Appendix A

Biological Assessment/Screening Level Risk Assessment/ Biological Opinion

Introduction

This appendix has been prepared by the U.S. Department of Energy (DOE) to comply with requirements set forth in Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.) and the National Environmental Policy Act (NEPA) (40 CFR 1502.25). It includes the following documents:

- Biological Assessment, including DOE's determinations (Appendix A1)
- A screening-level risk assessment (Appendix A2)
- The U.S. Fish and Wildlife Service (USF&WS) Biological Opinion (Appendix A3)

This appendix addresses the potential effects of remediation alternatives on listed threatened and endangered species and on critical habitat for the Moab, Utah, Uranium Mill Tailings Radiation Control Act (UMTRCA) site. The alternatives are discussed in detail in the *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Draft Environmental Impact Statement* (DOE/EIS-0355D). The analyses focus on contaminated ground water that is currently affecting the Colorado River. The alternatives evaluated in the environmental impact statement (EIS) address both surface remediation and ground water remediation under the proposed on-site and off-site disposal alternatives. All alternatives except the No Action alternative would include active ground water remediation at the Moab site, because this medium presents the greatest potential to adversely affect threatened and endangered aquatic species. Less emphasis is placed in this appendix on terrestrial species, because preliminary investigations and consultations do not indicate an imminent adverse effect to threatened and endangered terrestrial species for any of the proposed disposal cell locations.

Background

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 at 24 uranium-ore processing sites and associated vicinity properties (properties where uranium mill tailings were used as construction or fill material before the potential hazards associated with this material were known). In October 2000, the Floyd D. Spence National Defense Authorization Act (Floyd D. Spence Act) for fiscal year (FY) 2001 (Public Law 106–398) added the Moab site to the list of UMTRCA Title I sites and gave DOE responsibility for remediation of the site.

Prior to its transfer to DOE, the site had been owned and operated by the Uranium Reduction Company and later the Atlas Minerals Corporation under a license issued by the U.S. Nuclear Regulatory Commission (NRC). The processing facility no longer operates and has been dismantled except for one building that is currently used by DOE for maintenance and storage space. During its years of operation, the facility accumulated approximately 11.8 million tons of uranium mill tailings. Uranium mill tailings are the naturally radioactive residue from the processing of uranium ore. The tailings at the Moab site contain constituents that have contaminated the nearby soil and ground water at levels that exceed U.S. Environmental Protection Agency (EPA) standards in 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."

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. In May 1994, USF&WS provided comments to NRC on its Notice of Intent to prepare an EIS for site reclamation, stating concerns that included water depletion and contaminant effects on endangered fish. A biological assessment was prepared in 1995 and supplemented in 1997. USF&WS issued a Final Biological Opinion in 1998. The opinion was based on a proposed action of stabilizing the contaminated materials in place, and it concluded that continued leaching of existing concentrations of ammonia (and other constituents) would jeopardize the continued existence of endangered fish species in the Colorado River. In addition, depletion of Colorado River water (associated with remedial actions) would jeopardize four endangered species. The action would also affect critical river habitat for the razorback sucker and Colorado pikeminnow. In its Final Biological Opinion, USF&WS proposed mitigative measures that would be protective of endangered fish species and critical habitat. Because USF&WS considered ground water remediation an "interrelated action," the opinion included a request for an expedited ground water compliance action plan. DOE is addressing ground water remediation within the scope of the EIS.

Stakeholders, including federal and state agencies, have expressed concern that elevated levels of site-related ground water contaminants, primarily ammonia, are reaching the Colorado River. The USF&WS and Utah Division of Wildlife Resources (UDWR), among others, are concerned because the segment of the Colorado River near the Moab site is also designated critical habitat for four endangered fish species. The Columbia Environmental Research Center of the U.S. Geological Survey conducted a study in 1998. The study was updated in 2002 and concluded that ammonia concentrations entering the river from the Moab site may present a risk to endangered fish species (USGS 1999, 2002). The study also concluded that current Utah surface water quality standards for ammonia would be protective of fish species. DOE has identified, through a screening level risk assessment, four other contaminants of concern that could adversely affect aquatic receptors; manganese, copper, sulfate, and uranium. Appendix A2 summarizes the analyses that identified these contaminants of potential concern.

By letter dated February 8, 2001, during transition of ownership of the site to DOE, USF&WS withdrew its Biological Opinion pending additional consultation. Since acquiring the site, DOE has undertaken informal consultation and short-term actions to mitigate impacts to endangered fish. In 2002, 2003, and 2004, DOE consulted with USF&WS to implement initial and interim actions that are anticipated to reduce the influence of contamination on designated critical habitat. These actions are discussed in more detail in the attached Biological Assessment (BA).

Appendix A1

Biological Assessment

BIOLOGICAL ASSESSMENT
REMEDIATION OF THE MOAB URANIUM MILL TAILINGS

U.S. DEPARTMENT OF ENERGY
Grand Junction, Colorado

CONTACT PERSON: Don Metzler Phone Number: (970) 248-7612

LOCATION: Grand and San Juan Counties, Utah

Activities are contemplated in portions of the following townships, depending on the alternative selected in the *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Environmental Impact Statement* (EIS):

T 21 S	R 19, 20 E	T 30 S	R 23, 24 E
T 22 S	R 19, 20 E	T 31 S	R 23, 24 E
T 23 S	R 18, 19, 20 E	T 32 S	R 23, 24 E
T 24 S	R 19, 20 E	T 33 S	R 23, 24 E
T 25 S	R 20, 21 E	T 34 S	R 23, 24 E
T 26 S	R 21, 22 E	T 35 S	R 23, 24 E
T 27 S	R 22, 23 E	T 36 S	R 22, 23 E
T 28 S	R 22, 23 E	T 37 S	R 22 E
T 29 S	R 23 E	T 38 S	R 22 E

U.S. Geological Survey (USGS) Quadrangles: Crescent Junction, Klondike Bluffs, Valley City, Merrimac Butte, Golden Bar Canyon, Moab, Rill Creek, Kane Springs, La Sal Junction, La Sal West, Hatch Rock, Sandstone Draw, Church Rock, Monticello North, Monticello South, Abajo Peak, Blanding North, Blanding South.

A1−1.0 Introduction

This Biological Assessment (BA) documents and assesses the proposed surface and ground water remedial actions for disposition of the uranium mill tailings pile and mill-related contamination on vicinity properties located near Moab, Utah (Figure A1−1). Sufficient information is provided to determine the potential effects on federal threatened or endangered species of the proposed alternatives addressed in the U.S. Department of Energy's (DOE's) EIS. This BA also documents initial and interim actions implemented to date to mitigate ongoing impacts to aquatic species in the Colorado River caused by elevated ground water concentrations of mill-related contaminants (Section A1−4.3).

For some terrestrial species, site-specific investigations may need to be conducted prior to a final determination of effects. This BA is prepared in accordance with requirements in Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1531) and complies with the requirements established in U.S. Fish and Wildlife Service (USF&WS) regulations (50 CFR 402) and DOE's National Environmental Policy Act (NEPA) regulations (10 CFR 1021).

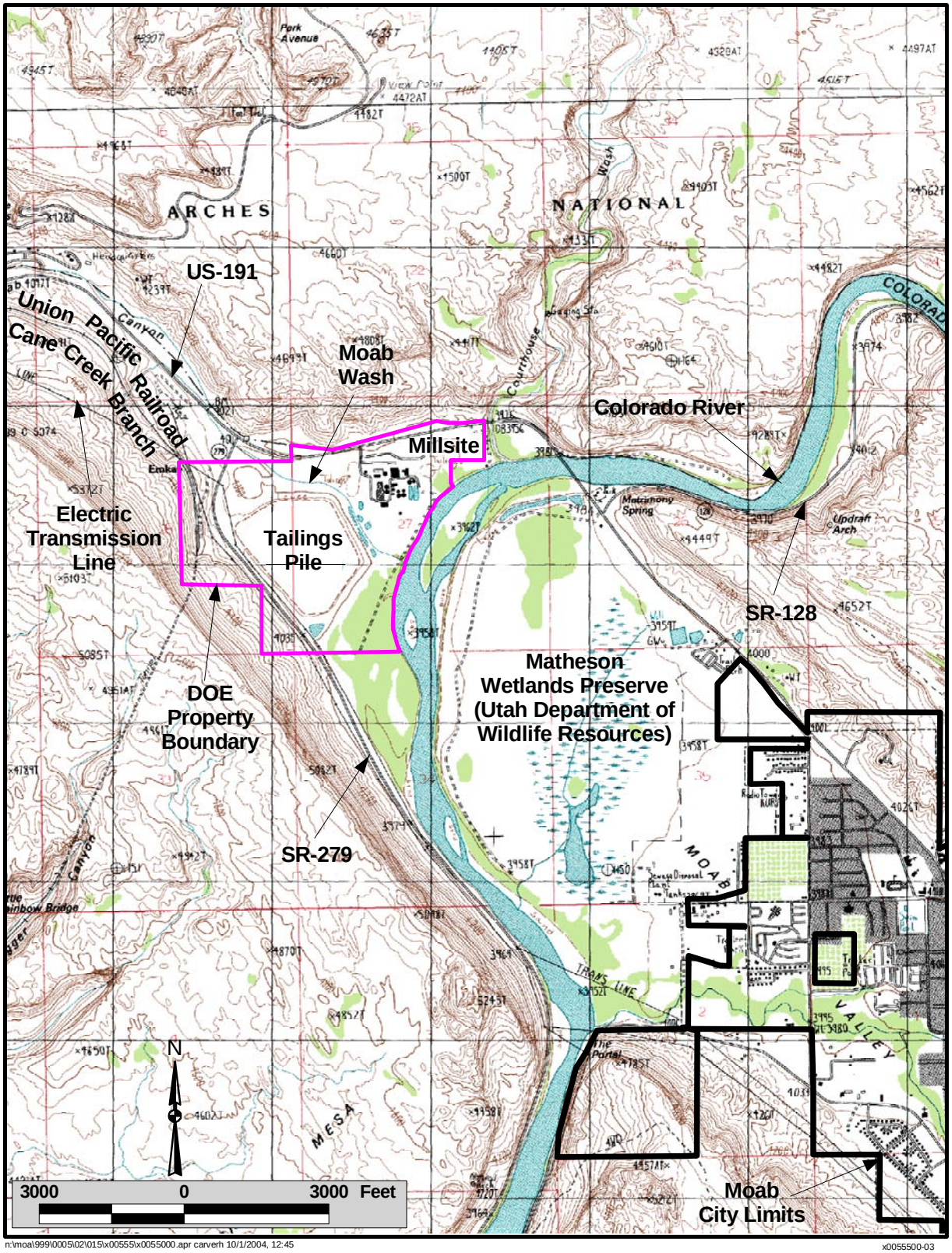

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Figure A1−1. Vicinity of the Moab Site

A1−2.0 Species Evaluated

Three plant, six bird, four fish, and two mammal species that may occur near the Moab site or at alternative proposed disposal sites are federally protected under the ESA. This list of species was based on consultation with the USF&WS (Table A1−1) during April 2003 (USF&WS 2003a, 2003b) and information obtained from the Utah Division of Wildlife Resources (UDWR) and the Bureau of Land Management (BLM), Moab and Monticello Offices.

Table A1−1. Species Considered in the 2004 BA for the Moab Site, Moab, Utah

Common Name	Scientific Name	Federal Status
PLANTS		
Navajo sedge	*Carex specuicola*	T
Jones cycladenia	*Cycladenia humilis* var. *jonesii*	T
Clay phacelia	*Phacelia argillacea*	E
BIRDS		
Bald eagle	*Haliaeetus leucocephalus*	T
Mexican spotted owl	*Strix occidentalis lucida*	T
California condor	*Gymnogyps californianus*	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E
Yellow-billed cuckoo	*Coccyzus americanus*	C
Gunnison sage grouse	*Centrocercus minimus*	C
FISH		
Humpback chub	*Gila cypha*	E
Bonytail	*Gila elegans*	E
Colorado pikeminnow	*Ptychocheilus lucius*	E
Razorback sucker	*Xyrauchen texanus*	E
MAMMALS		
Black-footed ferret	*Mustela nigripes*	E
White-tailed prairie dog	*Cynomys leucurus*	*

T = federal threatened, E = federal endangered, C = federal candidate, * = Petition Under Review

A1−2.1 Critical Habitat

The USF&WS has designated the floodplain and Colorado River segment adjacent to the Moab site as critical habitat for the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker (50 CFR 17.95). Critical habitat is defined as "…specific areas on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection" (USF&WS 1998b). Activities associated with the disposal site and alternative disposal sites would occur in the vicinity of this designated critical habitat. No critical habitat for terrestrial species exists in the vicinity of the Moab, Klondike Flats, Crescent Junction, or White Mesa Mill disposal site locations. Likewise, no critical terrestrial habitat has been identified within the transportation corridors. The proposed pipeline transportation route to the White Mesa Mill site is within 2 miles of designated critical habitat for Mexican spotted owl and is in the vicinity of a Gunnison sage grouse conservation area (not designated critical habitat).

A1−3.0 Consultation to Date

The U.S. Nuclear Regulatory Commission (NRC) initiated consultation on the remediation of the Moab uranium mill tailings pile during preparation of a previous EIS (NRC 1999). For that EIS, NRC prepared a BA in 1995 that concluded endangered fish species could be exposed to potentially toxic levels of site-related contaminants. The BA also concluded that remediation of the tailings pile could disturb breeding activities for the southwestern willow flycatcher, if this species were present in the vicinity of the millsite.

NRC updated its BA in 1997. In this revision, it was determined that ammonia was at potentially toxic levels where site ground water entered the river and that this constituent could adversely affect endangered fish. The updated BA further evaluated the potential for the southwestern willow flycatcher and peregrine falcon to be adversely affected by selenium and mercury. The results were inconclusive.

USF&WS issued its Final Biological Opinion in July 1998. At that time, it was the Service's opinion that capping the pile in place would jeopardize the continued existence of the razorback sucker and Colorado pikeminnow due to continued leaching of contaminants (primarily ammonia) into the Colorado River, water depletion in the river, and adverse modification of designated critical habitat. This opinion was based primarily on the lack of a ground water corrective action plan. It provided a set of reasonable and prudent measures that would help to minimize these adverse impacts. USF&WS also concluded that the proposed action would not jeopardize the southwestern willow flycatcher and provided prudent measures to minimize take of that species. The peregrine falcon was not addressed in the Biological Opinion.

NRC published its final EIS in 1999. However, responsibility for cleanup of the Moab tailings pile was transferred, by act of Congress, to DOE in October 2000 (Floyd D Spence Act, Public Law 106-398). In February 2001, based on circumstances that pre-dated transfer of the site to DOE, USF&WS rescinded its Final Biological Opinion. Since DOE acquired responsibility for the Moab site, many activities, including characterization, maintenance and operational activities, and interim actions, have taken place. Before implementing these actions, DOE consulted regularly with USF&WS concerning threatened and endangered species that may be affected by these activities. These consultations, and DOE determinations, resulted in concurrences by USF&WS dated March 23, 2001, September 12, 2001, January 22, 2002, and April 5, 2004. In all cases, it was determined that these actions would not jeopardize the continued existence of any aquatic or terrestrial threatened or endangered species.

