more detailed information concerning these federally listed species that may be in the vicinity of the Crescent Junction site or could be affected by activities at the site.

There is a cluster of known populations of Jones' cycladenia on BLM land in Grand County approximately 11 to 17 miles northeast of Moab (UDWR 2003b). However, there are no known occurrences of the species on the Crescent Junction site.

UDWR (2003b) reported an unconfirmed ferret sighting in the vicinity of the Crescent Junction site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Crescent Junction site.

Numerous white-tailed prairie dog (currently under review for federal listing) colonies ranging in size from 10 acres to 2,445 acres occur around the Crescent Junction area (Seglund 2004). It is unknown to what extent individual colonies or a combination of colonies could support black-footed ferrets.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. However, it is not known to nest or night roost nor is it known to have been observed in the vicinity of the Crescent Junction site.

Mexican spotted owls were historically reported to occupy the Book Cliffs to the north of the Crescent Junction site but have not been observed in the vicinity recently (USF&WS 2001).

There is no designated or proposed critical habitat for any of the above federally protected species in the vicinity of the Crescent Junction site.

DOE, in consultation with USF&WS and BLM, would determine the need for additional habitat evaluations and surveys for species that may be affected by the proposed action should this alternative be selected.

3.3.9.3 Other Special Status Species

Special status species are those that are protected under federal and state regulations other than the ESA; these regulations include the MBTA, Executive Order 13186, and Birds of Conservation Concern (USF&WS 2002f). UDWR provided a list of species that DOE should consider in this EIS (UDWR 2003b). Table 3–33 lists sensitive plant species that may occur in the site region. Table 3–34 describes state-listed animal species. Table 3–35 lists bird species protected under the MBTA and species listed as Birds of Conservation Concern.

Birds of primary concern are the peregrine falcon, red-tailed hawk, turkey vulture, burrowing owl, Swainson's hawk, and ferruginous hawk. Burrowing owl habitat may exist in the vicinity of white-tailed prairie dog colonies. Although burrowing owls have not been documented as occurring in the vicinity of this site, prairie dog burrows may provide suitable habitat for nesting.

3.3.10 Land Use

The Crescent Junction site is located in Grand County on lands administered by BLM approximately 31 miles north of the Moab site. The area under consideration encompasses 2,400 acres of undeveloped land near the base of the Book Cliffs on a low-lying plateau named Crescent Flats. It is north and northeast of the I-70 junction with US-191 at Crescent Junction. Area land uses are shown on Figure 3–18.

Although not designated by BLM as a recreational area, the site has no access controls, and the area's hiking, biking, and camping uses are low. BLM has designated the Crescent Junction area as access-limited to existing roads. Favorable weather allows recreational access in virtually all seasons. Although no recreational use numbers are available for this area, hiking, biking, and camping use has been observed to be low. The southern boundary of the Floy Canyon Wilderness Study Area is approximately 2 miles north and northwest of the site.

Existing land uses include grazing, oil and gas leasing, and mining claims. The site is part of the Crescent Canyon grazing allotment, which is currently under a grazing permit until 2010. There are no mining claims on the proposed disposal cell location. Currently, all sections of interest for the potential Crescent Junction site are held by oil and gas leases. None of the leases are held by production. The existing oil and gas leases expire between 2008 and 2011. BLM has temporarily suspended further mineral, oil, and gas leasing at this site, pending completion of this EIS.

The proposed location of the Williams Crescent Junction Petroleum Products terminal and pumping station is adjacent to the southern boundary of the site. The terminal would consist of a 50-acre fenced site that includes storage tanks, a truck-loading rack, a vapor combustion system, an electrical substation, offices, and warehouse buildings. This facility would be served largely by truck traffic. Williams estimates the average daily throughput from the trucks to be approximately 10,000 barrels per day.

The nearest commercial property is a gas station and convenience store at the Crescent Junction interchange (approximately 1.5 miles south) located between I-70 and the Union Pacific Railroad tracks. This property has at least one full-time resident and may have as many as five residents during the busy summer season. Much of the property on the east and west side of US-191 is owned by the State of Utah SITLA. These State lands are currently up for sale and are subject to future commercial development.

The northern boundary of Arches National Park is approximately 9 miles southeast of the Crescent Junction site.

3.3.11 Cultural Resources

The cultural history of the Crescent Junction site is discussed in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for this site is described in Section 3.1.13.2.

Results of the Class I inventory indicate that one linear Class III cultural resource survey, associated with a transmission line, has been conducted within the Crescent Junction site. On the basis of this survey, one prehistoric cultural site eligible for inclusion in the National Register of Historic Places has been identified within the boundaries of the site. The potential for cultural resources to occur on unsurveyed portions of the site is low. One predictive model based on soil type and landform (Berry 2003) indicates that an estimated 1.9 cultural sites per square mile could be expected to occur on the site.

No data exist concerning the presence of potential traditional cultural properties on the Crescent Junction site. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high) for traditional cultural properties associated with the Ute Mountain Ute Tribe, White Mesa Ute Tribe, Southern Ute Tribe, Navajo Nation, and Hopi Tribe. The likelihood of occurrence and their estimated density on the site are medium for traditional cultural properties associated with the Uintah-Ouray Ute Tribe (Fritz 2004).

3.3.12 Noise and Vibration

The Crescent Junction site is located in a quiet desert environment where natural phenomena such as wind, rain, and wildlife account for most natural background noise. At times, insect activity and birds may account for significant portions of environmental noise. Sources of man-made background noise may include traffic on I-70, Union Pacific Railroad, aircraft flying overhead, and off-road recreation. Average L_{dn} would likely range from 22 dB on calm days to 38 dB on windy days (Brattstrom and Bondello 1983).

Neither background noise nor ground vibration data are available for the Crescent Junction site. Traffic noise from I-70 could raise the 1-hour L_{eq} to 55 dBA at the southern edge of the site. However, the background noise level from natural and man-made noise would average less than 50 dBA across the site.

3.3.13 Visual Resources

The Crescent Junction site is located between I-70 and the towering Book Cliffs, a linear geologic feature that runs east-west on the north side of I-70 from Grand Junction, Colorado, to Price, Utah. The proposed disposal cell location is on flat to gently undulating, buff-colored ground that is sparsely vegetated with bunchgrasses and small shrubs. The steep, dissected cliffs of the Book Cliffs provide a dramatic backdrop to the north. Westbound and eastbound travelers on I-70, travelers stopping at a scenic overlook on eastbound I-70 (Figure 3–33), and patrons of the Crescent Junction gas station have a clear view of the proposed disposal cell location. The site is also visible from several residences, currently unoccupied, in the Crescent Junction area and from several residences on the west end of Thompson Springs, a small town 6 miles east of Crescent Junction. Visual resources are classified as Class III in this area (BLM 2003b) (see Section 3.1.15 for an explanation of visual resource classes).

3.3.14 Infrastructure

The infrastructure supporting the Crescent Junction site is essentially identical to that described in Section 3.2.13 for Klondike Flats, except that the Utah Power three-phase distribution line that would supply the site runs along CR-175.

Figure 3–33. View of the Crescent Junction Site from the I-70 Scenic Overlook

3.3.15 Transportation

Section 3.1.17 provides details of area federal, state, and county road and railroad use. Table 3–15 in Section 3.1.17 provides AADT, level of congestion, truck percent, and accident rates for US-191 from Moab to Crescent Junction and for I-70 in this area. Figure 3–21 shows the location of area roads and railroad lines. US-191 terminates at Crescent Junction and the I-70 interchange. Accident rates on US-191 are low, and it is not considered congested at this junction; however, accident rates on I-70 in the area are considered moderate. Both US-191 and I-70 are considered not congested in this area.

Several local county roads provide informal access to I-70 and area attractions or towns. These are also described in Section 3.1.17. CR-175 is a paved frontage road that connects Crescent Junction to Thompson Springs and other areas to the east. Two county roads, CR-233 and CR-234, begin just east of Crescent Junction and trend north into backcountry areas. They are dirt tracks and are not passable after heavy rains.

3.3.16 Socioeconomics

Crescent Junction is approximately 31 miles north of the Moab site in Grand County, Utah (discussed in Section 3.1.18). It consists of a combination gas station and convenience store with several unoccupied former residences. The nearest town is Thompson Springs, which is 6 miles east of Crescent Junction, where temporary housing is limited to a few trailers and a campground.

3.3.17 Human Health

3.3.17.1 Background Radon and Natural Radiation

The greatest hazard from natural radiation sources is inhaled radioactivity, mostly from radon-222 and its radioactive decay products in homes and buildings, which accounts for about 200 mrem/yr. Additional natural sources include radioactive material in the earth (primarily external radiation from the uranium and thorium decay series), radioactive material in the body (primarily potassium-40), and cosmic rays from space filtered by the atmosphere.

Section 3.2.16.1 discusses natural sources of radiation. The actual radiation dose from natural background radiation varies with location. On the basis of data from the Blanding, Utah, area, the radiation dose from cosmic and cosmogenic radioactivity would be about 68 mrem/yr at the Crescent Junction site. The radiation dose from external terrestrial radioactivity would be about 74 mrem/yr, and the radiation dose from radon-222 and its radioactive decay products would be about 260 mrem/yr (IUC 2003). The total natural background radiation dose at the Crescent Junction site would be about 440 mrem/yr, considerably higher than the national average of 300 mrem/yr (Table 3–36).

No one currently resides at the Crescent Junction site. Currently, one full-time resident lives near the gas station and convenience store (approximately 1.5 miles to the south), which is located immediately north of I-70 and east of US-191. As many as five residents have lived in the area during past summer seasons. According to 2000 census data, the population within 50 miles of the Crescent Junction site was about 10,200 (Figure 3–34). Assuming that all these people were exposed to 440 mrem/yr, the population dose would be about 4,500 person-rem per year.

Table 3–36. U.S. and the Crescent Junction Site Natural Background Radiation Doses

Source	U.S. Average Natural Background Radiation Dose (millirem per year)	Crescent Junction Natural Background Radiation Dose (millirem per year)
Cosmic and cosmogenic radioactivity	28	68
Terrestrial radioactivity	28	74
Internal radioactivity	40	40
Inhaled radioactivity	200	260
Rounded Total	**300**	**440**

3.3.18 Environmental Justice

Section 3.1.20 describes the legal basis for evaluating environmental justice and general census characteristics in Grand County. One census block within 50 miles of the Crescent Junction site is reported to have greater than 50 percent minority population; this census block is approximately 20 miles north of the Crescent Junction site (Figure 3–35). One census block group north of the Crescent Junction site shows a reported income of less than $18,244 (poverty level for a family of four). It is located about 25 miles north of the Crescent Junction site (Figure 3–36). As discussed in Section 3.1.20, approximately 94 percent of Grand County was identified in the 2000 census as white, non-Hispanic.

3.3.19 Pipeline Corridor

This section describes the proposed pipeline corridor between the Klondike Flats site and the Crescent Junction site. It does not repeat information from the Moab site to the Klondike Flats site (Section 3.2.18), unless the information is necessary to provide context for this discussion.

3.3.19.1 Geology

Between the Klondike Flats site and Crescent Junction site, the proposed pipeline corridor passes over the lower and middle parts of the Mancos Shale for about 10 miles. The Mancos Shale contains expansive clay (montmorillonite) that shrinks and swells with changes in water content. No active faults or subsidence potential exists in the corridor.

3.3.19.2 Soils

Soils within the proposed pipeline corridor are formed primarily on marine shale uplands and pediments and on alluvial fans and drainages consisting of sediments derived from nearby shale and sandstone uplands. Three general soil map units occur along this segment of the pipeline corridor from south to north: rock outcrop-Nakai-Moenkopi, Chipeta-Killpack-Blueflat, and Toddler-Ravola-Glenton (SCS 1989).

The potential natural vegetation on Nakai-Moenkopi soils include (1) the shrubs fourwing saltbush, shadscale, blackbrush, and winterfat and (2) the common grasses Indian ricegrass and galleta. Plant abundance and diversity on Chipeta-Killpack-Blueflat soils are very low, even for arid rangeland, because the low-permeability soils promote rapid runoff, have low available water capacity, and are often highly saline (SCS 1989). Potential vegetation consists primarily of low shrubs, including mat saltbush and Gardner saltbush with occasional shadscale and bud sagebrush. The potential natural vegetation of the Ravola-Toddler-Glenton soils is described in Section 3.2.8. Detailed descriptions of soil types and potential natural vegetation for this pipeline corridor are available in the SOWP (DOE 2003).

3.3.19.3 Ground Water

North of the Klondike Flats site, the pipeline corridor passes generally over the lowermost part of the Mancos Shale, and ground water in the underlying Dakota Sandstone and Cedar Mountain Formations is at depths of 100 to 300 ft. For the last 3 to 4 miles to the proposed disposal site, the pipeline corridor passes over an increasing thickness of Mancos Shale, and the depth to ground water in the Dakota/Cedar Mountain increases gradually to about 3,000 ft at the Crescent Junction site.

3.3.19.4 Surface Water

The proposed slurry pipeline corridor extending north from the Klondike Flats site to the Crescent Junction site would cross several washes (e.g., Klondike Wash and Thompson Wash) and a number of other smaller, unnamed drainage features, all of which are ephemeral. No perennial surface waters are present within this proposed pipeline corridor.

Storm water runoff in the local ephemeral streams is characterized by a rapid rise in flow rates, followed by rapid recession, primarily because of the small storage capacity of the surface soils in the area. The flows in these drainage features occur primarily in response to local heavy rainfall and, occasionally, snowmelt runoff.

Water Quality and Existing Surface Water Contamination

Because there are no perennial surface waters, no data are available regarding contamination of existing surface water resources. When storm water flows through the washes within this pipeline corridor, the water is laden with sediment, and water quality is anticipated to be poor. These ephemeral washes collect surface water runoff primarily from areas composed predominantly of the Mancos Shale. Soils associated with the Mancos Shale are alkaline and may have high concentrations of selenium. As a result, surface water quality from these drainage features would likely be characterized as having high salinity, turbidity, and hardness and having elevated levels of sulfate and selenium.

Relevant Water Quality Standards

All ephemeral water bodies in this pipeline corridor are eventually tributaries to either the Green River or the Colorado River; therefore, they are subject to the water quality classifications specified in Utah Administrative Code R317-2-13 (see Chapter 7.0).

3.3.19.5 Floodplains and Wetlands

No floodplains or wetlands are known to exist along the proposed pipeline route. However, because the route may cross intermittent washes with riparian vegetation, such washes would be investigated for any small, isolated wetlands prior to construction.

3.3.19.6 Terrestrial Ecology

Section 3.3.9 describes the affected environment for terrestrial ecology on a regional basis in the Crescent Junction site area (Maps 1 and 2, Appendix C). This section addresses only the areas, wildlife, and habitat that would be affected by the proposed pipeline corridor between the Klondike Flats and Crescent Junction sites. General information applicable to the species and site descriptions as described in Section 3.3.9 are not repeated in this section.

Approximately 10 miles of the route is aligned in relatively undisturbed areas. As was the case with the segment from Moab to the Klondike Flats site, habitat for mammals is limited by sparse vegetation along the segment from the Klondike Flats site to the Crescent Junction site. Large mammals adapted to a desert environment, such as the pronghorn antelope, are likely to be present intermittently in the proposed pipeline corridor.

Table 3–25 in Section 3.2.8 presents a list of federally listed threatened and endangered species that may occur in the vicinity of the Crescent Junction site. Appendix A1, "Biological Assessment," provides more detailed information concerning these species. Of these species, the black-footed ferret and bald eagle, as described in Section 3.2.8.2 are the primary federally listed species of concern in the vicinity of the pipeline corridor between the Crescent Junction and Klondike Flats sites. In addition, the white-tailed prairie dog, currently in review for federal listing, is also of concern.

UDWR (2003b) reported an unconfirmed sighting in the vicinity of the Crescent Junction site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur along the pipeline corridor between the Crescent Junction and Klondike Flats sites. The environmental assessment conducted for the Grand County landfill (BLM 1995), which is located within 3 miles of the Klondike Flats site, concluded that there is no present or historical evidence of black-footed ferrets. Nevertheless, the black-footed ferret is of primary concern where potentially suitable habitat (i.e., prairie dog colonies) may exist along the northernmost sections of the route.

Numerous white-tailed prairie dog (currently under review for federal listing) colonies ranging in size from 10 acres to 2,445 acres occur around the Crescent Junction area (Seglund 2004). It is unknown to what extent individual colonies or a combination of these colonies could support black-footed ferrets.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. However, it is not known to nest or night roost nor is it known to have been observed in the vicinity of the proposed pipeline corridor between the Moab site and the Crescent Junction site.

There is no designated or proposed critical habitat for any of the above federally protected species in the vicinity of the proposed pipeline corridor between the Klondike Flats site and the Crescent Junction site.

DOE, in consultation with USF&WS and BLM, would determine the need for additional habitat evaluations and surveys for threatened and endangered species that may be affected by the proposed action should this transportation mode be selected.

The burrowing owl (Cresto 2003), ferruginous hawk, peregrine falcon, and Swainson's hawk are not federally listed species, but they are included on the state list of sensitive species and are also protected under the MBTA. Because of previous sightings to the south of this site, it can be assumed that the peregrine falcon and ferruginous hawk may be present in the vicinity of the pipeline corridor.

3.3.19.7 Land Use

The proposed pipeline route from the Klondike Flats site to the Crescent Junction site is approximately 13 miles. Approximately 33 percent of the route would be located on federal lands administered by BLM, approximately 15 percent would be on private lands, and the remaining 52 percent would be on lands under the jurisdiction of the State of Utah.

3.3.19.8 Cultural Resources

The cultural history of this segment of the pipeline corridor is discussed in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for the proposed corridors is described in Section 3.1.13.2.

Results of the Class I inventory indicate that the segment of the pipeline corridor between the Klondike Flats site and Crescent Junction site contains approximately 20 known cultural sites that are either eligible for inclusion in the National Register of Historic Places or have been recommended as eligible. However, approximately 5 miles of the proposed route near the town of Crescent Junction have not been surveyed. The 20 sites include historic sites associated with transportation, mining, ranching, and agriculture; prehistoric lithic scatters of unknown affiliation; a small number of Formative and Archaic period sites; small rock art sites; and possibly protohistoric sites. No Paleoindian sites have been recorded along the corridor, and it is not likely that they would occur.

No data exist concerning the presence of potential traditional cultural properties along the pipeline corridor between the Klondike Flats site and Crescent Junction site. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high) for traditional cultural properties associated with the Southern Ute Tribe, Navajo Nation, and Hopi Tribe. The likelihood of occurrence and their estimated density are medium for traditional cultural properties associated with the Ute Mountain Ute Tribe and White Mesa Ute Tribe and medium to high for properties associated with the Uintah-Ouray Ute Tribe (Fritz 2004).

3.3.19.9 Visual Resources

Visual resources along the Klondike Flats portion of the Crescent Junction pipeline route are described in Section 3.2.18.9. Visual resources along the remainder of the route, between the Klondike Flats and Crescent Junction sites, consist primarily of flat to gently rolling, light beige and light gray desert plains that are sparsely vegetated by saltbush and bunchgrass. The background scenery along this portion of the route varies. Along the east side of the corridor lie the rugged red and beige rocks of Arches National Park; along the west side of the corridor near the Klondike Flats site lie the smooth, rounded, buff-colored bluffs of Mancos Shale.

Approximately 3 miles north of the Klondike Flats site, the bluffs on the west side of the corridor come to an end and are replaced by the wide, flat expanse of the gray Mancos Shale desert. Visual resource designations along the entire route from the Moab site to the Crescent Junction site include Class III areas (approximately 80 percent of the route), Class IV areas (approximately 10 percent of the route), and the Class II area within Moab Canyon (approximately 10 percent of the route). Section 3.1.15 presents descriptions of the various visual resource classes.

The portion of the pipeline route from Klondike Flats to Crescent Junction is visible to travelers on US-191 for approximately 3 miles north of the Klondike Flats site. At that point, the route veers off to the northeast along an existing pipeline route and is not visible to the general public until it crosses I-70 near the town of Crescent Junction.

3.4 White Mesa Mill Site

The proposed White Mesa Mill disposal site (White Mesa Mill site) is located in San Juan County, Utah, approximately 5 miles south of Blanding, Utah. Facilities consist of a uranium-ore processing mill, ore storage pad, and four lined tailings cells with leak-detection systems and ground water monitor wells. The facilities are situated within a 5,415-acre area of private property owned primarily by IUC. The mill itself occupies approximately 50 acres, and the tailings disposal ponds occupy approximately 450 acres. The site is accessible from a half-mile-long private road connected to US-191.

Since early 1997, the mill has processed more than 100,000 tons from several additional feed stocks. Since its inception, the mill has processed a total of 4,083,144 tons of materials. This total is for all processing periods combined. Annual production of yellowcake has been as high as 3.75 million pounds per year in the 1985–1990 period. In comparison, the Moab contaminated materials are estimated at 11.8 million tons and have an in situ dry density between 90 (slimes) and 97 pounds per cubic foot. A more detailed summary of White Mesa Mill operations is provided in Appendix G.

3.4.1 Geology

The existing White Mesa Mill site is in the central part of the Colorado Plateau physiographic province known as the Canyonlands section. The site is located mostly on White Mesa, which slopes gently southward with elevations decreasing from about 5,700 to 5,400 ft. The southernmost part of the site is in a canyon that drops down to about 5,000 ft in elevation and contains an unnamed drainage that is a tributary to the Right Hand Fork of Cottonwood Wash. IUC (2003) provides a detailed description of the site geology.

3.4.1.1 Stratigraphy

Bedrock at the site is covered by up to 25 ft of unconsolidated silt and very fine-grained sand. Some alluvial material (sand and gravel) may also be present in the eastern part of the area. A generalized stratigraphic column of the White Mesa Mill site is shown on Figure 3–37.

In the north part of the millsite, the first bedrock formation present is a few feet of Mancos Shale. Below the Mancos Shale is the Dakota Sandstone, with an average thickness of 39 ft consisting mainly of sandstone and shale. Below the Dakota is the Burro Canyon Formation, which is approximately 75 ft thick.

Beneath the Burro Canyon is the thick Morrison Formation, which is composed of four members in this area. In descending order (from youngest to oldest) from the surface, the members and their respective thicknesses in the site area are: Brushy Basin, 275 ft; Westwater Canyon, 60 ft; Recapture, 120 ft; and Salt Wash, 100 ft.

The Summerville Formation, consisting mainly of siltstones, is below the Morrison. Below the Summerville are the thick Entrada and Navajo Sandstones. These sandstones were deposited mainly in eolian environments, are highly permeable, and form the principal aquifer in the region.

3.4.1.2 Structure

The White Mesa Mill site is in the south part of the ancestral Paradox Basin, in the west part of the Blanding Basin subprovince (see Figure 3–1). Rock formations in the immediate area are nearly flat lying. At the millsite, bedrock dips generally 0.5 to 1 degree to the south (IUC 2003). No faults are known in the site area or within at least a 5-mile radius.

3.4.1.3 Geologic Resources

No oil and gas resources are known to occur beneath the site. Evaporite deposits such as salt (halite) and magnesium salts (carnallite) occur in the Paradox Formation at the site; potash occurs farther north in the Paradox Basin. Recovery of these deposits would be uneconomical because of their great depth and the relative thinness of the deposits compared to other areas in the Paradox Basin.

Although uranium and vanadium deposits are known to exist 5 miles to the west and northwest of the millsite, the potential for these deposits on the site is low. Sand and gravel deposits may underlie the surface of the eastern part of the site (Gloyn et al. 1995). However, these deposits are probably scattered and insignificant (IUC 2003).

Age	Formation and Members	Thickness (ft)
Late Cretaceous	Mancos Shale	Up to 50 preserved
Early Cretaceous	Dakota Sandstone	30–50
	Burro Canyon Formation	60–90
Jurassic	Morrison Formation, Brushy Basin Member	275
	Morrison Formation, Westwater Canyon Member	60
	Morrison Formation, Recapture Member	120
	Morrison Formation, Salt Wash Member	100
	Summerville Formation	50–100
	Entrada Sandstone	300–500
	Navajo Sandstone	500–700
	Kayenta Formation	200
	Wingate Sandstone	300–400
Pennsylvanian to Triassic	Various formations from Pennsylvanian to Triassic age	2,000–3,000
	Paradox Formation	1,000–3,000

Figure 3–37. Generalized Stratigraphic Column for the White Mesa Mill Site

3.4.1.4 Geologic Hazards

Montmorillonite is present in the Brushy Basin Member of the Morrison Formation. As described in Section 3.2.1.4 and Section 3.3.1.4, changes in water content cause swelling and shrinking that can lead to subsidence. This hazard is a problem only at the edges of and on the slopes of White Mesa where the member is exposed. The Brushy Basin Member is 100 to 150 ft below the surface over most of the site and in the area being considered for a disposal cell; therefore, overburden pressures from the overlying formations and lack of exposure would prevent shrinking and swelling from becoming a problem.

The hazard exists for landslides and slumps in the canyons bordering the site where the Brushy Basin Member of the Morrison Formation forms unstable slopes (Harty 1991). Here, mudstones of the Brushy Basin Member offer little support to competent, thick sandstones of the overlying Burro Canyon Formation, especially in areas of seepage.

Earthquake risk and seismic hazard in the site area are low (Wong and Humphrey 1989). The site area is in Uniform Building Code 1, indicating the lowest potential for earthquake damage (Olig 1991).

The site area has a moderate-to-high radon-hazard potential for occurrence of indoor radon based on the geologic factors of uranium concentrations, soil permeability, and ground water depth (Black 1993). The high rating stems from the relatively high concentration of uranium in the Salt Wash Member of the Morrison Formation, the relatively high soil permeability caused by shrinking and swelling of the soils derived from the Brushy Basin Member of the Morrison Formation, and the relatively deep depth to ground water (shallow depth to water retards radon migration).

3.4.2 Soils

The soil type in this area is primarily Blanding very fine sandy loam (USDA 1962), which is deep, well-drained, and of medium texture. The soil is moderately permeable and has slow surface runoff, so water can move through the profile readily and roots can penetrate easily. Because of the moderate infiltration characteristics, erosion potential is low. However, the flows resulting from thunderstorms are nearly instantaneous. When these soils are barren, they are considered to have a high potential for wind erosion.

Also occurring in small areas near the site is the soil type Mellenthin, a very rocky fine sandy loam (USDA 1962). This soil type is very similar to Blanding very fine sandy loam but is much shallower, often only 15 inches deep. The shallow depth influences the current and potential vegetation communities and, consequently, the wildlife habitat. It is also less suitable for reseeding because it has only moderate permeability, medium runoff, and low moisture-holding capacity. Table 3–37 lists characteristics of the soil at the White Mesa Mill site.

3.4.3 Air Quality

3.4.3.1 Ambient Quality

Prior to construction of the White Mesa Mill, comprehensive evaluations of ambient air quality conditions at the millsite were conducted in the late 1970s and documented in the *Environmental Report, White Mesa Uranium Project, San Juan County, Utah* (Dames & Moore 1978), and also in the *Final Environmental Statement Related to Operation of White Mesa Uranium Project* (NRC 1979). This section summarizes these past investigations.

The State of Utah has adopted EPA standards for gaseous emissions and particulates as applicable throughout the state. Federal and state primary and secondary air quality standards are presented in Table 3–4. Primary ambient air quality standards define the relative air quality levels judged necessary, with an adequate safety margin, to protect the public *health*. Secondary ambient air quality standards define levels of air quality that are judged necessary to protect the public *welfare* from any known or anticipated adverse effects of a pollutant.

The White Mesa Mill site is located within the Four Corners Interstate Air Quality Control Region, which encompasses parts of Colorado, Arizona, New Mexico, and Utah. Air quality for any given area is evaluated according to a classification system that was established for all air quality control regions in the United States. The classification system rates the five major air pollutants (particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and photochemical oxidants) as having a priority of I, II, or III. A priority I rating means that a portion of the region is significantly violating federal standards for a particular pollutant, and special emission controls are needed. If the emissions are predominantly from a single point source, then it is further classified as IA. A priority II indicates a better quality of air in the region; a priority III rating classifies the highest quality. The priority classifications for the Four Corners Air Quality Control Region, which includes the White Mesa Mill site, are as follows:

	Sulfur Dioxides	Particulate Matter	Nitrogen Oxides	Carbon Monoxide	Photochemical Oxidants
Priority Classification	IA	IA	III	III	III

Ambient pollutant concentrations that define the classification system are outlined in Table 3–38.

Table 3–38. Federal Regional Priority Classifications Based on Ambient Air Quality

Pollutant	Averaging Time	Air Quality for Each Priority Group[a,b]		
		I	II	III
Sulfur oxides	Annual 24 hour 3 hour	>100 µg/m³ >455 µg/m³	60–100 µg/m³ 260–455 µg/m³ 1,300 µg/m³	<60 µg/m³ <260 µg/m³ <1,300 µg/m³
Particulate matter	Annual 24 hour	>95 µg/m³ >325 µg/m³	60–95 µg/m³ 150–325 µg/m³	<60 µg/m³ <150 µg/m³
Carbon monoxide	8 hour 1 hour	>14 mg/m³ >55 mg/m³	NA	<14 mg/m³ <55 mg/m³
Nitrogen dioxide	Annual	>110 µg/m³	NA	<110 µg/m³
Photochemical oxidants	1 hour	>195 µg/m³	NA	<195 µg/m³

[a] In the absence of measured data to the contrary, any given region containing an area whose 1970 "urban place" population exceeds 200,000 will be classified priority I. All others will be classified priority III. Hydrocarbon classifications will be same as for photochemical oxidants. There is no priority II classification for carbon monoxide, nitrogen dioxide, and photochemical oxidants. Hydrocarbon classifications will be the same as for photochemical oxidants.

[b] µg/m³ = micrograms per cubic meter; mg/m³ = milligrams per cubic meter.

Air quality at the White Mesa Mill site area has a priority rating of IA, which signifies a violation of federal air standards for particulate matter and sulfur dioxide, both of which are attributable to emissions from fossil-fueled power plants located within the region. However, none of the power plants lie within 31 miles of the millsite, which suggests that the air quality in the vicinity of the site may be better than the priority IA classification indicates.

The State of Utah monitors total suspended particulates and sulfur dioxide at a station located 66 miles west of the millsite at Bull Frog Marina (Lake Powell). Except for the short-term (24-hour) particulate measurement, all reported values were well below the federal and State of Utah air quality standards. The 24-hour particulate violations are believed to have been caused by dust blown by high winds.

On the basis of data collected from sampling locations at the White Mesa Mill site for 1 year, dust-fall averaged 33 grams per square meter (g/m^2) per month; the highest monthly average was 102 g/m^2 occurring in August. Total suspended particulates monitoring from October 1977 through February 1978 produced a geometric mean of 18 $\mu g/m^3$. This value is well below the federal and state air quality standard of 50 $\mu g/m^3$. The maximum 24-hour concentration was 79 $\mu g/m^3$, or approximately one-half of the federal and state standard of 150 $\mu g/m^3$. Sulfation-rate monitoring at the White Mesa Mill site indicates that sulfur dioxide concentrations at the site are less than 0.005 parts per million (ppm). The federal and state standard for the annual average of sulfur dioxide is 0.03 ppm.

At the time of the 1978 environmental report (Dames and Moore 1978) and final environmental statement (NRC 1979), the Four Corners Air Quality Control Region had an air quality priority IA rating. This was an important consideration at the time because there was significant concern that windblown dust from coal storage stockpiles and air emissions (i.e., sulfur dioxides, particulate matter, carbon monoxide, and nitrogen oxides resulting from combustion of coal to power the mill) associated with operation of the mill would further degrade air quality in the region. However, the use of coal to fire boilers at the mill was discontinued in 1990. By 1994, propane was used to fire all process and heating boilers. The mill is no longer required to perform sulfation rate monitoring. NRC's final environmental statement concluded that operation of the White Mesa Mill would not have any significant impact upon regional air quality.

Currently, nonradioactive air emissions from the White Mesa Mill are regulated by the State of Utah in accordance with an air quality permit (1997 Approval Order DAQE-884-97). This permit establishes annual emission limits for the mill's yellowcake dryers and the vanadium circuit scrubber. Requirements for controlling dust from roads and fugitive sources are also included in this permit. The permit also specifies that the mill must comply with National Emissions Standards for Hazardous Air Pollutants for radon emissions (40 CFR 61). The air quality permit requires that particulate emissions (PM_{10}) to the atmosphere shall not exceed 0.40 pound per hour for each yellowcake dryer and 2.50 pounds per hour for the vanadium circuit scrubber. Compliance testing of the scrubber and dryers must be performed within 180 days of the startup of a new emission point or the inclusion of an emission point in the permit and, thereafter, if and when directed by UDEQ. Monitoring for radionuclide emissions is conducted while the mill is operating.

To ensure compliance with applicable air quality standards and the requirements of the permit, restrictions are in place that control emissions from specific pieces of milling equipment and operations. These restrictions ensure compliance with emission levels specified in the permit by controlling ore processing rates and propane gas consumption rates. The mill is required to submit an annual emission inventory to UDEQ. Table 3–39 summarizes the annual emission inventory for the key criteria emissions for the last 6 years. The key criteria emissions are PM_{10}, sulfur oxides, nitrogen oxides, volatile organic compounds, and carbon monoxide.

The NRC license also requires the mill to monitor total particulate matter. The mill's environmental air monitoring program uses four high-volume continuous air sampling stations; filters from each station are changed approximately every 7 days. Data collected from the air monitoring program are reported to NRC in semiannual effluent monitoring reports as required by 10 CFR 40.65.

Table 3–39. Air Emission Inventory for Key Criteria Emissions (tons per year)

Year	PM_{10}	Sulfur Oxides	Nitrogen Oxides	Volatile Organic Compounds	Carbon Monoxide
1997	0.775	0.255	3.859	2.120	7.257
1998	-	-	-	-	-
1999	2.57	1.15	18.11	2.16	14.14
2000	1.9	1.47	14.61	2.76	11.78
2001	-	-	-	-	-
2002	0.68	0.98	9.04	1.80	11.49

Environmental air monitoring data collected to date indicate that concentrations of total suspended particulate matter resulting from mill emissions are in compliance with the applicable regulatory limit of 50 $\mu g/m^3$ and do not vary significantly from ambient concentrations of particulate matter measured at the mill. During a recent mill run (April–October 1999), average concentrations for particulate matter ranged from 20 to 40 $\mu g/m^3$. By comparison, concentrations of particulate matter were measured at 26 to 44 $\mu g/m^3$ during a period in 2001 when operations were suspended at the mill.

3.4.3.2 Visibility

Southeastern Utah is known for its scenic vistas and attracts many visitors each year. Stack emissions (primarily steam) from the mill are visible to the public traveling US-191 east of the White Mesa Mill site. These emissions are not visible from the major recreational areas in the vicinity of the mill.

In its 1979 final environmental statement, NRC concluded that there would be no significant impacts to air quality as a result of the White Mesa Mill operations. NRC concluded that, although the operation of the mill would result in a slight increase in concentrations of particulate matter and ambient gaseous emissions, the concentrations would be below federal and state air quality standards, and they would not significantly degrade the regional air quality (NRC 1979).

Beginning with the 1994/1995 mill run, propane was used to fire all process and heating boilers. As a result, impacts to visibility resulting from windblown dust (from coal storage stockpiles) and from air emissions associated with the combustion of coal were significantly reduced.

3.4.4 Climate and Meteorology

The climate of the site area in southeastern Utah is classified as semiarid continental. Data from the National Weather Service station in Blanding (approximately 5 miles north of the site) are considered representative of the site weather conditions. Weather data summarized by the Utah Climate Center for the town of Blanding are presented in the following discussion (Pope and Brough 1996).

Although varying somewhat with elevation and terrain, the climate in the White Mesa Mill area is also considered as semiarid, with normal annual precipitation of about 13.4 inches. Precipitation is characterized by wide variations in annual and seasonal rainfall punctuated by long periods of drought. Most precipitation is in the form of rain; the average annual snowfall of about 40 inches accounts for about 29 percent of the annual total precipitation. The region has two separate rainfall seasons; one is in late summer to early autumn (July to October) and corresponds to the southwest monsoon season, and one is during the winter months of December to March. The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July.

The average annual Class A pan evaporation rate is 68 inches; the largest evaporation rate typically occurs in July (IUC 2003). Warm summers and cold winters typify the weather in the Blanding area. The mean annual temperature in Blanding is about 50 °F; the mean annual maximum is 63.6 °F, and the mean annual minimum is 36.4 °F. The coldest temperature recorded was –23 °F in February 1933 and the hottest temperature was 110 °F in June 1905. January is the coldest month, with an average low temperature of 16 °F and an average high temperature of 38 °F. July is the hottest month, with an average high temperature of 89 °F and an average low temperature of 57 °F.

Winds are usually light to moderate in the area during all seasons, although occasional stronger winds may occur in the late winter and spring. Winds are from the north and northeast approximately 30 percent of the time and from the south and southwest about 25 percent of the time. Winds are generally less than 15 mph; wind speeds faster than 25 mph occur less than 1 percent of the time.

3.4.5 Ground Water

3.4.5.1 Hydrostratigraphy

The White Mesa Mill site is underlain by unconsolidated alluvium and indurated sedimentary rocks of Cretaceous and Jurassic age consisting primarily of sandstone and shale. Ground water in the vicinity of the site occurs primarily as perched water in the Burro Canyon Formation of Cretaceous age, and under confined conditions in the Entrada and Navajo Sandstones of Jurassic age. The Entrada and Navajo Sandstones constitute the primary aquifer in the area of the White Mesa Mill site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation by approximately 1,000 ft of unsaturated materials of the Morrison and Summerville Formations of Jurassic age that have a low average vertical permeability and form a significant aquitard.

3.4.5.2 Ground Water Occurrence

Perched ground water beneath the site occurs primarily within the Burro Canyon Formation. The saturated thickness of the perched ground water zone generally increases to the north of the site. Perched ground water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member of the Morrison Formation. The contact between these two units generally dips to the south-southwest beneath the site. The permeability of the Burro Canyon Formation is generally low; no significant joints or fractures are documented by cores from any wells or borings in the area. Any fractures in cores collected from site borings were typically cemented and had no open space. Some conglomeratic zones within the perched ground water system were observed east to northeast of the tailings cells at the site and may represent a relatively continuous zone of higher permeability. This zone is hydraulically cross gradient to upgradient of the tailings cells with respect to perched ground water flow. The higher permeability zone may extend beneath the southeastern margin of the cells but does not appear to exist downgradient (south-southwest) of the tailings cells based on current data.

Perched ground water was noted at depths of approximately 50 to 110 ft below land surface in the vicinity of the tailings cells at the site (IUC 2003). Information collected by the State of Utah Division of Radiation Control in September 2002 indicated that depth to ground water ranged from 17 to 110 ft and averaged 71 ft. The saturated thickness of the perched ground water zone ranges from approximately 82 ft in the northeast portion of the site to less than 5 ft in the southwest portion of the site (IUC 2003). Perched ground water flow at the site is generally to the south-southwest, and hydraulic gradients range from 0.04 ft/ft to less than 0.01 ft/ft downgradient of the tailings cells. The ground water gradient changes from generally southwesterly in the western portion of the site to generally southerly in the eastern portion of the site. In general, perched ground water levels have not changed significantly in most areas. An increase in water levels in the east and northeast portions of the site since 1994 are probably attributable to seepage from two wildlife ponds (IUC 2003). This activity may affect the ground water flow regime in the perched ground water system in this area.

Recharge to the perched ground water system is through percolation of rainfall and snowmelt through surface soils over the mesa top, along with infiltration of water from the wildlife ponds. Perched ground water at the millsite discharges where the Burro Canyon Formation crops out in springs and seeps along Westwater Creek Canyon and Cottonwood Canyon to the west-southwest of the site and along Corral Canyon to the east of the site. The primary discharge point for perched water flowing beneath the tailings cells is believed to be Ruin Spring in Cottonwood Canyon, approximately 2.5 miles south-southwest of the millsite. Ruin Spring is the only spring that flows consistently. The Ute Mountain Ute Tribe has indicated that it has performed extensive surveys of the seeps and springs on the perimeter of the geographic White Mesa, including tribal and BLM land, and that Ruin Springs is not the only consistently flowing spring on the mesa. DOE has requested these data from the tribe and will address the data once they are received.

The Entrada and Navajo Sandstones are prolific aquifers beneath and in the vicinity of the White Mesa Mill site. Because water wells at the site are screened through both of these units, they will be considered as a single aquifer. Ground water in the Entrada/Navajo aquifer is under artesian pressure, rising 800 to 900 ft above the top of the Entrada contact with the overlying Summerville Formation. Static ground water levels are 390 to 500 ft below ground surface. The site is located within a region that has a dry to arid continental climate and an average annual precipitation of 13.4 inches (IUC 2003). Recharge to regional aquifers occurs primarily along the mountain fronts (such as the Henry Mountains to the west and the Abajo Mountains to the north) and along the flanks of folds (such as Comb Ridge Monocline to the west).

3.4.5.3 Ground Water Quality

The quality of the Burro Canyon perched ground water beneath and downgradient from the site is poor and extremely variable. Concentrations of TDS measured in water sampled from upgradient and downgradient wells range between 1,200 and 5,000 mg/L (IUC 2003). Split sampling by the State of Utah Division of Radiation Control in September 2002 indicated a TDS concentration in perched ground water ranging from 608 to 5,390 mg/L. Approximately 55 percent of the wells sampled had a TDS concentration of less than 3,000 mg/L. Consequently, these wells appear to intercept drinking-water-quality ground water under the Utah Ground Water Quality Protection Regulations (Class II ground water) (UAC 2003a). Sulfate concentrations measured in samples from three upgradient wells varied between 670 and 1,740 mg/L. The spatial variability of the ground water quality makes the definition of background water quality a challenge over the large extent of the millsite. This definition of background water quality is currently being refined.

Ground water monitoring for the past 20 years at the site has shown no impact to perched ground water from the tailings cells (IUC 2003). However, during the May 1999 sampling event, the presence of chloroform and other man-made volatile organic compounds was detected in samples from the perched aquifer beneath the White Mesa Mill site. Subsequent aquifer characterization by IUC indicated that the chloroform plume was approximately 1,700 ft long and located across the eastern margin of the IUC facility. According to IUC, the chloroform was used in the laboratory of an earlier ore-buying station that operated at the site. The chloroform used for that operation was disposed of through a leach field. However, IUC has not yet completed its ground water contaminant investigation report required by an August 23, 1999, UDEQ ground water corrective action order. Therefore, it is not yet known how many sources of chloroform actually contributed to the contaminant plume along the eastern margin of the site.

Water quality from Ruin Spring (discharge from the perched ground water system), approximately 2.5 miles south-southwest of the mill, is generally good; TDS concentration is less than 1,000 mg/L (IUC 2003).

Ground water quality in the Entrada/Navajo aquifer is good; TDS content ranges from 216 to 1,110 mg/L (IUC 2003). Sampling of ground water in the Entrada/Navajo aquifer is not required under the mill's monitoring program because the aquifer is isolated from the perched ground water zone by approximately 1,000 ft of rock formations that have a low average vertical permeability.

UDEQ has identified potential elevated uranium concentrations in the shallow alluvial aquifer that exceed state ground water quality standards. If UDEQ determined that ground water corrective action or remediation was required, DOE would consult with UDEQ to determine the most feasible location for the "dry cell".

3.4.5.4 Ground Water Use

Because of the generally low permeability of the perched ground water zone beneath the site, well yields are typically low (less than 0.5 gpm), although yields of about 2 gpm or greater may be possible in wells intercepting the higher permeability zones on the east side of the site (IUC 2003). Sufficient productivity can, in general, only be obtained in areas where the saturated thickness is greater, which is the primary reason that the perched ground water zone has been used on a limited basis as a water supply to the north (upgradient) of the site. The perched ground water is used primarily for stock watering and irrigation.

The Entrada/Navajo aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm and is used as a secondary source of potable water for the White Mesa Mill. Five deep water supply wells constructed by IUC at the White Mesa Mill facility (WW-1 through WW-5) are used for industrial and domestic needs. These wells are completed in the Entrada/Navajo aquifer. Also, two domestic water supply wells located 4.5 miles southeast of the millsite on the Ute Mountain Ute Indian Reservation draw water from this aquifer. Although the water quality and productivity of the Entrada/Navajo aquifer are generally good, the depth of the aquifer (approximately 1,200 ft below land surface) makes access difficult.

3.4.6 Surface Water

3.4.6.1 Surface Water Resources

No perennial surface water is present on the White Mesa Mill site. This lack of surface water results from the gentle slope of the mesa on which the site is located, the low average annual rainfall of 13.4 inches (measured at Blanding), local soil characteristics, and the porous bed material of local stream channels. The millsite is drained almost equally by Corral Creek on the east and by Westwater Creek and Cottonwood Wash on the west. White Mesa is defined by these two adjacent main drainages that have cut deeply into the regional sandstone formations. Storm water runoff in the local ephemeral streams is characterized by a rapid rise in flow rates followed by rapid recession, primarily because of the small storage capacity of the surface soils in the area. Monthly water flow is monitored on the larger drainage features (Cottonwood Wash, Recapture Creek, and Spring Creek); however, the smaller water courses closest to the millsite are not monitored because of their infrequent flows. Water flows through these drainages primarily during local heavy rainfall (occurring mostly during the months of August through October) and snowmelt (occurring mostly in April). Flow typically ceases in Corral and Westwater Creeks within 6 to 48 hours following significant storm events.

The U.S. Geological Survey (USGS) maintains two stream gages on watercourses in the region. One gaging station (No. 09378630) is located on Recapture Creek in the upper portion of the watershed at an elevation of 7,200 ft above mean sea level; the second gaging station (No. 098378700) is located on Cottonwood Wash approximately 7 miles southwest of Blanding at an elevation of 5,138 ft. Corral Creek has a drainage area of approximately 5.8 square miles adjacent to the site and is a tributary of Recapture Creek. Westwater Creek on the western edge of the site has a drainage area of nearly 27 square miles and is a tributary of Cottonwood Wash. Both Cottonwood Wash and Recapture Creek flow in a southerly direction and are tributaries of the major drainage artery of the region, the San Juan River. The San Juan River is a major tributary of the Colorado River and drains approximately 23,000 square miles above Bluff, Utah, which is located at the mouth of Cottonwood Wash. The San Juan River flows in a westerly direction toward its confluence with the Colorado River at Lake Powell, which is about 114 river miles west of Bluff. The major drainages in the vicinity of the White Mesa Mill site are summarized in Table 3–40. Total runoff from the site is estimated to be less than 0.5 inch annually.

Table 3–40. Drainage Basins Near the White Mesa Mill Site

Basin Description	Drainage Area (square miles)
Corral Creek at confluence with Recapture Creek	5.8
Westwater Creek at confluence with Cottonwood Wash	26.6
Cottonwood Wash at USGS gage west of millsite	<205
Cottonwood Wash at confluence with San Juan River	<332
Recapture Creek at USGS gage station	3.8
Recapture Creek at confluence with San Juan River	<200
San Juan River at USGS gage downstream at Bluff, Utah	<23,000

Source: *Description of the Affected Environment, White Mesa Mill, Blanding, Utah, for Transport by Slurry Pipeline and Disposal of the Moab Tailings* (IUC 2003)

Two small, ephemeral catch basins are located near the millsite; these ponds are filled by the mill to provide water and habitat for local wildlife. Springs and seeps at the edge of White Mesa are fed by the perched aquifer system and support wildlife and livestock in the area. These springs and seeps may constitute future points of exposure for mill tailings contaminants.

3.4.6.2 Surface Water Quality

Sampling of surface water quality in the mill vicinity began in July 1977 and continued through March 1978. Baseline data show conditions existing at the millsite and vicinity at that time. No samples were collected from the two catch basins at that time because they were dry. Sampling of ephemeral surface waters in the vicinity was possible only during major precipitation events; these streams are normally dry at other times.

Previous investigations (IUC 2003) concluded that surface water quality in the vicinity of the millsite is generally poor. Water samples collected from Westwater Creek were characterized as having high TDS (averaging 674 mg/L) and sulfate (averaging 117 mg/L). The waters were typically hard (total hardness measured as calcium carbonate averaged 223 mg/L) and had an average pH of 8.25; however, according to Utah ground-water classification and water-quality standards, TDS concentrations for a drinking water class II aquifer range from 500 to 3,000 mg/L. Estimated water velocities for Westwater Creek averaged 0.3 ft per second at the time of sampling. Samples from Cottonwood Creek were similar in quality to those from Westwater Creek, although TDS and sulfate levels were lower (TDS averaged 264 mg/L; sulfate averaged 40 mg/L) during heavy spring flow conditions (80 ft per second water velocity). During heavy runoff, the concentration of TDS in these streams increased to more than 1,500 mg/L. Concentrations of mercury and iron above background were measured in some samples. These values appear to reflect surface water quality in the area and are probably because of evaporative concentration and not because of human disturbance of the environment (NRC 1979).

In 1997, NRC prepared an environmental assessment (NRC 1997) to address renewal of the White Mesa Mill source material license (No. SUA-1358). NRC specified that surface water monitoring would be conducted at two sampling locations, Westwater Creek and Cottonwood Creek, adjacent to the mill. Grab samples were collected annually from Westwater Creek and quarterly from Cottonwood Creek.

These surface water samples were analyzed for TDS, total suspended solids, gross alpha, and total and dissolved concentrations of natural uranium, thorium-230, and radium-226. Field measurements included pH, specific conductivity, and temperature. Since the mill began operations in 1980, the measured values for these constituents have been consistently low.

Table 3–41 summarizes the results from monitoring conducted at Cottonwood Creek and Westwater Creek. In 2000 and 2002, Westwater Creek was dry, so no data are available for those years. Data from the mill's monitoring program indicate that concentrations of all analytes in samples collected from the Cottonwood and Westwater Creeks are within the range of background (NRC 1979).

3.4.6.3 Relevant Water Quality Standards

All ephemeral water bodies near the White Mesa Mill site area are tributaries of the San Juan River, which flows into the Colorado River; therefore, they are subject to the water quality classifications specified in Utah Administrative Code R317-2-13 (see Chapter 7.0).

3.4.7 Floodplains

Several streams exist near the White Mesa Mill site, but the site lies outside any potential floodplains. A more detailed description of these streams is available in Appendix F.

3.4.8 Wetlands

Topographic maps of the region potentially indicate 10 areas with riparian or wetland potential within the site boundary. Water resources in and near the White Mesa Mill site have not been assessed in detail, but several resources are known to exist. Appendix F includes more detailed descriptions and the locations of these known resources.

3.4.9 Terrestrial Ecology

This section describes the vegetation and wildlife, including protected and sensitive species, for the White Mesa Mill site. The region north of the millsite has the greatest diversity of vegetation compared to the other alternative sites. This diversity is primarily because of variation in life zones, elevations, and precipitation between the Moab site and the White Mesa Mill. However, sparsely vegetated desert-shrub communities dominate the immediate millsite area.

3.4.9.1 Terrestrial Vegetation and Wildlife

At the White Mesa Mill site, several areas were chained (i.e., trees and vegetation were removed) to support an active cattle ranch prior to mill operations. These areas were reseeded but are now mostly void of vegetation because of overgrazing, which has resulted in limited habitat. Current vegetation consists primarily of crested wheatgrass and invasive weeds. Surrounding areas of abandoned dry farms are dominated by annual weeds, rabbitbrush, snakeweed, sagebrush, and cheatgrass. Areas that were neither cultivated nor chained support sagebrush communities with a sparse understory of grasses, including galleta and crested wheatgrass. The potential vegetation consists of more than 50 percent palatable grasses such as western wheatgrass, Indian ricegrass, needle-and-thread, and squirreltail; 15 to 20 percent increaser grasses, including galleta and blue grama; 25 percent decreaser browse plants, including winterfat; and 5 to 10 percent big sagebrush, ephedra, and other shrubs. Forbs are rare.

On a visit to the site on January 29, 2003, the north and south sides of the entrance road to the White Mesa Mill were surveyed, and plant composition was documented. Three different areas similar to those described by the U.S. Department of Agriculture (USDA 1993) were observed. One area, northeast of the entrance road, is dominated by basin big sagebrush, which accounts for approximately 30 percent of the relative cover. The understory consists of galleta (20 to 30 percent), Indian ricegrass (5 percent), and cheatgrass (10 percent). Rubber rabbitbrush is growing along the disturbed soil next to the road. The area south of the entrance road is dominated by Wyoming big sagebrush (50 percent relative cover), and galleta and cheatgrass each account for approximately 10 percent of the relative cover. The northwest area of the entrance road has been previously seeded with crested wheatgrass (20 percent relative cover);

rubber rabbitbrush (30 percent) is the dominant shrub. Other grasses include galleta (5 percent) and cheatgrass (5 percent). Table 3–42 shows the vegetation characteristics of the site, and Table 3–43 presents detailed vegetative structure at the site.

The millsite is somewhat comparable to the Moab site in terms of wildlife diversity and abundance. Pronghorn antelope, mule deer, and bobcat may occur in the vicinity of the site, depending upon habitat type. The red fox, gray fox, badger, longtail weasel, desert cottontail, and black jackrabbit are known to occur on the site.

Table 3–42. Vegetation Characteristics on the Various Soil Types at the White Mesa Site

Soil Name	Range Site	Characteristic Potential Vegetation	Percent	Productivity (pounds/acre)	Rooting Depth (inches)
Blanding very fine sandy loam, 2 to 10 percent slopes	Semidesert loam	Wyoming big sagebrush *(Artemisia tridentata* ssp. *wyomingensis)*	20	400–800	>60
		Indian ricegrass (*Achnatherum hymenoides)*	15		
		Galleta (*Pleuraphis jamesii)*	10		
		Bottlebrush squirreltail (*Elymus elymoides)*	10		
		Winterfat *(Ceratoides arborescens)*	10		
		Globemallow (*Sphaeralcea* spp.)	5		
		Needle-and-thread *(Hesperostipa comata)*	5		
		Douglas rabbitbrush (*Chrysothamnous viscidiflorus)*	5		

Notes: USDA (1993), Mellenthin soil type not found.
Source: NRCS 2002; SCS 1989.

Table 3–43. Community Structure Parameters of the White Mesa Mill Site Plant Communities

Community Group/Species	Relative Density	Percent Cover	Relative Cover	Relative Frequency
Reseeded Grassland I				
Grasses and grasslike plants				
Crested wheatgrass (*Agropyron cristatum)*	92.0	12.0	78.2	66.4
Sixweeks fescue (*Vulpia octoflora)*	1.0	0.1	0.5	5.6
Galleta (*Pleuraphis jamesii)*	2.0	0.3	2.4	2.4
Squirreltail (*Elymus elymoides)*	1.0	0.1	0.5	2.4
Forbs				
Chicory *(Cichorium intybus)*	0.3	0.2	1.2	2.4
Scarlet globemallow (*Sphaeralcea coccinea)*	0.3	0.1	0.5	2.4
Shrubs				
Broom snakeweed (*Gutierrezia sarothrae)*	4.0	1.9	13.3	16.0
Pale desert-thorn (*Lycium pallidum)*	0.3	0.5	3.6	2.4
Total vegetative cover		15.2		
Bare Ground		61.0		
Litter		24.2		
Reseeded Grassland II				
Grasses and grasslike plants				
Crested wheatgrass (*Agropyron cristatum)*	96.0	8.9	82.7	75.0
Forbs				
Russian thistle (*Salsola kali)*	0.6	0.1	1.2	5.0
Scarlet globemallow (*Sphaeralcea coccinea)*	3.0	1.4	13.0	15.0

Seven species of amphibians are thought to occur in the area, but none are believed to inhabit the site. Up to 11 species of reptiles are believed to be in the vicinity of the millsite. No critical habitat exists in the millsite area.

3.4.9.2 Threatened and Endangered Species

This section describes federally listed terrestrial threatened and endangered, proposed, or candidate species that are or may be present in the White Mesa Mill site area. In March 2003, DOE requested an updated list of such species from USF&WS that may be present or affected by DOE's proposed alternatives. USF&WS responded in April 2003 with a list for San Juan County. Table 3–44 lists a subset of those species that may occur in the vicinity of the White Mesa Mill site.

Table 3–44. Federally Listed Threatened or Endangered Species Potentially Occurring in the Vicinity of the White Mesa Mill Site

Common Name	Scientific Name	Habitat Present and Affected	Species Present	Status	Comments
Navajo sedge	*Carex specuicola*	Possible	Possible	Threatened	
Southwestern willow flycatcher	*Empidonax traillii extimus*	Possible	Possible	Endangered	
Black-footed ferret	*Mustela nigripes*	No	No	Endangered	
Bald eagle	*Haliaeetus leucocephalus*	Possible	Possible	Threatened	Proposed for Delisting
Mexican spotted owl	*Strix occidentalis lucida*	Possible	Possible	Threatened	
Gunnison sage grouse	*Centrocercus minimus*	Possible	Possible	Candidate	

Spatial data for the species listed in Table 3–44 were obtained from the Utah Conservation Data Center (UCDC). This data set was compiled by the Utah Natural Heritage Program (UNHP) of UDWR, in which species occurrences are depicted as points at a scale of 1:24,000 on 7.5-minute topographic quad maps. Spatial data depicting the White Mesa Mill site were overlaid on the species of concern spatial data to evaluate known species occurrences in the area.

The status of each of these species in the vicinity of the White Mesa Mill site is briefly discussed below. Appendix A1, "Biological Assessment," provides more detailed information concerning these federally listed species that may be in the vicinity of the White Mesa Mill site or could be affected by activities at the site.

All of the known populations of Navajo sedge in Utah are located at least 20 miles southwest of the White Mesa Mill site and associated borrow areas (UDWR 2003b). The Navajo sedge also is unlikely to occur at the White Mesa Mill site because the species requires wetland areas that do not occur within the area to be disturbed by development of the disposal cell.

There was a reported southwestern willow flycatcher sighting in San Juan County in the vicinity of the slurry pipeline corridor (UDWR 2003b). However, there is no information on the date of the reported sighting or on whether the sighting was confirmed. There is no suitable habitat for flycatchers known to occur on the White Mesa Mill site because wetland areas do not occur within the area to be disturbed by development of the disposal cell.

UDWR (2003b) reported a confirmed ferret sighting in the vicinity of the White Mesa Mill site in 1937. However, all black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the White Mesa Mill site. Black-footed ferrets depend almost exclusively on prairie dog colonies for food, shelter, and denning. Although the area from Moab south along US-191 toward the White Mesa Mill site supports colonies of Gunnison's prairie dog (*Cynomys gunnisoni*) (Seglund 2004), no colonies are currently known to occur at or close to the White Mesa Mill site.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas, and they are known to frequent the area between Monticello and Blanding. However, bald eagles are not known to nest or night roost nor is it known to have been observed in the vicinity of the White Mesa Mill site.

Designated critical habitat for the Mexican spotted owl occurs within 2 miles of the transportation corridor just south (within 25 miles) of the Moab site. However, the southern tip of this section of critical habitat that lies within 2 miles of the transportation corridor is located at least 50 miles from the White Mesa Mill site. Further, data provided by UDWR (2003a) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. Thus, it is unlikely that spotted owls occur in the vicinity of the White Mesa Mill site.

Although the White Mesa Mill site is within a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000), this species is not known to occur at the White Mesa Mill site (IUC 2003).

There is no designated or proposed critical habitat for any of the above federally protected species in the vicinity of the White Mesa Mill site.

On the White Mesa Mill site, there is no recorded presence of any threatened and endangered species (IUC 2003), including amphibians or reptiles (Dames and Moore 1978; UDWR 2003b).

3.4.9.3 Other Special Status Species

As previously discussed, special status species are those that are protected under federal and state regulations other than the ESA, which include the MBTA, Executive Order 13186, and Birds of Conservation Concern (USF&WS 2002f). The State of Utah and federal land management agencies maintain a list of species that they consider threatened, endangered, or sensitive or otherwise of concern. UDWR identified several species of state concern (UDWR 2003b), which included BLM- and USFS-identified species. However, only those listed by the USF&WS under the ESA are included in Section 7 consultations or in the Biological Assessment. Although the special status species are not covered by the ESA, USF&WS encourages protection of these species.

Table 3–45 lists plant species considered by state and federal resource agencies to be endangered, threatened, or otherwise of concern that may occur in the site region. A number of the species listed by the State of Utah or considered sensitive by BLM are potentially present in the vicinity of the White Mesa Mill site.

Table 3–46 includes animal species listed by the State of Utah as endangered, threatened, or otherwise of concern that may be present in the project region. The list includes all species identified by UDWR as potentially occurring in San Juan County; in some cases, the known population locations or suitable habitats may not be close to the site. The species listed as endangered or threatened by UDWR are discussed below.

Raptors are of primary concern, including the burrowing owl, golden eagle, red-tailed hawk, and osprey. The Raptor Protection Act requires that surveys be conducted before disturbances, depending upon season and proximity to nesting areas. Other birds of concern in the area include the long-billed curlew, loggerhead shrike, gray vireo, virginia's warbler, cassin's sparrow, and brewer's sparrow. Species previously described are not discussed in this section.

The long-billed curlew, although typically associated with aquatic environments, is also found in a variety of habitats, including plains, prairies, and open rangeland. In discussions with the BLM Monticello office, it was discovered that this species is commonly found in habitats frequented by burrowing owls in the vicinity of the White Mesa Mill site. The loggerhead shrike is typically found in open country, low scrub, and desert environments characteristic of the northern and southernmost segments of the transportation corridor. The gray vireo and virginia's warbler are commonly found in the foothills zone characterized by piñon-juniper forest, scrub oak, and open chaparral. The cassin's and brewer's sparrows are found in habitat characterized by low brush (e.g., sagebrush) and arid to semiarid regions.

Table 3–47 lists bird species, including migratory birds, that may occur in the vicinity of the site, although on-site habitat limits typical nesting and breeding activities. Most of these species are protected under the MBTA, which prohibits take or destruction of birds, nests, or eggs of listed migratory birds.

3.4.10 Land Use

Of the more than 4.9 million acres in San Juan County, approximately 60 percent of the land is administered by federal agencies. There are several national parks in the county. The entire western boundary of the county is adjacent to Canyonlands National Park, Glen Canyon National Recreation Area, the Colorado and Green Rivers, and Lake Powell. Approximately 28 miles due west of the White Mesa Mill site is Natural Bridges National Monument. Hovenweep National Monument is about 25 miles to the east-southeast. San Juan County has a total of 15 national, state, and tribal parks and recreation areas. Most of these resources are within a 50-mile radius of the site, but none are in the immediate vicinity of the site.

Approximately 30 percent of San Juan County lands are in Indian reservations. The White Mesa Ute Indian Reservation totals more than 8,300 acres and is located 3.4 miles south of the site along both sides of US-191. Several small, isolated, and uninhabited Ute Reservation parcels are west of Blanding. The Navajo Reservation occupies the entire southern portion of the county and constitutes 28 percent of county lands.

Much of the land in San Juan County is public domain and open to recreational use. Tourism is increasingly becoming the mainstay of the local economy. Favorable weather allows off-road access for hikers, bikers, and off-highway vehicles in virtually all seasons. The Colorado River, which runs along the western border of the county, is a source of extensive recreational use for summer water sports. BLM administers most of the federal lands and makes the lands available for grazing, oil and gas leasing, and mining claims. As late as 1977, San Juan County was the largest processor of uranium ore in Utah. The Aneth Oil Field in southern Utah is the second largest field in Utah and is still producing. While oil production has been steadily declining, natural gas production is expanding. The USFS lands are also available for multiple uses such as recreational, agricultural, and timber and mining production.

Table 3–47. Sensitive Bird Species Protected Under the Fish and Wildlife Conservation Act and Migratory Bird Treaty Act That May Occur Near the White Mesa Mill Site

Species	Potential to Occur in Project Area
Order Falconiformes—Birds of prey	
Golden eagle *(Aquila chrysaetos)*	High
Northern harrier *(Circus cyaneous)*	Moderate
Prairie falcon *(Falco mexicanus)*	Moderate
Red-tailed hawk (*Buteo jamaicensis*)	High
Turkey vulture (*Cathartes aura)*	High
Order Gruiformes—Marsh and open country birds	
Black rail *(Laterallus jamaicensis)*	Moderate
Yellow rail *(Coturnicops noveboracensis)*	Low
Order Strigiformes—Nocturnal birds of prey	
Barn owl *(Tyto alba)*	Low
Flammulated owl *(Otus flammeolus)*	Low
Short-eared owl *(Asio flammeus)*	Low
Order Apodiformes—Small swallowlike birds	
Black swift *(Cypseloides niger)*	Low
Vaux's swift *(Chaetura vauxi)*	Low
Order Piciformes—Wood-boring birds	
Red-headed woodpecker *(Melanerpes erythrocephalus)*	Low
Williamson's sapsucker *(Sphyrapicus thyroideus)*	Low
Order Passeriformes—Perching birds	
Olive-sided flycatcher *(Contopus borealis)*	Low
Gray flycatcher *(Empidonax wrightii)*	Moderate
Pinyon jay *(Gymnorhinus cyaneocephalus)*	Low
Bendire's thrasher *(Toxostoma bendirei)*	High
Crissal thrasher *(Toxostoma dorsale)*	High
Bewick's wren *(Thryomanes bewickii)*	Moderate
Sedge wren *(Cistothorus platensis)*	Low
Verry *(Catharus fuscenscens)*	Moderate
Sprague's pipit *(Anthus spragueii)*	Low
Loggerhead shrike *(Lanius ludovicianus)*	Moderate
Gray vireo *(Vireo vicinior)*	Moderate
Virginia's warbler *(Vermivora virginiae)*	Moderate
Black-throated warbler *(Dendroica nigrescens)*	Low
Grace's warbler *(Dendroica graciae)*	Low
Blackpoll warbler *(Dendroica striata)*	Low
Dickcissell *(Spiza americana)*	Low
Sage sparrow *(Amphispiza belli)*	Low
Cassin's sparrow *(Aimophila cassinii)*	Low
Brewer's sparrow (*Spizella breweri)*	Moderate
Lark bunting *(Calamospiza melanocorys)*	High
Baird's sparrow *(Ammodramus bairdii)*	Low
Grasshopper sparrow *(Ammodramus savannarum)*	Low
McCown's longspur *(Calcarius mccownii)*	Low
Chestnut-collared longspur *(Calcarius ornatus)*	Low

Note: Birds listed in the table are protected under the Fish and Wildlife Conservation Act (Birds of Conservation Concern [2000] [USF&WS 2002f] and the MBTA [50 CFR 10], Executive Order 13186). Species listed as threatened or endangered under the ESA or considered endangered, threatened, or rare by the State of Utah are not included here.

Private land in San Juan County is dedicated almost entirely to agriculture. The areas most amenable to farming are in the east-central portion of the county. The principal crops are wheat and beans. There are no prime or unique farmlands in San Juan County. The arid climate, lack of irrigation, and the rugged landforms dictate grazing as the primary agricultural use. However, low rainfall and lack of sufficient vegetation limit livestock numbers. Except where irrigation is present, livestock herds are widely spaced, and federal grazing allotments cover large areas.

In the past, dry farming has been largely unsuccessful on soil types characteristic of this area. However, the Blanding soils are deep and easy to plow, have high moisture-holding capacity, and are high in inherent fertility if irrigated.

The White Mesa Mill site is a 5,415-acre parcel that is privately owned by IUC. Land use in the vicinity of the site and directly outside the property boundary is zoned agricultural by San Juan County. Land within 5 miles of the site is privately owned agricultural land. A parcel of land comprising the site is a six-section area that is zoned as an industrial controlled district. Blanding is expanding its commercial district to the south along US-191 in the direction of the site. It is currently 4.7 miles from the northern edge of the site to the southern expansion of Blanding development. A National Guard Armory is 3.7 miles north of the site.

The largest communities in San Juan County are Monticello and Blanding. Very few residents live near the site. The nearest full-time residence is a farm/ranch located 1.6 miles north of the site. A residence associated with a convenience store and gas station is located at the intersection of US-191 and SR-95 approximately 3 miles north of the site. In addition, there is a residence at the Blanding airport about 3.5 miles north of the site. The Ute Mountain Reservation is 3.4 miles south of the site, and the community of White Mesa is approximately 5 miles to the south. Figure 3–38 presents a land use map of the White Mesa Mill site area.

Ongoing consultations with White Mesa Mill elders have identified burial sites near the White Mesa Mill site entrance.

3.4.11 Cultural Resources

The cultural history of the White Mesa Mill site area is discussed in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for the White Mesa Mill site is described in Section 3.1.13.2.

Results of the Class I inventory (Davis et al. 2003) indicate that a number of Class III cultural resource surveys have been conducted at the White Mesa Mill site, primarily between 1976 and 1981. The areas of the White Mesa Mill site encompassed by the Class I inventory include Sections 28, 29, 32, and 33 of T. 37 S., R. 22 E. and Sections 4 and 5 and the north half of Section 9 of T. 38 S., R. 22 E. Within this area, the Class I inventory documented 231 cultural sites. Of these 231 sites, 196 (85 percent) have been determined eligible for inclusion in the National Register of Historic Places. Table 3–48 summarizes the types of sites documented for each section.

The probable time periods represented by the 231 sites are summarized, by section, in Table 3–49. Most of the sites are associated with Anasazi habitation between A.D. 450 and A.D. 1150. From an initial low frequency of Archaic and Basketmaker II sites (see Table 3–49 footnotes), there is a pronounced increase in Basketmaker III sites, followed by a steady increase in sites through the Pueblo I and Pueblo II periods. The population of prehistoric inhabitants appears to have peaked during early Pueblo II and remained fairly stable into the early Pueblo III period, after which it declined sharply. In contrast to the high number of prehistoric sites, only seven sites are attributed to the historic period. Of this total, one is a Navajo camp and one is a Ute camp; the other five lacked diagnostic artifacts or other attributes to determine cultural affiliation.

Table 3–48. White Mesa Mill Site—Summary of Cultural Sites by Type

Section	Habitation Site	Temporary Habitation Site	Limited Activity Site	Granary	Quarry	Unknown	Total	NRHP Eligible Yes/No
Sec. 28	17		11				28	21/7
Sec. 29	7	2	3	6		2	20	18/2
Sec. 32	15	2	12		2	7	38	31/7
Sec. 33	22		13			1	36	21/15
Sec. 4	38		5				43	43/0
Sec. 5	32	4	11				47	45/2
Sec. 9, N1/2	12	2	5				19	17/2
Total	143 (62%)	10 (4%)	60 (26%)	6 (3%)	2 (1%)	10 (4%)	231	196/35 (85%/15%)

NRHP = National Register of Historic Places

Within the 6.5-section area encompassed by the Class I inventory, a notable site distribution pattern—from northeast to southwest—is present. The more northerly Sections 28 and 29 average 24 sites per square mile; the middle Sections 32 and 33 average 37 sites per square mile; and the southerly Sections 4 and 5 average 45 sites per square mile. This increasing site density from northeast to southwest is likely a function of specific environmental factors—mainly, nearness to a water source. The more southerly sites are closer to the canyon edges where the water sources are located.

Recent interviews (Fritz 2004) with tribal members indicate that at least five potential traditional cultural properties associated with the White Mesa Ute Tribe exist on or near the White Mesa Mill site. These are "potential" traditional cultural properties because their eligibility for National Register status has yet to be determined; this determination would be made during the Section 106 consultation process. Interviews conducted with tribal members before the current mill was constructed indicate that sacred areas existed within the IUC site boundaries at that time as well (Fritz 2004). In the White Mesa Mill area, the likelihood of occurrence of traditional cultural properties and their estimated density are extremely high (on a scale of low-medium-high-extremely high) and are likely associated with the Ute Tribe, Navajo Nation, and Hopi Tribe (Fritz 2004). Traditional cultural properties in this area may include sacred gathering areas, sacred healing areas, sacred springs, and burial areas.

3.4.12 Noise and Vibration

The White Mesa Mill site is within the boundaries of the IUC site. Background noise levels are expected to be comparable to noise levels associated with open desert areas, with some influence from the existing IUC operation. These noise levels could approach 50 to 60 dBA at the White Mesa Mill site area as a result of operations at the IUC mill. US-191 passes about 1 mile to the east of the White Mesa Mill site area and does not significantly contribute to background noise (less than 50 dBA).

Neither background noise nor ground vibration data are available for the White Mesa Mill site. No residences are in the surrounding areas, although the land adjacent to IUC property may be used for outdoor recreation.

3.4.13 Visual Resources

The White Mesa Mill site is located immediately west of US-191 in a rural area approximately 5 miles south of the town of Blanding and 5 miles north of the community of White Mesa. Gently rolling rangelands dotted with sagebrush, piñon-pine, and juniper surround this commercial facility. Most of the facility consists of several large metal structures, a yellow-brick office building, and numerous earthen piles. The taller structures and piles are visible from US-191 but do not dominate the view because of their distance (approximately 0.5 mile) from the highway. The existing disposal cells are not visible from the highway (Figure 3–39).

Figure 3–39. View of the White Mesa Mill Site from the Entrance Road on US-191

Approximately 1.6 miles north of the facility is the nearest residence, from which the taller facility structures are barely visible. The areas proposed to be disturbed by the new disposal cells are not visible from US-191 or from the nearest residence. BLM places the area surrounding the facility in the Class III visual resources category (Sweeten 2003). Section 3.1.15 describes the visual resource classes.

3.4.14 Infrastructure

3.4.14.1 Waste Management

Mill-generated sewage is disposed of in an on-site state-approved leach field system. This system manages sanitary wastes generated by the 70 to 100 full-time workers that are typically employed when the mill is in production mode; the maximum capacity of the system is unknown. Mill-generated solid waste is disposed of in the on-site tailings cells.

3.4.14.2 Electric Power Supplies

An existing three-phase overhead power line runs adjacent to US-191; an existing substation that supplies the White Mesa Mill site is approximately 0.25 mile from the site. The existing power line ends approximately 4 miles north of where the booster pump station would be located.

3.4.14.3 Water Supplies

Potable and nonpotable water needs at the White Mesa Mill site are supplied from existing deep wells and the Recapture Reservoir, respectively. The Entrada/Navajo aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm (216,000 to 324,000 gallons per day) and is used as a secondary source of potable water for the White Mesa Mill site. There are five deep water supply wells constructed by IUC at the White Mesa facility.

3.4.15 Transportation

Table 3–15 in Section 3.1.17 describes AADT, congestion, truck percent, and accident rates on US-191 between Moab and Blanding. US-191 south of Moab is generally not congested; it carries AADT volumes that vary from 2,861 at the junction of US-191 and the White Mesa Mill site to 7,450 at the south Blanding city limits. At the San Juan County/Grand County line, traffic increases to an AADT of 8,510. The road is two-lane until it reaches downtown Moab. Two road segments are noted as having actual accident rates that exceed the expected accident rate; other reported segments are considered not congested and have low accident rates. The two segments that have high accident rates occur at the junction of US-191 and US-491 (formerly US-666) in Monticello, and at the junction of US-191 and SR-95 south of Blanding (see Figure 3–40).

Although road congestion and accident rates are considered low, south of Moab, US-191 follows rolling hills with often poor sight lines around curves.

No rail transportation is available between the Moab site and the White Mesa Mill site.

3.4.16 Socioeconomics

3.4.16.1 Demography of the Area

The 2000 census reported the population density of San Juan County as 1.8 individuals per square mile. By comparison, the statewide density is greater than 27.2 persons per square mile.

Blanding, approximately 5 miles north of the mill, is the largest population center near the millsite and had a 2000 census population of 3,162. Approximately 5 miles southeast of the White Mesa Mill site is the White Mesa community of approximately 277 Ute Mountain Ute tribal members. An estimated 60 to 75 individuals live within 5 miles of the site (IUC 2003) (Figure 3–41). The nearest resident to the millsite is approximately 1.6 miles north of the mill.

The Navajo Reservation is approximately 19 miles southeast of the mill. The nearest community on the Navajo Reservation is Montezuma Creek, with a population of about 507. Figure 3–41 provides population centers located within 50 miles of the millsite.

3.4.16.2 Socioeconomic Profiles

San Juan County is the largest and poorest county in Utah. As of October 2002, the unemployment rate in the county was 7.8 percent, compared to 5.2 percent in the state of Utah, and 5.6 percent for the nation. When operating, the White Mesa Mill is the largest private employer in San Juan County, employing 70 to 100 full-time workers. Typically, the mill employs a high percentage of minority workers. During the mill operation that began in June 2002, mill employment ranged from 45 to 75 percent Native Americans.

Since its inception in 1980, the mill has run on a campaign basis, in each case remaining on standby pending accumulation of sufficient ore stockpiles to justify a milling campaign. Currently, mill employees are predominantly residents of San Juan County or residents of neighboring counties who commute to the mill daily. Historically, the mill has drawn from residents of San Juan County and neighboring counties for each milling campaign, rather than relying upon an influx of workers to the area.

3.4.17 Human Health

Nationwide, on average, people are exposed to approximately 300 mrem/yr from natural background radiation (NCRP 1987). Table 3–50 summarizes the radiation doses from natural background, assuming residential exposure is occurring at the White Mesa Mill site.

Table 3–50. United States and the White Mesa Mill Site Natural Background Radiation Doses

Source	U.S. Average Natural Background Radiation Dose (millirem/yr)	White Mesa Mill Natural Background Radiation Dose (millirem/yr)
Cosmic and cosmogenic radioactivity	28	68
Terrestrial radioactivity	28	74
Internal radioactivity	40	40
Inhaled radioactivity	200	260
Rounded Total	300	440

The largest natural source is inhaled radioactivity, mostly from radon-222 and its radioactive decay products in homes and buildings, which accounts for about 200 mrem/yr. Additional natural sources include radioactive material in the earth (primarily external radiation from the uranium and thorium decay series), radioactive material in the body (primarily potassium-40), and cosmic rays from space filtered by the atmosphere.

The actual radiation dose from natural background radiation varies with location. On the basis of data for Blanding, the radiation dose from cosmic and cosmogenic radioactivity would be about 69 mrem/yr at the White Mesa Mill site, the radiation dose from external terrestrial radioactivity would be about 74 mrem/yr, and the radiation dose from radon-222 and its radioactive decay products would be about 260 mrem/yr (IUC 2003). The total natural background radiation dose at the White Mesa Mill site would be about 440 mrem/yr, considerably higher than the national average.

According to the 2000 census, the population within 50 miles of the White Mesa Mill site was about 21,800 (Figure 3–41). Assuming that all residents were exposed to 440 mrem/yr, the population dose would be about 9,600 person-rem per year.

Existing Operations at the White Mesa Mill

The individual radiation dose for members of the public from existing operations at the White Mesa Mill was estimated to be 10 mrem per year (IUC 2003). The population dose to the 50-mile population surrounding the White Mesa Mill site was estimated to be 4 person-rem per year (IUC 2003).

For workers at the White Mesa Mill, the average individual radiation dose was 0.11 rem in 1999. The population dose to these workers was 10 person-rem.

3.4.18 Environmental Justice

Section 3.1.20 describes the legal basis for evaluating environmental justice and general census characteristics in San Juan County. Figure 3–42 and Figure 3–43 provide the minority population distribution within 50 miles of the site and income by household, respectively. The Navajo Reservation occupies a significant portion (28 percent) of San Juan County. Figure 3–42 shows greater than 50 percent of the total population as minority occurring within 20 miles of the White Mesa Mill site. The Ute Mountain Reservation is adjacent to the White Mesa Mill site. Reported household incomes of less than $18,244 per year (poverty level for a family of four) are found in census group blocks within about one-half of the minority-populated areas south of the site.