In support of the preparation of the draft EIS for remediation of the Moab site, DOE sent a request for information to USF&WS in March 2003. USF&WS responded in April 2003 with an updated list of threatened, endangered, proposed, and candidate species that may occur in the potentially affected areas under the various alternatives.

On April 24, 2003, DOE and USF&WS met in Salt Lake City to discuss the BA approach and scope. This meeting also included discussions regarding options for preparing a biological opinion prior to identifying a preferred alternative.

A teleconference with USF&WS, DOE, the U.S. Environmental Protection Agency (EPA), and the Utah Department of Environmental Quality took place on July 9, 2003, to discuss the applicable numeric ammonia criteria.

On August 25, 2003, USF&WS and DOE met in Salt Lake City to further discuss applicable risk-based criteria and standards that would be protective of endangered fish. On November 3, 2003, the draft BA was forwarded to USF&WS for comment. DOE received initial comments on the BA in early December 2003. Following receipt of the comments, a meeting was held on December 15, 2003. Additional comments were received in early January 2004, followed by telephone conferences to clarify issues and concerns.

On April 14, 2004, DOE submitted the final draft BA to USF&WS. In June through August 2004, DOE and USF&WS consulted extensively to resolve final comments on this document.

On August 10, 2004, DOE received formal comments on the final draft BA.

A1−4.0 Description of the Proposed Action

DOE is proposing to remediate contaminated soils and materials and contaminated ground water at the Moab site. DOE will identify a preferred alternative prior to issuance of the EIS Record of Decision (ROD). Three alternatives are presented in the EIS:

- On-site disposal of tailings
- Off-site disposal of tailings (three locations, three transportation options considered)
- No action

On-site disposal of tailings is discussed in Section A1−4.1. Off-site disposal of tailings is discussed in Section A1−4.2. Active ground water remediation is proposed for both the on-site and off-site alternatives (Section A1−4.3.1). This BA places emphasis on ground water remediation due to contamination entering the Colorado River, which is designated critical habitat for four endangered fish species. The remediation goals (Section A1−4.3.2) are to reduce concentrations of five contaminants reaching the Colorado River to acceptable risk levels within 10 years of the ROD. Emphasis is placed on remediation of ammonia, which is the primary contaminant of concern. DOE implemented initial and interim actions (Section A1−4.3.3) in 2003 and 2004 in an attempt to begin reducing ammonia concentrations prior to full implementation of proposed ground water remediation.

DOE also analyzes the No Action alternative (Section 2.4 of the EIS), which serves as a baseline for comparing all alternatives, as required by NEPA regulation.

A1−4.1 On-Site (Moab) Remedial Actions

Under the on-site disposal alternative (Section A1−2.1 of the EIS), 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 (Figure A1−2). With the exception of specific engineering design changes, this alternative is similar to that proposed by the Atlas Corporation and described in Section A1−2.1 of NRC's 1999 EIS (NRC 1999). 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.

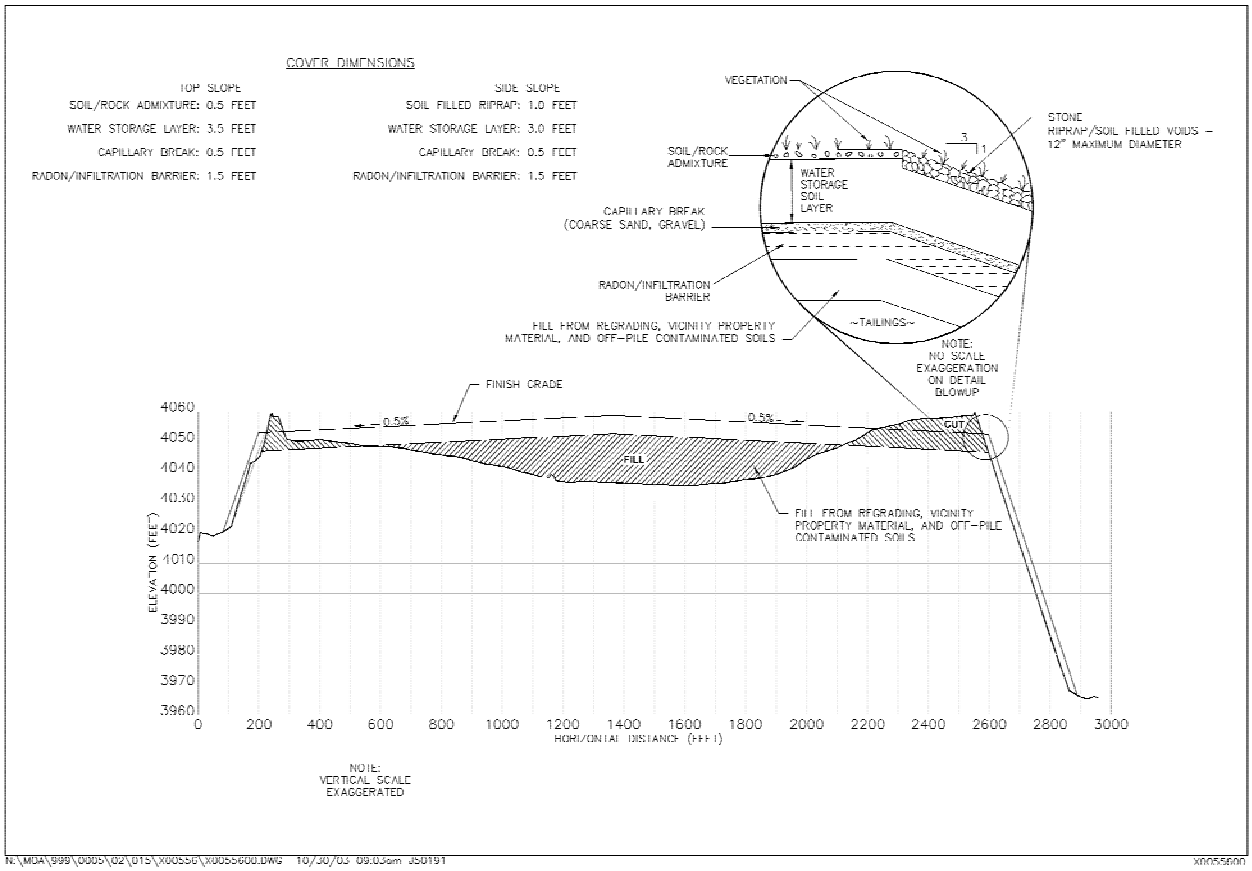

Figure A1−2. Typical Cross Section of Disposal Cell, On-Site Disposal Alternative

Activities would include grading and removing vegetation over almost the entire 439-acre site, both to prepare the site for subsequent activities and to remove surface contamination. These activities would remove remaining wildlife habitat (approximately 50 acres, primarily tamarisk) from the Moab site. Other site activities would include removing any existing structures and creating temporary construction support facilities (such as laydown yards, material stockpiles, vehicle maintenance and refueling areas, and vehicle decontamination facilities).

In the past, tailings material was removed from the Moab site and taken to off-site locations for a variety of purposes, such as backfill. In many cases, ore was stockpiled at various locations in the Moab area. For the purposes of analysis in the EIS, and based on available information and past experience, it has been estimated that about 98 locations, known as vicinity properties, may require remediation. All are relatively small (about 2,500 square feet [ft^2] and 300 cubic yards [yd^3]of material per site). These sites would be excavated and the materials transported by truck to the Moab site, where they would be stockpiled for eventual disposal at the selected disposal site.

If the on-site disposal alternative were selected, the route of Moab Wash (currently adjacent to the north and east sides of the tailings pile) would be altered to minimize potential damage to the tailings pile that could occur in the event of flooding. An engineered cover (Figure A1−2) consisting of a clay radon barrier, riprap, gravels, sands, and fine-grained soils would be constructed using materials obtained from several borrow areas (Figure A1−3, Table A1−2). Borrow materials would be transported to the Moab site by truck. Some improvements to existing roads may be required for access to some of the proposed borrow areas. Normal construction best management practices would be followed to limit wind and water erosion at the Moab site and borrow areas.

Table A1−2. Estimated Area of Disturbed Land at Borrow Areas for the Remediation Activities at the Moab Site, Moab, Utah

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 layer thickness of 12 ft at the borrow area.

Upon completion of remediation activities at the Moab site (under either the on-site or off-site disposal alternatives), the site would be graded and prepared for replanting, including any seedbed preparation activities. Replanting with native species would take place as early as practicable following completion of these activities, ideally at the onset of the next growing season. Areas of the Moab site currently dominated by tamarisk would be replanted with native riparian species that are of equal or higher functional value for wildlife, particularly for the southwestern willow flycatcher. Methods would be employed to maximize the competitive advantage of the replacement vegetation against encroachment of non-native species. DOE would use such means to ensure the establishment of the native vegetation but would not be required to maintain it in perpetuity.

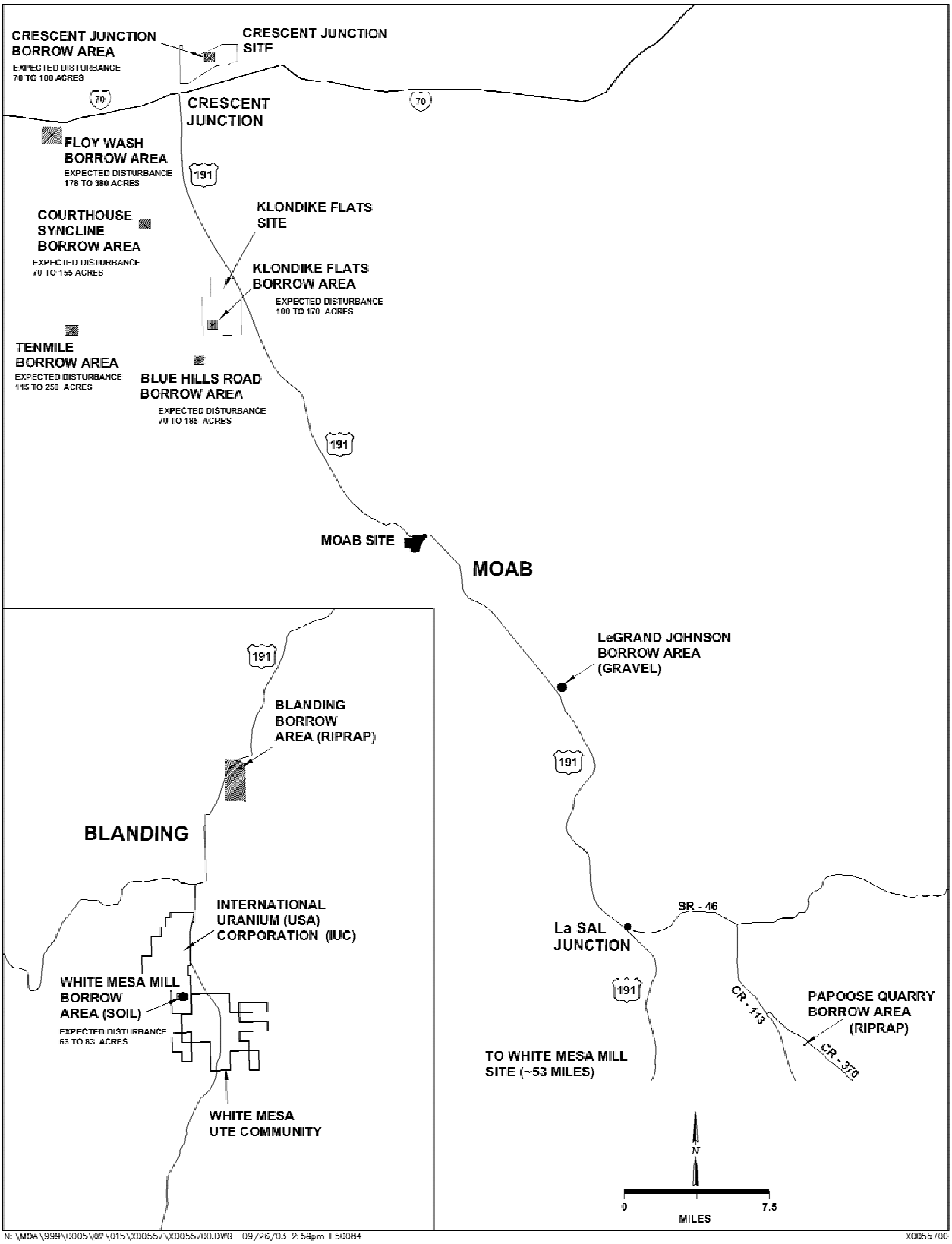

Figure A1−3. Location of Alternative Disposal Sites and Borrow Areas

A1−4.2 Off-Site Remedial Actions

Under the off-site disposal alternative (Section A1−2.2 of the EIS), the tailings pile, contaminated on-site soils and materials that are not yet in the existing pile, and contaminated materials from the vicinity properties would be transported to one of three proposed off-site disposal alternative locations: Klondike Flats, Crescent Junction, or White Mesa Mill (see Figure A1−3). Contaminated materials would be transported using one of three possible modes of transportation: truck, rail, or slurry pipeline; however, rail transportation is not an option for transportation to the White Mesa Mill site.

In addition to the activities at the Moab site described in Section A1–4.1, if the off-site disposal alternative were selected, approximately 346 to 489 acres of land would be disturbed at the selected disposal site, depending on the site and transportation option selected. Additional activities at the off-site disposal site would include preparing the disposal cell and constructing support facilities such as laydown areas, stockpile areas, vehicle maintenance and refueling facilities, temporary offices, and material-handling facilities. Depending on the transportation option selected, some infrastructure improvements would be performed. An engineered barrier cap would be constructed over the tailings using materials obtained from borrow areas that would most likely be located near the selected disposal site. Table A1−2 shows areas of disturbance at borrow areas. The degree of disturbance would depend upon the borrow areas actually used.

If the off-site disposal alternative were selected, the tailings and vicinity property materials would be prepared for transport to the selected disposal site. Truck transport would require minor construction to allow for more efficient entrance onto and exit from US-191 at the Moab site and at the alternative disposal sites. Rail transport would require construction of a loading facility at the Moab site and some additional track and unloading facilities at the selected disposal site.

If a slurry pipeline were chosen as the means to transport materials, the pipeline would primarily be aligned close to existing roads (primarily US-191) or existing natural gas or utility rights-of-way, although some new rights-of-way would be required.

A1−4.3 Moab Site Ground Water Remedial Actions

A1−4.3.1 Proposed Action

DOE's proposed action for ground water remediation at the Moab site is 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 in Section A1−4.3.3) that have already been implemented. Ground water remediation would be implemented under both the on-site and off-site tailings disposal alternatives. The remediation system would be designed to intercept contaminated ground water that is currently discharging into the near-bank, shoreline area of the Colorado River, which is designated critical habitat for endangered fish species. It is estimated that up to 5 years may be required to design and construct the remediation system. Once the system is implemented, up to 5 years of operation may be required before the action becomes completely effective and provides the requisite protection in the adjacent surface waters (Figure A1−4). However, these time frames are conservative, and the time needed to design, implement, and achieve protective levels may be substantially less. In addition, 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. This is discussed in more detail in Section A1–4.3.3. The system would be operated until ground water contaminant concentrations decreased to a level that would no longer present a risk to aquatic species. This is predicted to be 75 years for the off-site disposal alternative, and 80 years for the on-site disposal alternative (Figure A1−4). More detailed information is presented in Section 2.3 of the EIS.