The closest low-income block group is about 15 miles from the site. Areas west of US-191 that are considered to have greater than 50 percent minority population had reported incomes between $18,244 and $41,994.

3.4.19 Pipeline Corridor

3.4.19.1 Geology

This section describes the level of seismic risk, possibility for subsidence, landslide potential, and occurrence of expansive clay evaluated from a geologic perspective for the proposed pipeline route from the Moab site to the White Mesa Mill site.

Seismicity (and seismic risk) is low in this part of the central Paradox Basin, and has a low rate of occurrence with small- to moderate-magnitude earthquakes (Wong and Humphrey 1989). The pipeline route is in Uniform Building Code 1, indicating lowest potential for earthquake damage (Olig 1991).

Quaternary displacement is evident along the Shay Graben Faults (Wong and Humphrey 1989), and small earthquakes have possibly been associated with these faults (Wong et al. 1996), the eastern ends of which cross the pipeline route about 3 miles south of Church Rock. The similar east-striking Verdure Graben Fault system may also have had Quaternary displacement; the proposed pipeline corridor would cross this fault system about 5 to 6 miles south of Monticello.

Geologic conditions for subsidence and landslides were evaluated in the EIS for the Queston, Williams, and Kern River pipeline route (DOI 2001), which closely follows the proposed pipeline corridor from the Moab site to White Mesa Mill site south to near Wilson Arch. In that EIS, no risks for landslides, soil liquefaction, or collapsible soils were noted for the shared areas of these pipelines. Farther south on the proposed pipeline corridor, landslides are present in the Brushy Basin Member of the Morrison Formation on the north slope of the Sage Plain about 4 to 6 miles south of Church Rock (Harty 1991). Also, landslides occur in the Brushy Basin Member in the Recapture Wash area along the proposed pipeline (Harty 1991, 1993).

Expansive clay (montmorillonite), which can potentially cause engineering geologic problems when a change in water content causes shrinking and swelling, occurs in mudstones of the Brushy Basin Member of the Morrison Formation. The two main areas along the proposed pipeline corridor on this member, as noted by Mulvey (1992), are the Recapture Wash area and the area between Spanish Valley and Kane Springs.

3.4.19.2 Soils

For the purpose of soils discussion, this proposed pipeline corridor can be divided into two segments: Moab site to Peters Canyon, approximately 9 miles north of the city of Monticello (Maps 5 through 11, Appendix C), and Peters Canyon to the White Mesa Mill site (Maps 12 through 16, Appendix C). Peters Canyon marks a physiographic boundary between the lower-elevation canyon country of northern San Juan County and the rolling tableland of central San Juan County known as the Sage Plain. The head of Peters Canyon also marks a boundary between soils formed in semiarid and in subhumid climates (USDA 1962).

Four general soil map units or soil associations occur between the Moab and Peters Canyon segment of the pipeline corridor: Thoroughfare-Sheppard-Nakai, Begay-Moab-Redbank, Rizno Dry-Rock Outcrop, and Ustic Torriorthent-Ustic Calciorthids-Ustollic Haplargids (USDA 1991). The segment of the proposed pipeline corridor from Peters Canyon to the White Mesa Mill site crosses five general soil map units or soil associations in the higher, subhumid region of the Sage Plain, then drops into semiarid upland soil map units just south of the town of Blanding. The San Juan Area Soil Survey (USDA 1962) groups the soil series and soil map units as range sites based on land use and management. The soil types and potential natural vegetation for both of these pipeline corridor segments are described in the SOWP (DOE 2003).

3.4.19.3 Ground Water

Depth to ground water varies widely between Moab and the White Mesa Mill site. For the first 2 to 3 miles of the pipeline corridor southeast from the Moab site, ground water is shallow (within a few feet of the ground surface) in the Matheson Wetlands Preserve area of the Moab Valley. For the next approximately 10 miles, the pipeline corridor runs along the southwest flank of Spanish Valley in Quaternary alluvial fill and fan material, in which the depth to ground water is generally between 50 and 100 ft. In the approximately 3 miles between Spanish Valley and Kane Springs, the pipeline corridor crosses a higher elevation area that is underlain by the Salt Wash Member of the Morrison Formation, where depth to ground water is less than 100 ft. Except for a small area where shallow ground water is present in alluvium around the Hatch Wash crossing, ground water from Kane Springs south to about 2 miles south of Church Rock is in Entrada, Navajo, and Wingate Sandstones. As the pipeline corridor climbs southward up to the Sage Plain, ground water is in the Burro Canyon Formation and Dakota Sandstone. Ground water on the Sage Plain, which extends south generally to Recapture Wash and in alluvium where the pipeline corridor crosses Verdure Creek and Devil Canyon, is less than 50 ft deep. From the shallow alluvial water at Recapture Wash south to the White Mesa Mill site, the pipeline corridor is underlain by shallow (less than 50 ft deep), perched ground water in alluvial Quaternary terrace gravels and ground water in the immediately underlying bedrock (Gloyn et al. 1995).

3.4.19.4 Surface Water

The perennial waters that this pipeline corridor would either cross or affect include the Colorado River, Matheson Wetlands Preserve, Mill Creek, Pack Creek, Kane Springs Creek, Vega Creek, Montezuma Creek, Verdure Creek, Devil Canyon, Long Canyon, and Recapture Creek (these are shown on the segment reference maps in Appendix C).

The ephemeral/intermittent drainages that this pipeline corridor would either cross or affect are Muleshoe Canyon, West Coyote Creek, Joe Wilson Canyon, Hook and Ladder Gulch, Hatch Wash, Lightning Draw, Big Indian Wash, Sandstone Draw, Tank Wash, East Canyon, Peter's Canyon, South Canyon, Spring Creek, Halfway Hollow, Bull Hollow, Dodge Canyon, Whipstock Draw, Bullpup Canyon, Lem's Draw, Brown Canyon, and Corral Canyon. Numerous other smaller, unnamed drainages, all of which are intermittent, would also be affected (see the segment reference maps in Appendix C).

Water Quality and Existing Surface Water Contamination

None of the perennial water resources within the pipeline corridor are listed as "High Quality Waters" as defined by UDEQ regulations (UAC 2003b). However, water quality varies widely among many of the perennial surface-water resources identified within this pipeline corridor. As the pipeline corridor passes through higher elevations near the Verdure and Devil Canyon drainages south of Monticello, the water quality in these streams is higher than that observed in perennial water sources at lower elevations (e.g., the Colorado River at Moab, Recapture Creek at Blanding).

The seasonal washes located within this pipeline corridor are dry most of the year, and no water quality data are available. Flow occurs in these washes primarily after significant storm events. When storm water does flow through these washes, it is laden with sediments, and water quality is anticipated to be poor. Many of these ephemeral washes collect surface water runoff primarily from areas of Mancos Shale. Soils associated with the Mancos Shale are alkaline and may have high concentrations of selenium. As a result, surface water quality from these drainage features would likely be characterized as having high salinity, turbidity, hardness, and elevated levels of sulfate and selenium.

Relevant Water Quality Standards

All surface water bodies (both perennial and ephemeral) in this pipeline corridor are eventually tributaries to the Colorado River; therefore, they are subject to the water quality classifications specified in Utah Administrative Code R317-2-13 (see Chapter 7.0).

3.4.19.5 Floodplains and Wetlands

The White Mesa Mill pipeline would cross 11 perennial streams containing riparian vegetation and at least 21 intermittent drainages. The pipeline would also cross the Colorado River and the Matheson Wetlands Preserve. There have been previous utility crossings in the preserve, and the pipeline would follow these as closely as possible. Appendix F provides additional details relevant to the pipeline crossing.

3.4.19.6 Terrestrial Ecology

Section 3.4.9 describes the affected environment for terrestrial ecology for the White Mesa Mill site. This section addresses only the areas, wildlife, and habitat that may be affected by the proposed pipeline corridor (Maps 4 through 16, Appendix C). This transportation corridor is likely to support a greater diversity and abundance of vegetation and wildlife than the other pipeline routes. For example, the region near Monticello, north of the White Mesa Mill site, is dominated by the foothills life zone (transition zone), which ranges from 6,000 to 9,000 ft in elevation. Piñon-juniper forests and scattered ponderosa pine stands dominate this zone. General vegetation and wildlife information applicable to the regional descriptions as described in Section 3.4.9 is not repeated in this section.

Pronghorn antelope, mule deer, and bobcat occur along the proposed pipeline corridor and in the vicinity of the site, depending upon habitat type. The red fox, gray fox, badger, longtail weasel, desert cottontail, and black jackrabbit are known to occur along the southernmost segments of the corridor. Sagebrush communities along the route are home to many other species of small mammals, birds, and reptiles. Smaller mammals inhabiting the piñon-juniper woodland include raccoons, skunks, badgers, coyotes, woodrats, and deer mice. Bird species, including piñon jays and several species of raptors, also use the piñon-juniper habitat. Up to seven species of amphibians are thought to occur in riparian and wetland areas that may be within the pipeline corridor.

Critical habitat exists for several nonsensitive mammals and bird species along this segment of the pipeline corridor. The area that includes T. 30 S., R. 23 E. (Map 9, Appendix C) has been designated as critical habitat for the pronghorn antelope during fawning, and restrictions are in effect between May 15 and June 15 each year. Mule deer migration routes have been identified in T. 33 S. – T. 35 S., ranges to the east and west (Maps 11 through 14, Appendix C). Critical winter range is located in T. 35 S.–T. 37 S., (Maps 14 through 16, Appendix C) east of US-191, where restrictions are in effect from November 15 to April 30 each year.

The loggerhead shrike (*Lanius ludovicianus*) is typically found in open country, low scrub, and desert environments characteristic of the southernmost segments of the pipeline corridor. The gray vireo (*Vireo vicinior*) and virginia's warbler (*Vermivora virginiae*) may also exist in this area because they are commonly found in the foothills zone characterized by piñon-juniper forest, scrub oak, and open chaparral.

In March 2003, DOE requested an updated list of federally terrestrial threatened and endangered, proposed, or candidate species from USF&WS that may be present or affected by DOE's proposed alternatives. USF&WS responded in April 2003 with a list for San Juan County. Appendix A1, "Biological Assessment," provides more detailed information concerning these species. Table 3–51 lists a subset of those species that may occur in the vicinity of the pipeline corridor between the White Mesa Mill site and the Moab site.

Table 3–51. Federally Listed Threatened and Endangered Species Potentially Occurring in the Vicinity of the Proposed Pipeline Corridor

Common Name	Scientific Name	Habitat Present and Affected	Species Present	Status	Comments
Navajo sedge	*Carex specuicola*	Possible	Possible	Threatened	
Southwestern willow flycatcher	*Empidonax traillii extimus*	Possible	Possible	Endangered	
Black-footed ferret	*Mustela nigripes*	No	No	Endangered	
Yellow-billed cuckoo	*Coccyzus americanus*	No	No	Candidate	
Bald eagle	*Haliaeetus leucocephalus*	Possible	Possible	Threatened	Proposed for Delisting
Mexican spotted owl	*Strix occidentalis lucida*	Possible	Possible	Threatened	
Gunnison sage grouse	*Centrocercus minimus*	Possible	Possible	Candidate	

All of the known populations of Navajo sedge in Utah are located at least 20 miles southwest of the White Mesa Mill site and associated borrow areas (UDWR 2003b). However, because the Navajo sedge requires wetland areas, it could potentially occur within the pipeline corridor where it crosses seeps and springs.

There was a reported southwestern willow flycatcher sighting in San Juan County in the vicinity of the slurry pipeline corridor (UDWR 2003b). However, there is no information on the date of the reported sighting or on whether the sighting was confirmed. Flycatchers could potentially occur along wetland areas of the pipeline corridor. It is currently unknown whether or not these wetland areas constitute suitable nesting habitat and/or whether they could be used as stopover habitat during migration.

Like the southwestern willow flycatcher, the Western yellow-billed cuckoo is also a riparian obligate. However, the cuckoo most likely does not occur along wetland areas of the pipeline corridor because associated areas of riparian vegetation are likely to be much smaller than that required by the cuckoo for nesting (100 to 200 acres of contiguous large gallery-forming or developing trees).

UDWR (2003b) reported a confirmed ferret sighting in the vicinity of the White Mesa Mill site in 1937. However, all black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur in the vicinity of the pipeline between the White Mesa Mill site and the Moab site. However, black-footed ferrets depend almost exclusively on prairie dog colonies for food, shelter, and denning. The area from Moab south along US-191 toward the White Mesa Mill site supports colonies of Gunnison's prairie dog (Seglund 2004). It is unknown to what extent individual colonies or a combination of these colonies could support black-footed ferrets.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas, and bald eagles are common between Monticello and Blanding (Maps 12 through 14, Appendix C) during winter months. However, bald eagles are not currently known to night roost (or nest) near the route proposed for the pipeline corridor between the White Mesa Mill site and the Moab site.

Designated critical habitat for the Mexican spotted owl occurs within 2 miles of the pipeline corridor just south (within 25 miles) of the Moab site. Data provided by UDWR (2003a) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, based on proximity to critical habitat, spotted owls could potentially occur within 2 miles of the pipeline corridor just south (within 25 miles) of the Moab site.

The pipeline corridor between the White Mesa Mill site and the Moab site is within a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000). High quality habitat for the Gunnison sage grouse has been designated in T. 31 S.–T. 33 S., R. 24 E. (Maps 10 and 11, Appendix C).

Besides that noted above for the Mexican spotted owl, there is no designated or proposed critical habitat for any of the other federally protected species in the vicinity of the pipeline corridor between the White Mesa Mill site and the Moab site.

No threatened or endangered amphibians or reptiles are believed to be present within the area of the pipeline corridor (Dames and Moore 1978; UDWR 2003b).

DOE, in consultation with USF&WS and BLM, would determine the need for additional habitat evaluations and surveys for species that could be affected by the proposed action should this alternative be selected.

As previously discussed, special status species are those that are protected under federal and state regulations other than the ESA, which include the MBTA, Executive Order 13186, and Birds of Conservation Concern (USF&WS 2002f). The State of Utah and federal land management agencies maintain a list of species that they consider threatened, endangered, or sensitive or otherwise of concern. By letter dated May 30, 2003, UDWR identified several species of state concern, which included BLM- and USFS-identified species. However only those listed by USF&WS under the ESA are included in Section 7 consultations or in the Biological Assessment. Although the special status species are not covered by the ESA, the State of Utah, BLM, USFS, and USF&WS encourage protection of these species.

Table 3–52 lists sensitive plant species considered by state and federal resource management agencies to be of concern that may occur in the vicinity of the pipeline corridor. A number of the species listed are potentially present in the vicinity of the corridor; in some cases the known population locations or suitable habitat may not be close to the site.

Table 3–53 lists animal species considered by state and federal resource management agencies as endangered, threatened, or otherwise of concern that may be present in the vicinity of the pipeline corridor. A number of the species listed are potentially present in the vicinity of the corridor; in some cases the known population locations or suitable habitat may not be close to the site.

Table 3–54 lists bird species, including migratory birds, that may occur in the vicinity of the corridor, although on-site habitat limits typical nesting and breeding activities. Most of these species are protected under the MBTA, which prohibits take or destruction of birds, nests, or eggs of listed migratory birds.

The Abert's squirrel (*Sciurus aberti*) and burrowing owl are of primary concern along the pipeline corridor. Ponderosa pine stands in the vicinity of T. 35 S., R. 23 and R. 24 W. (Map 14, Appendix C) likely provide habitat for Abert's squirrel and many sensitive avian species. Burrowing owl habitat has been identified within T. 30 S., R. 23 and R. 24 E., (Map 9, Appendix C) and seasonal restrictions may apply; however, no critical habitat exists within the pipeline corridor.

3.4.19.7 Land Use

The proposed pipeline corridor south from the Moab site to the White Mesa Mill site is approximately 89 miles and would cross federal, State, and private land. Where possible, the pipeline would be constructed in the existing right-of-way. Where co-location was not possible or practical, the slurry pipeline would parallel existing rights-of-way. Approximately 27 percent of the corridor is administered by BLM and the USFS. Approximately 54 percent of the route is located on private and Nature Conservancy lands; the remaining 19 percent is under the jurisdiction of the State, including wildlife reserves.

3.4.19.8 Cultural Resources

The cultural history of the White Mesa Mill pipeline route is discussed in the more general cultural history of southeastern Utah described in Section 3.1.13.1; the Class I cultural resource inventory that was conducted for the corridor is described in Section 3.1.13.2.

The Class I inventory (Davis et al. 2003) indicates that Class III surveys have been conducted along most of the proposed pipeline route. An approximately1.5-mile section of the pipeline corridor north and south of the proposed pumping station (Map 8, Appendix C) has not been surveyed, and an approximately 8.5-mile section of the pipeline corridor from Dodge Point (Map 13, Appendix C) to Mustang Mesa (Map 15, Appendix C) has not been completely surveyed. Davis et al. (2003) estimate that, within these unsurveyed areas, approximately 127 sites per square mile could be expected to occur. Of the 127 sites, approximately 79 percent, or 100 sites, would be eligible for inclusion in the National Register of Historic Places.

Within the 1-mile-wide corridor along the entire pipeline corridor, approximately 203 cultural sites have been documented. Of this total, approximately 104 are considered eligible for inclusion in the National Register of Historic Places. Table 3–55 summarizes the types of cultural sites that are eligible for inclusion. The time periods represented by the sites range primarily from the prehistoric Archaic to the Pueblo III periods (7000 B.C.–A.D. 1300); however, the protohistoric and historic periods are represented by a number of sites.

A distinctive trend in cultural site densities occurs north to south along the length of the pipeline corridor. In the northern 10-mile section of the corridor, between Moab and the southern end of Spanish Valley (Map 6, Appendix C), typical site densities are 2.9 sites per linear mile. This area lacks the physical attributes that are deemed essential for long-term prehistoric habitation. Accordingly, the types of cultural sites documented in this section indicate a relatively transient use by prehistoric and protohistoric groups.

Table 3–55. White Mesa Mill Pipeline—Summary of Eligible Cultural Sites by Type

Site Type	Number of Sites
Temporary Camp	17
Long-Term Camp	1
Habitation Site	13
Limited Activity Site	21
Granary	7
Rock Art	1
Quarry	10
Road	5
Homestead	1
Unknown	28
Total	**104**

Along the middle section of the pipeline corridor, between the southern end of Spanish Valley and Peters Canyon (Map 10, Appendix C), cultural site densities average 8 sites per linear mile. This area contains a wide variety of bedrock exposures containing rock types that were exploited by prehistoric groups for the manufacturing of stone tools. The types of cultural sites documented in this area indicate that prehistoric groups used this area primarily for short-term activities such as lithic quarrying, tool manufacturing, and hunting and gathering of local natural resources.

The southern section of the pipeline corridor, between Peter's Canyon and the White Mesa Mill site, contains the highest density of cultural sites along the corridor. Within this section of the corridor, Class III surveys have been incomplete or nonexistent. As previously noted, Davis et al. (2003) estimated densities of approximately 127 sites per square mile in the Dodge Point/Mustang Mesa area. In the Recapture Wash area north of Blanding, archaeologists (Davis et al. 2003) documented an average of 56 cultural sites per square mile, and on White Mesa, Davis et al. (2003) documented an average of 34 cultural sites per square mile.

Recent interviews (Fritz 2004) with tribal members indicate that at least one potential traditional cultural property, a sacred ceremonial site, associated with the Ute Tribe exists along the proposed pipeline corridor. This is a "potential" traditional cultural property because its eligibility for National Register status has yet to be determined; this determination would be made during the Section 106 consultation process. The potential for the existence of additional traditional cultural properties and their estimated density are extremely high (on a scale of low-medium-high-extremely high); such properties would likely be associated with the Ute Tribe, Navajo Nation, and Hopi Tribe (Fritz 2004). Traditional cultural properties along the route may include sacred gathering areas, sacred healing areas, sacred springs, and burial areas.

3.4.19.9 Visual Resources

The 87-mile-long proposed pipeline corridor between the Moab and White Mesa Mill sites passes through areas designated primarily as Class III by BLM (see Section 3.1.15 for an explanation of visual resource classes). Approximately 20 percent of the route is classified as Class IV (south of Monticello and south of Blanding), and approximately 5 percent of the route is classified as Class II (Kane Springs Canyon, approximately 10 miles southeast of Moab; Long Canyon, approximately 10 miles northeast of Blanding; and Recapture Creek, approximately 3.5 miles northeast of Blanding).

A variety of visual settings occur throughout the Class III areas. Between Moab and Monticello, much of the landscape is characterized by gently to moderately rolling terrain that is abruptly dissected by dry, rocky arroyos. The predominantly red sandy soils are covered by moderately sparse vegetation composed of sagebrush, rabbitbrush, bunchgrasses, cheatgrass, piñon-pine, and juniper. Interspersed among the rolling hills are numerous red and beige sandstone outcrops, some occurring as isolated butte-like "islands" and others appearing as linear ridges and cliffs. Between Monticello and Blanding, the Class III areas are characterized more by rough-textured hills, ridges, and valleys that are thickly vegetated with sagebrush, piñon-pine, and juniper.

The Class IV areas south of Monticello and south of Blanding have been culturally modified by farming and ranching. The landscape is a gently to moderately rolling patchwork of plowed fields, green pastures, and cultivated wheat and alfalfa fields. Soils are predominantly red or dark reddish brown.

The Class II areas—Kane Springs Canyon, Long Canyon, and Recapture Creek—are characterized by steep, dissected canyons. The Kane Springs Canyon area contains the rugged red and beige ridges and cliffs of the Entrada Sandstone. These rocky ridges are sparsely vegetated with sagebrush and juniper. The canyons of Long Canyon and Recapture Creek are formed by the somewhat less rugged sandstone ridges and cliffs of the Burro Canyon Formation and Dakota Sandstone. The yellow-brown and tan rocks of these strata are covered with moderately dense piñon and juniper. Figure 3–44 and Figure 3–45 are photographs of the proposed pipeline crossings within Kane Springs Canyon and Recapture Creek, respectively.

Approximately 25 percent of the pipeline corridor, including those portions that cross Kane Springs Canyon and Recapture Creek, is visible to travelers on US-191. A 3- to 4-mile segment of the route that skirts the southwestern slope of Spanish Valley (Map 5, Appendix C) is visible to Moab residents and local traffic. The remaining 75 percent of the route is not visible to the general public.

3.5 Borrow Areas

Different types of borrow materials would be needed for cover materials. These materials range from silts and clays to riprap, or rock materials, that would be used to armor the sides of the disposal cell. Borrow areas that would provide these materials have been identified for each disposal alternative (see Figure 2–8). In some cases, a proposed borrow area would be used for more than one disposal alternative. Two of the proposed borrow areas (LeGrand Johnson and Papoose Quarry) are existing quarries, and specific information on rock materials present has been well documented. The proposed Floy Wash borrow area is near pits previously used by UDOT for highway materials. All other proposed borrow sources were selected on the basis of geologic reports and have not been field tested.

Once a disposal site was selected, the proposed borrow areas for that site would be evaluated for suitability by digging test pits and sampling boreholes. Borrow areas selected for analysis constitute an area larger than would be used. This would allow a contractor enough area to adequately test and configure the borrow area for project needs. For example, if the actual deposit of borrow material were not as deep as anticipated, a larger surface area would be required than if the deposit were thicker than anticipated. A larger area also would allow the contractor greater flexibility to avoid any sensitive resources encountered. Figure 2–8 shows the locations of the borrow areas.

3.5.1 Crescent Junction Borrow Area

The Crescent Junction borrow area is within the area designated as the Crescent Junction site area and, therefore, shares resource characteristics described in Section 3.3.

The general area is underlain by thick Mancos Shale that is composed primarily of mudstone with scattered thin beds of bentonite. The shallowest ground water is 3,000 ft deep in the Dakota Sandstone. No wetlands or federally regulated floodplains are present in this borrow area; however, during large storms, the nearby Crescent Wash will carry heavy flows of an indeterminate volume and lateral extent.

Air quality in this borrow area is expected to be similar to that described for the Moab, Crescent Junction, and Klondike Flats site alternatives. The Moab region is classified as an attainment area under the NAAQS (see Section 3.1.4 for further detail).

Wildlife diversity and densities are similar to those described in Section 3.3.9 and would be considered limited because of the semiarid climate, vegetation types, and habitat types present. However, the proximity of the Book Cliffs could increase the potential for cliff-dwelling raptors being present. Of the state listed sensitive species that are also protected under the MBTA, the ferruginous hawk and peregrine falcon are of primary concern. No important habitat has been identified for these or other non-federally protected wildlife species close to the Crescent Junction borrow area.

The Crescent Junction borrow area is located within the Crescent Junction site. Of the federally protected species listed in Table 3–32, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Crescent Junction borrow area.

UDWR (2003b) reported an unconfirmed sighting of the black-footed ferrets in the vicinity of the Crescent Junction borrow area in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Crescent Junction borrow area.

White-tailed prairie dog colonies around the Crescent Junction borrow area form a complex of colonies ranging in size from 10 acres to 2,445 acres (Seglund 2004). It is unknown to what extent individual colonies or a combination of colonies could support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Crescent Junction borrow area.

DOE, in consultation with USF&WS and BLM, would determine the need for habitat evaluations and surveys for species that may be affected.

The area surrounding the Crescent Junction borrow area is largely unpopulated. The nearest resident lives southeast of the I-70 interchange with US-191. Many unimproved dirt roads traverse the open country, and dispersed recreation, grazing, and oil and gas leasing occur in the general area, as described in Section 3.3.10.

Results of a Class I cultural resource inventory indicate that Class III cultural resource surveys have not been conducted at this site. Predictive modeling involving soil type and landform (Berry 2003) indicates that 1.9 cultural sites per square mile could be expected to occur within the borrow area. No data exist concerning the presence of potential traditional cultural properties on or near the borrow area. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high).

County, federal, and state road access to the general site area is described in Section 3.1.17 and is shown on Figure 3–21. There is no direct access to this borrow area from the Crescent Junction interchange with I-70, and it is anticipated that roads would need to be constructed for access to the borrow materials. If the materials were used for the Crescent Junction site alternative, only minor road improvements would be required. However, if these materials were used for another disposal site alternative, roads would need to be constructed from Crescent Junction or from the proposed Williams Crescent Junction terminal to access US-191.

3.5.2 Floy Wash Borrow Area

The Floy Wash borrow area is in an area that has been previously used by UDOT for borrow materials. It is located about 7 miles west-southwest of Crescent Junction just south of I-70. Material from the existing pits is from terrace gravel deposits that are up to 20 ft thick. The terrace deposits contain gravel composed of quartzite, chert, limestone, and sandstone rock types derived from sources in the Book and Roan Cliffs to the north. The terrace deposits overlie the 3,000-ft-thick Mancos Shale and are underlain by the water-bearing Dakota Sandstone. A single, ephemeral wash, Floy Wash, is immediately adjacent to the area. No perennial streams, wetlands, or federally regulated floodplains are located within the borrow area. A more detailed description of potential riparian resources is included in Appendix F, "Floodplain and Wetlands Assessment and Floodplain Statement of Findings for Remedial Action at the Moab Site." Minor use of surface water is limited to wildlife and livestock watering during and immediately after storms.

Soils at the Floy Wash site are classified as Mesa-Trook complex (SCS 1989) and are formed on mixed alluvium and fan pediments and terraces derived predominantly from sandstone and conglomerate. These soils are very deep, well-drained, fine sandy loams near the surface; below a depth of about 24 inches, they become very gravelly fine sandy loam.

Vegetation commonly supported on these soils consists of shadscale, galleta grass, Indian ricegrass, and fourwing saltbush. Vegetation observed during a site visit in April 2003 was dominated by phacelia and prickly pear cactus and reflects the history of the site as a gravel quarry. Other species observed include milkvetch, kochia, Gardner saltbush, mat saltbush, bud sagebrush, galleta, globemallow, and cheatgrass.

Depending on the condition of the plant community, wildlife species that may inhabit this area include game species such as antelope and chukar. Desert cottontail, black-tailed jackrabbit, and various other small mammal species may also find suitable habitat in this area. Coyote, red-tailed hawks, golden eagles, and northern harriers may find suitable hunting grounds on the Mesa-Trook soils.

Wildlife population diversity and densities are similar to those described for the Klondike Flats site (Section 3.2.8). Vegetation and habitat are limited and, therefore, limit species diversity. The proximity to I-70 may also limit species diversity.

The general area consists of land administered by BLM and interspersed with SITLA lands. This site is within the existing Athena grazing allotment. Immediate access off I-70 is available, although CR-334 is a backcountry dirt road that is part of the old highway alignment and would connect to US-191, as described in Section 3.1.17 and shown on Figure 3–21.

The Floy Wash borrow area is located nearest to the Crescent Junction site. Of the federally protected species listed in Table 3–32, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Floy Wash borrow area.

UDWR (2003b) reported an unconfirmed sighting of the black-footed ferrets in the vicinity of the Floy Wash borrow area in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Floy Wash borrow area.

White-tailed prairie dog colonies around the Crescent Junction area, located a few miles east of the Floy Wash borrow area, form a complex of colonies ranging in size from 10 to 2,445 acres (Seglund 2004). It is unknown to what extent individual colonies or a combination of colonies could support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Floy Wash borrow area.

Results of Class I cultural resource inventories indicate that Class III surveys have not been conducted for this site. However, on the basis of predictive modeling involving soil type and landform (Berry 2003), it is estimated that 2.7 cultural sites per square mile could be expected to occur within the borrow area. No data exist concerning the presence of potential traditional cultural properties on or near the borrow area. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high).

Noise levels at this site are expected to be comparable to noise levels associated with open desert areas. Vehicles on I-70 would constitute the nearest sources of man-made noise. However, activity at an existing borrow pit could also influence background noise levels. The site is situated on a broad, rolling, desert plain; it is sparsely vegetated with saltbush, cheatgrass, and prickly pear cactus. A 10- to 15-ft cut face exposes the types of borrow materials present. Around the site, distant canyons, buttes, and mesas form the background scenery. BLM assigns this area a Class III visual resource designation (Sweeten 2003) (Section 3.1.15 explains visual resource classes.) The borrow area is visible from I-70 and would be considered remote from populations.

3.5.3 Courthouse Syncline Borrow Area

The Courthouse Syncline borrow area is located several miles northwest of the Klondike Flats site. It is near the junction of Thompson and Crescent Washes in a broad open area of poorly developed drainages, where alluvial mud deposits less than 20 ft thick cover the surface. In addition to the alluvial mud deposits, some coarser-grained alluvial material (sand and gravel) also covers the surface of part of the site; this material has been transported from the Book Cliffs down Thompson Wash. The geologic setting at the borrow area is similar to that at the Klondike Flats site. The only significant difference is that the Mancos Shale beneath the borrow area is more than 1,000 ft thick and several hundred feet thicker than at the Klondike Flats site. Section 3.2 provides general background information on this area.

Thompson and Crescent Washes are considered ephemeral and are tributaries to Tenmile Wash, which is a tributary to the Green River. Both washes are dry most of the year and are typical of the drainage features in this area. Flows occur only after large storms. Use of surface water from these drainage features is limited to wildlife and livestock watering during and immediately after storms. No perennial streams, wetlands, or federally regulated floodplains are known to exist in the borrow area, but nearby Thompson and Crescent Washes contain potential riparian vegetation (see Appendix F).

Air quality in this borrow area is expected to be similar to that described for the Moab, Crescent Junction, and Klondike Flats sites. The Moab region is classified as an attainment area under the NAAQS (see Section 3.1.4 for further detail).

Wildlife resources are similar to those described for the Klondike Flats site and are limited by the limited vegetation and habitat present. However, an ephemeral wash on the southern perimeter of the site may provide cover and habitat for small mammals. No critical winter or summer range has been identified for wildlife in this area.

This area is currently open rangeland (Little Grand grazing allotment) administered by BLM. No residential areas or roads provide access. Area access is described in Section 3.1.17 and shown on Figure 3–21.

The Courthouse Syncline borrow area is located nearest to the Klondike Flats site. Of the federally protected species listed in Table 3–25, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Courthouse Syncline borrow area.

UDWR (2003b) reported an unconfirmed sighting of black-footed ferrets in the vicinity of the Courthouse Syncline borrow area in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Courthouse Syncline borrow area.

Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all of the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Courthouse Syncline borrow area.

DOE, in consultation with USF&WS and BLM, would determine the need for habitat evaluation and surveys for species that may be affected.

Results of a Class I cultural resources inventory indicate that Class III cultural resource surveys have not yet been conducted in this area. Predictive modeling involving soil type and landform

(Berry 2003) indicates that 22.4 to 27.4 cultural sites per square mile could be expected to occur within the borrow area. No data exist concerning the presence of potential traditional cultural properties on or near the borrow area. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of their occurrence and estimated density on the site are low (on a scale of low-medium-high-extremely high).

This borrow area is remotely located on a flat to gently rolling alluvial plain that is dotted with greasewood shrubs and small bunches of grasses and forbs. Small-scale dune-like features on the soil surface, formed by winds, are prevalent throughout the site. Far north of the site and forming the horizon are the Book Cliffs, a linear geologic feature that trends east-west from Grand Junction, Colorado, to Price, Utah. BLM assigns this area a Class III visual resource designation (Sweeten 2003). The site is not visible to the public.

Neither background noise nor ground vibration data are available for the Courthouse Syncline borrow area. Noise levels at the Courthouse Syncline borrow area are expected to be comparable to noise levels associated with open desert areas, typically 22 to 38 dBA. The nearest source of man-made noise is traffic on US-191; however, the borrow area is 2.75 miles west of the highway and the contribution of noise to the background noise at the borrow site is minimal (less than 40 dBA). Railroad traffic on the Union Pacific rail line that runs parallel to US-191 also has a low potential to contribute to background noise and ground vibration.

3.5.4 Klondike Flats Borrow Area

This borrow area is within the Klondike Flats site. Section 3.2 describes the resources present. Of the federally protected species listed in Table 3–25, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Klondike Flats borrow area.

UDWR (2003b) reported an unconfirmed sighting of the black-footed ferret in the vicinity of the Klondike Flats borrow area in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Klondike Flats borrow area.

Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all of the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Klondike Flats borrow area.

3.5.5 Tenmile Borrow Area

The Tenmile borrow area is located about 7 miles west of the Klondike Flats site. Rocks on the area surface are sandstones that are nearly flat lying; they consist of the Dewey Bridge Member of the Carmel Formation and the Slick Rock Member of the Entrada Sandstone. Other than small areas where sandstone is exposed, most of the area is covered by eolian sand. Ground water in the area is present at shallow depths (200 ft or less) in the Navajo Sandstone; springs emerge in draws near this site where the top of the Navajo Sandstone is exposed. No ephemeral or perennial surface water features or resources have been identified within this area, but Tenmile Wash, an ephemeral stream with potential riparian and/or wetland resources, exists nearby (see Appendix F). Section 3.2 provides general background information on this area.

Soils and potential natural vegetation at the Tenmile borrow area are classified as Nakai fine sandy loam, described previously in Sections 3.2.1 and 3.2.2. However, approximately 25 percent of Nakai sandy loam at the Tenmile borrow area is covered with stabilized and active parabolic dunes consisting of fine sand. Ephedra is the common dune stabilizer in the area. Other common plants are sand sage, hopsage, Indian ricegrass, and wild buckwheat in fine sand areas and fourwing saltbush, jimmyweed, rabbitbrush, galleta, and yucca in sandy loam areas. Tamarisk and greasewood occur in areas with relatively shallow ground water.

Air quality in this area is expected to be similar to that described for the Moab, Crescent Junction, and Klondike Flats sites. The Moab region is classified as an attainment area under the NAAQS (see Section 3.1.4 for further detail).

Wildlife population diversity and densities in the vicinity of this site are similar to those described for the Klondike Flats site in Section 3.2.8. Because of the level of recreational activity in this area, densities may be further limited seasonally. No critical winter or summer range has been identified for wildlife in this area. Of the identified threatened, endangered, or sensitive species potentially present, the black-footed ferret is the primary species of concern. No critical habitat is present in this area.

The Tenmile borrow area is located nearest to the Klondike Flats site. Of the federally protected species listed in Table 3–25, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Tenmile borrow area.

UDWR (2003b) reported an unconfirmed sighting of the black-footed ferret in the vicinity of the Klondike Flats site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Tenmile borrow area.

Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all of the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Tenmile borrow area.

DOE, in consultation with USF&WS and BLM, would determine the need for habitat evaluations and surveys for species that may be affected.

Land in the area is administered by BLM. Blue Hills Road is the major access to this site, although the area is laced with interconnecting backcountry roads and trails. There is high recreational use in the general area. Traffic counters placed on Blue Hills Road received up to 80 vehicle counts per day over a 1-month period, indicating that at least 80 individuals accessed this area daily over the period of record. Other uses in the area include grazing and oil and gas leasing. The nearest residence is approximately 9 miles east at the Canyonlands Field Airport.

Results of a Class I cultural resources inventory indicate that Class III cultural resource surveys have not yet been conducted in this area. Predictive modeling involving soil type and landform (Berry 2003) indicates that 22.4 to 27.4 cultural sites per square mile could be expected to occur within the borrow area. No data exist concerning the presence of potential traditional cultural properties on or near the borrow area. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of their occurrence and estimated density on the site are low to medium (on a scale of low-medium-high-extremely high).

Neither background noise nor ground vibration data are available for the Tenmile borrow area. Noise levels at the Tenmile borrow area are expected to be comparable to noise levels associated with open desert areas, typically 22 to 38 dBA. The nearest source of man-made noise is traffic on US-191. The borrow area is about 8 miles from US-191, and no contribution of highway noise to the background noise at the borrow site is expected. Railroad traffic on the Union Pacific rail line that runs parallel to US-191 also has a little potential to contribute to background noise and ground vibration.

This borrow area is situated on gently rolling topography that is capped by small, hummocky sand dunes. Scattered sand sage shrubs, bunch grasses, and desert primrose impart a rough texture to the lands and create a pleasing contrast to the pale red soils. Dominating the near-background are steep sandstone cliffs striated with red, beige, and tan rock strata. BLM currently assigns this area a Class IV visual resource designation (Sweeten 2003). This borrow area is highly visible to travelers on the adjacent road.

Access to the general area is described in Section 3.1.17 and shown on Figure 3–21.

3.5.6 Blue Hills Road Borrow Area

The Blue Hills Road borrow area is located about 4 miles south of the Klondike Flats site. A variety of rock types composing the Cedar Mountain Formation are exposed at this site. These rock types include mudstone, sandstone, gritstone, conglomerate, and limestone. Alluvial and eolian deposits cover bedrock in some areas within this borrow area. Ground water is at least 600 ft deep in the Entrada and Navajo Sandstones. Section 3.2 provides general background information on this area.

Soils at the Blue Hills Road borrow area are classified as Nakai fine sandy loam and the Toddler-Ravola-Glenton association. These soils and the potential natural vegetation are described in Sections 3.2.1 and 3.2.2.

A single, unnamed ephemeral wash, a tributary to Bartlett Wash and, therefore, to the Colorado River, is within the boundary of disturbance identified for this borrow area. No perennial surface waters, wetlands, or federally regulated floodplains are present within the boundaries of the borrow area, but a small spring with associated wetland vegetation exists directly adjacent to the southwestern boundary (see Appendix F).

Air quality in this area is expected to be similar to that described for the Moab, Crescent Junction, and Klondike Flats site alternatives. The Moab region is classified as an attainment area under the NAAQS (see Section 3.1.4 for further detail).

Wildlife population diversity and densities in the vicinity of this borrow area are similar to those already described for the Klondike Flats site (see Section 3.2.8). Because of the high level of recreational activity in the area and proximity of Blue Hills Road, densities and diversity are further limited. No critical winter or summer range has been identified for wildlife in this area.

The Blue Hills borrow area is located nearest to the Klondike Flats site. Of the federally protected species listed in Table 3–25, the endangered black-footed ferret and white-tailed prairie dog (currently under review for federal listing) could potentially occur on and/or in the vicinity of the Blue Hills borrow area.

UDWR (2003b) reported an unconfirmed sighting of black-footed ferrets in the vicinity of the Klondike Flats site in 1989. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne Counties in 1999 or their offspring could occur on or in the vicinity of the Blue Hills borrow area.

Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all of the colonies were relatively small and isolated, such that they would not support black-footed ferrets.

There is no designated or proposed critical habitat for the black-footed ferret in the vicinity of the Blue Hills borrow area.

DOE, in consultation with USF&WS and BLM, would determine the need for habitat evaluation and surveys for species that may be affected.

Oil and gas leases are in the area, but no oil or gas leases are currently active. A potassium permit was issued in 2001. Grazing occurs within the Arth's Pasture Grand grazing allotment. The closest residential property is adjacent to the Canyonlands Field Airport, approximately 3 miles east.

Results of a Class I cultural resource inventory indicate that Class III cultural resource surveys have not been conducted at this site. Predictive modeling involving soil type and landforms (Berry 2003) indicates that 1.9 to 27.4 cultural sites per square mile could be expected to occur within the borrow area. No data exist concerning the presence of potential traditional cultural properties on or near the borrow area. On the basis of Class I cultural resource inventory results, tribal interviews, and published and unpublished literature, the likelihood of occurrence and their estimated density on the site are low (on a scale of low-medium-high-extremely high).

Neither background noise nor ground vibration data are available for the Blue Hills Road borrow area. Noise levels at the Blue Hills Road borrow area are expected to be comparable to noise levels associated with open desert areas, typically 22 to 38 dBA. The nearest source of man-made noise is traffic on US-191. The borrow area is about 3 miles from the highway, and the contribution of noise to the background noise at the borrow site is minimal. Railroad traffic on the Union Pacific rail line that runs parallel to US-191 also has a low potential to contribute to background noise and ground vibration.

This borrow area is located on a smooth, flat, desert plain with evenly scattered bunchgrasses and forbs. The light- and dark-green plants form a moderate contrast with the pale, reddish-beige soils. In the immediate background, steep hillsides rise from the valley floor and form conical and horizontal features. BLM assigns this area a Class III visual resource designation (Sweeten 2003). This site is visible to travelers on Blue Hills Road.

3.5.7 LeGrand Johnson Borrow Area

This privately owned existing commercial gravel pit is located about 8 miles south of Moab along US-191 in Spanish Valley (see Figure 2–8). It has an estimated available volume of 600,000 yd^3 of sand, gravels, and road base materials. No federally protected species are known to occur at the LeGrand Johnson borrow area.

3.5.8 Papoose Quarry Borrow Area

This existing commercial quarry, operated by the Cotter Corporation on state lands, has an estimated available large rock volume of 13 million yd^3. It is located in Lisbon Valley south of SR-46 and at the intersection of CR-113 and CR-370 (see Figure 2–8). No federally protected species are known to occur at the Papoose Quarry borrow area.

3.5.9 Blanding Borrow Area

This borrow area, located north of the White Mesa Mill site and northeast of Blanding, is near existing sand and gravel pits. Section 3.4 provides area resource information.

Recapture Creek, a perennial stream, is located within this site area. Surface flow information is unavailable. There is also an intermittent stream present, and both it and Recapture Creek are vegetated by tamarisk, cottonwood, willow, and shrub oak (BLM 2003c). These streams would need a more detailed water resource inventory should this site be chosen. Wildlife present is believed to be similar to that described in Section 3.4.9. Compared to other borrow areas under consideration, this site is believed to support greater diversity and abundance of wildlife. Mule deer migration routes have been identified south of this site in T. 33 S. to T. 35 S. and within ranges both east and west of US-191. Critical winter range is found in T. 35 S. to T. 37 S. and in ranges east of US-191. Restrictions are in effect from November 15 to April 30 of each year.

Of the federally protected species that could be potentially present in the Blanding borrow area (Table 3–51), the Gunnison sage grouse, a federal candidate species, is of primary concern. The Blanding borrow area lies within a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000). High quality habitat for the Gunnison sage grouse has been designated in T. 31 S.–T. 33 S., R. 24 E. (Maps 10 and 11, Appendix C). The burrowing owl may also be present in the Blanding borrow area.

This site is easily accessible from US-191 (see Section 3.4.15) and is on land administered by BLM. It is within a designated transportation and utility corridor and is open to off-highway vehicle use. Other existing uses include grazing and mineral, oil, and gas leasing.

The cultural history of the Blanding borrow area is included in the more general cultural history of southeastern Utah described in Section 3.1.13.1.

Results of the Class I inventory indicate that Class III cultural resource surveys have not been completed for most of the Blanding borrow area. However, one Pueblo II (A.D. 900–1150) habitation site, eligible for inclusion in the National Register of Historic Places, has been documented in the area. On the basis of nearby archaeological surveys (Davis et al. 2003), it is estimated that approximately 56 cultural sites (or 45 sites eligible for inclusion in the National Register of Historic Places) per square mile could be expected to occur within or near the borrow area. The Blanding borrow area is an important plant gathering area for White Mesa Utes and is important to the traditional route from Allen Canyon/Cottonwood Wash area to the White Mesa community. Recent interviews (Fritz 2004) with tribal members indicate that at least two potential traditional cultural properties associated with the Ute Tribe exist on or near the proposed borrow area. These are "potential" traditional cultural properties because their eligibility for National Register status has yet to be determined; this determination would be made during the Section 106 consultation process. In this area, the likelihood of occurrence of traditional cultural properties and their estimated density are extremely high (on a scale of low-medium-high-extremely high) and are likely associated with the Ute Tribe, Navajo Nation, and Hopi Tribe (Fritz 2004). Traditional cultural properties on or near the site may include sacred gathering areas, sacred ceremonial sites, sacred healing areas, sacred springs, and burial areas.

Neither background noise nor ground vibration data are available for this borrow area. Noise levels at the IUC off-site borrow area are expected to be comparable to noise levels associated with open desert areas, typically 22 to 38 dBA. The nearest source of man-made noise is traffic on US-191 that passes through the northern part of this site. The community of Blanding is located about 1 mile from the southwest corner of the site. Background noise levels at the site would be influenced by traffic on US-191 and could raise noise levels to about 60 dBA measured 50 ft from roadside. There are no rail lines near the borrow area.

This site is located on a hilltop overlooking US-191. The beige soil material within the existing open borrow pits contrasts sharply with the smooth, rolling, dark-green hills surrounding the site. BLM assigns this area a Class III visual resource designation (Sweeten 2003). The site is currently visible for approximately 5 to 10 seconds to southbound travelers on US-191. Northbound travelers do not see the site.

3.5.10 White Mesa Mill Borrow Area

The White Mesa Mill borrow area is located south of Blanding within the IUC property boundary. This borrow area contains clay from the upper part of the Brushy Basin Member of the Morrison Formation that contains about 90 percent bentonite. The geologic setting is about 200 ft lower stratigraphically than at the White Mesa Mill site. Ground water is present in a perched shallow system in the Dakota Sandstone and Burro Canyon Formations. It emerges in seeps at the base of the Burro Canyon Formation in the slopes of the canyon above the borrow area. Ground water directly beneath the borrow area is in the deeper artesian aquifer of the Entrada and Navajo Sandstones. A description of area resources is provided in Section 3.4.

This site is remotely located at the head of a broad, deeply dissected canyon. Composed of valley bottoms and steep hill slopes, the area is a colorful mix of gray, maroon, and pale-green rock strata that are dotted with dark-green piñon and juniper trees. BLM-managed land surrounding this privately owned borrow area is designated Class III (Sweeten 2003). Because of its remote location, this site is not visible to the public.

Of the federally protected species that could be potentially present in the White Mesa Mill borrow area (Table 3–44), the Gunnison sage grouse, a federal candidate species, is of primary concern. The White Mesa Mill borrow area lies within the White Mesa Mill site which itself lies within a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000). However, this species is not known to occur at the White Mesa Mill site (IUC 2003).

The cultural history of the on-site IUC borrow area is included in the more general cultural history of southeastern Utah described in Section 3.1.13.1.

Results of the Class I inventory (Davis et al. 2003) indicate that a Class III survey was conducted at this borrow area in 1980 as part of the larger cultural resource inventory of the White Mesa Mill site. Six cultural sites are documented within the boundaries of the borrow area. Of these, three sites are eligible for inclusion in the National Register of Historic Places. One is a Pueblo II (A.D. 900–1150) permanent habitation site, one is a permanent habitation site of indeterminate age, and one is a General Pueblo (A.D. 750–1300) limited activity site. The White Mesa Mill borrow area is an important plant gathering area for White Mesa Utes and is important to the traditional route from Allen Canyon/Cottonwood Wash area to the White Mesa community. Ongoing interviews with White Mesa elders have identified burial sites in the area. Recent interviews (Fritz 2004) with tribal members indicate that at least three potential traditional cultural properties associated with the Ute Tribe exist on or near the proposed borrow area. These are "potential" traditional cultural properties because their eligibility for National Register status has yet to be determined; this determination would be made during the Section 106 consultation process. In this area, the likelihood of occurrence of traditional cultural properties and their estimated density are extremely high (on a scale of low-medium-high-extremely high) and are likely associated with the Ute Tribe, Navajo Nation, and Hopi Tribe (Fritz 2004). Traditional cultural properties on or near the site may include sacred gathering areas, sacred ceremonial sites, sacred healing areas, sacred springs, and burial areas.

Neither background noise nor ground vibration data are available for this borrow area. Noise levels at this borrow area reside within the boundaries of the White Mesa Mill site. Background levels are expected to be comparable to noise levels associated with open desert areas, with some influence from existing White Mesa Mill operations that are centered about 1 mile to the north of the borrow area. These noise levels could approach 50 to 60 dBA at the borrow area as a result of operations at the White Mesa Mill facilities. US-191 passes about 1 mile to the east of the designated borrow area. Background noise levels at the site would be influenced by traffic on US-191. There are no rail lines near the borrow area.

3.6 References

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4.0 Environmental Consequences

This chapter describes the short- and long-term impacts that would result from implementing the alternatives discussed in Chapter 2.0. It addresses the impacts of the on-site disposal alternative and three off-site disposal alternatives for contaminated materials at the Moab site, remediation of vicinity properties, and ground water compliance at the Moab site. The alternatives and sections in which they are fully discussed are

- On-site disposal at the Moab site (Section 4.1)
- Off-site disposal at the Klondike Flats site (Section 4.2)
- Off-site disposal at the Crescent Junction site (Section 4.3)
- Off-site disposal at the White Mesa Mill site (Section 4.4)
- Borrow area impacts (Section 4.5)
- No Action alternative (Section 4.6)

As characterized in Chapter 2.0, each alternative except the No Action alternative would include both on-site and off-site activities. In the following sections, impacts of the alternatives are broken down by activity under each environmental resource area:

- *Construction and operations at the Moab site*—these activities would include those needed for surface remediation, ground water compliance, and reduction of the influence of ground water on the Colorado River. These activities would also include construction and operation of any transportation facilities needed at the site to either dispose of the contaminated material on the site or remove the materials from the site for off-site disposal.

- *Characterization and remediation of vicinity properties*—these activities would include surveying, sampling soil, removing contaminated materials, and restoring landscaping. Contaminated materials from vicinity properties would first be transported to the Moab site under all remediation alternatives. These activities would be the same under all the alternatives and thus are addressed only once, under the on-site disposal alternative.

- *Construction and operations at one of the three off-site disposal sites*—these activities are addressed only for the off-site alternatives and would include construction and operation of any transportation facilities needed at the off-site disposal sites for the handling and disposal of contaminated materials.

- *Construction and operations relating to transportation*—these activities would include (1) transportation of contaminated materials from vicinity properties to the Moab site (the estimated volume of contaminated materials from vicinity properties is included as part of the total volume of contaminated materials to be disposed of under all alternatives), (2) transportation of materials from borrow sites to the Moab site and to one of the three off-site disposal sites, and (3) transportation of contaminated materials from the Moab site to one of the three off-site disposal sites (where applicable). For the off-site alternatives, this section addresses impacts of truck, rail, and slurry pipeline transportation of contaminated materials from the Moab site to the off-site locations.

- *Monitoring and maintenance*—these activities would include inspections and sampling conducted in accordance with the site's Long-Term Surveillance and Maintenance Plan, which would be approved by NRC.

As applicable, the impacts from these activities are summarized for each resource. Impacts at the 10 borrow areas analyzed are addressed in Section 4.5. The No Action alternative is discussed in Section 4.6.

Consistent with DOE and Council on Environmental Quality NEPA guidance, the analysis of impacts in this chapter focuses on those areas in which impacts may occur from any action proposed by the alternatives assessed in this EIS. For this reason, the level of detail and analysis varies among the resource areas according to the duration and degree of the expected impact.

4.1 On-Site Disposal (Moab Site)

This section discusses the short-term and long-term impacts associated with the on-site disposal alternative. The impacts are based on the proposed actions described in Section 2.1 and the affected environment described in Section 3.1. This alternative would result in impacts at the Moab site, vicinity properties, and borrow areas, and transportation impacts associated with commuting workers and the transport of vicinity property material and borrow material. The combined impacts that may result from these activities are summarized for each assessment area (e.g., Geology and Soils) at the end of each subsection.

4.1.1 Geology and Soils

4.1.1.1 Construction and Operations Impacts at the Moab Site

Geology

Proposed surface or ground water remediation at the Moab site would not be affected by seismic factors. The Moab site is located in an area where evidence indicates that significant earthquakes are rare. The Moab Fault lies deep beneath the site, but it does not pose a significant earthquake or surface-rupture threat to the tailings pile and is not a capable fault under NRC siting criteria. The site lies within Uniform Building Code 1, indicating the lowest potential for earthquake damage.

Two geologic processes, subsidence (basin settling) and incision (cutting into bedrock by the Colorado River), would affect the tailings pile very slowly over very long periods of time. These processes are discussed in Section 3.1.1.4. Incision and subsidence rates indicate that the impact to a disposal cell at the Moab site over the 1,000-year regulatory design period would be to lower the elevation of the cell by approximately 1.4 ft in relation to the Colorado River. This would place the 100-year floodplain of the Colorado River about 1.4 ft higher on the east toe of the cell, creating a higher probability for flooding over time. This potential impact would be very long term, and the potential hazard would be reduced by the proposed buried riprap diversion wall (see Figure 2–3). The proposed ground water remediation would not be affected by these long-term geologic processes. Subsidence would result in the tailings coming into permanent contact with the ground water in approximately 7,000 to 10,000 years.

Several geologic resources exist beneath the disposal cell, including sand and gravel, saline minerals, and brine. The sand and gravel resource would be adversely affected by the proposed on-site disposal alternative because it provides a foundation for the disposal cell and would have to remain undisturbed in perpetuity; therefore, this resource would be unavailable for commercial exploitation. Saline minerals and brine resources would not be affected because they could be physically accessed and recovered by slant drilling from areas adjacent to the site. However, past mill operations have likely introduced sufficient quantities of contaminants to these resources to prohibit future use under any alternative.

Soils

The major impact on soils at the Moab site under the on-site disposal alternative would be the excavation and relocation onto the tailings pile of approximately 234,000 tons (173,000 yd^3) of off-pile contaminated site soil and the backfilling (replacement) of these soils with approximately 320,000 yd^3 of clean reclamation borrow soil to a depth of approximately 6 inches. These would be short-term impacts that would result in some potential for soil erosion due to the site soil characteristics discussed in Section 3.1.2. The potential for erosion would continue until the cover was installed, the reclamation soil emplaced, and vegetation established. The potential for erosion would be reduced through implementation of the *Fugitive Dust Plan for the Moab, Utah, UMTRA Project Site* (DOE 2002a) and Utah Pollutant Discharge Elimination System storm water discharge requirements. Soil subsidence, a form of subsidence associated with surface flow and erosion processes, could occur at the site through the development of soil pipes, or voids in the soil. However, no soil pipes have been discovered to date, and the engineered cell would control surface flow to prevent the development of soil pipes and subsequent soil subsidence adjacent to the cell. Ground water remediation would not affect soils. Reclamation and revegetation, the final proposed construction phase (Section 2.1.1.4), would leave the soils on and surrounding the tailings impoundment less vulnerable to erosion than they are today.

4.1.1.2 Impacts from Characterization and Remediation of Vicinity Properties

Soil impacts at the vicinity properties would be qualitatively similar to those for the Moab site, but on a much smaller scale. The average area of disturbance at a vicinity property is expected to be 2,500 ft^2, less than 6 percent of an acre, and the total area of soil disturbance to all vicinity properties is expected to be approximately 6 acres. As necessary and appropriate, erosion control measures would be implemented as described for the Moab site. Remediation of vicinity properties would not be affected by geologic features or processes. It is highly unlikely that any geologic resources exist at any vicinity properties in quantities or locations that would justify commercial interest.

4.1.1.3 Impacts from All Sources

The loss of potential commercial availability of sand and gravel resources underlying the tailings pile could be a negative long-term impact to geologic resources. However, it is likely that these resources are contaminated from previous mill operations and are therefore unusable under any alternative. There would be a negative long-term impact on the disposal cell due to a very slow subsidence of the cell (1.4 ft over 1,000 years) into the 100-year floodplain of the Colorado River on the east toe of the cell, but this impact would not result in collapse of the pile. Negative, short-term impacts on soils would result from excavating contaminated soils, conducting construction activities, depositing contaminated materials in the tailings pile, recontouring, and capping the tailings pile. These activities would affect approximately 439 acres of the Moab site and 6 acres of vicinity properties. There would be no geologic or soils-related impacts associated with transportation, ground water remediation, or monitoring and maintenance activities under the on-site disposal alternative.

4.1.2 Air Quality

4.1.2.1 Construction and Operations Impacts at the Moab Site

During surface and ground water remediation (described in Sections 2.1.1 and 2.3.2), heavy-duty diesel equipment such as excavators, scrapers, and dozers would emit pollutants. Fugitive dust emissions would also occur. However, emission of fugitive dust would be minimized by using control measures, such as applying water or chemicals and covering truck beds. As shown in Table 4–1, the concentrations of criteria pollutants from the Moab site emissions are below the primary and secondary NAAQS in 40 CFR 50. The estimated concentrations of criteria air pollutants from emissions shown in Table 4–1 were derived by applying tailpipe emission factors provided in *Compilation of Air Pollutant Emission Factors* (EPA 2000) to the estimated construction fleet composition and duration of construction operations. With respect to PSD, and as noted in Section 3.1.4, the Moab site is in a Class II area but shares a common boundary with Arches National Park, a Class I area where maximum allowable increases in PM_{10} are limited to 4 $\mu g/m^3$ (annual arithmetic mean) and 8 $\mu g/m^3$ (24-hour maximum). However, Utah PSD regulations provide that concentrations of PM_{10} attributable to the increases in emissions from construction or other temporary emission-related activities shall be excluded in determining compliance with the maximum allowable increase (UAC 2000).

Table 4–1. Criteria Pollutant Concentrations from Emissions at the Moab Site

Pollutant	Averaging Period	Standard ($\mu g/m^3$)	Concentration from Emissions ($\mu g/m^3$)
Carbon monoxide	1-hour	40,000	31
	8-hour	10,000	22
Nitrogen dioxide	Annual	100	7.0
Sulfur dioxide	Annual	80	0.71
	24-hour	365	3.6
	3-hour	1,300	8.0
PM_{10}[a]	Annual	50	3.0
	24-hour	150	15

[a] PM_{10} includes fugitive dust emissions from construction activities.
$\mu g/m^3$ = micrograms per cubic meter.

In addition to the short-term criteria air pollutant emissions shown in Table 4–1, some long-term air emissions would be associated with ground water extraction and treatment activities. Emissions from ground water extraction would be expected to be minor because the system would probably use electric pumps. Emissions from treatment activities would depend on the treatment technology used. As noted in Section 2.3.2, operation of an evaporation pond, particularly spray evaporation, or ammonia-stripping treatment technology would probably be the alternatives with the highest potential for air emissions. Potential impacts from these emissions are discussed in Section 4.1.15, "Human Health," subsection 4.1.15.1, "Construction and Operations Impacts at the Moab Site."

4.1.2.2 Impacts from Characterization and Remediation of Vicinity Properties

During the remediation of vicinity properties, heavy-duty diesel trucks used to haul materials, automobiles used by workers, and backhoes or scrapers used to excavate, load, and unload materials would emit pollutants. Fugitive dust emissions would also occur, but they would be small because of the small acreage disturbed at each vicinity property (estimated to average 0.06 acre) and the relatively high moisture content of the material (DOE 1985). In addition, emission of fugitive dust at vicinity properties would be minimized by using control measures, such as applying water or chemicals and covering open truck beds.

During remediation of a typical vicinity property, an estimated 12.9 pounds of hydrocarbons, 23.6 pounds of nitrogen oxides, 0.7 pound of sulfur oxides, 157.6 pounds of carbon monoxide, and 0.5 pound of total suspended particulates would be emitted (DOE 1985). For remediation of 98 vicinity properties, a total of about 1,300 pounds of hydrocarbons, 2,300 pounds of nitrogen oxides, 70 pounds of sulfur oxides, 15,000 pounds of carbon monoxide, and 50 pounds of total suspended particulates would be emitted from vehicles. These emissions would be distributed geographically and temporally and would not cause any permanent air quality impacts (DOE 1985).

4.1.2.3 Construction and Operations Impacts Related to Transportation

The air quality impacts of transportation under the on-site disposal alternative are discussed in Section 4.1.15, "Human Health," subsection 4.1.15.3.

4.1.2.4 Monitoring and Maintenance Impacts

During monitoring and maintenance activities, there would be minimal use of heavy equipment on the Moab site. Therefore, concentrations of criteria pollutants would be similar to the background concentrations shown in Table 3–5, "Air Quality in the Moab Region."

4.1.2.5 Impacts from All Sources

Emissions of criteria air pollutants, including carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}, would occur at the Moab site and at vicinity properties because of the operation of heavy construction equipment and ground water remediation equipment. No criteria air pollutant emission concentrations at the Moab site, where concentrations are expected to be highest, would exceed NAAQS.

4.1.3 Ground Water

This section describes the short-term and long-term impacts to ground water that would result from on-site disposal of contaminated site and vicinity property materials. Ground water impacts would directly affect surface water. Impacts are assessed assuming that the final disposal cell would be in the same location as the existing tailings pile. The impacts analysis is based on the proposed action and alternatives described in Sections 2.1 and 2.3 and the affected environment as described in Section 3.1.6. No impacts to ground water at the site would result from remediation of vicinity properties, transportation activities, or monitoring and maintenance. Therefore, no further discussion for these activities is included in this section.

According to the most recent site conceptual model, three discrete mechanisms for contaminant transport are affecting the site ground water system: (1) downward seepage of contaminated fluids from the tailings pile to the ground water, (2) upward flux of contaminants from the brine interface to the freshwater layer, and (3) lateral movement of the legacy plume in the upper alluvial aquifer. All three are contributing ammonia to the Colorado River. Ground water potentially migrating beneath the Colorado River from the site is not anticipated to affect surface waters or aquatic communities on the east side of the river, in the vicinity of the Matheson Wetlands Preserve.

The naturally high salt content in the ground water prevents it from being a potential source of drinking water. Contaminated ground water would not be made available to the public and therefore would not pose a risk to public health. The impact analysis in this section addresses contaminants in ground water that influence surface water quality and subsequently aquatic receptors. Previous studies, recent DOE evaluations (DOE 2003a), and Chapter 3.0 indicate that ammonia is the primary contaminant of concern in ground water and could pose a risk to aquatic receptors in surface water. Active remediation of ground water would reduce the mass of ammonia discharging to the Colorado River and would prevent long-term adverse impacts to surface water and aquatic receptors. Active remediation would also ensure long-term protection of surface water and ecological receptors from risk that may be caused by other contaminants.

4.1.3.1 Construction and Operations Impacts at the Moab Site

For purposes of this EIS, short-term impacts to ground water would include the period from completion of the remedial action plan until concentrations in the surface water were protective of aquatic species, as described in Section 2.3. Therefore, short-term impacts would include those that would occur to ground water during surface remediation and during preparation of the site for active ground water remediation. Long-term impacts to ground water would be those that would occur during and after active remediation.

Although short-term impacts would not adversely affect human health, ground water impacts are discussed to provide an explanation of potential effects on surface water. In the short term, the potential exists for ammonia concentrations to increase slightly in the river as a result of tamarisk removal during surface remediation. If tamarisk were reestablished, phytoremediation would likely augment ground water and contaminant mass removal in ground water through root uptake. This, combined with active ground water remediation, would likely decrease ammonia concentrations affecting surface water. Tailings seepage and ammonia flux are all expected to decrease gradually both in the short and long term. Installation of extraction wells and trenches necessary for active remediation would not adversely affect ground water. Applications of clean water (discussed in Section 2.3.2.4) would not adversely affect ground water quality, as such applications are designed to enhance the quality of surface water.

In the long term, capping the tailings pile would reduce concentrations of ground water contaminants, including ammonia, to levels well below those currently existing, because decreased infiltration rates of precipitation through the tailings would reduce tailings pore fluid seepage. The seepage rate of tailings pore fluids would decline from the current rate of 20 gpm until consolidation of the tailings was complete and the steady-state condition of 0.8 gpm was reached in approximately 130 years. Ammonia flux from the brine and the legacy plume would decrease gradually through the action of natural processes (e.g., adsorption, geochemical degradation, dispersion) to background concentrations, as fresh ground water entered the site from recharge areas in the vicinity of Moab Wash and flowed beneath the tailings pile toward the Colorado River and as the contaminant mass in the brine was depleted.

Assumptions for tailings drainage and ammonia concentrations are presented in Table 4–2.

Table 4–2. Assumptions for Liquid Drainage and Ammonia Concentrations From the Tailings Pile for the On-Site Disposal Alternative

Parameter	Value
Infiltration rate	1 × 10^{-7} cm/s before construction and 1 × 10^{-8} cm/s after construction
Gravity drainage	Rate would decay from 8 gpm at present to 0.8 gpm at 130 years
Transient drainage	Rate would decay from 12 gpm at present to 0 gpm at 20 years
Initial ammonia concentration seepage from base of tailings pile	1,100 mg/L
Breakthrough ammonia concentration from upper salt layer	18,000 mg/L
Arrival time	1,100 years
Final concentration	1,100 mg/L
Exit time	1,540 years

cm/s = centimeters per second; gpm = gallons per minute; mg/L = milligrams per liter

Limited data suggest that there may be significantly higher ammonia concentrations in the upper 10 ft of tailings related to a 3- to 6-inch salt layer (DOE 2003a). In the future, as water infiltrates the upper portion of the tailings, it may dissolve the salt deposits, and pore fluid concentrations seeping from the base of the tailings could have up to 18,000 mg/L ammonia. These high concentrations would persist as long as salt deposits remain in the tailings. If the salt deposits become depleted by dissolution from infiltrating water, pore fluid concentrations would decrease. It is estimated that it would take approximately 1,100 years (longer than the disposal cell design life) for the relatively high ammonia concentrations to reach the ground water, and dissolution would continue for approximately 440 years until the salt layer was depleted. It is assumed that after the salt layer was depleted (in approximately 1,540 years), ammonia concentrations in the pore fluids would return to 1,100 mg/L (DOE 2003a).

If the on-site disposal alternative were selected, DOE would conduct more detailed field studies to confirm or refute the existence of the salt layer. Likewise, if the on-site alternative were selected, and if the existence of the salt layer were confirmed, additional field studies would then be conducted to characterize and map the salt layer. On the basis of these characterizations, DOE would conduct more reliable transport modeling and, based on the results, make a decision regarding the need for mitigation measures. If found to be necessary and appropriate, mitigation measures could include excavation and treatment of the salt layer, which could eliminate the concern over a secondary pulse of ammonia that might occur in the year 3100 time frame. However, given the still-unconfirmed presence of the salt layer and the nature of its possible future impacts, DOE has not conducted additional characterization of the potential impacts and associated mitigation measures or evaluated costs beyond the material presented here because DOE has determined that such information is not essential to a reasoned choice among the alternatives.

Available information is insufficient to reliably estimate the inventory of soluble mineral salts in the tailings, estimate the time for the salts to be completely depleted, or predict the future geochemical transformations that may occur. However, mineral depletion would trigger rapid decreases in pore water dissolved solids and ammonia concentrations. Because of the slow flow of water through the tailings, it is unlikely that mineral depletion would occur in any reasonable time period. In addition, the chemistry of the pore fluid would likely change as it percolated down through the tailings. Pore water pH would increase, and some minerals would form from reaction with minerals such as calcium carbonate. As acidic, high-concentration ammonia pore water moved down through high-pH, carbonate-bearing tailings, chemical precipitation would occur, and concentrations of some constituents would decrease. Thus, the ammonia concentration estimated at 18,000 mg/L (ammonia-N) could be significantly lower.

Ground water flow and transport modeling described in the SOWP (DOE 2003a) was performed to evaluate the impact of the on-site disposal alternative to the ground water system near the Colorado River from the three contaminant transport mechanisms (brine flux, legacy plume, and tailings seepage) over a period of 200 years. The modeling results, presented in Figure 4–1, indicate that most of the ammonia flux from the brine layer and the legacy plume in the alluvial aquifer would naturally flush to the river in approximately 80 years. At the end of the 80-year period, seepage of 1,100 mg/L ammonia from the base of the tailings pile would continue to decline until it reached a steady-state rate of 0.8 gpm; ground water concentrations near the river would decline below 0.7 mg/L ammonia after 200 years but remain above background. Predicted concentrations plotted in Figure 4–1 represent the maximum ammonia-N concentrations for a series of observations located along a transect parallel to the Colorado River downgradient from the toe of the tailings pile along a flow path near the center of the plume.

The target goal of 3 mg/L for ammonia in ground water, as discussed in Chapter 2.0, provides reasonable assurance of meeting the surface water remediation objective to provide protection of aquatic species. Modeling results indicate the ammonia concentrations in ground water near the bank of the Colorado River would be expected to decline from the current 500 to 1,000 mg/L to a maximum of approximately 3 mg/L in 80 years, and less than 0.7 mg/L at steady state in 200 years. Predicted concentrations in the ground water at 80 and 200 years in the future are summarized in Table 4–3. Predicted concentrations after 80 years and 200 years are illustrated in Figure 4–2 and Figure 4–3, respectively. As evident from the data presented in Table 4–3 and Figure 4–2, the on-site disposal alternative would meet the 3-mg/L target goal in ground water adjacent to the backwater habitat area.

Concentrations of treated ground water that would be reinjected into the aquifer would depend on the treatment options, as discussed in Section 2.3.2.1, but would not adversely affect ground water quality or human health. If reinjection were selected, contaminated ground water would be disposed of in accordance with state underground injection control regulations.

The potential exists in the long term (during and following active remediation) for ground water contaminant concentrations to be affected by a 100-year flood, similar to a flood that occurred in 1984, which was simulated to evaluate the impact of ammonia released to the Colorado River. A simplified analysis in the SOWP (Section 7.5.4) based on surveyed elevations of the tailings profile, river stage elevation measurements obtained during the 1984 flood, and physical properties of the tailings indicates that the drainage volume is approximately 591,250 ft^3 (4.4 million gallons). An average concentration of the tailings pore fluid of approximately 1,100 mg/L and an average drainage rate of the pore fluid of 307 gpm for 10 days would produce a source of approximately 1.8 million grams of ammonia per day. Model results suggest that near the bank of the Colorado River, the maximum ammonia concentration in ground water would increase ambient concentrations by just over 2 mg/L in approximately 10 years after a 100-year flood. However, effects of the tailings inundation would decline rapidly over a period of approximately 20 years after the flood event. After the estimated 80-year active remediation effort for the on-site disposal alternative, even during episodic flood events, water quality would remain protective of aquatic organisms at the point of exposure. Therefore, the on-site remedy could satisfy the requirements of 40 CFR 192.

This simplified analysis was performed as a screening step to evaluate the potential magnitude of a significant ground water rise caused by flooding in the Colorado River to determine if additional analysis would be warranted. Because the analysis was a worst-case scenario, and the ammonia concentrations were predicted to only slightly exceed 2 mg/L at the river, no additional analysis was deemed necessary.

Results of the simplified analysis probably overestimate the 2 mg/L ammonia concentration by one to two orders of magnitude for two reasons: (1) the actual drainage rate would be much less than the 307 gpm and (2) the ammonia concentrations in the seepage water would be much less than the assumed 1,100 mg/L. The actual drainage rate is overestimated because the analysis does not account for the low permeability of the sides of the pile that would be protected by a 1×10^{-8} centimeters per second (cm/s) clay layer and the low permeability of the dense basal layer of the tailings. These low permeabilities would limit the volume of water that enters into the pile. The analysis also conservatively assumes that the entire volume of water would equilibrate instantaneously to 1,100-mg/L ammonia while in contact with the tailings before draining. Therefore, it is very unlikely that the ammonia concentrations would approach 2 mg/L at the river.

4.1.3.2 Impacts from All Sources

Implementation of ground water remediation with application of supplemental standards would result in no adverse impacts to ground water and therefore would not adversely affect human health. In the long term, active remediation would reduce ammonia concentrations in ground water that are adversely affecting the Colorado River.

4.1.4 Surface Water

This section describes the short-term and long-term impacts to surface water that would result from on-site disposal of contaminated site and vicinity property materials. Impacts that could occur from remediation of surface materials and ground water are assessed assuming that the final disposal cell would be in the same location as the existing tailings pile. The impacts analysis is based on the proposed action and alternatives described in Sections 2.1 and 2.3 and the affected environment as described in Section 3.1.7. Section 4.1.4.1 discusses the impacts that would result from construction and operations. Section 4.1.4.2 discusses impacts associated with remediating vicinity properties. No impacts to surface water at the Moab site are anticipated as a result of transporting vicinity property materials to the site, or as a result of maintenance and operations following surface remediation. Therefore, these aspects are not discussed further. Section 4.1.4.3 summarizes the impacts from all sources for later comparison of impacts between the alternatives. Section 4.1.17 discusses potential impacts as a result of a post-remediation catastrophic event.

4.1.4.1 Construction and Operations Impacts at the Moab Site

In the short term, surface-disturbing activities, including removing tamarisk, excavating contaminated soils, regrading the disposal cell, realigning Moab Wash, and placing vicinity property materials on the site, present the potential for increased contamination and sediment runoff to the Colorado River and Moab Wash. However, no significant adverse impacts to surface water are anticipated because site controls and a storm water management plan would be implemented as described in Chapter 2.0. Enforcement of the plan would be shared jointly by DOE, the State of Utah, and, when applicable, the Corps of Engineers. Likewise, fuel storage areas would be managed and controlled in accordance with state regulations to prevent the release of petroleum products to surface waters. Withdrawal of surface water for clean water applications, as described in Section 2.3.2.4, and for dust control would be within the water rights granted by the State. Any work within Moab Wash or the Colorado River high water mark would be completed in accordance with a Clean Water Act Section 404 permit.

Concentrations of ammonia in surface water can exceed federal and state ambient water quality criteria in some locations at certain times. Contaminated ground water could continue to adversely affect surface water for up to 5 years after implementation of active ground water remediation (see Figure 2–42). However, interim actions, including DOE's proposed clean water application (Section 2.3.2.4), are being implemented and could be implemented periodically to reduce ammonia concentrations and minimize adverse effects to surface water quality.

An analysis of ground water impacts (Section 4.1.3) shows that ammonia concentrations in ground water would decrease through natural processes (e.g., adsorption, geochemical degradation, dispersion) until a steady-state concentration was reached. Surface water concentrations should decrease as well. For the on-site disposal alternative, this steady-state concentration is predicted to be approximately 0.7 mg/L, which is approximately a factor of 1,000 less than current concentrations. The correlation between ground water and surface water concentrations is expected to result in a similar decrease in surface water concentrations as well.

Long-term impacts to surface water as a result of active ground water remediation would depend on the extraction, treatment, and disposal options selected. The proposed active remediation would control ground water discharge to the river while natural processes reduced ammonia concentrations in the ground water to levels protective of aquatic species. After completion of active remediation, the potential does exist for a flood to slightly increase ammonia concentrations in ground water (Section 4.1.3.1), but this should have minimal impact to surface water concentrations.

Any treatment of contaminated ground water and discharge to surface waters, as described in Section 2.3.2, would be in accordance with state permitting requirements and therefore would not result in an adverse impact to Moab Wash or the Colorado River. Other treatment and disposal methods would also not adversely affect surface water.

Active remediation would be discontinued when ammonia concentrations in ground water reached acceptable levels that allow resumption of discharge to surface water (estimated at 80 years). At that time, discharge of ground water to the surface would have no discernible impact. However, concentrations of ammonia in surface water would probably remain above surface water background concentrations because of steady-state concentrations in ground water.

Storm water management during site reclamation would include berms between the site operational areas and the Colorado River and Moab Wash to ensure that the site is not inundated from flood events up to the magnitude associated with 100-year return intervals. Should a flood event of greater magnitude than this occur, there is a potential for tailings to be transported off the site and into the Colorado River and Moab Wash. Disposal alternatives that could involve on-site drying of tailings (i.e., off-site disposal via truck or rail haul) would have the potential for supplying a greater amount of tailings to floodwaters than alternatives that do not involve on-site drying (i.e., off-site disposal via slurry pipeline or on-site disposal) should a flood greater than a 100-year return interval occur. However, a substantial failure of the storm water pollution prevention system would reasonably occur only from a flood event greater than the 100-year return interval. As indicated by a recent USGS study (USGS 2005), the overbank flow velocities associated with an event of this magnitude would be less than 2 ft/s. There would be very limited ability to transport contaminants from the site due to the low velocity of the floodwaters, and the overbank flows would likely result in net deposition of sediment. The impact of these limited quantities of contaminants would be mitigated by mixing with the large volumes of floodwaters (72,000 cfs). The minimal amount of contaminants that may become suspended or dissolved into these floodwaters during the completion of on-site disposal would be dispersed and diluted in the floodwaters such that there would be no significantly measurable contamination in off-site sediment or river water.

4.1.4.2 Impacts from Characterization and Remediation of Vicinity Properties

Surface water located close to vicinity properties could be affected by sedimentation and possibly by contaminant runoff. DOE would implement a storm water control plan for those properties.

4.1.4.3 Impacts from All Sources

Short-term impacts to surface water as a result of construction and operation at the site and from characterization and remediation of vicinity properties would not be expected to be adverse. However, elevated contaminant levels in ground water would continue to adversely affect surface water in the short term until active remediation of ground water reduced concentrations. Once active remediation was implemented, contaminant concentrations in ground water discharging to surface water would decrease to levels that would be protective of aquatic species. Following completion of active remediation, levels would be expected to remain protective.

4.1.5 Floodplains and Wetlands

Impacts that could result from surface remediation are assessed with the assumption that the final disposal cell would be in the same location as the existing tailings pile. The impacts analysis is based on the proposed alternative action described in Section 2.1 and the affected environment as described in Sections 3.1.8 and 3.1.9. Impacts for this alternative are more thoroughly discussed in the floodplain/wetlands assessment (Appendix F).

4.1.5.1 Construction and Operations Impacts at the Moab Site

Soil excavation and removal of contaminated materials during surface remediation of the former millsite would occur within the 100- and 500-year floodplains. Removal of soils may permanently lower the elevation of the floodplain, resulting in greater exposure of the base of the pile (currently underground) to floodwaters, increased capacity of the floodplain, and possible changes to flooding patterns at the Matheson Wetlands Preserve.