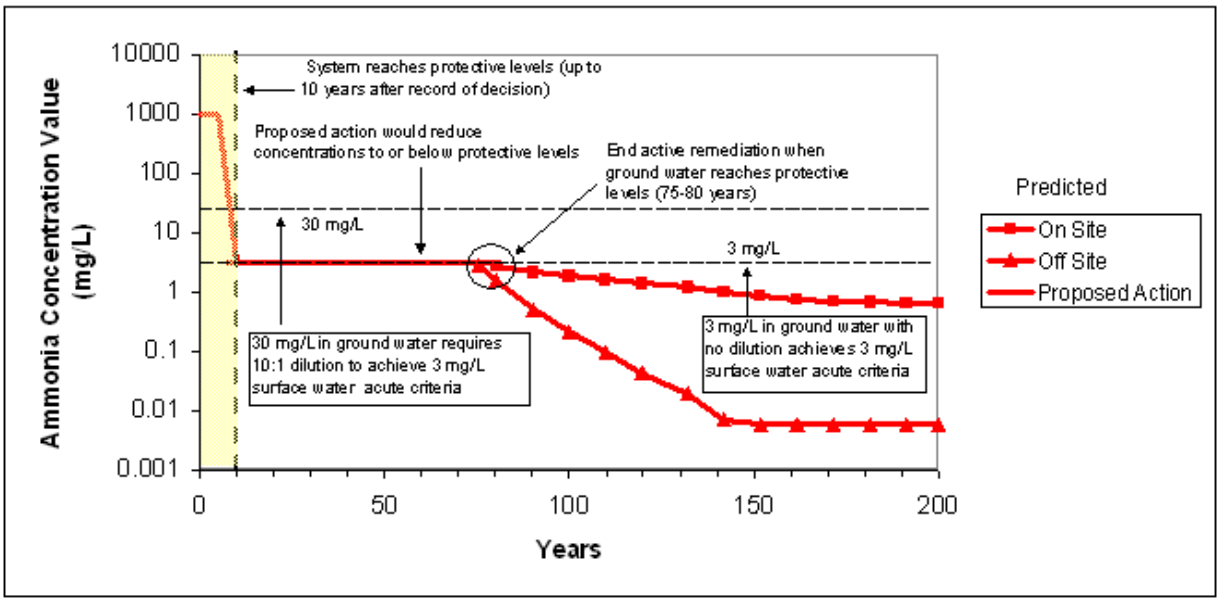

Figure A1−4. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation

Supplemental standards (40 CFR 192), would also be applied to ground water at the site. Ground water beneath the site qualifies for supplemental standards because it meets the criteria for limited use ground water. Section 2.3 of the EIS discusses ground water standards in more detail. These standards apply to human health and would not affect the active remediation goals discussed in the preceding sections.

A1−4.3.2 Remediation Goals for Contaminants of Concern

Aquatic Goals

Remediation goals are based on the contaminants of concern identified in Appendix A2 of the EIS, as summarized in Section A1−7.2 of this BA. Appendix A2 of the EIS, *Screening of Contaminants to Aquatic and Terrestrial Resources,* identified ammonia, copper, manganese, sulfate, and uranium as the chemical contaminants of concern. The primary contaminant of concern that would require ground water remediation is ammonia. The area of contamination varies with hydrologic regime but in general is confined to an area less than 53,800 ft^2 (approximately 1.25 acres) (USGS 2002).

Remediation goals for ammonia include the acute and chronic benchmarks based on ambient pH and temperature conditions in compliance with the National Recommended Water Quality Criteria (NWQC) (EPA 2002) and currently proposed Utah Water Quality Standards (UAC 2003, UDEQ 2003). The approach for setting the goals is discussed in Section 2.3 of the EIS. It is DOE's position that achieving a target goal of approximately 3 milligrams per liter (mg/L) for ammonia in ground water would result in compliance with the range of surface water standards in the Colorado River. The 3-mg/L target goal represents the low end of the reasonable range of acute standards. 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. In addition, based on analysis of collocated samples of interstitial ground water (pore water) and surface water, additional dilution occurs as the ammonia moves from the bank of the river into the water column. The dilution is estimated to be an average of 10-fold (DOE 2003a). The combination of active remediation, dilution into surface water, and the tendency for ammonia to volatilize should result in compliance with both acute and chronic ammonia standards in the river everywhere adjacent to the site. It is anticipated that ground water remediation would decrease and maintain the concentrations all of contaminants of concern at levels protective of aquatic species.

Terrestrial Goals

Contaminants of concern are identified in Appendix A2 of the EIS, and the potential effects of these contaminants are summarized in Section A1−8.2 of this BA. Appendix A2 of the EIS, *Screening of Contaminants to Aquatic and Terrestrial Resources,* identified mercury and selenium as contaminants of concern.

Remediation goals for terrestrial or avian species have not been established. This is due to limited potential for threatened or endangered receptors (both plant and animal) to be adversely affected by contaminated surface water or ground water, which is discussed in detail in Section A1−8.2 of this BA. Limited potential is based the risk analysis in Appendix A2 of the EIS and includes potential exposure pathways, potential presence of species, and potential use of ground water or surface water. Although specific goals are not established, concentrations of contaminants of concern would be reduced by proposed ground water remediation, which would reduce concentrations in surface water.

As a result of remediation, contaminants may concentrate in an evaporation pond. If concentrations presented a risk to threatened or endangered species, mitigation may be required as discussed in Section A1–8.1 of this BA.

A1−4.3.3 Initial and Interim Actions Related to the Proposed Action

As stated in Section A1−3.0, DOE, upon accepting responsibility for the site, initiated consultations with USF&WS. Based on these consultations, and after reviewing historical surface water quality studies and data, DOE and USF&WS both agreed that an immediate risk was posed to endangered fish and designated critical habitat. The source of the risk was identified as elevated concentrations of site-related ground water contaminants (primarily ammonia) reaching the Colorado River.

On April 30, 2002, USF&WS concurred with DOE's determination 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 cubic feet per second (cfs). The action focused on the segment of the Colorado River from Moab Wash extending approximately 800 feet (ft) downriver; that segment contributes the highest concentrations of contaminants to the river. The initial action was designed to take fresh water upstream of the site and pump it through a distribution system to backwater areas. The system was not installed in 2003 due to low flows. The system was installed and tested in 2004 but not fully implemented because the targeted backwater areas never held water. This was due to low river flows caused by drought.

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 gallons per minute (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 determination 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 added another 10 extraction wells (Phase II) near the first 10 wells to increase the rates 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 time frame considered under the proposed action. DOE will monitor surface water quality and provide the reports to USF&WS annually at a minimum.

A1−4.3.4 Ground Water Remediation Options

For purposes of this BA, active ground water remediation would consist of one or a combination of the options described below. All proposed remediation options would occur within the footprint of historical millsite activities and areas requiring surface remediation. Figure A1−5 shows the area of proposed ground water remediation. Final selection of the most appropriate option(s) would be documented in a remedial action plan (RAP) and would depend upon which surface disposal alternative is selected.

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

Section 2.3 of the EIS describes these remediation options in detail.

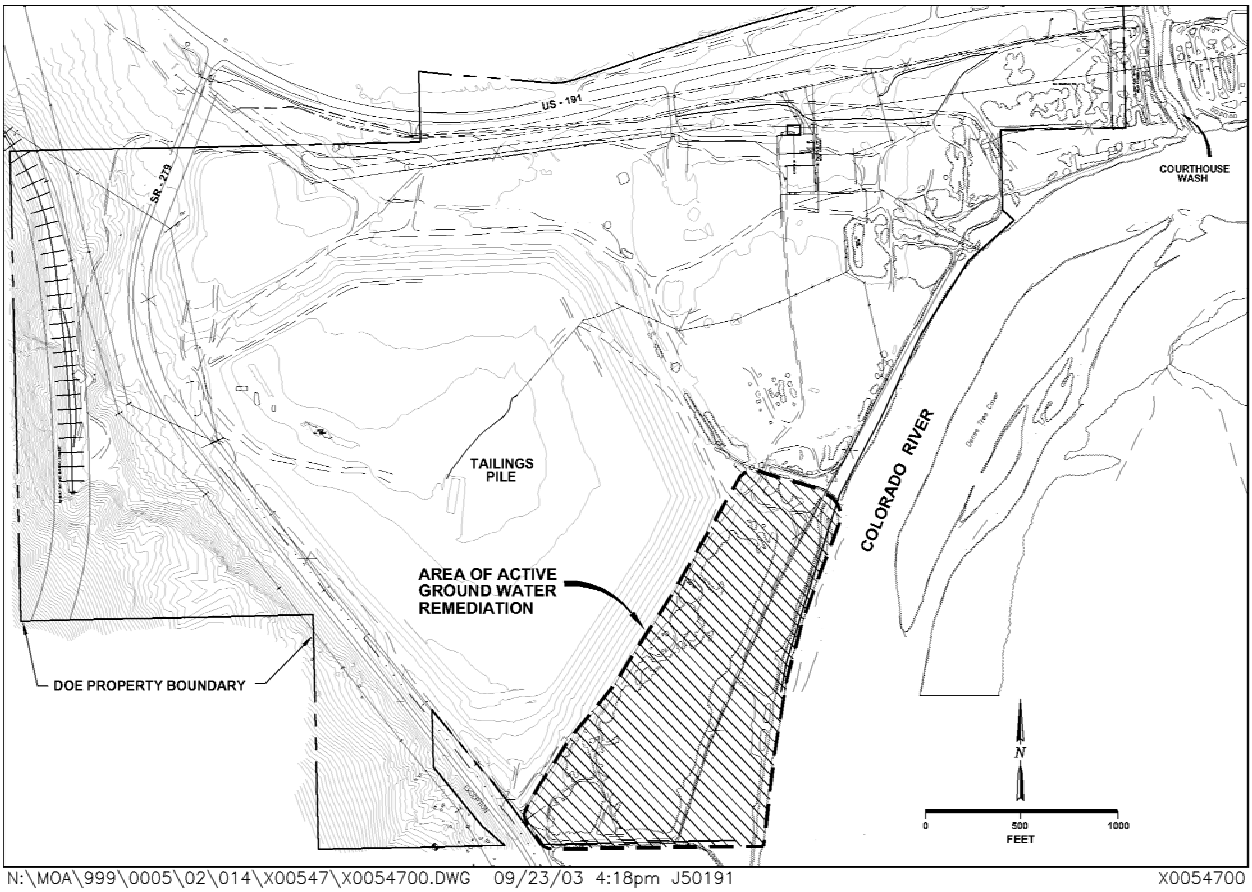

Figure A1−5. Area of Proposed Active Ground Water Remediation

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 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, which would be applicable for treatment of ammonia and other contaminants of concern (DOE 2003a). 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 a RAP following publication of the ROD. The Site Observational Work Plan (SOWP) (DOE 2003a) presents more detailed descriptions and discussion of 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 in this BA. 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 the USF&WS.

Solar evaporation would consist of putting the water into large, double-lined outdoor ponds built in the floodplain to withstand 100-year precipitation and flood events. In the absence of enhanced methods, a sufficiently large pond or ponds would need to be constructed in order to achieve evaporation rates that could keep up with extraction rates and complete remediation in a reasonable time frame. Estimated pond areas could range up to 40 acres, and a total of 60 acres of land would need to be disturbed. This would also require some type of small support facility. Devices such as spray nozzles could considerably enhance evaporation rates.

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. Based on 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 faster 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 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 biodegradation, including but not limited to phytoremediation. This option would require minimal infrastructure and could require state or federal permits, depending on the method of biodegradation.

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 where potentially suitable habitat for endangered fish may exist. This would likely take either or both of two possible 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 2002a) 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.

A1−4.3.5 Implementation and Operation

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. Design criteria and specifications would depend upon whether the on-site or off-site alternative is selected for tailings disposal.

After the system begins operation, DOE estimates that as much as an additional 5 years would 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 may be required to reach protective levels. The active remediation system would extract and treat ground water for 75 to 80 years (depending on whether the off-site or on-site surface remediation alternative were implemented) to maintain surface water quality goals. Contaminant concentrations in ground water would thus be reduced to acceptable risk levels prior to entry into the Colorado River. Active remediation would cease only after ground water and surface water monitoring confirmed that long-term remediation goals were achieved and after appropriate consultation and concurrence with USF&WS. The uncertainties and assumptions associated with the success of active remediation are discussed below.

DOE would monitor the progress of remedial actions to determine if goals are being met and would commit to ongoing consultation with USF&WS. In addition, DOE would provide monitoring data and remediation results annually to USF&WS.

Uncertainties

DOE does not have a quantitative estimate of uncertainty associated with the ground water modeling predictions estimating the time for ground water concentrations to reach levels protective of aquatic species. Sections 7.3.5.5, 7.6, and 7.8.3 of the SOWP (DOE 2003a) 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.

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

On the basis of site-specific data and a study of site conditions, DOE has a reasonable degree of confidence that protective conditions would be met and maintained during both the operation of the corrective action and following achievement of water quality goals. To ensure that protective conditions were met, DOE would monitor the ground water and surface water systems and would hold regular consultations with USF&WS. In addition, the active remediation system would continue throughout the 75- to 80-year remedial action period and into the post-remedial action confirmation monitoring period.

A1−5.0 Description of Project Areas

Preliminary consultations and investigations indicate that listed threatened or endangered terrestrial wildlife species are not known to occur, nor are they strongly expected to occur, at the Moab, Klondike Flats, Crescent Junction, or White Mesa Mill sites. The proposed pipeline corridor to the White Mesa Mill site provides the greatest potential for terrestrial threatened or endangered species to be present. However, before developing any disposal site, DOE, in consultation with USF&WS, would determine the need for additional habitat evaluations and surveys for species that could be affected. If threatened or endangered species or critical habitats were identified at a selected site, a mitigation plan would be developed to minimize potential adverse impacts. If impacts could not be avoided, additional Section 7 consultation would be required.

A1−5.1 Moab Site

A1−5.1.1 Terrestrial Setting

Historically, the entire Moab site has been created and altered by natural events such as floods and, more recently, by the activities related to milling operations. At present, significant vegetation does not occur on approximately 380 acres of the site; this severely limits use of this area by terrestrial wildlife. 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 to the west and north of the site along the transportation routes.

The upland soils at the site are Nakai sandy loam. The potential indigenous vegetation that might occur if the site were not disturbed from past mill operations includes grasses such as Indian ricegrass (*Achnatherum hymenoides*) and galleta (*Pleuraphis jamesii*) and the desert shrubs fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), and winterfat (*Krascheninnikovia lanata*). This potential vegetation could provide habitat for 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.

The existing vegetation reflects a history of disturbance. Plants observed during April 2003 include spike dropseed (*Sporobolus contractus*), sand dropseed (*Sporobolus cryptandrus*), tamarisk (*Tamarix parviflora*), black greasewood (*Sarcobatus vermiculatus*), gray rabbitbrush (*Ericameria nauseosa*), Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), big sagebrush (*Artemisia tridentata*), and galleta. The presence of tamarisk and low-density black greasewood indicates that ground water occurs within 20 to 50 ft of the surface.

A narrow strip of riparian habitat along the eastern site boundary between the upper floodplain terrace and the Colorado River also contains wetland plants and soils. This area includes the sandbar areas downstream of Moab Wash. The area was assessed but not formally delineated in February 2002. The presence of wetland vegetation and soils and predominance of water would likely qualify at least a portion (estimated at approximately 1 acre) of this area as U.S. Army Corps of Engineers jurisdictional wetlands. Seedling tamarisk is the predominant plant in these wetland areas; other wetland plants include saltgrass *(Distichlis spicata)*, cattail *(Typha sp.*), rush (*Juncus sp.*), bulrush *(Scirpus sp.)*, spikerush (*Eleocharis sp.*), redroot flat sedge (*Cyperus erythrorhizos*), and sandbar willow (*Salix exigua*).

Other riparian areas at the Moab site do not meet the criteria for classification as jurisdictional wetlands. These include the wooded areas of tamarisk and other species on the floodplain and an area of woody and emergent vegetation surrounding a holding pond for water pumped from the river.

Vegetation across the Colorado River, including the Scott M. Matheson Wetlands Preserve (Matheson Wetlands Preserve) on the river's east bank, includes habitat that consists of riparian woodland, grassland, and shadscale (saltbush) communities. Woodland, dominated by 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, and cattail (NRC 1999). More than 175 species of birds have been observed at the Matheson Wetlands Preserve, and a great blue heron (*Ardeaherodias*) rookery is present in its lower end (NRC 1999). The Matheson Wetlands Preserve has a variety of wetland types that include emergent wetlands, shrub wetlands, cottonwood stands, and ponds. It is the only sizable wetland remaining on the Colorado River in Utah and serves multiple environmental functions, including water quality preservation, flood protection, erosion control, and biological productivity and diversity.

A1−5.1.2 Aquatic Setting

The Moab site lies immediately adjacent to the Colorado River, the principal surface water resource for the area. The tailings pile is approximately 700 ft west of the river. The site is located on an alluvial terrace, which historically floods through the area, along the Moab Wash and into the Colorado River. The tailings pile is located within the 100-year recurrence interval storm floodplain of the Colorado River and within the floodplain of the probable maximum flood (PMF) of both the Colorado River and Moab Wash. Mussetter and Harvey (1994) identified two Colorado River flows that are significant for the Moab site. At a flow of approximately 40,000 cfs, the river elevation exceeds its banks and floods the Matheson Wetlands Preserve. There were a total of seven years from 1959 to 2002 when flows were greater than 40,000 cfs. The other critical flow occurs at about 70,000 cfs, which, according to Mussetter and Harvey (1994), produces a river elevation such that river water comes in contact with the toe of the tailings pile. Based on an analysis of the flow data from the gaging station upstream at Cisco, there has only been one day (in 1984) since 1959 in which the flow has exceeded 70,000 cfs. Section 3.1.8 of the EIS and Section 5.2 of the SOWP (DOE 2003a) provide further discussion of the floodplains and hydrology. The major tributaries of the Colorado River near the site include the Dolores River (located upstream) and the Green River (located downstream). The Matheson Wetlands Preserve is on the east bank of the Colorado River, across from the Moab site. Sections 3.1.1 and 3.1.7 of the EIS describe the geology and surface water further.

The aquatic species within the vicinity of the Moab site are associated with the Colorado River. The Colorado River has seasonal variations in flow and temperature following a snowpack-driven hydrograph (DOE 2003b). Aquatic species in the river have adapted to physical and chemical conditions that fluctuate naturally, both seasonally and daily. These conditions include river flow and flooding of intermittent backwaters and elevated floodplains, bottom scouring by sand and silt, temperature, sediment loading, chemical composition, and salinity (NRC 1999).

The Moab site is located at approximately river mile 64 on the Colorado River (NRC 1999) in a transition zone between two geomorphically distinct reaches. River miles on the Colorado River have been designated for the purposes of research programs; the beginning of the designation is at the confluence of the Green River into the Colorado River (Belknap and Belknap 1991; Osmundson et al. 1997). The immediate reach of the Colorado River upstream of the site is predominantly sand-bedded with a few cobble bars. Directly downstream of the site, the river is sand-bedded with sandbars and stabilized islands. A portion of the shoreline near the site has been stabilized by tamarisk, an invasive species, or stabilized with riprap. The tamarisk can form

cut banks 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 chain. Macroinvertebrate samples were collected at six locations in the vicinity of the site in 1999 (USGS 2002). At each location, a sample was collected 3 ft, 15 ft, and 30 ft from the shoreline. Over 40 macroinvertebrate taxa, including chironomids and oligochaetes, were found during this sampling effort. Rooted macrophytes (i.e., plants), along with algae and zooplankton, have been found in the intermittent backwater areas 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). Both native and non-native species are present in this reach of the Colorado River, including four federal endangered species (NRC 1999). Trammell and Chart found twelve non-native species and only five native species in surveys conducted from 1992 through 1996 (Trammell and Chart 1998).

Many components of the upper Colorado River ecosystem have changed over the last several decades. One change that affects the aquatic life of the river near Moab is the establishment of introduced, or non-native, fish species. The upper basin contains about 20 species of warm-water, non-native fish (USF&WS 2002a). The red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), channel catfish (*Ictalurus punctatus*), northern pike (*Esox lucius*), and green sunfish (*Lepomis cyanellus*) are the non-natives considered by Colorado River Basin researchers to be of greatest concern because of their suspected or documented negative interactions with native fishes (USF&WS 2002a). 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; USF&WS 2002a). Chapter 3.0 of the EIS describes the aquatic setting further.

A1−5.2 Klondike Flats

The proposed Klondike Flats disposal site is located on land administered by BLM about 18 miles north of the Moab site and just west of US-191 (Figure A1−6). The Klondike Flats site is remote and is located behind a low bluff such that the site is not visible from the highway. There are no perennial streams or other surface water features in or near this area; therefore, there are no significant aquatic ecological resources or wetlands that would be affected at the site. A portion of the site under consideration is designated for disposal in BLM's resource management plan (BLM 1983). The Grand County landfill is located within the area identified for disposal. The Canyonlands Field Airport is located immediately southeast of the Klondike Flats site. Access to the Grand County landfill is approximately 1 mile north of the Klondike Flats site and 1 mile west of US-191 on CR-236. Crescent Junction and the I-70 interchange are approximately 10 miles north of the site along US-191.

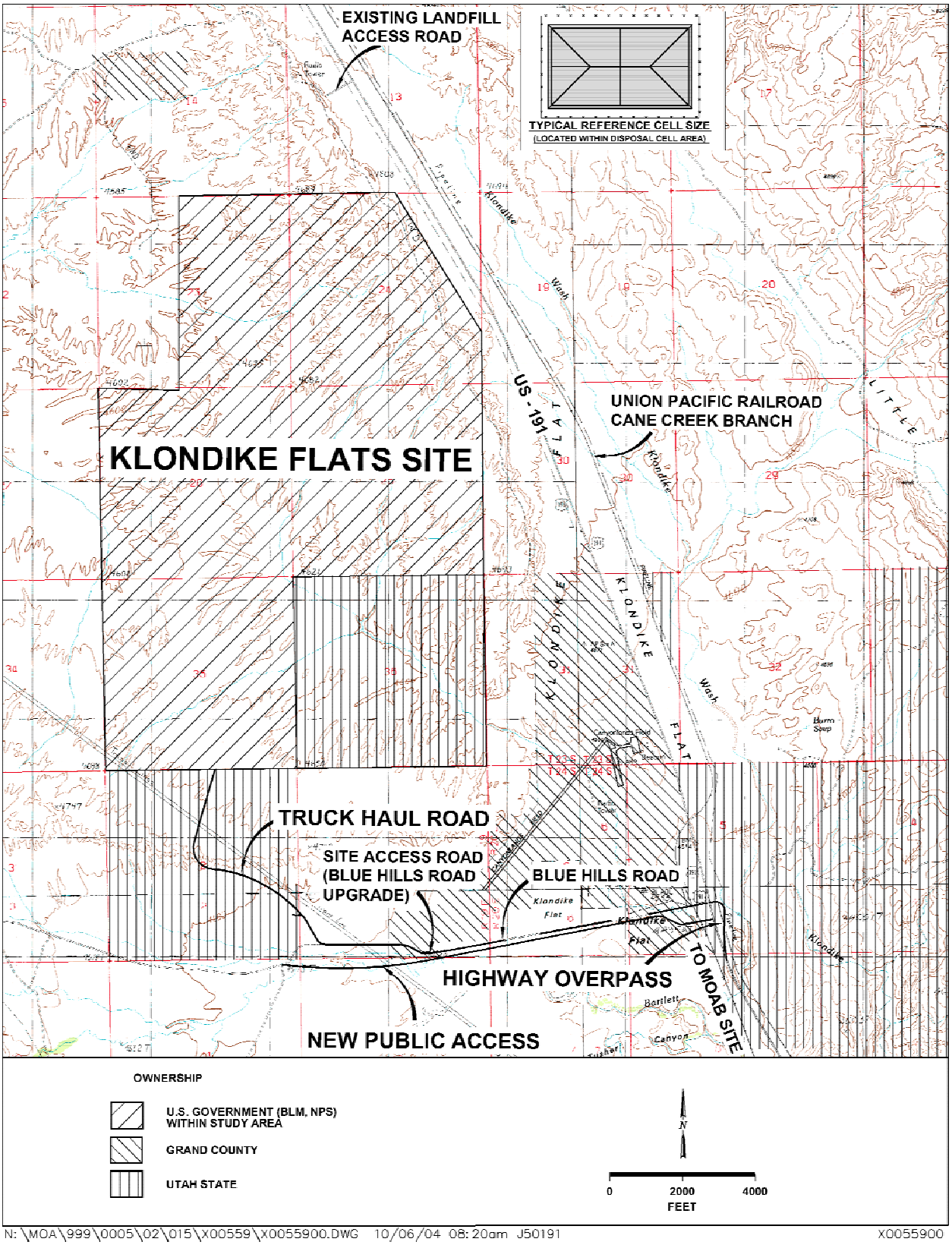

Figure A1−6. Klondike Flats Alternative Disposal Site

Plant abundance and diversity are generally very low, even for arid rangeland, because the low-permeability soils promote rapid runoff, have low water-holding capacity, and are often highly saline. Rooting depths vary from 5 to 20 inches. Extant vegetation on Chipeta soil within the Klondike Flats site is similar to the potential natural vegetation described in the Grand County Soil Survey (USDA 1989), which has limited value for grazing because of low productivity and poor palatability of dominant species. In upland areas, vegetation is dominated by low saltbushes (mat and Gardner saltbush [*Atriplex corrugata* and *Atriplex gardneri*]) with scattered shadscale, bud sagebrush (*Picrothamnus desertorum*), galleta, Indian ricegrass, and desert trumpet (*Eriogonum inflatum*). Maximum vegetative cover is about 50 percent. Prickly pear cactus, a grazing increaser that occurs in upland areas, is evidence 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, indicating that a slight increase in moisture can significantly increase plant abundance.

Water bodies in the vicinity of the Klondike Flats site consist primarily of ephemeral washes that are dry most of the year. The water from these washes eventually flows into either the Green River or the Colorado River. There are no wetlands in the area; however, there are several springs and wells nearby. These water sources are small, and nearby vegetation is primarily tamarisk.

The area surrounding and including the Klondike Flats site is available for recreation and other uses; however, existing access is limited to several dirt roads that are used for recreational access. Favorable weather allows off-road access for hikers, campers, mountain bikers, and off-highway vehicles during most of the year. Most recreational activities occur south 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 off-highway 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 during 2002. 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.

Transportation of materials between the Moab site and the Klondike Flats site would occur along the US-191/Union Pacific Railroad corridor. An existing natural gas pipeline right-of-way would be followed if a slurry pipeline were selected to transport materials. From the Moab site to the north for approximately 7 miles, this transportation route climbs through a relatively broad but steep-walled canyon with many side canyons.

A1−5.3 Crescent Junction

The proposed Crescent Junction disposal site is located on BLM-administered lands about 2 miles north of the town of Crescent Junction, which is an interchange on I-70 and US-191 (Figure A1−7). The site is about 30 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. No perennial streams are present, but ephemeral streams may carry high flows during heavy rains. Because no perennial streams or other surface water bodies are present on the Crescent Junction site, aquatic ecological resources and wetlands would not be adversely affected by activities at this site.

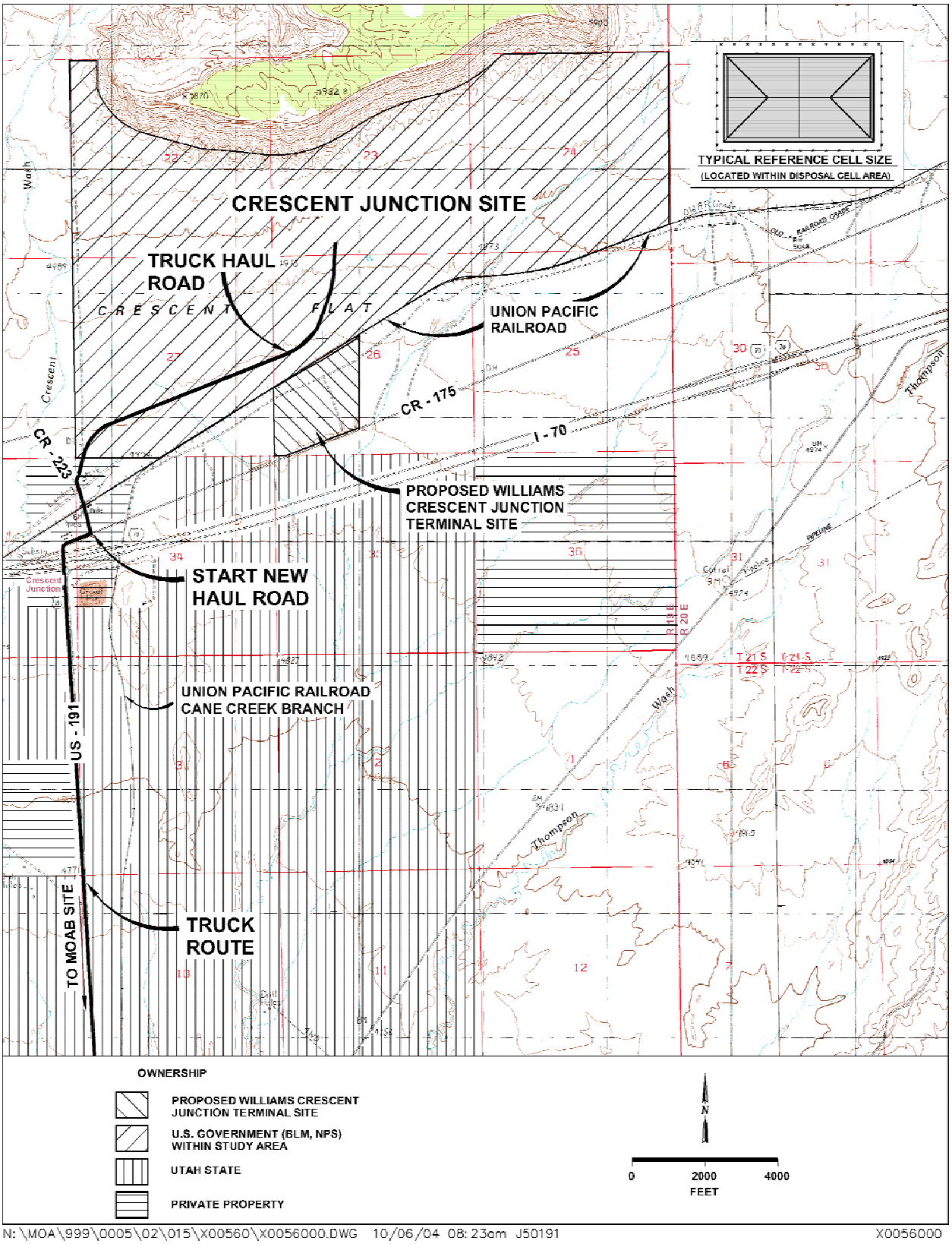

Figure A1−7. Crescent Junction Alternative Disposal Site

In most areas of the site, vegetation is indicative of disturbance and varies from the potential native vegetation. About 50 percent of the Crescent Junction site is covered by very sparse 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 (*Bromus tectorum*), and Russian thistle (*Salsola kali*). Vegetation in the south-central and southeast portions of the site also consists primarily of these three species with a few native shrubs and perennial grasses, including gardner saltbush, galleta, and Indian ricegrass. Range condition in this area would probably rate as poor to fair.