Rechanneling Moab Wash would affect the floodplain in the short term by changing drainage patterns and the river discharge point and by increasing runoff to the river. However, storm water management measures could also decrease the amount of water and sediment entering Moab Wash. In the long term, the realignment of Moab Wash would reduce the potential for storm water to affect the disposal cell. The wash would still enter the river upstream of endangered fish habitat, but its rechanneling could alter flow patterns and disrupt downstream wetlands. These effects would be long-term, and such action would require federal and state permits.

The proposed removal of the tamarisk and other vegetation adjacent to the river would be an adverse, short-term impact to the stability of the floodplain and wetlands until revegetation was complete.

The buried riprap wall would stabilize the soil in the floodplain. Therefore, an adverse impact would not be expected.

4.1.5.2 Impacts from Characterization and Remediation of Vicinity Properties

Vicinity properties may be located within the Colorado River, Pack Creek, or Mill Creek floodplains. If these sites are located within floodplains or wetlands, short-term impacts could result. Remediation would include excavating and transporting contaminated materials from vicinity properties to the Moab site. Because DOE would implement site controls (e.g., storm water management) and obtain necessary federal and state permits to control potential impacts during remediation, any short-term impacts to floodplains or wetlands would be expected to be minimal. Reconstruction and revegetation at vicinity properties would be consistent with the existing use of the property. Therefore, there would be no long-term impacts to floodplains or wetlands.

4.1.5.3 Construction and Operations Impacts Related to Transportation

Because existing roads would be used to transport contaminated materials from vicinity properties to the Moab site, no adverse impacts to floodplains and wetlands would be expected. New proposed routes from borrow areas would be investigated for wetlands prior to construction. Impacts would be avoided wherever possible by rerouting roads to bypass these areas. In the long term, disturbed areas would be restored to their previous condition, or as agreed to with the appropriate land management agency.

4.1.5.4 Impacts from All Sources

Long-term and short-term impacts would be associated with rechanneling Moab Wash and with remedial activities at the Moab site. Only short-term impacts would occur from characterization and remediation of vicinity properties and from constructing or updating transportation routes.

4.1.6 Aquatic Ecology

The aquatic resources within the vicinity of the Moab tailings pile are associated with the Colorado River. This assessment of environmental consequences focuses on the aquatic plants and animals in the river and on the shore between the site and the river. Potential impacts are discussed in terms of direct and indirect effects to individuals and populations, and the potential impacts to their habitat.

This section describes the short-term and long-term impacts to aquatic ecology, including receptors, which could result from on-site disposal of contaminated site and vicinity property materials. Section 4.1.17 discusses potential post-remediation impacts to aquatic species as a result of a catastrophic event. Adverse impacts could be a result of physical (e.g., mechanical disturbance, habitat alteration), chemical (e.g., ammonia contamination), and radiological influences. Of these, chemical influences from the adjacent ground water plume would be of greatest concern in the short term until active remediation reduced risk to aquatic species, especially endangered species. Federally listed species that could be potentially affected by both surface and ground water remedial actions include the endangered Colorado pikeminnow, razorback sucker, humpback chub, and bonytail.

Detailed discussion of impacts to endangered species is presented in Appendix A1, "Biological Assessment."

Impacts in this section are assessed with the assumption that (1) the disposal cell would be located in the same place as the existing tailings pile, and (2) the location of the legacy plume would not be affected by surface remediation activities. The impacts are based on the proposed action and alternatives described in Sections 2.1 and 2.3 and the affected environment as described in Section 3.1.10. Adverse impacts to surface water would not be expected to occur from transportation activities or monitoring and maintenance. Therefore, these activities are not discussed further in this section. It is expected that active remediation would be protective of aquatic species at the individual, population, and community levels of the Colorado River ecosystem.

4.1.6.1 Construction and Operations Impacts at the Moab Site

Mechanical Disturbance. The impact to aquatic species due to construction and operations at the Moab site would be from mechanical disturbances and loss of vegetation along the shoreline of Moab Wash and the Colorado River. Activities at the Moab site would likely disturb about 8,100 ft of Colorado River shoreline. The vegetation along the shoreline, consisting primarily of tamarisk, would be removed in order to excavate and remove contaminated soils (RRM). The tamarisk along the banks of Moab Wash as it enters the Colorado River would likely be removed as well.

The effects of mechanical disturbance would include the loss of shade and cover over the shoreline and potentially a loss of surface stability that could lead to increased erosion and siltation into the wash and river. Impacts to aquatic species due to these changes would be minimal. The shade and cover provided by the tamarisk is only along the edge of the river during high and moderate flows of the river. At low river flows, the shoreline vegetation provides no shade, and the flow into the wash is cut off. The potential also exists for water intake structures in the river to result in mortality to eggs, larvae, young-of-the-year, and juvenile fish life stages. DOE would minimize this potential by using one-quarter to three-eighths inch screened mesh on water intake structures.

Effects from siltation and erosion into the river and wash could fill in backwater areas that may be important to macroinvertebrates and fish. Moab Wash has been documented as potential pikeminnow nursery habitat that could be affected by siltation and erosion (NPS 2003). Erosion along the river shoreline could create new backwater areas, but these would likely be temporary and depend on river stage.

Federally listed species that could be potentially affected by the changes to the shoreline include the endangered Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. The Colorado River reach near the Moab site has been designated as critical habitat (50 CFR 17.95) for all four federal endangered fish species. Juvenile and adult Colorado pikeminnow, stocked adult razorback sucker and bonytail have been collected near the Moab site. Moab Wash and the riparian vegetation adjacent to the Colorado River potentially provide nursery habitat for young-of-the-year fish (NRC 1999, NPS 2003, UDWR 2003). Erosion and siltation events that change the depth and configuration of these backwater areas are likely to affect the extent of nursery habitat for endangered fish. Other fish, macroinvertebrates, and emergent plants associated with the backwater areas are also likely to be affected by erosion and siltation. The effects of erosion and siltation would be prevented or reduced by minimizing shoreline disruption, replacing vegetation, and installing erosion control devices.

Noise. Noise from site construction and operations is not expected to affect the aquatic environment. Activities along the shoreline are likely to be of short duration and are not likely to cause macroinvertebrate or fish communities to avoid the area.

Other Human Disturbances. Aspects of human presence such as personnel or vehicle movement and supplemental lighting are not expected to affect the aquatic environment.

Water depletion in the Colorado River as a result of remediation of the Moab site would be in accordance with the Cooperative Agreement to implement the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USF&WS 1987). The Cooperative Agreement was signed by the Secretary of the Interior and by the governors of the states of Colorado, Utah, and Wyoming. The Recovery Program requires that all Section 7 consultations address depletion impacts. A key element of the program requires a one-time contribution of $10 per acre-foot (adjusted annually for inflation) based on the average annual depletion through activities at the site, to be paid to USF&WS. The balance of the payment would be due at the commencement of construction at the site. The impacts due to water depletion can be offset by the one-time contribution, appropriate legal protection of instream flows pursuant to state law, and accomplishments of activities necessary to recover the endangered fish as specified in the Recovery Plan (NRC 1999). Further consultation would be necessary to determine any required permits and the financial contribution based on water depletion.

Effects of Flooding on Ground Water Remediation. Although effects of catastrophic flooding to the pile are considered in Section 4.1.17, there is also the possibility that flooding could affect the aquatic environment by interrupting ground water remediation. The interim action and proposed ground water remediation includes wells and pumps, or shallow trenches located between the foot of the pile and the river's edge (Section 2.3). Impacts to the aquatic environment could occur because of flooding of the remediation systems. As discussed in Section 3.1.8, the location for these systems is in the 100-year floodplain. If a flood were to inundate the remediation systems, contaminated ground water from the wells or trenches could be carried into the river. DOE expects that remediation systems would be quickly restored after the floodwaters receded. USF&WS would be notified if ground water remediation systems were shut down because of flooding, and monitoring of the river environment would take place to determine if the concentrations of contaminants of concern exceed aquatic benchmark values.

Temperature. Temperature can influence the development, metabolism, motility, and mobility of fish; affect the expression of other environmental factors; and destroy the integrity of a fish, causing its death (Beitinger et al. 2000). Impacts associated with activities related to remediation would not be expected to influence the temperature of the Colorado River. Leachate from the tailings pile travels through ground water into the river, and the temperature gradient is not expected to affect the aquatic environment.

Chemical Impacts to Aquatic Species. The tailings pile on the Moab site is the source of chemical contamination to ground water, which in turn is the source of contamination in the Colorado River.

The aquatic environment near the site has been characterized in Chapter 3.0. Characterization has included sampling sediment, fish tissue, and surface water near the Moab site and upstream background surface water. Sediment samples of the Colorado River were collected from 1995 through 1997; however, these samples were not considered in this analysis because of comments in the Final Biological Opinion in NRC's final EIS (NRC 1999) concerning the quality of the data for evaluation of impacts. Concerns for the quality of the sediment data include inappropriate procedures and protocols for sample collection and inadequate collection of samples for statistical evaluation. Fish were collected for tissue analyses from 1995 through 1997, and results of the fish tissue analyses also were not considered in this analysis because of comments similar to those made about the data quality of sediment samples (NRC 1999). An evaluation of the means and standard deviations for all the combined fish tissue data does not show a strong statistical difference in concentrations in the tissues collected upstream of the Moab site compared to those collected downstream.

The screening of contaminants is presented in Appendix A2 of the EIS and summarized here. The screening is based on surface water samples collected by Shepherd Miller, Inc. (SMI), DOE, and USGS. Samples were collected by SMI and DOE from 2000 through 2002. These data are presented in Appendix D of the *Site Observational Work Plan for the Moab, Utah, Site* (DOE 2003a). Water sample data were collected by USGS from 1998 through 2000 and are presented in *A Site-Specific Assessment of the Risk of Ammonia to Endangered Colorado Pikeminnow and Razorback Sucker Populations in the Upper Colorado River Adjacent to the Atlas Mill Tailings Pile, Moab, Utah* (USGS 2002). Many of the samples from other studies were considered, but quality issues were discovered during the evaluation of data for surface water samples taken prior to 2000. These issues included insufficient information to determine the location of the analyzed sample and laboratory quality control and quality assurance questions. Contaminants of potential concern for the Moab site were identified from institutional knowledge about the uranium milling processes used during operation of the Atlas mill and from the NRC EIS (NRC 1999). Surface water monitoring data were evaluated to determine if maximum concentrations were above detection limits, background levels, and federal and state criteria (i.e., benchmarks) for surface water quality.

Impacts to aquatic organisms can result from either acute or chronic exposures to contaminants of potential concern (Appendix A2). An acute exposure is defined as "the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect" (EPA 2002). A chronic exposure is defined as "the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect" (EPA 2002). Currently, the State of Utah criteria include an acute, 1-hour exposure and a chronic, 4-day exposure. Suter and Tsao (1996) were used where state and federal standards were not available. However, they used a method, referred to as Tier II, to establish criteria for aquatic benchmarks using fewer data than required by EPA in the NWQC. Also, they developed estimated lowest chronic values for fish extrapolated from laboratory studies. The standards are discussed further in Appendix A2 of the EIS.

Based on the evaluation of contaminants of potential concern in Appendix A2, the contaminants that would require further assessment and continued monitoring during ground water remediation for the Moab site are ammonia, copper, manganese, sulfate, and uranium. If active ground water remediation near the Colorado River were conducted, the maximum concentrations of these contaminants of concern where the ground water enters the river (nearshore environment) would decrease to levels below acute and chronic benchmarks. It is DOE's position that if acute criteria can be met everywhere, then chronic criteria can be met outside the mixing zone (Section 2.3.2). In addition, available data regarding interaction of ground water and surface water indicate that concentrations of most constituents decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease is observed on average).

Consequently, there is a reasonable assurance that protective surface water concentrations could be achieved by meeting less conservative goals than chronic standards in ground water. DOE believes that a target goal of 3 mg/L in ground water (the low end of the reasonable acute range) would provide adequate surface water protection. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and would be expected to result in a corresponding decrease in surface water. Coupled with the average 10-fold dilution and the tendency for ammonia to volatilize, this value should result in compliance with both acute and chronic ammonia standards in the river everywhere adjacent to the site. Therefore, DOE proposes to use the 3-mg/L concentration of ammonia as a target goal for evaluating ground water cleanup options. Potential synergistic effects between contaminants would be reduced through ground water remediation. Continued monitoring during ground water remediation would be necessary to verify that contaminant concentrations remained below both acute and chronic benchmarks for aquatic species.

Radiological Impacts to Aquatic Species. The primary source of radioactive contamination in the aquatic environment at the Moab site is ground water. The routes of exposure for the radioactive contaminants are the same as those for chemical contaminants. The contributors to radiological dose to the aquatic organisms at the Moab site that have been monitored include lead-210, polonium-210, radon-222, radium-226, radium-228, thorium-230, uranium-234, and uranium-238, and the general indicators of radionuclides, gross alpha and gross beta.

The RESRAD Biota Code (Version 1.0 Beta 3, June 3, 2003) was used to screen the dose rate to aquatic organisms based on the maximum observed concentrations of uranium-238, uranium-234, and radium-226 (DOE 2002b). These isotopes represent the highest values analyzed for radionuclides from 2000 to 2002. The protocol for screening assessment includes multiple tiers. The first-tier screening assessment using the maximum observed concentrations had a sum of fractions that equaled 3.16, which exceeded the DOE guidance level of 1.0 for aquatic biota. A second-tier analysis based on mean concentrations of these three radionuclides of those values above detection resulted in a sum of fractions value of 0.29. The results of the second-tier analysis indicate that dose rates are below the 1.0-rad-per-day guidance level adopted by DOE for screening dose rates to aquatic organisms.

Results of the RESRAD assessment indicate that the actual dose rates to aquatic organisms are below a population effect level. There are no guidelines for radiological effects to individuals, which is important in evaluating impacts to threatened and endangered species. The studies that were completed for the 1.0-rad-per-day criterion were based on exposures to organisms for 1 year, and then normalized to a dose rate based on a day. One can interpret these results to mean that a dose rate of 1.0 rad per day, if sustained for a year, would have an effect on some individuals but not on the population as a whole. Based on monitoring results from 2000 to 2002 and on the life styles of the endangered fish around the Moab site, radiological effects currently are not expected to adversely affect the aquatic environment.

In another study, the USGS concluded that there would be "no significant biological impacts to fish populations caused by radionuclide concentrations sampled in the Colorado River and sediments." It found that "radiochemical concentrations are elevated in ground water below the Moab pile; however, these waters do not result in a high radiation exposure to fish" (USGS 2002).

Ground water extraction near the Colorado River and the use of freshwater injection would further decrease the maximum concentrations of radionuclides in the shoreline of the Moab site. These activities would be necessary for reducing impacts from chemical contaminants. They would also reduce the potential for radiological effects to individuals, which is important to endangered species as well as populations.

4.1.6.2 Impacts from Characterization and Remediation of Vicinity Properties

Some vicinity properties may be close to surface water. In the short term, the potential exists for sedimentation, erosion, and alteration of habitat. However, the potential for adverse impacts would be minimal because of engineering and site controls for storm water runoff. As previously discussed, removal of vegetation in riparian areas could alter habitat and reduce stream cover and shade. However, few, if any, vicinity properties would likely be within surface waters or quality habitat for aquatic species. Consequently, any effects on aquatic biota from characterization and remediation of vicinity properties would likely be very small and of short duration (i.e., a few weeks) at each site.

4.1.7 Terrestrial Ecology

Appendix A1, "Biological Assessment," presents a detailed discussion of federally listed species that would be affected in the vicinity of the Moab site.

4.1.7.1 Construction and Operations Impact at the Moab Site

Habitat Loss. Under the on-site disposal alternative, the primary impact to terrestrial species and habitats due to construction and operations at the Moab site would be the mechanical disturbance and the resulting loss of vegetation and habitat. Activities at the Moab site would disturb approximately 439 acres within the site boundaries. Although most of the Moab site has very little to no vegetation, approximately 50 acres of habitat in the southern corner of the site is currently dominated by a relatively dense stand of tamarisk that would be lost in order to remove contaminated soil. The effects of this mechanical disturbance would include the loss of foraging and breeding habitat for various wildlife species, loss of shade and cover, including the areas near the Colorado River shoreline, and potentially a loss of surface stability that could lead to increased erosion and siltation.

Federally listed species that could be potentially affected by the habitat loss include the endangered southwestern willow flycatcher. The only federal candidate species that could be so affected is the western yellow-billed cuckoo. On May 12, June 24, and July 10, 2004, DOE and UDWR conducted field surveys of this tamarisk habitat and no flycatchers were detected. Further, UDWR concluded that this tamarisk constitutes only marginal nesting habitat at best (UDWR 2004b). Although flycatchers did not breed in this habitat in 2004, they could breed there in subsequent years. In addition, the southwestern willow flycatcher could potentially occur in the Matheson Wetlands Preserve across the Colorado River from the Moab site and several miles downstream from the Moab site (NRC 1999, USGS 2002). It could thus also use the Moab site for foraging or as stopover habitat during migration. Because the cuckoo has been known to nest across the river in the Matheson Wetlands Preserve (USGS 2001), it also could potentially use this tamarisk habitat for foraging. If this were the case, removal of this habitat still would only minimally affect cuckoos, if at all.

Other riparian birds also could be affected by the habitat loss as well as some species of mammals, reptiles, and amphibians. It is unlikely that removal of the 50 acres of tamarisk habitat would have a significant effect on the populations of any wildlife species in the Moab site vicinity, especially with the presence of hundreds of acres of similar habitat across the river in the Matheson Wetlands Preserve.

The effects of habitat loss would be of relatively short duration, especially if vegetation were replaced upon completion of surface cleanup. There could be a long-term benefit if the tamarisk were replaced with more desirable vegetation (such as willows) that would provide higher quality habitat for a greater number of species. Other measures that could be employed to reduce impacts include scheduling the removal of vegetation outside the nesting season and migration periods, minimizing the area of disturbance to the extent practical, and using best management practices for runoff and sediment control.

Noise. Noise from site construction and operations could have adverse impacts on terrestrial biota in the vicinity of the Moab site. Man-made noise can affect wildlife by inducing physiological changes, nest or habitat abandonment, or behavioral modifications, or it can disrupt communications required for breeding or defense (Larkin 1996). In contrast, wildlife may also habituate to man-made noise (Larkin 1996). Much of the available effects data focus on noise sources more extreme than construction activities, such as aircraft overflights (Efroymson et al. 2000), and most of the existing data are species-specific. Consequently, only a general evaluation of potential noise impacts at the Moab site is possible without specific knowledge about the locations of species relative to the noise source and without specific data on the responses of the same species to construction noises.

As described in Section 4.1.10, the maximum noise level generated by construction equipment at the Moab site would be estimated to be approximately 95 dBA measured at 49 ft. This noise level would decrease with distance, until it reached a daytime background level of approximately 65 dBA at 1,476 ft from the source (65 dBA is the normal daytime background level in Moab). If additional vegetation were removed from the site as part of construction operations, the effects of elevated noise levels on wildlife should be minimal, because wildlife would already have been displaced by the habitat removal discussed above. Further, there could be detectable elevated sound levels in habitats downstream and across the river resulting from work near the periphery of the site.

The southwestern willow flycatcher and threatened bald eagle are the only federally listed species that could be present near the periphery of the site and therefore could be affected by noise from site operations. The western yellow-billed cuckoo is the only federal candidate species that could be present near the periphery of the site and could also be affected. The willow flycatcher does not appear to be overly sensitive to low-level human activity outside of its breeding territory (USF&WS 2002). Typical mitigation measures that have been employed to minimize impacts to breeding willow flycatchers include limiting equipment use within about 300 to 1,000 ft of occupied territories (CDFG 2002). Consequently, it is unlikely that off-site southwestern willow flycatchers would be significantly affected by construction activities at the Moab site. The bald eagle is often more sensitive to human presence and noise than other species. However, it is not known to nest or night roost at the Moab site and is not commonly seen in the vicinity of the site, and it is therefore is unlikely to be affected by noise from site operations. Information on the response of yellow-billed cuckoo to noise is insufficient to evaluate potential impacts on this species.

Other Human Disturbance. Other aspects of human presence, such as personnel or vehicle movement and supplemental lighting, could have an effect on local wildlife under the on-site disposal alternative. However, because essentially all usable habitat at the Moab site would be removed as part of construction operations, it is doubtful that these factors would cause significant adverse impacts to wildlife at the site. Impacts to off-site populations could be minimized by limiting activities near the site periphery, pointing lights downward, or installing canopies to limit the amount of light beyond the site boundary.

Erosion. Runoff and erosion could affect terrestrial systems by damaging surface vegetation and by siltation of wetlands, which could disrupt breeding habitat for amphibians and insects. During operations, erosion could result from movement of vehicles and materials. In general, these effects could be minimized using standard best management practices to control erosion and sedimentation. In the long term, a disposal cell could result in significant erosion and sedimentation and could disturb recovering vegetation at the site. The potential for this to occur would be minimized by design requirements and site storm water runoff controls. This would tend to have a greater impact on aquatic rather than terrestrial ecology.

Chemical/Radiological Impacts from Contaminants in Surface Water. Because of the complexity of the analysis of these impacts, only a brief conclusion is presented here. Appendixes A2 and A1 present more detailed discussions.

There is no potential risk of chemical or radiotoxic effects for riparian vertebrates, including federally listed species that could potentially occur at the Moab site (southwestern willow flycatcher, western yellow-billed cuckoo, and bald eagle), from chemical or radioactive constituents in surface water under the No Action alternative. Consequently, there would be no effects under the on-site disposal alternative, since chemical and radionuclide concentrations would likely be reduced.

There is a potential risk of toxic effects to riparian plants from chemical constituents in surface water under the No Action alternative, assuming plant roots are in contact with the freshwater aquifer or associated soil water above it. However, such effects would be unlikely under the on-site disposal alternative, since chemical concentrations would likely be reduced. There would be no phytotoxic effects to federally listed plant species (Jones' cycladenia, Navajo sedge, and clay phacelia), since these are not known to occur on or near the Moab site.

There is no potential risk of radiotoxic effects to riparian plants from radioactive constituents in surface water under the No Action alternative. Consequently, there would be no effects under the on-site disposal alternative, since radionuclide concentrations would likely be reduced. There would also be no radiotoxic effects to federally listed plant species (Jones' cycladenia, Navajo sedge, and clay phacelia), since these are not known to occur on or near the Moab site.

Wildlife Exposure at Evaporation Ponds. One of the effluent treatment technologies under consideration is solar evaporation. Solar evaporation consists of pumping extracted ground water into large membrane-lined ponds built into the floodplain, allowing the water to evaporate naturally, and disposing of accumulated solids. Pond(s) would need to be of sufficient size that evaporation rates could keep up with extraction rates and complete remediation in a reasonable time frame. Estimated pond areas range up to 40 acres, and a total of 60 acres of land would need to be disturbed. This would include some type of support facility, but the facility would be expected to be small and would probably be located in already disturbed areas.

Potential impacts that could result from construction and operation of an evaporation pond include floodplain habitat disturbance and wildlife displacement/destruction or contaminant impacts. Habitat disturbance and wildlife displacement/destruction could be minimized by selecting a site in an area that has been previously disturbed or otherwise has relatively little habitat value and by avoiding clearing land during the nesting season of migratory birds. Evaporation ponds could attract wildlife that may be exposed to contaminants through ingestion of contaminated prey and water, dermal uptake of contaminated water and airborne contaminants, and inhalation of airborne contaminants. In addition to impacts from exposure, wildlife could transport contamination off site.

The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are the only federally listed species considered to be potentially present at the Moab site and that could thus be affected by an evaporation pond. The evaporation pond would be located in an area that has been previously disturbed and is generally devoid of vegetation (e.g., that could be used by bald eagles to perch in and flycatchers and cuckoos to forage in). Vegetation around the evaporation pond, if any, would be maintained in such a state that it would remain unattractive to these species. Further, the pond would also be located in an area where project activities and site maintenance operations would create continual disturbance. Consequently, the probability of visits from these three species to the pond would be expected to be low. Nevertheless, the pond would be qualitatively monitored for general wildlife use. If it were determined that one or more of these three species were frequenting the evaporation pond, techniques to minimize or eliminate use would be identified and implemented. Techniques may include deterrents such as noise (e.g., propane boom cannons), visual deterrents (e.g., reflectors, silhouettes, effigies, water color), or obstruction (e.g., netting).

Animal Intrusion into the Moab Tailings Pile. Because the barrier that would cover the Moab tailings pile would be designed to prevent animal intrusion, wildlife exposure to the tailings would not be expected.

4.1.7.2 Impacts from Characterization and Remediation of Vicinity Properties

Under the on-site disposal alternative, mechanical disturbance and a potential loss of vegetation and habitat would occur during remediation at the vicinity property sites. Each site would likely be small (average approximately 2,500 ft^2; see Section 2.1.2.2). Therefore, the magnitude of physical disturbance at each site would likely be small. This disturbance could result in minor habitat loss for some wildlife species and could potentially disturb populations of rare plant species. However, few if any of the vicinity properties would likely be in native condition or represent quality habitat for wildlife.

Activities at the vicinity property sites could affect wildlife in the surrounding area by introducing noise and increased human presence. However, most of the vicinity property sites are located close to human habitation or regular human activities, so most wildlife in the vicinity would likely be habituated to human presence. The quantity and scale of the equipment used (backhoes, graders, dump trucks) would be similar to that used in typical small-scale construction projects. There is a low probability for diesel or oil spills, and these would likely be quickly controlled and remediated. Consequently, the effects on terrestrial organisms from characterization and remediation of vicinity properties would likely be very small and of short duration (i.e., a few weeks) at each site.

4.1.7.3 Construction and Operations Impacts Related to Transportation

Under the on-site disposal alternative, the transportation of vicinity property and borrow materials to the Moab site could affect terrestrial organisms either through direct mortality (e.g., collisions) or indirectly through noise. The magnitude of impacts for both of these factors would be related to the number of trucks trips required to haul the materials and the total number of miles traveled by those trucks. As indicated in Table 3–15, over 2,800 vehicles per day travel on US-191 north of Moab, and at least 3,000 per day travel on US-191 south of Moab. The estimated increase in traffic associated with the on-site disposal alternative is discussed in Section 4.1.16. The increase in traffic could increase the number of animals killed or injured in collisions with vehicles, especially on US-191, the major artery that would carry commuters and on which borrow and vicinity property material would be transported. The likelihood of increased collisions with wildlife would be greatest during seasons when material transportation or commuting would occur before sunrise or after sunset.

Several types of animals are typically involved in vehicle collisions; most noticeable are large ungulates such as deer, pronghorn antelope, and bighorn sheep. Less noticeable but more prevalent are snakes, lizards, and small mammals. Bighorn sheep have been reintroduced into Arches National Park, and individuals are now occasionally seen near US-191 north of Moab. The increased truck traffic to haul borrow materials to the Moab site would probably slightly increase the number of bighorn sheep killed in that area.

The bald eagle is the only federally listed species that could incur an increase in traffic-related mortality. The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. Indeed, bald eagles could be found temporarily and infrequently using such areas when there are opportunities to feed on carrion, such as in big-game wintering areas or in prairie dog colonies. Therefore, it is possible that if traffic-related wildlife mortality increased due to the project, an increased number of eagles could be hit on highways. However, without data on this relationship, it is reasonable to assume that the number of eagles hit on highways would be proportional to the number of carrion available. The increase in the number of traffic-related wildlife mortalities is expected to be small. Consequently, the potential increase in associated eagle deaths is also expected to be small.

Transportation of vicinity property and borrow materials would also increase noise on US-191 because of increased truck traffic. Average background noise levels along US-191 are approximately 70 dBA measured at 49 ft, which is likely detectible to humans up to approximately 6 miles from the road (Section 3.1.14). As described in Section 4.1.10, the increased truck traffic due to hauling borrow materials would likely increase the average noise level by approximately 2 dBA at 49 ft from the highway. This difference in noise level is essentially imperceptible to humans and would not be noticeable as different from baseline conditions within several hundred yards.

The primary federally listed species that could be affected by this increased traffic noise would be the threatened Mexican spotted owl. Data provided by UDWR (2003) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, habitat models (BLM 2003) indicate that potential habitat areas may exist in the canyons near US-191 over the first 7 miles north from the Moab tailings pile. Nonetheless, these models are primarily based on physical and topographic features and do not consider vegetation requirements. Mexican spotted owls nest, roost, and forage in an array of different community types, but mixed-conifer forests dominated by Douglas fir and/or white fir are most common (USF&WS 1995). However, they may also nest, but less frequently, in arid, rocky, mostly unvegetated canyons (Romin 2004). Although there are no forested areas in the vicinity of US-191 north of Moab, there are arid canyons that largely or altogether lack forest-type vegetation. Thus, it is unlikely but possible that spotted owls occur in the canyons near US-191 over the first 7 miles north of the Moab site. If present, the species could be disturbed by noise from increased truck traffic. The area in the vicinity of this section of transportation corridor constitutes a very popular recreation area, with heavy use by off-highway vehicles and mountain bikes. Although the increase in truck traffic noise could be detectable up to several miles from the highway, the existing off-highway vehicle noise and associated human presence would likely have a greater and more direct impact on the owls.

The likelihood of adverse impacts from either vehicle collisions or increased noise levels would be greater at night than during the day. For example, deer are typically more active at dawn and dusk than during the day and are therefore more likely to be hit at that time. Highway noise would likely be detectable from farther away at night because of reduced levels of background noise. The vehicle collision and noise impacts of transportation would return to previously existing conditions at the completion of activities at the Moab site, and no long-term effects would be expected.

4.1.7.4 Monitoring and Maintenance Impacts

Routine post-closure monitoring and maintenance of the Moab site would not be expected to have any impacts to terrestrial species or habitats. However, in the event that major corrective actions were needed, some of the recovering vegetation on and around the disposal site could be disturbed.

4.1.7.5 Impacts from All Sources

Overall impacts to terrestrial ecological resources under the on-site disposal alternative include approximately 50 acres of tamarisk habitat loss at the Moab site (the rest of the site is considered to have zero habitat quality) and a maximum of approximately 550 acres of desert habitat at the borrow sites (assuming use of Floy Wash for cover soils and Klondike Flats for radon barrier soils). Additional habitat would be lost at the commercial quarry sites for sand, gravel, and riprap. Habitat value would decrease slightly near US-191 because of the increased truck traffic required to haul borrow materials, and traffic-related wildlife mortalities would increase slightly because of increased traffic.

4.1.8 Land Use

Under the on-site disposal alternative, impacts to land use would include potential changes to existing land use at the site or to nearby properties.

4.1.8.1 Construction and Operations Impacts at the Moab Site

Construction and operations at the Moab site, which is currently under federal ownership and control, would not alter the existing land use at the site. Noise and vibrations that could occur as a result of these activities would be unlikely to travel off the site and thus would be unlikely to affect the use of adjacent property or nearby recreational areas (see also Section 4.1.10). Following surface remediation, ground water contamination would remain beneath the site, and DOE would operate a ground water treatment facility until ground water cleanup goals were met, estimated to be 80 years. The land occupied by the mill tailings pile would remain under federal ownership and control in perpetuity, creating a long-term loss of that acreage for beneficial land use by other government or private owners.

4.1.8.2 Impacts from Characterization and Remediation of Vicinity Properties

Under the on-site disposal alternative, remediation of vicinity properties could result in short-term displacement of some families or businesses if relocation were necessary during the removal of contaminated materials from properties. It is unlikely that contamination at any vicinity property would be extensive enough to cause it to be left in place, thereby requiring a change of land use or implementation of access or use restrictions.

4.1.8.3 Construction and Operations Impacts Related to Transportation

All vicinity property material and borrow material would be transported to the Moab site by trucks using existing roadways. No additional road construction or road improvement is expected to be necessary. Noise and traffic disruptions could occur as a result of the transport of these materials; such disruptions could temporarily disturb residents, businesses, and recreational users along the travel routes (see Sections 4.1.10 and 4.1.16) and temporarily affect current uses of the property. These impacts would last for the duration of remediation at the Moab site.

4.1.8.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities at the Moab site would not affect land use as long as the site remained under federal ownership and control. No monitoring or maintenance would be expected for any of the vicinity properties.

4.1.8.5 Impacts from All Sources

Short-term, temporary land use impacts would be expected as a result of remediation of vicinity properties. Under the on-site disposal alternative, the land required for the disposal cell would remain in federal ownership in perpetuity. Additional acreage may be required to support ground water remediation infrastructure. Therefore, there would be no changes in land use from the current status in the foreseeable future. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation.

The long-term commitment of the Moab site for disposal would conflict with Grand County land use planning that designates the site as a "Specially Planned Area" during remediation activities according to County Ordinance 346, but that envisions future land uses that would allow for low-density residential use upon completion of remediation.

4.1.9 Cultural Resources

This section addresses the potential for the disturbance of known cultural resources or the discovery of unknown resources under the on-site disposal alternative.

4.1.9.1 Construction and Operations Impacts at the Moab Site

Construction and operations at the Moab site would adversely affect some or all of the remaining structures and features associated with the historical uranium mill, which has been recommended for inclusion in the National Register of Historic Places, because they could be removed or dismantled during remediation. Most or all of the features associated with the historical mill are radioactively contaminated. At this time, it is not known which structures may be kept or dismantled. However, a collapsed log cabin is eligible for inclusion in the National Register and would be left in place; a radiological survey of this site has shown that the materials and soils are not contaminated. None of the other eligible cultural resources at or near the Moab site (including the one recorded traditional cultural property) would be affected by construction and operations at the site. DOE plans to consult with the State Historic Preservation Officer and other interested parties to determine mitigation measures for those millsite features that would be demolished. Mitigation measures might include (1) documenting and photographing the features in accordance with the Utah State Historic Preservation Officer's standards, (2) providing historical information about the millsite and its operations to the Dan O'Laurie Canyon Country Museum in Moab, and (3) constructing a roadside turnout and erecting a kiosk containing historical information about the site.

Cultural resources located near areas of disturbance could be adversely affected indirectly through illicit collection, vandalism, or inadvertent destruction as a result of increased human activity in the area. DOE would require site workers to receive training on the need to protect cultural resources and the legal consequences of disturbing cultural resources.

4.1.9.2 Impacts from Characterization and Remediation of Vicinity Properties

Most of the vicinity properties are highly disturbed sites and would not likely contain significant cultural resources that could be affected by characterization and remediation of those properties. However, DOE would procure the services of a qualified and permitted professional archaeologist to assess the need to conduct Class III cultural resource surveys at Arches National Park, the Matheson Wetlands Preserve, and other properties as appropriate. If cultural resources eligible for inclusion in the National Register of Historic Places were located on a property and could be adversely affected, DOE would consult with the State Historic Preservation Officer and affected parties to determine mitigation measures.

4.1.9.3 Construction and Operations Impacts Related to Transportation

Impacts to cultural resources would not occur from construction and operations related to transportation because no new highway construction near the Moab site would take place.

4.1.9.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities under the on-site disposal alternative would not affect cultural resources.

4.1.9.5 Impacts from All Sources

Table 4–4 lists the total number of cultural sites eligible for inclusion in the National Register of Historic Places that could be adversely affected under the on-site disposal alternative.

Table 4–4. Number of Cultural Sites That Could Be Adversely Affected Under the On-Site Disposal Alternative

Location/Activity	No. of Cultural Sites Adversely Affected
Moab site (construction and operations)	0–2
Radon barrier material (Klondike Flats borrow area)	3–7
Cover soil material (Floy Wash borrow area)	1–2
Total	**4–11**

4.1.10 Noise and Vibration

This section addresses the impacts of noise and ground vibration, primarily to human receptors, under the on-site disposal alternative. Where appropriate, impacts to wildlife and cultural resources are also identified. Unless indicated otherwise, all noise and vibration impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.1.10.1 Construction and Operations Impacts at the Moab Site

Noise associated with the on-site disposal alternative would come from construction activities, movement of contaminated soil from the site to the tailings pile, and movement of borrow materials on the site. The largest sources of noise on the site would be heavy earth-moving equipment. Typical noise emissions from construction equipment such as trucks, front-end loaders, bulldozers, excavators, and other heavy equipment range from 70 to 85 dBA at a 50-ft distance (Table 4–5) (Parsons 2003). A combination of the loudest pieces of equipment would have a cumulative noise source of 95 dBA at a 50-ft reference distance. This assumption is conservative, since general operation of equipment would not result in maximum noise levels, and all the equipment would never be at the same point at the same time.

Table 4–5. Noise Levels (dBA) Used for Noise Assessment

Source of Noise	Reference Distance (ft)	Range of Measured Noise Levels (dBA)	Maximum Noise Level Estimate Used (dBA)
Loader	50	82	85
Bulldozer	50	85	85
Backhoe	50	80–82	85
Blade	50	85	85
Roller	50	82	85
Dump Truck	50	79	85
Concrete Truck	50	82	85
Truck at 60 mph	25	81–87	95
Truck at 30 mph	25	77–80	85
Car at 70 mph	25	76–78	80
Car at 35 mph	25	61–65	67
Freight Train	30	72–82	97

A maximum noise level of 95 dBA at 50 ft would produce a 1,480-ft radius of influence where 1-hour L_{eq} noise levels would exceed the noise standard (65 dBA) for the city of Moab (Moab City Ordinance 17.74.080, "Noise Levels"). Moab city limits are approximately 9,840 ft from the tailings pile, well beyond the distance necessary for noise to attenuate to levels below applicable standards. There is one rural residence within 1,480 ft of the site boundary, located adjacent to the northeast portion of the site. This rural residence is on the opposite side of the site from the tailings pile and is more than 1,480 ft from where most of the earth-moving activity would occur.

Surface remediation would not be expected to generate noise levels that would exceed levels associated with earth-moving equipment, and there would be no off-site impact to people. Activities located between the tailings pile and the Colorado River could disrupt wildlife inhabiting the riparian zone along the western shoreline of the Colorado River and recreational users of the river.

Background levels of ground vibration range between 62 and 65 dBV. Ground vibration generated from construction equipment at the Moab site would be estimated to have a maximum level of 95 dBV (Hanson et al. 1991). Levels of ground vibration that approach 92 to 100 dBV could damage fragile buildings. Ground vibration is estimated to follow a logarithmic decrease as distance from the source increases. Vibrations from a 95-dBV source should decrease to levels below human detection within 820 ft. The entrance to Arches National Park is within 820 ft of the Moab site boundary, and visitors could experience small vibrations as a result of activities at the Moab site. Some cultural sites containing rock structures are within 300 to 400 ft of the Moab site boundary, but ground vibration levels are not expected to reach levels (estimated to be 92 to 100 dBV) that would damage these structures at that distance.

4.1.10.2 Impacts from Characterization and Remediation of Vicinity Properties

Remediation of vicinity properties would increase noise levels at the sites as a result of operating excavating equipment, loading trucks for removal, unloading borrow materials at the sites, and performing grading and finishing work. Activities would be limited to usually one piece of heavy equipment (shovel, bulldozer, or grader) and a truck transporting soil to or from the site during daylight hours. People residing on or near the vicinity properties could be disturbed by the noise associated with these activities. A region of influence would extend 820 ft from the remediation site, at which point the modeled noise levels would drop to 65 dBA. These activities would produce a temporary, adverse impact on the properties adjacent to the vicinity properties.

The activities required for remediation of vicinity properties could also produce ground vibration at levels that would disturb nearby residences, but the vibrations would not damage any buildings.

4.1.10.3 Construction and Operations Impacts Related to Transportation

Remediation of vicinity properties would generate noise from trucks used to transport material from the vicinity properties to the Moab site and transport borrow materials from borrow areas to the properties. Many of these trucks would travel through Moab. A total of 30 trips for removal and 30 trips for delivery of borrow material would occur for each of the estimated 98 sites. This would result in a total of 120 truck trips (coming and going) for each of the 98 sites. Remediation of the vicinity properties would last 1 to 3 years, and each site would take 4 to 6 weeks to complete. On average, there would be less than one truck trip per hour, and the contribution above background 1-hour L_{eq} noise levels would be minimal.

In order to haul borrow materials to the Moab site, an upgrade of the existing site entrance from US-191 would be necessary. This construction would employ equipment similar to that used for construction at the Moab site. An estimated maximum noise source of 95 dBA would attenuate to 65 dBA within 1,480 ft. The only receptors potentially located within 1,480 ft of any transportation infrastructure construction would be at Arches National Park. However, the topography and access to Arches National Park make it unlikely that any members of the public would be using the park within 1,480 ft of the construction.

For trucks hauling borrow material to the Moab site (estimated 43 round trips per day), the 1-hour L_{eq} at the construction site would be insignificant compared to the 95-dBA maximum noise level assumed for construction activities. Estimates of noise impacts to areas adjacent to transportation routes for the borrow material are listed in Table 4–6. For all the transportation routes, the impact of additional noise generated by trucks hauling borrow material would be minimal. The distance from US-191 that is modeled to have 1-hour L_{eq} sound pressure level above 65 dBA would increase by 52 ft, from 164 to 216 ft (30 percent increase), by the additional truck traffic. This transportation route goes by Arches National Park and would increase the noise level on a small portion of the park. The National Park has a visitor's center approximately 490 ft from US-191. Noise levels would not be expected to exceed noise standards at the visitor's center or to increase the noise level at the visitor's center by a perceptible amount. The I-70 corridor between Floy Wash and Crescent Junction would be expected to see the largest region of influence, modeled at 243 ft from the roadway.

Table 4–6. Noise Impacts (1-hour L_{eq}) Around Transportation Routes for Borrow Material

Highway Section	Hourly Average Baseline Noise (dBA) at 25 ft From Source	Hourly Average Project Truck Traffic	Hourly Average Project Truck Traffic Noise (dBA) at 25 ft From Source	Total Noise (dBA) at 25 ft From Source	Increase at 25 ft (dBA) From Truck
Floy Wash to Crescent Junction Exit	74	5.6	66	75	0.7
Crescent Junction to Moab	73	8.3	68	74	1.2
Klondike Flats to Moab	73	8.3	68	74	1.2
Moab[a]	66	1.8	54	66	0.3
La Sal Junction through Moab	73	1.8	61	73	0.3
Spanish Valley through Moab	70	1	59	70	0.3
Lisbon Valley to La Sal Junction	57	1.8	61	63	5.8

Assumptions: Single project truck vehicle noise 95 dBA[b] at 60 mph[a], 25 ft from source.
Single project truck vehicle noise 85 dBA[b] at 60 mph[a], 25 ft from source.

[a] Project truck speed 30 mph within Moab city limits, 60 mph elsewhere.

[b] Conservative estimation based on values from multiple sources (Bowlby 1991, Sandberg 2001)

Transportation of borrow materials through the city of Moab would not be expected to result in a noticeable increase in traffic noise because of the reduced speeds through town and the higher background traffic noise. The route from Lisbon Valley to La Sal Junction would have the greatest impact from trucks hauling borrow material because of the low baseline noise levels. However, the noise levels (1-hour L_{eq}) would not exceed the 65 dBA residential noise standard (Moab City Ordinance 17.74.080, "Noise Levels").

Ground vibration generated by vehicles with rubber tires would be minimal, especially on smooth pavement. Potholes could increase the ground vibration generated by trucks, so vibration within the city of Moab could increase by a small amount. However, ground vibration generated by trucks hauling borrow material would be very near the threshold of human perception at the source.

4.1.10.4 Monitoring and Maintenance Impacts

Monitoring and maintenance of the Moab site would not be expected to result in significant generation of noise. Any noise generated by these activities would attenuate to levels near background before leaving the disposal site boundary.

4.1.10.5 Impacts from All Sources

Noise generated as a result of the on-site disposal alternative would not exceed the city of Moab residential noise standard of 65 dBA at any receptor locations. The receptors with the most potential to notice any increase in noise generated by this alternative would include the resident located on the eastern boundary of the site, residents along SR-46 between Lisbon Valley and La Sal Junction, and visitors at Arches National Park. Ground vibration generated by on-site activities and trucks would be expected to be at or below human perception in most instances.

4.1.11 Visual Resources

This section describes the impacts to physical features of the landscape from activities proposed under the on-site disposal alternative. The impacts would be imposed on viewers who live in, work in, or visit an area and can see ongoing human activities or the results of those activities.

4.1.11.1 Construction and Operations Impacts at the Moab Site

The primary viewers of construction and operations at the Moab site would be southbound and northbound travelers on US-191 and SR-279. Other viewers would include residents of the home immediately northeast of the site, residents of a home at The Portal RV and Park, and a limited number of visitors to Arches National Park. The darkened areas in Figure 4–4 indicate locations from which the disposal cell could potentially be viewed.

The visibility analysis used to create this map is based on elevation and topography and does not take into account the potential obstruction of views from cultural modifications (such as buildings) and vegetation. Consequently, activities at the site would not be viewed from the major portion of the darkened area south and east of the site because of shielding by buildings and tall vegetation (mainly cottonwood trees and tamarisk shrubs).

Travelers southbound on US-191 would be able to view construction activities and the completed disposal cell for approximately 2.5 minutes; viewing time for northbound travelers would be approximately 1.3 minutes. For both northbound and southbound travelers on SR-279, viewing times would be approximately 2.5 minutes. Residents of the home located at The Portal RV and Park generally would not have a clear view of the site or disposal cell when local vegetation is green. The site and cell would become more apparent in winter when the trees and shrubs lose their leaves. Residents at the home immediately northeast of the site would have a clear view of the site year-round. Travelers through Arches National Park would be able to view the site along a 1.2-mile section of the park's access road, from the park entrance to a hairpin turn at the top of the climb; after the turn, the site would not be visible. Construction activities at the site and the completed disposal cell would not dominate the view of the park's visitors, as vehicle drivers would most likely be focused on the park's narrow, winding road, and passengers would likely be viewing the more dramatic features of the park. The primary visual impact on the nearby residents and park visitors would be the dusk and dawn lighting during the construction period.

The views of southbound and northbound travelers on US-191 would be the most dramatically affected by this alternative. DOE evaluated visual impacts from three key observation points: (1) along southbound US-191 for a distance of approximately 2 miles, (2) along northbound US-191 for a distance of approximately 1 mile, and (3) along SR-279 for approximately 1.5 miles. At each observation point, DOE assessed the degree and types of changes that would occur in the landscape from the proposed activities (constructing the disposal cell with heavy equipment, covering the side slopes of the current tailings pile with light-gray riprap, filling the riprap interstices with reddish soil, and seeding the entire disposal cell with native or adapted plant species).

During the construction period, the primary visual impacts from the three key observation points would be associated with the dusk and dawn lighting and noticeable movement of heavy equipment on the site. Exhaust emissions and dust generated by the equipment also would be noticeable. In an otherwise natural and still landscape, the lighting, movement, and emissions of the heavy equipment would create moderate contrasts during the day and strong contrasts during dawn, dusk, and nighttime hours. Once the cell was completed, the heavy equipment and on-site lighting would be removed, thus eliminating these impacts in the long term. The short-term adverse visual impacts from construction activities could be minimized by planting a "hedgerow" of trees and shrubs between the disposal cell and US-191 and SR-279. Once the plants matured, they would shield much of the on-site construction activities from travelers during the spring, summer, and fall months.

The strongest contrasts would occur for an approximate 3- to 5-year period after the disposal cell was completed and before vegetation was well established, as shown in the photo simulation in Figure 4–5. In contrast with the natural, complex terrain created by rugged canyon walls, jagged rock formations, and distant mountain peaks, the disposal cell would be characterized by horizontal lines and a simple geometric form. In addition, the pink-stippled, light-gray color of the riprapped side slopes would contrast strongly with the predominant reds and beiges of the natural landscape. The riprap would impart a somewhat rugged texture to the side slopes when viewed close-up. However, from a distance, the side slopes would appear smooth and would create yet another contrast with the surroundings.

Visual Resource Contrast Rating

DOE used BLM's Visual Resource Contrast Rating system (BLM 2003b) to evaluate visual impacts that would occur as a result of the proposed alternatives. From **key observation points**, DOE's visual resource specialist observed the existing landscape at each site proposed to be disturbed under one or more of the alternatives. The basic elements of the landscape—**form, line, color, and texture**—were then compared to the basic elements that would occur as a result of the proposed activity. The degree of contrast that would occur was then rated as **none, weak, moderate, or strong**.

Definitions

Key observation point—one or a series of points on a travel route or at a use area where the view of a proposed activity would be most revealing.

Basic landscape elements—

Form: the mass or shape of an object or group of unified objects, such as the shape of a barren area, a cliff formation, or a pipeline.
Line: the path, real or imagined, that the eye follows when perceiving abrupt differences in form, color, or texture. Within landscapes, lines may be found as ridges, skylines, structures, or changes in vegetation types.
Color: the value, chroma, hue, and reflectivity of an object or area.
Texture: the visual manifestations of the interplay of light and shadow created by the variations in the surface of an object or landscape.

Degrees of contrast—

None: the contrast is not visible or perceived.
Weak: the contrast can be seen but does not attract attention.
Moderate: the contrast begins to attract attention and begins to dominate the landscape.
Strong: the contrast demands attention, will not be overlooked, and is dominant in the landscape.

Figure 4–5. Simulated View of the Moab Disposal Cell from the Southbound Lane of US-191 Immediately After Construction

[Before UDOT widened US-191]

After vegetation was well established, the strong contrasts in line, form, color, and texture would be lessened, as shown in the photo simulation in Figure 4–6. Desert shrubs such as rabbitbrush and fourwing saltbush would be expected to become established on the side slopes and would alter the overall appearance of the cell. Although the dominant form of the cell would remain simple and geometric, the vegetation would soften the harsh horizontal lines and add complexity to the cell's color and texture. Overall, a moderate contrast with the surrounding landscape would be expected.

Neither the strong contrasts anticipated to occur in the short term nor the moderate contrasts anticipated to occur in the long term would be compatible with the Class II objectives (see Section 3.1.15) that BLM has assigned to the nearby landscapes. To meet Class II objectives, the level of change to the existing landscape would have to be low, could not attract the attention of the casual observer, and should repeat the basic elements of line, form, color, and texture that are found in the predominant natural features (BLM 2003). The strong and moderate visual contrasts could be mitigated somewhat by placing beige- and red-colored riprap on the side slopes (instead of light gray); and recontouring the cell to a more complex, less geometric shape. Even then, Class II visual objectives may not be achievable from all viewing locations. DOE is not required to meet the objectives of BLM's visual resource management system on the DOE-owned Moab site; however, the system provides a useful way to measure the effects of a proposed action on visual resources.

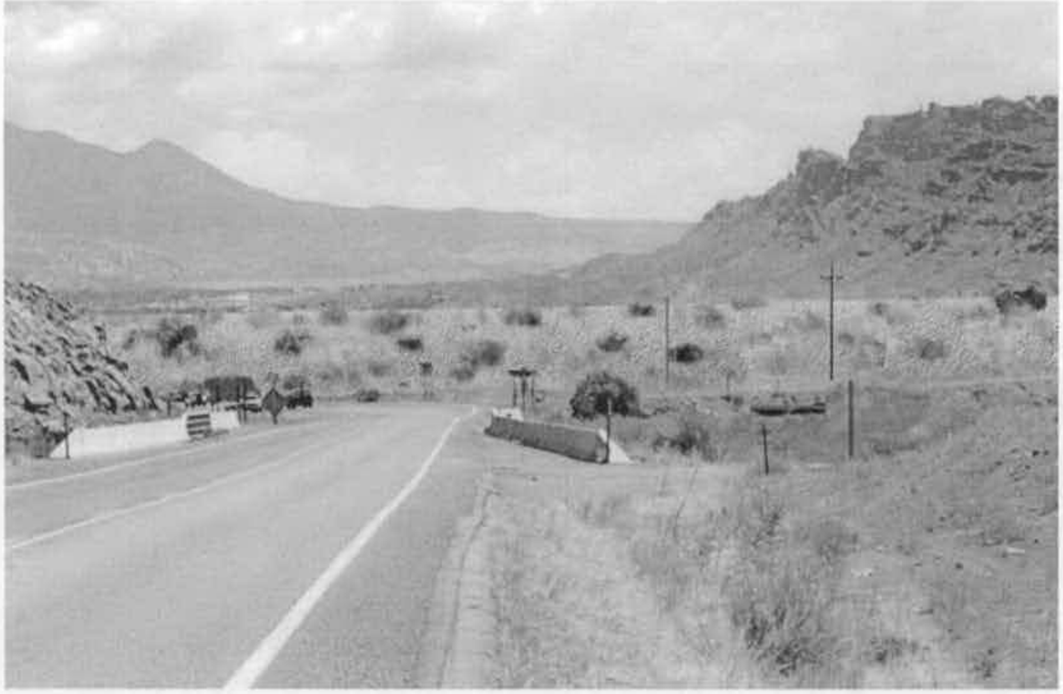

Figure 4–6. Simulated View of the Moab Disposal Cell from the Southbound Lane of US-191 After Vegetation Is Established

[Before UDOT widened US-191]

4.1.11.2 Impacts from Characterization and Remediation of Vicinity Properties

Remediation of vicinity properties would result in short-term adverse impacts to visual resources. The removal of vegetation and consequent increase in barren ground would create strong, local contrasts in line, form, texture, and color. The primary viewers of these contrasts would be the residents of the home or facility undergoing remediation and nearby neighbors. Most of the contrasts would be eliminated in the short term, as DOE would replace barren lawn areas with green sod, replace shrubs and trees with nursery-grown plants, and resurface paved areas. No long-term impacts to visual resources would be expected to occur.

4.1.11.3 Construction and Operations Impacts Related to Transportation

Impacts to visual resources would not be expected to occur from transporting vicinity property material or borrow material to the Moab site. Moab residents would notice the presence of large dump trucks and heavy equipment in residential neighborhoods during remediation of vicinity properties, but this impact would be short term and minor.

4.1.11.4 Monitoring and Maintenance Impacts

Impacts to visual resources would not occur from monitoring and maintenance activities under the on-site disposal alternative.

4.1.11.5 Impacts from All Sources

Stabilizing the tailings pile at its current location on the Moab site would likely have adverse impacts on visual resources. Although the tailings pile would remain in its present location on the Moab site, riprap would be placed on the side slopes, and interstitial voids would be filled with soils and planted with vegetation. From the key observation points established for the site, the predominantly smooth, horizontal lines created by the pile would continue to create a strong contrast with the adjacent vertical sandstone cliffs. Due to its relatively large size, the pile could dominate the view of the casual observer from the US-191 and SR-279 key observation points. It would likely be recognized as an anomalous feature. If light gray riprap were used, it would contrast strongly with the reds of the surrounding cliffs. Unlike the pile in its current condition (covered in red soils), it would likely be noticed by visitors to the Moab area. The visual contrasts that would occur under this alternative would not be compatible with the Class II objectives that BLM has assigned to the nearby landscapes. Although DOE is not required to meet the objectives of BLM's visual resource management system on the DOE-owned Moab site, the system provides a useful way to measure the effects of a proposed action on visual resources. Table 4–7 summarizes the visual resource impacts expected to occur under the on-site disposal alternative. The primary negative impacts would occur in the short term and long term from disposal cell construction.

Table 4–7. Summary of Visual Resource Impacts Under the On-Site Disposal Alternative

Location/Activity	**Visual Resource Impacts**	
	Short Term	**Long Term**
Moab site	Strong adverse impacts primarily to travelers on US-191 and SR-279	Moderate adverse impacts primarily to travelers on US-191 and SR-279
Klondike Flats borrow area (radon barrier material)	Negligible to no adverse impacts; site not visible to most casual observers	No adverse impacts
Cover soil borrow area	Negligible to strong adverse impacts, depending upon borrow source	No adverse impacts
Vicinity properties	Strong adverse impacts to residents and neighbors	No adverse impacts
Truck haul	Minor adverse impact to residents and neighbors	No adverse impacts
Monitoring and maintenance	No adverse impacts	No adverse impacts

4.1.12 Infrastructure

This section addresses potential impacts on the availability of electric power, potable water, nonpotable water, sewage treatment, rail service, and highways. Unless indicated otherwise, all infrastructure impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.1.12.1 Construction and Operations Impacts at the Moab Site

The primary electrical demands would be associated with the use of the existing mill building as an equipment/vehicle maintenance shop, field office trailer power, security lighting, nighttime operations lighting (if work activities continued into nighttime), river pump stations, and decontamination spray pumps. The electrical service at the Moab site would be required to support an estimated basic demand of 600 kVA. Electric Systems Consultants (ESC) of Fort Collins, Colorado, developed and reviewed this projected demand with Mathew Yates, Pacific Corporation (Utah Power and Light), Moab, Utah. Pacific Corporation indicated that this demand would present no capacity problems to the existing electrical supply system at the site, nor would system upgrades be required (ESC 2003).

Implementation of this alternative would require an estimated 4,200 gallons of potable water per day to be purchased from the city of Moab. The city potable water system, which is spring-based, currently delivers about 3 million gallons of water per day during the high-demand summer season and about 1 million gallons per day in winter. The City has indicated that the projected 4,200-gallon-per-day demand would not represent a significant impact and could be met without adversely affecting the city's water supply or requiring system upgrades (Swenson 2003).

This alternative would also consume 70 acre-feet of nonpotable water annually (or a project total of approximately 490 acre-feet, assuming a 7-year project duration). All of this water would be drawn from the Colorado River under DOE's existing Moab site water rights, which authorizes DOE to withdraw approximately 3 cfs consumptive use and approximately 3 cfs nonconsumptive use. The authorized total of 6 cfs allows for withdrawal of approximately 4,560 acre-feet per year.

The projected 70 acre-feet per year of total usage is approximately 3 percent of DOE's annual authorized consumptive use withdrawal volume, and less than the 100 acre-feet per year deemed by USF&WS to be protective of endangered fish species. This level of protection complies with the cooperative agreement to implement the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USF&WS 1987). Therefore, there would be only a minor impact to designated critical habitat.

Activities at the Moab site would generate approximately 10,000 gallons of sanitary waste per week. The waste would be stored in portable toilets or in septic tanks connected to trailers at the on-site support area. The waste would be disposed of in the city of Moab's sewage treatment plant, which can treat up to 1.5 million gallons of sewage per day and currently treats less than 1 million gallons per day (see Section 3.1.16.1). Consequently, the 10,000-gallons-per-week estimate would represent about 2 percent of the city's current excess treatment volumetric capacity and would not be a significant impact. However, the City restricts the amount of waste it will accept from septic tanks and portable toilets (all sources) to 9,000 gallons per day, and it will only receive such wastes 3 days per week. These restrictions could constrain the amount of waste the City would accept from the Moab site, depending on amounts the city was receiving from other sources. This potential impact could be alleviated by coordinating shipments of the site's sanitary waste so that the restrictions would not be exceeded, or by diluting the waste to a density similar to that of sanitary waste in sewer lines, thereby making disposal acceptable. The City has indicated that it would work with contractors to accommodate disposal schedules and evaluate the applicability of the 9,000-gallon-per-day limit if the waste were diluted. If dilution were necessary, it would represent a relatively small increase in the total nonpotable water use.

4.1.12.2 Impacts from Characterization and Remediation of Vicinity Properties

Under the on-site disposal alternative, activities at the vicinity properties would have no impacts on the local power or rail infrastructure. There would be no impacts on potable or nonpotable water requirements beyond those discussed for activities at the Moab site, which include consumption due to activities at vicinity properties. Not more than one portable toilet should be required for the remediation of any of the vicinity properties. One portable toilet would generate less than 100 gallons of concentrated sanitary waste per week, which should not negatively affect the 9,000-gallon-per-day capacity of the Moab sewage treatment plant for this type of waste.

4.1.12.3 Construction and Operations Impacts Related to Transportation

Transportation of contaminated materials from vicinity properties to the Moab site and transportation of borrow materials from borrow areas to the Moab site would have no impact on the local or regional power, water, or rail infrastructures. Truck traffic transporting vicinity property or borrow area material to the Moab site would result in increased wear and tear on local roads and on US-191. The cost to the state for these impacts would be offset through vehicle registration and special permit fees, both of which provide revenue to the state general highway fund for road maintenance and repair. Transportation plans would include provisions for enforcing speed limits, road load limits, and any other applicable traffic laws.

4.1.12.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would be generally limited to periodic inspections and activities to remedy incipient erosion. DOE anticipates that these activities would not impact any element of the local or regional infrastructures.

4.1.12.5 Impacts from All Sources

Power demand of 600 kVA could be met with no impact to Utah Power's existing electric supply infrastructure servicing the site. Potable water demand of 4,200 gallons per day could be met with no adverse impact to the city of Moab's existing potable water supply infrastructure. Nonpotable water demand of 70 acre-feet per year would represent about 3 percent of DOE's existing Colorado River water usage rights at the Moab site. The estimated 10,000 gallons of sanitary waste per week could be treated by the city of Moab's existing sanitary waste treatment infrastructure, but the city's limit of 9,000 gallons per day of concentrated sanitary waste from septic tanks and portable toilets could be exceeded. Mitigation measures to address this potential exceedance would entail coordinating shipment schedules or diluting the waste prior to shipment. Shipments of vicinity property material and borrow materials to the Moab site would result in accelerated wear and tear on neighborhood, county, and state roads. Truck permit and registration fees would compensate the State and Grand County for this unavoidable adverse impact to the road infrastructure.

4.1.13 Solid Waste Management

This section discusses impacts from the generation of solid waste under the on-site disposal alternative. These wastes would be generated for the duration of the remedial action and would cease once remedial action was completed.

4.1.13.1 Construction and Operations Impacts at the Moab Site

Activities at the Moab site would generate approximately 1,040 yd^3 of uncontaminated solid waste per year for 7 to 10 years. This waste would be disposed of at the Grand County landfill, which has a projected life span of 64 years at a disposal rate of 30,000 to 35,000 yd^3 per year. The Grand County landfill received approximately 36,000 yd^3 of solid waste in 2002; therefore, the volumes of solid waste generated at the Moab site and disposed of at the landfill would not negatively affect the Grand County landfill's life span.

Because the ground water contamination beneath the Moab site includes uranium and radium as well as ammonia and other contaminants (See Section 3.1.6.3), any of the screened ground water treatment technologies discussed in Sections 2.3.2.1 would generate RRM during the estimated 80-year duration of ground water remediation under the on-site alternative. Section 2.3.2.1 discusses possible treatment technologies for the extracted ground water. As noted in Section 2.3.2.1, discharge of ground water to the Colorado River would require extensive treatment and appropriate permits. Either deep well or shallow injection technologies would also require appropriate State and NRC permits. An evaporation treatment technology would require provisions for disposal of the RRM solids that would accumulate in the evaporation ponds. On the basis of dissolved solids content of the ground water, DOE estimates that an evaporation treatment technology would generate approximately 6,600 tons of RRM annually for the 80 years that ground water treatment was ongoing. This waste stream would be disposed of in a properly licensed facility such as a DOE-controlled disposal cell or a commercial disposal facility.

4.1.13.2 Impacts from Characterization and Remediation of Vicinity Properties

Almost all wastes generated at vicinity properties (an average of 300 yd^3 for each vicinity property) would be contaminated material that would be transported to the Moab site for disposal. A very small volume of uncontaminated solid waste could be generated during the remediation of the vicinity properties and would be disposed of directly in the Grand County landfill or in trash receptacles near the vicinity properties. The volume of solid waste generated during the remediation of each vicinity property would be variable but would not negatively affect the Grand County landfill's life span.

4.1.13.3 Construction and Operations Impacts Related to Transportation

Small volumes of uncontaminated solid waste could be generated during transportation of contaminated materials from vicinity properties to the Moab site and during transportation of borrow materials to the Moab site. These wastes would be disposed of in the Grand County landfill.

4.1.13.4 Monitoring and Maintenance Impacts

Very small volumes of waste would be generated as a result of ongoing inspections and monitoring. All wastes would be managed in accordance with applicable laws and regulations.

4.1.13.5 Impacts from All Sources

Management of an estimated 1,040 yd^3 of uncontaminated solid wastes generated as a result of activities at the site for 7 to 10 years would not result in adverse environmental or waste disposal capacity impacts. About 6,600 tons of RRM would be generated annually for 80 years if an evaporation-based ground water remediation treatment were implemented. These wastes would be handled, recycled, or disposed of according to approved waste management plans and applicable state and federal regulations.

4.1.14 Socioeconomics

This section discusses the potential socioeconomic impacts under the on-site disposal alternative. Project activities would be executed over three phases: a pre-remediation phase, a remediation phase, and a post-remediation phase. The potential impacts are examined using geographically and industrially detailed information on expected direct and indirect changes in output, earnings, and employment over the construction and transportation phases of the project. The analysis also considers potential impacts from increased demand for temporary housing, and the short-term and long-term influence of surface remediation on the regional tax base and future economic development opportunities.

The affected socioeconomic region of influence covers Grand County and San Juan County in southwestern Utah. The impact analysis uses annualized project cost information specific to actions undertaken for the on-site disposal alternative developed from DOE's cost estimates for each alternative. This information is summarized for all on-site and off-site disposal alternatives in Table 4–8.

Data sources used for these estimates include:

- Actual vendor quotes
- RS Means 2003 Cost Estimating Guides (RS Means 2003)
  —Environmental Remediation Cost Data—Unit Pricing, 9th Edition
  —Environmental Remediation Cost Data—Assemblies, 9th Edition
  —Site Work & Landscape Cost Data, 22nd Edition
  —Building Construction Cost Data, 61st Edition
  —Heavy Construction Cost Data, 17th Edition
- Similar project experience

The cost information provided in Table 4–8 itemizes the total project costs by alternative that were summarized in Table 2–35 and includes cost for:

A. The pre-remediation phase during which design, procurement, and site preparation would occur.
B. The remediation phase of the project during which surface and ground water remediation would occur.
C. A 10-percent cost-contingency on these two phases.
D. Total surface remediation costs assuming an 8-year duration.
E. Annual ground water remediation costs that would be incurred for 80 years under on-site disposal and 75 years for the off-site disposal alternatives and annual post-surface remediation costs.
F. Total annual costs for each alternative during active surface and ground water remediation assuming an 8-year duration.

On the basis of the above cost information, economic impacts for the Moab remediation project were estimated using the Regional Input-Output Modeling System II (RIMS II) method of the Bureau of Economic Analysis, U.S. Department of Commerce (BEA 1997). This methodology is widely used in systematic analysis of economic impacts from large-scale public sector projects. The RIMS II method takes account of interindustry relationships within the two-county socioeconomic region of influence, which largely determine how the regional economy would respond to the infusion of new spending resulting from construction-transportation activities undertaken in the Moab site remediation.

The RIMS II multipliers used in the analysis were estimated by the Bureau of Economic Analysis specifically for Utah's Grand and San Juan counties. Final-demand and direct-effect multipliers for the construction sector are used in estimating the impact of the Moab surface remediation project on regional output, earnings, and employment. The impact on annual output of goods and services and labor earnings is calculated as the products of the final-demand multipliers (1.3178 and 0.3250) and annualized project cost. The impact on annual labor employment is calculated as the product of the direct-effect multiplier (1.4262) and estimated direct employment for each action alternative. Table 4–9 reports the associated economic impacts along with annual project costs.

Table 4–9. Economic Impacts in the Two-County Socioeconomic Region of Influence

On-Site Disposal[a]	Annual Cost	Annual Output of Goods and Services	Annual Labor Earnings	Jobs
Moab Site	$20,739,125	$27,330,019	$6,740,216	171

[a] Economic impacts for regional output of goods and services and labor earnings are calculated based on final-demand multipliers provided by the Bureau of Economic Analysis. The respective multiplier values (1.3178 and 0.3250) are multiplied by annualized cost to generate the impact values shown. Employment impacts are calculated as the product of the direct-effects multiplier (1.4262) and 120 total direct jobs (see Table 2–4).

The industries expected to be initially affected by the project include the regional construction and transportation industries, along with supporting service industries (especially hotels and restaurants). The project workforce is assumed to come from outside the socioeconomic region of influence and to spend a portion of their earnings on housing, food, and other goods and services within the two-county socioeconomic region of influence.

These impacts are based on estimated annual project costs of $20,739,125 over an 8-year disposal period, followed by estimated annual costs of $942,000 over an additional 80-year period of ground water remediation/site monitoring. These annual expenditures would cover the various activities described above, including construction and operations at the Moab site; ground water remediation; characterization and remediation of vicinity properties; transportation of vicinity property materials and borrow materials to the Moab site; and monitoring and maintenance impacts. Over the 8-year disposal period, the annual expenditures reflect increased annual output of goods and services of $27,330,019; increased annual labor earnings of $6,740,216; and increased direct and indirect employment of 171. Annual ground water remediation and site monitoring expenditures over the 80-year period following completion of surface remediation would not have significant impacts on the output of goods and services, labor earnings, or employment levels in the two-county region.

The potential shorter-term impacts from the on-site disposal alternative include effects on the demand for temporary housing. Project workers would take up temporary housing in the two-county socioeconomic region of influence, and their spending on goods and services would result in the collection of tax revenues by the state. As noted in Section 3.1.18.2, the availability of temporary housing is heavily dependent on tourist-recreation activity. The remediation project would tend to cause some crowding-out impacts during the peak tourism season due to increased competition for temporary accommodations. However, lower vacancy rates would be expected during the off-season, as workers took up temporary accommodation in the two counties. The increase in the workforce would tend to last over the duration of the surface remediation project. Consequently, any potential impacts on public safety (police, fire, medical) or on local school systems would be restricted to the duration of the project.

Longer-term beneficial impacts from the on-site disposal alternative relate to greater opportunities for economic development in the Moab area and greater diversification of the tax base. Currently, the local tax base depends heavily on the seasonally driven tourist-recreation sector. New spending and tax collections during and after the remediation process would help diversify the current tourist-driven tax base. These longer-term impacts would depend upon continued growth in the recreational demand for land and water resources in the socioeconomic region of influence, particularly in the vicinity of the Moab site and vicinity properties. The remediation process would improve both land and water quality in these areas and would safeguard surface and ground water quality for future beneficial uses along the Colorado River, such as rafting and camping.

4.1.15 Human Health

This section addresses potential impacts to human health under the on-site disposal alternative. These impacts include the potential for worker deaths that could occur as a result of industrial accidents, worker or public latent cancer fatalities that could occur as a result of exposure to radiation from activities at the Moab site, at vicinity properties, or during transportation of materials to the Moab site. In addition, residents would be exposed to radon gas and radioactive particulates released from the Moab site.

4.1.15.1 Construction and Operations Impacts at the Moab Site

Under the on-site disposal alternative, construction activities at the Moab site would be estimated to result in less than one fatality (0.16) as a result of industrial accidents.

During operations, workers at the site would be exposed to radon gas (an inhalation hazard) and external radiation from the mill tailings at the site. According to environmental monitoring data collected on the tailings pile, the average radon concentration over the period 2002 and 2003 was 5.9 pCi/L. This is equivalent to 0.041 working level, using an equilibrium factor of 0.7 (Wasiolek and Schery 1993). A worker exposed to this level of radon for 2,000 hours per year has a latent cancer fatality risk of 2.6×10^{-4} per year of exposure. Based on an external gamma radiation survey conducted on top of the tailings pile, the average external gamma exposure rate was about 0.35 milliroentgen per hour (mR/h). A worker exposed to this level of radiation for 2,000 hours per year would have a latent cancer fatality risk of 3.5×10^{-4} per year of exposure. The total latent cancer fatality risk to the worker on the tailings pile would be 6.1×10^{-3} per year of exposure (Table 4–10), or 1.5×10^{-3} over the 5-year duration of activities at the Moab site.

Table 4–10. Worker Impacts for the On-Site Disposal Alternative (Moab Site)

Category of Worker	Radon-Related LCFs[a]	External Radiation-Related LCFs[a]	Total LCFs[a]
Annual			
Individual	2.6×10^{-4}	3.5×10^{-4}	6.1×10^{-4}
Population	0.012	0.016	0.028
5-Year Duration of Activities			
Individual	6.5×10^{-4}	8.8×10^{-4}	1.5×10^{-3}
Population	0.030	0.041	0.071

[a] LCF = latent cancer fatality based on 47 workers at the Moab site.

Remediation at the Moab site would employ about 47 workers. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.028 per year of exposure, or 0.071 over the 5-year duration of surface remediation activities at the Moab site.

For non-workers (i.e., local residents), monitoring data collected during 2002 and 2003 around the Moab site indicate that the radon concentration at the location of the maximally exposed individual is about 1.9 pCi/L. Assuming that this individual was exposed for 8,760 hours per year, this would be equivalent to a latent cancer fatality risk of 1.2×10^{-3} over the 5-year duration of activities for the on-site disposal alternative.

Monitoring data collected during 2002 and 2003 indicate that the latent cancer fatality risk to the maximally exposed individual from radioactive particulates would be about 4×10^{-6} over the 5-year duration of activities for the on-site disposal alternative.

For the population, over the 5 years of activity at the Moab site, the latent cancer fatality risk from radon releases to the population surrounding Moab would be 0.080.

As described under the proposed action for ground water remediation (Section 2.3.2), a 40-acre evaporation pond could be constructed to treat extracted ground water. The water pumped to this pond would be contaminated with ammonia at concentrations of about 1,000 mg/L. The atmospheric concentration of this ammonia for a nearby resident was estimated to be about 2.1 mg/m^3. This concentration is less than the Temporary Emergency Exposure Limit-0 (TEEL-0) value of 15 mg/m^3 for ammonia, which is the threshold concentration below which most people experience no adverse health effects.

4.1.15.2 Impacts from Characterization and Remediation of Vicinity Properties

Remediation at vicinity properties would be estimated to result in less than one fatality (0.031) as a result of industrial accidents.

Radiation exposure at the vicinity properties has not been extensively characterized. However, on the basis of data from other vicinity properties (DOE 1985), the indoor radon level at vicinity properties was estimated to be about 0.046 working levels (7 pCi/L), and the external gamma exposure rate at vicinity properties was estimated to be 0.12 mR/h. A worker exposed for 2,000 hours per year would have a latent cancer fatality risk of 2.9×10^{-4} for radon and 1.2×10^{-4} for external radiation. The total latent cancer fatality risk for a worker at vicinity properties would be 4.1×10^{-4} per year of exposure (Table 4–11), or 1.2×10^{-3} over the 3-year duration of activities at the vicinity properties.

Table 4–11. Worker Impacts for the On-Site Disposal Alternative (Vicinity Properties)

Category of Worker	Radon-Related LCFs[a]	External Radiation-Related LCFs[a]	Total LCFs[a]
Annual			
Individual	2.9×10^{-4}	1.2×10^{-4}	4.1×10^{-4}
Population	6.7×10^{-3}	2.9×10^{-3}	9.6×10^{-3}
Duration of Activities			
Individual	8.7×10^{-4}	3.7×10^{-4}	1.2×10^{-3}
Population	0.020	8.6×10^{-3}	0.029

[a] Based on 23 workers at vicinity property sites.

About 23 workers would be employed at the vicinity properties. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 9.6×10^{-3} per year of exposure, or 0.029 over the 3-year duration of activities at the vicinity properties.

Prior to remediation activities, people living at the vicinity properties would be exposed to radon and external gamma radiation levels similar to those mentioned previously—indoor radon levels of about 0.046 working levels (7 pCi/L) and external gamma exposure rate of about 120 microroentgens per hour (μR/h). A person exposed for 8,760 hours per year would have a latent cancer fatality risk of 1.3×10^{-3} for radon and 6.5×10^{-4} for external gamma radiation. The total latent cancer fatality risk for a person at vicinity properties prior to remediation would be 1.9×10^{-3} per year of exposure, or 9.6×10^{-3} if this individual lived at a vicinity property for 5 years prior to remediation. If four people lived at each of the 98 vicinity properties, the latent cancer fatality risk for these 392 people would be 0.76 per year of exposure. If these people lived in the vicinity properties for 5 years, about 4 (3.8) of them would die from cancer caused by the mill tailings contamination.

Remediation of the vicinity properties would reduce the radon and external radiation levels at those properties to levels specified by EPA standards, 0.02 working levels (about 3 pCi/L) for radon and 20 μR/h for external gamma exposure rate. A person exposed for 8,760 hours per year would have a latent cancer fatality risk of 5.5×10^{-4} for radon and 1.1×10^{-4} for external gamma radiation. The total latent cancer fatality risk for a person at vicinity properties would be 6.6×10^{-4} per year of exposure. If four people lived at each of the 98 vicinity properties, the annual latent cancer fatality risk for all of these people combined would be 0.26. Over the 30-year post-remediation time period, about 8 (7.8) of these people would die from cancer. Over the entire 35-year pre- and post-remediation time period, about 12 of these people would die from cancer.

4.1.15.3 Construction and Operations Impacts Related to Transportation

The on-site disposal alternative would require about 2,940 shipments of contaminated materials from vicinity properties to the Moab site and 56,463 shipments of borrow material to the Moab site. The borrow material would consist of cover soils, radon and infiltration barrier soils, sand and gravel, riprap, and Moab site reclamation soils.

The transportation impacts of shipping contaminated materials from vicinity properties and borrow material would be from two sources: radiological impacts and nonradiological impacts. Radiological impacts would be from incident-free transportation and from transportation accidents that released contaminated material. There would be no radiological impacts from moving borrow material because it is not contaminated. Nonradiological impacts would be from engine pollution (emissions from the trucks moving the contaminated material and the borrow material) and from traffic fatalities. The total transportation impacts would be the sum of the radiological and nonradiological impacts. Additional details on these analyses are provided in Appendix H.

Table 4–12 lists the transportation impacts for the on-site disposal alternative. For this alternative, DOE estimates there would be less than one fatality. In comparison, about 40,000 traffic fatalities occur annually in the United States (U.S. Census Bureau 2000) and about 335 occur annually in Utah (DOT 2004).

Table 4–12. Transportation Impacts for the On-Site Disposal Alternative

Alternative	Radiological			Nonradiological		Total Fatalities
	Incident-Free		Accident Risk LCFs	Pollution Health Effects Fatalities	Traffic Fatalities	
	Public LCFs	Worker LCFs				
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	1.1×10^{-3}	0.081	0.082
Mill tailings	0	0	0	0	0	0
Total	$\mathbf{2.7 \times 10^{-5}}$	$\mathbf{3.9 \times 10^{-5}}$	$\mathbf{6.9 \times 10^{-9}}$	$\mathbf{1.5 \times 10^{-3}}$	**0.082**	**0.084**

LCF = latent cancer fatality.

Workers. For truck shipments of mill tailings from vicinity properties to the Moab site, the maximally exposed transportation worker would be the truck driver. This person would receive a radiation dose of 26 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 1.3×10^{-5}.

Public. For truck shipments of mill tailings from vicinity properties to the Moab site, the maximally exposed member of the public would be a person who happened to be in a traffic jam next to a truck containing mill tailings. This person would receive a radiation dose of 0.084 mrem, which is equivalent to a probability of a latent cancer fatality of about 5.0×10^{-8}.

Accidents. The maximally exposed individual member of the public would receive a radiation dose of 0.048 mrem or 4.8×10^{-5} rem from the maximum dose reasonably foreseeable in a transportation accident involving a shipment of mill tailings from a vicinity property to the Moab site. This is equivalent to a probability of a latent cancer fatality of about 2.9×10^{-8}. The probability of this accident is about 4×10^{-4} per year. The population would receive a collective radiation dose of 5.6×10^{-4} person-rem from this accident. This is equivalent to a probability of a latent cancer fatality of about 3.3×10^{-7}.

4.1.15.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would include checking water quality, installing a long-term ground water monitoring system, and conducting periodic maintenance and inspections of the site (checking for erosion, damaged fencing, etc.). None of these activities would be expected to breach the cap over the tailings; the installation of the ground water system would be done in clean areas after remediation was complete. Data from another UMTRCA site indicate that the on-site disposal alternative would be effective in isolating contaminants in the tailings from individuals conducting activities on the site. DOE (2001) concluded that both radon and gamma levels associated with the capped-in-place tailings pile at the Shiprock site in New Mexico were indistinguishable from naturally occurring radiation levels. Therefore, the risk to workers conducting monitoring and maintenance would be comparable to the latent cancer fatality risk from background levels of radioactivity in Utah, about 3 × 10^{-4} per year of exposure.

4.1.15.5 Impacts from All Sources

Under the on-site disposal alternative, construction activities would occur at vicinity properties, borrow areas, and at the Moab site. Table 4–13 lists the construction-related impacts (fatalities) from these activities. For this alternative, less than one fatality would be estimated to occur from all construction activities.

Table 4–13. Construction-Related Fatalities for the On-Site Disposal Alternative

Alternative	Construction Fatalities
Truck option	
Vicinity properties	0.031
Borrow areas	0.014
Moab site activities	0.11
Total	**0.16**

Table 4–14 shows the total impacts that could occur to workers as a result of exposure to radiation during activities at the Moab site and at vicinity properties.

Table 4–14. Worker Impacts for the On-Site Disposal Alternative (Moab Site and Vicinity Properties)

Category of Worker	Site	Radon-Related LCFs	External Radiation-Related LCFs	Total LCFs[a,b]
Annual				
Individual	Moab	2.6×10^{-4}	3.5×10^{-4}	6.1×10^{-4}
	Vicinity properties	2.9×10^{-4}	1.2×10^{-4}	4.1×10^{-4}
Population	Moab	0.012	0.016	0.028
	Vicinity properties	6.7×10^{-3}	2.9×10^{-3}	9.6×10^{-3}
Total		**0.019**	**0.019**	**0.038**
5-Year Duration of Activities				
Individual	Moab	6.5×10^{-4}	8.8×10^{-4}	1.5×10^{-3}
	Vicinity properties	8.7×10^{-4}	3.7×10^{-4}	1.2×10^{-3}
Population	Moab	0.030	0.041	0.071
	Vicinity properties	0.020	8.6×10^{-3}	0.029
Total		**0.052**	**0.051**	**.103**

[a] Based on 47 workers at the Moab site.
[b] Based on 23 workers at vicinity property sites.

Based on as-built radon flux measurements from completed uranium mill tailings disposal cells constructed under both Title I (federal UMTRA Project sites) and Title II (private licensees) of UMTRCA, it is anticipated that actual radon flux would be two orders of magnitude less than the 20-pCi/m^2-s EPA protective standard promulgated in 40 CFR 192. Consequently, it is not expected that radon release from the capped pile would be a contributing source to future exposures. Table 4–15 presents the risks that would occur from residual on-site contamination (ground water) to a future resident, rafter, and camper on the Moab site. In all cases, added cancer risk would be less than a one-in-one-million probability of developing cancer. The potential for noncarcinogenic impacts would be less than the benchmark (a hazard index of 1). The detailed assumptions and calculation methods used to estimate these risk are presented in Appendix D.

Even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible and that DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 pCi/m^2-s, under EPA's regulations (40 CFR 192). On the basis of this emission rate and the dimensions of the tailings pile, the latent cancer fatality risk for a nearby resident of Moab would be 8.9×10^{-5} per year of exposure, or 2.7×10^{-3} over the 30-year period following the end of construction and operations. This latent cancer fatality risk is less than the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure or 0.9×10^{-2} over 30 years. Stated differently, the incremental additional latent cancer fatality risk from the maximum permissible disposal cell radon flux to the nearest individual, which is likely orders of magnitude greater than realistic future emission rates, is roughly one-third of the risk from natural background conditions to an individual in the state of Utah. The calculation methods used to estimate these risk are also presented in Appendix D.

Similarly, the annual latent cancer fatality risk for the population within a 50-mile radius of the site was estimated to be 6×10^{-3}. For this same population, the latent cancer fatality risk from the maximum permissible disposal cell radon flux would be 0.18 over the 30-year period following the end of construction and operations. These calculations are based on a distributed population size of 11,028.

The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the half lives of the radionuclides contained in the uranium mill tailings. In the time frame of 200 to 1,000 years, the major route of exposure of people would be through the inhalation of radon progeny from the disposal cell. The ground water at the Moab site is naturally high in salts and would not be used for human consumption. Releases of radionuclides to surface water would be diluted by the flow of the Colorado River. Consequently, it is unlikely that ground water and surface water would contribute large latent cancer fatality risks relative to inhalation of radon progeny. With the disposal cell cover in place and the Moab site being under perpetual care, it is likely that the latent cancer fatality risk for an inadvertent intruder would also be low.

As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time. Therefore, the annual latent cancer fatality risk for a nearby Moab resident would be about the same immediately after the cover is installed as it would be 1,000 years after the cover is installed, about 8.9×10^{-5} per year of exposure. Based on the 20-pCi/m^2-s radon release rate, for the population within a 50-mile radius of the site, the estimated annual latent cancer fatality risk would be 6×10^{-3}. As with the radioactivity in the disposal cell, the annual population risk would also not decrease appreciably over the 200- to 1,000-year time frame. If it is assumed that the population around the Moab site remains constant over 1,000 years, then an estimated 6 latent cancer fatalities over the 1,000-year time period would occur.

4.1.16 Traffic

This section summarizes potential impacts to traffic in the area affected by the on-site disposal alternative. In the following discussions, estimated percent increases in traffic are based on increases over the 2001 AADT for all vehicles or for trucks on segments of US-191 or I-70 (see Table 3–15). Implementation of this alternative would increase area traffic due to construction and operations at the Moab site, remediation of vicinity properties, and transport of borrow materials from borrow areas to the Moab site and vicinity properties. There would be initial unknown but minor short-term (period of several months) increases in area traffic on US-191 while various site preparations took place. These activities would include bringing heavy construction equipment to the site, such as backhoes, graders, front-end loaders, bulldozers, and trucks; constructing secure stockpile areas for various materials to be used during the remedial action (e.g., diesel fuel, water for dust control); and bringing a variety of construction trades to the site to set up temporary field offices and prepare road access areas. These activities would add to area traffic and could result in minor congestion and inconveniences near the site entrance on US-191.

Workers would commute to the Moab site for jobs at the site, at vicinity properties, and at borrow areas. DOE estimates that the average annual vehicle trips associated with these workers could increase daily traffic in central Moab by an estimated 240 vehicle trips per day on US-191. Although the addition of 240 vehicle trips per day would result in only a 1-percent increase in daily traffic (the reported 2001 AADT in central Moab was 16,045 vehicles of all types), UDOT reports the current traffic situation in Moab as highly congested. Thus, these additional vehicle trips would exacerbate the current congestion problem. Miscellaneous trips for supplies and meals would also add to traffic congestion. However, the above estimate is based on a worst-case analysis that assumes that all 120 workers (see Table 2–4) would need to traverse central Moab to access the Moab site. It is more likely that some workers, possibly one-half of the work force, would come from cities north of Moab, such as Green River, Utah, or Grand Junction, Colorado, and that some workers would car-pool. Also, these trips would occur before 7:00 a.m. and after 7:30 p.m., which are times of the day when traffic volumes would be lower.

Trucks carrying borrow material would travel from borrow sources north (cover, radon barrier, and reclamation soils) and south (sand, gravel, and riprap) of the Moab site, and all of these trips would occur on segments of US-191. North of the Moab site, average annual daily truck traffic on US-191 would increase by 70 daily trips (calculated from Table 2–2). Average annual daily truck trips would increase from 857 to 927, or approximately an 8 percent increase over 2001 levels. Because the destination of these trucks would be the Moab site, they would not pass through the city of Moab. An estimated 16 truck trips per day would be required to provide sand, gravel, and riprap from sources south of the Moab site. This increase would not be expected to affect traffic on US-191 south of Moab, but because these trucks would have to pass through Moab they would add to the traffic congestion on US-191 in central Moab.

Trucks carrying vicinity property material to the Moab site (and transporting backfill to the properties) would use US-191 both north and south of Moab (Figure 2–7) and also local roads or streets. The estimated maximum of 48 daily one-way trips hauling this material would increase the average annual truck traffic on US-191 by 6 percent. Many of these trips would traverse all or part of Moab.

Monitoring and maintenance activities at the site would result in fewer than five vehicles per day and would be inconsequential compared to existing traffic volumes.

4.1.17 Disposal Cell Failure from Natural Phenomena

This section addresses the potential natural processes that could cause a failure of the disposal cell at the Moab site and the expected consequences and potential risks. The focus of this analysis is to evaluate the potential consequences of contaminants in the water and sediments of the Colorado River based on a significant (catastrophic) release of tailings. The probability of a significant release would be very small over the design life of the on-site disposal cell. Because the initiating event is highly unlikely, failure of mitigation measures and long-term management must be assumed. However, a catastrophic failure was assumed to occur in order to evaluate the potential consequences (risks) and provide decision-makers with impacts that would be unique to on-site disposal.

Several processes could affect the integrity of the disposal cell at the Moab site:

- *Flooding*—Over the design life of the disposal cell (200 to 1,000 years) and beyond, severe flooding of the Colorado River and of the Moab Wash drainage could occur from a large precipitation event in the Moab area and upstream of the Moab area. Flooding as an initiating event for catastrophic failure would be mitigated with side slope armament of sufficient size to prevent erosion from floodwaters, as described in Section 2.1.3.1. The expected consequences from a flood event are discussed further in Section 4.1.3.1.
- *River Migration*—The Colorado River could migrate into the disposal cell over an extended period of time. Catastrophic failure of the disposal cell due to sudden river migration from a single event is considered extremely unlikely. Therefore, river migration would be assumed to occur over many years, and a failure of long-term management of the pile would also have to occur for tailings releases to be significant. The likelihood of river migration as an initiating event would be reduced by the construction of a barrier wall, as described in Section 2.1.4, between the river and the disposal cell to deflect river encroachment.
- *Seismic Activity/Basin Settling*—Although seismic activity is unlikely (see Section 3.1.1.4), the Moab site sits on salt beds that are prone to dissolution over an extended period of time. Dissolution of the salt beds could cause differential settling and disrupt the integrity of the disposal cell. Assuming failure of long-term management, settling of the entire cell would tend to increase the possibility of impacts from radon emissions, floods, or river migration and would tend to increase the potential for ground water contamination.

- *Cap Erosion/Failure*—During major storms or basin settling, it is possible that some failure or breach of the tailings pile cap or cover could occur. Assuming failure of long-term management, this would result in a slow release of contamination to the river and would include the possibility of increased radon releases.

For purposes of this analysis, two types of failures were evaluated even though highly unlikely: catastrophic and long-term. A catastrophic failure could occur during a major flood or a seismic event. A long-term, slow release would be possible for events such as river migration, basin settling, or intermittent erosion of the cell cover. Long-term failures assume smaller-quantity releases over an extended period (many years); a continuation of this type of release would also require a failure of long-term management (this assumes that no repairs to the damaged cell would be done). This type of release, which is possible at all UMTRCA Title I sites, can be mitigated. DOE's newly created (2003) Office of Legacy Management is responsible for monitoring and mitigating this type of release. The hypothetical catastrophic failure could release a large quantity of tailings into a relatively small volume of water compared to long-term releases, which would release a small quantity of tailings into a large volume of water (river flow over many years). Consequently, the assumptions associated with the hypothetical catastrophic event would yield the worst-case situation (more tailings released and higher contaminant concentrations in water).

Risks to humans would be based on some type of activity that would bring people in contact with contamination. In this case, the contamination currently in the tailings pile was assumed to be dispersed downstream during an event such as a flood, and it was assumed that people would come in contact with this contamination in the water or sediments. Exposure of humans to the contamination would depend on what people were doing in the contaminated area. Examples could include building a house and living in this area, camping, or river rafting. These events result in differing time periods that people could spend in contaminated areas and differing activities that could cause someone to be exposed to the contamination (e.g., drinking contaminated water, breathing contaminated air). Risks increase with increasing time and exposure to contamination. Situations where people were exposed to contaminated media (soil, sediments, water, air) for a long period (many hours per day for many years) would yield the highest risks for the same level of contamination in the contaminated media. Other activities such as camping in a contaminated area would yield lower risks because exposure to contamination would occur for a limited number of days per year.

Two types of scenarios were analyzed. First, it was assumed that someone would build a house on contaminated sediments released from the tailings pile at a location downstream of the pile (residential scenario). This scenario assumes a home would be built in a contaminated area and the contaminated water (in this case, contaminated surface water) would be used as the primary drinking water source for many years (in reality, the contaminant concentrations in water would only last on the order of days; therefore, the exposures to contaminated water under a residential scenario are unrealistically high but provide an upper bound to the potential risks). The most significant risks would occur from ingestion of contaminated drinking water and exposure to the radon in air originating from radium-226. This assumes that a flood deposited contaminated sediments in an area where it was feasible to construct a house (e.g., outside the 100-year floodplain).

Second, it was assumed someone would camp in a contaminated area downstream of the pile (camping scenario). The camping scenario assumes two overnight camping events per year in contaminated areas and the accidental ingestion of contaminated surface water and sediments. This scenario was assumed because it yields more worst-case risks than those estimated using assumptions for rafting (the other likely recreational use of the area downstream of the Moab site).

Table 4–16 presents the estimated maximum level of contaminants in water and sediment that would still be protective of human (and ecological) health. The basis for these levels is provided in Appendix D.

Table 4–16. Maximum Exposure Level of Contaminants Protective of Human Health and Ecological Resources

Medium/ Contaminant	Maximum Exposure Level Protective of Human Health (Residential Scenario)[a]	Maximum Exposure Level Protective of Human Health (Camping Scenario)[a]	Maximum Exposure Level Protective of Ecological Resources (Aquatic)[a]	Maximum Exposure Level Protective of Ecological Resources (Terrestrial)[a,b]
Water/uranium	0.11 mg/L	19–36 mg/L	0.0026–0.455 mg/L 1.3 mg/L (chronic) 2.1 mg/L (acute)	7.00–68.8 mg/L
Water/ammonia-N	0.21 mg/L	NA	Approx. 0.6 to 1.2 mg/L (chronic) 3–6 mg/L (acute)	NA
Sediment/uranium	0.23 mg/kg	30,000–120,000 mg/kg	NA	NA
Sediment/radium-226	5 pCi/g[c]	1,700 to 6,900 pCi/g	NA	NA

[a] Concentrations in water and sediments that are greater than the listed exposure levels may indicate a potential unacceptable risk.

[b] Range values are the lowest wildlife no-observed-adverse-effects-level (NOAEL) drinking water standards, 7.00 for mammals (white-tailed deer) and 68.8 for birds (rough-winged swallow) (see Appendix A2).

[c] pCi/g = picocuries per gram.

For the purpose of analysis, a large disposal cell failure (20 to 80 percent of the tailings eroded) was assumed to occur over a short duration (10 hours). Although such a large event would be unlikely, the analysis is useful in projecting potential environmental consequences of a worst-case scenario. The Colorado River was assumed to be at high flood stage during the tailings release. Concentrations of uranium, ammonia as nitrogen, and radium-226, the most prevalent contaminants, were estimated for the failure scenarios.

The following assumptions were made to estimate the concentrations of uranium and ammonia as nitrogen in Colorado River water following a catastrophic tailings release (DOE 2003b):

- The total volume of tailings is 10.5 million tons; 25 percent of the volume is pore water (NRC 1999).
- Volumes of 20 and 80 percent of the tailings eroded into the river at a constant rate over a period of 10 hours (NRC 1999).
- Disposal cell failure occurs during a PMF, and the average river flux over the 10-hour period is 150,000 cfs, or half the 300,000 cfs maximum flux (NRC 1999).

- Concentrations of uranium and ammonia in tailings pore fluids and solid phases are the geometric means of all tailings samples.
- Uranium partitions between solid-phase tailings and river water according to a linear relationship with a distribution ratio of 3.0 mL/g.
- All ammonia is dissolved into the river water (based on its common occurrence in soluble salts at the Moab site).
- Colorado River water mixes with Green River water at a ratio of 1.2:1.0, a 30-year average value determined from river gage stations at Cisco, Utah (Colorado River), and Green River, Utah (Green River) (USGS 2004).
- There is no dispersion of the dissolved phase.
- Colorado River water mixes uniformly with 50 percent of the water in Lake Powell; Lake Powell contains 6.85 trillion gallons (USBR 2004).
- There is no sorption of dissolved contaminants to clean suspended load in the river.

The concentration of uranium in the river water at the Moab site is calculated by assuming the total released uranium (derived from both the solid-phases and the pore water) is distributed linearly between the tailings solids phases and the dissolved aqueous phase:

$$C_{rw} = M_{tot}/(M_s \times R_d + V_{rw})$$

where

C_{rw} = concentration of uranium in river water (mg/L)
M_{tot} = total mass of uranium derived from tailings solids and pore water (kg)
M_s = mass of solid tailings phases (kg)
R_d = distribution coefficient (3 L/kg)
V_{rw} = volume of river water based on 150,000 cfs for 10 hours

The calculation indicates that the river has 1.0 to 4.0 mg/L uranium and 21 to 84 mg/L ammonia (as N) at the Moab site immediately following the release (Table 4-17). The Green River enters the Colorado River about 50 miles downstream. Water transport time to the Green River confluence is about 15 hours. Mixing with water from the Green River dilutes the uranium concentration to 0.55 to 2.2 mg/L (Table 4–17). Mixing with water in Lake Powell further dilutes the uranium concentration to 0.006 to 0.012 mg/L. The ammonia (as N) concentrations decrease to 12 to 48 mg/L and 0.12 to 0.48 mg/L following dilution by the Green River and Lake Powell, respectively (Table 4–17). Further chemical degradation of ammonia would be expected as it is transported from the Moab site through Lake Powell, although ammonia degradation was not evaluated as part of this analysis. In addition, it is likely that concentrations of uranium would be similar to natural background values by the time the water exits Lake Powell. Further dilution would be expected by Lake Mead, and dilution by dispersion, although not included in the analysis, can be expected to be significant.

Table 4–17. Calculated Concentrations of Dissolved Uranium and Ammonia (as N) in Colorado River Water Following a Catastrophic Failure at the Moab Site

Constituent	Tailings Pore Fluid (mg/L)	Tailings Solid Phase (mg/kg)	Concentration at Moab Site (20% release (mg/L)	Concentration at Moab Site (80% release (mg/L)	Concentration after Green River (20% release) (mg/L)	Concentration after Green River (80% release) (mg/L)	Concentration after Lake Powell (20% release) (mg/L)	Concentration after Lake Powell (80 % release) (mg/L)
Uranium	6.63	81.0	1.0	4.0	0.55	2.2	0.006	0.012
Ammonia-N	1,607	1,654	21	84	12	48	0.12	0.48

Source: DOE 2003b.
mg/L = milligrams per liter.

Sediment released during a catastrophic event would deposit in the river bottom or along banks or become part of the suspended load. Fine-grained portions of the sediment would remain in suspension and rapidly transport downstream. Where the river overflowed its banks, fine-grained sediment would be deposited by settling in standing water. The concentrations of contamination in backwater areas would depend on (1) the proportion of fine-grained tailings to clean suspended load, (2) concentration in the suspended tailings, and (3) the mass deposited over a given area. During periods of low flow, fine-grained sediment would be deposited; during high flow, these deposits would be remobilized and transported farther downstream. The sediment would be dispersed and mixed with clean sediment during transport, causing a continual decrease in contaminant load. Based on detailed studies of deposition of radioactive sediment in the Colorado River Basin, it would be expected that very small amounts of contamination would accumulate in the main river channel (HEW 1963).

The most significant mill-related contaminant in the sediment would be radium-226 because of its low tendency to partition (dissolve) in water and its abundance in the tailings (HEW 1963). The calculated radium concentration is based on the assumption that all the radium-226 is partitioned to (held in) the solid phases. Concentration of uranium in the suspended load was calculated by assuming chemical equilibrium with the dissolved phase. Fifty percent of the tailings sediment is assumed to become suspended load, and the other 50 percent is bedload. Uranium concentration in the suspended load of clean sediment is assumed to be 2,000 mg/L and is based on USGS suspended load data from the Cisco, Utah, gaging and sampling station (DOE 2003b).

Table 4–18 presents the calculated concentrations of uranium and radium-226 in the suspended sediment load. These concentrations represent the maximum values that could result in areas where suspended sediment settles out, such as an overbank area. The uranium concentrations in the Colorado River based on the 20-percent failure scenario (2.2 mg/kg near the Moab site and 1.2 mg/kg below the confluence with the Green River) are relatively low and are near the crustal average of 1.8 mg/kg (Mason and Moore 1982). Radium-226 concentrations are well above the 40 CFR 192 cleanup standards of 5 and 15 pCi/g in all cases. Radium-226 deposited from suspended sediment after a catastrophic failure could be of concern.

Table 4–18. Calculated Concentrations of Uranium and Radium-226 in Suspended Load in the Colorado River Following a Catastrophic Failure at the Moab Site

Constituent	Concentration at the Moab Site (20% release)	Concentration at the Moab Site (80% release)	Concentration Below Green River Confluence (20% release)	Concentration Below Green River Confluence (80% release)
Uranium (mg/kg)	2.2	8.8	1.2	4.8
Radium-226 (pCi/g)	944	1,173	515	640

Source: DOE 2003b.
mg/kg = milligrams per kilogram; pCi/g = picocuries per gram.

Table 4–19 compares the maximum exposure levels that would be protective of human and ecological health to the estimated range of concentrations after a catastrophic disposal cell failure.

Table 4–19. Comparison of Risk-Based Maximum Exposure Levels to Estimated Concentrations Following a Disposal Cell Failure

Medium/ Contaminant	Concentration Range (Lake Powell to Moab)	Maximum Exposure Level Protective of Human Health (Residential Scenario)[a]	Maximum Exposure Level Protective of Human Health (Camping Scenario)[a]	Maximum Exposure Level Protective of Ecological Resources (Aquatic)[a] (mg/L)
Water/uranium (mg/L)	0.006–4.0	0.11	19–36	0.0026–0.455 1.3 (chronic) 2.1 (acute)
Water/ammonia-N (mg/L)	0.12–84	0.21	NA	Approx. 0.6 to 1.2 (chronic) 3–6 (acute)
Sediment/uranium (mg/kg)	1.2–8.8	0.23	30,000–120,000	N/A
Sediment/ radium-226 (pCi/g)	515–1,173	5	1,700–6,900	N/A

[a] Concentrations in water and sediments that are greater than the listed exposure levels may indicate a potential risk.
mg/kg = milligrams per kilogram; mg/L = milligrams per liter; pCi/g = picocuries per gram; N/A = not available.

As shown in the tables, if a house were constructed in a contaminated area and contaminated water was used as the primary source of drinking water, risk above the protective levels would occur under the residential scenario. This impact would be more pronounced near the Moab site and would decrease after the influx of the Green River and mixing occurred in Lake Powell. The highest risks would likely occur from constructing a house in an area contaminated with radium-226. Potential concentrations would be much higher than the protective levels for surface soils.

Concentrations under the camping scenario would not appear to present risk above protection levels.

The degree of contaminant impact to aquatic receptors would depend upon (1) the type, duration, and areal extent of the failure event, and (2) the mass and concentrations of contaminants released into the Colorado River. Because of uncertainties associated with a contaminant release, and cumulative effects that are not contaminant-related, specific impacts to endangered species are difficult to assess.

Assuming catastrophic failure, short-term adverse impacts to aquatic receptors from contaminants would be likely in surface waters and sediments adjacent to the site. These negative impacts would likely decrease as the contaminant concentrations were reduced through dilution and dispersion downstream. Impacts from elevated ammonia at the Moab site downstream to Lake Powell would likely be short term, although fish kills would be possible where concentrations exceeded the acute standards. Ammonia degrades and volatilizes and is not expected to persist in the environment. Although the uranium surface water benchmarks would be exceeded, impacts would more likely occur from elevated concentrations in the sediment. Uranium accumulates in sediments and enters the food chain by adsorption on surfaces of plants and animals and by ingestion of sediments and contaminated food (Driver 1994; Cooley and Klaverkamp 2000; Swanson 1983). Thus, impacts from uranium in the sediments may be longer term because it complexes with sediments where it is likely to be more persistent.

Catastrophic disposal cell failure as a result of an unexpected event could also cause negative impacts to aquatic habitat within areas that are relatively close to the site. Habitat loss could include degradation of backwater nursery areas as a result of elevated concentrations of contaminants and sediment loading. This loss could be extensive in the short term. Once the river dynamics normalized, newly created fish habitat, including backwater areas, could be adversely affected depending upon the duration and concentrations of the contaminant release from the material deposited from the pile.

Catastrophic disposal cell failure would also result in increased turbidity and sediment, which could affect the aquatic and benthic producers. With the loss of primary producers, there would be an effect to the entire food chain.

If mitigated, long-term failure would not likely result in negative impacts to aquatic biota. This type of release can be mitigated with current engineering and technology. DOE's newly created (2003) Office of Legacy Management is responsible for monitoring and mitigating this type of release. In addition, all currently available evaluations of the site's geologic and hydrologic conditions suggest that future lateral migration of the river will tend toward the east, away from the site (See Table 2–33, No. 10 in the EIS). Further, DOE has incorporated a buried riprap diversion wall into the on-site disposal design to mitigate potential impacts should lateral river migration occur. It has been estimated that this engineering control could easily be enhanced or modified in the future should river migration cause encroachment on the site and the disposal cell.

Assuming catastrophic failure, uranium concentrations in Colorado River water would not likely cause negative impacts to terrestrial receptors from the Moab site downstream to Lake Powell. The potential for negative impacts from elevated uranium concentrations in sediment and shoreline soils is unknown. The variable nature of these substrates influences uranium bioavailability and uptake; thus, no single value or benchmark can be applied (Driver 1994). However, riparian communities would be expected to be lost and dependent species displaced. Habitat loss would be extensive and short term. Recolonization of riparian communities and dependent biota would be expected.

Long-term disposal cell failure would not result in negative impacts to terrestrial biota either through increased contaminant concentrations or habitat loss. Estimated concentrations of uranium after a catastrophic failure would approach the background concentrations currently found in Lake Powell. Ammonia levels might still be elevated in Lake Powell, but considerable volatilization and degradation would be expected as the contamination traveled downstream (this was not considered in the calculations). Much of the radium-226 would be expected to settle out in Lake Powell. Therefore, a major tailings release is not anticipated to significantly increase risks to the human populations located downstream of Lake Powell.

4.1.18 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. Minority and low-income populations in the area within 50 miles of the Moab site are described in Section 3.1.20.

The Council on Environmental Quality has issued guidance (CEQ 1997) to federal agencies to assist them with their NEPA procedures so that environmental justice concerns are effectively identified and addressed. In this guidance, the Council encouraged federal agencies to supplement the guidance with their own specific procedures tailored to particular programs or activities of an agency. DOE has prepared guidance, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, Second Edition* (DOE 2004), based on Executive Order 12898 and the Council on Environmental Quality environmental justice guidance.

Among other things, the DOE guidance states that even for actions that are at the low end of the scale with respect to the significance of environmental impacts, some consideration (which could be qualitative) is needed to show that DOE considered environmental justice concerns. DOE needs to demonstrate that it considered apparent pathways or uses of resources that are unique to a minority or low-income community before determining that, even in light of these special pathways or practices, there are no disproportionately high and adverse impacts on the minority or low-income population. The DOE guidance also defines "minority population" as a populace where either (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population.

In the EIS, DOE applied the environmental justice guidance to determine whether there could be any disproportionately high and adverse human health or environmental impacts on minority or low-income populations surrounding the Moab site as a result of the implementation of the on-site disposal alternative. Environmental justice concerns were analyzed through an assessment of the impacts reported for on-site disposal. Although no high and adverse impacts were identified, DOE considered whether minority or low-income populations would be disproportionately affected by the alternatives.

An assessment of the census data found that, within the 50-mile area around the Moab site, less than 1 percent of the population had a household income below $18,244, the poverty level for a family of four.

DOE has identified no high and adverse impacts, and there are no minority or low-income populations who would be disproportionately affected by implementation of the on-site disposal alternative.

4.2 Off-Site Disposal (Klondike Flats Site)

The Klondike Flats site is the closest of the alternative disposal sites to the Moab site (approximately 18 miles to the north). This section discusses the short-term and long-term impacts associated with the first of three off-site disposal alternatives. The impacts are based on the proposed actions described in Section 2.2 and the affected environment described in Section 3.2 of this EIS. This alternative may result in the following impacts:

- Impacts at the Moab site
- Impacts at the Klondike Flats site
- Transportation impacts associated with moving tailings from the Moab site to the Klondike Flats site
- Monitoring and maintenance impacts at the Klondike Flats site

The combined impacts that may result from these activities are then summarized for each assessment area (e.g., Geology and Soils) at the end of each subsection. For many activities, impacts at the Moab site would not differ significantly from those described in Section 4.1. Impacts of characterization and remediation of vicinity properties would be the same as those described in Section 4.1. Transportation impacts would vary, depending upon the transportation mode (truck, rail, or slurry pipeline). Vicinity property materials would be co-transported from the Moab site to the Klondike Flats site. Therefore, impacts associated with transporting vicinity property materials are not addressed separately. Impacts associated with borrow areas are addressed collectively in Section 4.5 and are therefore not addressed in this section.

4.2.1. Geology and Soils

Monitoring and maintenance activities would not adversely affect geology and soils. Therefore, these activities are not addressed further in this section.

4.2.1.1 Construction and Operations Impacts at the Moab Site

The geology and impacts at the Moab site due to surface and ground water remediation would be the same as those described for the on-site disposal alternative in Section 4.1.1.1. The soil impacts at the Moab site would be similar to those described in Section 4.1.1.1; however, the approximately 234,000 tons (173, 000 yd^3) of excavated off-pile contaminated site soil would be shipped off-site rather than relocated to the tailings pile. Excavation and backfilling of the tailings pile and the estimated 420,000 yd^3 (2 ft) of contaminated subpile soil that would occur under the off-site disposal alternative would increase the potential for short-term soil erosion at the Moab site.

4.2.1.2 Construction and Operations Impacts at the Klondike Flats Site

Geology

Earthquake risks and seismic activity at the site are low. No hazards to disposal cell stability, such as landslides, slumping, or rock falls, are known to exist. Identified geological resources underlying Klondike Flats are too deep for economical exploitation and therefore would not be affected by the Klondike Flats disposal alternative.

Soils

The primary impact to soils would be the excavation to construct the new disposal cell; this impact would be short term. In addition, approximately 2.2 million yd^3 of borrow soil and other borrow material would be excavated for use at the disposal cell site and Moab site. The maximum area of disturbance to the cell construction area would be 435 acres. The short-term erosion potential and erosion mitigation measures would be identical to those described for the on-site disposal alternative. In addition, UMTRA Project experience has shown that after construction of low-permeability layers within a disposal cell, soils adjacent to the cell are subject to increased long-term erosion due to runoff from the cell. The potential for this long-term erosion to occur would be reduced through the proposed design enhancements along the edges of the cell. Construction of the disposal cell would not result in soil subsidence impacts because construction of the cell would involve removing soils to bedrock.

4.2.1.3 Construction and Operations Impacts Associated With Transportation

Table 4–20 summarizes the areal extent of disturbed soils at the Moab and Klondike Flats sites, including the extent of on-site soils disturbance for each transportation mode (see Section 2.2.7.3). The table also shows the additional disturbance between the Moab site and the Klondike Flats site for each mode. Off-site disturbances would range from 40 to 85 acres; the slurry pipeline would involve the greatest disturbance.

Table 4–20. Summary of Short-Term Soil Impacts—Klondike Flats Off-Site Disposal Alternative

Soil Disturbance Location or Source	Area of Soil Disturbance (acres)
Moab Site (on site)	439
Klondike Flats (on-site; including transportation disturbances)	
Truck transportation	435
Rail transportation	420
Slurry pipeline transportation	435
Moab to Klondike Flats (off site; exclusive of on site)	
Truck transportation	40
Rail transportation	69
Slurry pipeline transportation	85

4.2.1.4 Impacts from All Sources

Under the Klondike Flats disposal alternative, impacts to soils would be short term and would occur from excavation and other disturbances to soils associated with surface remediation activities at the Moab site; construction of the disposal cell, cell access roads and staging areas; and from construction of infrastructure to support the selected transportation method. Table 4–20 summarizes the areal extent of disturbed soils at all locations under the Klondike Flats off-site disposal alternative. The potential for long-term erosion of soils adjacent to the disposal cell exists but would be controlled by construction design enhancements.

4.2.2 Air Quality

Monitoring and maintenance activities would not adversely affect air quality. Therefore, these activities are not addressed further in this section.

4.2.2.1 Construction and Operations Impacts at the Moab Site

During remediation activities at the Moab site, heavy-duty diesel equipment such as graders, scrapers, and dozers would emit pollutants and fugitive dust. Emission of fugitive dust would be minimized by use of control measures, such as applying water or chemicals and covering open-bodied trucks. As shown in Table 4–21, concentrations of criteria pollutants from the Moab site emissions would be below the primary and secondary NAAQS in 40 CFR 50; concentrations estimated for the truck, rail, or slurry pipeline options would all be about the same. The estimated concentrations shown in Table 4–21 and Table 4–22 were derived by applying tailpipe emission factors provided in *Compilation of Air Pollutant Emission Factors* (EPA 2000) to the estimated construction fleet composition and duration of construction operations.

Table 4–21. Criteria Pollutant Concentrations at the Moab Site

Pollutant	Averaging Period	Standard (μg/m^3)	Concentration from Emissions (μg/m^3)
Carbon monoxide	1-hour	40,000	40
	8-hour	10,000	28
Nitrogen dioxide	Annual	100	9.1
Sulfur dioxide	Annual	80	0.90
	24-hour	365	4.5
	3-hour	1,300	10
PM$_{10}$ [a]	Annual	50	3.2
	24-hour	150	16

[a] PM$_{10}$ includes fugitive dust emissions from construction activities.
μg/m^3 = micrograms per cubic meter.

Table 4–22. Criteria Pollutant Concentrations at the Klondike Flats Site

Pollutant	Averaging Period	Standard (μg/m^3)	Concentration from Emissions (μg/m^3)
Carbon monoxide	1-hour	40,000	53
	8-hour	10,000	37
Nitrogen dioxide	Annual	100	12
Sulfur dioxide	Annual	80	1.3
	24-hour	365	6.3
	3-hour	1,300	14
PM$_{10}$ [a]	Annual	50	3.6
	24-hour	150	18

[a] PM$_{10}$ includes fugitive dust emissions from construction activities.
μg/m^3 = micrograms per cubic meter.

4.2.2.2 Construction and Operations Impacts at the Klondike Flats Site

During construction activities at the Klondike Flats site, heavy-duty diesel equipment such as graders, scrapers, and dozers would emit pollutants and fugitive dust. Emission of fugitive dust would be minimized by use of control measures, such as applying water or chemicals and covering open truck beds. As shown in Table 4–22, concentrations of criteria pollutants from the Klondike Flats site emissions would be below the primary and secondary NAAQS in 40 CFR 50; concentrations estimated for the truck, rail, or slurry pipeline options would all be about the same. As noted in Section 4.1.2.1, Utah PSD regulations provide that concentrations of PM_{10} attributable to the increases in emissions from construction or other temporary emission-related activities shall be excluded in determining compliance with the maximum allowable increase.

4.2.2.3 Construction and Operations Impacts Related to Transportation

The air quality impacts of transportation under the Klondike Flats disposal alternative are included in Section 4.2.15, "Human Health."

4.2.2.4 Impacts from All Sources

Emissions of criteria air pollutants, including carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}, would occur at the Moab site, Klondike Flats site, and vicinity properties due to the operation of heavy construction equipment and ground water remediation equipment. No criteria air pollutant emission concentrations at the Klondike Flats site, where concentrations would be expected to be highest, would exceed NAAQS.

4.2.3 Ground Water

Monitoring and maintenance activities would not result in adverse impacts to ground water. Therefore, these activities are not assessed further in this section.

4.2.3.1 Construction and Operations Impacts at the Moab Site

Short-term impacts to ground water would be similar to those described under the on-site disposal alternative. Until construction was completed and the tailings pile was removed from the site, seepage contributed by pore fluids from the base of tailings pile would be expected to contribute a continuous source of 1,100 mg/L ammonia to the ground water system. However, if the pile were removed, no long-term potential for natural subsidence or for seepage of tailings fluids and the salt layer, as described in Section 4.1.3, from the tailings pile to the ground water would exist. The seepage rate from the tailings as a function of time and ammonia concentration is summarized in Table 4–23. In addition, the potential for increasing ammonia concentrations in surface water as a result of a flood would be eliminated.

Table 4–23. Assumptions for Liquid Drainage and Ammonia Concentrations From the Tailings Pile Under the Off-Site Disposal Alternative

Parameter	Value
Infiltration rate	1×10^{-7} cm/s
Gravity drainage	Constant rate: 8 gpm
Transient drainage	Rate would decay from 12 gpm at present to 0 gpm when construction ended
Initial ammonia concentration seepage from base of tailings pile	1,100 mg/L during construction
Breakthrough ammonia concentration from upper salt layer	Not applicable once tailings were removed
Arrival time	Not applicable once tailings were removed
Final concentration	0 mg/L once tailings were removed
Exit time	Not applicable once tailings were removed

gpm = gallons per minute; mg/L = milligrams per liter; cm/s = centimeters per second

Modeling results, presented in Figure 4–7, indicate that most of the ammonia flux from the brine layer and the legacy plume in the alluvial aquifer would flush naturally to the river in approximately 60 to 80 years. At the end of this period, concentrations would decline more rapidly under the off-site disposal alternative than under the No Action alternative or the on-site disposal alternative, because the continuing source of ammonia seeping from the base of the tailings pile would no longer be present. Ground water concentrations would continue to decline until background levels were reached. Predicted concentrations plotted in Figure 4–7 represent the maximum ammonia-N concentrations from a series of observations located along a transect parallel to the Colorado River downgradient from the toe of the tailings pile along a flow path near the center of the plume.

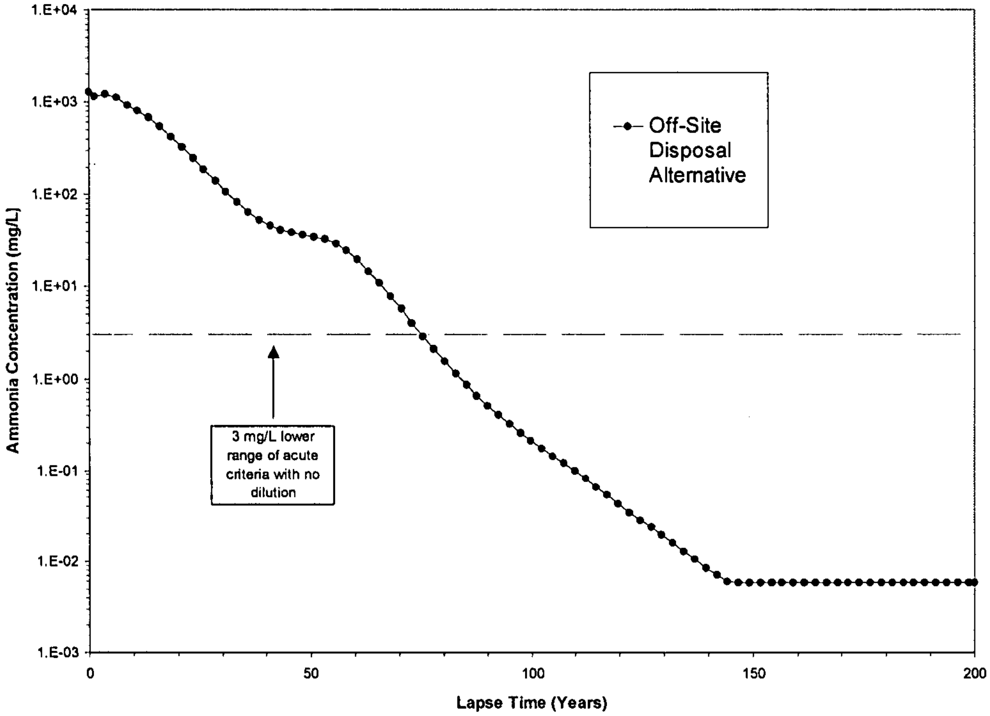

Figure 4–7. Predicted Ammonia Concentrations in Ground Water Adjacent to the Colorado River Under the Off-Site Disposal Alternative

Modeling results indicate that ammonia concentrations in ground water near the bank of the Colorado River would be expected to decline from the current 500 to 1,000 mg/L to a maximum of approximately 3 mg/L in 75 years and reach background concentrations in approximately 150 years. Concentrations at 75 years are illustrated in Figure 4–8.

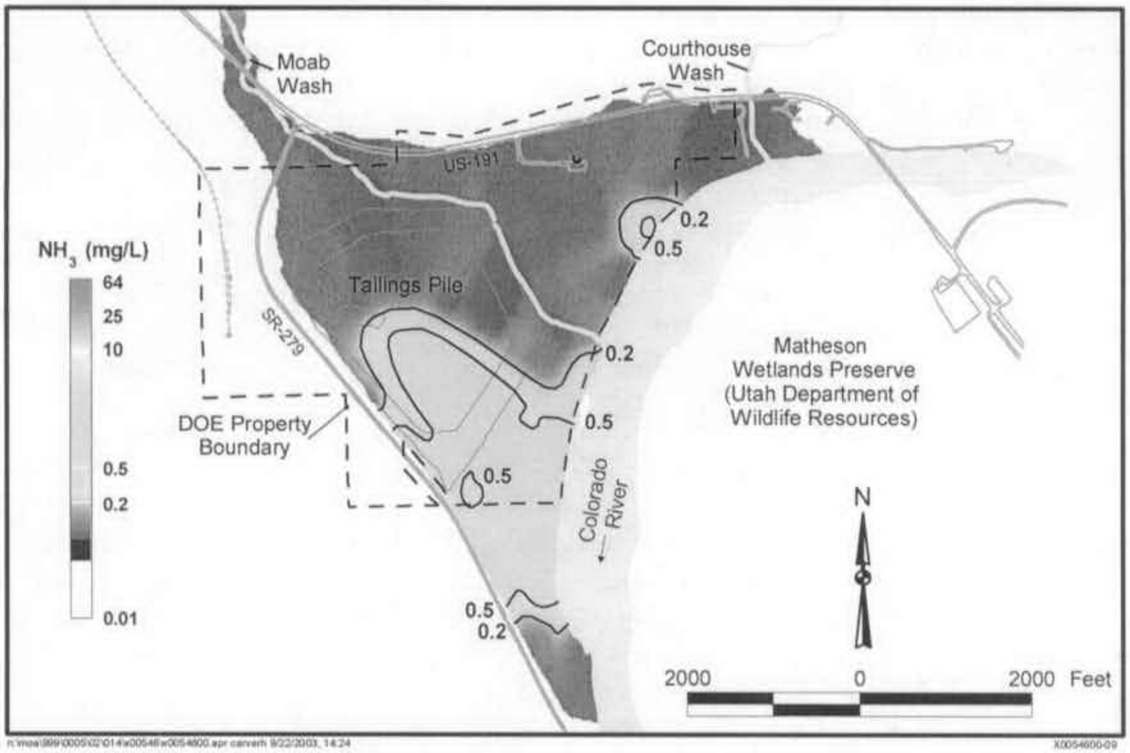

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Figure 4–8. Predicted Ammonia Concentrations in Alluvial Ground Water After 75 Years Under the Off-Site Disposal Alternative

4.2.3.2 Construction and Operations Impacts at the Klondike Flats Site

There would be no anticipated effects on regional or local ground water quality resulting from a proposed disposal cell in the Klondike Flats area; the uppermost aquifer (Dakota Sandstone or Cedar Mountain Formation) is approximately 400 to 500 ft below land surface. The Dakota Sandstone is separated from the surface by a thick section of relatively impermeable Mancos Shale that acts as an aquitard to inhibit ground water flow to deeper stratigraphic units. A first-order estimate of travel time for any water seeping from the cell to migrate through the Mancos Shale and reach the uppermost aquifer is over 25,000 years. This estimate is based on a typical hydraulic conductivity value of 1.0×10^{-9} cm/s for marine shale (Freeze and Cherry 1979) and a porosity of 0.06 (Morris and Johnson 1967). This travel time estimate would be verified by site characterization if this site were selected as the off-site alternative. The Ferron Sandstone Member is approximately 200 to 300 ft above the base of the Mancos Shale but is not considered a water-bearing unit. The first significant regional ground water resource is in the Navajo Sandstone, approximately 1,500 to 2,000 ft below land surface. This ground water resource would not be affected by a proposed disposal facility in this area. The areal extent and duration of potential impacts would be limited or nonexistent. There would be no beneficial or adverse effects on ground water if the proposed disposal cell were located at this site. There are no sole-source aquifers in the area within reasonable range of potential impact from the proposed disposal cell.

There would be no anticipated present or future effects on ground water use in the area because there is very little current use and none in the immediate area of the proposed disposal cell.

The compliance strategy for ground water protection would be to meet maximum concentration limits or background levels in the uppermost aquifer, which would be ground water in the Dakota Sandstone or Cedar Mountain Formation. Implementation of this strategy would be enhanced by hydrogeologic isolation (from the 400 to 500 ft of Mancos Shale) and disposal cell design.

4.2.3.3 Construction and Operations Impacts Related to Transportation

In areas that may be affected by the transportation corridors, depth to ground water in the uppermost aquifer varies from less than 100 ft near the Moab site to more than 700 ft near the Klondike Flats site. Therefore, no adverse impacts to ground water as a result of transportation modes are expected.

4.2.3.4 Impacts from All Sources

Ground water at the Moab site would not be adversely affected. Active remediation of ground water influencing surface water would result in reducing the adverse impact to surface water. No adverse impacts would occur to ground water at the Klondike Flats site or to ground water in the transportation corridors.

4.2.4 Surface Water

Because no perennial surface waters are present at the Klondike Flats site, there would be no short-term or long-term impacts to surface water as a result of construction or operations. Likewise, no perennial surface waters are present in the transportation corridors, resulting in no adverse impacts. Monitoring and maintenance activities would not result in adverse impacts at the Klondike Flats site. Therefore, these activities are not assessed further in this section.

4.2.4.1 Construction and Operations Impacts at the Moab Site

Impacts to surface water would be similar to those described under the on-site disposal alternative (Section 4.1.4.1). In the short term, sediment runoff would be controlled during construction and operations activities. Also in the short term, site-related contaminant concentrations affecting the Colorado River would be reduced through implementation of interim actions. Within 5 years of implementing active ground water remediation, contaminant concentrations in surface water would meet applicable surface water criteria. Surface water monitoring would continue after completion of active remediation to verify that contaminant concentrations in surface water were below surface water criteria.

Storm water management during site reclamation would include berms between the site operational areas and the Colorado River and Moab Wash to ensure that the site was not inundated from a flood up to the magnitude associated with a 100-year return interval. If a flood of greater magnitude than this occurred, there would be a potential for tailings to be transported off the site and into the Colorado River and Moab Wash. During a flood greater than the 100-year return interval, alternatives that include on-site drying of tailings materials (i.e., off-site disposal using truck or rail haul) would have the potential for supplying a greater amount of tailings to floodwaters than alternatives that do not include on-site drying (i.e., off-site disposal using slurry pipeline or on-site disposal).

Qualitatively, a substantial failure of the storm water pollution prevention system would reasonably occur only from a flood event greater than the 100-year return interval. As indicated by a recent USGS study (USGS 2005), the overbank flow velocities associated with an event of this magnitude would be less than 2 ft/s. These velocities would have very limited ability to transport contaminants from the site and would likely result in net deposition of sediment. However, the greater flow velocities associated with a flood event through Moab Wash would have a greater ability to transport contaminants from the site to the Colorado River. In either case, the minimal amount of contaminants that may become suspended or dissolved into Colorado River or Moab Wash floodwaters during the completion of either on-site or off-site disposal would be dispersed and diluted in the floodwaters such that there would be no significantly measurable contamination in off-site sediment or river water. A detailed failure analysis was not deemed necessary because (1) the storm water pollution prevention system would be designed for a 100-year event, a level typically applied for permanent civil structures, (2) the duration of activities within the floodplain would be limited to a few years, and (3) the velocities of floodwaters are projected to be low.

4.2.5 Floodplains/Wetlands

Because the Klondike Flats site has no known floodplains or wetlands, no adverse impacts would be expected as a result of monitoring and maintenance or construction and operations activities. A more detailed discussion of impacts to floodplains and wetlands is included in Appendix F.

4.2.5.1 Construction and Operations Impacts at the Moab Site

Impacts at the Moab site under this alternative would be similar to those described under the on-site disposal alternative (Section 4.1.5.1). Impacts due to rechanneling Moab Wash would not occur, but the meanders that would be added to Moab Wash in its current location would result in its carrying less sediment to the river than it does now. The buried riprap wall would not be installed, so no impacts would result. Short-term impacts to the floodplain would result from construction of tailings processing areas; these areas would be removed after remediation.

4.2.5.2 Construction and Operations Impacts Related to Transportation

Because ephemeral and intermittent washes with riparian resources are located near Klondike Flats, the potential for short-term impacts due to construction of transportation routes exists. Impacts would be minimized by avoiding these areas wherever possible and implementing measures to restrict sediment or water runoff from the roads. No long-term impacts would be expected.

4.2.5.3 Impacts from All Sources

At the Moab site, there would be short-term adverse impacts to wetlands and floodplains, and long-term impacts to floodplains associated with remediation and construction activities. Long-term effects associated with adding meanders to Moab Wash would be expected, but they would be beneficial.

4.2.6 Aquatic Ecology

Because no perennial surface waters are present, no adverse impacts to aquatic communities or receptors would occur as a result of construction and operations or monitoring and maintenance at the Klondike Flats site. Therefore, these activities are not discussed further in this section.

4.2.6.1 Construction and Operations Impacts at the Moab Site

Impacts to aquatic biota and habitats at the Moab site would be very similar to those described under the on-site disposal alternative. As described in Chapter 2.0, it is assumed that the same amount of physical disturbance would occur at the Moab site regardless of the disposal option. Chemical and radiological impacts to aquatic resources would be similar to those under the on-site disposal alternative in the short term. The annual use of 235 to 730 acre-feet (depending on transportation mode) of nonpotable Colorado River water would be within DOE's authorized river water use rights but would exceed the 100-acre-foot annual limit set by USF&WS as protective. This unavoidable impact would be mitigated through negotiated water depletion payments. In the long term, removal of the tailings pile combined with active ground water remediation would decrease the time that the contaminants from the disposal cell would affect aquatic resources.

4.2.6.2 Construction and Operations Impacts Related to Transportation

Because no perennial surface waters are present along the transportation corridor between the Moab site and the Klondike Flats site, no adverse effects to aquatic receptors would occur as a result of transportation at the Klondike Flats site. Therefore, transportation-related impacts are not discussed further.

4.2.6.3 Impacts from All Sources

Overall impacts to aquatic ecological resources under the Klondike Flats off-site disposal alternative would include short-term impacts (1) from construction activities along the edge of the Colorado River at the Moab site, (2) from construction of transportation infrastructure across ephemeral surface water channels, and (3) potentially from any transportation spills. These short-term impacts would not occur once the disposal cell construction and the transportation of tailings were complete. No long-term adverse impacts to aquatic resources are expected.

4.2.7 Terrestrial Ecology

Under the off-site disposal alternative, the physical, chemical, and radiological impacts to terrestrial species and habitats associated with construction and operations at the Moab site would be similar to those described for on-site disposal (Section 4.1.7). Appendix A1, "Biological Assessment," presents a detailed discussion of federally listed species that would be affected in the Klondike Flats area.

4.2.7.1 Construction and Operations Impacts at the Klondike Flats Site

Construction of a disposal cell and ancillary support facilities would disturb up to 435 acres at the Klondike Flats site in the disposal cell area. The impacts of physical disturbance would include the short-term loss of cover, foraging, and breeding habitat in construction areas. In the long term, the area occupied by the proposed disposal cell would result in a permanent loss of habitat. Species with small home ranges would be displaced. However, species with larger home ranges are not anticipated to be adversely affected.

The endangered black-footed ferret (*Mustela nigripes*) is the only federally listed species that could potentially be affected by habitat disturbance resulting from construction of a disposal cell. The white-tailed prairie dog (*Cynomys leucurus*), upon which the black-footed ferret depends, is the only species currently in review for federal listing that could be so affected. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne counties in 1999 or their offspring could occur on or in the vicinity of the Klondike Flats disposal site, although the UDWR (2003) reported an unconfirmed sighting in the area in 1989. Consequently, impacts from construction to the black-footed ferret would not be anticipated.

Surveys for white-tailed prairie dogs have been conducted at the Klondike Flats site (BLM 1995). At that time, it was determined that all of the colonies were relatively small and isolated, such that they would not support black-footed ferrets. Prior to development of the Klondike Flats disposal site, the area would be surveyed and the potential effects to white-tailed prairie dogs evaluated. In addition, the potential of such colonies to support black-footed ferrets would also be evaluated simultaneously.

Noise due to construction and operations could have an adverse effect on terrestrial wildlife. At the Klondike Flats site, noise would be generated by construction equipment and material transfer operations. It is estimated that the maximum noise levels that would be generated when all equipment was operating would be approximately 95 dBA measured at 49 ft. This noise level would attenuate over a distance of approximately 6 miles until it reached the quiet desert background level of approximately 30 dBA.

Noise can affect terrestrial organisms by causing physiological changes or behavioral modifications, including nest abandonment. It can also disrupt communication and defense systems. Any of the species that may be present at the Klondike Flats site could be affected by the noise associated with construction and operations. Some of these, such as burrowing owls and prairie dogs, are frequently found close to human activities and may thus be more likely to habituate to noise above background levels.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. The bald eagle is the only federally listed species in the vicinity of the Klondike Flats site that could be affected by noise from site operations. However, it is not known to nest or night roost in the area, nor is it commonly seen in the area, and it would therefore be unlikely to be affected.

Other effects of human presence, including night lighting, also would reduce the overall habitat value of the area. As with noise, some species become habituated to human presence, but others, such as deer or pronghorn antelope, could avoid the site during human activities. The Klondike Flats site is surrounded by many square miles of similar habitat. Therefore, individuals that avoided the vicinity of construction activities would not be forced into less desirable habitat.

Because the effects of noise, supplemental lighting, and human presence could be greater at night than during the day, double-shift operations would likely have greater impact than single-shift operations. The effects of noise, supplemental lighting, and human presence could be mitigated by limiting the amount of light off the site, minimizing activities at the periphery of the site, and limiting especially loud activities to daylight hours and to seasons when the effects on biota would be reduced. There would not likely be chemical impacts at the Klondike Flats site. Accidental spills of diesel, oil, or other materials would be quickly controlled and mitigated.

Other species of interest, if present, that could be affected by construction of a disposal cell and the associated types of disturbance discussed above, include the burrowing owl, Swainson's hawk, ferruginous hawk, and peregrine falcon.

Impacts of physical disturbance could be avoided or minimized in several ways. The most important action would be to conduct site-specific investigations prior to any development activities at the site to determine the presence of any species of concern. Additional actions would include minimizing site disturbance to the extent practical, revegetating disturbed lands and the cover cap after cleanup was completed, and scheduling ground-clearing activities during periods that would not disturb nesting migratory birds.

4.2.7.2 Impacts of Transportation

The effects to terrestrial species and habitats of transporting the tailings to the Klondike Flats site would depend on the transportation option selected. Truck transport would increase collision mortality and noise, rail transport would increase noise and require greater land development at the Klondike Flats site, and a slurry pipeline would likely disrupt more habitat along the pipeline corridor.

At the Klondike Flats site, much of the cover and radon barrier borrow materials could be obtained from borrow sites relatively near the disposal site, and much of the transport of borrow materials would occur on lower-speed access roads than US-191. This could translate into a lower rate of wildlife-vehicle collisions and less noise due to truck transport of borrow materials compared to transporting the materials from more distant borrow sites on higher-speed access roads.

Truck Transportation Option

Truck transportation of tailings materials from the Moab site to the Klondike Flats site would increase the amount of truck traffic on US-191 north of Moab (Section 4.2.16). This increase in traffic would likely lead to an increase in traffic-related wildlife mortalities and an increase in the average noise levels in the vicinity of the highway.

Bighorn sheep are occasionally observed in the vicinity of US-191, and there have been traffic-related mortalities in the area. Other species potentially affected include mule deer and pronghorn antelope. Small mammals, reptiles, and possibly birds would also suffer increased highway mortality rates. However, it is unlikely that the regional population of any wildlife species would be significantly affected by this increased traffic mortality rate.

The bald eagle is the only federally listed species that could incur an increase in traffic-related mortality. The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. Bald eagles could be found temporarily and infrequently using such areas when there are opportunities to feed on carrion, such as in big-game wintering areas or in prairie dog colonies. Therefore, it is possible that if traffic-related wildlife mortality increased due to the project, an increased number of eagles could be hit on highways. However, without data on this relationship, it is reasonable to assume that the number of eagles hit on highways would be proportional to the number of carrion available. The increase in the number of traffic-related wildlife mortalities is expected to be small. Consequently, the potential increase in associated eagle deaths is also expected to be small.

The increased truck traffic along US-191 resulting from transport of tailings from the Moab site to the Klondike Flats site would likely increase ambient noise levels by approximately 5 dB (measured at 49 ft). However, no adverse effect to terrestrial wildlife is anticipated.

The primary federally listed species that could be affected by this increased traffic noise would be the Mexican spotted owl. Data provided by the UDWR (2003) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, habitat models (BLM 2003) indicate that potential habitat areas may exist in the canyons near US-191 over the first 7 miles north from the Moab tailings pile. Nonetheless, these models are primarily based on physical and topographic features and do not consider vegetation requirements. Mexican spotted owls nest, roost, and forage in an array of different community types, but mixed-conifer forests dominated by Douglas fir and/or white fir are most common (USF&WS 1995). However, they may also nest, but less frequently so, in arid, rocky, mostly unvegetated canyons (Romin 2004).

Although there are no forested areas in the vicinity of US-191 north of Moab, there are arid canyons that largely or altogether lack forest-type vegetation. Thus, it is unlikely but possible that spotted owls occur in the canyons near US-191 over the first 7 miles north of the Moab site. If present, the species could be disturbed by noise from increased truck traffic. The area around this section of transportation corridor is a popular recreation area, with heavy use by off-highway vehicles and mountain bikes. Although the increase in truck traffic noise could be detectable up to several miles from the highway, the existing off-road vehicle noise and associated human presence would likely have a greater and more direct impact on the owls.

The potential for impacts to terrestrial wildlife from truck transportation of tailings would be greater in the evening or at night than during the day. Therefore, the impacts of double-shift operations would probably be greater than those of single-shift operations. In either case, such impacts would be of relatively short duration and would cease once the transfer of materials to the disposal cell was completed.

Rail Transportation Option

Rail transportation of tailings from the Moab site to the Klondike Flats site would result in less frequent but potentially higher intermittent noise and ground vibration levels (Section 4.2.10) compared to the truck transportation option. As with truck traffic, this would probably not adversely affect Mexican spotted owls in the vicinity of the rail corridor. Other wildlife species could be sensitive to noise from the rail system, but because of the degree of off-road recreational activity in the area, most wildlife is probably somewhat habituated to human presence and noise. The potential collision-mortality rate would be lower using rail transport compared to the truck transportation option.

Development of the rail infrastructure would disturb slightly more land than either of the other two transportation options. Most of this would occur very near or within the Klondike Flats site boundaries and would not result in increased habitat fragmentation.

The effects of noise on wildlife would be of relatively short duration and would cease at the completion of tailings transport. Because of the poor soils and arid climate, reclamation of the rail infrastructure areas, if pursued, would be slow, resulting in longer-term effects.

Slurry Pipeline Option

Use of a slurry pipeline system to transport tailings from the Moab site to the Klondike Flats site would disturb less habitat at the Klondike Flats site than either of the other transport options. However, this option would increase the amount of potential habitat disturbance away from the disposal site along the transportation corridor.

Construction of the pipeline would disturb some habitat along the route; however, much of this habitat occurs in previously disturbed corridors.

Installation of the pipeline system could disturb species along the transportation corridor such as the Mexican spotted owl, white-tailed prairie dog, black-footed ferret, and species of ground-nesting migratory birds, if present. Site-specific investigations would be conducted prior to pipeline construction to identify any populations of these species. If present, potential impacts could be mitigated by adjusting the location of the pipeline route, or constructing the pipeline during periods of the year that would not disrupt nesting of spotted owls or migratory birds. Operation of the pipeline would not be expected to have any adverse effects on wildlife species or habitats.

4.2.7.3 Monitoring and Maintenance Impacts

Routine post-closure monitoring and maintenance of a disposal cell at the Klondike Flats site would not be expected to have any impacts to terrestrial species or habitats. In the event that major corrective actions were needed, some vegetation recovering on and around the disposal site could be disturbed.

4.2.7.4 Impacts from All Sources

Overall impacts to terrestrial ecological resources from the Klondike Flats off-site disposal alternative would include approximately 50 acres of tamarisk habitat lost at the Moab site (the rest of the site is considered to have zero habitat quality), a maximum of approximately 690 acres of desert habitat at the borrow sites, 420 to 435 acres for development of the disposal cell, and varying additional acreage depending on the mode of transportation.

Total maximum habitat disturbance for the truck or rail transport options from all activities (Moab site, borrow areas, transportation, and Klondike Flats site) would be approximately 1,200–1,245 acres. If the slurry pipeline option were selected, 85 acres would be disturbed for the pipeline corridor and 24 for support roads, bringing the total maximum disturbance from all activities to approximately 1,385 acres.

An additional amount of habitat would be lost at the commercial quarry sites for sand, gravel, and riprap. There would be a slight decrease in habitat value near US-191 if the truck transport option were selected because of increased truck traffic required to haul tailings materials, and there would be a slight increase in traffic-related wildlife mortalities. The rail transport option would result in slightly higher average noise levels near the rail corridor. Impacts of borrow material haulage would be less than for the on-site disposal alternative because the radon barrier and cover materials would be available near the disposal cell site, and haulage of these materials at highway speeds on US-191 would not be required.

4.2.8 Land Use

4.2.8.1 Construction and Operations Impacts at the Moab Site

Impacts to land use would include potential changes to existing land use at the Moab site or at nearby properties. Land use impacts of construction and operations at the Moab site with final disposal at Klondike Flats would be primarily short-term impacts. Construction and operations at the Moab site, which is currently under federal ownership and control, would not alter existing land use at the site. Noise and vibrations that could occur as a result of these activities would be unlikely to travel off the site and thus would be unlikely to affect the use of adjacent or nearby recreational areas (see Section 4.2.10).

Some long-term land use impacts would occur at the Moab site. Following removal of the tailings, ground water contamination would remain beneath the site, and DOE would retain some land for a water treatment facility that would operate until surface water goals were met. Property designated for this facility would likely be in federal ownership for 75 years, creating a loss of that acreage for beneficial land use during this period by other government or private owners and potential interference with other uses of the site.

As discussed in Section 1.4.5, release of portions of the site for future uses would depend on the success of site remediation. DOE's ultimate goal would be to remediate to unrestricted surface use standards. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation.

The long-term commitment of the Moab site for ground water remediation would conflict with Grand County land use planning that designates the site as a Specially Planned Area during remediation activities according to County Ordinance 346, but that envisions future land uses that would allow for low-density residential uses upon completion of remediation.

4.2.8.2 Construction and Operations Impacts at the Klondike Flats Site

Impacts to land use would include potential changes to existing land use at the affected site or at nearby properties. The land selected for the Klondike Flats site is currently administered by BLM. The approximately 435 acres needed for the cell construction area would be withdrawn from BLM administration and transferred to DOE in perpetuity. All surface and subsurface land uses would be vested with DOE.

The Klondike Flats site is currently part of the Big Flat grazing allotment, which is under permit until 2013. This permit would be vacated, and there would be a loss of 0.4 percent of the allotment's grazing rights for the current permittee. The Klondike Flats site is also available for oil and gas and mineral leasing. A disposal cell in this location would create a long-term loss of all grazing rights and oil and gas and mineral extraction in perpetuity. This would create a long-term loss of revenue for any surface or subsurface permits or leases on the site.

All three options for transportation to the Klondike Flats site would require a permanent access road and land for other transportation modes and the associated infrastructure. About 40 acres of land would be required for the truck haul option transportation infrastructure, including a new overpass to exit US-191. For a rail haul option, approximately 69 additional acres would be needed to construct new rail spurs, a transfer station, and haul roads. Wherever possible, a slurry pipeline would be constructed in the existing pipeline right-of-way or along the US-191 right-of-way. However, approximately 24 acres would be disturbed for a transfer station. For a slurry pipeline, some truck haul roads would still be needed, and the associated impacts would still exist because not all materials could be transported by slurry pipeline to the site for final disposal and must be transported by other means. Land disturbance for the slurry pipeline would be short term because the property allocated for such use would be reclaimed once remediation of the Moab site was complete and the disposal cell was capped.

Regardless of the mode of transportation, a new public access road would be constructed parallel to CR-138 (Blue Hills Road) to facilitate public and recreational traffic south of the site, which has seen increasing motorized and nonmotorized recreational use. It is likely that the new access road would be constructed in the existing county right-of-way, and no new land use impacts would occur. The location and length of the permanent access road would vary depending on the transportation mode and would require approximately 7,000 ft of right-of-way across a southern section of the site, which is currently administered by the State of Utah.

4.2.8.3 Construction and Operations Impacts Related to Transportation

Under the truck haul option, trucks would use the existing highway between the Moab site and the Klondike Flats site. As noted, a new public access road would be constructed to the site. There is an existing rail line between Moab and a location near Klondike Flats. Other than the construction and operation of a rail spur from this line to the Klondike Flats site, there would be no additional land use impacts as a result of the rail haul option.

Noise and vibration would occur above background levels as a result of transporting the tailings by truck or rail and could temporarily disturb residents, businesses, and recreational users along the travel routes (see Section 4.2.10) and temporarily affect current uses of those properties. Traffic disruptions could occur as a result of increased truck traffic and adversely affect residents, businesses, and recreational users along the travel routes (see Section 4.2.16).

The slurry pipeline route from the Moab site to the Klondike Flats site would be 18.8 miles, all within lands administered by BLM. The pipeline would be located in an existing right-of-way to the extent possible, or in a right-of-way parallel to the existing right-of-way. Use of an existing right-of-way would not adversely affect existing land use; use of a corridor parallel to the existing right-of-way would cause minor, short-term land use impacts. When the project was completed, if DOE decided that the pipeline could not be used for other purposes, the pipeline would be removed and the land returned to its original condition.

4.2.8.4 Monitoring and Maintenance Impacts

Monitoring and maintenance of a disposal cell at the Klondike Flats site would not impose any land use impacts as long as the site remained under federal ownership and control. Monitoring locations such as wells that were required outside of DOE's property would impose minor land use impacts.

4.2.8.5 Impacts from All Sources

Short-term land use impacts would occur at the Moab site during construction and reclamation. Long-term impacts would result from ongoing ground water cleanup. Residual contamination at the site or on surrounding properties could create a need for short- to long-term access and restrictions in the form of institutional controls.

Long-term land use impacts would occur at the Klondike Flats site and for the permanent access road. The land use impacts created by the rail and slurry pipeline transportation options would be short term because the land needed for these transportation modes would be reclaimed and returned to BLM for prior designated land use. Of the total potential land use disturbance at Klondike Flats, approximately 420–435 acres for cell construction and up to 24 acres for dedicated access roads would remain under DOE ownership in perpetuity. DOE is deferring decisions regarding future uses and ownership of the 439-acre Moab site pending a determination of the success of remediation activities.

4.2.9 Cultural Resources

This section addresses the potential for disturbance of known cultural resources or the discovery of unknown resources associated with the Klondike Flats off-site disposal alternative.

4.2.9.1 Construction and Operations Impacts at the Moab Site

Under the Klondike Flats off-site disposal alternative, impacts to cultural resources from construction and operations at the Moab site would be the same as those described in Section 4.1.9.1.

4.2.9.2 Construction and Operations Impacts at the Klondike Flats Site

On the basis of current estimates (see Section 3.2.10), 15 to 19 cultural sites eligible for inclusion in the National Register of Historic Places could be adversely affected by construction and operations at the Klondike Flats disposal site. The Class III cultural resource survey that DOE would conduct at the Klondike Flats site would indicate the precise number and types of cultural sites present. Along with the Class III survey, DOE would conduct a site-specific study to identify potential traditional cultural properties that may exist on the site (there is a low to medium likelihood that they would occur). DOE, BLM, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures through the Section 106 consultation process (see Section 3.1.13.3). Mitigation measures might include (1) avoiding the cultural resource sites, (2) monitoring the cultural resource during surface-disturbing activities, (3) excavating and recording cultural resource data before construction activities began, or (4) moving cultural resource objects from areas of disturbance to nearby undisturbed areas.

Cultural resources located near areas of disturbance could be adversely affected indirectly (through illicit collection, vandalism, or inadvertent destruction) as a result of increased human activity in the area. DOE would require site workers to receive training on the need to protect cultural resources and the legal consequences of disturbing cultural resources.

4.2.9.3 Construction and Operations Impacts Related to Transportation

Under the truck transportation mode, one to four cultural sites (one site near the Moab site; up to three sites near the Klondike Flats site) eligible for inclusion in the National Register of Historic Places could be adversely affected by the construction of transportation infrastructure. Up to three cultural sites near the Klondike Flats site could be adversely affected under the rail alternative.

A total of 25 eligible cultural sites are known to exist within 0.5 mile of the proposed slurry pipeline to the Klondike Flats site. Of these, 6 to 20 could be adversely affected during pipeline construction. The potential for traditional cultural properties to occur along the pipeline route is medium to high. If these properties were located along the route, they most likely would be adversely affected as well. DOE, BLM, UDOT, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures for these sites through the Section 106 consultation process.

In addition to these direct impacts, cultural resources located near the pipeline could be adversely affected indirectly through illicit collection, vandalism, or inadvertent destruction as a result of increased human activity in the area.

4.2.9.4 Monitoring and Maintenance Impacts

Impacts to cultural resources would not occur from monitoring and maintenance activities under the Klondike Flats disposal alternative.

4.2.9.5 Impacts from All Sources

Table 4–24 lists the total number of cultural sites eligible for inclusion in the National Register of Historic Places that could be adversely affected under each of the Klondike Flats site transportation options.

Table 4–24. Number of Cultural Sites That Could Be Adversely Affected Under the Three Transportation Options

Location/Activity	**Transportation Mode**		
	Truck	**Rail**	**Slurry Pipeline**
Moab site (construction and operations)	0–2	0–2	0–2
Moab site (highway improvements)	1	0	0
Klondike Flats site (including radon barrier borrow area and site access road)	15–19	15–19	15–19
Cover soil borrow area	0–11	0–11	0–11
Overpass and haul road for truck transport to Klondike Flats site	0–3	NA	0–1
Rail infrastructure at Klondike Flats site	NA	0–3	NA
Pipeline construction	NA	NA	6–20[a]
Total	**16–36**	**15–35**	**21–53[a]**

[a] Numbers do not include potential traditional cultural properties that have not yet been identified along the pipeline route; the likelihood of their occurrence is medium to high.

4.2.10 Noise and Vibration

This section addresses the impacts of noise and ground vibration primarily to human receptors. Where appropriate, impacts to wildlife and cultural resources are also identified. Unless indicated otherwise, all noise and vibration impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.2.10.1 Construction and Operations Impacts at the Moab Site

Under this alternative, noise at the Moab site would come from construction activities and removal of the tailings pile. The largest sources of noise on the site would be heavy earth-moving equipment. The noise generated from these activities would not differ significantly from the noise generated at the Moab site under the on-site disposal alternative. See Section 4.1.10 for a description of the noise associated with construction and earth-moving activities.

For the rail transportation alternative, a conveyor system would be constructed to move the tailings uphill to the rail cars. This would represent an additional noise source. Estimates of noise from conveyor systems vary, but in general, the motor would be the most significant source of noise for a conveyor system. Diesel generators produce less than 80 dBA at a 23-ft reference distance (according to manufacturer specifications) when outfitted with mufflers and enclosures. The maximum level for a conveyor system of 90 dBA at 23 ft would attenuate to 65 dBA within 820 ft. The conveyor system would be located more than 980 ft from Arches National Park, and 1.1 miles from the nearest residence. The additional noise generated by a conveyor system would be indistinguishable relative to the noise generated by other construction equipment such as trucks and bulldozers.

Ground vibration generated by heavy equipment at the Moab site is discussed in Section 4.1.10. No appreciable differences would be expected in ground-level vibration between the on-site disposal alternative and the Klondike Flats off-site disposal alternative.

4.2.10.2 Construction and Operations Impacts at the Klondike Flats Site

Noise at the Klondike Flats site would come from construction activities and movement of the tailings. Regardless of the transportation method used, tailings disposal would require excavating soil and moving the tailings. Borrow materials brought in to cover the disposal cell would also be unloaded and moved. The most significant source of noise from these activities would be heavy equipment such as bulldozers and trucks. Similar to the analysis of the Moab site, a maximum noise level of 95 dBA (1-hour L_{eq}) was assumed to constitute a conservative estimate. This maximum noise level would attenuate to a level below the Moab 65-dBA residential noise standard within 1,480 ft. The only residence near the Klondike Flats site is the Canyonlands Field Airport, where four to seven people reside. This airport is located approximately 2,950 ft from the boundary of the Klondike Flats site and is outside the region of influence for noise.

Background levels of ground vibration range between 62 and 65 dBV. Ground vibration generated from equipment operations at the Klondike Flats site is estimated to have a maximum noise level of up to 95 dBV (Hanson et al. 1991). Ground vibration is estimated to follow a logarithmic decrease as distance from the source increases. Vibrations from a 95-dBV source should decrease to levels below human detection within 820 ft.

4.2.10.3 Construction and Operations Impacts Related to Transportation

Noise from transportation of material from the Moab site to the Klondike Flats site would originate from truck traffic, rail traffic, construction of temporary overpasses, or construction of a slurry pipeline. Truck traffic would occur along US-191 and access roads. Rail traffic would occur along existing rail lines and a new rail spur. Noise from construction of the slurry pipeline would occur along the pipeline corridor, which would run essentially parallel to US-191.

For truck transportation, the maximum hourly average of tailings haul truck traffic passing any point on US-191 between the Moab site and Klondike Flats site would be approximately 40 trucks. Current traffic along this stretch of highway produces a 1-hour L_{eq} of 73 dBA at 25 ft. Assuming attenuation from a line source and molecular absorption, there is a region of influence of 164 ft where noise levels exceed the 65-dBA Moab residential standard (Moab City Ordinance 17.74.080, "Noise Levels"). Assuming the project trucks were going 60 mph and generated 95 dBA at 25 ft from the source, the region of influence would increase by 260 ft to 426 ft. No permanent residences are within this region of influence along the transportation route. Noise generated along access roads should be less than along the highway because of the lower driving speed. No residences are within 0.6 mile of the proposed truck access roads.

For train transportation, the noise would be less than with truck transportation. The region of influence around the rail line that would exceed 65 dBA is estimated to be less than 330 ft. There are no residents within 330 ft of the existing rail line or the spur that would be added.

For slurry pipeline construction, a maximum noise level of 95 dBA is a conservative estimate. The region of influence around the construction site would be 1,480 ft. The location of the noise would move as construction progressed and would end once construction was complete.

There would also be short-term noise associated with the construction of access roads, temporary overpasses, the slurry pipeline, or a new rail spur. These sources of noise would be temporary and would occur more than 0.6 mile from the nearest residents at Canyonlands Field Airport. Noise associated with these activities would attenuate to levels below 65 dBA before reaching the airport.

Ground vibration was considered only for the train and slurry pipeline alternatives, since rubber-wheeled vehicles such as trucks produce minimal amounts of ground vibration. Vibration from rail traffic could reach 90 dBV but would likely be less because of the slow travel speeds expected (10 to 30 mph, depending on grade and crossings). This level of ground vibration would attenuate to background levels within 660 ft of the source. No residents or sensitive receptors were identified within 660 ft of the existing rail line or the spur that would be added. Construction of a slurry pipeline would likely result in ground vibration above background levels within Arches National Park. The estimated maximum level for ground vibration produced during construction of a slurry pipeline would be 95 dBV. This level would result in ground vibration above background levels 820 ft from the source and levels above human perception within 330 ft of the source. Some cultural sites containing rock structures and the historic rock bridge at Arches National Park would be within 2,620 ft of the pipeline, but ground vibration levels would not reach levels (estimated to be 92 to 100 dBV) that would damage these structures.

4.2.10.4 Monitoring and Maintenance Impacts

Monitoring and maintenance of the Klondike Flats site would not be expected to result in significant generation of noise. Any noise generated by these activities would attenuate to near background levels before leaving the boundary of the disposal site.

4.2.10.5 Impacts from All Sources

Noise generated under the Klondike Flats off-site disposal alternative would not exceed the Moab residential noise standard of 65 dBA at any receptor locations. The receptors with the most potential to notice any increase in noise generated by this alternative would include the residences located on the eastern boundary of the Moab site and visitors at Arches National Park. If two 10-hour shifts were used instead of a single 12-hour shift, the noise generated would not change substantially, but there could be a higher potential for annoyance from late-night and early-morning activities.

4.2.11 Visual Resources

This section describes the impacts to the physical features of the landscape that impart scenic value in the region affected by the Klondike Flats off-site disposal alternative. The impacts would be imposed on viewers who live in, work in, or visit an area and can see ongoing human activities or the results of those activities.

4.2.11.1 Construction and Operations Impacts at the Moab Site

Construction and operations at the Moab site would have adverse impacts on visual resources during the construction period. During this period, the primary visual impacts would be associated with the noticeable movement of heavy equipment on the site as well as exhaust emissions and dust generated by the equipment. In an otherwise natural and still landscape, the movement and emissions of the heavy equipment would create a moderate contrast. Removal of the tailings pile, section by section, would increase the contrast between the pile and surrounding landscape until the pile was completely removed. These moderate to strong contrasts would result from the increase in smooth horizontal and vertical lines associated with cuts into the pile. Dusk and dawn lighting (and nighttime lighting under a double-shift work scenario) would be noticeable from all the key observation points as well. The primary viewers of construction activities, the length of time the activities might be viewed, and potential mitigation measures are described in Section 4.1.11.1.

After the tailings were removed, the entire Moab site would be regraded and revegetated with native or adapted plant species. Until vegetation was established on the site (3 to 5 years), the 439 acres of smooth-textured, barren, red soil would contrast strongly with the more rugged, vegetated surroundings. In the long term, these contrasts would become negligible as the site developed a more natural, vegetated look. Scenic views of the Colorado River corridor, with its spectacular canyons and green riverbanks, would expand and become more prominent for travelers on US-191 and SR-279. Figure 4–9 shows a photo simulation of the Moab site after tailings removal and revegetation. Although the future use of the site is not known, removal of the pile and revegetation of the site would have strong positive visual impacts.