Vegetation in the southwest portion of the site is probably influenced by a shallow aquifer and consists of sparse shrubs, including black greasewood, shadscale, and gardner saltbush. Understory vegetation consists primarily of annual weeds, such as cheatgrass and Russian thistle, with a few perennial grasses (galleta, Indian ricegrass). Tamarisk occurs occasionally in the drainages.

Water bodies in the vicinity of the Crescent Junction site consist of ephemeral washes that are dry most of the year. The water from these washes eventually flows into the Green River. There are no known wetlands in the area.

Although not designated by BLM as a recreational area, the site has no access controls and the area is used for hiking, biking, and camping. While the Crescent Junction area is designated as access-limited, it can be accessed by secondary dirt roads and may thus incur off-road vehicle use. The site is part of the Crescent Canyon grazing allotment, which is currently under a grazing permit until 2010. Currently, all sections of interest for the potential Crescent Junction site are held by oil and gas leases, although none are in production.

Transportation to the Crescent Junction site would be along US-191 or the Union Pacific Railroad. A slurry pipeline would follow existing natural gas pipeline rights-of-way. Transportation to the Crescent Junction site would also pass through the canyon area north of Moab.

A1−5.4 White Mesa Mill

The proposed White Mesa Mill disposal site is located in San Juan County, Utah, approximately 5 miles south of Blanding, Utah. The proposed disposal cell site (Figure A1−8) is situated within 5,415 acres of property owned primarily by International Uranium (USA) Corporation (IUC). Existing facilities at the site consist of a mill, ore storage pad, and four lined tailings cells with leak detection systems and ground water monitor wells. 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. Other than the tailings disposal ponds, no perennial surface water is present at the White Mesa Mill site. Wetlands at the site are restricted to very small areas where perched ground water discharges to springs and seeps along Westwater Creek Canyon and Cottonwood Creek Canyon to the west-southwest of the site and along Corral Canyon to the east of the site near the Burro Canyon Formation. Ruin Spring, about 2 miles southwest of the millsite, is the only spring that is known to flow on a consistent basis. The other springs and seeps have not been known to flow year-round, although plants such as cattails have been observed around the seep in Cottonwood Canyon.

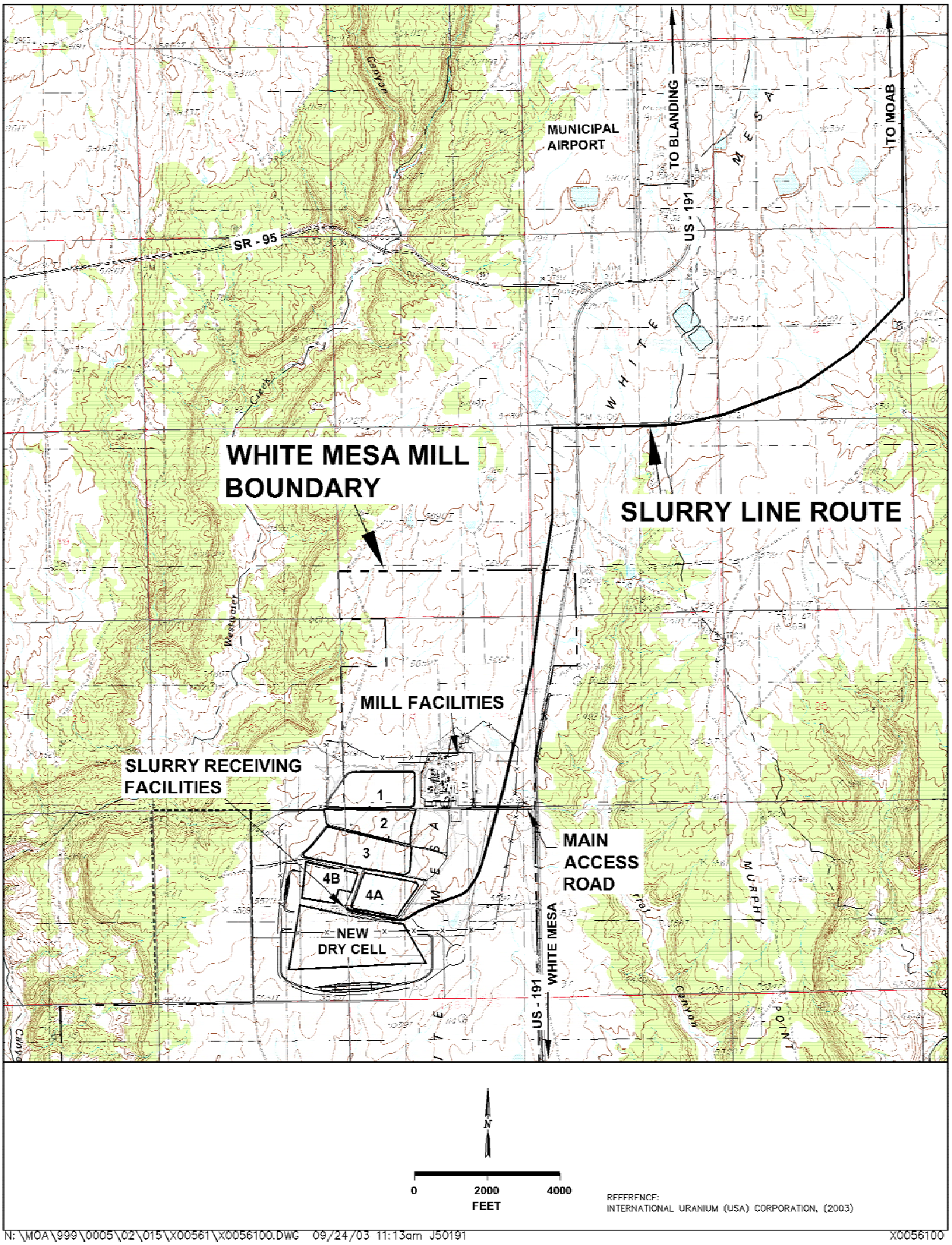

Figure A1−8. White Mesa Mill Alternative Disposal Site

At the White Mesa Mill site, several areas were chained (to remove unwanted vegetation) to support an active cattle ranch prior to mill operations. These areas were reseeded but are now mostly void of vegetation due to overgrazing. Current vegetation consists primarily of crested wheatgrass and invasive weeds. Annual weeds, rabbitbrush, snakeweed, sagebrush, and cheatgrass dominate vegetation in the surrounding areas, which include some abandoned dry farms. Areas that were neither cultivated nor chained support sagebrush communities with a sparse understory of grasses, including galleta and crested wheatgrass. Forbs are rarely found. Potential vegetation consists of more than 50 percent palatable grasses such as western wheatgrass, Indian ricegrass, needle-and-thread grass, 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.

Truck transportation between Moab and the White Mesa Mill site would be along US-191. There is no existing rail route south of Moab; therefore, rail transport to White Mesa Mill is not considered an option. A slurry pipeline would follow mostly existing rights-of-way through federally administered lands. However, approximately 29 miles of new rights-of way would be required, which would occur in an area that likely supports a greater diversity and abundance of vegetation and wildlife than the other pipeline routes. For example, the region near Monticello, Utah, north of the White Mesa Mill site where the new right-of-way would pass, supports piñon-juniper forests, and scattered ponderosa pine stands dominate this zone at higher elevations.

Recent NRC environmental assessments for the White Mesa Mill site concluded that no threatened or endangered species were being adversely affected by current mill operations (IUC 2003).

A1−6.0 Borrow Areas

Preliminary consultations and investigations do not indicate the presence of threatened or endangered species at borrow sites. However, the proposed borrow areas may need further evaluation to determine habitat, species presence, and other ecological characteristics. Preliminary evaluations of these areas indicate that no aquatic resources are present. Before developing any 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. If threatened or endangered species or critical habitats were identified on a selected area, a mitigation plan would be developed or a different borrow area would be selected, in order to minimize or eliminate impacts. If impacts could not be avoided, additional Section 7 consultation would be required. Figure A1−3 shows the borrow area locations.

A1−6.1 Crescent Junction Borrow Area

The Crescent Wash borrow area is located within the Crescent Junction disposal site and shares the same environmental features.

A1−6.2 Floy Wash Borrow Area

The Floy Wash borrow area is within an area that has been previously used by the State of Utah Department of Transportation for borrow materials. It is located about 7 miles west of Crescent Junction and I-70. The Floy Wash borrow area includes a small reservoir with tamarisk as the main vegetative component. This area is subject to flooding and is also bordered by Floy Wash, located half a mile to the northwest and west. Floy Wash has 80 acres of native and exotic riparian and wetland habitats, including lentic wetlands and tamarisk and willow areas (BLM 2003a). BLM has rated the wash as a "functioning at risk" system, meaning that it fulfills some, but not all, of the definitions of a properly functioning riparian system (BLM 2002).

Potential vegetation of Mesa-Trook complex soils (USDA 1989), found on the Floy Wash borrow area, consists of shadscale, galleta grass, Indian ricegrass, and fourwing saltbush. Phacelia (another phacelia species, not the endangered clay phacelia [*Phacelia argillosa*] described in Section A1−8.1.3) and prickly pear cacti dominated vegetation observed during a site visit in April 2003, which 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.

A1−6.3 Courthouse Syncline Borrow Area

The Courthouse Syncline borrow area is located several miles northwest of the Klondike Flats disposal site. This borrow area is located about 1 mile from Thompson Wash and Crescent Wash, both of which are intermittent and support tamarisk totaling approximately 34 acres. Otherwise, vegetation on the Courthouse Syncline borrow area is similar to that of the Klondike Flats disposal site.

A1−6.4 Klondike Flats Borrow Area

The Klondike Flats borrow area is located within the Klondike Flats disposal site and shares the same environmental features.

A1−6.5 Tenmile Borrow Area

The Tenmile borrow area is located about 7 miles west of the Klondike Flats site. No ephemeral or perennial surface water features have been identified in this area. Soils and potential natural vegetation at the Tenmile borrow area are classified as Nakai fine sandy loam; however, approximately 25 percent of the Tenmile borrow area consists of stabilized and active parabolic dunes 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. The Tenmile borrow area is located within one-half mile of Tenmile Wash, an ephemeral wash system dominated by tamarisk.

Land in the area is administered by BLM. Blue Hills Road provides major access to the Tenmile borrow area, and the area is laced with interconnecting backcountry roads and trails. There is high recreational use of the general area.

A1−6.6 Blue Hills Road Borrow Area

The Blue Hills Road borrow area is located about 4 miles south of the Klondike Flats site. 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 similar to that described for the Klondike Flats disposal site.

Land in the area is administered by BLM. Blue Hills Road provides major access to the Blue Hills Road borrow area, and the vicinity is laced with interconnecting backcountry roads and trails. There is high recreational use of the general area.

A1−6.7 LeGrand Johnson Borrow Area

This privately owned commercial gravel pit is located about 8 miles south of Moab along US-191 in Spanish Valley. The site is surrounded by other past or present quarry and borrow sites and other developments. Obtaining borrow materials from this site would not be expected to greatly alter the effects of current borrow area operations on the terrestrial environment.

A1−6.8 Papoose Quarry Borrow Area

This existing commercial quarry, owned by the Cotter Corporation, is located in Lisbon Valley south of SR-46 and at the intersection of CR-113 and CR-370. Obtaining borrow materials from this site would not be expected to greatly alter the effects of current quarry operations on the terrestrial environment.

A1−6.9 Blanding Borrow Area

The Blanding borrow area, located north of the White Mesa Mill site and northeast of Blanding, is near existing sand and gravel pits. This site can be readily accessed from US-191 and is on land administered by BLM. It lies within a designated transportation and utility corridor and is open to off-road vehicle use. Recapture Creek, a perennial stream, and an intermittent stream are located within the Blanding borrow area. Both watercourses are dominated by tamarisk, cottonwood, willow, and shrub oak (BLM 2002). Compared to other borrow areas under consideration, this site is believed to support greater wildlife diversity and abundance.

A1−6.10 White Mesa Mill Borrow Area

The White Mesa Mill borrow area is located south of Blanding at the head of a broad, heavily dissected canyon within the IUC property boundary. Sparse piñon-juniper, saltbush, and sagebrush communities currently dominate the area.

A1−7.0 Analysis for Aquatic Species

A1−7.1 Species Accounts and Status in the Proposed Action Area

The major portions of the upper Colorado and Green rivers, including tributaries, have been designated by USF&WS as critical habitat for the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail (Table A1−3). The segment of the Colorado River near the Moab site is within this designated critical habitat. These fish species are considered endangered by USF&WS. Conservation of these species requires the identification and management of water resources and habitat that are important for their survival and propagation (i.e., spawning areas, nursery grounds, and interactions with predators and competitors) (50 CFR 17.95).

Table A1−3. Status of Aquatic Species

Common Name	Scientific Name	Status
Humpback chub	*Gila cypha*	Endangered
Bonytail	*Gila elegans*	Endangered
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered

The Colorado pikeminnow, razorback sucker, humpback chub, and bonytail are included in the Upper Colorado River Endangered Fish Recovery Program (USF&WS 2002a, 2002b, 2002c, 2002d). The program goal is "to recover the endangered fishes while water development proceeds in compliance with State and Federal laws, including the ESA, State water law, interstate compacts, and Federal trust responsibilities to American Indian Tribes" (USF&WS 2002a, 2002b, 2002c, 2002d). Management actions identified as part of the recovery goals for these species include "minimizing the risk of hazardous-materials spills in critical habitats and remediation of water-quality problems." Contaminants of concern, primarily ammonia, pose a threat to the Colorado pikeminnow and razorback sucker. There is also the risk of "catastrophic pile failure that could affect important nursery areas and destroy other fish habitat" (USF&WS 2002a, 2002b). Disposal cell or pile failure is discussed further in Section A1−7.2.