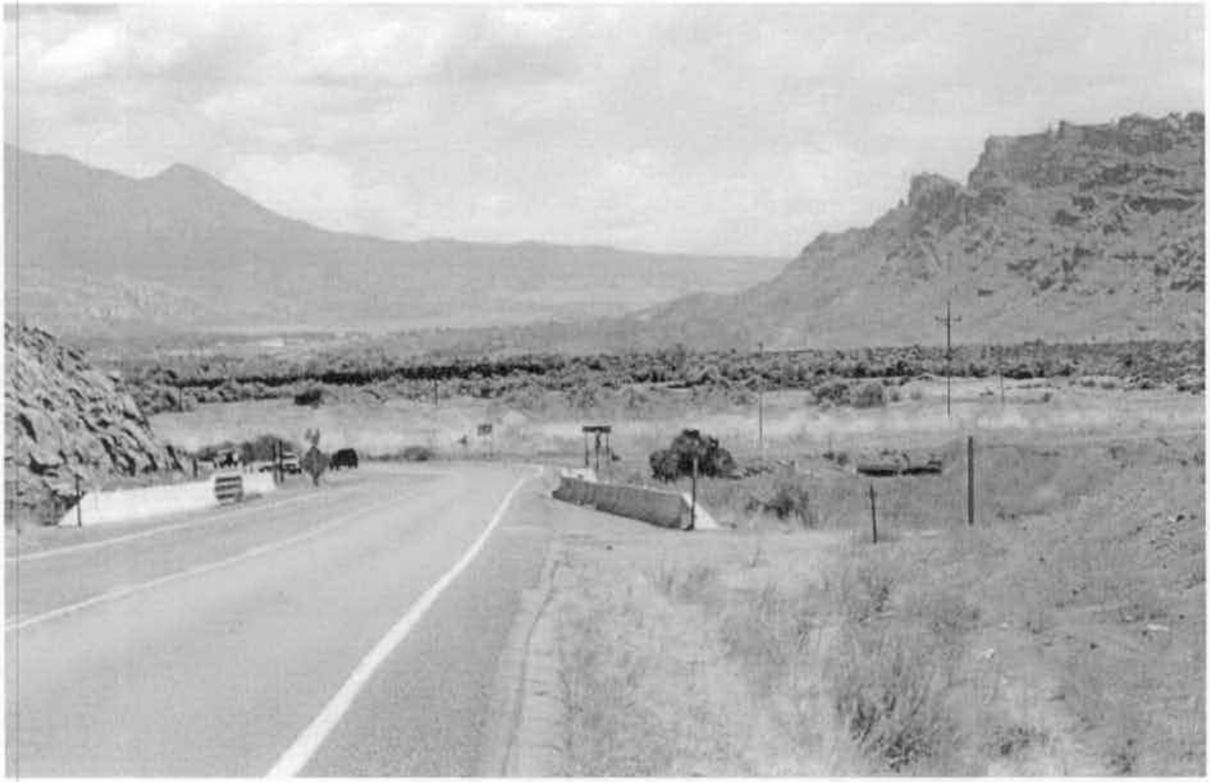

Figure 4–9. Simulated View of the Moab Site from Southbound Lane of US-191 After Tailings Pile Removal

[Before UDOT widened US-191]

4.2.11.2 Construction and Operations Impacts at the Klondike Flats Site

Construction and operations at the Klondike Flats site would have minor adverse effects on visual resources, primarily because construction activities and the completed disposal cell would not be seen by most people. DOE selected four key observation points from which to assess visual impacts: (1) US-191 southbound, (2) US-191 northbound, (3) Blue Hills Road, and (4) Arches National Park. Figure 4–10 and Figure 4–11 show DOE's visibility analysis results for two potential locations for the Klondike Flats disposal cell—one in Section 35 of T. 23 S, R. 19 E (Figure 4–10) and one in Section 25 of the same township (Figure 4–11). The darkened areas indicate locations from which a disposal cell could potentially be viewed. The visibility analysis used to create this map is based on elevation and topography. It does not take into account the potential obstruction of views from cultural modifications or vegetation, or the effects of distance on visibility. Without visual aids, such as binoculars, most people would not be able to recognize a disposal cell at distances greater than 5 to 10 miles.

The visibility analysis results for both cell-location scenarios indicate that travelers on US-191, Blue Hills Road, and most areas within Arches National Park would not be able to view the Klondike Flats disposal cell. The one potential adverse impact from cell construction at these key observation points would be from the lighting used during dawn and dusk hours (and at nighttime under the double-shift work scenario) during the construction period. This impact would be expected to be minor, as shielded night lighting would be used to minimize glare. No lighting would remain at the site once the cell was completed.

Figure 4–10 indicates that the disposal cell would be in a viewer's line of sight from the I-70 scenic overlook and the Windows View area in Arches National Park. DOE staff visited both locations and determined that both were too distant from the Klondike Flats site for a cell to be discernible. In both figures, the darkened areas within a 10-mile radius of the Klondike Flats site are in remote locations that generally would not be accessible by vehicle. The only group that would likely view construction activities and the completed disposal cell from these remote locations would be persons recreating in the area.

DOE's proposed action at the Klondike Flats site would be compatible with BLM's Class III visual resource objectives for this area, as the Class III designation allows an activity to attract, but not dominate, the attention of casual observers (BLM 2003). Construction activities and the completed disposal cell would not be seen by the general public.

4.2.11.3 Construction and Operations Impacts Related to Transportation

Truck Haul

Under the truck haul option, the newly constructed US-191 overpass and access road to the Klondike Flats site would be visible to travelers on US-191 and Blue Hills Road, respectively. These features, however, would not draw the attention of most travelers; they are common features in the modern, culturally modified landscape, and travelers would expect to see these kinds of features. Once the disposal cell was completed, the overpass and a portion (about a 2-mile section) of the access road would be removed and reclaimed. After 3 to 5 years of vegetation growth, the former locations of these features would not be apparent.

The number of trucks per hour that would use US-191 and the haul road adjacent to Blue Hills Road on any given day to transport materials (tailings, borrow material, and vicinity property material) would vary, probably significantly, depending on the phase of operation and other factors during the approximately 3 to 5 years (depending on work shift scenario) during which construction and transportation activities would be ongoing (Figure 2–1). Table H–7 reports a total of approximately 331,000 material shipments, which would represent approximately 662,000 one-way trips, conservatively assuming that all shipments consisted of two legs.

A single 12-hour work shift ongoing for 5 years (350 days/year) and a double 10-hour work shift ongoing for 3 years both represent 21,000 work hours. Thus, on average, regardless of the work shift scenario, DOE estimates that it would require approximately 32 trucks per hour using US-191 and the haul road adjacent to Blue Hills Road to transport all materials. This increase in truck traffic may or may not be noticed by travelers on US-191, which already is a primary trucking route. Because truck traffic is currently pervasive on US-191, the visual impacts of the potential additional traffic would be negligible for US-191 travelers. For travelers on Blue Hills Road, between US-191 and the turn-off to the disposal cell site, the addition of 32 trucks per hour would have adverse visual impacts. In an isolated, somewhat desolate, desert setting, the additional truck traffic would create moderate to strong contrasts (depending upon the amount of motorized recreational traffic present) in movement and would draw attention to the project. These impacts would be short term (3 to 5 years) only.

For the general public, this transportation option would be compatible with BLM's Class III visual resource objectives. For a relatively small number of recreationists who travel Blue Hills

Road, this transportation option would not be compatible with Class III objectives during the 3- to 5-year period of disposal cell construction.

Rail Haul

Under the rail haul option, the newly constructed railroad spur would be visible to travelers on US-191 and Blue Hills Road. As under the truck haul option, this feature would not draw the attention of most travelers, as it is a feature commonly found along highways. The train/truck transfer station that would be constructed under this option would draw the attention of recreationists traveling Blue Hills Road. The station would not be visible to travelers on US-191. The station's buildings and rotary dump—characterized by bold, angular, smooth surfaces—would create a strong contrast with the surrounding natural landscape, which is characterized by smooth, flat desert plains, horizontal mesa tops, and sparsely scattered vegetation The movement of haul trucks between the rotary dump and disposal cell site would also create moderate to strong contrast, depending upon the amount of motorized recreational traffic present. These adverse impacts would occur throughout the construction period. Once the disposal cell was completed, haul truck traffic would cease, the station would be dismantled, and the station area would be reclaimed with native vegetation. After 3 to 5 years of vegetation growth, the visual impact would be eliminated. Because of the strong visual contrast the station and truck traffic would create for travelers on Blue Hills Road, this transportation option would not be compatible with BLM's Class III visual resource objectives during the construction period. However, Class III objectives would be met once the station was dismantled.

Slurry Pipeline

Under the slurry pipeline option, adverse visual resource impacts would occur during pipeline construction and for approximately 3 to 5 years afterward, during revegetation of the corridor. After construction of the disposal cell was completed, the pipeline would be removed, again disturbing the land and creating adverse visual impacts. The primary viewers of the pipeline corridor would be travelers on US-191, as the corridor would be visible from the highway along most of its length (with the exception of a 4-mile stretch that parallels historic US-160). In Moab Canyon, the smooth, linear, unvegetated swath created by pipeline construction would contrast moderately with the surrounding features, some of which are linear and barren of vegetation (US-191, historic US-160, railroad grade) and some of which are complex, rugged, or vegetated (canyon walls, sagebrush-covered hills). After vegetation was established along the corridor, the contrast would be weak or nonexistent. The visual impacts associated with construction of the pipeline would not be compatible with BLM's Class II objectives in Moab Canyon. To meet Class II objectives, the level of change to the existing landscape would have to be low, could not attract the attention of a casual observer, and should repeat the basic elements of line, form, color, and texture that are found in the predominant natural features. Class II objectives would be met once the corridor became revegetated, after approximately 3 to 5 years.

North of Moab Canyon, the pipeline route would cross terrain that is designated Class III and Class IV by BLM. In these areas, the smooth, linear, unvegetated swath created by pipeline construction would contrast moderately with the surrounding features, characterized primarily by light-beige and light-gray, rolling desert plains and smooth, rounded, buff-colored bluffs.

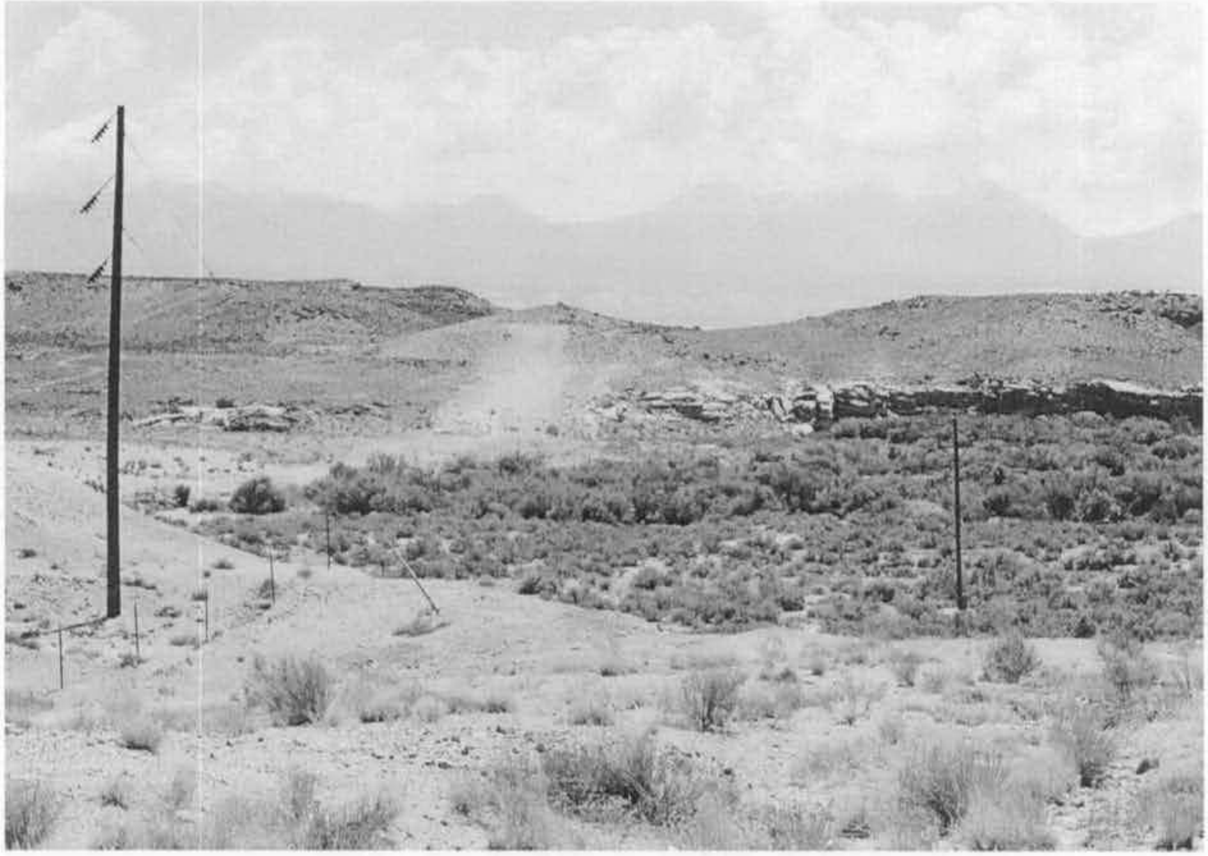

Figure 4–12. View of 5-Year-Old Pipeline Corridor from US-191, Approximately 2 Miles South of Blue Hills Road Turnoff

After vegetation was established along the corridor, the contrast between the corridor and surrounding landscape would be moderate to nonexistent, depending upon the success of revegetation. Figure 4–12 shows a view from US-191 of an existing pipeline corridor 5 years after construction. DOE's proposed pipeline would parallel this corridor. The visual impacts associated with construction and revegetation of the pipeline would be compatible with BLM's Class III and IV objectives.

4.2.11.4 Monitoring and Maintenance Impacts

Impacts to visual resources would not occur from monitoring and maintenance activities under the Klondike Flats disposal alternative.

4.2.11.5 Impacts from All Sources

Moving the tailings pile from the Moab site to the Klondike Flats site under any transportation option would have short-term, adverse visual impacts and negligible to no long-term adverse visual impacts, primarily because the short-term construction activities and the completed disposal cell would not be seen by most people. At the Moab site, removal of the pile would have strong beneficial impacts to visual resources. Table 4–25 summarizes visual resource impacts that would be expected under this alternative.

Table 4–25. Summary of Visual Resource Impacts Under the Klondike Flats Off-Site Disposal Alternative

Location/Activity	**Visual Resource Impacts**	
	Short Term	**Long Term**
Moab site	Strong adverse impacts primarily to travelers on US-191 and SR-279	Strong positive impacts from removal of tailings pile
Klondike Flats disposal cell site	Negligible to no adverse impacts; site not visible to most casual observers	Negligible to no adverse impacts; site not visible to most casual observers
Cover soil borrow area	Negligible to strong adverse impacts, depending upon borrow source	No adverse impacts
Truck haul[a]	Negligible adverse impacts to US-191 travelers; moderate to strong adverse impacts to Blue Hills Road travelers	No adverse impacts
Rail haul[a]	Negligible adverse impacts to US-191 travelers; strong adverse impacts to Blue Hills Road travelers	No adverse impacts
Slurry pipeline[a]	Moderate adverse impacts to travelers on US-191	Moderate to no adverse impacts to travelers on US-191
Monitoring and maintenance	No adverse impacts	No adverse impacts

[a] Only one transportation option would be selected.

4.2.12 Infrastructure

This section addresses potential impacts on the availability of electric power, potable water, nonpotable water, sewage treatment, rail service, and highways. Unless indicated otherwise, all infrastructure impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.2.12.1 Construction and Operations Impacts at the Moab Site

The basic 600-kVA power demand at the Moab site discussed for the on-site disposal alternative would also apply at the Moab site under all three off-site disposal alternatives. In addition, the rail and slurry pipeline options would result in additional power demands. For truck transportation, the total power demand would be 600 kVA, the same as for the on-site disposal alternative. Rail transportation would require an additional 100 kVA of demand, for a total demand of 700 kVA. Slurry pipeline transportation would require an additional 2,800 kVA, for a total demand of 3,400 kVA. ESC Inc. developed and reviewed this projected demand with Mathew Yates, Pacific Corporation, Moab. Pacific Corporation indicated that this demand would present no capacity problems to the existing electric supply system at the site, nor would system upgrades be required (ESC 2003).

The estimated average daily potable water consumption would differ for the three possible modes of transportation. Assuming the more aggressive double 10-hour work schedule, these demands would be approximately 11,000 gallons per day for slurry pipeline transportation, 12,500 gallons per day for rail transportation, and 15,000 gallons per day for truck transportation.[1] The city of Moab has indicated that these demands could be met without adversely affecting the city's water supply or requiring system upgrades (Swenson 2003).

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[1] In Table 2–25, the data shown assume the less aggressive single 12-hour work schedule; the estimates above assume the more aggressive double 10-hour schedule. Further, data in the table show collective consumption at the Moab site, an off-site cell location, and transportation-related usages. For estimating usage at different locations, DOE assumed that half the usage shown in the table would be at the Moab site and half at the off-site disposal site.

The estimated average annual nonpotable water demand impact would differ for the three possible modes of transportation. Assuming the more aggressive double 10-hour schedule for rail and truck transportation, these demands would be approximately 120 acre-feet per year for both rail and truck transportation.[2] For the slurry pipeline mode of transportation, DOE assumes that all 730 acre-feet per year shown in Table 2–24 would come from the Colorado River at the Moab site, although DOE recognizes that some nonpotable makeup water from the off-site disposal sites would be used if necessary. As noted in Section 4.1.12.1, DOE is authorized to withdraw approximately 3 cfs (2,366 acre-feet per year) from the Colorado River for consumptive use and an equal amount for nonconsumptive use. The highest potential demand of 730 acre-feet per year (pipeline transportation) converts to approximately 1.0 cfs, or one-third of DOE's annual authorized consumptive withdrawal volume.

The proposed new rail sidings and rail infrastructure would neither enhance nor detract from the rail infrastructure currently servicing the area and would be removed upon completion of the project. The proposed new acceleration and deceleration lanes and overpasses would neither enhance nor detract from the road infrastructure currently servicing the area; they, too, would be removed upon completion of the project.

Sanitary waste impacts would be the same as those described for the Moab site in Section 4.1.12.1.

4.2.12.2 Construction and Operations Impacts at the Klondike Flats Site

Power demands for construction and operations at the Klondike Flats site would be qualitatively similar to but quantitatively less than those for the Moab site. The impact on the existing electrical infrastructure servicing the Klondike Flats site area would differ for the three alternative modes of transportation. For truck transportation, the total power demand would be 300 kVA; for rail transportation, the total power demand would be 600 kVA; and for slurry pipeline transportation, the total power demand would be 2,500 kVA. ESC of Fort Collins, Colorado, developed and reviewed this projected demand with Mathew Yates, Pacific Corporation (Utah Power and Light), Moab. The capacity of the existing electrical distribution system circuit would support the additional demands for the truck or rail haul options. However, the electrical demands of the slurry pipeline option would require a distribution circuit upgrade from Utah Power's Seven Mile substation, which is located about 6 miles south at the intersection of SR 191 and SR 313, or an upgrade of the Bookcliffs substation, which is located about 12 miles north in Crescent Junction. If the slurry pipeline option were implemented, the selection of the substation for upgrading would be based on a full utility engineering evaluation at the time of construction (ESC 2003).

The potable water demand at the Klondike Flats site would be the same as the demand at the Moab site (Section 4.1.12.1). That is, assuming the more aggressive double 10-hour work schedule, potable water demands would be approximately 5,500 gallons per day for slurry pipeline transportation, 6,250 gallons per day for rail transportation, and 7,500 gallons per day for truck transportation. These demands would not adversely affect the city water supply system.

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[2] In Table 2–24 (Nonpotable Water Consumption), the data show collective consumption at the Moab site, the off-site cell location, and transportation-related usages. For estimating usage at the Moab site only, DOE assumed 50 percent of the collective 235 to 240 acre-feet/year usage for rail or truck transport shown in the table, or approximately 120 acre-feet per year.

The nonpotable water demands for Klondike Flats site would be the same as the demand at the Moab site (Section 4.1.12.1). All of the nonpotable water would come from the Colorado River. For the truck and rail transportation modes, DOE assumes that approximately half of the total demand for nonpotable water would be consumed at the off-site disposal site.

Activities at the Klondike Flats site would generate 5,000 to 11,000 gallons of sanitary waste per week, depending on the transportation mode. This would be in addition to the 10,000 gallons per week generated at the Moab site. The waste would be stored in portable toilets and septic tanks and transported for treatment at the city of Moab sewage treatment plant. The total 15,000 to 21,000 gallons of sanitary waste per week would not exceed the city's current excess capacity (see Section 4.1.12.1); however, the same 9,000-gallon-per-day restrictions for wastes from septic tanks and portable toilets described in Section 4.1.12.1 would also apply.

4.2.12.3 Construction and Operations Impacts Related to Transportation

The proposed new rail sidings and rail infrastructure and the proposed acceleration and deceleration lanes and overpasses would neither enhance nor detract from the rail and road infrastructure currently servicing the area and would be removed upon project completion. Truck traffic transporting contaminated materials or borrow area material to the Klondike Flats site or the Moab site would result in increased wear and tear on local roads and on US-191. However, UDOT has indicated that the additional trucks resulting from the truck haul option could be accommodated with current highway design and planned improvements (UDOT 2002). The cost to the State from wear and tear on roads would be offset through vehicle registration and special permit fees, both of which provide revenue to the state general highway fund for road maintenance and repair. Transportation plans would include provisions for enforcing speed limits, road load limits, and any other applicable traffic laws.

The proposed 100 tons of cargo per railcar is currently the National Association of Railroads average cargo weight per car, and neither this load weight nor the proposed 30 cars per train would pose any track use restrictions. However, the proposed increase in train frequency (four to eight round trips per day compared to the current one round trip per week) would require increased track inspections and maintenance and possible speed restrictions in specific areas due to increased wear and tear on the track and crossings. The required increased maintenance costs would be built into the rate quotes for the shipments. The increased volume of traffic may require crossing gates at specific crossings. A decision regarding crossing gates would be made jointly by UDOT, Grand County, and the railroad, based on final determinations of train frequency and schedules (Legg 2003).

Overall site power requirements under the Klondike Flats off-site disposal alternative, including those for transportation-related operations, are presented in Chapter 2.0. The truck transportation mode would not entail additional power demands over the 300 kVA required for site construction and operations. However, the rail transportation mode would draw an additional 300 kVA (600 kVA total demand), and the slurry pump would draw an additional 2,200 kVA (2,500 kVA total demand).

4.2.12.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would be generally limited to periodic inspections and activities to remedy incipient erosion. DOE expects that these activities would not affect the local or regional infrastructures.

4.2.12.5 Impacts from All Sources

At the Moab site, the maximum power demand of 3,400 kVA (slurry pipeline transportation option) could be met with no impact to Utah Power's existing electric supply infrastructure servicing the site. At the Klondike Flats site, the power demands of the rail and truck transportation options could be met with no impact to Utah Power's existing electric supply infrastructure servicing the area, but the 2,500-kVA demand of the slurry pipeline option would require a distribution circuit upgrade at Utah Power's Bookcliff or Seven Mile substation. At the Moab site and the Klondike Flats site, the maximum potable water demand of 7,500 gallons per day for both locations (truck transport option) could be met with no adverse impact to the city of Moab's existing potable water supply infrastructure. At the Moab site and the Klondike Flats site, the combined maximum nonpotable water demand of 730 acre-feet per year (slurry pipeline transportation option) would be approximately one-third of DOE's existing Colorado River water usage rights at the Moab site. Sanitary waste impacts at the Moab site and Klondike Flats site would be the same as those described for the Moab site in Section 4.1.12.5. Shipments of vicinity property material and borrow material to the Moab and Klondike Flats sites would result in wear and tear on state and county roads. In addition, implementation of the truck transportation option would result in further road wear and tear. Truck permit and registration fees would compensate Utah and Grand County for this unavoidable adverse impact to the road infrastructure. If the rail transportation option were implemented, there would be increased wear and tear on the Cane Creek Branch rail line and the need to schedule more frequent track and rail bed inspections, maintenance, and repair. Shipping fees paid to Union Pacific Railroad would compensate the railroad for this unavoidable adverse impact to the rail infrastructure.

4.2.13 Solid Waste Management

This section discusses impacts from generation of solid waste under this alternative. These wastes would be generated for the duration of remedial action. Contaminated solid wastes generated at the site would be disposed of in the tailings pile. The impacts of construction and operations at the Moab site under the Klondike Flats disposal alternative would be the same as those described in Section 4.1.13.1 with the exception that RRM from ground water treatment would be generated for an estimated 75 rather than 80 years.

4.2.13.1 Construction and Operations Impacts at the Klondike Flats Site

Activities at the Klondike Flats site would generate approximately 1,040 yd^3 of uncontaminated solid waste, which would be disposed of at the Grand County landfill, with the same impacts as the on-site disposal alternative (see Section 4.1.13.1).

4.2.13.2 Construction and Operations Impacts Related to Transportation

Small volumes of uncontaminated solid waste would be generated during transportation of contaminated materials. These wastes would be disposed of in the Grand County landfill.

4.2.13.3 Monitoring and Maintenance Impacts

Very small volumes of waste would be generated as a result of ongoing inspections and monitoring. All wastes would be managed in accordance with applicable laws and regulations.

4.2.13.4 Impacts from All Sources

Management of an estimated 1,040 yd^3 of solid wastes generated as a result of the Klondike Flats off-site disposal alternative would not result in adverse environmental or waste disposal capacity impacts. Sixty-six hundred tons of RMM would be generated annually for 75 years if an evaporation-based ground water remediation treatment were implemented. These wastes would be handled, recycled, or disposed of according to approved waste management plans and applicable state and federal regulations.

4.2.14 Socioeconomics

This section discusses potential socioeconomic impacts for the off-site disposal alternative at the Klondike Flats site. The aggregate impacts would depend on the mode of transportation used: truck, rail, or slurry pipeline. These impacts are examined using geographically and industrially detailed information on expected direct and indirect changes in output, earnings, and employment over the construction and transportation phases of the project. The analysis also considers potential impacts from increased demand for temporary housing, and the short-term and long-term influence of the surface remediation on the regional tax base and future economic development opportunities.

As discussed in Section 4.1.14, for purposes of analysis, the principal affected socioeconomic region of influence is assumed to be Grand and San Juan Counties in southeastern Utah. For the Klondike Flats alternative, some socioeconomic impacts may carry over to the adjacent Utah Counties of Emory and Carbon and into Mesa County, Colorado. The impact analysis uses project cost and workforce information specific to actions undertaken for the off-site disposal alternative (summarized in Section 4.1.14, Table 4–8). On the basis of this information, economic impacts in the principal two-county socioeconomic region of influence are evaluated using RIMS II regional multipliers obtained from the U.S. Department of Commerce Bureau of Economic Analysis (BEA 1997) (described in Section 4.1.14). The industries expected to be initially affected by the project include the regional construction and transportation industries, along with supporting service industries (especially hotels and restaurants). The project workforce is assumed to come from outside the socioeconomic region of influence and to spend a portion of their earnings on housing, food, and other goods and services within the principal two-county socioeconomic region of influence.

The economic impacts for the off-site disposal alternative at the Klondike Flats site are summarized in Table 4–26. The annual project cost under the truck transport option is estimated to be $41,287,950 over an 8-year disposal period, followed by estimated annual costs of $933,000 during the 75-year period of active ground water remediation/site monitoring. Annual costs under the rail transport option are estimated to be $48,978,463 over the 8-year disposal period, followed by $933,000 over the ground water remediation/site monitoring period. The slurry pipeline transport option is expected to have annual costs of $49,401,688 over the disposal period, and $933,000 over the ground water/site remediation period. Project expenditures over the 8-year disposal period would result in changes in the output of goods and services, labor

Table 4–26. Economic Impacts in the Principal Two-County Socioeconomic Region of Influence Under the Klondike Flats Off-Site Disposal Alternative

Transport Method	Annual Cost	Annual Output of Goods and Services	Annual Labor Earnings		Jobs
Truck	$41,287,950	$54,563,048		$13,418,584	391
Rail	$48,978,463	$64,697,605		$15,918,000	315
Pipeline	$49,401,688	$65,255,331	Year 1	$16,055,548	335
			Years 2–8	15,097,007	315

Note: Economic impacts for regional output of goods and services and labor earnings are calculated based on final-demand multipliers provided by the Bureau of Economic Analysis. The respective multiplier values (1.3178 and 0.3250) are multiplied by annualized cost to generate the impact values shown. Employment impacts are calculated as the product of the direct-effects multiplier (1.4262) and total direct jobs for each action alternative (see Tables 2–16, 2–17, and 2–18).

earnings, and employment levels, particularly in the regional construction/transportation industries. Under the truck transport option, the regional output of goods and services would increase by $54,563,048 a year over the 8-year disposal period. Under the rail transport or slurry pipeline options, annual output of goods and services would increase by $64,697,605 and $65,255,331, respectively. The new spending would also increase labor earnings and employment. Under the truck option, earnings and employment would rise by $13,418,584 and 391 direct and indirect jobs. The increase in labor earnings and employment would be $15,918,000 and 315 direct and indirect jobs under the rail transport option. Increased regional earnings under the slurry pipeline option would initially rise to $16,055,548 and 335 jobs during the first-year construction phase of the pipeline. Thereafter, earnings and employment would scale down to $15,097,007 and 315 jobs. The annual expenditures during ground water remediation and site monitoring of $933,000 would not produce significant impacts on the output of goods and services, labor earnings, or employment levels in the two-county socioeconomic region of influence.

The potential shorter-term impacts under the Klondike Flats off-site disposal alternative would include increased demand for temporary housing (discussed in Section 4.1.14) and transportation-related inconveniences to motorists (discussed in Section 4.2.16). The extent of these shorter-term impacts would depend on levels of tourism-recreation activities and the mode of transportation used in the remediation process. Longer-term beneficial impacts from remediation at the Moab site would relate to greater opportunities for economic development in the Moab area and greater diversification of the tax base (discussed in Section 4.1.14).

4.2.15 Human Health

This section addresses potential impacts to human health. These impacts are worker deaths that could occur as a result of industrial accidents and worker or public latent cancer fatalities that could occur as a result of exposure to radiation from activities at the Moab and Klondike Flats sites, at vicinity properties, or during transportation of materials.

4.2.15.1 Construction and Operations Impacts at the Moab Site and Klondike Flats Site

Under the Klondike Flats off-site disposal alternative, construction activities would occur at the Moab site, vicinity properties, borrow areas, and the Klondike Flats site. Table 4–27 lists the impacts from these activities. For each transportation option under this alternative, less than one fatality would be estimated to occur from construction activities.

Table 4–27. Construction-Related Fatalities Under the Klondike Flats Off-Site Disposal Alternative

Alternative	Construction Fatalities
Truck Option	
Vicinity properties	0.031
Borrow areas	0.042
Moab and Klondike Flats activities	0.31
Total	**0.38**
Rail Option	
Vicinity properties	0.031
Borrow areas	0.037
Moab and Klondike Flats activities	0.32
Total	**0.39**
Slurry Pipeline Option	
Vicinity properties	0.031
Borrow areas	0.042
Moab and Klondike Flats activities	0.36
Total	**0.43**

Workers. Under the Klondike Flats disposal alternative, workers would be exposed to radon gas (an inhalation hazard) and external radiation from the mill tailings at the Moab site, vicinity properties, and the Klondike Flats site. According to results of monitoring data collected during construction of an evaporation pond on the tailings pile, the highest radon level measured on the pile was 0.096 working levels (21 pCi/L). A worker exposed to this level of radon for 2,000 hours per year would have a latent cancer fatality risk of 6.1×10^{-4} per year of exposure. The highest external gamma exposure rate measured on the tailings pile was about 0.60 mR/h. A worker exposed to this level of radiation for 2,000 hours per year would have a latent cancer fatality risk of 6.0×10^{-4} per year of exposure. The total latent cancer fatality risk to the worker on the tailings pile would be 1.2×10^{-3} per year of exposure (Table 4–28), or 6.0×10^{-3} over the 5-year duration of activities at the Moab site. Assuming that the radon and external gamma radiation levels were comparable at Klondike Flats, this would also be the latent fatality risk at Klondike Flats.

At the Moab site, there would be 67 workers. Assuming that they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.081 per year of exposure or 0.40 over the 5-year duration of activities at the Moab site. At the Klondike Flats site, there would be 70 workers. Assuming that they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.085 per year of exposure or 0.42 over the 5-year duration of activities at Klondike Flats.

Impacts to workers as a result of activities at the vicinity properties would be the same as those under the on-site disposal alternative, as would be the lack of impacts from ground water treatment; these impacts are described in Section 4.1.15.2.

Table 4–28. Worker Impacts Under the Klondike Flats Off-Site Disposal Alternative

Worker	Site	Radon Related LCFs[a,b]	External Radiation-Related LCFs[a,b]	Total LCFs[a,b]
Annual				
Individual	Moab	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	Klondike Flats	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	Vicinity properties	2.9×10^{-4}	1.2×10^{-4}	4.1×10^{-4}
Population	Moab	0.041	0.040	0.081
	Klondike Flats	0.043	0.042	0.085
	Vicinity properties	6.7×10^{-3}	2.9×10^{-3}	9.6×10^{-3}
	Total	**0.091**	**0.085**	**0.18**
5-Year Duration of Activities				
Individual	Moab	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	Klondike Flats	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	Vicinity properties	8.7×10^{-4}	3.7×10^{-4}	1.2×10^{-3}
Population	Moab	0.20	0.20	0.40
	Klondike Flats	0.21	0.21	0.42
	Vicinity properties	0.020	8.6×10^{-3}	0.029
	Total	**0.43**	**0.42**	**0.85**

[a] Based on 67 workers at the Moab site, 70 workers at the Klondike Flats site, and 23 workers at vicinity property sites.
[b] LCF = latent cancer fatality

Public. Under the Klondike Flats off-site disposal alternative, nearby residents would be exposed to radon gas released at the Moab site and at Klondike Flats. The average radium-226 content of the tailings, 516 pCi/g, would produce a latent cancer fatality risk for a maximally exposed individual (nearby resident) in Moab of 8.8×10^{-3} over the 5-year duration of activities at the Moab site and 1.8×10^{-5} over the 5-year duration of activities at Klondike Flats. These estimates include radon released from the drying areas at the Moab site. If a slurry pipeline were used to move the tailings to Klondike Flats, the drying areas would not be necessary, and the resulting latent cancer fatality risk for a nearby resident at Moab would be reduced to 6.9×10^{-3} over the 5-year duration of activities at the Moab site.

For the population, over the 5 years of activities at Klondike Flats, the latent cancer fatality risk to the population surrounding Klondike Flats would be 0.011. Over the 5 years of activities at the Moab site, the latent cancer fatality risk to the population surrounding the Moab site would be 1.0. If a slurry pipeline were used to move the tailings to the Klondike Flats site, the drying areas would not be necessary, and the resulting latent cancer fatality risk for the population surrounding the Moab site would be reduced to 0.74 over the 5-year duration of activities at the Moab site.

Nearby residents would also be exposed to radioactive particulates (e.g., radium-226, polonium-210, thorium-230, and uranium) blown off the site from the Moab site and at Klondike Flats. Estimates based on monitoring data collected during 1998 and 1999 from the Monticello, Utah, mill tailings site when uranium mill tailings were being excavated indicate that the latent cancer fatality risk from radioactive particulates would be about 0.1 percent of the risk from radon emissions from the Moab site and Klondike Flats. This is due to the aggressive dust suppression practices that would be used to minimize emissions of radioactive particulates.

4.2.15.2 Construction and Operations Impacts Related to Transportation

Under the Klondike Flats disposal alternative, there would be a total of 330,926 shipments if trucks were used to move the tailings from the Moab site to Klondike Flats (Table 4–29). If rail were used, there would be a total of 68,154 shipments. If a slurry pipeline were used to move the tailings, there would be 64,314 shipments. These shipments would include contaminated material from vicinity properties, uranium mill tailings, and borrow material, which would consist of cover soils, radon and infiltration barrier soils, sand and gravel, riprap, and Moab site reclamation soils.

Table 4–29. Shipments Under the Klondike Flats Off-Site Disposal Alternative

Material	Truck Option		Rail Option		Slurry Pipeline Option	
	Shipments	**Mode**	**Shipments**	**Mode**	**Shipments**	**Mode**
Vicinity property material	2,940	Truck	2,940	Truck	2,940	Truck
Borrow material	59,186	Truck	59,186	Truck	59,186	Truck
Uranium mill tailings	268,800	Truck	3,840 2,188	Rail[a] Truck	2,188	Truck
Total	**330,926**		**68,154**		**64,314**	

[a] Each rail shipment would consist of 30 railcars of uranium mill tailings.

The transportation impacts of shipping contaminated materials from vicinity properties, mill tailings, and borrow material would be from two sources: radiological impacts and nonradiological impacts. Radiological impacts would be from incident-free transportation and from transportation accidents that released contaminated material. There would be no radiological impacts from moving borrow material because it is not contaminated. Nonradiological impacts would be from engine pollutants (emissions from the truck or train moving the contaminated materials from vicinity properties, mill tailings, and the borrow material) and from traffic fatalities. The total transportation impacts would be the sum of the radiological and nonradiological impacts. Additional details on these analyses are provided in Appendix H.

Table 4–30 lists the transportation impacts under the Klondike Flats off-site disposal alternative. For this alternative, there would less than one fatality. In comparison, about 40,000 traffic fatalities occur annually in the United States (U.S. Census Bureau 2000) and about 335 occur annually in Utah (DOT 2004).

Workers. For truck shipments of mill tailings from the Moab site to Klondike Flats, the maximally exposed transportation worker would be the truck driver. This person was assumed to drive the truck containing mill tailings for 1,000 hours per year. For the other 1,000 hours per year, the truck would be empty. This driver would receive a radiation dose of 220 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-4}.

Table 4–30. Transportation Impacts Under the Klondike Flats Off-Site Disposal Alternative

Alternative	Radiological			Nonradiological		Total Fatalities
	Incident-Free		Accident Risk LCFs	Pollution Health Effects Fatalities	Traffic Fatalities	
	Public LCFs	Worker LCFs				
Truck Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	9.3×10^{-4}	0.081	0.082
Mill tailings	1.6×10^{-3}	0.010	2.0×10^{-9}	9.6×10^{-5}	0.26	0.27
Total	$\mathbf{1.6 \times 10^{-3}}$	**0.010**	$\mathbf{8.9 \times 10^{-9}}$	$\mathbf{1.4 \times 10^{-3}}$	**0.34**	**0.35**
Rail Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	9.3×10^{-4}	0.081	0.082
Mill tailings	1.6×10^{-5}	1.6×10^{-3}	3.5×10^{-9}	6.1×10^{-5}	0.15	0.15
Total	$\mathbf{4.3 \times 10^{-5}}$	$\mathbf{1.6 \times 10^{-3}}$	$\mathbf{1.0 \times 10^{-8}}$	$\mathbf{1.4 \times 10^{-3}}$	**0.23**	**0.23**
Slurry Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	9.3×10^{-4}	0.081	0.082
Mill tailings	1.3×10^{-5}	8.4×10^{-5}	1.6×10^{-11}	7.8×10^{-7}	2.1×10^{-3}	2.2×10^{-3}
Total	$\mathbf{4.0 \times 10^{-5}}$	$\mathbf{1.2 \times 10^{-4}}$	$\mathbf{6.9 \times 10^{-9}}$	$\mathbf{1.3 \times 10^{-3}}$	**0.084**	**0.086**

For rail shipments of mill tailings from the Moab site to Klondike Flats, the maximally exposed transportation worker would be an individual who inspects the loading of the rail cars. This person would receive a radiation dose of 440 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 2.2×10^{-4}.

Public. For truck shipments of mill tailings from the Moab site to Klondike Flats, the maximally exposed member of the public would be a resident who lived along the road on which the tailings were shipped. This person would receive a radiation dose of 1.0 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 6.3×10^{-7}.

For rail shipments of mill tailings from the Moab site to Klondike Flats, the maximally exposed member of the public would be a resident who lived along the rail line on which the tailings were shipped. This person would receive a radiation dose of 0.53 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 3.2×10^{-7}.

Accidents. If trucks were used to transport the mill tailings from the Moab site to Klondike Flats, the maximally exposed individual would receive a radiation dose of 0.16 mrem or 1.6×10^{-4} rem from the maximum dose reasonably foreseeable for a transportation accident involving a shipment of mill tailings. This is equivalent to a probability of a latent cancer fatality of about 9.6×10^{-8}. The probability of this accident is about 0.06 per year.

If this accident occurred near Moab, the population would receive a collective radiation dose of 1.8×10^{-3} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-6}. If this accident occurred in a rural area, the population would receive a collective radiation dose of 2.9×10^{-6} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.7×10^{-9}.

If rail were used to transport the mill tailings from the Moab site to Klondike Flats, the maximally exposed individual would receive a radiation dose of 1.4 mrem or 1.4×10^{-3} rem from the maximum dose reasonably foreseeable for a transportation accident involving a shipment of mill tailings. This is equivalent to a probability of a latent cancer fatality of about 8.5×10^{-7}. The probability of this accident is about 0.3 per year.

If this accident occurred near Moab, the population would receive a collective radiation dose of 0.017 person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.0×10^{-5}. If this accident occurred in a rural area, the population would receive a collective radiation dose of 2.7×10^{-5} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.6×10^{-8}.

4.2.15.3 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would include checking water quality and installing a long-term ground water remediation system at the Moab site, and conducting periodic maintenance and inspections of the Klondike Flats site (checking for erosion, damaged fencing, etc.). None of these activities would be expected to breach the cap over the tailings; installation of the Moab site ground water system would be done in clean areas after remediation was complete. Data from another UMTRCA site indicate that the Klondike Flats off-site disposal alternative would be effective in isolating the contaminants in the tailings from individuals conducting activities on the site. DOE (2001) concluded that both radon and gamma levels associated with the capped-in-place tailings pile at the Shiprock site in New Mexico were indistinguishable from naturally occurring radiation levels. Therefore, the latent cancer fatality risk to workers conducting monitoring and maintenance would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

4.2.15.4 Impacts from All Sources

Under the Klondike Flats off-site disposal alternative, less than one fatality would be estimated to occur from construction activities under any of the transportation options. Transportation of contaminated materials from the Moab site to the Klondike Flats site would result in the exposure of workers and the public to very small amounts of radiation; these exposures would not be expected to result in any latent cancer fatalities to any population. Ammonia releases from ground water remediation would be well below threshold concentrations for human health effects.

Based on as-built radon flux measurements from completed uranium mill tailings disposal cells constructed under both Title I (federal UMTRA Project sites) and Title II (private licensees) of UMTRCA, it is anticipated that actual radon flux would be two orders of magnitude less than the 20-pCi/m^2-s EPA protective standard promulgated in 40 CFR 192. However, even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible and that DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 pCi/m^2-s, under EPA's regulations (40 CFR 192).

Based on this emission rate and the dimensions of the disposal cell, the latent cancer fatality risk for a nearby resident would be 1.5×10^{-7} per year of exposure, or 4.4×10^{-6} over the 30-year period following the end of construction and operations. This latent cancer fatality risk is less than the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

For the population near the Klondike Flats site, the latent cancer fatality risk would be 2.8×10^{-3} over the 30-year period following the end of construction and operations.

At the Moab site, radon emissions would fall to background levels because the mill tailings pile would have been relocated. The latent cancer fatality risk would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-3} per year of exposure.

The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the half lives of the radionuclides contained in the uranium mill tailings. In the time frame of 200 to 1,000 years, the major route of exposure of people would be through the inhalation of radon progeny from the disposal cell. There is no surface water pathway at the Klondike Flats site. The uppermost aquifer at the Klondike Flats site is 400 to 500 ft below the surface, and the travel time to the uppermost aquifer is over 25,000 years, so it is unlikely that ground water would contribute large latent cancer fatality risks relative to inhalation of radon progeny. With the disposal cell cover in place and the Klondike Flats site being under perpetual care, it is likely that the latent cancer fatality risk for an inadvertent intruder would also be low.

After the disposal cell cover was installed, the estimated annual latent cancer fatality risk from radon for a nearby Klondike Flats resident would be 1.5×10^{-7}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. Therefore, the annual latent cancer fatality risk for a nearby Klondike Flats resident would be about the same immediately after the cover was installed as it would be 1,000 years after the cover was installed. This assumes that the nearby resident remains at his or her present location. If the resident were to move closer to the disposal cell, the annual latent cancer fatality risk would be similar to the risk at the Moab site, 8.9×10^{-5} per year of exposure.

Based on the 20-pCi/m^2-s radon release rate, for the population within a 50-mile radius of the Klondike Flats site, the annual latent cancer fatality risk was estimated to be 9.3×10^{-5}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. If it is assumed that the population around the Klondike Flats site remains constant over 1,000 years, then the estimated latent cancer fatality risk over the 1,000-year time period would be 0.09.

4.2.16 Traffic

This section summarizes potential impacts to traffic in the area affected by the Klondike Flats disposal alternative. In the following discussions, estimated percent increases in traffic are based on increases over the 2001 AADT for all vehicles or for trucks on segments of US-191 or I-70 published by UDOT (see Table 3–15).

Implementation of this alternative would increase area traffic as a result of construction and operations at the Moab site, remediation of vicinity properties, transport of tailings from the Moab site to the Klondike Flats site, and transport of borrow materials from borrow areas to the Moab site, vicinity properties, and the Klondike Flats site.

There would be initial minor short-term (period of several months) increases in area traffic on US-191 while preparations took place at the Moab site and at the Klondike Flats site. These activities would include bringing heavy equipment such as backhoes, graders, front-end loaders, bulldozers, and trucks to the sites; and constructing secure stockpile areas for various materials to be used during the remedial action (e.g., diesel fuel, water for dust control). In addition, a variety of construction trades would need to access the sites to set up temporary field offices and prepare road access areas. These activities would add to area traffic and could result in minor congestion and inconveniences near the site entrances on US-191.

Construction workers would commute to the Moab site for jobs at the site, at vicinity properties, and at borrow areas. DOE estimates that the average annual number of vehicle trips associated with these workers could increase daily traffic in central Moab by an estimated 380 vehicle trips per day on US-191 (calculated from Table 2–16). Transportation-related workers would also commute to jobs. DOE estimates that the vehicle trips associated with these workers could increase daily traffic on US-191 by 168 vehicle trips per day (truck transportation option) (calculated from Table 2–16). If all workers traveled through central Moab to access their work location, an estimated 548 new vehicle trips per day would result in an estimated 3-percent increase in traffic in central Moab. (The rail and pipeline transportation modes would also result in a 3-percent increase in traffic in downtown Moab from commuters.) The current traffic situation in Moab is reported by UDOT as highly congested, and these additional vehicle trips would exacerbate the current congestion problem. Miscellaneous trips for supplies and meals would also add to traffic congestion. However, this estimate is based on a worst-case analysis that assumes the maximum number of transportation workers (truck option) and that all workers would need to traverse central Moab to access the Moab and Klondike Flats sites. It is more likely that some workers, possibly one-half of the work force, would come from cities north of Moab, such as Green River, Utah, or Grand Junction, Colorado, and that some workers would car-pool. In addition, assuming a double work shift, approximately half of these trips would occur before 7:00 a.m. and just after 4:00 a.m., times of the day when traffic volumes are typically lower. The short-term (estimated 6 months) impact that would be associated with the 250 pipeline construction workers under the pipeline option was not considered a worst-case scenario.

Transporting contaminated vicinity property material and associated backfill material to the Moab site would require up to 48 daily truck trips on local roads and US-191, some or most of which would transit central Moab (Section 2.1.2.2). Assuming the worst-case traffic scenario of a double work shift, transporting all contaminated material from the Moab site to the Klondike Flats site would require an estimated 768 daily tandem truck trips (Table 2–9) on US-191, none of which would transit central Moab. This would increase existing levels of all traffic on US-191 between the Moab site and Klondike Flats by 29 percent, or an estimated 95-percent increase in truck traffic on US-191. Using truck transportation under this alternative would almost double truck use of US-191 from the existing use; however, this increase would be distributed evenly over the 20 hours per day that work would be ongoing under a double-shift work schedule.

Trucks carrying borrow material would originate from borrow sources north and south of the Klondike Flats site. All of these trips would occur on segments of US-191. North of Moab, truck traffic would increase by 116 trucks per day, or a 14-percent increase in truck traffic on US-191 north of the disposal site. A portion of these materials would continue to the Moab site to be used for site restoration. Because the destination of these trucks would be the Klondike Flats site or the Moab site, traffic in central Moab would not be affected. However, an estimated nine truck trips carrying borrow materials from south of Moab would also occur. These trips are not considered further, as their impact would be minor compared to existing traffic levels of 16,045 in central Moab.

In addition to use of US-191, borrow material shipments coming from the Floy Wash borrow area would also need to use I-70. As shown in Table 3–15, the existing AADT on I-70 west of Crescent Junction is 7,040 vehicles of all types. Assuming all cover and Moab site reclamation soils came from Floy Wash, the addition of 116 trips per day would result in a 2-percent increase over current AADT volumes on 1-70. Truck volume on I-70 would increase from 1,126 trucks to 1,246 heavy trucks per day, a 10-percent increase. I-70 in this area is not considered congested by UDOT and does not currently carry large volumes of traffic.

Although there would be sustained increases in the AADT on US-191, project components would include an overpass to access the upgraded disposal site road (Blue Hills Road) and acceleration and deceleration lanes that would alleviate safety concerns related to use of US-191 by recreational and commercial truck traffic. It is anticipated that upgrading US-191 from two to four lanes between SR-313 and the Moab site would be completed prior to the start of this project.

Rail transport would also require the transport of borrow materials as described above (116 truck trips per day related to transport of borrow materials from borrow areas north of Moab, and 9 trips per day related to transport of borrow sources south of Moab). It would also require 2–5 truck trips per day to haul contaminated debris that could not be carried by rail. This additional truck traffic on US-191 would not be noticeable.

Rail transport would require between 8 and 16 daily train trips to carry contaminated materials between the Moab site and Klondike Flats site, which would occur 6 days a week. One to two trains per hour would travel past intersecting county or state roads, which would result in vehicle delays of 2 to 3 minutes at the various railroad crossings. These delays would affect primarily SR-313, Gemini Bridges, Blue Hills Road, and other county roads used for backcountry access. There would be potential safety concerns over motorists waiting at the intersection of Blue Hills Road and US-191 for the railroad crossing to clear. Blue Hills Road provides access to heavily used backcountry areas.

A slurry pipeline would also require limited transport of materials by truck. Transport of oversized materials that could not be transported by pipeline would result in additional minor use of trucks on US-191 (about six trucks per day). In addition, borrow materials would be transported as described under the truck transportation option.

Annual monitoring and maintenance activities at the site would result in no increases in traffic volumes.

4.2.17 Disposal Cell Failure from Natural Phenomena

It is possible that a disposal cell failure could occur at the Klondike Flats site. The possibility of failure at this site would be much lower than at the Moab site because it was selected for analysis, in part, to avoid the more dynamic characteristics of the Moab site (see Chapter 3.0). The Klondike Flats site is not located near a river, does not have historical seismic activity, and is not prone to settling. In addition, this site is located farther away from populated areas or sensitive habitats than the Moab site, which would reduce the potential risks if a disposal cell failure occurred. Therefore, the possibility of a failure occurring and resulting in potential risks at the Klondike Flats site would be much lower than the potential risks of a disposal cell failure at the Moab site. For this reason, a potential failure at this site was not evaluated.

4.2.18 Environmental Justice

The basis for DOE's analysis of environmental justice impacts is described in Section 4.1.18. One census block area with a reported annual household income of less than $18,244 (poverty level for a family of four) is found about 30 miles north of the site. Although this population could be exposed to small doses of radiation as a result of activities under this alternative, there is no evidence that it would be exposed at a level any higher than the general population. Although traffic in central Moab would be an adverse impact, it does not appear that minority or low-income populations would suffer disproportionately.

DOE has identified no high and adverse impacts, and no minority or low-income populations that would be disproportionately affected by the implementation of the Klondike Flats disposal alternative.

4.3 Off-Site Disposal (Crescent Junction Site)

This section discusses the short-term and long-term impacts associated with the second of three off-site disposal alternatives. The Crescent Junction site is located approximately 31 miles north of the Moab site and approximately 13 miles north of the Klondike Flats site. The impacts are based on the proposed actions described in Section 2.2, and the affected environment described in Section 3.3, of this EIS. This alternative may result in the following impacts:

- Impacts at the Moab site
- Impacts at the Crescent Junction site
- Transportation impacts associated with moving tailings from the Moab site to the Crescent Junction site
- Monitoring and maintenance impacts at the Crescent Junction site

The combined impacts that may result from these activities are summarized for each assessment area (e.g., Geology and Soils) at the end of each subsection. For many activities, impacts at the Moab site would not differ significantly from those described in Section 4.2 for Klondike Flats. Likewise, construction and operation impacts at the Crescent Junction site, as well as monitoring and maintenance impacts, would be similar to those addressed for the Klondike Flats site.

Contaminated vicinity property materials would be transported from the Moab site to the Crescent Junction site. Therefore, impacts associated with transporting vicinity property materials are not addressed separately. Impacts associated with borrow areas are addressed collectively in Section 4.5 and are therefore not addressed in this section.

4.3.1 Geology and Soils

Construction and operations impacts to geology and soils at the Moab and Crescent Junction sites, as well as monitoring and maintenance impacts, would be very similar to or the same as those described in Section 4.2.1 for the Klondike Flats off-site disposal alternative. Impacts from all sources would also be qualitatively identical and quantitatively very similar to those described for the Klondike Flats site in Section 4.2.1. The only differences would be the degree of off-site disturbances associated with transportation modes, as seen by comparing Table 4–31 and Table 4–20. The potential for long-term erosion of soils adjacent to the disposal cell exists but would be controlled by construction design enhancements.

Table 4–31. Summary of Short-Term Soil Impacts—Crescent Junction Off-Site Disposal Alternative

Soil Disturbance Location or Source	Area of Soil Disturbance (acres)
Moab site (on site)	439
Crescent Junction (on-site; including transportation disturbances)	
Truck transportation	435
Rail transportation	420
Slurry pipeline transportation	435
Moab to Crescent Junction (off-site; exclusive of on-site)	
Truck transportation	13
Rail transportation	57
Slurry pipeline transportation	164

4.3.2 Air Quality

Construction and operations impacts to air quality at the Moab and Crescent Junction sites, as well as monitoring and maintenance impacts, would be very similar to or the same as those described in Section 4.2.2 for the Klondike Flats off-site disposal alternative. Emissions of criteria air pollutants, including carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}, would occur at the Moab site, Crescent Junction site, vicinity properties, and borrow areas because of the operation of heavy construction equipment and ground water remediation equipment. No criteria air pollutant emission concentrations would exceed NAAQS as a result of construction and operations at the Crescent Junction site. Consequently, the analysis of air quality impacts is not repeated in this section.

4.3.3 Ground Water

Ground water impacts as a result of construction and operations at the Moab site and of monitoring and maintenance at the Crescent Junction site would be comparable to those described in Section 4.2.3.1. Therefore, these concerns are not addressed further in this section.

4.3.3.1 Construction and Operations Impacts at the Crescent Junction Site

No anticipated adverse impacts on regional or local ground water quality would result from a proposed disposal cell in the Crescent Junction area because of the depth (3,000 ft) to the uppermost aquifer. In addition, the Dakota Sandstone Formation is separated from the surface by a very thick section of relatively impermeable Mancos Shale, which forms an aquitard that inhibits ground water migration to deeper ground water. Estimated travel time for any water seeping from the cell to migrate through the Mancos Shale and reach the uppermost aquifer is estimated at over 170,000 years. This estimate is based on a typical hydraulic conductivity value of 1.0×10^{-9} cm/s for marine shale (Freeze and Cherry 1979) and a porosity of 0.06 (Morris and Johnson 1967). This travel time estimate would be verified by site characterization if this site were selected as the off-site alternative. Because there are no sole-source aquifers in the area within reasonable range of impact of the proposed disposal cell, the potential for adverse impacts to ground water would be further limited.

4.3.3.2 Construction and Operations Impacts Related to Transportation

Potential impacts to ground water associated with transportation would be limited to the slurry pipeline. There is a possibility that a line could break or leak. However, because of engineering controls for the pipeline (see Section 2.2.4.3), little potential exists for a spill to reach ground water at depths ranging from 100 to 300 ft (the closest depths to ground water along the entire route).

4.3.3.3 Impacts from All Sources

No impacts to ground water are expected at the Crescent Junction site. Ground water impacts that would occur at the Moab site from off-site disposal are discussed in Section 4.2.3.

4.3.4 Surface Water

Impacts to surface water from construction and operations at the Moab site would be similar to those described in Section 4.2.4. At the Crescent Junction site, there would be no impacts to surface water as a result of construction and operations or monitoring and maintenance. Approximately 100 ft of buried pipeline would be placed within ephemeral stream crossings under this alternative. Transportation-related impacts would be limited to the potential for short-term surface disturbance as a result of construction through ephemeral washes and to spills that could occur. However, the potential for short-term adverse effects would be limited with well-planned routing and site control measures as described in Chapter 2.0.

4.3.5 Floodplains/Wetlands

Construction and operations impacts that would occur to floodplains and wetlands at the Moab site from off-site disposal would be very similar to those described in Section 4.2.5.

4.3.5.1 Construction and Operations Impacts at the Crescent Junction Site

Because the Crescent Junction site would be located outside of the flood-prone areas of Crescent Wash and Crooked Wash, the likelihood of the proposed disposal cell location being affected by floodwaters is very low. The potential exists for construction of the disposal cell to increase sedimentation during a storm in the Crescent Wash drainage. However, site storm water controls would minimize the potential for any short-term impacts to Crescent Wash. No long-term impacts would be expected because no modifications would remain in the drainage following completion of remediation. There would be no impacts to wetlands because none are known to exist in the area.

4.3.5.2 Construction and Operations Impacts Related to Transportation

No wetland areas are known to exist along the proposed transportation routes, but the area would be investigated prior to construction. Potential impacts to ephemeral washes and any associated wetlands would be short term as a result of construction or upgrading roads, rail spurs, or the pipeline. Affected areas would be restored, avoiding any adverse long-term impact.

4.3.5.3 Impacts from All Sources

No long-term effects would be expected under the Crescent Junction off-site disposal alternative. Short-term impacts to Crescent Wash and wetlands, if they exist, would occur along proposed transportation routes.

4.3.6 Aquatic Ecology

Under this alternative, the short-term physical impacts to aquatic biota and habitats, including federally listed species, at the Moab site associated with construction and operations from off-site disposal would be very similar to those described in Section 4.2.6. Chemical and radiological impacts to aquatic resources would also be similar to those described in Section 4.2.6. Because there are no perennial surface waters at the Crescent Junction site, no adverse impacts to aquatic ecology would occur as a result of construction and operations, monitoring and maintenance activities, or transportation at that site. Therefore, these issues are not discussed further.

4.3.7 Terrestrial Ecology

Under this alternative, the physical, chemical, and radiological impacts to terrestrial species and habitats associated with construction and operations at the Moab site would be very similar to those described for on-site disposal (Section 4.1). Appendix A1, "Biological Assessment," presents a detailed discussion of potential effects on federally listed species at the Crescent Junction site.

4.3.7.1 Construction and Operations Impacts at the Crescent Junction Site

Construction of a disposal cell and ancillary support facilities would disturb up to 435 acres at the Crescent Junction site. The impacts of physical disturbance would include the short-term loss of cover, foraging, and breeding habitat in construction areas. In the long term, the area occupied by the disposal cell would result in a permanent loss of habitat. Species with small home ranges would be displaced. However, species with larger home ranges would not be expected to be adversely affected.

The black-footed ferret is the only federally listed species that could potentially be affected by habitat disturbance resulting from construction of a disposal cell. The white-tailed prairie dog, upon which the black-footed ferret depends, is the only species currently in review for federal listing that could be so affected. All black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne counties in 1999 or their offspring could occur on or near the Crescent Junction disposal site, although UDWR (2003) reported an unconfirmed sighting in the area in 1989. Consequently, no impacts from construction to the black-footed ferret would be anticipated.

Numerous white-tailed prairie dog colonies ranging in size from 10 acres to 2,445 acres occur around the Crescent Junction area (Seglund 2004). It is unknown to what extent individual colonies or a combination of colonies could support black-footed ferrets. Prior to development of the Crescent Junction disposal site, the area would be surveyed and the potential effects to white-tailed prairie dogs evaluated. In addition, the potential of such colonies to support black-footed ferrets would also be evaluated simultaneously.

Noise due to construction and operations could have an adverse effect on terrestrial wildlife. At the Crescent Junction site, noise would be generated by construction equipment and material transfer operations. It is estimated that the maximum noise levels that would be generated when all equipment was operating would be approximately 95 dBA measured at 49 ft. This noise level would attenuate over a distance of approximately 6 miles until it reached the quiet desert background level of approximately 30 dBA.

Noise can affect terrestrial organisms by causing physiological changes or behavioral modifications, including nest abandonment. It can also disrupt communication and defense systems. Any of the species that may be present at the site could be affected by the noise associated with construction and operations. Some of these, such as burrowing owls and prairie dogs, are frequently found near human activities and may thus be more likely to habituate to noise above background levels.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. The bald eagle is the only federally listed species in the vicinity of the Crescent Junction site that could be affected by noise from site operations. However, it is not known to nest or night roost in the area, nor is it commonly seen in the area, and it would therefore be unlikely to be affected.

Other effects of human presence, including night lighting, also would reduce the overall habitat value of the area. As with noise, some species become habituated to human presence, but others, such as deer or pronghorn antelope, could avoid the site during human activities. The site is surrounded by many square miles of similar habitat. Therefore, individuals that avoided the vicinity of construction activities would not be forced into less desirable habitat.

The effects of noise, supplemental lighting, and human presence could be greater at night than during the day. Therefore, double-shift operations would likely have a greater impact than single-shift operations. The effects of noise, supplemental lighting, and human presence could be mitigated by limiting the amount of light off the site, minimizing activities at the periphery of the site, and limiting especially loud activities to daylight hours and to seasons when the effects on biota would be reduced. There would not likely be chemical impacts at the site. Accidental spills of diesel, oil, or other materials would be quickly controlled and mitigated.

Other species of interest, if present, that could be affected by construction of a disposal cell and the associated types of disturbance discussed above, include the burrowing owl, Swainson's hawk, ferruginous hawk, and peregrine falcon. Mexican spotted owls were historically reported to occupy the Book Cliffs to the north of the site but have not been observed in the vicinity recently (USF&WS 1995).

Development of the site for a disposal cell would reduce the amount of habitat available for white-tailed prairie dogs but likely would not affect the overall local population. In the short term, avian species (e.g., raptors) could be affected by loss of foraging habitat. Birds that may nest in the area (e.g., burrowing owl and ferruginous hawk) could be displaced during construction activities. However, it is unlikely that population abundance and distribution of these species would be adversely affected in the long term.

Short-term impacts of physical disturbance could be avoided or minimized in several ways. The most important action would be to conduct site-specific investigations prior to site development activities to determine the presence of any species of concern. Additional actions would include minimizing site disturbance to the extent practical, revegetating disturbed lands and the cover cap once it was completed, and scheduling ground-clearing activities during periods that would not disturb nesting migratory birds.

There would not likely be chemical or radiological impacts at the Crescent Junction site. Accidental spills of diesel, oil, or other materials could be quickly controlled and mitigated.

4.3.7.2 Impacts of Transportation

The effects to terrestrial species and habitats of transporting the tailings to the Crescent Junction site would depend on the transportation option selected. In the short term, truck transport could increase collision mortality and noise, rail transport could increase noise, and a slurry pipeline would disturb more habitat in the pipeline corridor.

Much of the transport of borrow materials would occur on lower-speed access roads rather than US-191. This could result in a lower rate of wildlife-vehicle collisions and less noise due to truck transport of borrow materials compared to transporting the materials from more distant borrow sites.

Truck Transportation Option

There is the potential for greater mortality for species, including the bighorn sheep, that frequent the US-191 corridor. Other species potentially affected include mule deer and pronghorn antelope. Small mammals, reptiles, and possibly birds would also suffer increased highway mortality rates. However, it is unlikely that the regional populations of any wildlife species, with the possible exception of the bighorn sheep, would be affected by this increased traffic mortality rate.

The bald eagle is the only federally listed species that could incur an increase in traffic-related mortality. The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. Bald eagles could be found temporarily and infrequently using such areas when there are opportunities to feed on carrion, such as in big-game wintering areas or in prairie dog colonies. Therefore, it is possible that if traffic-related wildlife mortality increased because of the project, an increased number of eagles could be hit on highways. However, without data on this relationship, it is reasonable to assume that the number of eagles hit on highways would be proportional to the number of carrion available. The increase in the number of traffic-related wildlife mortalities is expected to be small. Consequently, the potential increase in associated eagle deaths is also expected to be small.

The increased truck traffic along US-191 resulting from transport of tailings from the Moab site to the Crescent Junction site would likely increase ambient noise levels by approximately 5 dB (measured at 49 ft). However, no adverse effect to terrestrial wildlife is anticipated.

The primary federally listed species that could be affected by this increased traffic noise would be the Mexican spotted owl. Data provided by UDWR (2003) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. However, habitat models (BLM 2003) indicate that potential habitat areas may exist in the canyons near US-191 over the first 7 miles north from the Moab tailings pile. Nonetheless, these models are primarily based on physical and topographic features and do not consider vegetation requirements. Mexican spotted owls nest, roost, and forage in an array of different community types, but mixed-conifer forests dominated by Douglas fir and/or white fir are most common (USF&WS 1995). However, they may also nest, but less frequently, in arid, rocky, mostly unvegetated canyons (Romin 2004). Although there are no forested areas in the vicinity of US-191 north of Moab, there are arid canyons that largely or altogether lack forest-type vegetation. Thus, it is unlikely but possible that spotted owls occur in the canyons near US-191 over the first 7 miles north of the Moab site. If present, the species could be disturbed by noise from increased truck traffic. The area around this section of transportation corridor is a popular recreation area, with heavy use by off-highway vehicles and mountain bikes. Although the increase in truck traffic noise could be detectable up to several miles from the highway, the existing off-road vehicle noise and associated human presence would likely have a greater and more direct impact on the owls.

The potential for impacts to terrestrial wildlife from truck transportation of tailings would be greater in the evening or at night than during the day. Therefore, double-shift operations would probably have a greater potential for adverse impacts than single-shift operations. In either case, the impacts would be of relatively short duration and would cease once the transfer of materials to the disposal cell was completed.

Rail Transportation Option

Rail transportation of tailings from the Moab site to the Crescent Junction site would result in less frequent but potentially higher intermittent noise and ground vibration levels compared to the truck transportation option. Some wildlife species could be sensitive to noise from the rail system. However, because of the degree of off-road recreational activity in the area, as well as nearly 3,000 cars and trucks per day on US-191, most of the wildlife in the area would likely be somewhat habituated to human presence and noise. The potential collision-mortality rate would be lower using rail transport than truck transport.

Slurry Pipeline Option

Use of a slurry pipeline system to transport tailings material from the Moab site to the Crescent Junction site would result in a greater amount of short-term surface disturbance compared to the other two transportation modes.

Because much of the proposed pipeline route would be within, parallel to, or adjacent to either US-191 or the Williams Gas pipeline rights-of-way, construction impacts would be expected to be minimal. However, some previously undisturbed habitat would be removed in the short term. Installation of the pipeline system could disturb species such as the Mexican spotted owl, white-tailed prairie dog, black-footed ferret, and species of ground-nesting migratory birds. Such impacts could be managed by performing site-specific investigations prior to pipeline construction to identify populations of these species of concern, adjusting the pipeline location if needed, and constructing the pipeline during periods of the year that would not disrupt nesting. Operation of the pipeline would not be expected to have any adverse effects on wildlife or habitat under the Crescent Junction off-site disposal alternative.

4.3.7.3 Monitoring and Maintenance Impacts

Routine post-closure monitoring and maintenance of a disposal cell at the Crescent Junction site would not be expected to affect terrestrial species or habitats. If major corrective actions were needed, some of the recovering vegetation on and around the disposal site could be disturbed.

4.3.7.4 Impacts from All Sources

Overall impacts to terrestrial ecological resources under the Crescent Junction off-site disposal alternative would include approximately 50 acres of tamarisk habitat lost at the Moab site (the rest of the site has a habitat value of zero), a maximum of approximately 690 acres of desert habitat at the borrow sites, 420 to 435 acres for construction of the disposal cell, and varying additional acreage depending on the mode of transportation.

Total maximum habitat disturbance for truck or rail transportation options from all activities (Moab site, borrow areas, transportation, and Crescent Junction site) would be approximately 1,175–1,235 acres. If the slurry pipeline option were selected, 164 acres of habitat could be disturbed for the pipeline corridor and 11 for support roads, bringing the total maximum habitat disturbance from all activities to approximately 1,345 acres.

Additional habitat would be lost at the commercial quarry sites for sand, gravel, and riprap. There would be a slight decrease in habitat value near US-191 if the truck transport option were selected because of the increased truck traffic required to haul tailings materials, and there would be a slight increase in traffic-related wildlife mortalities. Rail transport of tailings materials would slightly increase average noise levels along the rail route. Impacts of borrow material haulage would be less than under the on-site disposal alternative because the cover materials would be available near the disposal cell site (all other materials would require longer-distance transport), and haulage of these materials at highway speeds on US-191 would not be required.

4.3.8 Land Use

The land use impacts at the Moab site under the Crescent Junction off-site disposal alternative would be the same as those described in Section 4.2.8.

4.3.8.1 Construction and Operations Impacts at the Crescent Junction Site

Approximately 420 to 435 acres needed in the long term for the cell construction area would be withdrawn from BLM administration and transferred to DOE in perpetuity. All surface and subsurface land uses would be vested with DOE. These lands would be removed from the Crescent Canyon grazing allotment (1.9-percent reduction). Oil and gas leases would be terminated. Affected permittees and lessees would be compensated for lost grazing and oil and gas rights. The disposal cell would also result in long-term loss of all surface uses and leasing and mineral extraction in perpetuity on the withdrawn acreage and would result in a long-term loss of revenue for BLM for any surface or subsurface permits or leases on the site.

4.3.8.2 Construction and Operations Impacts Related to Transportation

The three options for transportation to the Crescent Junction site would likely result in restricted use of lands occupied by transportation infrastructure in the short term. For the rail haul option, approximately 57 acres would be temporarily dedicated to a new rail spur and a transfer station, which would be removed and reclaimed once tailings transport was completed. The slurry pipeline would be constructed predominantly in existing rights-of-way. Impacts to lands required for the transfer station, the slurry pipeline receiving facility, and the slurry pipeline would also be short term; these lands would be returned to their previous use once transportation of tailings was completed. Long-term land use (up to 13 acres) would be required for a permanent access road constructed from CR-223 to the disposal site under the truck transportation option.

4.3.8.3 Monitoring and Maintenance Impacts

The Crescent Junction site would be transferred to DOE, so there would be no additional impacts from monitoring and maintenance at the site. If monitoring locations were required outside DOE's property, lands required for wells or other monitoring equipment and the associated access would be negotiated and maintained.

4.3.8.4 Impacts from All Sources

Land use impacts at the Moab site would be similar to those described in Section 4.2.8. In addition, long-term land use impacts would occur at the Crescent Junction site for the cell and for the permanent access road to the site. The land use impacts associated with the rail spur, the transfer station required for the rail haul, the slurry receiving facility, and the slurry pipeline itself would be short term because these transportation modes and associated infrastructure would be reclaimed and returned to BLM for prior designated land use. There would be no impacts for borrow materials procured from commercial facilities. Of the total potential land use disturbance at the Crescent Junction site, approximately 420–435 acres for cell construction and up to 13 acres for dedicated access roads would remain under DOE ownership in perpetuity. DOE is deferring decisions regarding future uses and ownership of the 439-acre Moab site pending a determination of the success of remediation activities.

4.3.9 Cultural Resources

This section addresses the potential for the disturbance of known cultural resources or the discovery of unknown resources under the Crescent Junction off-site disposal alternative.

4.3.9.1 Construction and Operations at the Moab Site

Construction and operations impacts at the Moab site would be the same as those described in Section 4.1.9.1.

4.3.9.2 Construction and Operations Impacts at the Crescent Junction Site

On the basis of current estimates in Chapter 3.0, one to two cultural sites eligible for inclusion in the National Register of Historic Places could be adversely affected by construction and operations at the Crescent Junction site. The Class III cultural resource survey that DOE would conduct at the Crescent Junction site would indicate the precise number and types of cultural sites present. Along with the Class III survey, DOE would conduct a site-specific study to identify potential traditional cultural properties that may exist on the site (there is a low to medium likelihood that they would occur). DOE, BLM, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures through the Section 106 consultation process (see Section 3.1.13.3). Mitigation measures might include (1) avoiding the cultural resource sites, (2) monitoring the cultural resource during surface-disturbing activities, (3) excavating and recording cultural resource data before construction activities began, or (4) moving the cultural resource objects from areas of disturbance to nearby undisturbed areas.

Cultural resources located near areas of disturbance could be adversely affected indirectly (through illicit collection, vandalism, or inadvertent destruction) as a result of increased human activity in the area. DOE would require site workers to receive training on the need for cultural resource protection and the legal consequences of disturbing cultural resources.

4.3.9.3 Construction and Operations Impacts Related to Transportation

Because of the expected low density of cultural sites, construction of the infrastructure needed for the truck and rail alternatives would not be expected to adversely affect cultural resources at or near the Crescent Junction site. One cultural site—the historic US-160 that parallels US-191—could be adversely affected by construction of a highway overpass and acceleration lane at the Moab site under the truck option.

A total of 45 cultural sites eligible for inclusion in the National Register of Historic Places are known to exist within 0.5 mile of the proposed slurry pipeline route to the Crescent Junction site. Of these, 11 to 25 could be adversely affected during pipeline construction. The potential for traditional cultural properties to occur along the pipeline route is low to high. If these properties were located along the route, they most likely would be adversely affected as well. DOE, BLM, UDOT, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures for these sites through the Section 106 consultation process.

In addition to these direct impacts, cultural resources located near the pipeline could be adversely affected indirectly (through illicit collection, vandalism, or inadvertent destruction) as a result of increased human activity in the area.

4.3.9.4 Monitoring and Maintenance Impacts

Monitoring and maintenance at the Crescent Junction site would have no effect on cultural resources.

4.3.9.5 Impacts from All Sources

Table 4–32 lists the total number of cultural sites eligible for inclusion in the National Register of Historic Places that could be adversely affected under each of the Crescent Junction transportation options.

Table 4–32. Number of Cultural Sites That Could Be Adversely Affected Under the Three Transportation Options

Location/Activity	Transportation Mode		
	Truck	**Rail**	**Slurry Pipeline**
Moab site (construction and operations)	0–2	0–2	0–2
Moab site (highway improvements)	1	0	0
Crescent Junction disposal cell area (including cover soil borrow area)	1–2	1–2	1–2
Radon barrier borrow area	3–7	3–7	3–7
Haul road for truck transport at Crescent Junction site	0	N/A	0
Rail infrastructure at Crescent Junction site	N/A	0	N/A
Pipeline construction	N/A	N/A	11–25[a]
Total	**5–12**	**4–11**	**15–36[a]**

[a] Numbers do not include potential traditional cultural properties that have not yet been identified along the pipeline route; the likelihood of their occurrence is low to high.

4.3.10 Noise and Vibration

This section addresses the impacts of noise and ground vibration primarily to human receptors. Where appropriate, impacts to wildlife and cultural resources are also identified. Unless otherwise indicated, all noise and vibration impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.3.10.1 Construction and Operations Impacts at the Moab Site

Noise from the Moab site under the Crescent Junction off-site disposal alternative would come from construction activities and removal of the tailings pile. The largest sources of noise on the site would be heavy earth-moving equipment. The noise generated from these activities would not differ significantly from the noise generated at the Moab site under the on-site disposal alternative. Section 4.1.10 describes the noise associated with construction and earth-moving activities. A description of the noise generated by a conveyor system for the train transportation option is presented in Section 4.2.10.1.

Ground vibration generated by heavy equipment at the Moab site is discussed in Section 4.1.10. No appreciable differences would be expected in ground-level vibration between the on-site disposal alternative and the Crescent Junction off-site disposal alternative.

4.3.10.2 Construction and Operations Impacts at the Crescent Junction Site

Noise at the Crescent Junction site from the disposal of tailings would come from construction activities and movement of the tailings. The type of noise generated from these activities and the region of influence around the site are described in Section 4.2.10.2 for the Klondike Flats site. No appreciable differences would be expected in the source or levels of noise. However, the receptors around Crescent Junction would be different from those around the Klondike Flats site. A gas station and several (one to five) residents are located approximately 2,620 ft south of the Crescent Junction site. These receptors are beyond the estimated 1,480-ft region of influence that would exceed the 65-dBA residential standard for the city of Moab (Moab City Ordinance 17.74.080, "Noise Levels").

Ground vibration generated from construction and operations at the Crescent Junction site would be the same as those discussed in Section 4.2.10.2. There are no receptors at the Crescent Junction site within the 820 ft estimated for ground vibration to attenuate to background levels.

4.3.10.3 Construction and Operations Impacts Related to Transportation

Noise from transportation of material from the Moab site to the Crescent Junction site would originate from truck traffic, rail traffic, or construction of a slurry pipeline. A description of the noise generated from these activities and the region of influence around the transportation routes is included in Section 4.2.10.3. No appreciable differences would be expected in the source or levels of noise. However, the receptors around Crescent Junction would be different from those around the Klondike Flats site. For the truck haul alternative, noise levels at the gas station and residences could exceed the 65-dBA residential standard for the city of Moab (Moab City Ordinance 17.74.080, "Noise Levels"). The exact location of these buildings relative to the transportation route is not known. The region of influence around the transportation route expected to exceed 65 dBA is 430 ft. The increase in noise caused by truck-hauling activity would be estimated to be 4 dBA (1-hour L_{eq}). The actual increase could be less, depending on truck speed on the highway overpass.

Construction of a slurry pipeline would likely result in ground vibration above background levels within Arches National Park. The estimated maximum level for ground vibration produced during construction of a slurry pipeline would be 95 dBV. This level would result in ground vibration above background levels 820 ft from the source and levels above human perception within 330 ft of the source. Some cultural sites containing rock structures and the historic rock bridge at Arches National Park would be within 2,620 ft of the pipeline, but ground vibration levels would not reach levels (estimated at 92 to 100 dBV) that would damage these structures.

4.3.10.4 Monitoring and Maintenance Impacts

Monitoring and maintenance of the Crescent Junction site would not be expected to result in significant generation of noise. Any noise generated by these activities would attenuate to near background levels before leaving the site boundary.

4.3.10.5 Impacts from All Sources

Noise generated under the Crescent Junction off-site disposal alternative would not exceed the Moab residential noise standard of 65 dBA at any receptor locations. The receptors with the most potential to notice any increase in noise generated by this alternative include the resident located on the eastern boundary of the site, visitors at Arches National Park, and residents near the gas station at Crescent Junction. If two 10-hour shifts were used instead of a single 12-hour shift, the noise generated would not change substantially, but there could be a higher potential for annoyance from late-night and early-morning activities.

4.3.11 Visual Resources

This section describes the impacts to those physical features of the landscape that impart scenic value in the region affected by this alternative. The impacts would be imposed on viewers who live in, work in, or visit an area and can see ongoing human activities or the results of those activities. Construction and operations impacts to visual resources at the Moab site would be the same as those described in Section 4.2.11.1. No impacts to visual resources would occur from monitoring and maintenance activities under this alternative. Therefore, these activities are not addressed further.

4.3.11.1 Construction and Operations at the Crescent Junction Site

Construction and operations at the Crescent Junction site would have moderate adverse effects on visual resources, primarily because construction activities and the completed disposal cell would be viewed by a large number of travelers on I-70. DOE selected five key observation points from which to assess visual impacts: (1) western Thompson Springs residences, (2) Crescent Junction residences, (3) I-70 westbound, (4) I-70 eastbound, and (5) I-70 scenic overlook. Figure 4–13 shows DOE's visibility analysis results for a proposed disposal cell at the Crescent Junction site. The darkened areas indicate locations from which a disposal cell could potentially be viewed. The visibility analysis used to create this map is based on elevation and topography. It does not take into account the potential obstruction of views from cultural modifications or vegetation or the effects of distance on visibility. Without visual aids, such as binoculars, most people would not be able to recognize a disposal cell at distances greater than 5 to 10 miles.

The visibility analysis results indicate that residents of Thompson Springs and Crescent Junction, travelers on I-70, and visitors to the I-70 scenic overlook would be able to view the Crescent Junction disposal cell. Given the distance from the disposal cell and viewing angle, residents in western Thompson Springs would not likely be able to view construction activities during the construction period. They would, however, likely notice dust during daylight hours and light during dawn and dusk (and at nighttime under a double-shift work scenario). Neither dust nor light would be visible after construction was completed, as no dust-producing activities would occur, and no lighting would remain at the site. Residents would not be able to see much of the completed disposal cell. The cell would appear as a thin, grayish-beige sliver of earth for 3 to 5 years after completion; contrasts with the surrounding buff-colored landscape would be weak. After the cell was revegetated, it would not be noticeable.

Views of construction activities and the completed disposal cell from residences (four mobile homes, two of which are unoccupied, and one house) in Crescent Junction would be obstructed primarily by the railroad grade located between the homes and the cell and secondarily by the foliage of cottonwood and Siberian elm trees. Like the residents in Thompson Springs, residents of the Crescent Junction homes would likely see dust during daylight hours and light during dawn and dusk (and at nighttime under a double-shift work scenario). These visual impacts would not occur after disposal cell construction was completed.

Travelers would have a clear view of the completed disposal cell from both the westbound and eastbound lanes of I-70. Viewing times from both lanes would be approximately 3 minutes for the driver and 3.5 minutes for passengers. Because of the 1-mile distance to the disposal cell and the viewing angle from the freeway, travelers may or may not notice construction activities. The disposal cell itself would create a weak to moderate contrast with the surrounding landscape. Relative to the steep, dissected cliffs of the 1,000-ft-high Book Cliffs, the 30-ft-high disposal cell would appear as a light-gray, slender, linear form (see Figure 4–14). The cell could be camouflaged somewhat by the linear railroad grade located between the observers and the cell. After 3 to 5 years, shrubby vegetation on the light-gray side slopes would camouflage the color and linearity of the cell even more, lessening the potential visual contrast (Figure 4–15).

For visitors at the I-70 scenic overlook, the completed disposal cell would create a moderate to strong contrast with the surrounding landscape. The higher viewing angle from this location would allow observers to view the top and side slopes of the cell. Viewing time would be approximately 5 to 10 minutes. Before the cell was revegetated, its simple, barren, geometric form and relatively bright surface would contrast moderately to strongly with the more complex, vertical form of the Book Cliffs and the adjacent, vegetated desert plain (Figure 4–16). After vegetation was established, the simple, rectangular form would be camouflaged somewhat by shrubs and would create a weak to moderate contrast with the adjacent desert plain (Figure 4–17).

From all but the I-70 scenic overlook key observation point, DOE's proposed action at the Crescent Junction site would be compatible with BLM's Class III visual resource objectives for this area, as the Class III designation allows an activity to attract, but not dominate, the attention of casual observers (BLM 2003). Class III objectives would be met from the I-70 scenic overlook after vegetation was established on the cell.

4.3.11.2 Construction and Operations Impacts Related to Transportation

Truck Haul

Construction of a 2.5-mile access road from Crescent Junction to the proposed disposal cell site under the truck haul option would have negligible impacts to visual resources. From all key observation points, the linear feature would contrast weakly with the natural surroundings and existing linear features (US-191, CR-175, railroad grade, I-70) in the area. Most travelers would not notice the road. Travelers at the I-70 scenic overlook and local residents would likely notice the haul truck traffic on the access road. DOE estimates that, on average, approximately 28 trucks per hour would use US-191 and the access road to transport tailings, vicinity property, and borrow materials during the 3 to 5 years of operations. Given the proximity to I-70 traffic and traffic associated with the Crescent Junction store and gas station, the adverse visual impact from the additional movement and dust would be negligible to moderate. Overall, this transportation option would be compatible with BLM's Class III visual resource objectives.

Rail Haul

The newly constructed railroad spur would not be visible from any of the key observation points, with the exception of the I-70 scenic overlook. This feature by itself would not draw the attention of most observers, as it is a feature commonly found along highways. Because of distance and viewing angles, the train/truck transfer station constructed on the Crescent Junction site might be noticed but would not dominate the views from any of the key observation points. Travelers at the I-70 scenic overlook and local residents would likely notice the haul truck traffic between the transfer station and disposal cell. Potentially, approximately 29 trucks per hour could be transporting tailings and borrow materials on the access road during the 3 to 5 years of disposal cell construction at the Crescent Junction site. Given the proximity to I-70 traffic and traffic associated with the Crescent Junction store and gas station, the adverse visual impact from the additional movement and dust would be negligible to moderate. Once the disposal cell was completed, haul truck traffic would cease, the transfer station would be dismantled, and the station area would be reclaimed with native species. After 3 to 5 years of vegetation growth, the visual impact would be eliminated. This transportation option would be compatible with BLM's Class III visual resource objectives.

Slurry Pipeline

Visual impacts from construction of a slurry pipeline between Moab and the Klondike Flats portion of the pipeline are described in Section 4.2.11.3. Between the Klondike Flats and Crescent Junction portion of the pipeline, approximately 3 miles of the corridor immediately north of the Klondike Flats site would be visible to travelers on US-191. In this 3-mile section, the smooth, linear, unvegetated swath created by pipeline construction would contrast moderately with the surrounding features, characterized primarily by light-beige and light-gray, rolling desert plains and smooth, rounded, buff-colored bluffs. After the pipeline was removed and the corridor revegetated, the contrast between the corridor and surrounding landscape would be moderate to nonexistent, depending upon the success of revegetation.

North of the 3-mile section visible to travelers, the corridor would veer off to the northeast along an existing pipeline route and would not be visible to the general public until it crossed I-70 near the town of Crescent Junction. Most travelers would not notice either a barren or vegetated pipeline corridor that crossed beneath the freeway because of their travel speed and the presence of a number of other linear features (I-70, US-191, CR-175, railroad grade) in the area. The visual impacts associated with construction and revegetation of the pipeline would be compatible with BLM's Class III and IV objectives for this area.

4.3.11.3 Impacts from All Sources

Moving the tailings pile from the Moab site to the Crescent Junction site would have some moderate, short-term, adverse visual impacts and moderate to no long-term adverse visual impacts, primarily because the short-term construction activities and the completed disposal cell would not be seen by many people. At the Moab site, removal of the pile would have strong beneficial impacts to visual resources. Table 4–33 summarizes visual resource impacts expected to occur under this alternative.

Table 4–33. Summary of Visual Resource Impacts Under the Crescent Junction Off-Site Disposal Alternative

Location/Activity	Visual Resource Impacts	
	Short-Term	Long-Term
Moab site	Strong adverse impacts primarily to travelers on US-191 and SR-279	Strong positive impacts from removal of tailings pile
Crescent Junction disposal site	Weak to strong adverse impacts, depending upon viewing location	Moderate to no adverse impacts, depending upon viewing location
Cover soil borrow area	Negligible to strong adverse impacts, depending upon borrow source	No adverse impacts
Truck haul[a]	Negligible to moderate adverse impacts	No adverse impacts
Rail haul[a]	Negligible to moderate adverse impacts	No adverse impacts
Slurry pipeline[a]	Moderate adverse impacts to travelers on US-191	Moderate to no adverse impacts to travelers on US-191
Monitoring and maintenance	No adverse impacts	No adverse impacts

[a] Only one transportation option would be selected.

4.3.12 Infrastructure

This section addresses potential impacts on the availability of electric power, potable water, nonpotable water, sewage treatment, rail service, and highways. Unless otherwise indicated, all infrastructure impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.3.12.1 Construction and Operations Impacts at the Moab Site

The infrastructure impacts associated with construction and operations at the Moab site would be the same as those described for the truck and rail options in Section 4.2.12.1. For the slurry pipeline option, electric power demand would be 4,800 kVA, 1,400 kVA more than under the Klondike Flats off-site disposal alternative.

4.3.12.2 Construction and Operations Impacts at the Crescent Junction Site

The infrastructure impacts associated with construction and operations at the Crescent Junction site would be the same as those described in Section 4.2.12.2 for construction and operations at the Klondike Flats site, with the exception of electric power demands. The impact on the existing electrical infrastructure servicing the Crescent Junction disposal cell area would differ for the three alternative modes of transportation. For truck transportation, the total power demand would be 300 kVA; for rail transportation, the total power demand would be 600 kVA. Both of these options would require the same demand as for the Klondike Flats site. For slurry pipeline transportation, however, the demand would be 2,800 kVA, 300 kVA more than for the Klondike Flats site. ESC of Fort Collins, Colorado, developed and reviewed this projected demand with Mathew Yates, Pacific Corporation, Moab. Pacific Corporation indicated that this demand would present no capacity problems to the existing electric supply system at the site, nor would system upgrades be required (ESC 2003).

4.3.12.3 Construction and Operations Impacts Related to Transportation

Infrastructure impacts associated with transportation would be qualitatively similar to those described in Section 4.2.12.3 for the Klondike Flats site. Quantitatively, there would be an increased incremental electric power demand. Overall site power requirements for Crescent Junction, including those for transportation-related operations, are presented in Chapter 2.0. The truck transportation mode would not entail additional power demands over the 300 kVA required for site construction and operations. However, the rail transportation mode would draw an additional 300 kVA (600 kVA total demand), and the slurry pump would draw an additional 2,500 kVA (2,800 kVA total demand).

4.3.12.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would be generally limited to periodic inspections and activities to remedy incipient erosion as necessary. DOE does not expect these activities to affect the local or regional infrastructures.

4.3.12.5 Impacts from All Sources

Regional and local supplies of power, water, and sewage treatment capacity would be adequate to meet the requirements of the Crescent Junction off-site disposal alternative. Transportation would cause increased wear and tear on roads, which would be paid for through vehicle registration and special permit fees.

4.3.13 Solid Waste Management

The impacts of solid waste management under the Crescent Junction off-site disposal alternative would be identical to those described in Section 4.2.13 for the Klondike Flats off-site disposal alternative.

4.3.14 Socioeconomics

The socioeconomic impacts from off-site disposal at the Crescent Junction site would be similar in scope to those described in Section 4.2.14. As was assumed for the Klondike Flats alternative (Section 4.2.14), for purposes of analysis, the principal affected socioeconomic region of influence is assumed to be Grand and San Juan Counties in southeastern Utah. For the Crescent Junction alternative, some socioeconomic impacts may carry over to the adjacent Utah Counties of Emory and Carbon and into Mesa County, Colorado. Aggregate expenditures under this alternative would include construction and surface remediation at the Moab and Crescent Junction sites, ground water remediation, remediation of vicinity properties, and transportation of materials from the Moab site and vicinity properties to the Crescent Junction site. As described in Section 4.2.14, the aggregate impacts would depend on the mode of transportation used. The project cost data and economic impact estimation methodology are described in Section 4.1.14.

The economic impacts of off-site disposal at the Crescent Junction site are summarized in Table 4–34. The annual project costs over the 8-year disposal period are estimated to be $41,741,425 under the truck transport option. Under the rail transport option, the annual spending over the disposal period is estimated to be $49,423,275. The slurry pipeline transport option is expected to increase annual spending over the 8-year period by $50,258,588. Over the remaining 75-year ground water remediation/site monitoring period, the annual project costs are estimated to be $933,000 under each transportation option. The project spending would increase the final demand for the construction and transportation industries. Under the truck transport option, regional output of goods and services would increase by $55,006,850 a year. Under the rail transport and slurry pipeline options, the demand for goods and services would increase by $65,129,992 and $66,230,767, respectively. Project spending over the disposal period would also increase labor earnings and employment. Under the truck option, earnings and employment would rise by $13,565,963 and 431 direct and indirect jobs. The increase in labor earnings and employment would be $16,062,564 and 335 direct and indirect jobs under the rail option. Increased regional earnings under the slurry pipeline option would initially rise to $16,334,041 and 458 jobs during the first-year construction phase of the pipeline. Thereafter, earnings and employment would scale down to $15,097,007 and 315 jobs.

Table 4–34. Economic Impacts in the Principal Two-County Socioeconomic Region of Influence Under the Crescent Junction Off-Site Disposal Alternative

Transport Method	Annual Cost	Annual Output of Goods and Services	Annual Labor Earnings	Jobs
Truck	$41,741,425	$55,006,850	$13,565,963	431
Rail	$49,423,275	$65,129,992	$16,062,564	335
Pipeline	$50,258,588	$66,230,767	Year 1 $16,334,041	458
			Years 2–8 15,097,007	315

Note: Economic impacts for regional output of goods and services and labor earnings are calculated based on final-demand multipliers provided by the Bureau of Economic Analysis. The respective multiplier values (1.3178 and 0.3250) are multiplied by annualized cost to generate the impact values shown. Employment impacts are calculated as the product of the direct-effects multiplier (1.4262) and total direct jobs for each action alternative (see Tables 2–16, 2–17, and 2–18).

The potential shorter-term impacts under the Crescent Junction off-site disposal alternative would include increased demand for temporary housing (discussed in Section 4.1.14) and transportation-related inconveniences to motorists (discussed in Section 4.3.16). The extent of these shorter-term impacts would depend on levels of tourism-recreation activities and the mode of transportation used in the remediation process. Longer-term beneficial impacts from the off-site disposal alternative would relate to greater opportunities for economic development in the Moab area and greater diversification of the tax base (discussed in Section 4.1.14).

4.3.15 Human Health

This section addresses potential impacts to human health. These impacts are worker deaths that could occur as a result of industrial accidents and worker or public latent cancer fatalities that could occur as a result of exposure to radiation from activities at the Moab and Crescent Junction sites, at vicinity properties, or during transportation of materials.

4.3.15.1 Construction and Operations at the Moab Site and the Crescent Junction Site

Under the Crescent Junction off-site disposal alternative, construction activities would occur at vicinity properties, borrow areas, Crescent Junction, and at the Moab site. Table 4–35 lists the impacts from these activities. For each option under this alternative, less than one fatality would be estimated to occur from construction activities.

Table 4–35. Construction-Related Fatalities Under the Crescent Junction Off-Site Disposal Alternative

Alternative	Construction Fatalities
Truck Option	
Vicinity properties	0.031
Borrow areas	0.042
Moab and Crescent Junction activities	0.31
Total	**0.38**
Rail Option	
Vicinity properties	0.031
Borrow areas	0.037
Moab and Crescent Junction activities	0.32
Total	**0.39**
Slurry Option	
Vicinity Properties	0.031
Borrow areas	0.042
Moab and Crescent Junction activities	0.39
Total	**0.47**

Workers. Under the Crescent Junction off-site disposal alternative, workers would be exposed to radon gas (an inhalation hazard) and external radiation from the mill tailings at the Moab site, vicinity properties, and Crescent Junction. According to monitoring data collected during construction of an evaporation pond on the mill tailings pile, the highest radon level measured on the mill tailings pile was 0.096 working levels (21 pCi/L). A worker exposed to this level of radon for 2,000 hours per year would have a latent cancer fatality risk of 6.1×10^{-4} per year of exposure. The highest external gamma exposure rate measured on the mill tailings pile was about 0.60 mR/h. A worker exposed to this level of radiation for 2,000 hours per year would have a latent cancer fatality risk of 6.0×10^{-4} per year of exposure. The total latent cancer fatality risk to the worker on the mill tailings pile would be 1.2×10^{-3} per year of exposure (Table 4–36) or 6.0×10^{-3} over the 5-year duration of activities at the Moab site. Assuming that the radon and external radiation levels were comparable at the Crescent Junction site, this would also be the latent cancer fatality risk at the Crescent Junction site.

The Moab site would employ about 67 workers. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.081 per year of exposure, or 0.40 over the 5-year duration of activities at the Moab site. The Crescent Junction site would employ about 70 workers. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.085 per year of exposure, or 0.42 over the 5-year duration of activities at the Crescent Junction site.

Table 4–36. Worker Impacts Under the Crescent Junction Off-Site Disposal Alternative

Worker	Site	Radon-Related LCFs[a,b]	External Radiation-Related LCFs[a,b]	Total LCFs[a,b]
Annual				
Individual	Moab	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	Crescent Junction	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	Vicinity Properties	2.9×10^{-4}	1.2×10^{-4}	4.1×10^{-4}
Population	Moab	0.041	0.040	0.081
	Crescent Junction	0.043	0.042	0.085
	Vicinity Properties	6.7×10^{-3}	2.9×10^{-3}	9.6×10^{-3}
	Total	**0.091**	**0.085**	**0.18**
5-Year Duration of Activities				
Individual	Moab	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	Crescent Junction	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	Vicinity Properties	8.7×10^{-4}	3.7×10^{-4}	1.2×10^{-3}
Population	Moab	0.20	0.20	0.40
	Crescent Junction	0.21	0.21	0.42
	Vicinity Properties	0.020	8.6×10^{-3}	0.029
	Total	**0.43**	**0.42**	**0.85**

[a] Based on 67 workers at the Moab site, 70 workers at the Crescent Junction site, and 23 workers at vicinity property sites.
[b] LCF = latent cancer fatality.

Impacts to workers as a result of activities at the vicinity properties would be the same as under the on-site disposal alternative, as would be the lack of impacts from ground water treatment; these impacts are described in Section 4.1.15.2.

Under the Crescent Junction off-site disposal alternative, nearby residents would be exposed to radon gas released from the Moab site and at Crescent Junction. The average radium-226 content of the tailings, 516 pCi/g, would produce a latent cancer fatality risk for a nearby resident in Moab of 8.8×10^{-3} over the 5-year duration of activities at the Moab site and 7.5×10^{-5} over the 5-year duration of activities at the Crescent Junction site. These estimates include radon released from the drying areas at the Moab site. If a slurry pipeline were used to move the tailings to Crescent Junction, the drying areas would not be necessary, and the resulting latent cancer fatality risk for a nearby resident at Moab would be reduced to 6.9×10^{-3} over the 5-year duration of activities at Moab.

For the population, over the 5 years of activities at the Crescent Junction site, the latent cancer fatality risk to the population surrounding Crescent Junction would be 8.3×10^{-3}. Over the 5 years of activities at the Moab site, the latent cancer fatality risk to the population surrounding the Moab site would be 1.0. If a slurry pipeline were used to move the tailings to Crescent Junction, the drying areas would not be necessary, and the resulting latent cancer fatality risk for the population surrounding the Moab site would be reduced to 0.74 over the 5-year duration of activities at the Moab site.

Nearby residents would also be exposed to windblown radioactive particulates (e.g., radium-226, polonium-210, thorium-230, and uranium) from the Moab site and the Crescent Junction site. Estimates based on monitoring data collected during 1998 and 1999 from the Monticello mill tailings site when uranium mill tailings were being excavated indicate that the latent cancer fatality risk from radioactive particulates would be about 0.1 percent of the risk from radon emissions from the Moab site and Crescent Junction site. This is due to the aggressive dust suppression practices that would be used to minimize emissions of radioactive particulates.

4.3.15.2 Construction and Operations Impacts Relating to Transportation

Under the Crescent Junction off-site disposal alternative, there would be a total of 292,888 shipments if trucks were used to move the tailings from the Moab site to the Crescent Junction site (Table 4–37). If rail were used, there would be a total of 30,116 shipments. If a slurry pipeline were used to move the tailings, there would be 26,276 shipments. These shipments would include contaminated material from vicinity properties, uranium mill tailings, and borrow material, which would consist of cover soils, radon and infiltration barrier soils, sand and gravel, riprap, and Moab site reclamation soils.

Table 4–37. Shipments Under the Crescent Junction Off-Site Disposal Alternative

Material	Truck Option		Rail Option		Slurry Pipeline Option	
	Shipments	**Mode**	**Shipments**	**Mode**	**Shipments**	**Mode**
Vicinity property material	2,940	Truck	2,940	Truck	2,940	Truck
Borrow material	21,148	Truck	21,148	Truck	21,148	Truck
Uranium mill tailings	268,800	Truck	3,840 2,188	Rail[a] Truck	2,188	Truck
Total	**292,888**		**30,116**		**26,276**	

[a]Each rail shipment would consist of 30 railcars of uranium mill tailings.

The transportation impacts of shipping contaminated materials from vicinity properties, mill tailings, and borrow material would be from two sources: radiological impacts and nonradiological impacts. Radiological impacts would be from incident-free transportation and from transportation accidents that released contaminated material. There would be no radiological impacts from moving borrow material because it is not contaminated. Nonradiological impacts would be from engine pollutants (emissions from the truck or train moving the contaminated materials from vicinity properties, mill tailings, and the borrow material) and from traffic fatalities. The total transportation impacts would be the sum of the radiological and nonradiological impacts. Additional details on these analyses are provided in Appendix H.

Table 4–38 lists the transportation impacts under the Crescent Junction off-site disposal alternative. For this alternative, there would less than one fatality. In comparison, about 40,000 traffic fatalities occur annually in the United States (U.S. Census Bureau 2000).

Table 4–38. Transportation Impacts Under the Crescent Junction Off-Site Disposal Alternative

Alternative	**Radiological**			**Nonradiological**		**Total Fatalities**
	Incident-Free		**Accident Risk LCFs**	**Pollution Health Effects Fatalities**	**Traffic Fatalities**	
	Public LCFs	**Worker LCFs**				
Truck Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	8.9×10^{-4}	0.042	0.043
Mill tailings	2.7×10^{-3}	0.017	3.3×10^{-9}	1.6×10^{-4}	0.43	0.45
Total	**2.7×10^{-3}**	**0.017**	**1.0×10^{-8}**	**1.4×10^{-3}**	**0.47**	**0.49**
Rail Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	8.9×10^{-4}	0.042	0.043
Mill tailings	2.7×10^{-5}	1.7×10^{-3}	6.5×10^{-9}	1.1×10^{-4}	0.29	0.29
Total	**5.4×10^{-5}**	**1.7×10^{-3}**	**1.3×10^{-8}**	**1.4×10^{-3}**	**0.33**	**0.33**
Slurry Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	8.9×10^{-4}	0.042	0.043
Mill tailings	2.2×10^{-5}	1.4×10^{-4}	2.7×10^{-11}	1.3×10^{-6}	3.5×10^{-3}	3.7×10^{-3}
Total	**4.9×10^{-5}**	**1.8×10^{-4}**	**6.9×10^{-9}**	**1.3×10^{-3}**	**0.047**	**0.048**

LCF = latent cancer fatality.

Workers. For truck shipments of mill tailings from the Moab site to Crescent Junction, the maximally exposed transportation worker would be the truck driver. This person was assumed to drive the truck containing mill tailings for 1,000 hours per year. For the other 1,000 hours per year, the truck would be empty. This driver would receive a radiation dose of 220 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-4}.

For rail shipments of mill tailings from the Moab site to Crescent Junction, the maximally exposed transportation worker would be an individual who inspected the loading of the rail cars. This person would receive a radiation dose of 440 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 2.2×10^{-4}.

Public. For truck shipments of mill tailings from the Moab site to Crescent Junction, the maximally exposed member of the public would be a resident who lived along the road on which the tailings were shipped. This person would receive a radiation dose of 1.0 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 6.3×10^{-7}.

For rail shipments of mill tailings from the Moab site to Crescent Junction, the maximally exposed member of the public would be a resident who lived along the rail line on which the tailings were shipped. This person would receive a radiation dose of 0.53 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 3.2×10^{-7}.

Accidents. If trucks were used to transport the mill tailings from the Moab site to Crescent Junction, the maximally exposed individual would receive a radiation dose of 0.16 mrem, or 1.6×10^{-4} rem from the maximum dose reasonably foreseeable for a transportation accident involving a shipment of mill tailings. This is equivalent to a probability of a latent cancer fatality of about 9.6×10^{-8}. The probability of this accident is about 0.1 per year.

If this accident occurred near Moab, the population would receive a collective radiation dose of 1.8×10^{-3} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-6}. If this accident occurred in a rural area, the population would receive a collective radiation dose of 2.9×10^{-6} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.7×10^{-9}.

If rail were used to transport the mill tailings from the Moab site to Crescent Junction, the maximally exposed individual would receive a radiation dose of 1.4 mrem or 1.4×10^{-3} rem from the maximum dose reasonably foreseeable for a transportation accident involving a shipment of mill tailings. This is equivalent to a probability of a latent cancer fatality of about 8.5×10^{-7}. The probability of this accident is about 0.5 per year.

If this accident occurred near Moab, the population would receive a collective radiation dose of 0.017 person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.0×10^{-5}. If this accident occurred in a rural area, the population would receive a collective radiation dose of 2.7×10^{-5} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.6×10^{-8}.

4.3.15.3 Monitoring and Maintenance Impacts

Monitoring and maintenance activities would include checking water quality and installing a long-term ground water remediation system at the Moab site, and conducting periodic maintenance and inspections of the Crescent Junction site (checking for erosion, damaged fencing, etc.). None of these activities would be expected to breach the cap over the tailings; installation of the ground water system would be done in clean areas after remediation was complete. Data from another UMTRCA site indicate that the Crescent Junction alternative would be effective in isolating the contaminants in the tailings from individuals conducting activities on the site. DOE (2001) concluded that both radon and gamma levels associated with the capped-in-place tailings pile at the Shiprock site in New Mexico were indistinguishable from naturally occurring radiation levels. Therefore, the latent cancer fatality risk to workers conducting monitoring and maintenance would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

4.3.15.4 Impacts from All Sources

Under the Crescent Junction off-site disposal alternative, less than one fatality would be estimated to occur from construction activities under any of the transportation options. Transportation of contaminated materials from the Moab site to the Crescent Junction site would result in the exposure of workers and the public to very small amounts of radiation; these exposures would not be expected to result in any latent cancer fatalities to any population.

Ammonia releases from ground water remediation would be well below threshold concentrations for human health effects.

Based on as-built radon flux measurements from completed uranium mill tailings disposal cells constructed under both Title I (federal UMTRA sites) and Title II (private licensees) of UMTRCA, it is anticipated that actual radon flux would be two orders of magnitude less than the 20-pCi/m^2-s EPA protective standard promulgated in 40 CFR 192. However, even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible and that DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 pCi/m^2-s, under EPA's regulations (40 CFR 192).

Based on this emission rate and the dimensions of the disposal cell, the latent cancer fatality risk for a nearby resident would be 6.2×10^{-7} per year of exposure, or 1.8×10^{-5} over the 30-year period following the end of construction and operations. This latent cancer fatality risk is less than the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

For the population near the Crescent Junction site, the latent cancer fatality risk would be 2.0×10^{-3} over the 30-year period following the end of construction and operations.

At the Moab site, radon emissions would fall to background levels because the mill tailings pile would have been relocated. The latent cancer fatality risk would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the half lives of the radionuclides in the uranium mill tailings.

In the time frame of 200 to 1,000 years, the major route of exposure of people would be through the inhalation of radon progeny from the disposal cell. There is no surface water pathway at the Crescent Junction site. The uppermost aquifer at the Crescent Junction site is 3,000 ft below the surface, and the travel time to the uppermost aquifer is over 170,000 years, so it is unlikely that ground water would contribute large latent cancer fatality risks relative to inhalation of radon progeny. With the disposal cell cover in place and the Crescent Junction site under perpetual care, it is likely that the latent cancer fatality risk for an inadvertent intruder would also be low.

After the disposal cell cover was installed, the estimated annual latent cancer fatality risk from radon for a nearby Crescent Junction resident would be 6.2×10^{-7}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. Therefore, the annual latent cancer fatality risk for a nearby Crescent Junction resident would be about the same immediately after the cover was installed as it would be 1,000 years after the cover was installed. This assumes that the nearby resident remains at his or her present location. If the resident were to move closer to the disposal cell, the annual latent cancer fatality risk would be similar to the risk at the Moab site, 8.9×10^{-5} per year of exposure.

Based on the 20-pCi/m^2-s radon release rate, for the population within a 50-mile radius of the Crescent Junction site, the annual latent cancer fatality risk was estimated to be 6.7×10^{-5}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. If it is assumed that the population around the Crescent Junction site remains constant over 1,000 years, then the estimated latent cancer fatality risk over the 1,000-year time period would be 0.07.

4.3.16 Traffic

Traffic impacts under the Crescent Junction off-site disposal alternative would be qualitatively identical and quantitatively very similar to those described for the Klondike Flats off-site disposal alternative in Section 4.2.16. Under the truck transportation mode, the percent increase in traffic on US-191 from transporting the tailings would affect approximately 12 more miles of the highway due to the additional distance from the Moab site. A second difference is that road transportation of cover soils borrow material (43 daily round trips; see Table 2–7) required for the Klondike Flats disposal alternative would not be necessary because these soils would be available at the Crescent Junction disposal site. The resulting difference in percent increase in traffic is shown in Table 2–32. Because all other aspects of traffic impacts would be the same, the full analysis of traffic impacts is not repeated in this section.

4.3.17 Disposal Cell Failure from Natural Phenomena

It is possible that a disposal cell failure could occur at the Crescent Junction site. The possibility of failure at this site is much lower than at the Moab site because it was selected for analysis, in part, to avoid the more dynamic characteristics of the Moab site (see Chapter 3.0). The Crescent Junction site is not located near a river, does not have historical seismic activity, and is not prone to settling. In addition, this site is located farther away from populated areas or sensitive habitats than the Moab site, which would reduce the potential risks if a disposal cell failure occurred. Therefore, the possibility of a failure occurring and resulting in potential risks at the Crescent Junction site would be much lower than the potential risks of a disposal cell failure at the Moab site. For this reason, a potential failure at this site was not evaluated.

4.3.18 Environmental Justice

The basis for DOE's analysis of environmental justice impacts is described in Section 4.1.18. One census block area with a reported annual household income less than $18,244 (poverty level for a family of four) is found about 25 miles north of the Crescent Junction site. Although this population could be exposed to small doses of radiation as a result of activities under this alternative, there is no evidence that it would be exposed at a level any higher than the general population. Although traffic in central Moab would be an adverse impact, it does not appear that minority or low-income populations would suffer disproportionately.

DOE has identified no high and adverse impacts, and no minority or low-income populations would be disproportionately affected by the implementation of the Crescent Junction off-site disposal alternative.

4.4 Off-Site Disposal (White Mesa Mill Site)

This section discusses the short-term and long-term impacts associated with off-site disposal at the White Mesa Mill site, the third of the three off-site disposal alternatives. The White Mesa Mill site is located approximately 85 miles south of the Moab site. The impacts are based on the proposed actions described in Section 2.2 and the affected environment described in Sections 3.1 and 3.4. This alternative may result in the following impacts:

- Impacts at the Moab site
- Impacts at the White Mesa Mill site
- Impacts associated with moving tailings from the Moab site to the White Mesa Mill site

The combined impacts that could result from these activities are summarized for each assessment area (e.g., Geology and Soils) at the end of each subsection. For many activities, impacts at the Moab site would not differ significantly from those described in Section 4.2 for the Klondike Flats site. Likewise, construction and operation impacts at the White Mesa Mill site would be similar to those addressed for the Klondike Flats and Crescent Junction sites, with the exception that the White Mesa Mill site is already an operating waste disposal facility.

Transportation impacts would vary depending upon the transportation mode (truck or slurry pipeline). Contaminated vicinity property material would be transported from the Moab site to the White Mesa Mill site along with the tailings. Therefore, impacts associated with transporting vicinity property materials are not addressed separately. Impacts associated with transporting borrow materials are addressed in Section 4.5.

4.4.1 Geology and Soils

4.4.1.1 Construction and Operations Impacts at the Moab Site

Under the White Mesa Mill off-site disposal alternative, the geology and soil impacts at the Moab site would be the same as those described in Section 4.2.1.1.

4.4.1.2 Construction and Operations Impacts at the White Mesa Mill Site

Geology

Impacts related to geology at the White Mesa Mill site would be similar to those described for the Klondike Flats site in Section 4.2.1.2, with some exceptions relating primarily to potential geologic hazards. Although the potential for an impact from a seismic event remains low, there is a potential for subsidence at the edges and slopes of the White Mesa Mill site and for landslides and slumps in the canyons bordering the site. These are not serious hazards and are only of significance over extremely long time frames (many thousands of years).

Soils

Impacts related to soils at the White Mesa Mill site would be similar to those described for the Klondike Flats site in Section 4.2.1.2 with the exception that the estimated maximum area of disturbed soils from construction of a new cell and a staging and support area would be 346 acres for either the truck or slurry pipeline mode of transportation.

4.4.1.3 Construction and Operations Impacts Related To Transportation

The truck and slurry pipeline transportation options would both result in disturbances to soils due to construction of temporary off-site transportation infrastructure elements and corridors between the Moab and White Mesa Mill sites. These would include highway exchanges or the pipeline right-of-way. Because much of the requisite truck transportation infrastructure already exists at the White Mesa Mill site, truck transportation would require only limited additional disturbances, approximately 2 acres. The pipeline right-of-way from the Moab site to the White Mesa Mill site would result in short-term disturbance to approximately 430 acres of soil.

4.4.1.4 Impacts from All Sources

Sand and gravel resources beneath the Moab site would be unavailable for commercial exploitation under all the alternatives due to residual contamination, even after surface and ground water remediation was complete. Geologic hazards near the White Mesa Mill site are not serious and could only affect the stability of the disposal cell over many thousands of years. Table 4–39 summarizes estimated areas of disturbed soils. Areas where soil would be disturbed and subsequently restored include the entire Moab site, areas of new construction at the White Mesa Mill site, and highway exchanges or the pipeline right-of-way.

Table 4–39. Summary of Impacts Related to Soil Disturbance—White Mesa Mill Site Off-Site Disposal Alternative

Soil Disturbance Location or Source	Area of Soil Disturbance (acres)
Moab site	439
White Mesa Mill site	
Truck transportation option	346
Slurry pipeline transportation option	346
Off-site transportation infrastructure or corridor	
Truck transportation infrastructure Slurry pipeline right-of-way	2 430

4.4.2 Air Quality

Air quality impacts under the White Mesa Mill off-site disposal alternative would be very similar both qualitatively and quantitatively to those described for the Klondike Flats off-site disposal alternative in Section 4.2.2. As shown in Table 4–40 and Table 4–21, the concentrations of criteria air pollutants estimated to occur at the Moab site would be identical under both the White Mesa Mill and Klondike Flats off-site disposal alternatives. As shown in Table 4–41 (White Mesa Mill site) and Table 4–22 (Klondike Flats site), the estimated concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would be approximately 10 percent higher at the White Mesa Mill site than at the Klondike Flats site, and concentrations of PM_{10} would be approximately 8 percent lower at the White Mesa Mill site. The potential for greater emissions at the White Mesa Mill site is associated primarily with the truck haul transportation mode. The estimated concentrations from emissions shown in Table 4–40 and Table 4–41 were derived by applying tailpipe emission factors provided in *Compilation of Air Pollutant Emission Factors* (EPA 2000) to the estimated construction fleet composition and duration of construction operations. All emissions of criteria air pollutants would be well below the primary and secondary NAAQS in 40 CFR 50 under either the truck or pipeline transportation option.

Table 4–40. Criteria Pollutant Concentrations at the Moab Site

Pollutant	Averaging Period	Standard ($\mu g/m^3$)	Concentration from Emissions ($\mu g/m^3$)
Carbon monoxide	1-hour	40,000	40
	8-hour	10,000	28
Nitrogen dioxide	Annual	100	9.1
Sulfur dioxide	Annual	80	0.90
	24-hour	365	4.5
	3-hour	1,300	10
PM_{10}[a]	Annual	50	3.2
	24-hour	150	16

[a] PM_{10} includes fugitive dust emissions from construction activities.
$\mu g/m^3$ = micrograms per cubic meter.

Table 4–41. Criteria Pollutant Concentrations at the White Mesa Mill Site

Pollutant	Averaging Period	Standard ($\mu g/m^3$)	Concentration from Emissions ($\mu g/m^3$)
Carbon monoxide	1-hour	40,000	59
	8-hour	10,000	41
Nitrogen dioxide	Annual	100	13
Sulfur dioxide	Annual	80	1.4
	24-hour	365	7.0
	3-hour	1,300	16
PM_{10}[a]	Annual	50	3.3
	24-hour	150	17

[a] PM_{10} includes fugitive dust emissions from construction activities.
$\mu g/m^3$ = micrograms per cubic meter.

4.4.3 Ground Water

Ground water impacts as a result of construction and operations at the Moab site and of monitoring and maintenance at the White Mesa Mill site would be comparable to those described in Section 4.2.3.1. Therefore, these concerns are not addressed further in this section.

No impacts as a result of monitoring and maintenance under the White Mesa Mill off-site disposal alternative would occur at the site. Therefore, these concerns are not discussed further in this section.

4.4.3.1 Construction and Operations Impacts at the White Mesa Mill Site

The potential exists for adverse impacts to ground water quality at the White Mesa Mill site in the long term due to the shallow perched aquifer in the Burro Canyon Formation. This aquifer, located approximately 50 to 110 ft below land surface, already has milling-related contamination as a result of past operations at the White Mesa Mill, as documented by IUC and others. Any contaminants contributed by the Moab tailings would be in addition to existing contamination. Therefore, the potential would exist for an incremental increase in adverse effects to the shallow aquifer. However, the potential for Moab site tailings to add contamination to the shallow aquifer would be minimized by construction of a designed low-permeability cover on the disposal cell. The cover would minimize the infiltration and migration of constituents to ground water.

The potential also exists for migration of both existing and Moab site-contributed contaminants to reach springs and seeps downgradient of the White Mesa Mill site, which has been investigated by IUC (IUC 2003). The nearest discharge point located most directly downgradient from the tailings cells is Ruin Spring, approximately 10,000 ft south-southwest of the cells. The estimated travel time from the proposed disposal cell location to the perched ground water zone, and then to Ruin Spring, was calculated using assumptions of average porosity, average hydraulic gradient, and an average permeability range. The total estimated average travel time for contaminants contributed by the Moab tailings to reach Ruin Spring under current conditions is between 3,570 and 7,690 years. This assumes no dispersion and an average hydraulic gradient of 0.012 ft/ft over the range of permeabilities used (IUC 2003). However, there is currently no evidence of contaminated ground water reaching Ruin Spring.

A deeper aquifer, the Entrada/Navajo, is located approximately 1,000 ft below the base of the Burro Canyon Formation. This is a confined aquifer that serves as a major regional ground water resource and would not be anticipated to be affected by the proposed disposal cell. However, the State of Utah Division of Radiation Control noted that there is evidence of contamination from the shallow aquifer reaching the deeper confined aquifer according to test results from IUC water supply well WW-2, which is completed in the deeper aquifer. No adverse impacts to sole-source aquifers would occur, as there are none in the area that would be affected by the proposed disposal cell.

The compliance strategy for ground water protection would be consistent with the UMTRCA Title II requirements already in place at the White Mesa Mill site and would depend on the current status of the site's NRC license. Compliance with ground water standards could involve implementation of ACLs if approved by NRC.

4.4.3.2 Construction and Operations Impacts Related to Transportation

Under the White Mesa Mill off-site disposal alternative, depth to ground water in the shallow (uppermost) aquifer varies along the proposed pipeline route from very shallow in the Matheson Wetlands Preserve area to approximately 100 ft below land surface in other areas. Truck transportation would not adversely affect ground water. Because of controls identified in Chapter 2.0 concerning installation and operation of a slurry pipeline, it is also unlikely that there would be any impacts to shallow ground water as a result of this transportation mode.

4.4.4 Surface Water

Under the White Mesa Mill off-site disposal alternative, construction and operations impacts at the Moab site would be similar to those described in Section 4.2.4.1. No impacts to surface water as a result of monitoring and maintenance are anticipated. Therefore, these activities are not discussed further in this section.

4.4.4.1 Construction and Operations Impacts at the White Mesa Mill Site

Construction at the White Mesa Mill site would have a potential short-term impact that could be caused by sediment runoff into adjacent surface waters. However, because of their locations, the stock watering ponds, wildlife pond, ephemeral catch and seepage basins, and intermittent flowing streams would likely not be affected.

Seeps and springs adjacent to the White Mesa Mill site could be affected in the long term by contaminated ground water, as described in Section 4.4.3.1. However, impacts would be considered minimal because of the cell cover design and time frame for ground water to reach these areas.

4.4.4.2 Construction and Operations Impacts Related to Transportation

Under the White Mesa Mill off-site disposal alternative, construction of a slurry pipeline would affect the Colorado River and an estimated 10 other perennial streams and 21 intermittent drainages. An estimated 3,500 ft of directional drilling would be required for stream crossings, and up to 1 mile of open-cut buried crossings for other drainages. Therefore, the potential exists for short-term adverse impacts to surface water as a result of construction of a slurry pipeline in locations where surface waters exist. Such impacts would be associated with sedimentation and increased turbidity from siltation during construction. However, these impacts would be minimized or eliminated by site controls described in Chapter 2.0. No adverse impacts to surface water as a result of truck transportation of the tailings would be anticipated.

4.4.5 Floodplains/Wetlands

4.4.5.1 Construction and Operations Impacts at the Moab Site

Impacts to floodplains and wetlands at the Moab site would be identical to those described in Section 4.2.5.1.

4.4.5.2 Construction and Operations Impacts at the White Mesa Mill Site

There would be no impact from flooding at the White Mesa Mill site because this site is located beyond the potential floodplains of nearby streams. There could be short-term impacts to potential wetland and riparian areas in these streams from increased runoff during disposal cell excavation. Additional potential impacts to wetlands at the White Mesa Mill site are unknown because a detailed assessment of wetlands has not been done.

4.4.5.3 Construction and Operations Impacts Related to Transportation

At the Moab site, the slurry pipeline option would affect the Colorado River floodplain and Matheson Wetlands Preserve during construction. Construction of the pipeline could also involve drilling under other floodplain and wetland areas along the proposed route to the White Mesa Mill site. These areas would be identified and potential impacts more fully assessed prior to completion of the remedial action plan.

4.4.5.4 Impacts from All Sources

Impacts from all sources would be the same as those described in Section 4.2.5.3. In addition, there would be the potential for short-term impacts to nearby wetlands and floodplains from runoff during disposal cell excavation. There would be the potential for adverse impacts to wetlands and floodplains if the pipeline transportation mode were implemented.

4.4.6 Aquatic Ecology

No monitoring or maintenance impacts to aquatic ecology would be anticipated under the White Mesa Mill off-site disposal alternative. Therefore, these activities are not discussed further in this section.

4.4.6.1 Construction and Operations Impacts at the Moab Site

Under all of the off-site disposal alternatives, the impacts to aquatic biota and habitats at the Moab site would be very similar to those described for on-site disposal (Section 4.1.6.1). It is assumed that the same amount of physical disturbance would occur at the Moab site regardless of the disposal option. Off-site disposal would probably decrease the potential for runoff and siltation at the Moab site. Chemical and radiological impacts to aquatic resources would be similar to those described for the on-site disposal alternative. The annual use of 235 to 730 acre-feet (depending on transportation mode) of nonpotable Colorado River water would be within DOE's authorized river water use rights. (Some of the projected potable water demand would be met using IUC's Recapture Reservoir rights). If Colorado River water use exceeded the 100 acre-foot annual limit set by USF&WS as protective, the unavoidable impact would be mitigated through negotiated water depletion payments.

4.4.6.2 Construction and Operations Impacts at the White Mesa Mill Site

There are no surface waters with sustainable aquatic species near locations where construction and operation activities would occur at the White Mesa Mill site; therefore, no physical, chemical, or radiological adverse impacts to aquatic receptors would occur.

4.4.6.3 Construction and Operations Impacts Related to Transportation

The impacts to aquatic biota and habitat from transporting the Moab tailings to the White Mesa Mill site would depend on the transportation option selected. Surface waters along the transportation corridors to White Mesa Mill are discussed in Chapter 3.0. Aquatic receptors, including benthic macroinvertebrates, could be adversely affected by sedimentation of stream crossings during slurry pipeline construction. Although fish would most likely avoid the turbid area, spawning substrate and stream invertebrates could be adversely affected in the short term. Impacts to aquatic resources could also occur as a result of a truck transportation spill or pipeline breach into aquatic environments along the transportation routes. Impacts from spills would depend on the amount of material released and the ability to retrieve the material before contaminants dissolved into the aquatic environment. However, project controls would ensure that minimal or no impacts would be expected.

4.4.6.4 Impacts from All Sources

Overall potential impacts to aquatic ecology would include impacts from slurry pipeline construction activities in surface waters, including the Colorado River adjacent to the Moab site. Impacts to surface waters could also occur as a result of truck spills. However, because of the volume of materials, the short duration, and site controls, the potential for these impacts would be minimal.

4.4.7 Terrestrial Ecology

4.4.7.1 Construction and Operations Impacts at the Moab Site

Under all the off-site disposal alternatives, impacts to terrestrial biota and habitats at the Moab site would be very similar to those described for on-site disposal (Section 4.1.7.1). It is assumed that the same amount of physical disturbance would occur at the Moab site regardless of the disposal option. Noise levels would probably be comparable under both the on-site and off-site disposal alternatives, because roughly the same numbers and types of equipment would be required. Off-site disposal would probably decrease the potential for runoff and sedimentation at the Moab site. Chemical and radiological impacts to terrestrial resources would be similar to those described under the on-site disposal alternative. Appendix A1, "Biological Assessment," discusses potential effects to federally listed species at this site in more detail.

4.4.7.2 Construction and Operations Impacts at the White Mesa Mill Site

Under the White Mesa Mill off-site disposal alternative, development of a disposal cell and support facilities would disturb approximately 346 acres in the disposal cell area. The effects of physical disturbance would include the loss of foraging and breeding habitat. Wildlife species known to use the White Mesa Mill site include mule deer, which migrate through the area and browse it fairly heavily. Many other wildlife species are known to occur in the site vicinity (Section 3.4.9).

The southwestern willow flycatcher and black-footed ferret are the only federally listed species that could potentially be affected by habitat disturbance resulting from construction of a disposal cell. There was a reported flycatcher sighting in San Juan County in the vicinity of the slurry pipeline corridor (UDWR 2003). However, there is no information on the date of the reported sighting or on whether the sighting was confirmed. There is no suitable habitat for flycatchers known to occur on the White Mesa Mill site. Consequently, impacts to this species from disposal cell construction would not be anticipated.

UDWR (2003) reported a confirmed ferret sighting in the vicinity of the White Mesa Mill disposal site in 1937. However, all black-footed ferrets currently in the wild are believed to be the result of a federal reintroduction program. It is highly unlikely that the black-footed ferrets reintroduced in Uinta and Duchesne counties in 1999 or their offspring could occur on or in the vicinity of the White Mesa Mill site. Black-footed ferrets depend almost exclusively on prairie dog colonies for food, shelter, and denning. Although the area from Moab south along US-191 toward the White Mesa Mill site supports colonies of Gunnison's prairie dog (*Cynomys gunnisoni*) (Seglund 2004), no colonies are currently known to occur at or close to the White Mesa Mill site. Consequently, impacts from construction to the black-footed ferret would not be anticipated.

Impacts of physical disturbance could be avoided or minimized in several ways. The most important action would be to conduct field surveys prior to any site development activities to determine the presence of any species of concern. Additional actions would include minimizing site disturbance to the extent practicable, revegetating disturbed lands and the cover cap once it was completed, and scheduling ground-clearing activities during periods that would not disturb nesting migratory birds.

Noise due to construction and operations could have an adverse effect on terrestrial wildlife. At the White Mesa Mill site, noise would be generated by construction equipment and material transfer operations. The estimated maximum noise levels that would be generated when all equipment was operating would be approximately 95 dBA at 49 ft. The noise level would attenuate over a distance of approximately 6 miles until it reached the quiet desert background level of approximately 30 dBA. However, the White Mesa Mill is an active uranium milling site, which has a relatively high background noise level when operating. Therefore, much of the wildlife currently at or near the White Mesa Mill site is probably already habituated to human presence and noise.

Noise can affect terrestrial organisms by causing physiological changes and behavioral modifications, including nest abandonment. It can also disrupt communication and defense systems. Any of the species that may be present at the White Mesa site could be affected by the noise associated with construction and operations.

The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. The bald eagle is the only federally listed species in the vicinity of the White Mesa Mill site that could be affected by noise from site operations. However, it is not known to nest or night roost in the area, nor is it commonly seen in the area, and it would therefore be unlikely to be affected.

Other effects of human presence, including night lighting, also would reduce the overall habitat value of the area. As with noise, some species become habituated to human presence, but others such as deer or pronghorn antelope could avoid the site during human activities. The White Mesa Mill site is surrounded by many square miles of similar or better habitat. Therefore, individuals that avoided the area because of construction activities would not be forced into less desirable habitat.

The effects of noise, supplemental lighting, and human presence could be greater at night than during the day. Therefore, double-shift operations would likely have a greater impact than single-shift operations. The effects of noise, supplemental lighting, and human presence could be mitigated by limiting the amount of light off the site, minimizing activities at the periphery of the site, and limiting especially loud activities to daylight hours and to seasons when the effects on biota would be reduced.

There would not likely be chemical impacts at the White Mesa Mill site. Accidental spills of diesel, oil, or other materials would be quickly controlled and mitigated.

4.4.7.3 Impacts of Transportation

The effects of transporting the Moab tailings to the White Mesa Mill site would depend on the transportation option selected. Truck transport would increase collision mortality and highway noise, but a slurry pipeline could disrupt more habitat along the pipeline corridor. Borrow materials would be transported to the White Mesa Mill by truck, regardless of the selected mode of tailings transport.

Truck Transportation Option

Truck transportation of tailings from the Moab site to the White Mesa Mill site would increase the amount of truck traffic on US-191 south of Moab (Section 4.4.16). This increase in traffic would likely lead to an increase in traffic-related wildlife mortalities and an increase in the average noise levels in the vicinity of the highway.

The highway route between Moab and White Mesa Mill crosses important migration routes for mule deer and critical range for pronghorn antelope. At least during periods of migration, the increase in truck traffic could lead to an increase in mortality of these species.

The bald eagle is the only federally listed species that could incur an increase in traffic-related mortality. The Gunnison sage grouse is the only federal candidate species that could be so affected. The Utah Gap Analysis (UDWR 1999) indicates that potential high-quality bald eagle wintering habitat exists throughout many of the project areas. Bald eagles could be found temporarily and infrequently using such areas when there are opportunities to feed on carrion, such as in big-game wintering areas or in prairie dog colonies. Therefore, it is possible that if traffic-related wildlife mortality increased due to the project, an increased number of eagles could be hit on highways. However, without data on this relationship, it is reasonable to assume that the number of eagles hit on highways would be proportional to the number of carrion available. The increase in the number of traffic-related wildlife mortalities is expected to be small. Consequently, the potential increase in associated eagle deaths is also expected be small.

The Gunnison sage grouse was observed in 1999 in San Juan County in the vicinity of the proposed slurry pipeline corridor between Moab and the White Mesa Mill site. Much of the area near the proposed pipeline route between Moab and White Mesa is part of a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000). The increased truck traffic could increase traffic-related mortality for this species.

As described in Section 4.4.10, the increased truck traffic along US-191 resulting from transport of tailings from the Moab site to the White Mesa Mill site would likely increase ambient noise levels by approximately 5 dB (measured at 49 ft). Although the highway noise (average baseline approximately 70 dBA) could be detected by humans over distances of 6 to 7 miles, the additional noise due to the additional trucks would not be perceptible beyond several hundred yards.

The primary federally listed species that could be affected by this increased traffic noise would be the Mexican spotted owl. Designated critical habitat for the spotted owl occurs within 2 miles of the transportation corridor just south (within 25 miles) of the Moab site. However, data provided by UDWR (2003) indicated that there were no occurrences of the Mexican spotted owl in any of the project areas. Thus, it is possible but unlikely that spotted owls occur in this area. If present, the species could potentially be disturbed by noise from increased truck traffic, although the probability of such a disturbance, based on the incremental increase in highway noise, would be minimal.

The potential for impacts to terrestrial wildlife from truck transportation of tailings would be greater in the evening or at night than during the day. Therefore, the impacts of two-shift operations would probably be greater than those of single-shift operations. In either case, the impacts would be of relatively short duration and would cease once the transfer of materials to the disposal cell was completed.

Slurry Pipeline Option

Use of a slurry pipeline system to transport tailings from the Moab site to the White Mesa Mill site would increase the amount of habitat disturbance along the transportation corridor.

Most of the slurry pipeline route to the White Mesa Mill site is parallel and adjacent to either US-191 or existing gas pipeline rights-of-way. However, approximately 28.7 miles of new right-of-way would be required along this route. Construction of the pipeline within existing corridors would not likely have an adverse ecological impact other than disturbance of revegetated previously disturbed areas. Construction within new rights-of-way would affect a greater variety of habitats.

Wetland areas could be inhabited by Utah state-listed plant species of concern. Animal species that could be affected include the black-footed ferret, Mexican spotted owl, southwestern willow flycatcher, and Gunnison sage grouse, as well as numerous animal species listed by Utah as species of concern. Black-footed ferrets have been observed at five locations in the region between the Moab site and the north IUC borrow area (UDWR 2003). However, it is unlikely that ferrets are present along the route of the proposed pipeline, based on the rationale provided in the discussion of the black-footed ferret in Section 4.4.7.2.

Mexican spotted owls are not likely to occur near the proposed slurry pipeline route because the route would not cross through or near any steep-walled canyons that are preferred nesting areas (USF&WS 1995 and 2001). Southwestern willow flycatchers are not likely to occur in the area because the proposed route crosses very little wooded-riparian habitat. Gunnison sage grouse could be affected, since much of the area near the proposed pipeline route between Moab and White Mesa is part of a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000). A thorough survey of the pipeline right-of-way would be performed prior to construction, and appropriate mitigation plans would be developed if any of these species were identified within the right-of-way.

In addition to field surveys to identify populations of these species of concern, mitigation could consist of adjusting the pipeline location if needed and constructing the pipeline during periods of the year that would not disrupt the breeding or nesting of Gunnison sage grouse, spotted owls, willow flycatchers, or migratory birds. Operation of the pipeline would not be expected to have any adverse effects on wildlife species or habitats.

4.4.7.4 Monitoring and Maintenance Impacts

Routine post-closure monitoring and maintenance of a disposal cell at the White Mesa Mill site would not be expected to have any impacts on terrestrial species or habitats. If major corrective actions were needed, some of the recovering vegetation on and around the disposal site could be disturbed.

4.4.7.5 Impacts from All Sources

Overall impacts to terrestrial ecological resources under the White Mesa Mill off-site disposal alternative would include approximately 50 acres of tamarisk habitat lost at the Moab site (the rest of the site is considered to have zero habitat quality). A maximum of approximately 174 acres would be disturbed at borrow areas, approximately 90 percent of which would be for

Moab site reclamation soil assumed to be obtained at the Floy Wash borrow area (White Mesa Mill disposal cell cover soils would be obtained from cell excavation material). Disturbances for disposal cell and borrow material excavation would include approximately 96 acres of disturbed piñon-juniper, scrub, or forested habitat. Approximately 346 acres would be disturbed for disposal cell construction.

The truck transportation option would require only 2 acres of disturbance for infrastructure construction. Total disturbance from all activities (Moab site, borrow areas, transportation, and White Mesa Mill site) from truck transportation would be approximately 570 acres. The slurry pipeline option would require 430 acres of disturbance for the pipeline corridor for a total of approximately 1,000 acres disturbance from all activities. Additional habitat could be lost at the commercial quarry sites for sand and gravel.

There would be a slight decrease in habitat value near US-191 because of the increased truck traffic required to haul tailings if the truck transport option were selected, and there would be a slight increase in traffic-related wildlife mortalities. Impacts of borrow material haulage would be less than those under the on-site disposal alternative because the radon barrier and cover materials would be available near the disposal cell site, and haulage of these materials at highway speeds on US-191 would not be required.

4.4.8 Land Use

4.4.8.1 Construction and Operations Impacts at the Moab Site

Under the White Mesa Mill off-site disposal alternative, the land use impacts at the Moab site would be the same as those described in Section 4.2.8.1 for the Klondike Flats disposal alternative.

4.4.8.2 Construction and Operations Impacts at the White Mesa Mill Site

No impacts that are not part of IUC's existing operating plan would occur from construction and operations on IUC's property at the White Mesa Mill site. In addition, there would be no land use impacts from borrow materials secured from commercial operations. There would be short-term impacts from borrow areas permitted on BLM lands. Obtaining borrow material from areas on BLM lands would create only short-term impacts because these areas would be reclaimed and returned to BLM for prior designated uses. Disposal of tailings from the Moab site would commit 346 additional acres to permanent waste disposal.

4.4.8.3 Construction and Operations Impacts Related to Transportation

The truck haul transportation mode would require an additional 2 acres of disturbance to build an overpass over US-191 and to build additional acceleration and deceleration lanes to the existing highway at the site entrance. It is likely these would be built in the existing right-of-way and would create no additional land use impacts. A slurry pipeline would be built in the existing pipeline right-of-way for most of the distance, but would require an additional 28.7 miles of new right-of-way.

4.4.8.4 Monitoring and Maintenance Impacts

There would be no additional impacts from monitoring and maintenance at the site. If other monitoring locations were required outside IUC's property, wells or other monitoring equipment and the associated access would be negotiated and maintained.

4.4.8.5 Impacts from All Sources

Under the White Mesa Mill off-site disposal alternative, the primary long- and short-term land use impacts would occur from the activities at the Moab site, as described in Section 4.2.8.1. In addition, there could be short-term impacts from securing borrow materials from any borrow area on BLM property.

4.4.9 Cultural Resources

This section addresses the potential for the disturbance of known cultural resources or the discovery of unknown resources under the White Mesa Mill off-site disposal alternative.

4.4.9.1 Construction and Operations Impacts at the Moab Site

Impacts to cultural resources at the Moab site under the White Mesa Mill off-site disposal alternative would be the same as those described in Section 4.1.9.1.

4.4.9.2 Construction and Operations at the White Mesa Mill Site

On the basis of previous cultural surveys, 9 to 12 cultural sites eligible for inclusion in the National Register of Historic Places would be directly affected by construction of a disposal cell at the White Mesa Mill site. Table 4–42 lists the identification number, type, cultural affiliation of the 12 cultural sites, and recommendations made by the author of the Class I cultural resource inventory (Davis et al. 2003) for further cultural work. A minimum of five potential traditional cultural properties also could be adversely affected by disposal cell construction.

Before construction of the disposal cell began, DOE, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures for these sites through the Section 106 consultation process (Section 3.1.13.3). The archaeological sites would likely be excavated by professional archaeologists, and cultural resource data would be recovered and recorded. Given the archaeological discoveries made elsewhere on the White Mesa Mill facility (Casjens 1980), it is probable that additional archaeological structures, features, and objects would be unearthed during excavating. Mitigation of the potential traditional cultural properties, which may include sacred gathering areas, sacred healing areas, sacred springs, and burial areas, would be extremely difficult given the density and variety of these resources, the importance attached to them by tribal members, and the number of tribal entities that would be involved in consultations.

Table 4–42. Cultural Sites That May Be Adversely Affected by Disposal Cell Construction at the White Mesa Mill Site

Site Identification Number	Site Type	Cultural Affiliation	Recommendation for Further Work
42SA 6392	Limited activity	Unknown	Resurvey; update site form
42SA 6393	Limited activity	Basketmaker III to Pueblo II	Resurvey; update site form
42SA 6397	Limited activity	Early Pueblo II	Resurvey; update site form
42SA 6398	Limited activity	Basketmaker III to Pueblo I	Resurvey; update site form
42SA 6399	Habitation	Pueblo I to Pueblo II	Resurvey; update site form
42SA 6400	Limited activity	Basketmaker III to Pueblo I	Resurvey; update site form
42SA 6401	Limited activity	Basketmaker III	Resurvey; update site form
42SA 6429	Habitation	Pueblo II	Resurvey; update site form
42SA 6430	Habitation	Pueblo II	Resurvey; update site form
42SA 6431	Limited activity	Pueblo II	Resurvey; update site form
42SA 6433	Habitation	Pueblo III	Resurvey; update site form
42SA 13964	Temporary camp	Historical	Resurvey; update site form

4.4.9.3 Construction and Operations Impacts Related to Transportation

Under the trucking option, one cultural site—the historic US-160 that parallels US-191—would be adversely affected by construction of the deceleration lane at the Moab site. Up to three cultural sites could be adversely affected by haul road construction (depending on the final location of the road) at the White Mesa Mill site. Table 4–43 lists the identification number, type, cultural affiliation of the three cultural sites, and recommendations made by the author of the Class I cultural resource inventory (Davis et al. 2003) for further cultural work.

Table 4–43. Cultural Sites That Could Be Adversely Affected by Haul Road Construction at the White Mesa Mill Site

Site Identification Number	Site Type	Cultural Affiliation	Recommendation for Further Work
42SA 6402	Limited activity	Pueblo III	Resurvey; update site form
42SA 7750	Limited activity	Basketmaker III to Pueblo II	Resurvey; update site form
42SA 7753	Limited activity	Basketmaker III to Pueblo I	Resurvey; update site form

A total of 104 cultural sites eligible for inclusion in the National Register of Historic Places are known to exist within 0.5 mile of the proposed slurry pipeline route to the White Mesa Mill site. An additional 90 to 300 sites are estimated to occur in the unsurveyed portions of the pipeline. Of the 194 to 404 total, 50 to 100 could be adversely affected during pipeline construction. The one potential traditional cultural property known to exist along the pipeline route also would be adversely affected. Consequently, DOE estimates that at least 51 to 101 cultural sites could be adversely affected by the pipeline. If additional traditional cultural properties were located along the route (the potential for their occurrence is extremely high), they also would likely be adversely affected.

DOE, BLM, UDOT, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures for these sites through the Section 106 consultation process (see Section 3.1.13.3). Mitigation measures could include (1) avoiding the sites, (2) monitoring the cultural resource during surface-disturbing activities, (3) excavating and recording cultural resource data before construction activities began, or (4) moving the cultural resource objects from areas of disturbance to nearby undisturbed areas. Given the likely density and variety of potential traditional cultural properties located along the route, the importance attached to them by tribal members, and the number of tribal entities that would be involved in consultations, mitigation of these sites would be extremely difficult.

In addition to these direct impacts, cultural resources located near the pipeline could be adversely affected indirectly through illicit collection, vandalism, or inadvertent destruction as a result of increased human activity in the area.

4.4.9.4 Monitoring and Maintenance Impacts

Under the White Mesa Mill off-site disposal alternative, impacts to cultural resources would not occur from monitoring and maintenance activities.

4.4.9.5 Impacts from All Sources

Table 4–44 lists the total number of cultural sites eligible for inclusion in the National Register of Historic Places that could be adversely affected under each of the White Mesa Mill site transportation alternatives.

Table 4–44. Number of Cultural Sites That Could Be Adversely Affected Under the Two White Mesa Mill Site Transportation Options

Location/Activity	**Transportation Mode**	
	Truck	**Slurry Pipeline**
Moab site (construction and operations)	0–2	0–2
Moab site (highway improvements)	1	0
White Mesa Mill site haul road construction	0–3	0–3
White Mesa Mill disposal cell area	14–17	14–17
Radon barrier borrow area (White Mesa Mill borrow area)	6	6
Riprap borrow area (Blanding borrow area)	3	3
Pipeline construction	NA	51–101[a]
Total	**24–32**	**74–132[a]**

[a] Numbers do not include potential traditional cultural properties that have not yet been identified along the pipeline route; the likelihood of their occurrence is extremely high.

4.4.10 Noise and Vibration

This section addresses the impacts of noise and ground vibration under the White Mesa Mill off-site disposal alternative, primarily to human receptors. Where appropriate, impacts to wildlife and cultural resources are also identified. Unless indicated otherwise, all noise and vibration impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.4.10.1 Construction and Operations Impacts at the Moab Site

Noise from the Moab site under the White Mesa Mill off-site disposal alternative would come from construction activities and removal of the tailings pile. The largest sources of noise on the site would be heavy earth-moving equipment. Noise generated from these activities would not differ significantly from the noise generated at the Moab site under the on-site disposal alternative. Section 4.1.10 describes the noise associated with construction and earth-moving activities.

Ground vibration generated by heavy equipment at the Moab site is discussed in Section 4.1.10. No appreciable differences would be expected in ground-level vibration at the Moab site between the on-site disposal alternative and the White Mesa Mill off-site disposal alternative.

4.4.10.2 Construction and Operations Impacts at the White Mesa Mill Site

Noise at the White Mesa Mill site from the disposal of tailings would come from construction activities and hauling the tailings. The type of noise generated from these activities is described in Section 4.2.10.2 for the Klondike Flats site. No appreciable differences would be expected in the source or levels of noise. However, the receptors around the White Mesa Mill site would be different from those around the Klondike Flats site. No residences are within the estimated 1,480-ft region of influence around the White Mesa Mill site.

Ground vibration generated from construction and operations at the White Mesa Mill site would be the same as those discussed in Section 4.2.10.2. There are no receptors at the White Mesa Mill site within the 820 ft estimated for ground vibration to attenuate to background levels. There are no sites of cultural importance that would be affected by ground vibration at the White Mesa Mill site.

4.4.10.3 Construction and Operations Impacts Related to Transportation

Transportation options for disposal at the White Mesa Mill site are truck and slurry pipeline. Truck traffic noise would be from traffic on US-191; the slurry pipeline noise would follow the pipeline route and would persist only during construction of the slurry pipeline. Trucks transporting the tailings would pass through four communities: Moab, La Sal Junction, Monticello, and Blanding. The increase in noise in each of these communities and around the highway sections between the cities would vary according to traffic levels (Table 4–45). Through Moab, due to the low truck speed, the noise levels would be expected to exceed 65 dBA only out to 82 ft from the road. US-191 passes through some residential areas within the city of Moab, so some residential buildings could be exposed to noise levels above the Moab residential standard of 65 dBA (Moab City Ordinance 17.74.080, "Noise Levels"). South of the Moab city limits, speed limits increase, and the region of influence would increase accordingly. For this area, the region estimated to exceed 65 dBA is 422 ft from the highway. It is likely that residents live within this region of influence. In the other communities between the Moab site and White Mesa Mill, some residential structures are likely to be within the 360-ft region of influence estimated for highway sections south of La Sal Junction, at Monticello, and at Blanding.

Table 4–45. Noise Impacts Around Transportation Routes for the White Mesa Mill Off-Site Disposal Alternative

Highway Section	Hourly Average Baseline Noise (dBA) at 25 ft From Source	Hourly Average Project Truck Traffic	Hourly Average Project Truck Traffic Noise (dBA) at 25 ft From Source	Total Noise (dBA) at 25 ft From Source	Region of Influence (ft)	Increase at 25 ft (dBA) From Truck Hauling Activities
Moab[a]	66	40	68	70	82	4.1
La Sal Junction through Moab	73	40	75	77	422	4.1
White Mesa to La Sal Junction	71	40	75	76	360	5.4

Assumptions:
Single project truck vehicle noise 95 dBA[b] at 60 mph[a], 25 ft from source.
Single project truck vehicle noise 85 dBA[b] at 60 mph[a], 25 ft from source.
[a] Project truck speed 30 mph within Moab city limits, 60 mph everywhere else.
[b] Conservative estimation based on values from multiple sources (Bowlby 1991, Sandberg 2001).

Noise emissions from construction of a slurry pipeline are described in Section 4.2.10.3. A 1,480-ft region of influence is estimated around the slurry pipeline route. The proposed routes for the slurry pipeline between the Moab site and the White Mesa Mill site would generally avoid communities. Few if any receptors would likely reside within 1,480 ft of the pipeline route. Construction of a slurry pipeline would likely result in ground vibration above background levels. The estimated maximum level for ground vibrations emitted by construction of a slurry pipeline would be 95 dBV. This level would result in ground vibration above background levels 820 ft from the source and levels above human perception within 330 ft of the source. Some cultural sites containing rock granaries and a historic homestead lie within 2,620 ft of the pipeline, but ground vibration levels at these resources would not reach levels (estimated at 92 to 100 dBV) that would damage these structures.

4.4.10.4 Monitoring and Maintenance Impacts

Monitoring and maintenance of the White Mesa Mill site would not be expected to result in significant generation of noise. Any noise generated by these activities would attenuate to near background levels before leaving the boundary of the disposal site.

4.4.10.5 Impacts from All Sources

Noise generated by the White Mesa Mill truck haul option would exceed the Moab residential noise standard of 65 dBA at some receptor locations. The receptors with the most potential to notice any increase in noise generated by this alternative would include residents living near US-191 in and around Moab, the resident located on the eastern boundary of the Moab site, and residents of communities between Moab and the White Mesa Mill. If two 10-hour shifts were used instead of a single 12-hour shift, the noise generated would not change substantially, but there could be a higher potential for annoyance from late-night and early-morning activities.

4.4.11 Visual Resources

This section describes the impacts to those physical features of the landscape that impart scenic value in the region affected by the White Mesa Mill off-site disposal alternative. The impacts would be imposed on viewers who live in, work in, or visit an area and could see ongoing human activities or the results of those activities.

4.4.11.1 Construction and Operations Impacts at the Moab Site

Under the White Mesa Mill off-site disposal alternative, impacts to visual resources at the Moab site would be the same as those described in Section 4.2.11.1.

4.4.11.2 Construction and Operations at the White Mesa Mill Site

Construction and operations at the White Mesa Mill site would have minor adverse effects on visual resources, primarily because construction activities and the completed disposal cell would not be seen by most people. DOE selected four key observation points from which to assess visual impacts: (1) US-191 southbound, (2) US-191 northbound, (3) the nearest residence, and (4) the White Mesa Ute community. Figure 4–18 shows DOE's visibility analysis results for the proposed disposal cell location. The darkened areas indicate locations from which a disposal cell could potentially be viewed. The visibility analysis used to create this map is based on elevation and topography and does not take into account the potential obstruction of views from cultural modifications or vegetation or the effects of distance on visibility. Without visual aids, such as binoculars, most people would not be able to recognize a disposal cell at distances greater than 5 to 10 miles.

The visibility analysis results indicate that travelers on US-191 would not likely see a cell. In Figure 4–18, small darkened areas are present at two locations along the highway within 5 miles of the site. Given the speed of travel, angle of view, and distance from the site, travelers would more likely notice the existing structures and topsoil salvage piles on the site than a more distant, lower-profile disposal cell. The view of DOE's disposal cell from the nearest residence, located approximately 1.6 miles north of the site's entrance road, would be obstructed by the structures and disposal cells currently located at the site. Because of distance, a disposal cell would not likely be visible from any locations within the White Mesa Ute community. The one potential adverse impact from cell construction at these key observation points would be from the lighting used during dawn and dusk hours (and at nighttime under the double-shift work scenario) during the construction period. Because the White Mesa Mill is a commercial facility, it is not known if night lighting would continue in the long term.

The activities proposed under this alternative would be compatible with BLM's Class III visual resource objectives for the area surrounding the site (BLM 2003). Although DOE is not required to meet the objectives of BLM's visual resource management system on the privately owned White Mesa Mill site, the system provides a useful way to measure the effects of a proposed action on visual resources.

4.4.11.3 Construction and Operations Impacts Related to Transportation

<u>Truck Haul</u>

Under the White Mesa Mill off-site disposal alternative, impacts to visual resources would not occur under the truck haul transportation option.

Slurry Pipeline

Approximately 25 percent of the pipeline corridor would be visible to the general public, mainly to Moab residents and travelers on US-191. DOE selected three key observation points from which to assess visual impacts: (1) US-191 at Kane Springs Canyon, (2) US-191 at the booster pump station in Lisbon Valley, and (3) US-191 at Recapture Creek. The Kane Springs Canyon and Recapture Creek areas have Class II visual resource designations, and the booster pump station in Lisbon Valley has a Class III designation.

From the Kane Springs Canyon key observation point, northbound travelers on US-191 would have a 20-second view of the pipeline corridor's cut through the massive, prominent Entrada Sandstone outcrop located west of the highway (see Figure 3–44). Southbound travelers would not see the cut. The trench-like, vertical cut would contrast strongly with the smooth, horizontal lines created by the Entrada Sandstone. Although the viewing time would be relatively short, the strong contrast in line and form created by the cut would likely draw the attention of some travelers. Construction of a slurry pipeline at this location would not meet the area's Class II visual resource objectives in the short term or long term, as the cut would be a permanent feature.

Northbound travelers on US-191 would have a 10- to 15-second view of the proposed booster pump station in Lisbon Valley. The view of the station by southbound travelers would be obstructed by a large rock outcrop. The simple, angular, geometric form of the pump station, with its smooth surfaces, and the associated barren parking area would contrast strongly with the more complex, semi-rugged, vegetated surroundings. Figure 4–19 shows a photo simulation of the proposed pump station and newly constructed pipeline. Because the size of the station would be relatively small against the massive, prominent rock outcrops and cliff faces in the background, the overall contrast would be weak for most travelers. The proposed action would meet the area's Class III visual resource objectives.

Across Recapture Creek canyon, the pipeline corridor would parallel an existing pipeline at the base of the existing Recapture Creek dam and US-191 road grade. Travelers on US-191 would not likely see the pipeline corridor as they crossed the dam because of the downward viewing angle and their travel speed. Rather, their attention would likely be focused on the strikingly deep blue-green water of Recapture Creek Reservoir and the rugged cliffs of the Burro Canyon Formation. After the pipeline was removed and the corridor revegetated, the corridor would not be visible. Construction of a slurry pipeline at this location would be compatible with BLM's Class II visual resource objectives.

Construction of the remainder of the pipeline route that would be visible to the general public would be expected to meet BLM's Class III and Class IV visual resource objectives. In these areas, the smooth, linear, unvegetated swath created by pipeline construction would contrast moderately with the surrounding landscapes (see Section 3.4.19.9). After the pipeline was removed and the corridor revegetated, the contrast between the corridor and surrounding landscape would be moderate to nonexistent, depending upon the success of revegetation. Figure 4–20 shows a photo simulation of the booster pump station area in Lisbon Valley after reclamation.

4.4.11.4 Monitoring and Maintenance Impacts

Monitoring and maintenance activities under the White Mesa Mill off-site disposal alternative would have no impacts to visual resources.

4.4.11.5 Impacts from All Sources

Moving the uranium mill tailings pile from the Moab site to the White Mesa Mill site would have some moderate, short-term, adverse visual impacts and moderate to no long-term adverse visual impacts, primarily because the short-term construction activities and the completed disposal cell would not be seen by many people. At the Moab site, removal of the pile would have strong beneficial impacts to visual resources. Table 4–46 summarizes visual resource impacts expected under this alternative.

Table 4–46. Summary of Visual Resource Impacts Under the White Mesa Mill Off-Site Disposal Alternative

Location/Activity	Visual Resource Impacts	
	Short Term	Long Term
Moab site	Strong adverse impacts primarily to travelers on US-191 and SR-279	Strong positive impacts from removal of tailings pile
White Mesa Mill site	Minor adverse impacts from night lighting	Unknown impacts from night lighting
White Mesa borrow area	No adverse impacts	No adverse impacts
Blanding borrow area	Moderate adverse impacts to southbound US-191 travelers	No adverse impacts
Truck haul[a]	No adverse impacts	No adverse impacts
Slurry pipeline[a]	Overall, moderate adverse impacts to travelers on US-191	Overall, moderate to no adverse impacts to travelers on US-191
Monitoring and maintenance	No adverse impacts	No adverse impacts

[a] Only one transportation option would be selected.

4.4.12 Infrastructure

This section addresses potential impacts on the availability of electric power, potable water, nonpotable water, sewage treatment, and highways under the White Mesa Mill off-site disposal alternative. Unless indicated otherwise, all infrastructure impacts would be temporary and would last only as long as project construction and operations were ongoing.

4.4.12.1 Construction and Operations Impacts at the Moab Site

The infrastructure impacts associated with construction and operations at the Moab site would be the same as those described in Section 4.2.12.1 for the Klondike Flats site, with the exception of the electric power demand under the slurry pipeline option. Under that option, the power demands would be 6,100 kVA, 2,700 kVA more than for the Klondike Flats site. ESC Inc. developed and reviewed this projected demand with Mathew Yates, Pacific Corporation, Moab. Pacific Corporation indicated that this demand would present no capacity problems to the existing electric supply system at the site, nor would system upgrades be required (ESC 2003).

4.4.12.2 Construction and Operations Impacts at the White Mesa Mill Site

Qualitatively, the infrastructure impacts associated with construction and operations at the White Mesa Mill site would be the same as those described for the truck and pipeline options in Section 4.2.12.2 for the Klondike Flats site and in Section 4.3.12.2 for the Crescent Junction site, with the exception of electric power demands. The impact on the existing electrical infrastructure servicing the White Mesa Mill site would differ for the two alternative modes of transportation. For truck transportation, the total power demand at the White Mesa Mill site would be 300 kVA, which is the basic demand required for site construction and operations. The same basic demand would be required at the Klondike Flats or Crescent Junction sites. For slurry pipeline transportation, the demand would be 3,100 kVA, 600 kVA more than for the Klondike Flats site and 300 kVA more than for the Crescent Junction site. ESC of Fort Collins, Colorado, developed and reviewed this projected demand with Mathew Yates, Pacific Corporation, Moab. Pacific Corporation indicated that capacity of the existing distribution circuit would be adequate for the truck haul option. However, the slurry pipeline transport system would require the addition of a substation transformer at Utah Power's Blanding substation and a distribution upgrade from the substation to the White Mesa Mill site. In addition, the intermediate slurry pump booster station facility would require (1) the addition of a substation transformer at Utah Power's La Sal substation, (2) a new 3-mile power line extension to the proposed site of a pump booster station, and (3) an upgrade of the existing line from the La Sal substation to its current end point (ESC 2003).

Quantitatively, potable and nonpotable water demands would be the same as those previously described for the Moab site in Section 4.2.12.1 and the other two off-site disposal sites in Sections 4.2.12.2 and 4.3.12.2. However, in contrast to the other sites, the sources of the water would not be the city of Moab (for potable water) or the Colorado River (for nonpotable water). The Entrada/Navajo aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm (216,000 to 324,000 gallons per day) and is used as a secondary source of potable water for the White Mesa Mill. IUC has constructed five deep water supply wells at the White Mesa Mill. The yield capabilities from these wells would be sufficient to meet the maximum demand for potable water from implementing the proposed action at the White Mesa Mill site—that is, 7,500 gallons per day for the truck transportation option. Nonpotable water would be drawn from the existing Recapture Reservoir, where IUC currently holds major water use rights.