A1−7.1.1 Colorado Pikeminnow

Habitat/Reproduction. Colorado pikeminnow, a large, predatory fish belonging to the minnow family, was once abundant and widely distributed in the Colorado River basin. Wild populations of Colorado pikeminnow currently occupy only about 25 percent of their historical range in the basin, including the upper Colorado River from Palisade, Colorado, to Lake Powell, Utah (USF&WS 2002a). Natural reproduction of Colorado pikeminnow is known to occur in the upper Colorado, Green, Yampa, Gunnison and San Juan Rivers (USF&WS 2002a). Although adult and juvenile fish move intermittently through the reach of the Colorado adjacent to the Moab Site, the entire reach is considered occupied habitat at all times. Exposure of pikeminnow to Moab site-related contamination is related to the presence of suitable habitat and to the presence or absence of contamination in those suitable areas. The areal extent and type of pikeminnow habitat near Moab changes with the time of the year, water temperature, pH, changes in river morphology, water level, and water quality. The interaction and connections

among these habitat characteristics and the exact location of suitable habitat can change over time. These changes can occur over very short periods of less than a day to seasonal, annual, and even decadal periods of time.

Throughout most of the year, juvenile, subadult, and adult pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in the nearshore areas of main river channels (USF&WS 2002a). During the spring and early summer, the adults use shorelines, floodplain habitats, flooded tributary mouths, and flooded side canyons that are available only during high flows (Tyus 1990, USF&WS 2002a). These high spring flows provide an important cue to prepare adults for spawning migration (USF&WS 2002a). During the spawning season, adults have been reported to migrate up to 200 miles upstream or downstream to reach spawning areas (Tyus 1990). By late August or September, most adults return to home ranges occupied the previous spring (Muth et al. 2000). Juvenile pikeminnow, which are more commonly collected in the lower reaches of the river, are more wide-ranging in their habitat preference compared to adults. Juveniles feed on small-bodied fishes that spend much of their life in or associated with low velocity habitats. Whereas adult pikeminnow are found in the lower Colorado River, the greatest concentration of adults (spawning population) occurs upstream of the Moab site in Colorado (USF&WS 2004a).

Pikeminnows spawn on cobble bars in the upper reaches of the river, upstream of Westwater Canyon (USF&WS 2004a). Spawning occurs during period of declining flows during June, July, or August (Tyus and Haines 1991, Muth et al. 2000, Tyus 1990). After hatching, larvae passively drift downstream to settle into relatively low-velocity river reaches where they are entrained in backwater nursery habitats. Larvae develop paired fins and are then classified as young-of-the-year. They remain in these backwater habitats throughout most of their first year of life (USF&WS 2002a). Backwater areas are vital to successful recruitment of early life stages of Colorado pikeminnow. The pikeminnow larvae occupy these in-channel backwaters soon after hatching. They tend to occur in backwaters that are large, warm, deep (approximately 1 ft) and turbid (USF&WS 2002a). Larval and juvenile pikeminnow (0 to 1 year) show a preference for secondary channel habitats (Trammell and Chart 1998, Rakowski and Schmidt 1997, Day et al. 1999, USF&WS 2002a), and they are primarily found in low-velocity waters, which include backwaters (Tyus and Haines 1991, Trammell and Chart 1998). During the fall, they utilize 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 over-winter survival of the larval and juvenile fish (Trammell and Chart 1998). The backwater areas are considered primary, preferred habitat for juveniles; however, both adults and juveniles can occur in a variety of habitats throughout the year. 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).

Aerial observations of the Colorado River were conducted between 1992 and 1996 to estimate backwater habitat from river mile 53.5 to 64.0. In addition, Colorado River flow data (in cubic feet per second) were recorded from the U.S. Geological Survey (USGS) Cisco, Utah, gaging station (Station No. 09180500) for each observation. Flows recorded during the observations ranged from 2,490 to 9,260 cfs. Base river flow typically ranges from 3,000 to 5,000 cfs for most of the year. Between April and July, the river discharge and stage dramatically increase in response to snowmelt runoff. On average, the river stage rises approximately 7 ft during peak flows at the Cisco gaging station (DOE 2003b). The average total backwater area for flows under

5,000 cfs was 2.3 acres (ranging from 0.4 to 4.4 acres). The average total backwater area for flows over 5,000 cfs was 1.2 acres (ranging from 0.9 to 2.0 acres).

Backwater areas were also quantified for areas adjacent to and immediately downstream of the Moab site (river mile 61 to 64). The average total backwater area in river mile 61 to 64 was 1.2 acres (ranging from 0.2 to 2.1 acres) for flows under 5,000 cfs and 0.9 acre (ranging from 0.4 to 1.9 acres) for flows over 5,000 cfs. Fifty to 70 percent of the backwater areas from river mile 53.5 to 64.0 were found in the stretch of the Colorado River in the vicinity of the Moab site (river mile 61 to 64).

A field visit with UDWR on December 19, 2001, identified backwater areas that may be used by larval and juvenile pikeminnows beginning at the mouth of Moab Wash and extending approximately 1,200 ft south. Within this area, three locations extending about 600 to 800 ft south of the wash were tentatively identified as having the greatest potential for suitable nursery habitat at river flows that inundate these areas each year.

Based on multiple studies of young-of-the-year pikeminnow habitat, researchers have established a protocol for sampling backwater areas to monitor pikeminnow recovery efforts (Trammell and Christopherson 1999). The protocol calls for sampling backwaters with a minimum surface area of 322 ft^2 and a minimum depth of 0.98 ft for the Interagency Standardized Monitoring Program (ISMP). The relatively permanent "average" secondary channel backwater areas have mean surface areas of 10,749 ft^2 and mean depths of 1.38 ft (Trammell and Christopherson 1999). Besides area and depth requirements, quality pikeminnow habitat must also be sufficiently turbid to provide adequate cover. Recent studies of pikeminnow in the Green River found a positive correlation of pikeminnow with higher turbidity; it was therefore recommended that a minimum depth for sampling in these turbid areas be reduced to 0.7 to 0.8 ft (Day et al. 1999).

Known Occurrences in the Project Area. There are estimated to be 600 to 900 adult pikeminnows 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). Age 0–1 fish and juveniles are found in the upper Colorado River downstream of Palisade to Lake Powell (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. Both adults and subadults have been collected in Moab Wash and directly downstream from the tailings pile (USGS 2002). Up to 53 young-of-the-year pikeminnow were captured between river mile 48 and 84 (Osmundson et al. 1997). In a mark-recapture study of adult pikeminnow in this reach (river mile 48 to 84), 21 of 51 (41 percent) fish were caught between river mile 57 and 65 (Osmundson et al. 1997). Surveys in 1992 to 1996 by Trammell and Chart (1998) found adult and larval pikeminnow between river mile 55 and 65.

As part of the ISMP, pikeminnow nursery habitat was sampled each fall (1986 to 2002) between river mile 53.5 and 63.5. 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 mile 61 and 63.5. Five of the 13 backwater areas sampled contained a total of 83 young-of-the-year pikeminnow comprising 24 percent of the total pikeminnow captured between river mile 53.5 and 63.5 during ISMP sampling (UDWR 2003a).

In the spring of 2003, USF&WS captured 8 stocked adult pikeminnow between river miles 60 and 64, 4 between river miles 64 and 70, and 20 between river miles 50 and 60 (USF&WS 2004b).

UDWR sampled three locations within 1,000 ft of the Moab Wash in April 2004. Each site was sampled using seines. Red shiner and plains killifish were collected. However, Colorado pikeminnow were not collected during these sampling events (UDWR 2004).

Diet. Pikeminnow less than 2.0 inches total length prey on small aquatic invertebrates in side channels and backwaters; juveniles between 2.0 and 4.0 inches total length still in the backwater nursery habitat eat invertebrates and other fish; and pikeminnow greater than 4.0 inches total length prey mainly on other fish (Muth and Snyder 1995; USF&WS 2002a).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, and pesticides and pollutants (USF&WS 2002a). The Moab site poses two significant threats to the Colorado pikeminnow: "toxic discharges of pollutants, particularly ammonia, through ground water to the Colorado River and the risk of catastrophic pile failure, that could affect important nursery areas and destroy other fish habitat" (USF&WS 2002a).

A1−7.1.2 Razorback Sucker

General Distribution. The endangered razorback sucker is one of the most imperiled fishes in the basin and exists naturally as only a few disjunct populations of 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 non-native fishes (Hamilton 1998; USF&WS 1998a; Muth et al. 2000). Wild populations of razorback sucker were virtually extirpated from the Colorado River system by 1990. Since the mid-1990s, the recovery program has been reintroducing hatchery-reared fish in the Colorado and Gunnison rivers (USF&WS 2004a).

Habitat. 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). The razorback sucker may be found almost anywhere in the river, including slow runs in the main channel, inundated floodplains and tributaries, eddies and backwaters, sandy bottom riffles, and gravel pits (50 CFR 17.95). Young razorback suckers require nursery habitat with warm, shallow water such as tributary mouths, backwaters, or inundated floodplains (Modde 1996, Muth et al. 2000). Stocked juvenile and adult razorback sucker actively seek out flooded habitat in the Colorado River system and are likely using flooded habitats available at the mouth of Courthouse Wash, Moab Wash, the mouth of Mill Creek and Kane Springs (USF&WS 2004a). 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). The Matheson Wetlands Preserve area is also potential nursery habitat for the razorback sucker (NPS 2003). For purposes of this BA, it is assumed that the razorback sucker may be present in the project area.

Known Occurrences 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 the Grand Valley, near Grand Junction, Colorado, just upstream and downstream of the confluence with the Gunnison River (USF&WS 2002b). Recaptures of stocked individuals have been increasing in recent years throughout the river, including near the Moab site (USF&WS 2004a). In 2003, USF&WS captured 3 stocked adult razorback suckers between river miles 60 and 64, 10 between river miles 64 and 70, and 8 between river miles 50 and 60 (USF&WS 2004b). USF&WS sampled this stretch of river in the spring of 2004 and captured 6 stocked adults between river miles 64 and 70, 2 between river miles 60 and 64, and 3 between river miles 45 and 60 (USF&WS 2004c). No young razorback suckers have been captured anywhere in the upper Colorado River since the mid-1960s (USF&WS 2002b; USGS 2002; NPS 2003). However, in recent years, stocked razorback sucker have reproduced in the Gunnison River, and naturally produced larvae are now in the Colorado River system (USF&WS 2004a).

Diet. The diet of all life stages is varied and includes invertebrates, zooplankton, phytoplankton, algae, and detritus (Behnke and Benson 1980, Muth et al. 1998, Marsh 1987, Muth et al. 2000).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, and pesticides and pollutants (USF&WS 2002b). The Moab site poses two significant threats to the razorback sucker: “toxic discharges of pollutants, particularly ammonia, through ground water to the Colorado River and the risk of catastrophic pile failure, that could affect important nursery areas and destroy other fish habitat” (USF&WS 2002b).

A1−7.1.3 Humpback Chub

Habitat/Distribution. The humpback chub, a large cyprinid fish, prefers deep canyons with swift water and rapids (USF&WS 2002c; Muth et al. 2000). Historical abundance of the humpback chub is unknown, and historical distribution is incomplete (Muth et al. 2000; USF&WS 2002c). The species primarily inhabits relatively inaccessible canyons of the Colorado River Basin and was rare in early collections (USF&WS 2002c). 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 area, 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).

Humpback chub are more sedentary than other native Colorado River fishes and are capable of completing their life cycle in relatively short stretches of the river. Radiotelemetry and tagging studies consistently show high fidelity by humpback chub for specific river locations occupied by respective populations. 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) mainstem Colorado River in Marble and Grand Canyons and the little Colorado River, Arizona (USF&WS 2002c). The nearest downstream population occurs in Cataract Canyon (over 50 miles downstream of the Moab site) (USF&WS 2002c). The population in Cataract Canyon consists of about 500 adults (USF&WS 2003c). Populations in the Upper Colorado River Basin appear healthy and stable. The population at Black Rocks and Westwater Canyon, near the Colorado-Utah state line, is estimated at about 2,900 adults (USF&WS 2003c).

Known Occurrences in the Project Area. 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).

Threats. Threats to this species include streamflow regulation, habitat modification, predation by non-native fish species, parasitism, hybridization with other native *Gila*, and pesticides and pollutants (USF&WS 2002c).

A1−7.1.4 Bonytail

Habitat/Distribution/Known Occurrences in the Project Area. Little is known about the specific habitat requirements of bonytail because this species was extirpated from most of its historical range prior to extensive fishery surveys (USF&WS 2002d). The bonytail uses mainstem river channels, where it has been observed in pools and eddies, as well as inundated riparian areas. Available distribution data show that flooded bottomland habitats are important growth and conditioning areas for bonytail, particularly as nursery habitats for young (USF&WS 2002d). Potential habitat for both adult and juvenile fish exists in the reach of the Colorado River near the Moab site.

Currently, no self-sustaining populations of bonytail exist in the wild, and very few individuals have been caught throughout the Upper Colorado Basin (USF&WS 2002d). Since the mid-1990s, the recovery program has been reintroducing hatchery-reared fish in the Colorado River. Some of the stocked fish have been recaptured, indicating at least short-term survival (USF&WS 2002d). Recaptures of these stocked individuals have been increasing in recent years throughout the river, including near the Moab site (USF&WS 2004a). In 2003, a stocked adult bonytail was captured by USF&WS at river mile 66.2, just upstream of the Moab site (USF&WS 2004b). In 2004, a stocked adult was captured at river mile 69.2. (USF&WS 2004c).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, hybridization, and pesticides and pollutants (USF&WS 2002d).

A1−7.2 Potential Effects of Proposed Actions on Aquatic Species

The impacts described below would be applicable at the Moab site, under either on-site or off-site disposal alternatives.

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 the Moab Wash and 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 materials (i.e., soils contaminated with residual radioactive material). The vegetation along the shoreline, consisting primarily of tamarisk, would be removed in order to complete remediation of the tailings pile. 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 threatened and endangered 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 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 based 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 and 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 2003a). Erosion and siltation events that change the depth and configuration of these backwater areas are likely to have an effect on 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 to determine the financial contribution based on water depletion, and required permits, if any, would be necessary.

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 associated with a contaminant release. The degree of contaminant impact to endangered species 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. Due to uncertainties associated with a contaminant release, and cumulative effects that are not contaminant-related, specific impacts to endangered species are difficult to assess.

Two basic types of failures could occur: catastrophic and long-term. These are described in more detail in Section 4.1.17 of the EIS. A catastrophic (i.e., sudden and unexpected) failure could occur as a result of a major flood or seismic event and would likely affect the entire Moab region. The analysis of a catastrophic failure considered the following assumptions to estimate the concentrations of uranium and ammonia as nitrogen in Colorado River water (DOE 2003c):

- 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 milliliters per gram.
- 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.

While engineering design of the disposal cell could compensate somewhat for this type of catastrophic event, planned mitigation would, at best, be speculative. A long-term, slow release could occur as a result of river migration, basin settling, or periodic 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 (a scenario that assumes no repairs to the damaged cell would be done). This type of release, which is possible at all Uranium Mill Tailings Radiation Control Act (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 focus of this analysis is to evaluate the potential qualitative consequences of contaminants in the water and sediments of the Colorado River based on a significant (catastrophic) release of

tailings. DOE has evaluated the hydrologic and geologic conditions of the northwestern portion of Spanish Valley and the Colorado River corridor at Moab (see Sections 3.1.1, 3.1.6, and 3.1.7 of the EIS). DOE has determined that catastrophic failure of the pile from sudden or catastrophic lateral migration of the Colorado River into the Moab site for the disposal cell design period of 200 to 1,000 years does not pose a realistic hazard. Given the known geologic and hydrologic context, the likelihood of catastrophic failure, though not statistically quantified, is considered extremely unlikely. Although the probability of a significant release would be very small over the design life of the on-site disposal cell, this type of failure was assumed to occur in order to qualitatively evaluate the potential consequences (risks).

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).

For purposes 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.

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 continuous decrease in contaminant load. Detailed studies of deposition of radioactive sediment in the Colorado River Basin have shown that very small amounts of contamination would be expected to accumulate in the main river channel (HEW 1963).

After a catastrophic failure, contaminants would likely cause short-term adverse impacts to aquatic receptors 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 levels at the Moab site downstream to Lake Powell would likely be short-term. Ammonia degrades and volatilizes and would not be 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 on the duration and concentrations of the contaminant release.

Catastrophic disposal cell failure would also result in increased turbidity and sediment, which could affect the aquatic and benthic producers. The loss of primary producers would affect the entire food chain.

If mitigated, long-term failure would not likely result in negative impacts to aquatic biota. DOE's 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). Also, 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, expanded, or modified in the future should river migration encroach on the site and the disposal cell.

Effects of Flooding on Ground Water Remediation. Catastrophic flooding could also affect the aquatic environment by flooding the ground water remediation systems. The interim action and proposed ground water remediation includes wells or shallow trenches located between the foot of the pile and the river's edge (Section A1−4.3). As discussed in Section 3.1.8 of the EIS, the location for these systems is in the 100-year floodplain. If a flood were to inundate the remediation systems, ground water with contaminant concentrations exceeding the aquatic benchmarks could pass through the region toward the river. DOE expects that remediation systems would be quickly restored after the flood waters receded. USF&WS would be notified if ground water remediation systems were shut down due to flooding, and the river environment would be monitored to determine if the concentrations of contaminants of concern exceed benchmark.

Temperature. Temperature can influence the development, metabolism, motility, and mobility of fish; effect the expression of other environmental factors; and destroy the integrity of a fish, causing its death (Beitinger et al. 2000). Colorado pikeminnow spawn when the water temperature reaches 16 to 22 °C (61 to 72 °F), and the humpback chub spawns at temperatures greater than 17 °C (63 °F) (Muth et al. 2000). The Colorado pikeminnow, humpback chub, bonytail, and razorback sucker prefer temperatures between 24 and 25 °C (75 and 77 °F) (Bulkley and Pimentel 1983). Razorback suckers avoid temperatures above 27.4 °C (81 °F) and below 14.7 °C (58 °F) (Bulkley and Pimentel 1983). Young-of-the-year pikeminnow stop growing at temperatures less than 13 °C (55 °F) (Trammell and Chart 1998). During the fall and early winter, as the water temperature cools to less than 13°C (55 °F), the habitat available for overwintering become very important (Trammell and Chart 1998). A preference for temperatures somewhat warmer than the main river channel may also be important. However, in a study of the Colorado River pikeminnow nursery habitat, it was noted that fluctuations of temperature in backwater areas result in a lower mean daily temperature than in the main channel and that if pikeminnow closely follow temperature gradients, movement in and out of backwaters would be more frequent that previously assumed (Trammell and Chart 1998). The season of year, turbidity, and the temperature of the ground water can affect the fluctuation of temperature in the backwater relative to the main channel.

Impacts associated with activities related to remediation would not be expected to influence the temperature of the Colorado River. Leachate from the pile travels through the ground water pathway 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 influencing the Colorado River.

Characterization of the aquatic environment near the site is described in Chapter 3.0 of the EIS. 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, those samples were not considered in this analysis because of comments in the USF&WS 1998 Final Biological Opinion (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 the fish tissue samples also were not considered in this analysis because of comments on data quality that were similar to those made about sediment samples in the USF&WS 1998 Final Biological Opinion. 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 SOWP (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.

The 2000 through 2002 surface water sampling data set was examined first to determine which sample results were above the detection limit set by the laboratory (Appendix A2 of the EIS). If an analyte was not detected, the laboratory reported a value equal to the method detection limit. Analytes not detected were assessed using values corresponding to one-half the method detection limit, based on EPA protocol (EPA 2001a, 2001b). The maximum concentration for the contaminant at any location or time was then compared to the maximum background concentration. Three upstream locations were considered as background stations for the Moab site. If a constituent was undetected in all background samples, then one-half the reported detection limit was used in the evaluation. Finally, the maximum concentration above background was compared to benchmarks for evaluating impacts to aquatic biota.

Benchmarks for the contaminants at the Moab site included the NWQC (EPA 2002) and proposed State of Utah water quality criteria (UAC 2003). The benchmarks used in the contaminant screening are listed in Appendix A2 of the EIS. Narrative and numeric water quality criteria are the foundation of a water-quality-based control program. The Clean Water Act standards mandate that water standards be established (33 U.S.C. 1251 et seq.). Water quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. Utah's water quality standards are applicable to "waters of the State." Utah water quality standards apply to all waters within the state of Utah, with the exception of those waters that are within Indian Country, as defined in 18 U.S.C. Section 1151. DOE notes that the ground water discharge at the Moab site is not a point source water discharge requiring a permit and that residual radioactive material is not considered a "pollutant" under the Clean Water Act (40 CFR § 122.2; see also Utah Administrative Code Section R317-8-1.5[34] and [35]). However, DOE is proposing to remediate ground water discharging from the Moab site under 40 CFR 192. DOE recognizes the need to comply with surface water quality criteria to the extent practical, including the need to minimize, and preferably eliminate, risks to human health and the environment. Thus, the surface water standards set by Utah, including federal and state water quality criteria, were used for this assessment.

In some cases, federal or state criteria have not been established for contaminants of potential concern in surface water. Therefore, criteria established by Suter and Tsao (1996) for aquatic biota were used. Suter and Tsao (1996) provide a compilation of aquatic toxicity values, including National Ambient Water Quality Criteria, derived Tier II values (secondary chronic and acute values), and chronic values from a variety of other government sources.

Impacts to aquatic organisms can result from either acute or chronic exposures to contaminants of potential concern (Appendix A2 of the EIS). 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. As mentioned, 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.

The 2000 through 2002 surface water sampling data were compared to the ecotoxicological screening benchmarks (Appendix A2 of the EIS). This comparison further pared the list of contaminants of potential concern for assessing potential impacts to aquatic biota. Contaminants were not considered further when (1) the maximum concentration and maximum background concentration were below detection limits and below all benchmarks, or (2) the maximum concentration was less than all the benchmarks. These contaminants were further evaluated on the basis of the number of samples, location of the samples, and relevance of the flow regime at the time of sampling in comparison to the potential for exposure to aquatic biota.

The 1998 through 2000 data summarized 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) were also examined. Results presented in the USGS report indicate that the pile represents a localized source of ground water input containing elevated levels of contaminants, including copper, manganese, zinc, and radiochemicals. These contaminants were measured at levels that exceeded benchmarks during the low-water hydrologic period ranging from August through March. Based on the results of this study, USGS summary data for copper, manganese, zinc, and total alpha were evaluated using the process previously described. These results are discussed where applicable within the constituent-by-constituent discussions in Appendix A2 of the EIS.

Based on the evaluation of contaminants of potential concern in Appendix A2 of the EIS, 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 remediation of the ground water near the Colorado River were conducted, the maximum concentrations of these contaminants of concern in the region 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 A1–4.3.2 of this BA, and Section 2.3.2.1 of the EIS). 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 concentrations. Coupled with the average 10-fold dilution, and the tendency for ammonia to volatilize, this concentration 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 active 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 radiological contamination to enter the aquatic environment at the Moab site is ground water. The routes of exposure for the radiological 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, radium-226, radium-228, radon-222, thorium-230, uranium-234, and uranium-238, and the general indicator 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 guidance level associated with the 1.0-rad-per-day criterion adopted by DOE for screening dose rates to aquatic organisms.

The 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, radionuclides in ground water discharging to the river currently are not expected to adversely affect the aquatic environment.

In its site-specific assessment, 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.

A1−8.0 Analysis for Terrestrial Species

A1−8.1 Species Accounts and Status in the Proposed Action Area

Spatial data for federally listed plant and animal species were obtained from the Utah Conservation Data Center (UCDC). This data set was compiled by the Utah Natural Heritage Program (UNHP) of the 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 project areas were overlaid on the spatial data depicting the occurrence of species of concern. Table A1−4 summarizes the listing status for terrestrial species discussed in this BA.

Table A1−4. Status of Terrestrial Species

Common Name	Scientific Name	Status	Federal Register Citation
Plants			
Jones' cycladenia	*Cycladenia jonesii*	Threatened	51 FR 16526–16530 (1986)
Navajo sedge	*Carex specuicola*	Threatened	50 FR 19370–19374 (1985)
Clay phacelia	*Phacelia argillosa*	Endangered	43 FR 44810–44812 (1978)
Birds			
Bald eagle	*Haliaeetus leucocephalus*	Threatened, but proposed for delisting	64 FR 36454–36464 (1999)
California condor	*Gymnogyps californianus*	Endangered	61 FR 54043–54060 (1996)
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	66 FR 8530–8553 (2001)
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	62 FR 39129–39147 (1997)
Gunnison sage grouse	*Centrocercus minimus*	Candidate	67 FR 40657–40679 (2002)
Western yellow-billed cuckoo	*Coccyzus americanus*	Candidate	66 FR 38611–38626 (2001)
Mammals			
Black-footed ferret	*Mustela nigripes*	Endangered	67 FR 57558–57567 (2002)
White-tailed prairie dog	*Cynomys leucurus*	Species of Concern	67 FR 57558–57567 (2002)

A1−8.1.1 Jones' Cycladenia

Jones' cycladenia is an herbaceous perennial 4 to 6 inches tall and is the only member of its genus in the Intermountain West.

Distribution. Jones' cycladenia has a disjunct distribution, occurring in the canyonlands of the Colorado Plateau in four counties in Utah: Emery, Garfield, Grand, and Kane, and in Coconino County, Arizona (UDWR 2003b). There is a cluster of known populations on BLM land in Grand County approximately 11 to 17 miles northeast of Moab (UDWR 2003b).

Soils and Community Associations. 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 4,000 to 6,800 ft (UDWR 2003b). The Grand County populations in Castle Valley and along Onion Creek are growing in mixed desert shrub and in the lower edge of the piñon-pine and juniper community at 4,920 to 5,580 ft on sparsely vegetated hills derived from arkosic (containing unweathered feldspar) sandstone of the Cutler Formation.

Threats. The primary threat to Jones' cycladenia is habitat disturbance.

Critical Habitat. No critical habitat has been designated for this species (USF&WS 2003b).

Known Occurrences in the Project Area. There were no occurrences of Jones' cycladenia in any of the quads that contain project areas.

Findings. Jones' cycladenia would be most affected by habitat destruction. This species is not known to exist at or near any of the proposed disposal sites, transportation routes, or borrow areas. However, many of the potential project areas have not been well surveyed for this or other rare species. Therefore, prior to development of any disposal site, borrow area, or transportation route, a thorough survey of the area should be performed. If Jones' cycladenia were found, an

alternate site would be considered or a mitigation plan would be developed to prevent adverse effects.

A1−8.1.2 Navajo Sedge

Distribution. Navajo sedge occurs in the canyons of Kane and San Juan counties in Utah, and in immediately adjacent Coconino County, Arizona (UDWR 2003b).

Soils and Community Associations. Navajo sedge is restricted to seep, spring, and hanging garden habitats in Navajo Sandstone, at elevations ranging from 3,770 to 5,980 ft (UDWR 2003b).

Critical Habitat. Critical habitat designated for this species consists of about 6,460 ft^2. This area contains the entire habitat occupied by the species where it occurs near Inscription House Ruin on the Navajo Indian Reservation in Coconino County, Arizona.

Threats. The primary threats to Navajo sedge and its critical habitat are spring development and sheep grazing (UDWR 2003b).

Known Occurrences in the Project Area. All of the known populations in Utah are located at least 20 miles southwest of the White Mesa Mill disposal site and associated borrow areas (UDWR 2003b).

Findings. Navajo sedge would be most affected by habitat destruction. This species is not known to exist at or near any of the proposed disposal sites, transportation routes, or borrow areas. However, many of the potential project areas have not been well surveyed for this or other rare species. Therefore, prior to development of any disposal site, borrow area, or transportation route; a thorough survey of the area should be performed. If Navajo sedge were found, an alternate site would be considered or a mitigation plan would be developed to prevent adverse effects.

A1−8.1.3 Clay Phacelia

Distribution. This species was included at the suggestion of BLM. Clay phacelia is thought to be restricted to Green River shales in Spanish Fork Canyon in Utah County, Utah (UDWR 2003b). However, UDWR (1998) suggests that specimens collected from Green River shales in Grand and Uinta counties, Utah, and in adjacent Colorado that were previously identified as *P. glandulosa* may properly belong to the endangered *P. argillosa*, based on seed morphology.

Findings. Based on current knowledge, it is unlikely that clay phacelia exists in the vicinity of any of the project sites. However, many of the potential project areas have not been well surveyed for this or other rare species. Therefore, prior to development of any disposal site, borrow area, or transportation route, a thorough survey of the area should be performed. In particular, areas that may have Green River shale should be examined for clay phacelia. In the unlikely event that this species were found, an alternate site would be considered or a mitigation plan would be developed, in cooperation with USF&WS and BLM, to prevent adverse effects.

A1−8.1.4 Bald Eagle

Habitat and Diet. The bald eagle is a bird of aquatic ecosystems. It frequents estuaries, large lakes, reservoirs, major rivers, and some seacoast habitats. Fish is the major component of its diet, but waterfowl, seagulls, and carrion are also eaten. The species may also use prairies if adequate food is available. Bald eagles usually nest in trees near water but are known to nest on cliffs; they rarely nest on the ground. Nest sites are usually in large trees along shorelines in relatively remote areas that are free of disturbance. In winter, bald eagles often congregate at specific wintering sites that are generally close to open water and offer good perch trees and night roosts.

Critical Habitat. No critical habitat has been designated for this species (USF&WS 2003b).

Known Occurrences in the Project Area. Only four nest sites were known in Utah as of 2000, three of them in the southeastern part of the state (UDWR 2003b). The nearest nest is at Cisco Landing on the Colorado River approximately 19 miles upriver from the Moab site. Utah has a large wintering bald eagle population scattered throughout the state. They are known to occur in winter and spring in the Matheson Wetlands Preserve (UDWR 2003b, Seglund 2004). The Utah Gap Analysis indicates that potential high-quality wintering habitat occurs in the vicinity of almost all the potential disposal sites and borrow areas (UDWR 1999). However, more recent information provided by UDWR (UDWR 2003b, Seglund 2004) indicates that bald eagles are not known to occur near any of these project sites.

Findings—Habitat and Human Disturbance. Bald eagles are not likely to be greatly affected by habitat destruction or by noise, lights, and human presence, since they do not nest at or near any of the project sites and may roost only occasionally in the vicinity of the Moab site. Activities at the Moab site would not remove any known bald eagle roost trees. Further, as indicated above, eagles probably rely more heavily on the large Matheson Wetlands Preserve than on the 50 acres of tamarisk at the Moab site.