Activities at the White Mesa Mill site would generate 5,000 to 11,000 gallons of sanitary waste per week, depending on the transportation mode. This volume would be in addition to the 10,000 gallons per week generated at the Moab site. Sanitary waste generated at the White Mesa Mill site would be disposed of in the on-site, State-approved leach field system or in the city of Blanding's sewage treatment plant. The White Mesa Mill currently disposes of all its sanitary waste in the leach field system. However, it is unknown whether this system has the capacity to manage the sanitary waste that would be generated by the additional workers required at the site. If necessary, the additional sanitary waste could be stored at the White Mesa Mill site in portable toilets and septic tanks and disposed of in the Blanding sewage treatment plant. The Blanding sewage treatment plant has the capacity to serve 5,000 people, but only 3,000 people currently dispose of sanitary waste at the plant. Consequently, there would be sufficient excess capacity to accommodate the additional workers at the site under either transportation mode. There are currently no restrictions for receiving concentrated sanitary waste of the type stored in septic tanks and portable toilets.

4.4.12.3 Construction and Operations Impacts Related to Transportation

For the truck transportation option, there would be no infrastructure impacts above the 300 kVA demand for site construction and operations. However, the slurry pipeline option would represent an additional demand of 2,800 kVA for the pipeline terminal station. The slurry pump booster station that would be required for pipeline operations represents a demand of 4,800 kVA; it would require the installation of a new substation transformer at the Utah Power La Sal substation, approximately 3 miles of new distribution line from the new substation to the proposed booster pump location, and an upgrade of the existing line from the La Sal substation to its current end point.

Impacts to the road infrastructure would be qualitatively similar to those described in Section 4.2.12.3.

4.4.12.4 Monitoring and Maintenance Impacts

Under the White Mesa Mill off-site disposal alternative, monitoring and maintenance activities would be generally limited to periodic inspections and activities to remedy incipient erosion, as necessary. DOE does not expect these activities to affect the local or regional infrastructures.

4.4.12.5 Impacts from All Sources

Regional and local supplies of power, water, and sewage treatment capacity would be adequate to meet the requirements of the White Mesa Mill off-site disposal alternative. Transportation would cause increased wear on roads, which would be paid for through vehicle registration and special permit fees.

4.4.13 Solid Waste Management

Waste management impacts would be the same as those described for the Klondike Flats site in Section 4.2.13, except that the estimated 1,040 yd^3/year of solid waste generated at the White Mesa Mill site would not be sent to a municipal or county landfill. Consistent with White Mesa Mill practice, all solid waste generated at the site would be disposed of in an existing or in the new tailings disposal cell. This additional annual waste volume amounts to a cube approximately 10 yards on a side and would be insignificant compared to the volume of the disposal cell.

4.4.14 Socioeconomics

The socioeconomic impacts from off-site disposal at the White Mesa Mill site would be similar in scope to those described in Sections 4.2.14 and 4.3.14. The aggregate expenditures under this alternative would cover construction and surface remediation at the Moab and White Mesa Mill sites, ground water remediation, remediation of vicinity properties, and transportation of materials from the Moab site and vicinity properties to the White Mesa Mill site. The project cost data and economic impact estimation methodology are described in Section 4.1.14.

The economic impacts of off-site disposal at the White Mesa Mill site are summarized in Table 4–47. Truck transport and slurry pipeline transport options are considered under the White Mesa Mill off-site disposal alternative. Over the 8-year disposal period, the annual project costs are estimated to be $52,522,525 under the truck transport option and $58,224,925 under the slurry pipeline transport option. In both cases, the 75-year ground water remediation/site monitoring phase of the project is estimated to cost $933,000 per year. The truck transport option

Table 4–47. Economic Impacts in the Two-County Socioeconomic Region of Influence Under the White Mesa Mill Off-Site Disposal Alternative

Transport Method	Annual Cost	Annual Output of Goods and Services	Annual Labor Earnings		Jobs
Truck	$52,522,525	$69,214,183		$17,069,821	598
Pipeline	$58,224,925	$76,728,806	Year 1	$18,923,101	778
			Years 2–8	15,336,642	320

Note: Economic impacts for regional output of goods and services and labor earnings are calculated based on final-demand multipliers provided by the Bureau of Economic Analysis. The respective multiplier values (1.3178 and 0.3250) are multiplied by annualized cost to generate the impact values shown. Employment impacts are calculated as the product of the direct-effects multiplier (1.4262) and total direct jobs for each action alternative (see Tables 2–16, 2–17, and 2–18).

would increase regional output of goods and services by $69,214,183 a year. Under the slurry pipeline option, the demand for goods and services would increase by $76,728,806. The new spending would also increase labor earnings and employment. Under the truck transport option, earnings and employment would rise by $17,069,821 and 598 direct and indirect jobs. Under the slurry pipeline option, the increase in labor earnings and employment would be $18,923,101 and 778 direct and indirect jobs during the first-year construction phase of the pipeline. Thereafter, earnings and employment would scale down to $15,336,642 and 320 direct and indirect jobs.

The potential shorter-term impacts under the White Mesa Mill off-site disposal alternative would include increased demand for temporary housing (discussed in Section 4.1.14) and transportation-related inconveniences to motorists (discussed in Section 4.4.16). The extent of these shorter-term impacts would depend on levels of tourism-recreation activities and the mode of transportation used in the remediation process. Longer-term beneficial impacts under the off-site disposal alternative would relate to greater opportunities for economic development in the Moab area and the communities of San Juan County and greater diversification of the tax base (discussed in Section 4.1.14).

4.4.15 Human Health

This section addresses potential impacts to human health under the White Mesa Mill off-site disposal alternative. These impacts are worker deaths that could occur as a result of industrial accidents and worker or public latent cancer fatalities that could occur as a result of exposure to radiation from activities at the Moab and White Mesa Mill sites, at vicinity properties, or during transportation of materials.

4.4.15.1 Construction and Operations at the Moab Site and the White Mesa Mill Site

Under the White Mesa Mill off-site disposal alternative, construction activities would occur at vicinity properties, borrow areas, White Mesa Mill, and the Moab site. Table 4–48 lists the impacts from these activities. For each option under this alternative, less than one fatality would be estimated to occur from construction activities.

Table 4–48. Construction-Related Fatalities for White Mesa Mill Disposal Alternative

Alternative	Construction Fatalities
Truck Option	
Vicinity properties	0.031
Borrow areas	0.042
Moab and White Mesa Mill activities	0.31
Total	**0.38**
Slurry Option	
Vicinity properties	0.031
Borrow areas	0.042
Moab and White Mesa Mill activities	0.47
Total	**0.54**

Workers. Under the White Mesa Mill off-site disposal alternative, workers would be exposed to radon gas (an inhalation hazard) and external radiation from the mill tailings at the Moab site, vicinity properties, and at White Mesa Mill. Monitoring data collected during construction of an evaporation pond on the tailings pile at the Moab site indicate that the highest radon level measured on the pile was 0.096 working levels (21 pCi/L). A worker exposed to this level of radon for 2,000 hours per year would have a latent cancer fatality risk of 6.1×10^{-4} per year of exposure. The highest gamma exposure rate measured on the mill tailings pile was about 0.60 mR/h. A worker exposed to this level of radiation for 2,000 hours per year would have a latent cancer fatality risk of 6.0×10^{-4} per year of exposure. The total latent cancer fatality risk to the worker on the mill tailings pile would be 1.2×10^{-3} per year of exposure (Table 4–49) or 6.0×10^{-3} over the 5-year duration of activities at the Moab site. Assuming that the radon and external radiation levels were comparable at White Mesa Mill, this would also be the latent fatality risk at the White Mesa Mill site.

Table 4–49. Worker Impacts Under the White Mesa Mill Off-Site Disposal Alternative

Worker	Site	Radon Related LCFs[a,b]	External Radiation Related LCFs[a,b]	Total LCFs[a,b]
Annual				
Individual	Moab	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	White Mesa Mill	6.1×10^{-4}	6.0×10^{-4}	1.2×10^{-3}
	Vicinity properties	2.9×10^{-4}	1.2×10^{-4}	4.1×10^{-4}
Population	Moab	0.041	0.040	0.081
	White Mesa Mill	0.043	0.042	0.085
	Vicinity properties	6.7×10^{-3}	2.9×10^{-3}	9.6×10^{-3}
	Total	**0.091**	**0.085**	**0.18**
5-Year Duration of Activities				
Individual	Moab	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	White Mesa Mill	3.0×10^{-3}	3.0×10^{-3}	6.0×10^{-3}
	Vicinity properties	8.7×10^{-4}	3.7×10^{-4}	1.2×10^{-3}
Population	Moab	0.20	0.20	0.40
	White Mesa Mill	0.21	0.21	0.42
	Vicinity properties	0.020	8.6×10^{-3}	0.029
	Total	**0.43**	**0.42**	**0.85**

[a] Based on 67 workers at the Moab site, 70 workers at the White Mesa Mill site, and 23 workers at vicinity property sites.
[b] LCF = latent cancer fatality.

The Moab site would employ about 67 workers. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.081 per year of exposure, or 0.40 over the 5-year duration of activities at the Moab site. The White Mesa Mill site would employ about 70 workers. If they were all exposed to radon and external radiation at the levels discussed for individual workers, the latent cancer fatality risk for this population of workers would be 0.085 per year of exposure, or 0.42 over the 5-year duration of activities at White Mesa Mill.

Impacts to workers as a result of activities at the vicinity properties would be the same as those under the on-site disposal alternative, as would be the lack of impacts from ground water treatment; these impacts are described in Section 4.1.15.2.

Under the White Mesa Mill off-site disposal alternative, nearby residents would be exposed to radon gas released at the Moab site and at the White Mesa Mill site. The average radium-226 content of the tailings, 516 pCi/g, would produce a latent cancer fatality risk for a nearby resident in Moab of 8.8×10^{-3} over the 5-year duration of activities at the Moab site and 7.8×10^{-6} over the 5-year duration of activities at the White Mesa Mill site. These estimates include radon released from the drying areas at Moab. If a slurry pipeline were used to move the tailings to the White Mesa Mill site, the drying areas would not be necessary, and the resulting latent cancer fatality risk for a nearby resident at Moab would be reduced to 6.9×10^{-3} over the 5-year duration of activities at Moab.

For the population, over the 5 years of activities at White Mesa Mill, the latent cancer fatality risk to the population surrounding the White Mesa Mill site would be 0.012. Over the 5 years of activities at the Moab site, the latent cancer fatality risk to the population surrounding the Moab site would be 1.0. If a slurry pipeline were used to move the tailings to White Mesa Mill, the drying areas would not be necessary, and the resulting latent cancer fatality risk for the population surrounding the Moab site would be reduced to 0.74 over the 5-year duration of activities at the Moab site.

Nearby residents would also be exposed to radioactive particulates (e.g., radium-226, polonium-210, thorium-230, and uranium) windblown from the Moab site and from the White Mesa Mill site. Estimates based on monitoring data collected during 1998 and 1999 from the Monticello mill tailings site when uranium mill tailings were being excavated indicate that the latent cancer fatality risk from radioactive particulates would be about 0.1 percent of the risk from radon emissions from the Moab site and the White Mesa Mill site. This is due to the aggressive dust suppression practices that would be used to minimize emissions of radioactive particulates.

4.4.15.2 Construction and Operations Impacts Relating to Transportation

Under the White Mesa Mill off-site disposal alternative, there would be a total of 292,888 shipments if trucks were used to move the tailings (Table 4–50). If a slurry pipeline were used to move the tailings, there would be 26,276 shipments. These shipments would include contaminated material from vicinity properties, uranium mill tailings, and borrow material, which would consist of cover soils, radon and infiltration barrier soils, sand and gravel, riprap, and Moab site reclamation soils.

Table 4–50. Shipments Under the White Mesa Mill Off-Site Disposal Alternative

Material	Truck Option		Slurry Pipeline Option	
	Shipments	Mode	Shipments	Mode
Vicinity property material	2,940	Truck	2,940	Truck
Borrow material	21,148	Truck	21,148	Truck
Uranium mill tailings	268,800	Truck	2,188	Truck
Total	**292,888**		**26,276**	

The transportation impacts of shipping contaminated materials from vicinity properties, mill tailings, and borrow material would be from two sources: radiological impacts and nonradiological impacts. Radiological impacts would be from incident-free transportation and from transportation accidents that released contaminated material. There would be no radiological impacts from moving borrow material because it is not contaminated. Nonradiological impacts would be from engine pollutants (emissions from the truck moving the contaminated materials from vicinity properties, the mill tailings, and the borrow material), and from traffic fatalities. The total transportation impacts would be the sum of the radiological and nonradiological impacts. Additional details on these analyses are provided in Appendix H.

Table 4–51 lists the transportation impacts under the White Mesa Mill off-site disposal alternative. For this alternative, there would about one fatality if trucks were used to move the tailings. If a slurry pipeline were used, there would less than one fatality. In comparison, about 40,000 traffic fatalities occur annually in the United States (U.S. Census Bureau 2000).

Table 4–51. Transportation Impacts Under the White Mesa Mill Off-Site Disposal Alternative

Alternative	Radiological			Nonradiological		Total Fatalities
	Incident-Free		Accident Risk LCFs	Pollution Health Effects Fatalities	Traffic Fatalities	
	Public LCFs	Worker LCFs				
Truck Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	1.2×10^{-3}	0.053	0.054
Mill tailings	0.026	0.049	1.4×10^{-6}	0.067	1.2	1.3
Total	**0.026**	**0.049**	$\mathbf{1.4 \times 10^{-6}}$	**0.069**	**1.3**	**1.4**
Slurry Option						
Vicinity properties	2.7×10^{-5}	3.9×10^{-5}	6.9×10^{-9}	3.7×10^{-4}	1.1×10^{-3}	1.5×10^{-3}
Borrow material	0	0	0	1.2×10^{-3}	0.053	0.054
Mill tailings	2.1×10^{-4}	4.0×10^{-4}	1.1×10^{-8}	5.4×10^{-4}	9.6×10^{-3}	0.011
Total	$\mathbf{2.4 \times 10^{-4}}$	$\mathbf{4.4 \times 10^{-4}}$	$\mathbf{1.8 \times 10^{-8}}$	$\mathbf{2.1 \times 10^{-3}}$	**0.064**	**0.067**

LCF = latent cancer fatality

Workers. For truck shipments of mill tailings from the Moab site to White Mesa Mill, the maximally exposed transportation worker would be the truck driver. This person was assumed to drive the truck containing mill tailings for 1,000 hours per year. For the other 1,000 hours per year, the truck would be empty. This driver would receive a radiation dose of 220 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-4}.

Public. For truck shipments of mill tailings from the Moab site to White Mesa Mill, the maximally exposed member of the public would be a resident who lived along the road on which the tailings were shipped. This person would receive a radiation dose of 1.0 mrem/yr, which is equivalent to a probability of a latent cancer fatality of about 6.3×10^{-7}.

Accidents. If trucks were used to transport the mill tailings from the Moab site to White Mesa Mill, the maximally exposed individual would receive a radiation dose of 0.16 mrem, or 1.6×10^{-4} rem from the maximum dose reasonably foreseeable for a transportation accident involving a shipment of mill tailings. This is equivalent to a probability of a latent cancer fatality of about 9.6×10^{-8}. The probability of this accident is about 0.3 per year.

If this accident occurred near Moab, Monticello, or Blanding, the population would receive a collective radiation dose of 1.8×10^{-3} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.1×10^{-6}. If this accident occurred in a rural area, the population would receive a collective radiation dose of 2.9×10^{-6} person-rem, which is equivalent to a probability of a latent cancer fatality of about 1.7×10^{-9}.

4.4.15.3 Monitoring and Maintenance

Monitoring and maintenance activities would include checking water quality and installing a long-term ground water remediation system at the Moab site, and conducting periodic maintenance and inspections of the White Mesa Mill site (checking for erosion, damaged fencing, etc.). None of these activities would be expected to breach the cap over the tailings. Installation of the ground water remediation system at the Moab site would be done in clean areas after remediation was complete. Data from another UMTRCA site indicate that the White Mesa Mill off-site disposal alternative would be effective in isolating the contaminants in the tailings from individuals conducting activities on the site. DOE (2001) concluded that both radon and gamma levels associated with the capped-in-place tailings pile at the Shiprock site in New Mexico were indistinguishable from naturally occurring radiation levels. Therefore, the latent cancer fatality risk to workers conducting monitoring and maintenance would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

4.4.15.4 Impacts from All Sources

Under the White Mesa Mill off-site disposal alternative, less than one fatality would be estimated to occur from construction activities under either transportation option. Transportation of contaminated materials from the Moab site to the White Mesa Mill site would result in the exposure of workers and the public to very small amounts of radiation; these exposures would not be expected to result in any latent cancer fatalities to any population. Ammonia releases from ground water remediation would be well below threshold concentrations for human health effects.

Based on as-built radon flux measurements from completed uranium mill tailings disposal cells constructed under both Title I (federal UMTRA sites) and Title II (private licensees) of UMTRCA, it is anticipated that actual radon flux would be two orders of magnitude less than the 20-pCi/m^2-s EPA protective standard promulgated in 40 CFR 192. However, even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible and that DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 pCi/m^2-s, under EPA's regulations (40 CFR 192).

On the basis of this emission rate and the dimensions of the disposal cell, the latent cancer fatality risk for a nearby resident would be 6.4×10^{-8} per year of exposure, or 1.9×10^{-6} over the 30-year period following the end of construction and operations. This latent cancer fatality risk is less than the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

For the population near the White Mesa Mill site, the latent cancer fatality risk would be 3.0×10^{-3} over the 30-year period following the end of construction and operations.

At the Moab site, radon emissions would fall to background levels because the mill tailings pile would have been relocated. The latent cancer fatality risk would be comparable to the risk from background levels of radioactivity in Utah, about 3×10^{-4} per year of exposure.

The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the half lives of the radionuclides contained in the uranium mill tailings. In the time frame of 200 to 1,000 years, the major route of exposure of people is likely to be inhalation of radon progeny from the disposal cell. A person could drill a well into the shallow aquifer near the White Mesa Mill site, but it is more likely that this person would use the surface water at Ruin Spring, located about 10,000 ft from the disposal cell. The travel time for contaminants from the disposal cell to the spring is in the range of 3,570 to 7,690 years, so it is unlikely that the water at Ruin Spring would contribute large latent cancer fatality risks relative to inhalation of radon progeny. With the disposal cell cover in place and the White Mesa Mill site under perpetual care, it is likely that the latent cancer fatality risk for an inadvertent intruder would also be low.

After the disposal cell cover was installed, the estimated annual latent cancer fatality risk from radon for a nearby White Mesa resident would be 6.4×10^{-8}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. Therefore, the annual latent cancer fatality risk for a nearby White Mesa resident would be about the same immediately after the cover was installed as it would be 1,000 years after the cover was installed. This assumes that the nearby resident remains at his or her present location. If the resident were to move closer to the disposal cell, the annual latent cancer fatality risk would be similar to the risk at the Moab site, 8.9×10^{-5} per year of exposure.

Based on the 20 pCi/m^2-s radon release rate, for the population within a 50-mile radius of the White Mesa Mill site, the annual latent cancer fatality risk was estimated to be 9.9×10^{-5}. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time frame. If it is assumed that the population around the White Mesa Mill site remains constant over 1,000 years, then the estimated latent cancer fatality risk over the 1,000-year time period would be 0.1.

4.4.16 Traffic

This section summarizes potential impacts to traffic in the area affected under the White Mesa Mill off-site disposal alternative. In the following discussions, estimated percent increases in traffic are based on increases over the 2001 AADT for all vehicles or for trucks on segments of US-191 (see Table 3–15). Implementation of this alternative would increase area traffic because of construction and operations at the Moab site, remediation of vicinity properties, transport of tailings from the Moab site to the White Mesa Mill site, and transport of borrow materials from borrow areas to the Moab site, vicinity properties, and the White Mesa Mill site.

There would be initial minor short-term (period of several months) increases in area traffic on US-191 while various preparations took place at the Moab site and at the White Mesa Mill site. These activities would include bringing heavy construction equipment, such as backhoes, graders, front-end loaders, bulldozers, and trucks, to those sites; and constructing secure stockpile areas for various materials to be used during the remedial action (e.g., diesel fuel, water for dust control). In addition, a variety of construction trades would need to access the sites to set up temporary field offices and prepare road access areas. These activities would add to area traffic and could result in minor congestion and inconveniences near the site entrances on US-191.

Construction workers would commute to the Moab site for jobs at the site, at vicinity properties, and at borrow areas. DOE estimates that the average annual vehicle trips associated with 190 workers could increase daily traffic in central Moab by 380 vehicle trips per day on US-191 (truck transportation mode). Transportation-related workers would also commute to jobs. An additional 458 vehicle trips per day on US-191 would be attributed to the 229 transportation-related workers. It is likely that one-half or more of these workers (minimum of 115 workers) would live in towns south of Moab, such as Monticello, Blanding, or White Mesa, and would not affect travel patterns in Moab. However, if all workers commuted through central Moab, it would increase traffic there by 5 percent. (The pipeline transportation mode could increase traffic in downtown Moab by 3 percent). The current traffic situation in Moab is reported by UDOT as highly congested, and these additional vehicle trips would exacerbate the current congestion problem. Miscellaneous trips for supplies and meals would also add to traffic congestion. It is expected that some workers would car-pool, which would reduce travel impacts. In addition, assuming a double work shift, approximately half of these trips would occur before 7:00 a.m. and just after 4:00 a.m., times of the day when traffic volumes are typically lower. The impact associated with the 502 pipeline construction workers was not considered a worst-case scenario due to the relatively short time frame (9 months) and transient nature of the construction. A double work shift would involve the first shift arriving before 7:00 a.m. and leaving just after 5:30 p.m. The second shift would arrive just before 5:30 p.m. and leave just after 4:00 a.m.

Transporting contaminated vicinity property material to the Moab site and transporting clean backfill material to the vicinity properties would require up to 48 daily truck trips on local roads and US-191. Some or most of these trips would transit central Moab (Section 2.1.2.2). Assuming the worst-case traffic scenario of a double work shift, transporting all contaminated material from the Moab site to the White Mesa Mill site would require an estimated 768 daily tandem truck trips (calculated from Table 2–9) on US-191, all of which would transit central Moab. UDOT reports the 2001 average annual daily truck traffic through central Moab as 4 percent of the total vehicle count, or 642 trucks. Truck traffic related to hauling materials (tailings and vicinity property material) through central Moab would result in a 127-percent increase in downtown truck traffic, from 642 trucks to an estimated 1,458. Although this increase would be distributed evenly over the 20 hours per day that work was ongoing under a double-shift work schedule, it would be an extreme impact to the already congested central Moab area, particularly during the peak tourist season when daily vehicle counts are highest.

For the segments of US-191 from south of central Moab to the White Mesa Mill site, the truck traffic on US-191 constitutes between 7 and 14 percent of the total vehicle traffic, or between approximately 370 to 1,190 trucks per day, depending on the segment of US-191. Adding 768 tandem trucks per day would increase truck traffic between 65 and 186 percent, depending on the segment. Although the percent change would be high, for most of the route between Moab and the White Mesa Mill site, the average daily traffic counts and truck use are low, and UDOT does not report any of the route as congested.

A slurry pipeline would also require limited transport of materials by truck. Transport of oversized materials that could not be transported by pipeline would result in additional minor use of trucks on US-191 (about six truck trips per day). In addition, borrow materials would be transported as described under the truck transportation option above.

Annual monitoring and maintenance activities at the site would result in no increases in traffic volumes.

4.4.17 Disposal Cell Failure from Natural Phenomena

It is possible that a disposal cell failure could occur at the White Mesa Mill site. The possibility of failure at this site would be much lower than at the Moab site because it was selected for analysis, in part, to avoid the more dynamic characteristics of the Moab site (see Chapter 3.0). The White Mesa Mill site is not located near a river, does not have historical seismic activity, and is not prone to settling. In addition, this site is located farther away from populated areas or sensitive habitats than the Moab site, which would reduce the potential risks if a disposal cell failure occurred. Therefore, the possibility of a failure occurring and resulting in potential risks at the White Mesa Mill site would be much lower than the potential risks of a disposal cell failure at the Moab site. For this reason, potential failure at this site was not evaluated.

4.4.18 Environmental Justice

The basis for DOE's analysis of environmental justice impacts is described in Section 4.1.18. The area approximately 20 miles south of the White Mesa Mill site has a large segment in which the minority population is greater than 50 percent. The White Mesa Ute Reservation is adjacent to the White Mesa Mill site, and the Navajo Reservation occupies a significant portion (28 percent) of San Juan County, where the White Mesa Mill site is located. Reported household incomes of less than $18,244 (poverty level for a family of four) per year are found in census group blocks within about one-half of the populated areas south of the site. The lowest income block group is about 15 miles from the site. Although these populations could be exposed to small doses of radiation as a result of activities under this alternative, there is no evidence that they would be exposed at a level any higher than the general population.

To address potential exposure pathways that could be unique to members of the low-income or minority populations using the area around the White Mesa Mill, two additional human health analyses have been generated for (1) an individual consuming water from Ruin Springs and (2) an individual consuming deer meat from a deer that inhabited the vicinity of the White Mesa Mill site.

Impacts at Ruin Spring. Impacts were estimated for an individual who occupied the area in the vicinity of the Ruin Spring site, which is located about 2 miles south-southwest of the White Mesa Mill operating facilities and disposal cells. This individual was assumed to occupy the Ruin Spring site for 1 day per week or 1,248 hours per year. The individual was also assumed to breathe air containing radon and radon progeny released from the White Mesa Mill and to drink water from Ruin Spring. The drinking water consumption rate was estimated to be 2 liters per day. Impacts from drinking water consumption were estimated using radionuclide concentrations measured in 2003 at Ruin Spring. The latent cancer fatality risk for this individual was estimated to be 1.5×10^{-5} per year of exposure, or 7.4×10^{-5} over the 5 years of activities at the White Mesa Mill site.

Impacts from Subsistence Consumption of Deer Meat. Mule deer (*Odocoileus hemionus*) graze in the vicinity of the White Mesa Mill site and are harvested by local residents. Environmental data collected from 1998 through 2002 for radionuclide concentrations in forage and soil and radionuclide concentrations in water measured in 2003 were used to estimate impacts for an individual who obtained 100 percent of his meat from mule deer that graze in the vicinity of the White Mesa Mill site. This analysis assumed that the mule deer obtained 100 percent of its food and water near the White Mesa Mill site. The latent cancer fatality risk for this individual was estimated to be 4.7×10^{-8} per year, or 2.3×10^{-7} over the 5 years of activities at the White Mesa Mill site.

The risks calculated under these two unique exposure pathways would be less than those predicted for the nearby resident in Section 4.4.15.1 for the disposal of the Moab site mill tailings at the White Mesa Mill site.

Disproportionately high and adverse impacts to minority and low-income populations would occur under this alternative as a result of unavoidable adverse impacts on potential traditional cultural properties located on and near the White Mesa Mill site, the proposed White Mesa Mill pipeline route, White Mesa Mill borrow area, and Blanding borrow area (see Sections 4.4.9 and 4.5). At least 11 potential traditional cultural properties would be unavoidably and adversely affected. If this alternative were implemented, the likelihood that additional traditional cultural properties would be located (once cultural studies were completed) is extremely high. These sacred, religious, and/or ceremonial sites are associated with the Ute, Navajo, and Hopi cultures and peoples.

4.5 Borrow Areas

Impacts at borrow areas are discussed here as a separate, stand-alone topic in response to a request by BLM, one of the cooperating agencies. BLM indicated that analyzing impacts to borrow areas as a stand-alone topic would facilitate the subsequent analyses necessary to authorize DOE to use borrow material at BLM-managed borrow areas.

DOE assessed the potential impacts of removing borrow materials from 10 borrow areas (Crescent Junction, Floy Wash, Courthouse Syncline, Klondike Flats, Tenmile, Blue Hills Road, LeGrand Johnson, Papoose Quarry, Blanding, and White Mesa Mill). Figure 2–8 shows the locations of the 10 borrow areas analyzed.

As shown in Table 4–52, the impacts of removing materials from the proposed borrow areas would be similar among all the sites. Four of the sites (Floy Wash, LeGrand Johnson, Papoose Quarry, and Blanding) are existing borrow areas. Five other sites are on land managed by BLM (Crescent Junction, Courthouse Syncline, Klondike Flats, Tenmile, and Blanding) and would require the issuance of a borrow area permit by BLM. The acreages identified in Table 4–52 for BLM-managed borrow areas have been segregated for DOE's use.

Construction or upgrading of roads necessary to transport materials from borrow areas to vicinity properties or the Moab site may affect floodplains and wetlands, if present.

Short-term land use impacts would occur on borrow sites providing materials for construction. All borrow sites except those associated with the White Mesa Mill site are within grazing allotments for BLM, and grazing rights could be temporarily vacated. The borrow sites would be reclaimed, and the acreage would be available for any uses designated prior to mineral extraction. There would be no land use impacts from materials procured from commercial operations.

Tenmile, Blue Hills Road, and White Mesa Mill would be the sites with the highest potential for affecting cultural resources. DOE would conduct Class III cultural resource surveys as necessary to identify the precise numbers and types of cultural sites that could be present at the potential borrow sites and would work with BLM (if the area were on land managed by BLM), the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation to determine appropriate mitigation measures for affected sites if cultural resources were found.

Only two sites, LeGrand Johnson and Papoose Quarry, would not likely have federally listed threatened and endangered species occurring on or near the site. Appendix A1, "Biological Assessment," discusses potential effects at these locations in more detail. If it is determined that species are present and could be adversely affected, DOE, in consultation with the USF&WS, BLM, and UDWR, would implement mitigation measures. Species that could be affected are discussed in Sections 4.1.7, 4.2.7, 4.3.7 and 4.4.7. Surveys and investigations would not be undertaken for existing commercial sites.

Potential impacts to plants and wildlife would be limited to terrestrial ecological resources during the time the borrow areas would be used. Because the borrow areas have no aquatic resources, no short-term or long-term impacts would occur. No long-term impacts to aquatic or terrestrial resources would occur following reclamation of the borrow areas.

4.6 No Action Alternative

Under the No Action alternative, no contaminated materials would be remediated or removed from the Moab site or vicinity properties. There would be no ground water remediation, and no site controls or activities to protect human health or the environment would be undertaken. All site activities, including operations and maintenance activities, would cease, and public access to the site would be unrestricted.

4.6.1 Geology and Soils

Impacts to geological resources underlying the tailings pile would be the same as those under the on-site disposal alternative, as stated in Section 4.1.1.1. Contaminated on-site soils would not be disturbed. In addition, without the mitigating effect of dike construction, the effects of floods of the Colorado River may progressively erode and remove the east side of the tailings over the next 1,000 years. Soil erosion would not be controlled, and contaminated materials, including soils, could discharge to Moab Wash and the Colorado River during storms.

4.6.2 Air Quality

Without continuing dust control, air quality standards relating to particulate emissions would be violated under the No Action alternative.

4.6.3 Ground Water

Existing conditions at the Moab site would persist under the No Action alternative. Because a ground water compliance strategy would not be developed, no remedial action would be taken. The three mechanisms for contaminant transport described in Section 4.1.3 (downward seepage of contaminated fluids, upward flux of contaminants, and lateral movement of the legacy plume) would probably produce the following impacts under the No Action alternative, assuming the pile remained in the same location and was not capped.

Seepage of tailings fluids from the tailings pile would be expected to contribute a continuous source of 1,100 mg/L ammonia to the alluvial ground water. The seepage rate of pore fluids from the tailings pile would decline from the current rate of 20 gpm until most pore fluids in the tailings were drained (i.e., tailings were consolidated). Once the transient drainage was complete (in approximately 20 years), a steady-state rate of 8 gpm would be reached. The assumptions for ammonia concentrations and seepage rate as a function of time are summarized in Table 4–53.

Ground water flow and transport modeling (DOE 2003a) was performed to evaluate the impact of the No Action alternative to the ground water system near the Colorado River from the three contaminant transport mechanisms. Results of the modeling are presented in Figure 4–21. Predicted concentrations plotted in Figure 4–21 represent the maximum ammonia-N concentration from a series of observations, located along a transect parallel to the Colorado River downgradient from the toe of the tailings pile near the center of the plume. The modeling results indicate that most of the ammonia flux from the brine layer and the legacy plume in the alluvial aquifer would flush naturally to the river in approximately 75 years. At that time, it is anticipated that the maximum ground water concentrations near the river will have declined to approximately 6 mg/L.

Table 4–53. Assumptions for Liquid Drainage from the Tailings Pile and Ammonia Concentrations for the No Action Alternative

Parameter	Value
Infiltration rate	1×10^{-7} cm/s
Gravity drainage	Constant rate: 8 gpm
Transient drainage	Rate would decay from 12 gpm at present to 0 gpm at 20 years
Initial ammonia concentration seepage from base of tailings pile	1,100 mg/L
Breakthrough ammonia concentration from upper salt layer	18,000 mg/L
Arrival time	168 years
Final concentration	1,100 mg/L
Exit time	217 years

Modeling results indicate that ammonia concentrations in ground water near the bank of the Colorado River would decline from the current 500 to 1,000 mg/L ammonia to a maximum of approximately 6 mg/L in 75 years. The predicted concentration in ground water at 75 years is illustrated in Figure 4–22. As shown in Figure 4–21, the No Action alternative would not meet the 3-mg/L target goal, and ammonia concentrations would remain above background.

Discharge of contaminants to the ground water system could be affected by infiltration of precipitation and by rewetting of the base of the tailings pile during flooding, as described in Section 4.1.3. Infiltration of precipitation as a result of not capping the pile would result in seepage of 1,100 mg/L ammonia from the base of the tailings pile at a steady rate of 8 gpm. Infiltration of precipitation could also dissolve salts in the tailings, as described in Section 4.1.3. As a result, there is the potential for ammonia pore fluid concentrations, estimated to be as high as 18,000 mg/L, to influence the ground water system in approximately 168 years. The chemistry of the pore fluid would likely change as it percolated down through the tailings; thus, the ammonia concentration estimated at 18,000 mg/L could be significantly lower.

4.6.4 Surface Water

Contaminated soil and sediment runoff would not be contained and would result in contamination load to the Colorado River over several storm events. Although some soil contamination would be contained by leaving the tamarisk in place, eventually most would reach the Colorado River.

Contaminated ground water would continue to discharge to surface water, and the potential would continue to exist for contaminant concentrations in surface water to exceed federal and state aquatic water quality criteria along the bank of the Colorado River. As with the other alternatives, ground water contaminant concentrations would continue to decrease through time and would result in a corresponding decrease in surface water concentrations as well. However, this decrease would only rely on natural processes and is projected to result in a decrease of ammonia concentrations to approximately 6 mg/L. During the period of time that ground water contaminant concentrations were declining, no active remediation would be conducted, and elevated levels of contaminants, including ammonia, could be expected. Once steady-state concentrations were reached in ground water, ammonia could still be present in surface water, and concentrations would be higher than background levels.

4.6.5 Floodplain/Wetlands

Contaminated soils and the tailings pile would remain in the floodplain of Moab Wash and the Colorado River. Although the No Action alternative would result in fewer short-term surface-disturbing impacts because no construction would take place, implementation of this alternative would contaminate wetlands adjacent to the Colorado River in the long term.

4.6.6 Aquatic Ecology

Under the No Action alternative, ground water would continue to enter the Colorado River at its current state of contamination for an indefinite period of time. As discussed in Appendix A2, contaminants of concern are entering the surface water environment at concentrations that exceed acute and chronic benchmarks for aquatic biota. No ground water remediation to prevent infiltration of contamination in the tailings pile or associated buried mill wastes from reaching the ground water and subsequently entering the aquatic environment would occur under the No Action alternative.

Concentrations of the contaminants of concern are likely affecting the aquatic biota in the nearshore environment of the Colorado River. The concentrations exceed acute and chronic benchmarks (Appendix A2). The Colorado pikeminnow is likely affected by the presence of these contaminants. The bonytail and humpback chub do not inhabit the river near the site and would not likely be adversely affected. The razorback sucker, although not currently found near the site, does use habitat like that near the Moab site and would thus likely be affected. Appendix A1, "Biological Assessment," discusses potential impacts of this alternative in more detail.

4.6.7 Terrestrial Ecology

Under the No Action alternative, tamarisk at the Moab site would continue to dominate the Colorado River shoreline, and there would be no habitat impacts at the Moab site or at vicinity properties. Consequently, there would be no destruction or displacement of federal- or state-listed species, or wildlife in general, due to habitat alteration. There would also be no disturbance of wildlife except that caused by ambient levels of noise, human presence, vehicles, and other sources.

Because there would be no restoration of the tailings pile at the Moab site, animals could burrow into contaminated soils. This could result in acute and chronic toxic effects to wildlife.

Federal- or state-listed species, or wildlife in general, could be exposed to contaminants in soils at the Moab site and in adjacent nearshore surface water of the Colorado River. Exposure to contaminants in both media may occur via several pathways, including ingestion of prey and water, incidental soil ingestion, dermal uptake from soil and water, and inhalation of airborne contaminants. The primary pathway for wildlife exposure to contaminants in surface water would likely be through ingestion of prey and water within the surface water near the shoreline. Appendix A1, "Biological Assessment," discusses in detail potential impacts to federally listed species from ingestion of prey and water in the nearshore surface water.

No adverse effects are anticipated for wildlife, including federally listed species, from chemical or radioactive contaminants in surface water. However, terrestrial plants could be affected by some of the metals, but only if the plant roots extend into the freshwater aquifer or associated soil water above it. Because the depth of plant roots is currently unknown, potential impacts to plants from contaminants in soils could not be evaluated.

4.6.8 Land Use

Under the No Action alternative, the 439 acres at the Moab site would be unusable for any purpose and would be incompatible with the Grand County land use goals. The site is currently designated as a Specially Planned Area in accordance with Grand County Ordinance 346 of the Grand County North Gateway Plan. This interim planning is valid while reclamation is in effect. Future zoning allows for low-density residential housing. If no actions were taken, the property land use would have to change, because there would be no opportunity for the property to be used for any purpose, and no portion of the property would be available for future beneficial use. The surrounding property values would likely be diminished as a result of the condition of the property and of the uncertainty about the extent of residual contamination. It is also likely that the current and future land use of surrounding properties would change because of proximity to the site.

There would be no land use impacts to BLM lands. There would be no disturbance to BLM lands to secure borrow materials, and no permits or leases on BLM lands would be interrupted.

4.6.9 Cultural Resources

Cultural resources would not be affected under the No Action alternative.

4.6.10 Noise and Vibration

There would be no change in noise or ground vibration levels under the No Action alternative. Similarly, noise and ground vibration impacts associated with the operation of off-site disposal locations, borrow sites, and transportation of tailings and borrow material would not occur.

4.6.11 Visual Resources

The tailings pile would remain in its present condition under the No Action alternative. From the key observation points established for the site (see Section 4.1.11.1), the predominantly smooth, horizontal lines created by the pile would continue to create a moderate contrast with the adjacent vertical sandstone cliffs. Due to its relatively large size, the pile would dominate the view of the casual observer from the southbound US-191 and SR-279 key observation points; however, it would not necessarily be recognized as an anomalous feature, as its red color blends with the reds of the surrounding cliffs. It would likely continue to go unnoticed by many first-time visitors to the Moab area.

The moderate visual contrasts that would occur under this alternative would not be compatible with the Class II objectives that BLM has assigned to the nearby landscapes. Although DOE is not required to meet the objectives of BLM's visual resource management system on the DOE-owned Moab site, the system provides a useful way to measure the effects of the No Action alternative on visual resources.

4.6.12 Infrastructure

Implementation of the No Action alternative would not require the consumption of any additional electric power or water. No additional sanitary waste would be generated.

4.6.13 Solid Waste Management

Under the No Action alternative, DOE would not generate the previously described volumes of solid waste and RRM associated with surface and ground water remediation.

4.6.14 Socioeconomics

Under the No Action alternative, there would be no remediation of ground water or contaminated materials at the Moab site or vicinity properties. Also, public access to the site would be unrestricted, without site controls or activities to protect human health or the environment. Consequently, the potential socioeconomic impacts from the No Action alternative would relate to potential longer-term damages that would result from leaving the pile in its present form. These damages would include potential adverse effects to human health, diminished quality of land and water resources, and potential losses in future economic development opportunities.

As discussed in Section 3.1.19.2, the current risk from exposure to contaminants at the Moab site involves individuals living adjacent to the site (approximately 2,200 ft from the tailings pile) and recreational users of land adjacent to the site (e.g., Moab residents, outdoor recreation visitors). Currently, no members of this public are receiving prolonged exposure to on-site contaminants, which consist of both radioactive and nonradioactive components (e.g., heavy metals). However, in the absence of continued maintenance and monitoring activities at the site, the potential exists for longer-term adverse impacts from exposure to these contaminants.

The No Action alternative also poses greater risks of contamination of the Colorado River due to continued leaching of contaminated materials from the pile and other on-site contamination. The monetary value of these potential environmental damages is difficult to quantify. Nonetheless, the qualitative implications could involve fewer recreational uses of land in the vicinity of the Moab site. Such negative effects could diminish interest in tourism-recreational activities in the two-county socioeconomic region of influence.

As discussed in Section 3.1.18, the regional economy and its tax base are heavily dependent on the seasonally driven tourist-recreation sector. By not undertaking remedial actions at the Moab site, the potential exists for environmental damages, resulting in fewer visitors to the area and thus economic losses to the tourist-based economy in the long term.

4.6.15 Human Health

Under the No Action alternative, people who live in the vicinity properties would continue to be exposed to radon gas and external radiation. In addition, people who live near the Moab site would be exposed to radon gas and radioactive particulates released from the tailings pile.

The vicinity properties near the Moab site have not been extensively characterized. However, on the basis of data from other vicinity properties (DOE 1985), the indoor radon level at vicinity properties was estimated to be about 0.046 working levels (7 pCi/L), and the external gamma exposure rate at vicinity properties was estimated to be 120 μR/h. A person exposed for 8,760 hours per year would have a latent cancer fatality risk of 1.3×10^{-3} for radon and 6.5×10^{-4} for external gamma radiation. The total latent cancer fatality risk for a person at vicinity properties would be 1.9×10^{-3} per year of exposure, or 0.067 if this individual lived at a vicinity property for 35 years, which corresponds to the 5-year operational period plus the 30-year post-operational period evaluated for the on-site and off-site disposal alternatives. If four people lived at each of the estimated 98 vicinity properties, the latent cancer fatality risk for these 392 people would be 0.76 per year of exposure. If these people lived in the vicinity properties for 35 years, about 26 of them would die from cancer caused by the mill tailings contamination.

Monitoring data collected during 2002 and 2003 around the Moab site indicate that the radon concentration at the location of the maximally exposed individual is about 1.9 pCi/L in air. A person exposed for 8,760 hours per year would have a latent cancer fatality risk of 2.4×10^{-4} per year of exposure, or 8.3×10^{-3} for 35 years of exposure. For the population around the Moab site, the latent cancer fatality risk from radon releases would be 0.016 per year of exposure, or 0.56 for 35 years of exposure. On the basis of monitoring data collected during 2002 and 2003, the latent cancer fatality risk from radioactive particulates would be about 7×10^{-7} per year of exposure.

Because there would be no maintenance activities under the No Action alternative, the cover of the mill tailings pile would erode over time and radon releases would increase. For the maximally exposed individual, the latent cancer fatality risk from radon after the cover had been eroded would be about 1.4×10^{-3} per year of exposure, or 0.048 for 35 years of exposure. For the population around the Moab site, the latent cancer fatality risk from radon releases would be 0.15 per year of exposure, or about 5.2 fatalities for 35 years of exposure. Releases of radioactive particulates would also increase and could slightly increase these latent cancer fatality risks.

Under the No Action alternative, no future site-related activities would occur. Therefore, there would be no risks associated with monitoring and maintenance. The only potential future risks would be associated with other uses of the site by recreational users or local residents. Under this alternative, the potential future uses were assumed to be residential (on land northeast of the current tailings pile), rafting (stopping on the site to rest or eat), and camping (overnight stay in areas near the river).

Table 4–54 presents the risks that would occur from on-site contamination to a future resident, rafter, and camper on the Moab site. Using benchmarks of less than a one-in-one-million (1×10^{-6}) probability of developing cancer for the added cancer risks, a hazard index of greater than 1.0 for noncarcinogens, and a dose rate of greater than 100 mrem/yr, indicate that future risks under this alternative would likely exceed this benchmark for the residential scenario but not for the other future land uses. The detailed assumptions and calculation methods used to estimate these risk are presented in Appendix D.

Under the No Action alternative, no maintenance activities would be conducted. Over the 1,000-year time frame, the cover of the mill tailings pile would erode, and radon releases would increase. Over this period of time, the amount of radioactivity in the uranium mill tailings pile will decrease slightly, less than 1 percent, due to the half lives of the radionuclides contained in the uranium mill tailings. The ground water at the Moab site is naturally high in salts and would not be used for human consumption. Releases of radionuclides to surface water would be diluted by the flow of the Colorado River. Consequently, it is unlikely that ground water and surface water would contribute large latent cancer fatality risks relative to inhalation of radon progeny.

For a nearby Moab resident, the annual latent cancer fatality risk from radon after the cover had been eroded would be about 1.4×10^{-3}. As with the radioactivity in the disposal cell, the annual risk will also not decrease appreciably over the 200- to 1,000-year time frame. Therefore, the annual latent cancer fatality risk for a nearby Moab resident would be about the same immediately after the cover had eroded as it would be 1,000 years after the cover had eroded.

For the population around the Moab site, the annual latent cancer fatality risk from radon releases would be 0.15 after the cover had eroded. As with the radioactivity in the disposal cell, the annual risk will also not decrease appreciably over the 200- to 1,000-year time frame. If it is assumed that the population around the Moab site remains constant over 1,000 years, then an estimated 150 latent cancer fatalities over the 1,000-year time period would occur.

It is possible that an inadvertent intruder could occupy the Moab site after the cover eroded. In the short term, the external gamma exposure rates and radon concentrations would be similar to those for workers during remediation of the pile. In the long term, the risks for the inadvertent intruder would be similar to the risks shown in Table 4–54 for the residential scenario.

4.6.16 Traffic

With no work activities at the Moab site, there would be no traffic associated with accessing the site. The minor amount of traffic associated with current site activities would no longer occur.

4.6.17 Tailings Pile Failure from Natural Phenomena

Overall, the possibility of failure and the consequences would be the greatest under the No Action alternative because it would not include the use of engineering controls to mitigate impacts from floods and other natural events, as would occur under the on-site disposal alternative. Because no additional engineered enhancements (e.g., riprap) would be added under the No Action alternative, this alternative would be expected to have consequences closer to the high end of the tailings release assumptions (80 percent tailings release) and risk ranges listed for the on-site disposal alternative assuming a hypothetical failure event.

4.6.18 Environmental Justice

The basis for DOE's analysis of environmental justice impacts is described in Section 4.1.18. An assessment of the census data found that, within the 50-mile radius of the Moab site, less than 1 percent of the population had a household income below $18,244 (the poverty level for a family of four). There is no evidence that a minority population would be exposed to risk at a level higher than the general population.

Although the impacts of the No Action alternative could be high and adverse, DOE has identified no minority or low-income populations that would be disproportionately affected under this alternative.

4.7 Mitigation Measures

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of NEPA (40 CFR 1500–1508) require that an EIS include a discussion of appropriate mitigation measures (40 CFR 1502.14[f], 40 CFR 1502.16[h]). The term "mitigation measures" includes measures taken to

- Avoid impacts by not taking all or part of an action.
- Minimize impacts by limiting the degree or magnitude of the action and its implementation.
- Rectify impacts by repairing, rehabilitating, or restoring the affected environment.
- Reduce or eliminate impacts by preservation and maintenance operations during the action.
- Compensate for an impact by replacing or substituting resources or environments.

This section specifies measures that could be taken to mitigate adverse impacts associated with DOE's proposed remediation of the Moab site. Most of the mitigation measures discussed would be applicable in some degree to all of the alternative actions and transportation modes described in this EIS. Therefore, mitigation measures are not discussed for each action alternative. Those measures that would be uniquely associated with a specific alternative action or transportation mode (e.g., railroad crossing gates) are identified.

The identification of mitigation measures in this section does not constitute a commitment by DOE to undertake any or all of them. Any such commitments would be incorporated in the ROD following publication of the final EIS. A more detailed description of mitigation measures and an implementation and monitoring plan would be published after the ROD. Mitigation commitments would be tailored to the action selected in the ROD and to the specific location and environment that would be affected by the selected action.

Upon completion of this EIS and the ROD, DOE will develop a remedial action plan and other planning and monitoring documents for remediation of contaminated materials. The remedial action plan and other planning and monitoring documents will provide the conceptual engineering reclamation design and incorporate a ground water compliance strategy and corrective actions. These documents will also integrate into the remediation strategy, measures discussed in the EIS that would reduce or mitigate the impacts that would result from the proposed actions and, where appropriate, identify the mechanisms by which the success of mitigative actions will be evaluated and reported. In addition, as stipulated by the USF&WS in their Biological Opinion (Appendix A3), a biota monitoring plan and a water quality study plan will be generated and implemented to observe and report upon the effects of current and future conditions on fish and evaluate the effectiveness of ground water remediation efforts.

The measures that DOE could implement are delineated below by the specific resource area that they would affect. However, mitigation measures are not repeated where they would apply to multiple impact areas. For example, the use of tarps to cover trucks transporting tailings would mitigate both air quality and human health impacts but are identified only under air quality. Some of the mitigation measures identified below are permit requirements or standard operating procedures but are included here to illustrate the range of activities that would mitigate adverse impacts.

4.7.1 Geology and Soils

- Minimize vegetation disturbance and removal wherever possible.
- Remove and set aside the topsoil overlying borrow soils and maintain the ability of the topsoil stockpiles to support living organisms. Replace, recontour, and revegetate (reseed/replant) topsoil after removal of borrow soil.
- Recontour, revegetate, and maintain all disturbed land areas with diverse, native plant communities to the fullest degree possible.
- Use large-scale (e.g., natural windbreaks/artificial windscreens) and small-scale (e.g., baled straw, drift fences, living fences) wind/erosion control techniques, soil stabilizers (e.g., asphalt emulsions, biomulches, crimped straw, gravel mulches, polymer emulsions, straw blankets, surfactants), soil amendments (e.g., fertilizers), irrigation, and animal damage control measures, as necessary, to ensure establishment of replacement vegetation.
- Minimize soil erosion through recontouring, revegetation, and implementation of the Utah Pollution Discharge Elimination System storm water discharge requirements.
- Apply storm water management measures such as berms, drainage ditches, sediment traps, contour furrowing, retention ponds, and check dams.
- Regularly inspect and maintain project facilities, including the access roads, to ensure that erosion levels remain the same as or less than current conditions.

4.7.2 Air Quality

- Implement a dust control system following provisions in the *Fugitive Dust Control Plan for the Moab, Utah, UMTRA Project Site* (DOE 2002a), which complies with State of Utah requirements specified in the *Utah Administrative Code* titled "Emission Standards: Fugitive Emissions and Fugitive Dust" (UAC 2000). Apply liquid or solid surfactants (e.g., sodium or magnesium chloride or water) as necessary to control fugitive dust.
- Limit vehicle speeds along dirt roads or construction sites to 25 mph.
- Shut down idling construction equipment, if feasible.
- Use tarps or other mechanical means to cover haul truck beds and tailings conveyor belts.
- Use surfactants or car covers to stabilize tailings being hauled by rail.
- Use negative-pressure facilities for sieving/repulping for slurry formation.

4.7.3 Surface Water

- Develop, promulgate, and implement a storm water management plan that complies with all requirements of the Utah Pollutant Discharge Elimination System general permit and U.S. Army Corps of Engineers permit requirements.
- Place new access roads/pipeline corridors outside of ephemeral stream areas, where possible.
- Ensure that engineered crossings comply with UDEQ installation guidelines where access roads/pipeline corridors cross stream beds or dry washes. Methods may include avoiding installation during periods of flow, armoring streambanks near the culvert entrances and exits, installing culverts on straight sections of stream to ensure unimpeded flow, and following the contour of the stream channel. If access roads cross a dry wash, the road gradient should be 0 percent to avoid diverting surface waters from the channel.
- Install appropriate water and sediment control devices at all dry wash crossings, if necessary.
- Develop and implement a spill prevention and contingency plan to minimize the potential for spills of hazardous material, including provisions for storage of hazardous materials and refueling of construction equipment within confines of protective berms.
- Develop a spill containment and recovery plan and notification and activation protocols.
- Keep vehicles and equipment in good working order to prevent oil and fuel leaks.
- If the on-site alternative were selected, conduct additional studies of the upper 10 ft of salt layer in the tailings pile and, if necessary, determine appropriate mitigation options. Options may include excavation and aboveground treatment prior to placing the cap.

4.7.4 Floodplains and Wetlands

- If the on-site disposal alternative were implemented, provide flood/river migration protection to the pile by installing a buried riprap diversion wall.
- If it is conclusively demonstrated that mill-related ground water contamination is reaching the Matheson Wetlands Preserve, install and operate a ground water remediation system on the east bank of the Colorado River.
- Delineate wetlands and, wherever possible, locate construction activities (including pipeline and access roads) away from wetland areas. Where avoidance is not possible, provide

compensation for wetland impacts in accordance with U.S. Army Corps of Engineers Section 404 permitting requirements.

- Revegetate disturbed areas of the floodplain at the Moab site.

4.7.5 Aquatic Ecology

- Screen the intake to the enhanced water pump station to minimize entrainment of aquatic species.
- Implement interim actions designed to reduce contaminant concentrations in ground water to minimize impacts to aquatic species prior to the time when active ground water remediation would begin to reduce the risk to aquatic species.

4.7.6 Terrestrial Ecology

- Conduct field surveys prior to development activities to identify populations of species of concern. Adjust the construction footprint, access road alignments, or pipeline corridors to avoid them if possible.
- Minimize habitat and wildlife displacement/destruction by placing new construction in areas with relatively little habitat value and minimizing site disturbance to the extent practicable.
- Schedule ground-clearing activities during periods that would not disrupt breeding or nesting bird species of concern or migratory birds.
- Minimize the amount of time between ground clearing and site reclamation (establishment of replacement vegetation) in order to reduce the amount of time an area or habitat is taken out of wildlife use (facilitate recolonization by wildlife as expeditiously as possible).
- Avoid impacts by limiting activities near the site periphery, pointing lights downward, and installing light shields to limit the amount of light beyond the site boundary.
- Design the tailings pile cover to limit animal intrusion.

4.7.7 Cultural Resources

- Document and photograph the existing mill facilities in consultation with the State Historic Preservation Officer.
- Minimize potential adverse impacts to buried archaeological or cultural resources.

  During construction of the proposed pipeline or disposal cells, there is the possibility of encountering buried archaeological or cultural resources, including human remains. To minimize the potential adverse effects to unanticipated discoveries during construction, basic information would be provided to workers involved in ground-disturbing activities regarding the recognition of archaeological resources and Native American cultural items and the procedures to be followed upon discovery. The construction contractor would be required to ensure that discovery procedures were implemented in all applicable cases. These procedures would address the responsibilities under 36 CFR 800.13, 43 CFR 10.4, Section 3(d)(1) of the Native American Graves Protection and Repatriation Act (NAGPRA), and the State of Utah historic preservation and burial laws.

Discovery procedures (summarized below) would be addressed in detail during consultation with the State Historic Preservation Officer. Should human remains be discovered, the local coroner, law enforcement agency, and DOE must be notified immediately. If the burials were identified as being Native American, NAGPRA regulations could be applicable. Immediately after the discovery, construction in the area would cease. A qualified archaeologist would evaluate the extent of the construction exclusion zone. Construction would not resume in the area until directed by the archaeologist. In compliance with applicable state and federal laws, notification of other agencies, Native American groups, and/or the State Historic Preservation Officer could be required prior to removal to determine which party had a legitimate claim to the remains. In the event that archaeological resources were discovered after the project had begun, a qualified archaeologist would be notified, and all construction in the vicinity of the discovery would cease. An evaluation would be made regarding the extent of the construction exclusion zone, and construction would not resume in the area until directed by the archaeologist. DOE and the State Historic Preservation Officer would be notified. For expediency's sake, the newly discovered property would be considered eligible for the National Register of Historic Places (as stipulated in 36 CFR 800.13[c]) and a treatment plan would be developed to mitigate any adverse effects. However, if the property is clearly ineligible, and there is agreement with this determination by the representative of DOE and the State Historic Preservation Officer, the property would be considered not eligible and would not be subject to further consideration.

- Require site workers to receive training on the need to protect cultural resources and the legal consequences of disturbing cultural resources.
- Document the existing mill facilities in consultation with the State Historic Preservation Officer.
- Perform site-specific cultural and archeological surveys and traditional cultural properties investigations prior to any ground disturbance.
- Plan and conduct all construction (access roads, disposal cells, support facilities, etc.) so as to avoid known cultural resource sites to the fullest extent possible.
- Use existing access roads and previously disturbed land to the fullest extent possible to minimize new disturbances.
- Limit construction equipment to designated areas.
- Limit information regarding the location of cultural resources to a need-to-know basis. On maps and in specifications provided to construction contractors, indicate cultural sites as generic avoidance areas to maintain site confidentiality.
- Monitor an eligible cultural resource during surface-disturbing activities to ensure that it is avoided.
- Move cultural resource objects from areas of disturbance to nearby undisturbed areas.
- Excavate and record cultural resource data prior to the start of construction activities.
- Maintain consultations with affected tribes and communities regarding traditional cultural properties.
- Provide historical information about the former Atlas millsite and its operations to the Dan O'Laurie Canyon Country Museum in Moab, Utah.
- Construct a roadside turnout at the Moab site and erect a kiosk containing historical information about the former Atlas millsite.

4.7.8 Noise and Vibration

- Use equipment with sound-control devices installed to the fullest extent possible.
- Use equipment with muffled exhaust.
- Prohibit noise-generating construction activity within 1,000 ft of a residential structure between the hours of 10:00 p.m. and 7:00 a.m.
- Notify landowners directly affected by remediation of vicinity properties at least 48 hours before initiation of activities.
- Avoid any activities that could pose a vibration hazard to irreplaceable geologic formations (for example, the arches in Arches National Park or elsewhere).

4.7.9 Visual Resources

- Paint temporary field offices and other erected or emplaced facilities or structures a color similar to the background soils or vegetation to reduce visual impacts to potential viewers.
- Shield night lighting to reduce night sky glare that could be visible from Arches National Park.
- Plant a hedgerow of trees and shrubs between the Moab tailings pile and US-191 and SR-279 to reduce visual contrasts.
- To reduce adverse visual impacts of a permanent disposal cell on the Moab site, lessen the steepness of the side slopes, place beige- and red-colored riprap on the side slopes, and recontour the cell to a more complex, less geometric, shape.

4.7.10 Infrastructure

- Stagger or coordinate shipments of sanitary waste to the Moab sewage treatment plant to avoid taxing treatment plant capacities.

4.7.11 Traffic

- Coordinate routing and scheduling of construction traffic with state and county road staff and Union Pacific Railroad.
- Employ traffic control flaggers and post signs warning of construction activity and merging traffic when necessary for short interruptions of traffic.
- Repair any damage to local roads caused by vicinity property remediation.
- Install gates on access roads if requested to reduce unauthorized use.
- Spread debris haulage out over the life of the project to minimize transportation impacts.
- If rail transportation were identified as DOE's preferred alternative, coordinate with the Union Pacific Railroad, the DOT, and the UDOT regarding the need to enhance the safety of grade level rail/road crossings by using approaches such as signing and pavement markings, active warning devices, illumination, crossing surfaces, sight-distance improvements, geometric improvements to the roadway approaches, and closing and/or consolidating crossings.

- If it were determined that projected train frequency and speed combined with projected road traffic warranted installation of the improvements listed above, fund the improvements and, if requested by the railroad, remove and dispose of the improvements after completion of rail haul operations.

4.7.12 Health and Safety

- Use signs and a system of ropes or fences to delineate radiation control areas to reduce exposure to radioactive material.
- Control access to contamination areas.
- Perform radiological surveys and decontamination as needed to reduce the spread of and exposure to radioactive material.
- Perform industrial hygiene surveys to identify potential chemical hazards and reduce exposure.
- Decontaminate trucks and/or railcars hauling radioactive material after loading and unloading of contaminated material.
- Install a leak detection and management system if the slurry pipeline option were selected for an off-site disposal alternative.

4.8 References

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43 CFR 10. U.S. Department of the Interior, Bureau of Reclamation, "Native American Graves Protection and Repatriation Regulations."

40 CFR 50. U.S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards."

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

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5.0 Cumulative Impacts

This chapter addresses the potential for cumulative environmental impacts resulting from implementation of the on-site or off-site disposal alternatives and other past, present, and reasonably foreseeable future actions in the affected region.

Council on Environmental Quality regulations implementing the procedural provisions of NEPA require federal agencies to consider the cumulative impacts of a proposal (40 CFR 1508.25[c]). A cumulative impact on the environment is the impact that would result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). This type of assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

The on-site and off-site alternative locations under consideration are located in rural areas with no major industrial or commercial centers nearby. No past, present, or reasonably foreseeable future actions are anticipated to result in cumulative impacts when considered with the proposed alternative. However, other present and reasonably foreseeable future actions could result in cumulative impacts to the other sites when considered together with the on-site or off-site disposal alternatives. These actions are

- Seasonal tourism in and around Moab
- Widening of US-191 between Moab and Crescent Junction
- Planned Williams Petroleum Products pipeline project
- Ongoing activities at the White Mesa Mill site

These actions, and the potential for creating cumulative impacts, are addressed below.

5.1 Seasonal Tourism

Several national parks are in the vicinity of the Moab site and the off-site alternatives. Arches National Park is adjacent to the north border of the Moab site, and Canyonlands National Park is approximately 12 miles southwest of the site. In 2002, 765,000 visitor days were recorded at Arches National Park; 41,524 of that number included at least one overnight stay. Most of the land in the area is open to recreational uses, and tourism is an important part of the Moab economy. Favorable weather allows recreational access for hikers, bikers, and off-highway vehicle users and others in all seasons. The Colorado River adjacent to the Moab site is a source of extensive recreational use for spring and summer water sports. The land directly south of the Moab site is often used by campers and hikers throughout the summer. Activities at the Moab site, together with tourism, could have a cumulative impact on traffic congestion (e.g., increases in truck traffic as high as 186 percent; see Table 2–28) in central Moab.

5.2 Widening of US-191

US-191 has been upgraded to four lanes between Moab and the intersection of US-191 and SR-313. The upgrades also include adding two turn lanes at the entrance to Arches National Park, at Gemini Bridges, and at SR-313; adding a 2-mile-long bicycle lane on the northeast side of US-191; and adding center divides along some stretches of the highway. Because these upgrades were completed in 2004, and no definitive plans for additional improvements are known, it is unlikely that this highway construction project and the transport of uranium mill tailings from the Moab site would result in cumulative impacts.

5.3 Williams Petroleum Products Pipeline Project

The Williams Petroleum Products pipeline project is a recently approved project that would extend from Bloomfield, New Mexico, to Salt Lake City, Utah. The pipeline project would include (1) converting approximately 220 miles of an existing natural gas pipeline system to transport refined petroleum products from Bloomfield to Crescent Junction and (2) constructing approximately 260 miles of new refined petroleum product pipeline extending west from Crescent Junction to a terminal just north of Salt Lake City. The Williams pipeline project was approved by BLM in a ROD signed October 12, 2001; however, construction has not begun because of ongoing litigation (Mackiewicz 2003). This pipeline project would include aboveground and underground facilities near the proposed Crescent Junction disposal site. However, according to the company, as of May of 2005 there are no plans to implement the Crescent Junction aspects of this project in the foreseeable future, and the schedule for the other aspects of the propose actions is uncertain.

The purpose of the Williams pipeline project would be to transport refined petroleum products from northwest New Mexico to intermediate storage locations at Crescent Junction and Nephi, Utah, and ultimately to a terminal north of Salt Lake City, where the petroleum products could be distributed to markets in Utah and western Colorado. The pipeline project is being designed to transport up to 75,000 barrels per day of gasoline, diesel, and jet fuel (a barrel of petroleum contains 42 gallons). The project would involve

- Converting 220 miles of existing 10- and 12-inch-diameter natural-gas pipelines to transport refined petroleum products from Bloomfield to a proposed terminal east of Crescent Junction.
- Constructing a new 12-inch refined-petroleum pipeline on a 50-ft-wide right-of-way extending from the new Crescent Junction terminal to a terminal with existing refineries in the north Salt Lake City area.
- Constructing new product terminals consisting of storage tanks and truck-loading facilities at Crescent Junction and Nephi.

The portion of the project between Bloomfield and Crescent Junction is further outlined below because this segment of the pipeline project could lead to future interactions with the disposal of mill tailings at the Crescent Junction site alternative.

The 220-mile, 10- and 12-inch conversion segment would extend north from Williams Kutz Pump Station near Bloomfield to the proposed Crescent Junction terminal near the US-191/I-70 junction. The existing 10- and 12-inch pipelines currently carry natural-gas products. These pipeline segments would be retrofitted by installing 43 motor and manual valves that could be used to shut down the pipeline in the event of a large leak or failure. In addition, a new pump station would be built on approximately 4 acres near DOE's proposed Crescent Junction site. The existing pipeline segments to be converted would be used in their present condition once the valves, end piping, and pump stations are completed. Because these sections already comply with current pipeline safety requirements, they are not subject to hydrostatic testing or inspection in association with the proposed change in service (DOI 2001). The existing pipelines are situated within an existing utility corridor that includes several other utility lines, including natural gas pipelines and electric transmission lines.

The new 12-inch pipeline segment would extend from the proposed Crescent Junction terminal to an existing terminal north of Salt Lake City. Proceeding west from Crescent Junction, the first 98 miles of new pipeline would be installed within a new 75-foot-wide construction right-of-way generally running parallel to an existing utility corridor. The construction right-of-way would revert to a 50-foot-wide permanent right-of-way after surface rehabilitation. This section of new pipeline would cross the Green River once and the Price River twice. The remaining sections of new pipeline extending from Price to the Salt Lake City area would also lie within existing utility corridors. These pipeline sections are not discussed further because these areas are a considerable distance from the actions associated with the Moab project.

If implemented as conceived, the Crescent Junction terminal would be constructed on a 65-acre tract of BLM-administered land in Section 26, T. 22 S., R. 19 E. This site is adjacent to existing railroad lines and just east of the US-191/I-70 junction. The terminal facility would include petroleum product storage tanks, a truck-loading rack, vapor combustion system, electrical substation, offices, and warehouse buildings, all to be situated within a 50-acre fenced area served by a new access road connecting to US-191. The terminal offices would house control equipment and serve as an office for station operations. A technician shop and product-testing laboratory building would also be constructed at this terminal facility. The total terminal tank storage capacity would be approximately 190,000 barrels. Tanks would include three gasoline storage tanks; two fuel oil storage tanks; individual storage tanks for gasoline mix, fuel oil mix, and butane; and one relief tank. All tanks would be enclosed within an earthen berm of sufficient height to contain 110 percent of the total contents of the largest tank. Initial products planned for truck loading and shipment include regular and premium unleaded gasoline and low-sulfur No. 2 fuel oil. Vapors produced during truck loading would be collected into a positive, closed-loop system and disposed of by combustion. Average throughput for truck dispatch is estimated to be approximately 10,000 barrels per day. On the basis of use of single trucks that could load 180 barrels per load, the expected truck traffic visits would likely range from 50 to 60 trucks per day.

The new pipeline would be built in three different pipeline construction spreads. The Crescent Junction-to-Price pump station spread is considered a high-production spread that would require about 90 to 150 workers. The new pipeline construction would involve several sequences of construction, starting with clearing and grading and ending with placement of final erosion-control features and reclamation. After ground clearing and leveling, heavy equipment would be brought in to dig ditches. Ditches could be open several days until the pipe is placed and backfilled. Typical soil cover depth after placement would be approximately 3 ft or less in rocky terrain. Pump stations would be located adjacent to the right-of-way, and construction would involve the installation of pump equipment and piping. The pumps would be connected to the pipeline by lateral lines, and shutoff valves would be installed to isolate the pump stations from the pipeline in the event of an emergency. Construction of the Crescent Junction pump station would follow the same general construction procedures for the Crescent Junction terminal except that no large tanks or truck racks would be constructed. Approximately 20 to 50 workers would be needed to construct the proposed Crescent Junction pump station. Construction of the Crescent Junction terminal would require a construction crew of 20 to 30 workers for initial site work and 40 to 60 workers for tank erection and installation of the mechanical and electrical facilities. The terminal would require an estimated 8 to 12 months to complete. Construction crews would consist of general contractors, heavy equipment operators, pipe welders, electricians, instrumentation specialists, millwrights, laborers, and quality assurance specialists.

The completed pipeline would be patrolled from the air every 3 weeks at a minimum and at least 26 times per year. Williams would employ a leak-detection system integrated with its SCADA monitoring system. To help prevent external corrosion leading to leaks, a protective coating would be applied to the exterior of the new pipeline segments, and cathodic protection would be used on all pipeline segments to help minimize corrosion.

The impacts of constructing and operating the Williams pipeline project, including increases in truck traffic and consequences of an accident, could result in cumulative impacts when considered together with the impacts of constructing a uranium mill tailings disposal cell at the Crescent Junction site alternative. Even if both DOE and Williams decide to implement these projects at the same time, the magnitude of potential traffic impacts would be small, as the extent of overlapping use of roadways within the Crescent Junction area would be a mile or less before Williams employees would merge onto I-70 and no longer compete with DOE traffic.

5.4 Ongoing Operations at White Mesa Mill

The White Mesa Mill site is a 5,415-acre parcel that is privately owned by IUC. On-site facilities consist of a uranium mill, uranium-ore storage pad, and four lined uranium mill-tailings disposal cells. Since 1997, the mill has processed more than 100,000 tons of uranium ore. Although mill operations and disposal of tailings from the Moab site would occur on the White Mesa Mill site, the two operations are not expected to result in cumulative doses to the workforces for each operation because there would be sufficient distance between the two operations. This expectation is based on the assumption that there would be two separate groups of workers: one group that would work exclusively on the IUC areas of the White Mesa facility and one group that would work exclusively on the disposal cell for the Moab tailings. For each group of workers, the radon and gamma dose would be predominantly from the tailings in their immediate vicinity, not from tailings located at a distance. For example, the radon dose from tailings in a person's immediate vicinity is about 10 times greater than the radon dose from tailings located in an adjacent cell. For gamma doses, the dose from tailings in a person's immediate vicinity is more than 10 times greater than the gamma doses from tailings located in an adjacent cell.

If IUC decides to expand its operations at the White Mesa Mill site, this expansion would result in an increase in the disturbed area and a potential increase in the disturbance of cultural resources. Although expansion is unlikely given the foreseeable business climate and the available capacity in the existing disposal cells, an expansion of the facility, together with the potential use of approximately 346 acres for a disposal cell for the Moab tailings, could result in cumulative impacts to cultural resources.

5.5 References

40 CFR 1500-1508. Council on Environmental Quality, "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act."

DOI (U.S. Department of the Interior), 2001. *Final Environmental Impact Statement, Questar, Williams, and Kern River Pipeline Project*, June.

Mackiewicz, M., 2003. Personal communication, M. Mackiewicz, BLM Realty Specialist, Price (Utah) Field Office, with G. Karriker, S.M. Stoller Corporation, July 25.

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6.0 Unavoidable Impacts, Short-Term Uses and Long-Term Productivity, and Irreversible or Irretrievable Commitment of Resources

In addition to a discussion of the environmental impacts of the proposed action and a discussion of alternatives, NEPA requires that an EIS contain information on any adverse environmental impacts that are unavoidable, on short-term uses and long-term productivity of the environment, and on any irreversible or irretrievable commitment of resources.

6.1 Unavoidable Adverse Impacts

Under all action alternatives, there would be a very slight increase in radiation doses to the public and workers as a result of remediation and disposal activities, which could result in a very slight increase in excess cancer risk based on a 5-year remediation period and a 30-year post remediation exposure period. For these activities, the highest increased total risk of a latent cancer fatality for the maximally exposed member of the public in Moab for the duration of the activities would be 3.9E-3 under the on-site disposal alternative; the total risk of a latent cancer fatality for the maximally exposed member of the public in Moab for the duration of the activities under the off-site disposal alternatives would be 8.8E-3. In addition, radon exposures at the off-site disposal sites would result in a latent cancer fatality risk to the maximally exposed member of the public of 2.2E-5 at Klondike Flats, 9.4E-5 at Crescent Junction, and 9.7E-6 at White Mesa Mill.

For the population around Moab, the total risk of a latent cancer fatality would be 0.26 for the on-site disposal alternative. The total risk of a latent cancer fatality for the population around Moab for the off-site disposal alternatives would be 1.0 if the truck or rail transportation options were used, or 0.74 latent cancer fatalities if the slurry pipeline option were used. In addition, radon exposures at the off-site disposal sites would result in a latent cancer fatality risk of 0.014 for the population around Klondike, 0.010 for the population around Crescent Junction, and 0.015 for the population around White Mesa.

Under the action alternatives, it is estimated that there would be 12 latent cancer fatalities in the population exposed at vicinity properties. If the vicinity properties were not remediated, it is estimated that there would be 26 latent cancer fatalities in the population exposed at vicinity properties. For the maximally exposed individual at the vicinity properties, the risk of a latent cancer fatality is estimated to be 0.029 for the action alternatives and 0.067 if the vicinity properties were not remediated.

Under the action alternatives, there would be an unavoidable increase in truck and other construction-related traffic and traffic due to commuting workers. This unavoidable adverse impact would occur 5 to 7 days a week, would last for the duration of Moab site surface remediation activities (up to 8 years), and would primarily but not exclusively impact US-191. Off-site transportation of tailings by truck would result in the greatest increase in traffic. The highest traffic impacts would occur if tailings were trucked to White Mesa Mill. Under this disposal alternative and transportation mode there would be an unavoidable impact (121 percent increase in truck traffic) on the already congested traffic situation in downtown Moab.

Additional traffic and noise associated with remediation activities would result in displacement and increased mortality of wildlife close to construction areas and transportation routes.

Under all off-site alternatives, projected annual withdrawals of Colorado River water would exceed the 100-acre-foot protective limit set by USF&WS. Maximum estimated annual requirements range from 235 to 730 acre-feet and would continue for 3 to 5 years, depending on work schedules and transportation modes. Pipeline transportation to Klondike Flats or Crescent Junction would require the greatest volume of Colorado River water; river water requirements for a pipeline to White Mesa Mill would be partially offset by the use of Recapture Reservoir for recycle water.

Unavoidable adverse impacts to cultural resources and traditional cultural properties would likely occur under all but the No Action alternative. Unavoidable impacts would be greatest under the White Mesa Mill alternative. The density, variety, and complexity of cultural resources that would be unavoidably and adversely affected would be so great under the White Mesa Mill alternative that mitigation would be extremely difficult. Although a similar potential for unavoidable adverse effects would occur under the other alternatives, the lower densities of known resources would allow mitigation measures to be more easily implemented.

6.2 Relationship Between Local Short-Term Uses of the Environment and Long-Term Productivity

Implementation of the alternatives would create a conflict between the local short-term uses of the environment and long-term productivity. Under all alternatives, land required for the disposal cell would be unavailable for other uses in perpetuity. This conflict would be more significant for the on-site disposal alternative, given the proximity of the Moab site to the city of Moab and to heavily used recreation areas such as Arches National Park. Under the on-site alternative, at least the entire 130-acre pile would be unavailable for other uses in perpetuity. Moreover, under all alternatives, the area at the Moab site used for ground water treatment would be unavailable for at least 75 years. This area could be 40 acres or more if an evaporation technology were implemented. Also under any alternative, the final decisions on possible future release and uses of the approximately 309-acre off-pile area of the Moab site must be deferred pending a determination of the success of surface remediation.

Under the off-site alternatives, the 346- to 439-acre disposal cell areas would be unavailable in perpetuity. This conflict would be the least significant for the White Mesa Mill site alternative because that site already includes four uranium mill tailings disposal cells.

6.3 Irreversible or Irretrievable Commitment of Resources

The irreversible or irretrievable commitment of resources that would occur if the on-site or off-site disposal alternatives were implemented are (1) the use of fossil fuels in the transport of tailings and borrow materials, (2) the use of borrow materials, (3) the use of steel if the slurry pipeline transport were chosen, and (4) the use of land for the disposal cell in perpetuity. All alternatives would require an irretrievable commitment of millions of gallons of diesel fuel. The estimated total diesel fuel consumption for the on-site disposal alternative would be 4 to 5 million gallons (see Section 2.1.5.4). The estimated total diesel fuel consumption for off-site disposal would range from 12 to 20 million gallons for truck transportation, from 10 to

11 million gallons for rail transportation, and from 7 to 9 million gallons for slurry pipeline transportation.

Implementation of any of the alternatives would also require the use of borrow materials to cap the tailings pile and for site reclamation. These materials would include cover soils, radon/infiltration barrier soils, sand and gravel, and riprap. DOE estimates that the total volume of irretrievably committed borrow material would be approximately 1.7 million yd^3 for the on-site disposal alternative and 2.2 million yd^3 for each of the off-site disposal alternatives. DOE estimates that the maximum area of land that would be disturbed to extract borrow materials would be 550 acres for the on-site disposal alternative, 690 acres for the Klondike Flats or the Crescent Junction off-site disposal alternatives, and 174 acres for the White Mesa Mill off-site disposal alternative. The estimated acres of disturbed land do not include disturbances associated with obtaining sand, gravel, or riprap from commercial vendors. DOE believes these estimates represent maximum areas of disturbance; however, the final acreage of disturbed land would depend on the selection of borrow areas and depths to which borrow soils would be extracted.

Pipeline transport of tailings for off-site disposal would use between 4,400 tons (for Klondike Flats) and 24,000 tons (for White Mesa Mill) of steel that may become sufficiently contaminated to require disposal in the cell.

Under any alternative, there would be an irreversible and irretrievable commitment of the land that would be dedicated to the disposal cell. These commitments are described in Section 6.2.

All alternatives would result in the irretrievable commitment of Colorado River water, although the usages would all be within the limits of DOE's Colorado River water usage rights. Much of the use would be irretrievable because the water would be used for on-site or off-site decontamination, other construction-related uses, or possibly slurry production and ultimately would evaporate in double-lined evaporation ponds. The estimated maximum annual consumption of nonpotable water is 130 to 235 acre-feet for the rail transportation option, 135 to 240 acre-feet for truck transportation, and 730 acre-feet for slurry pipeline transportation (see Table 2–24). This water would be drawn from the Colorado River for the Klondike Flats and Crescent Junction alternatives. For the White Mesa Mill alternative, part of the decontamination water and the slurry pipeline makeup water would be drawn from the Recapture Reservoir. These annual figures are conservative upper bounds for irretrievable commitments of nonpotable water.

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7.0 Regulatory Requirements

This chapter presents descriptions of federal, tribal, and state regulatory requirements that may be applicable to the on-site and off-site disposal alternatives.

For this EIS, regulatory requirements are the laws, regulations, executive orders, and regulatory guidance that are, or may be, applicable to the alternatives analyzed in this EIS and that are critical to the decision-making process. The discussion of regulatory requirements is divided into three categories: federal, Native American, and state.

7.1 Federal Regulatory Requirements

7.1.1 National Environmental Policy Act, 42 *United States Code* (U.S.C.) §§ 4321 et seq.

NEPA requires that a federal agency evaluate the potential environmental effects of implementing a proposed action. The Council on Environmental Quality has promulgated regulations to implement the procedural provisions of NEPA. These regulations are binding on all federal agencies and are codified at 40 CFR 1500–1508. These regulations specify the content of an EIS and include requirements for cooperating agency and public involvement. In addition, DOE has promulgated its own NEPA-implementing regulations, which are codified at 10 CFR 1021. DOE has complied, or is complying, with these requirements in generating this EIS.

This EIS is also intended for use by the BLM and the NPS to meet NEPA requirements for decisions they may need to make with respect to the proposed remediation and disposal of the Moab uranium mill tailings pile. The *Bureau of Land Management Manual 1790* (BLM 1988a) and *National Environmental Policy Act Handbook* (BLM 1988b) implement BLM NEPA regulations. NPS NEPA regulations are implemented under Director's Order 12 *Conservation Planning and Environmental Impact Analysis and Decision-Making* (NPS 2001).

7.1.2 Uranium Mill Tailings Radiation Control Act, 42 U.S.C. §§ 7901 et seq., as amended

In 1978, public concern about potential human health and environmental effects of uranium mill tailings led Congress to pass UMTRCA, which amended the Atomic Energy Act. In UMTRCA (Title I), Congress acknowledged the potentially harmful health effects associated with uranium mill tailings and identified 24 inactive uranium-ore processing sites that must be considered for remedial action. UMTRCA directs EPA, DOE, and NRC to undertake certain actions as described below.

Title I of UMTRCA provides the basis for

- EPA standards for the remediation of RRM-contaminated soils, buildings, and materials that ensure protection of human health and the environment.
- EPA standards and compliance options for RRM-contaminated ground water, including supplemental standards, ACLs, and institutional controls.
- EPA standards for remediation of vicinity properties.

- NRC review of completed site remediation for compliance with EPA standards.
- NRC licensing of the site, property transfers to states, or DOE long-term surveillance and maintenance.

In 1983, Congress amended UMTRCA, directing EPA to promulgate general environmental standards for the processing, possession, transfer, and disposal of uranium mill tailings. These standards, titled "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings" (codified at 40 CFR 192 [Subparts A, B, and C]), include exposure limits for surface contamination and concentration limits for ground water contamination. DOE is responsible for ensuring compliance with surface and ground water standards at Title I sites.

Title II of UMTRCA provides the basis for regulating active uranium-ore processing sites licensed by NRC. Although it is not applicable to the inactive Moab site, it is applicable to the currently operating White Mesa Mill.

The 40 CFR 192 Subpart A disposal standards for control of RRM are design based with specific performance requirements: ensure that a disposal cell will be reasonably effective for up to 1,000 years (and a minimum of 200 years); limit the release of radon-222 to the atmosphere; and provide ground water protection. Numerical standards are provided for radon-222 releases to the atmosphere and for ground water protection. Corrective actions are required within an 18-month period if contaminant concentrations in ground water at disposal sites exceed the ground water protection standards. Provisions in 40 CFR 192 also allow for the application of supplemental standards and ACLs for ground water contaminants based on site-specific circumstances.

Radon-222

Radon is a naturally occurring inert radioactive gas found in soil, rock, and water throughout the United States. It has numerous isotopes, but radon-220 and radon-222 are the most common. Radon causes lung cancer and is a threat to human health because it tends to collect in homes, sometimes to very high concentrations. As a result, radon is the largest source of exposure to naturally occurring radiation.

Radon-222 is the decay product of radium-226. Radon-222 and its parent, radium-226, are part of the long decay chain for uranium-238. Because uranium is essentially ubiquitous in the Earth's crust, radium-226 and radon-222 are present in almost all rock, soil, and water.

Subpart B standards for cleanup provide numerical standards for cleanup that are based on concentrations of radium-226 in surface materials (e.g., soils) and for exposure to radiation in buildings. Ground water cleanup standards are the same as the protection standards specified in Subpart A. In addition to active remediation, natural flushing is an acceptable means of meeting the standards if they can be met within 100 years and if enforceable institutional controls can be put in place during this time.

Subpart C of 40 CFR 192 provides guidance for implementing Subparts A and B. Subpart C requires that standards be met on a site-specific basis using information gathered during site characterization and monitoring. A RAP is required to demonstrate how requirements of Subparts A and B are to be met. Criteria are also presented for determining the applicability of supplemental standards.

Following a decision to remediate the Moab site, DOE would prepare a remedial action plan for the site. The plan would describe the site restoration activities that, when remedial action was completed, would result in compliance with applicable environmental standards. This plan would be reviewed by NRC, which must approve the plan.

UMTRCA Title I also requires that upon completion of remedial action, each designated disposal site must be monitored and maintained by a federal agency under the NRC general license at 10 CFR 40.27. To meet this requirement, DOE would prepare a long-term surveillance plan for the disposal site. The plan would specify how DOE would care for and operate the disposal site. Upon NRC concurrence in the plan, the disposal site would be accepted under the general license. The NRC license does not expire. Thus, DOE, or a successor federal or state agency, would have responsibility to care for the disposal site in perpetuity.

7.1.3 Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (Public Law No. 106-398)

The Floyd D. Spence National Defense Authorization Act, enacted in October 2000, gave DOE responsibility for remediation of the Moab site and mandated that the site be remediated in accordance with Title I of UMTRCA. The act also directed that a Plan for Remediation be completed and that NAS provide assistance to DOE in evaluating costs, benefits, and risks associated with remediation alternatives.

7.1.4 Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)

The ESA provides for the protection of threatened and endangered species and designated critical habitat. Section 7 of the act requires federal agencies, having reason to believe that a prospective action may affect an endangered or threatened species or its critical habitat, to consult with USF&WS to ensure that the action does not jeopardize the continued existence of the species or destroy critical habitat. Endangered species and critical habitat exist in the vicinity of the Moab site.

7.1.5 Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.)

The Fish and Wildlife Coordination Act promotes more effectual planning and cooperation between federal, state, public, and private agencies for the conservation and rehabilitation of the nation's fish and wildlife and authorizes the U.S. Department of the Interior to provide assistance. This act requires consultation with USF&WS on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area.

7.1.6 Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703 et seq.)

The Migratory Bird Treaty Act, as amended, is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying conditions such as the mode of harvest, hunting seasons, and bag limits. The act stipulates that it is unlawful to "take, possess, . . . any migratory bird," unless obtained under a permit. Migratory birds may be affected by one or more of the alternatives.

7.1.7 Clean Water Act, 33 U.S.C. §§ 1251 et seq.

This act and its implementing regulations (40 CFR Parts 110–112, 122–125, 130–131, 230–231, and 404; and 33 CFR 322–330) regulate pollution prevention and discharges of point and non-point discharges, establish water quality standards, and regulate discharges of dredged or fill material into waters of the United States. Although mill tailings are exempt from the definition of a pollutant, discharges from wastewater treatment facilities (if required) may be subject to regulation under the Clean Water Act. Construction activities that disturb more than 1 acre of land require compliance with storm-water management and erosion-control regulations and require storm-water discharge permits. Dredging or filling activities of the Colorado River would also require a U.S. Army Corps of Engineers Clean Water Act Section 404 permit.

7.1.8 Rivers and Harbors Act of 1899, Section 10, 33 U.S.C. 403

This provision regulates the construction of any development or building that affects the "navigable capacity of any of the waters of the United States" and requires the U.S. Army Corps of Engineers' approval of any action "to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States. . . ."

7.1.9 Floodplain Management and Protection of Wetlands, 10 CFR 1022

DOE regulations codified at 10 CFR 1022 implement the requirements of Executive Orders 11988 (*Floodplain Management*) and 11990 (*Protection of Wetlands*) for actions that may affect these areas. Specifically, they require federal agencies to evaluate actions they may take to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain or a wetland. A portion of the Moab site falls within the 100-year floodplain of the Colorado River, and wetlands exist within and adjacent to the site; however, a formal wetlands delineation has not been conducted to date. A "Floodplain and Wetlands Assessment for Remedial Action at the Moab Site" and a Statement of Findings as required by the DOE regulations is attached as Appendix F to this EIS. Any wetland area disturbance during remediation and restoration must comply with the appropriate requirements. Wetland areas must be identified and delineated for the Moab site and any off-site project locations.

7.1.10 Safe Drinking Water Act, 42 U.S.C. 300f et seq.

The primary objective of this act is to protect the quality of public water supplies. This law grants EPA the authority to protect the quality of public drinking water supplies by establishing national primary drinking water regulations. EPA has delegated authority for enforcement of drinking water standards to the states. EPA regulations (codified at 40 CFR Parts 123, 141, 145, 147, and 149) specify maximum contaminant levels, including those for radioactivity, in public water systems, which are generally defined as systems that serve at least 15 service connections or serve at least 25 year-round residents. The city of Moab derives most of its drinking water from a well field in the Glen Canyon aquifer near the northeast canyon wall of Spanish Valley. Two water-supply wells located near the entrance to Arches National Park are located in the Navajo Formation. The Colorado River is not currently used as a drinking water supply for the City of Moab.

7.1.11 Clean Air Act, 42 U.S.C. §§ 7401 et seq., as amended

This act and its implementing regulations regulate air emissions from treatment processes and construction equipment, fugitive dust, and radon emissions from the tailings pile. The National and Secondary Ambient Air Quality Standards (codified at 40 CFR Parts 50 and 53) address standards and monitoring requirements for PM_{10} and for lead in ambient air. The National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 Subpart T) requirements are applicable to control radon emissions from the disposal of uranium mill tailings and apply to the final tailings disposal location after long-term stabilization of the disposal site has been completed as described at 40 CFR 61.221(a) and 40 CFR 61.223(e). However, the NESHAP requirements for radon emissions do not apply during periods of active remediation.

7.1.12 Archaeological Resources Protection Act, 16 U.S.C. §§ 470aa et seq., and National Historic Preservation Act, 16 U.S.C. §§ 470 et seq.

Cultural and historic resources are protected by these acts and their implementing regulations and by Executive Orders 11593 (*Protection and Enhancement of the Cultural Environment*) and 13007 (*Protection and Accommodation of Access to Indian Sacred Sites*). The regulations at 36 CFR 800 require federal agencies to take into account the effect of a proposed action on a structure or object that is included on or is eligible for the National Register of Historic Places and to establish procedures to identify and provide for preservation of historic and archeological data that might be destroyed through alteration of terrain as a result of a federal action. Cultural resources may be present in areas of the proposed alternatives.

7.1.13 Antiquities Act, 16 U.S.C. 431 et seq.

The Antiquities Act protects historic and prehistoric ruins, monuments, and objects of antiquity (including paleontological resources) on lands owned or controlled by the federal government. If historic or prehistoric ruins or objects were identified during the construction or operation of facilities, DOE would have to determine if adverse effects to these ruins or objects would occur. If so, the Secretary of the Interior would have to grant permission to proceed with the activity (36 CFR 296 and 43 CFR Parts 3 and 7).

7.1.14 Federal Land Policy and Management Act, 43 U.S.C. 1701 et seq.

The Federal Land Policy and Management Act (FLPMA), Title V, governs rights-of-way and withdrawals on federal lands administered by BLM (U.S. Department of the Interior). This act requires an application, review, and study by the administering agency and decisions by the Secretary of the Interior on withdrawal of federal lands, including terms and conditions of withdrawals. Access to and use of public lands administered by BLM are primarily governed by regulations regarding rights-of-way (43 CFR 2800) and withdrawals of public domain land from public use (43 CFR 2300).

7.1.15 Noise Control Act of 1972, 42 U.S.C. 4901 et seq., as amended

Section 4 of the Noise Control Act of 1972, as amended, directs all federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise jeopardizing health and welfare.

7.1.16 Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 et seq., as amended

RCRA gives EPA the authority to control hazardous waste from "cradle to grave," including the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also established a framework for the management of nonhazardous wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites. However, based on historical practices at UMTRA sites, there is the potential for RCRA-regulated waste to be "commingled" with RRM at some vicinity properties. Regulations governing RCRA-regulated waste are in 40 CFR 260–273. This includes waste that may be subject to recycling provisions of the regulations. For the purpose of analysis in this EIS, DOE assumed that all commingled waste would ultimately be approved for management and disposal as RRM and would be disposed of in the selected disposal cell.

7.1.17 Hazardous Materials Transportation Act, 49 U.S.C 1801 et seq.

Transportation of hazardous and radioactive materials in commerce must be conducted in compliance with all applicable state and federal regulations as codified at 49 CFR 130–180. The DOT exemption at 40 CFR 761 may be applied to the bulk transportation of regulated radioactive mill tailings. This exemption provides relief from labeling, placarding, and manifesting requirements that are normally applicable to individual bulk shipments. Bulk transportation packaging requirements for haul trucks and rail cars (e.g., diapering tailgates on haul trucks, covering loads, reducing moisture content) would apply.

7.1.18 Toxic Substances Control Act, 7 U.S.C. 136 et seq.

Some of the provisions of the Toxic Substances Control Act regulate the management and disposal of asbestos and polychlorinated biphenyls (PCBs) that may be present at the site. Although these materials would be managed as RRM on the site, regulations in 40 CFR 761 and 763 would be applicable as best management practices. Both asbestos and PCBs are eligible for disposal in UMTRA disposal cells.

7.1.19 Executive Order 12898 (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, February 11, 1994)

This executive order requires each federal agency to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

7.2 Native American Regulatory Requirements

7.2.1 American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)

This act reaffirms Native American religious freedom under the first amendment to the U.S. Constitution and establishes policy to protect and preserve the inherent and constitutional right of Native Americans to believe, express, and exercise their traditional religions. This law ensures the protection of sacred locations and access of Native Americans to those sacred locations and traditional resources that are integral to the practice of their religions. Further, it establishes requirements that would apply to Native American sacred locations, traditional resources, or traditional religious practices potentially affected by construction and operation activities.

7.2.2 Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001)

The Native American Graves Protection and Repatriation Act directs the Secretary of the Interior to guide the repatriation of federal archaeological collections and collections that are culturally affiliated with Native American tribes and held by museums that receive federal funding. Major actions to be taken under this law include (1) the establishment of a review committee with monitoring and policy-making responsibilities; (2) the development of regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims; (3) the oversight of museum programs designed to meet the inventory requirements and deadlines of this law; and (4) the development of procedures to handle unexpected discoveries of graves or grave goods during activities on federal or tribal land. The provisions of the act would be invoked if any excavations associated with construction or operation activities led to unexpected discoveries of Native American graves or grave artifacts.

7.2.3 Executive Order 13007, Indian Sacred Sites

This order directs federal agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adverse effects to sacred sites and to provide access to those sites to Native Americans for religious practices. The order directs agencies to plan projects to provide protection of and access to sacred sites to the extent compatible with the project.

7.2.4 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments

This order directs federal agencies to establish regular and meaningful consultation and collaboration with tribal governments in the development of federal policies that have tribal implications, to strengthen U.S. government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates on tribal governments.

7.3 State Regulatory Requirements

7.3.1 Clean Water Act Implementing Regulations

Utah Administrative Code (U.A.C.) Section R317-2-13 (Water Quality Standards) classifies the Colorado River and its tributaries as

1C	Protected as a raw water source for domestic purposes with prior treatment processes as required by the Utah Department of Health;
2B	Protected for boating, water skiing, and similar uses, excluding swimming;
3B	Protected for warmwater species of game fish and other warmwater aquatic life, including the necessary aquatic organisms in their food chain; and
4	Protected for agricultural uses, including irrigation of crops and stock watering.

Numeric criteria specific to each of these use designations are specified at U.A.C. Section R317-2-14.

7.3.2 State Water Appropriations

Uses of surface water and ground water require compliance with water rights appropriations requirements that are administered by the Utah State Engineer's Office, Department of Natural Resources, Division of Water Rights. Ponding of ground water, construction dewatering of ground water, and use of surface water (i.e., Colorado River) for dust suppression and tailings compaction may be considered consumptive use.

7.3.3 Clean Air Act Implementing Regulations

Utah Air Conservation Rules (19 U.A.C. Section 19-2-101 et seq.) require that fugitive dust be minimized or that measures be taken to prevent its occurrence. Air emissions from a ground water treatment system could also potentially be regulated by these requirements and would require a permit. The Utah Administrative Code requires that ambient air quality be monitored during construction activities.

7.3.4 Radioactive Materials Licensing

As authorized by the Atomic Energy Act of 1954, as amended, the State of Utah is an Agreement State under NRC's program for regulating uranium mills. The *Utah Administrative Code* (UAC) R313-24-4(1)(b) requires the White Mesa Mill site to comply with State requirements for ground water protection. In addition, NRC transferred authority for the regulation of the possession of by-product material by persons to the State of Utah in August 2004. The State's regulatory authority would not apply to DOE's actions at Moab, Klondike Flats, or Crescent Junction.

7.4 References

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

10 CFR 1021. U.S. Department of Energy, "National Environmental Policy Act (NEPA) Implementing Procedures."

10 CFR 1022. U.S. Department of Energy, "Compliance with Floodplain and Wetlands Environmental Review Requirements."

33 CFR 322-330. U.S. Department of Defense, "Navigation and Navigable Waters."

36 CFR 296. U.S. Department of Agriculture, "Protection of Archaeological Resources: Uniform Regulations."

36 CFR 800. Advisory Council on Historic Preservation, "Protection of Historic Properties."

40 CFR 50. U.S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards."

40 CFR 53. U.S. Environmental Protection Agency, "Ambient Air Monitoring Reference and Equivalent Methods."

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

40 CFR 110-112, 122-125, 130-131, 230-231, and 404. U.S. Environmental Protection Agency, "Protection of the Environment."

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

40 CFR 260. U.S. Environmental Protection Agency, "Hazardous Waste Management System: General."

40 CFR 761. U.S. Environmental Protection Agency, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions."

40 CFR 763. U.S. Environmental Protection Agency, "Asbestos."

40 CFR 1500-1508. Council on Environmental Quality, "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act."

43 CFR 3. U.S. Department of the Interior, "Preservation of American Antiquities."

43 CFR 7. U.S. Department of the Interior, "Protection of Archaeological Resources."

43 CFR 2300. U.S. Department of the Interior, "Land Withdrawals."

43 CFR 2800. U.S. Department of the Interior, "Rights-of-Way, Principles and Procedures."

49 CFR 130. U.S. Department of Transportation, "Oil Spill Prevention and Response Plans."

BLM (Bureau of Land Management), 1988a. *BLM Manual Section 1790, National Environmental Policy Act of 1969* MS 1790, October 25.

BLM (Bureau of Land Management), 1988b. *National Environmental Policy Act Handbook*, BLM Handbook H-1790-1, October 25.

NPS (National Park Service), 2001. *Conservation Planning and Environmental Impact Analysis and Decision-Making*, NPS Director's Order and Handbook 12, January 8.

8.0 List of Preparers and Disclosure Statements

This chapter identifies the individuals who were principal preparers of this document and provides the disclosure statement of all contractors participating in the preparation of this EIS.

Thomas L. Anderson	*Affiliation*	Battelle
	Education	B.S. Botany, Ohio State University
	Technical Experience	31 years of experience and senior-level project management on more than 100 NEPA documents involving all aspects of DOE's nuclear and non-nuclear missions.
	EIS Responsibility	Project Manager and text preparation
Cheri I. Bahrke	*Affiliation*	Battelle
	Education	B.A. Geology, Indiana University
	Technical Experience	11 years of experience in environmental restoration, 7 years of experience in preparing NEPA documents for all aspects of DOE environmental restoration projects.
	EIS Responsibility	Text preparation of Land Use and Institutional Controls chapter
James M. Becker	*Affiliation*	Battelle
	Education	M.S. Wildlife Ecology, University of Washington B.S. Range and Wildlife Science, Brigham Young University
	Technical Experience	10 years of experience in preparing ecological evaluations for NEPA documents, ecological risk assessments, and biological assessments for energy-related projects.
	EIS Responsibility	Terrestrial ecology; affected environment, environmental consequences, and biological assessment
Sandra J. Beranich	*Affiliation*	Subcontractor to S.M. Stoller Corporation
	Education	M.A. Geography, University of Oregon B.A. Geology, Southern Illinois University
	Technical Experience	20 years of diverse experience related to preparation of portions of or entire NEPA documents for federal agencies and general coordination and management of NEPA or related documents, including 8 years of experience working on NEPA reports and studies for the DOE UMTRA Project. Areas of expertise include land use and transportation.
	EIS Responsibility	General project coordination for Chapter 3.0, "Affected Environment"; preparation of transportation and traffic sections

Joel Berwick	*Affiliation*	U.S. Department of Energy
	Education	B.S. University of Wyoming
	Technical Experience	18 years of experience in managing and supporting remedial actions. His work on the Monticello project involved the construction oversight of a state-of-the-art water-balance repository cover.
	EIS Responsibility	DOE Project Engineer for Moab
Robert W. Bleil	*Affiliation*	Battelle
	Education	B.S. Natural Resources and Wildlife Management, Colorado State University A.S. Pre-Law, Champlain College Environmental Science – Berkshire Community College
	Technical Experience	26 years of experience managing and preparing NEPA documents for BLM, USF&WS, private industry, and DOE. Contractor NEPA Compliance Lead at the DOE office in Grand Junction since 1990.
	EIS Responsibility	EIS Deputy Manager; technical content for aquatic and terrestrial ecology, biological assessment, regulatory requirements, and overall document preparation
Amoret L. Bunn	*Affiliation*	Battelle
	Education	Ph.D. Engineering, University of New Hampshire M.S. Civil Engineering, University of New Hampshire B.S. Biology, Virginia Polytechnic Institute and State University
	Technical Experience	10 years of experience in preparing ecological evaluations for NEPA documents and ecological risk assessment and biological assessments for energy-related projects.
	EIS Responsibility	Aquatic ecology; affected environment, environmental consequences, and biological assessment
Clay Carpenter	*Affiliation*	S.M. Stoller Corporation
	Education	M.B.A. George Washington University B.S. Chemical Engineering, University of Virginia
	Technical Experience	23 years of experience in risk assessment and project management.
	EIS Responsibility	Human health risk assessment, construction risks, and failure scenario evaluation
James R. Christensen	*Affiliation*	Subcontractor to S.M. Stoller Corporation
	Education	B.S. Anthropology, University of Idaho
	Technical Experience	Project Manager with SWCA Environmental Consultants, Historical Anthropology Program, Salt Lake City, Utah 11 years of experience in cultural resource management, specializing in historical archaeology, history, and prehistoric archaeology.
	EIS Responsibility	Evaluation of Moab Project site features for historical significance; supervision of Class III cultural resource survey on Moab Project site

Laura E. Cummins	*Affiliation*	S.M. Stoller Corporation
	Education	Ph.D. Geology, Florida State University M.S. Geology, Bowling Green State University B.S. Geology, Bowling Green State University
	Technical Experience	15 years of technical and regulatory environmental experience, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), NEPA, risk assessment (human health and ecological), and geochemistry. Experience with DOE CERCLA/RCRA/UMTRA sites, EPA Superfund hazardous waste sites, and underground storage tank sites.
	EIS Responsibility	Human health and ecological risk, water quality issues, and ground water compliance
Dennis J. DuPont	*Affiliation*	S.M. Stoller Corporation
	Education	Certificate, Mesa State College
	Technical Experience	15 years of experience in document production.
	EIS Responsibility	Document coordinator and word processor
Linda M. Edwards	*Affiliation*	S.M. Stoller Corporation
	Education	B.S. Organizational Management, Colorado Christian University
	Technical Experience	8 years of experience in document production.
	EIS Responsibility	Review document redlines and prepared .pdf files
John E. Elmer	*Affiliation*	S.M. Stoller Corporation
	Education	M.B.A. Western State University B.S. Civil Engineering, Colorado State University
	Technical Experience	10 years of experience in managing civil and environmental remediation projects, including studies, design, and construction and 15 years of experience managing environmental remediation projects for DOE involving low-level radioactive waste.
	EIS Responsibility	Lead for engineering and construction; text preparation
William E. Fallon	*Affiliation*	Battelle
	Education	Ph.D. Pharmaceutical Sciences, University of Rhode Island
	Technical Experience	25 years of experience as manager of and technical contributor to large DOE and EPA programs.
	EIS Responsibility	Chapter 2.0 text preparation, integration, and technical coordination; cross-chapter consistency review
David S. Foster	*Affiliation*	S.M. Stoller Corporation
	Education	B.A. Philosophy, University of Colorado; additional coursework in chemistry, geology, and hydrology
	Technical Experience	25 years of experience: analyst, Union Carbide Corporation Environmental Laboratory; health physics technician, Oak Ridge Associated Universities; chemical sampling coordinator and technical writer/editor, Oak Ridge National Laboratory; technical writer/editor, S.M. Stoller Corporation
	EIS Responsibility	Technical editor

Brad Fritz	*Affiliation*	Battelle
	Education	M.S. Environmental Engineering, Washington State University B.S. Physics, Eastern Oregon University
	Technical Experience	3 years of experience in data analysis.
	EIS Responsibility	Conducting and writing noise and vibration analyses
John Fritz	*Affiliation*	Subcontractor to S.M. Stoller Corporation
	Education	Ph.D. University of Utah B.S. Eastern New Mexico University
	Technical Experience	30 years of experience in cultural, archaeological, and traditional cultural property research and instruction.
	EIS Responsibility	Lead investigator for cultural archaeological and traditional cultural properties characterization
Michael J. Gardner	*Affiliation*	Battelle
	Education	M.A. Public Administration, University of Colorado B.S. Geological Engineering, Brigham Young University
	Technical Experience	16 years of environmental engineering and regulatory compliance experience associated with various DOE environmental restoration projects.
	EIS Responsibility	Collection of environmental monitoring data and text preparation
Craig S. Goodknight	*Affiliation*	S.M. Stoller Corporation
	Education	M.S. Geology, University of New Mexico B.S. Geology, University of Tulsa
	Technical Experience	30 years of experience in geology of western Colorado and eastern Utah, includes experience as BLM District Geologist in eastern Utah, National Uranium Resource Evaluation program, and UMTRA Title I and II sites.
	EIS Responsibility	Technical Lead for preparation of geology section of EIS
Kenneth E. Karp	*Affiliation*	MFG, Inc.
	Education	B.S. Geology, Mesa State College
	Technical Experience	15 years of experience in site investigations and feasibility and alternative evaluation studies; 10 years of experience managing environmental restoration and compliance projects related to CERCLA, RCRA, and UMTRA sites.
	EIS Responsibility	Lead for ground and surface water; text preparation

Marilyn K. Kastens	*Affiliation*	Battelle
	Education	M.S. Soil Science, Oregon State University B.A. Geography, Oklahoma University
	Technical Experience	20 years of experience in environmental compliance and NEPA issues with DOE and BLM.
	EIS Responsibility	Prepared cultural resource and visual resource sections of EIS
N. Edward LaBonte	*Affiliation*	S.M. Stoller Corporation
	Education	B.S. Computer Management Science, Metropolitan State College
	Technical Experience	18 years of experience in Geographic Information Systems (GIS).
	EIS Responsibility	EIS Figure Coordinator and GIS Data Manager
Susan D. Lyon	*Affiliation*	S.M. Stoller Corporation
	Education	Certificate, Mesa State College
	Technical Experience	20 years of experience in document production.
	EIS Responsibility	Word process document and review redlines
Melvin W. Madril, P.E.	*Affiliation*	S.M. Stoller Corporation
	Education	B.S. Civil Engineering, University of Southern Colorado
	Technical Experience	25 years of civil engineering experience in site development, infrastructure design, and project and construction management; the last 18 years in engineering design and project management for radioactive contaminated soils and ground water remediation at various DOE sites.
	EIS Responsibility	Transportation studies, infrastructure conceptual design, labor, and equipment and natural resources consumption estimates
Steven J. Maheras	*Affiliation*	Battelle
	Education	Ph.D. Health Physics, Colorado State University
	Technical Experience	15 years of experience in health physics, transportation risk assessment, and radiological assessment.
	EIS Responsibility	Transportation risk assessment, air quality analysis, human health and safety analysis
Thomas I. McSweeney	*Affiliation*	Battelle
	Education	Ph.D. Chemical Engineering, University of Michigan
	Technical Experience	32 years of experience in risk assessment and safety analysis.
	EIS Responsibility	Transportation risk assessment

Donald R. Metzler, P.Hg.	*Affiliation*	U.S. Department of Energy
	Education	M.S. Hydrogeology, San Diego State University Registered geologist in California and Arizona and certified professional hydrogeologist with the American Institute of Hydrology B.S. Agricultural Science, California Polytechnic State University
	Technical Experience	Project Manager of the UMTRA Ground Water Project and involved in the UMTRA Program for 14 years. Work with uranium mill tailings has involved characterization, disposal cell cover performance, compliance strategy development, remedial action, and project management.
	EIS Responsibility	DOE Federal Project Director for the Moab, Utah, Uranium Mill Tailings Remediation Project. Development of ground water remediation strategy and technical reviewer of ground water modeling and disposal cell cover design
Judith D. Miller	*Affiliation*	S.M. Stoller Corporation
	Education	B.A. Communications, Mesa State College
	Technical Experience	Graphics design.
	EIS Responsibility	Graphics preparation
Duane A. Neitzel	*Affiliation*	Battelle
	Education	M.S. Biological Sciences, Washington State University B.S. Zoology, University of Washington
	Technical Experience	30 years of experience in managing and preparing NEPA documents for DOE and NRC.
	EIS Responsibility	Aquatic ecology; affected environment, environmental consequences, and biological assessment
Daniel W. Nordeen	*Affiliation*	S.M. Stoller Corporation
	Education	B.S. Civil Engineering, Colorado State University
	Technical Experience	15 years of experience in civil engineering site design and cost estimating with all aspects of the DOE UMTRA Project and CERCLA projects for disposal of low-level nuclear waste.
	EIS Responsibility	Conceptual design of alternatives, cost estimates, and text preparation
Douglas M. Osborn	*Affiliation*	Battelle
	Education	B.S. Chemical Engineering, Ohio State University
	Technical Experience	6 years of experience operating nuclear reactors in the U.S. Navy; 3 years experience in managing and maintaining a mechanical engineering laboratory at Ohio State University; 3 months of experience as nuclear engineering research intern.
	EIS Responsibility	Technical support
Desiree Padgett	*Affiliation*	Battelle
	Education	B.A. Journalism, University of New Mexico
	Technical Experience	18 years of experience editing technical documents for the U.S. Department of Defense and DOE, including 8 years of experience editing NEPA documents.
	EIS Responsibility	Technical Editor

Ray Plieness	*Affiliation*	U.S. Department of Energy
	Education	B.S. Civil Engineering, Montana State University
	Technical Experience	25 years of experience managing construction, hazardous waste, and nuclear remediation projects.
	EIS Responsibility	Contractor EIS Project Manager and text preparation
Ted M. Poston	*Affiliation*	Battelle
	Education	M.S. Fisheries, University of Washington
	Technical Experience	29 years of experience in ecological, environmental and toxicological research with 22 years of NEPA experience in community noise assessments and ecology.
	EIS Responsibility	Coordinated noise and ground vibration section and consulted on ecology sections
Barbara Price	*Affiliation*	S.M. Stoller Corporation
	Education	B.A. Sociology, Anthropology, Adams State College B.S. Computer Science, Math, Mesa State College
	Technical Experience	17 years of professional experience as a computer programmer and analyst. 14 years of supporting various areas of business administration for DOE contractors with an emphasis on financial software development and support.
	EIS Responsibility	Database developer/Administrator
Phyllis Price	*Affiliation*	S.M. Stoller Corporation
	Education	A.A.S. Ferris State University
	Technical Experience	28 years of experience in graphic design and illustration.
	EIS Responsibility	Graphics preparation
Cynthia L. Rakowski	*Affiliation*	Battelle
	Education	M.S. Watershed Science, Utah State University B.S. Physics, Montana State University
	Technical Experience	10 years of experience integrating geomorphology and habitat availability for endangered fishes.
	EIS Responsibility	Aquatic ecology
Michael T. Rectanus	*Affiliation*	Battelle
	Education	B.S. Chemical Engineering, Ohio University
	Technical Experience	6 years of experience conducting air quality impact assessments for EISs and PSD construction permit applications.
	EIS Responsibility	Air quality analysis
Donna L. Riddle	*Affiliation*	S.M. Stoller Corporation
	Education	B.S. Environmental Restoration, Mesa State College
	Technical Experience	20 years of experience in quality assurance program definition and implementation and monitoring for DOE contractors.
	EIS Responsibility	Contractor QA Manager; quality consultation on EIS

Christine D. Ross	*Affiliation*	Battelle
	Education	A.A. Microcomputer Management, Specializing in Multimedia, Albuquerque Technical Vocational Institute
	Technical Experience	9 years of experience in graphic and desktop publishing work, 4 years of experience in GIS software and technology.
	EIS Responsibility	Prepared population, low-income, and minority maps for Chapter 3.0.
Wendee K. Ryan	*Affiliation*	S.M. Stoller Corporation
	Education	B.A. Speech Communication, Colorado State University
	Technical Experience	7 years of experience in Public Affairs for DOE contractors.
	EIS Responsibility	Public relations
Linda Sheader	*Affiliation*	Battelle
	Education	M.A. Botany, University of California Berkeley B.A. Biology, Adams State College
	Technical Experience	6 years of experience in wetlands delineation, restoration designs and monitoring, reclamation, botany, and plant ecology.
	EIS Responsibility	Revise floodplains and wetlands assessment and related sections
Gregory M. Smith	*Affiliation*	S.M. Stoller Corporation
	Education	M.S. Civil (Geotechnical) Engineering, Colorado State University
	Technical Experience	20 years of experience designing and constructing low-level uranium waste disposal cells for DOE.
	EIS Responsibility	Wind rose diagrams and affected environment text
J. Amanda Stegen	*Affiliation*	Battelle
	Education	M.S. Biology, University of Washington B.S. Wildlife Biology, Washington State University
	Technical Experience	10 years of experience in preparing ecological evaluations for NEPA documents and ecological risk assessment and biological assessments for energy-related projects.
	EIS Responsibility	Aquatic ecology, affected environment, environmental consequences, and biological assessment
Karen Sutton	*Affiliation*	S.M. Stoller Corporation
	Education	Various business training courses
	Technical Experience	23 years; United Banks of Colorado; 16 years Training and Employee Safety; 4 years Records
	EIS Responsibility	Reproduction and assembly

Lucinda Low Swartz	*Affiliation*	Battelle
	Education	J.D. Washington College of Law, The American University B.A. Political Science and Administrative Studies (joint major), University of California at Riverside
	Technical Experience	23 years of experience in environmental law and regulation.
	EIS Responsibility	Summary; Chapters 1.0 and 5.0 through 7.0, environmental laws and regulations; and technical review
Cathy Thomas	*Affiliation*	S.M. Stoller Corporation
	Education	M.L.S. Emporia State University B.S. Education, Emporia State University
	Technical Experience	30 years of experience in educational, medical, and corporate libraries conducting research for educators and clients.
	EIS Responsibility	Assisted in preparation of bibliographies
Carlos A. Ulibarri	*Affiliation*	New Mexico Institute of Mining and Technology and Battelle
	Education	Ph.D. Economics, University of New Mexico
	Technical Experience	10 years of experience in evaluating socioeconomic impacts of DOE projects involving environmental, energy, and nuclear regulatory programs.
	EIS Responsibility	Technical lead for socioeconomic impact evaluation
Gretchen Van Reyper	*Affiliation*	HRL Compliance, independent subcontractor
	Education	B.S. Environmental Studies/Biology, Minnesota State University-Mankato
	Technical Experience	10 years of wetland and botany experience in federal and private sectors; 3 years of NEPA document assistance.
	EIS Responsibility	Floodplain and wetland sections and sensitive plant species list
Paul G. Wetherstein	*Affiliation*	Battelle
	Education	A.A.S. Environmental Restoration Technology, Mesa State College
	Technical Experience	16 years of experience in environmental remediation, including 10 years in hazardous waste management involving DOE's uranium mill tailings work.
	EIS Responsibility	Research waste management issues for each alternative site
Toby Wright	*Affiliation*	MFG, Inc
	Education	M.S. Civil Engineering, Colorado State University B.S. Geosciences, University of Arizona
	Technical Experience	17 years of experience in environmental characterization, restoration and remediation design and management of private and federal clients.
	EIS Responsibility	Contractor Project Manager

Julio Zimbron	*Affiliation*	MFG, Inc.
	Education	Ph.D. Chemical Engineering, Colorado State University M.Sc. Chemical Engineering, Colorado State University B.S. Biochemical Engineering, Monterrey Institute of Technology, Mexico
	Technical Experience	Engineering design of water and air pollution control systems, including bioremediation, chemical treatment, and solids separation technologies.
	EIS Responsibility	Water treatment alternatives screening

Subcontract Agreement #STLR-3730-002-CP
NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE REMEDIATION OF THE MOAB URANIUM MILL TAILINGS SITE, GRAND COUNTY, UTAH ENVIRONMENTAL IMPACT STATEMENT

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require a contractor who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. In accordance with these requirements, Battelle Memorial Institute hereby certifies that to the best of its knowledge it has no financial or other interest in the outcome of the referenced EIS project.

In accordance with these requirements, **Battelle Memorial Institute** hereby certifies as follows: check either (a) or (b).

(a) X To the best of **Battelle Memorial Institute's** knowledge, it has no financial or other interest in the outcome of the referenced EIS project.

(b) ___ Battelle Memorial Institute has the following financial or other interest in the outcome of the referenced EIS projects hereby agree to divest themselves of such interest prior to the start of the work.

Financial or Other Interest
1.
2.
3.

Certified by:
Lorraine N. Stein
Signature

for Ralph K. Henricks
Name

Contracting Officer
Title

02/18/2003
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE REMEDIATION OF THE MOAB MILL TAILINGS SITE IN GRAND COUNTY, UTAH ENVIRONMENTAL IMPACT STATEMENT

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require a contractor who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial or other interest in the outcome of the project" for purposes of this disclosure, is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Questions 71a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)" 46 FR 18026-18038 at 18031.

In accordance with these requirements, **Intera Incorporated** hereby certifies as follows: check either (a) or (b).

(a) X **Intera Incorporated** has no financial or other interest in the outcome of the referenced EIS projects.

(b) ____ ________________________________ has the following financial or other interest in the outcome of the referenced EIS projects hereby agree to divest themselves of such interest prior to the start of the work.

Financial or Other Interest

1.
2.
3.

Certified by:

____
Signature

Patrick F. MALONE
Name

Contracting Officer
Title

January 20, 2003
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE REMEDIATION OF THE MOAB MILL TAILINGS SITE IN GRAND COUNTY, UTAH
ENVIRONMENTAL IMPACT STATEMENT

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require a contractor who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial or other interest in the outcome of the project" for purposes of this disclosure, is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Questions 71a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)" 46 FR 18026-18038 at 18031.

In accordance with these requirements, MFG hereby certifies as follows: check either (a) or (b).

(a) X MFG has no financial or other interest in the outcome of the referenced EIS projects.

(b) ___ ________________________, has the following financial or other interest in the outcome of the referenced EIS projects hereby agree to divest themselves of such interest prior to the start of the work.

Financial or Other Interest

1.
2.
3.

Certified by:

Craig A. Hamil
Signature

Craig A. Hamilton
Name

President/COO
Title

January 17, 2003
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE REMEDIATION OF THE MOAB MILL TAILINGS SITE IN GRAND COUNTY, UTAH
ENVIRONMENTAL IMPACT STATEMENT

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require a contractor who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial or other interest in the outcome of the project" for purposes of this disclosure, is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Questions 71a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)" 46 FR 18026-18038 at 18031.

In accordance with these requirements, **S.M. Stoller Corporation** hereby certifies as follows: check either (a) or (b).

(a) X **S.M. Stoller Corporation** has no financial or other interest in the outcome of the referenced EIS projects.

(b) ____ ________________________________ has the following financial or other interest in the outcome of the referenced EIS projects hereby agree to divest themselves of such interest prior to the start of the work.

Financial or Other Interest

1.
2.
3.

Certified by:

Signature

James K. Archibald
Name

V.P. and General Manager
Title

January 17, 2003
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE REMEDIATION OF THE MOAB MILL TAILINGS SITE IN GRAND COUNTY, UTAH ENVIRONMENTAL IMPACT STATEMENT

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require a contractor who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial or other interest in the outcome of the project" for purposes of this disclosure, is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Questions 71a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)" 46 FR 18026-18038 at 18031.

In accordance with these requirements, **Teledyne Brown Engineering, Inc.** hereby certifies as follows: check either (a) or (b).

(a) X **Teledyne Brown Engineering, Inc.** has no financial or other interest in the outcome of the referenced EIS projects.

(b) ____ ________________________ has the following financial or other interest in the outcome of the referenced EIS projects hereby agree to divest themselves of such interest prior to the start of the work.

Financial or Other Interest

1.
2.
3.

Certified by:

Renee H. Varner
Signature

Renee H. Varner
Name

Sr. Contract Administrator
Title

January 17, 2003
Date

End of current text

9.0 List of Agencies, Organizations, and Individuals Receiving Copies of the EIS

Government Officials—Federal

Mr. Frank Bain, Bureau of Land Management
Mr. Matthew Blevins, U.S. Nuclear Regulatory Commission
Mr. Jim Carter, Bureau of Land Management
Mr. Tom Chart, U.S. Fish and Wildlife Service
Mr. Jim Fairchild, U.S. Geological Survey
Mr. Scott Flanders, U.S. Nuclear Regulatory Commission
Mr. Myron Fliegel, U.S. Nuclear Regulatory Commission
Dr. Richard Graham, U.S. EPA Region 8
Mr. Paul Henderson, Canyonlands National Park
Mr. Norm Henderson, National Park Service
Mr. Steven Hoffman, Office of the Regional Solicitor, U.S. Department of the Interior
Ms. Cherie Hutchison, U.S. Department of Labor, Mine Safety and Health Administration
Mr. Ken Jacobson, U.S. Army Corps of Engineers
Mr. Sam Keith, Center for Disease Control
Mr. Henry Maddux, U.S. Fish and Wildlife Service
Ms. Camille Mittelholtz, U.S. Department of Transportation
Ms. Anne Norton Miller, U.S. EPA Headquarters
Mr. Peter Penoyer, National Park Service
Mr. Robert E. Roberts, U.S. Environmental Protection Agency
Mr. Cordell Roy, National Park Service
Mr. Dan Schultheisz, U.S. EPA
Mr. Fred Skaer, Office of NEPA Facilitation (HEPE-1)
Mr. Robert F. Stewart, U.S. Department of Interior
Mr. Larry Svoboda, U.S. EPA Region 8
Mr. Willie Taylor, U.S. Department of the Interior, Office of Environmental Policy and Compliance
Mr. Gary Torres, Bureau of Land Management
Mr. Daryl Trotter, Bureau of Land Management
Ms. Mary von Koch, Bureau of Land Management
Mr. Bruce Waddell, U.S. Fish and Wildlife Service
Mr. Dave Wood, National Park Service
Ms. Margaret Wyatt, Bureau of Land Management

Elected Officials and Staffers—Federal

The Honorable Wayne Allard, United States Senate
The Honorable Joe Baca, U.S. House of Representatives
The Honorable Joe Barton, U.S. House of Representatives
The Honorable Xavier Becerra, U.S. House of Representatives
The Honorable Robert F. Bennett, United States Senate
Mr. Mike Reberg, Office of Congressman James Matheson

The Honorable Shelley Berkley, U.S. House of Representatives
The Honorable Howard L. Berman, U.S. House of Representatives
The Honorable Marion Berry, U.S. House of Representatives
The Honorable Jeff Bingaman, United States Senate
The Honorable Rob Bishop, U.S. House of Representatives
The Honorable Mary Bono, U.S. House of Representatives
The Honorable Barbara Boxer, United States Senate
The Honorable Robert C. Byrd, United States Senate
The Honorable Ken Calvert, U.S. House of Representatives
The Honorable Chris Cannon, U.S. House of Representatives
The Honorable Lois Capps, U.S. House of Representatives
The Honorable Thad Cochran, United States Senate
The Honorable Jim Costa, U.S. House of Representatives
The Honorable Christopher Cox, U.S. House of Representatives
The Honorable Randy (Duke) Cunningham, U.S. House of Representatives
The Honorable Susan Davis, U.S. House of Representatives
The Honorable John Dingell, U.S. House of Representatives
The Honorable Pete Domenici, United States Senate
The Honorable John Doolittle, U.S. House of Representatives
The Honorable David Dreier, U.S. House of Representatives
The Honorable Chet Edwards, U.S. House of Representatives
The Honorable Jo Ann Emerson, U.S. House of Representatives
The Honorable John Ensign, United States Senate
The Honorable Terry Everett, U.S. House of Representatives
The Honorable Diane Feinstein, United States Senate
The Honorable Bob Filner, U.S. House of Representatives
The Honorable Jeff Flake, U.S. House of Representatives
The Honorable Trent Franks, U.S. House of Representatives
The Honorable Elton Gallegly, U.S. House of Representatives
The Honorable Jim Gibbons, U.S. House of Representatives
The Honorable Raul Grijalva, U.S. House of Representatives
The Honorable Jane Harman, U.S. House of Representatives
The Honorable Orrin Hatch, United States Senate
The Honorable J. D. Hayworth, U.S. House of Representatives
The Honorable David L. Hobson, U.S. House of Representatives
The Honorable Duncan Hunter, U.S. House of Representatives
The Honorable Darrell E. Issa, U.S. House of Representatives
The Honorable Jim Kolbe, U.S. House of Representatives
The Honorable Jon Kyl, United States Senate
The Honorable Tom Latham, U.S. House of Representatives
The Honorable Carl Levin, United States Senate
The Honorable Jerry Lewis, U.S. House of Representatives
The Honorable James Matheson, U.S. House of Representatives
The Honorable John McCain, United States Senate
The Honorable Howard P. McKeon, U.S. House of Representatives
The Honorable Juanita Millender-McDonald, U.S. House of Representatives
The Honorable Gary G. Miller, U.S. House of Representatives
The Honorable Grace Napolitano, U.S. House of Representatives
The Honorable Bill Nelson, United States Senate

The Honorable Devin Nunes, U.S. House of Representatives
The Honorable David R. Obey, U.S. House of Representatives
The Honorable Ed Pastor, U.S. House of Representatives
The Honorable John E. Peterson, U.S. House of Representatives
The Honorable Jon Porter, U.S. House of Representatives
The Honorable Harry Reid, United States Senate
The Honorable Rick Renzi, U.S. House of Representatives
The Honorable Silvestre Reyes, U.S. House of Representatives
Mr. Bruce Richeson, Office of Senator Robert F. Bennett
The Honorable Dana Rohrabacher, U.S. House of Representatives
The Honorable Lucille Roybal-Allard, U.S. House of Representatives
The Honorable Edward R. Royce, U.S. House of Representatives
The Honorable John Salazar, U.S. House of Representatives
The Honorable Ken Salazar, United States Senate
The Honorable Linda Sanchez, U.S. House of Representatives
The Honorable Loretta Sanchez, U.S. House of Representatives
The Honorable Adam B. Schiff, U.S. House of Representatives
The Honorable Jeff Sessions, United States Senate
The Honorable John Shadegg, U.S. House of Representatives
The Honorable Brad Sherman, U.S. House of Representatives
The Honorable Ike Skelton, U.S. House of Representatives
The Honorable Hilda L. Solis, U.S. House of Representatives
The Honorable William M. Thomas, U.S. House of Representatives
The Honorable Peter J. Visclosky, U.S. House of Representatives
The Honorable John Warner, United State Senate
The Honorable Maxine Waters, U.S. House of Representatives
The Honorable Diane E. Watson, U.S. House of Representatives
The Honorable Henry A. Waxman, U.S. House of Representatives

Tribal

Vice Chairman Smiley Arrowchis, The Ute Tribe
Ms. Elayne Atcitty, White Mesa Ute Indian Tribe
Mr. Neil Cloud, Southern Ute Indian Tribe
Mr. Daniel Eddy, Jr., Colorado River Indian Tribes
Mr. Robert Holden, National Congress of American Indians
Mr. O. Roland McCook, The Ute Tribe
Ms. Nora McDowell, Fort Mojave Indian Tribe
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Governor Arlen P. Quetawki, Sr., Pueblo of Zuni
Mr. Tom Rice, Ute Mountain Ute Tribe
Mr. Edward D. "Tito" Smith, Chemehuevi Indian Tribe
Mr. Arvin Trujillo, Navajo Nation Division of Natural Resources
Ms. Mary Jane Yazzie, White Mesa Ute Council

Government Officials—State

Ms. Sheila Brown, Governor's Office of Planning and Research
Ms. LaVonne Garrison, State of Utah School & Institutional Trust Lands Administration
Mr. Hugh Kirkham, Utah Department of Transportation
Mr. Leroy Mead, Utah Division of Wildlife Resources
Mr. Loren Morton, Utah Department of Environmental Quality
Mr. Fred Nelson, Utah State Attorney General's Office
Dr. Dianne Nielson, Utah Department of Environmental Quality
Mr. Stephen A. Owens, Arizona Department of Environmental Quality
Mr. Mark Page, State of Utah, Division of Water Rights
Mr. Daren Rasmussen, Utah Department of Natural Resources Division of Water Rights
Ms. Terry Roberts, Governor's Office of Planning and Research
Mr. Bill Sinclair, Utah Department of Environmental Quality
Mr. Joseph C. Strolin, Nevada Agency for Nuclear Projects
Mr. Reese Tietje, State of Nevada
Mr. William Werner, Arizona Department of Environmental Quality
Ms. Carolyn Wright, Utah Department of Natural Resources Center for Policy and Planning

Elected Officials—State

The Honorable Kenny C. Guinn, Governor of Nevada
The Honorable Jon Huntsman Jr., Governor of Utah
The Honorable Janet Napolitano, Governor of Arizona
The Honorable Bill Owens, Governor of Colorado
The Honorable Arnold Schwarzenegger, Governor of California

Interest Groups

Sierra Club
Greenaction Indigenous Lands Project
Mr. Bradley Angel, GreenAction for Health and Environmental Justice
Ms. Sue Bellagamba, The Nature Conservancy, Moab Project Office
Ms. Ashley Benton, John Burroughs School
Ms. Eleanor Bliss, Grand Canyon Trust, Moab Office
Ms. Danielle Brian, Project on Government Oversight
Mr. Jim Bridgman, Alliance for Nuclear Accountability
Mr. Dan Brook, Univerisity of California at Berkeley
Mr. David Brunner, National Fish and Wildlife Foundation
Mr. Jay Chen, Colorado River Board of California
Mr. Tom Clements, Greenpeace International
Dr. Thomas B. Cochran, Natural Resources Defense Council
Ms. Jana Cranmer, Point Loma Nazarene University
Mr. James H. Davenport, Colorado River Commission of Nevada
Ms. Libby Fayad, National Parks Conservation Association
Ms. Susan Gordon, Alliance for Nuclear Accountability

Ms. Jeannie Gregory, San Diego Natural History Museum
Mr. Jason Groenewold, Healthy Environment Alliance of Utah
Mr. John Hadder, Citizen Alert
Dr. Jack Hamilton, University of Utah
Mr. David Harper, Mohave Cultural Preservation Program
Mr. Bill Hedden, Grand Canyon Trust, Moab Office
Ms. Peggy Maze Johnson, Citizen Alert
Ms. Laura Kamala, Grand Canyon Trust
Mr. Fred Krupp, Environmental Defense
Mr. Lawson LeGate, Sierra Club
Mr. David Livermore, The Nature Conservancy
Mr. Bill Love, Sierra Club
Mr. William B. Mackie, Western Governors' Association
Ms. Danielle Mentzer, Point Loma Nazarene University
Dr. Michael Mooring, Point Loma Nazarene University
Mr. Nadejda Murahovscaia, Point Loma Nazarene University
Ms. Denise Oblak, Utah Guides & Outfitters Assn.
Ms. Cynthia Ovando-Knutson, Point Loma Nazarene University
Dr. Keith Pedersen, Point Loma Nazarene University
Mr. Carl Pope, Sierra Club
Ms. Dianne Rabello, Point Loma Nazarene University
Ms. Pandora Rose, Mountain Defense League
Mr. Richard J. Sawicki, The Wilderness Society
Ms. Indra Serrano, Point Loma Nazarene University
Ms. Stacey Street, Point Loma Nazarene University
Mr. David A. Thompson, Kearny High Educational Center
Ms. Karla VanderZanden, Canyonlands Field Institute
Mr. Ivan Weber, U.S. Green Building Council-Utah
Mr. John Weisheit, Living Rivers and Colorado Riverkeepers
Ms. Jane Williams, California Communities Against Toxics
Ms. Ellen Wohl, Department of Earth Resources Colorado State University
Mr. Gerald R. Zimmerman, Colorado River Board of California

Local Officials

Grand County Council
Grand County Library
San Juan County
Mr. Rick Bailey, San Juan County Commission
Ms. Judy Bane, Grand County
Ms. Audrey Graham, Grand County Council
Mr. Bart Koch, Metropolitan Water District of Southern California
Ms. Joette Langianese, Grand County Council
Mr. Jim Lewis, Grand County Council
Ms. Lila Martinez, Metropolitan Water District of Southern California
Mr. Patrick McDermott, Bluff Service Area Board of Trustees
Mr. Al McLeod, Grand County Council
Mr. Jerry McNeely, Grand County Council

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Ms. Gloria A. Rivera, Imperial Irrigation District
Mayor Dave Sakrison, City of Moab
Mr. Darrell H. Smith, Salt Lake County Council of Governments
Ms. Maureen A. Stapleton, San Diego County Water Authority
Mr. Rex Tanner, Grand County
Town Council, Town of Castle Valley
Mr. Dennis Underwood, Metropolitan Water District of Southern California
Mr. Chris Webb, City of Blanding
Thompson Springs

Media—Print, Radio, and Television

Ms. Caroline Bleakley, KLAS-TV
Mr. Gary Harmon, The Daily Sentinel
Mr. Tom Harvey, The Salt Lake Tribune
Mr. David Hasemyer, San Diego Union Tribune
Ms. Nancy Lofholm, The Denver Post
Mr. Phil Mueller, KCYN, 97.1 FM
Mr. Alan Stahler, KZMR Radio
Ms. Christy Williams, KZMU
Times Independent

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Ms. Yolanda Badback
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Ms. Helen Barker
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Ms. Barbie Bergman
Ms. Diane Berliner
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Ms. & Mr. Lila and Irv Berman
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Mr. Chad Beyer
Ms. Bettina Bickel
Ms. Danielle Bifulci
Mr. and Mrs. Mike & Jean Binyon
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Ms. Randi Blackwell
Mr. Russell Blalack
Mr. Norman Bloom, Williams Environmental Services, Inc.
Ms. Jenny Blue
Mr. Donald Blume
Mr. David Bodner
Mr. Evert Boer
Mr. Lee A. Bogear
Mr. William C. Boling
Ms. Patricia Bolt
Ms. Barbara Bolton
Mr. Paul Bookidis
Mr. Michael Bordenave
Mr. Wayne Bostic
Ms. Karen Bowden
Mr. & Ms. Philip and Sharon Bowles
Ms. Nan Singh Bowman
Ms. Margaret Bowman
Ms. Cleal Bradford
Ms. Victoria Brandon
Mr. Richard H. Brant
Mr. Carl Brasow, Coastal Caverns
Dr. Joseph Braun
Ms. Joan Breiding
Ms. Susan Breisch
Ms. Marlene Bremner
Mr. Matt Brennan
Mr. William Bretz
Mr. Jeff Bright
Mr. Dennis Brittenbach
Mr. B.A. Broughton
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Mr. Frederick Brown
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Ms. Darcey Brown
Ms. Lynn Brown
Ms. Phyllis Brown
Ms. Myrna Brown

Mr. Robert Browne
Ms. Sarah Brownrigg
Mr. Scott M. Bruner
Ms. Jean-Marie Bruno, Park Water Company
Ms. Debbie Brush
Mr. Gary Bryant
Mr. Richard Bryant
Ms. Amy Brzeczek
Ms. Heidi Buech
Ms. Amoret L Bunn, Battelle/Pacific Northwest Laboratory
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Ms. Bitsa Burger
Ms. Jessica Burgett
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Mr. Anthony Caico
Ms. Barbara G. Campbell Weir
Mr. Chase Cantrell
Ms. & Mr. Sandra and Richard Capano
Ms. Sylvia Cardella
Mr. & Mrs. Jim & Ginny Carlson
Ms. Cathleen A. Carlson
Ms. Virgina Carlson
Ms. Jan Carmichael
Ms. Andrea Carpenter
Dr. Donna Carr
Ms. & Mr. Gaile & Bob Carr
Ms. Claire Carren
Ms. Barbara Caton
Ms. Sharon Cavallo
Ms. Sherry Celine
Ms. Audrey Celine
Mr. Robert M Cerello
Ms. Jessie Chambliss
Mr. Victor Chan
Ms. Kai Chan
Ms. Maureen Chase
Ms. Lisa Chase
Mr. Kerry Chavez
Mr. R. L. Christie
Ms. Cathy Cirina
Mr. David P. Clark
Ms. Pamela Clark
Mr. Brad Clark

Mr. Dustin Clark
Mr. Dustin Clark
Ms. Frances Clark
Ms. Monette Clark
Mr. Hereen Claudio
Mr. Bruce Coburn
Ms. Stacy Coleman
Mr. Brian Collins
Ms. Sandra Collins
Mr. Joe Colosimo
Ms. Vira Confectioner
Ms. Sara Conklin
Mr. Thomas Conroy
Mr. Clay Conway, Gaeaorama, Inc.
Ms. Erin Cooney
Ms. Lisa Copeland
Ms. Betty Coram
Mr. Dave Cozzens
Ms. Amy Crews
Mr. & Ms. Dale and Janice Cross
Mr. Sam Crowell
Mr. Lawrence Crowley
Mr. Ken Cuddeback
Mr. Jonathan Cupp
Ms. Patricia L. Curley
Ms. Laurel Dailey-White
Ms. Susan Dameron
Ms. Patricia Daniels
Mr. John Francis Darke
Ms. Ena DaSilva
Mr. Jon Davidson
Mr. Juan de Greiff
Mr David De Morelli
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Ms. Diana Dee
Ms. Jennifer Delker
Mr. Larry Dennis
Ms. Rachael Denny
Mr. Kinjal Desai
Ms. Eileen Deutsch
Ms. Jessica Dicamillo
Ms. Karen Dickerman
Ms. Marina Diehl
Ms. Deb Dillon
Dr. John C. Dohrenwend, Southwest Satellite Imaging
Mr. Matthew Donatoni
Ms. Jennifer Doob
Ms. Liza Doran

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Ms. Anna Dowling
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Ms. Mercy Drake
Ms. Alice Drogin
Mr. Ken Drogin
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Ms. Roseann Dudrick
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Ms. Barbara Dunn
Mr. Louis Dunn
Mr. Eddy Dunn
Ms. Collette DuPont
Ms. Christine Dupre
Ms. Claire Dye
Ms. Susan Dzienius
Mr. Scott Edmonson
Ms. Sue Eininger
Mr. Rob Elliott, Arizona Raft Adventures, Inc.
Mr. David Ellis
Ms. Stephanie Embrey
Ms. Connie Emerine
Mr. Michael Emery
Mr. Todd Enders
Mr. David Enevoldsen
Ms. Rebecca English
Ms. Karen Erickson
Mr. Joseph Espanol
Mr. Douglas Estes
Mr. Michael W. Evans
Ms. Lauren Evans
Ms. Laura Evans
Ms. Nancy Evans
Mr. David Everist
Ms. Janice Fahey
Ms. Maureen Fahlberg
Mr. Ron Faich
Mr. Bill Fallon, Battelle Memorial Institute
Ms. Beverly Falor
Ms. Janeen Faulk
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Mr. Roger Featherstone, Earthworks
Ms. Justina Fedorchuk
Mr. Tom Ferguson
Ms. Heather Feuer
Mr. Lynn Fielder
Ms. Sarah Fields
Mr. David Firshein

Mr. John Fischer
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Mr. Jeffery A. Garcia
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Mr. Frank Gardner, Bhate Associates
Mr. Wayne Garland
Ms. Katherine Garrett
Mr. Jamie Gates
Ms. Catherine Gauthier-Campbell
Mr. John Geddie
Mr. John Geiger
Ms. Sheryl Lynn Gerety
Mr. James Giannini
Mr. Delamar Gibbons
Mr. Jim Gibson
Ms. Patty Giffin
Mr. Kenneth John Gilmour
Mr. Steve Glazer
Mr. & Ms. Bill & Donna Gleason
Mr. Mark Gleason
Ms. Monica Goddard
Mr. Alan Goggins
Mr. Ernest Goitein
Mr. Richard Goldman
Ms. Judith Goldstein
Mr. David Gomez

Mr. Michael Gonzalez
Ms. Autumn Gonzalez
Ms. Margaret Goodman
Mr. Joe Gordon, S.M. Stoller Corporation
Ms. Audrey Graham
Ms. Kimberley Graham
Ms. Ariel Graham
Mr. Alvin Grancell
Ms. Sandra Granich
Mr. Jerald Grantham
Mr. Robert Greenburg
Mr. Jack Greene
Mr. Tony Greiner
Mr. Fred Griest
Ms. Dian Griffith
Ms. Bonnie Gross
Mr. Paul B Grossman
Ms. Robin Gustus
Ms. Pam Hackley
Ms. Melena Hagen
Ms. Pamela Hahler
Dr. Dee Hahn
Ms. Sarah Jane Hall
Ms. & Mr. Brook & Linda Hall
Mr. Bob Hamel
Ms. Karla Hancock
Ms. Kim Hanks
Mr. Jim Hanley
Mr. Chong Hao
Mr. Mark Harper
Ms. Laura Harper
Ms. Susie Harrington
Mr. Chris Harrington
Mr. Kelly Harris
Mr. Bruce Harrison
Ms. Katherine Harrod
Ms. Linda Harrour
Mr. Andrew Harsig
Ms. Torie Hartge
Mr. Doug Hartung
Ms. Nora Lee Hastings
Mr. Bob Haugen
Ms. Sara Hayes
Mr. Gary Hazen
Mr. Slim Heilpern
Mr. Christian Heinold
Mr. G. Heinrichsdorff
Mr. Chris Heintzelman
Ms. Meckenzie Helmandollar

Ms. Marilyn Hempel
Ms. Bonnie Hendricks, EDAW, Inc.
Ms. Christine Henze
Ms. Kathy Herman
Ms. Julie Hernandez
Mr. Rex Herron
Mr. John R. Hess
Mr. Lance Hetherington
Mr. Brost Hety
Mr. David Hicks
Ms. Lucy Bastida Hilliard
Mr. Don Hinds
Mr. Daniel Hirsch, Committee to Bridge the Gap
Mr. Ron Hochstein, International Uranium Corporation
Mr. Christian Holenstein
Mr. Frank Holgate
Mr. Richard Hollister
Ms. Jennifer Holmes
Ms. Linda Holmes
Mr. Ronald Holmes
Mr. Carl Honecker
Mr. Gary L. Honeyman, Union Pacific Railroad
Mr. John Hotchkiss
Mr. Jack Houghton
Ms. Gail Houston
Ms. Jennifer Hoyt
Ms. Tamara Huddleston, Environmental Enforcement Section
Ms. Linda Hudek
Mr. & Ms. Tom and Lois Hughes
Ms. Shannon Hughes
Mr. Curt Hull, S.M. Stoller Corporation
Mr. Eumy Hung
Ms. Tamara Hurley
Mr. Verne Huser
Ms. Nancy Inaba
Mr. Lantz M. Indergard, RG
Mr. Timothy Indermuehle
Ms. Eleanor Inskip
Mr. Keith G. Irwin
Mr. Craig Irwin
Mr. Chris Isensee
Mr. Brandon Ives
Mr. David Januzelli
Ms. Marilyn Jempel
Mr. Jon Jenkins
Mr. Basil Jenkins
Ms. Kim Johnson
Mr. William Johnson
Mr. Ferd Johnson

Mr. Kim Johnson
Mr. John Johnson
Mr. Bob Johnston
Mr. Irwin Jones
Ms. Patricia Jones
Ms. Penni Jones
Mr. Allan B. Jones
Ms. Kalen Jones
Mr. James Jones, Tidewater Oil and Gas Company, LLC
Ms. Lou Ann Joyal
Ms. Kate Juenger
Mr. Lee Juskalian
Mr. Periel Kaczmarek
Mr. Max Kaehn
Ms. Karen Kain
Ms. Angela T. Kantola
Mr. Morris Kaplan
Mr. Samuel Karcher
Mr. Lynn Karsh
Ms. Joni Kay
Mr. D Kearns
Mr. Riley Keating
Ms. Nina Keefer
Ms. Sharon Keeney
Mr. Jason Keith, The Access Fun
Ms. Alice Kelly
Mr. Shahido Kempter
Mr. Bill Kennedy
Mr. Dan Kent
Mr. Rob Kerchen
Mr. Lonnie Key
Ms. Lynda Key
Mr. Mha Atma Khalsa
Mr. Nezer Khan
Mr. Donald Kiffmeyer
Ms. Jayne L King
Ms. Karen Kirschling
Ms. Millie Kitchin
Ms. Karen Kite
Ms. Raechel Kjonaas
Ms. Julie Kleinert
Ms. Antonia Klohr
Mr. Carmen Kluscor
Ms. Charlotte Kollmeyer
Ms. Rebecca Koo
Ms. Shirley Kosek
Ms. Katherine Kosmeya-Dodge
Mr. Roy Kranz
Mr. David B. Kuhlman

Ms. Rochelle La Frinere
Ms. Juanita E. LaBlond
Mr. David Lacy
Ms. & Mr. Dorothy & Ken Lamm
Ms. Suzanne Landa
Mr. D. Landau
Ms. Mireya Landin
Ms. Amanda Landis-Hanna
Ms. Sheryl Landrum
Ms. Nancy Laplaca
Ms. Audrey Lareau
Ms. Laura Larkin
Mr. Zach Latham
Ms. Leona L Lauder
Ms. Vicki Lawrence
Ms. Melissa Lazaro
Ms. Debra Lee
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10.0 Glossary

active remediation	The use of active ground water remediation methods such as gradient manipulation, ground water extraction and treatment, or in situ ground water treatment to restore ground water quality to acceptable levels.
acute concentration	The concentration of a contaminant in a medium (air, water, and soil) that would produce an acute exposure. Acute exposure is a single, short-term exposure (usually a day or less) to radiation, a toxic substance, or other stressors that may result in severe biological harm or death.
alluvium	Sediments generally composed of clay, silt, sand, gravel, or similar unconsolidated material deposited by flowing rivers and streams.
ammonia	A nitrogen-based compound that exists in either the un-ionized form (NH_3) or as the ammonium ion (NH_4^+).
aquifer	A geologic unit (rock or sediment) that can store and transmit water at rates sufficient to supply reasonable amounts of water to wells and springs.
aquitard	A layer of low-permeability formation immediately above or below an aquifer that retards but does not prevent the flow of ground water to or from the aquifer. It does not readily yield water to wells and springs but may serve as a storage unit for ground water.
background ground water quality	The composition of ground water in areas near the millsite that are geologically similar to the millsite and were not affected by ore-processing activities.
benchmark	An established criterion, known point, or metric used to compare measured or estimated values of chemicals in the environment. Benchmarks generally represent concentrations for a particular medium (e.g., air, soil, water, food) that are acceptable for given receptors (e.g., humans, animals).
benthos	The plants and animals living on the river bottom.
biota	Living organisms.
borrow material	Rock, soil, or other earth materials that are excavated from one location and transported for use at another location, generally for construction purposes (e.g., as fill material).
brine	The USGS classification of water with a TDS concentration of more than 35,000 mg/L. In the EIS, briny water in the basin fill aquifer beneath the Moab site is salty ground water, which became salty mostly from dissolution of evaporite minerals in the Paradox Formation.

chronic concentration	Concentration of a contaminant in an environmental medium (air, soil, and water) that would produce a chronic exposure. A chronic exposure is a continuous or intermittent exposure of an organism to a stressor (e.g., a toxic substance or ionizing radiation) over an extended period of time or significant fraction (often 10 percent or more) of the life span of the organism. Generally, chronic exposure is considered to produce only effects that can be observed some time following initial exposure. These may include impaired reproduction or growth, genetic effects, and other effects such as cancer, precancerous lesions, benign tumors, cataracts, skin changes, and congenital defects.
cultural resources	Historic properties, archaeological resources, and cultural items, such as (1) archaeological materials (e.g., artifacts) and sites that date to the prehistoric, historic, and ethnohistoric periods that are currently located on, or are buried beneath, the ground surface; (2) standing structures and/or their component parts that are more than 50 years of age or are important because they represent a major historical theme or era (e.g., Manhattan Project, Cold War); (3) structures that have an important technological, architectural, or local significance; (4) cultural and natural places, selected natural resources, and sacred objects that have importance for Native Americans; and (5) American folklife traditions and arts.
decreaser grasses	The grasses most eagerly sought after by grazing animals—they tend to decrease as grazing pressure increases. Most grasses are defined as being pasture increasers or decreasers.
distribution coefficient (K_d and R_d)	A ratio of the concentration of a chemical in soil to the concentration in water under equilibrium conditions (i.e., concentration in soil divided by the concentration in water).
floodplain (including 100 and 500 year)	The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river, and covered with water when the river overflows its banks. The floodplain is built of alluvium carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A 100-year floodplain is the area of land that has a 1.0 percent or greater chance of being flooded in any given year. A 500-year floodplain is the area of land that has a 0.2 percent chance of being flooded in any given year.
flow-and-transport modeling	Use of computer software to try to simulate subsurface movement of water and chemicals to predict future conditions in an aquifer.

fresh water	The USGS classification of water based on the following concentration ranges of TDS: fresh water has less than 1,000 mg/L TDS, slightly saline water has 1,000 to 3,000 mg/L TDS, moderately saline water has 3,000 to 10,000 mg/L TDS, very saline water has 10,000 to 35,000 mg/L TDS, and brine has more than 35,000 mg/L TDS. In the EIS, fresh water in the basin fill aquifer beneath the Moab site is referred to as the upper portion of the aquifer that overlies the deeper briny ground water.
fugitive dust	(1) Dust emitted that does not pass through a stack, vent, chimney, or similar opening where it could be captured by a control device. (2) Any dust emitted other than from a stack.
increaser grasses	Grasses that become better established as grazing pressure increases because they are less palatable—they tend to increase as more favored species are grazed out. Most grasses are defined as being pasture increasers or decreasers.
institutional controls	Used to limit or eliminate access to, or uses of, land, facilities, and other real and personal property to prevent inadvertent human and environmental exposure to residual contamination and other hazards. These controls maintain the safety and security of human health and the environment and of the site itself. Institutional controls may include legal controls such as zoning restrictions and deed annotations and physical barriers such as fences and markers. Also included are methods to preserve information and data and to inform current and future generations of the hazards and risks.
kilovolt amperes (kVA)	A unit of electric measurement equal to the product of a kilovolt volt and an ampere. For direct current, it is a measure of power and is the same as a kilowatt; for alternating current, it is a measure of apparent power.
legacy plume	Site-related ground water contamination that is found in the freshwater layer of the ground water system and that would still be present even if no further contamination of the ground water takes place.
long-term surveillance and maintenance	A task performed by the DOE Office of Legacy Management through the DOE in Grand Junction, Colorado. The Office of Legacy Management provides expertise and resources necessary to manage low-level radioactive material disposal and impoundment sites after remedial action is complete.
macrophytes	Large aquatic plants.
maximally exposed individual	A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (e.g., inhalation, ingestion, direct exposure).
millirem (mrem)	One thousandth of a rem (0.001 rem); see *rem*.

mixing zone	A limited portion of a body of water, contiguous to a discharge, where dilution is in progress but has not yet resulted in a concentration that will meet certain standards for all pollutants (from State of Utah surface water regulation R317-2-13).
natural flushing	Allowing the natural ground water movement and geochemical processes to decrease contaminant concentrations.
PEIS	*Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project,* prepared by DOE in 1996 for the UMTRA Ground Water Project. The PEIS is intended to serve as a programmatic planning document that provides an objective basis for determining site-specific ground water compliance strategies at the UMTRA Project sites.
pH	A measure of the relative acidity or alkalinity of a solution, expressed in a scale of 0 to 14, with a neutral point at 7. Acid solutions have pH values lower than 7, and basic (i.e., alkaline) solutions have pH values higher than 7. Because pH is the negative logarithm of the hydrogen ion (H^+) concentration, each unit increase in pH expresses a change in state of a factor of 10. For example, pH 5 is 10 times more acidic than pH 6, and pH 9 is 10 times more alkaline than pH 8.
plant community	A group of interacting plant species that share a common habitat, including incoming solar radiation, soil water, and nutrients, that recycle nutrients from the soil to living tissue and back again and that alternate with each other in time and space. Plant community is a general term that can be applied to vegetation types of almost any size or longevity. A plant association is a particular type of community that has been described sufficiently and repeatedly in several locations.
PM_{10}	Particulate matter in air small enough to move easily into the lower respiratory tract, defined as particles less than 10 micrometers in aerodynamic diameter.
phytoremediation	Use of plants to remove contaminants from ground water through root uptake. At the Moab site, tamarisk roots take in nitrogen compounds (e.g., ammonia and nitrate) from ground water.
phreatophyte	Deep-rooted plants that obtain water directly from the water table or a permanent ground water source.
picocurie	A unit of radioactivity equal to one trillionth (10^{-12}) of a curie. A curie is a unit of radioactivity equal to 37 billion nuclear disintegrations per second.
plume	The volume of contaminated ground water originating at a contaminant source such as the tailings pile at the Moab site and migrating downgradient.

probable maximum flood	The hypothetical flood that is considered to be the most severe reasonably possible flood, based on the comprehensive application of maximum precipitation and other hydrological factors favorable for maximum flood runoff (e.g., sequential storms and snowmelts). It is usually several times larger than the maximum recorded flood.
radium-226	A radioactive metallic element in the decay chain that begins with uranium-238 and ends with lead-206, a stable isotope. Radium-226 has a half-life of about 1,600 years and decays to radon-222, an inert gas.
radon-222	A radioactive inert gas in the decay chain that begins with uranium-238 and ends with lead-206, a stable isotope. Radon has a half-life of about 3.8 days and decays into polonium-218, a metallic ion.
reasonable maximum exposure	The highest exposure that is reasonably expected to occur at a site (EPA risk assessment guidance) (exposure is defined as the contact of an organism with a chemical or physical agent).
recharge areas	Areas in which water on the ground surface (e.g., precipitation or a water body) infiltrates downward and replenishes an aquifer.
rem	A unit of radioactive dose equivalent, equal to the absorbed dose in tissue multiplied by an appropriate quality factor and possibly other modifying factors. Derived from "roentgen equivalent man," referring to the dose of ionizing radiation that will cause the same biological effect as one roentgen of X-ray or gamma ray exposure.
record of decision (ROD)	A public document that records a federal agency's decisions concerning a proposed action for which the agency has prepared an EIS. The ROD is prepared in accordance with the requirements of the Council on Environmental Quality NEPA regulations (40 CFR 1505.2). A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternatives, factors balanced by the agency in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and, if not, why they were not.
rim syncline	A local depression that develops between salt diapirs resulting from movement of underlying salt toward the diapir structure.
river incision	The geologic process by which the Colorado River cuts down through the bedrock sandstone outcroppings located upstream and downstream of the Moab site.
river mile	The distance of a point on a river measured in miles from the river's mouth along the low-water channel.

saline	The USGS classification of water based on the following concentration ranges of TDS: fresh water has less than 1,000 mg/L TDS, slightly saline water has 1,000 to 3,000 mg/L TDS, moderately saline water has 3,000 to 10,000 mg/L TDS, very saline water has 10,000 to 35,000 mg/L TDS, and brine has more than 35,000 mg/L TDS. In the EIS, saline water in the basin fill aquifer beneath the Moab site is referred to as salty ground water, which is salty mostly from dissolution of evaporite minerals in the Paradox Formation.
salt-cored anticline	An anticline in which salt (from evaporating seawater, including other materials such as silt and clay) has flowed upward and formed the core of the anticline.
salt diapir	A dome or elongate anticlinal fold in which the overlying rocks have been ruptured or pierced by the squeezing out of low-density salt deposits and their resulting upward movement.
settling	The gradual compacting and lowering of the height of a tailings pile. It is caused by the weight of the pile squeezing liquids from slimes downward and out of the pile.
slimes	The fine-grained fraction of the mill tailings that consists of clay- and silt-sized grains; defined as material that will pass through a 200-mesh Tyler-equivalent sieve.
steady-state conditions	Conditions that exist when a system is in equilibrium and that do not change significantly over time (e.g., ground water constituent concentrations that remain essentially constant).
subsidence	The geologic process that is lowering the entire tailings pile at the Moab site because of ground water dissolving the Paradox Formation salt deposits that underlie the Moab-Spanish Valley.
supplemental standards	A narrative exemption from remediating ground water to prescriptive numeric standards (background concentrations, maximum concentration limits [MCLs], or alternate concentration limits [ACLs]), if one or more of the eight criteria in 40 CFR 192.21 are met. At the Moab site, the applicable criterion is limited-use ground water, (40 CFR 192.21[g]), which means that ground water has naturally occurring total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L), and widespread TDS contamination is not related to past milling activities at the site. The PEIS (DOE 1996) also discusses supplemental standards within the context of "no ground water remediation." However, guidance in 40 CFR 192.22 directs that where the designation of limited-use ground water applies, remediation shall "assure, at a minimum, protection of human health and the environment."
tailings pore fluids	Water in the pore spaces between the mineral grains that make up the tailings pile at the Moab site. Fluids can be remnants of fluids disposed of in the former tailings ponds or precipitation that seeped into the pile.

total dissolved solids (TDS)	A measurement of the nonvolatile constituents dissolved in water. TDS is measured by filtering a water sample through a glass fiber filter having an average pore size of 1 micrometer, evaporating a measured volume of the filtered water to dryness at 105 degrees Celsius (°C), then drying the residue to a constant weight at 180 °C. The result is expressed in milligrams of residue per liter of water sample. Water with more than 2,000 to 3,000 mg/L TDS is generally too salty to drink. TDS concentration of seawater is about 35,000 mg/L.
traditional cultural property (TCP)	A significant place or object associated with historical and cultural practices or beliefs of a living community that is rooted in that community's history and is important in maintaining the continuing cultural identity of the community.
UMTRA Project	Uranium Mill Tailings Remedial Action Project that was approved by Congress in 1978 and gave DOE authority to clean up inactive uranium-ore processing sites and vicinity properties, including ground water.
uranium	A radioactive, metallic element that is the heaviest of the naturally occurring elements. Uranium has 14 known isotopes, of which uranium-238 (half-life of about 4.5 billion years) is the most abundant. Uranium-235 (half-life of about 700 million years) is used as a fuel for nuclear fission.
vicinity properties	Properties, either public or private in the vicinity of designated uranium-ore processing sites, that are believed to be contaminated with RRM and may be eligible for characterization and cleanup under the UMTRA Project.
wetland	Areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.
working level	A measure of radon daughter concentration, consisting of any combination of short-lived radon-222 decay products in 1 liter of air that result in the ultimate emission of alpha particle energy of 1.5×10^5 million electron volts.
young-of-the-year	Juvenile fish less than 1 year old.
zooplankton	The animal constituent of the small plants and animals that float or drift in fresh water, mainly insects or fish.

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