The Utah Gap Analysis indicates that potential high-quality wintering habitat exists throughout the other 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. Although no data on this relationship are available, 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 would likely be small. Consequently, the potential increase in associated eagle deaths would also likely be small.

Findings—Exposure to Contaminants in Surface Water. If the bald eagle inhabits the vicinity of the Moab tailings pile, the most prevalent route of exposure to chemical and radioactive constituents would likely be from ingestion of prey and surface water in the nearshore environment. The potential for chronic effects from ingestion of chemical contaminants in food and surface water was evaluated for the No Action alternative using the osprey (*Pandion haliaetus*) as a surrogate (see Appendix A2 of the EIS). The maximum surface water concentrations of mercury and selenium exceeded no observed adverse effect level (NOAEL)- and lowest observed adverse effect level (LOAEL)-based food/drinking water benchmarks for the osprey (Sample et al. 1996). NOAEL benchmarks are values believed to represent

nonhazardous concentrations. LOAEL benchmarks are threshold values for which chronic adverse effects are likely to become evident at the level of the individual.

Implicit in this benchmark is the assumption that the diet of the benchmark species (osprey) consists entirely of contaminated food/drinking water. In the context of the BA, this means that the food/water consumption of the analogous consultation species (i.e., the species for which the benchmark species is a reasonable surrogate—the bald eagle) would need to occur entirely within the surface waters of the nearshore environment within the contaminated portion of the river in order for the toxicological benchmark to be valid.

It is possible that eagles could consume fish from surface waters contaminated by ground water flowing beneath the tailings pile. However, because bald eagles generally forage over much larger areas and are present in the vicinity only during winter and spring, it is unlikely that enough contaminated food material would be obtained from the contaminated area to result in adverse toxicological effects.

Any potential effects to the bald eagle that could arise from exposure to radionuclides would be discountable (i.e., extremely unlikely to occur) (see Section A1–8.2 of this BA and Appendix A2 of the EIS).

Findings—Exposure to Contaminants at the Evaporation Pond(s). The bald eagle could potentially be affected by contaminant exposure at the evaporation pond(s) via ingestion of contaminated prey and water, dermal uptake of contaminated water and airborne contaminants, and inhalation of airborne contaminants.

As indicated above, eagles would probably rely more heavily on the large Matheson Wetlands Preserve than on habitat at the site of the Moab tailings pile, including the evaporation pond(s). The evaporation pond(s) would also be located in an area where project activities and site maintenance operations would create continual disturbance. Further, because of distance, disturbance, and the fact that the evaporation pond(s) would be located in an area that has been previously disturbed and is generally devoid of vegetation (which could provide perch and roost sites), the likelihood of visits from bald eagles would be small.

The evaporation pond(s) would be qualitatively monitored for general wildlife use, regardless of the potential presence of the bald eagle. Consequently, if it were determined that bald eagles were frequenting the evaporation pond(s), techniques to minimize or eliminate use would be identified and implemented. Techniques could include noise (e.g., propane boom cannons) or obstruction (e.g., netting).

If, during the course of the proposed actions, bald eagles were observed in the vicinity of any of the project sites, DOE would inform USF&WS, and reasonable and appropriate mitigation measures would be agreed upon and implemented in order to minimize or avoid potential impacts to the species. If impacts could not be avoided, additional Section 7 consultation would be required.

A1−8.1.5 California Condor

Historical Information. By the time Europeans arrived in western North America, California condors occurred in a narrow Pacific coastal strip from British Columbia, Canada, to Baja

California Norte, Mexico. By 1987, the California condor's range was reduced to a wishbone-shaped area encompassing six counties in southern California. Mortality factors include habitat loss; however, the factors that have been most important in decline of the species have not been determined. In 1987, the last wild condor was captured and taken to the San Diego Wild Animal Park. Beginning with the first successful captive breeding of California condors in 1988, the total population increased annually and stood at 121 individuals in 1996: 104 in the captive flock and 17 in the wild (USF&WS 1998b).

Habitat, Diet, and Reproduction. California condors lay only one egg every other year, on the floor of a cliff cavity or cave or in a crevice among boulders on a steep slope (UDWR 2003b). Cliffs and tall conifers, including dead snags, are generally used as roost sites in nesting areas. The California condor is an opportunistic scavenger, feeding only on carcasses. Although most roost sites are near nesting or foraging areas, scattered roost sites are located throughout its range.

Distribution in Utah. In Utah, condor sightings were historically rare, 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]). However, sightings of birds that were released in northern Arizona have been made almost statewide 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 2003b).

Critical Habitat. Critical habitat has been designated for this species only within the state of California (42 FR 47840–47845 [1977]).

Known Occurrences in the Project Area. California condors are not known to regularly occur within the project area. Occasional transient individuals may be possible.

Findings. In addition to the lack of known occurrences in the project area, the sites that could be disturbed by project activities are minute compared to the apparently large areas required for foraging by California condors. Further, the proposed project areas include no known habitat features in particular that would be sought out or used by condors.

A1−8.1.6 Mexican Spotted Owl

Distribution. The Mexican spotted owl inhabits canyon and montane forest habitats across its range, which extends from southern Utah and Colorado, through Arizona, New Mexico, and west Texas, to the mountains of central Mexico (66 FR 8530–8553 [2001]).

Diet, Reproduction, and Migration. Mexican spotted owls do not nest every year and average about one young per pair (66 FR 8530–8553 [2001]). Their diet includes a variety of mammals, birds, reptiles, and insects (58 FR 14248–14271 [1993]) but consists most commonly of small- and medium-sized rodents, such as woodrats, peromyscid mice, and microtine voles. Some individuals are year-round residents within an area, some remain in the same general area but show shifts in habitat use patterns, and some migrate short distances (12 to 31 miles) during winter, generally migrating to more open habitat at lower elevations (66 FR 8530–8553 [2001]).

Habitat. At the northern edge of their range in northeastern Arizona, southwestern Colorado, and Utah, Mexican spotted owls may occur year-round at 4,400 to 6,800 ft within the piñon-juniper

zone below mixed-conifer forests (58 FR 14248–14271 [1993]). Within this zone, canyon habitats are used for nesting and roosting and are typically characterized by the cooler conditions found in steep, narrow canyons, often containing crevices, ledges, and/or caves (typically used for nest placement). These canyons frequently contain small clumps or stringers of ponderosa pine, Douglas fir, white fir, and/or piñon-juniper. Deciduous riparian and upland trees may also be present (66 FR 8530–8553 [2001]). However, Mexican spotted owls may also nest, but less frequently so, in arid, rocky, mostly unvegetated canyons (Romin 2004). Adjacent uplands are usually vegetated by a variety of plant associations, including piñon-juniper woodland, desert scrub vegetation, ponderosa pine-Gambel oak, ponderosa pine, or mixed conifer (66 FR 8530–8553 [2001]).

Threats. The Mexican spotted owl is threatened by destruction and modification of habitat caused by timber harvest and fires and increased predation associated with habitat fragmentation (58 FR 14248–14271 [1993]).

Critical Habitat. In 2001, approximately 4.6 million acres of critical habitat in Utah, Arizona, Colorado, and New Mexico were designated, with the majority occurring in Utah (3.2 million acres) (66 FR 8530–8553 [2001]). The critical habitat in Utah consists of five units, two of which (CP-13 and CP-14) are located in San Juan County (USF&WS 2003a).

Known Occurrences in the Project Area. Data provided by UDWR (2003a) indicated that there were no occurrences of the Mexican spotted owl in any of the quads that contained project areas. However, designated critical habitat occurs within 2 miles of the transportation corridor just south (within 25 miles) of the Moab site. Habitat models (BLM 2003b) also 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 (58 FR 14248–14271 [1993]). However, as noted above, 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.

Findings. There are no known Mexican spotted owl occurrences or critical habitat within any of the project areas. However, owls could occur along US-191 over the first 7 miles north from the Moab tailings pile and, if present, could be disturbed by noise from increased truck traffic or from construction of a slurry pipeline.

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.

If a slurry pipeline option were selected, the route should be surveyed for Mexican spotted owls prior to construction. If any owls or potential habitat areas were identified, an appropriate mitigation plan would be developed to minimize potential adverse impacts, including scheduling activities such that owl nesting and fledging would not be disturbed. If impacts could not be avoided, additional Section 7 consultation would be required.

A1−8.1.7 Southwestern Willow Flycatcher

Range-Wide Distribution. The southwestern willow flycatcher's breeding range includes southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern portions of Nevada and Utah, and extreme northwestern Mexico. The subspecies most likely winters in Mexico, Central America, and perhaps northern South America (USF&WS 2002e).

Distribution in Utah. The recovery plan for the southwestern willow flycatcher places the northern limit of its breeding range in Utah south of the Moab site (USF&WS 2002e). In addition, UDWR (UDWR 2003a) specified only the southern parts of the state as the known distribution of this subspecies in Utah. However, the range line specified in the recovery plan (USF&WS 2002e) was recently extended to well north of the Moab site (USF&WS 2003d) because the subspecific identity of willow flycatchers remains unresolved in central Utah (due to the occurrence of a similar subspecies, *E.t. adastus*, at higher elevations in the central and northern part of the state) (USF&WS 2002e) and because it is believed that the Colorado and Green river systems may provide travel corridors and suitable habitat for the subspecies (USF&WS 2003d).

General Nesting Habitats. The southwestern willow flycatcher breeds in different types of dense riparian habitats, across a large elevational and geographic area. It usually breeds in patchy to dense riparian habitats along streams or other wetlands, near or adjacent to surface water or underlain by saturated soil. Common tree and shrub species comprising nesting habitat include willows (*Salix* spp.), seepwillow (aka mulefat; *Baccharis* spp.), boxelder (*Acer negundo*), stinging nettle (*Urtica* spp.), blackberry (*Rubus* spp.), cottonwood (*Populus* spp.), arrowweed (*Tessaria sericea*), tamarisk (*Tamarix ramosissima*, also known as saltcedar), and Russian olive (*Eleagnus angustifolia*) (USF&WS 2002e).

Habitat characteristics such as plant species composition, size and shape of habitat patch, canopy structure, vegetation height, and vegetation density vary across the subspecies' range. However, general unifying characteristics of flycatcher habitat can be identified. Regardless of the plant species composition or height, occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings. In most cases, this dense vegetation occurs within the first 10 to 13 ft above the ground. These dense patches are often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still surface water and/or saturated soil is present at or near breeding sites during wet or nondrought years (USF&WS 2002e).

Thickets of trees and shrubs used for nesting range in height from 6 to 98 ft. Lower-stature thickets (6 to 13 ft) tend to be found at higher elevation sites; tall-stature habitats are at middle- and lower-elevation riparian forests. Nest sites typically have dense foliage from the ground level up to approximately 13 ft above the ground, although dense foliage may exist only at the shrub level, or as a low dense canopy. Nest sites typically have a dense canopy, but nests may be

placed in a tree at the edge of a habitat patch, with sparse canopy overhead. The diversity of nest site plant species may be low (e.g., monocultures of willow or tamarisk) or comparatively high. Nest site vegetation may be even- or uneven-aged, but is usually dense (USF&WS 2002e).

Historically, the southwestern willow flycatcher nested in native vegetation such as willows, buttonbush, boxelder, and *Baccharis*, sometimes with a scattered overstory of cottonwood. Following modern changes in riparian plant communities, the flycatcher still nests in native vegetation where available, but it also nests in thickets dominated by tamarisk and Russian olive and in habitats where native and non-native trees and shrubs are present in essentially even mixtures (USF&WS 2002e).

Nesting Habitats Dominated by Exotic Plants. Southwestern willow flycatchers nest in some riparian habitats dominated by exotics, primarily tamarisk and Russian olive. Most such exotic habitats range below 3,940 ft elevation and are nearly monotypic, dense stands of tamarisk or Russian olive that form a nearly continuous, closed canopy with no distinct overstory layer. Canopy height generally averages 16 to 33 ft, with canopy density uniformly high. The lower 6.5 ft of vegetation often consists of dense, dead branches. Thus, live foliage density may be relatively low from 0 to 6.5 ft above the ground but increases higher in the canopy (USF&WS 2002e).

Forty-seven percent of southwestern willow flycatcher territories occurred in mixed native/exotic habitat (more than 10 percent exotic), and 25 percent were at sites where tamarisk was dominant. Flycatchers nest in tamarisk at many river sites and, in many cases, use tamarisk even if native willows are present. Southwestern willow flycatchers nest in tamarisk at sites along the Colorado, Verde, Gila, San Pedro, Salt, Bill Williams, Santa Maria, and Big Sandy rivers in Arizona; Tonto Creek in Arizona; the Rio Grande and Gila rivers in New Mexico; the San Dieguito, lower San Luis Rey, and Sweetwater rivers in California; and Meadow Valley Wash and the Virgin River in Nevada. Rangewide, 86 percent of nests in mixed and exotic habitats were in tamarisk. In Arizona, 93 percent of the 758 nests documented from 1993 to 1999 in mixed and exotic habitats were in tamarisk. Tamarisk nests are at least as successful as nests in other substrates (USF&WS 2002e).

Because the physical and structural characteristics of tamarisk stands vary widely, not all have the same value as flycatcher breeding habitat. Among sites with tamarisk, suitable flycatcher breeding habitat usually occurs where the tamarisk is tall and dense, with surface water and/or wet soils present, and where it is intermixed with native riparian trees and shrubs. However, flycatchers breed in a few patches consisting of more than 90 percent tamarisk, with dry soils and surface water more than 600 ft away from some of their territories (USF&WS 2002e).

Suitable Nesting Habitat. “Suitable habitat” for southwestern willow flycatchers is defined as a riparian area with all the components needed to provide conditions suitable for breeding. These conditions are generally dense, mesic riparian shrub and tree communities 0.25 acre (minimum nest patch size) or greater in size within floodplains large enough to accommodate riparian patches at least 33 ft wide (USF&WS 2002e).

Diet and Reproduction. The nesting period of the southwestern willow flycatcher may vary depending on altitude and latitude. However, it generally begins in May with its arrival at breeding grounds and terminates with fledging in July and early August (USF&WS 2002e).

The southwestern willow flycatcher is an insectivore that forages within and occasionally above dense riparian vegetation, taking insects on the wing and gleaning them from foliage (USF&WS 2002e). According to DeLay et al. (2002) and Drost et al. (2001), southwestern willow flycatchers consume a variety of prey items, but the most prevalent included true bugs, bees and wasps, true flies, beetles, leafhoppers, and some spiders and dragonfly/damselflies. The southwestern willow flycatcher also may consume berries and seeds (USF&WS 2002e, UDWR 2003b).

Range-Wide Population Status and Nesting Areas in Utah. The total population of southwestern willow flycatchers across the species' range was estimated at 1,200 to 1,300 pairs in 2002. The population as a whole consists of extremely small, widely separated breeding groups. In Utah, for example, the willow flycatcher has been described as a common summer resident. However, there are few records concerning the breeding range in the southern portion of the state. Historically, southern Utah's largest flycatcher populations may have been those along the Colorado River and its tributaries in Glen Canyon; these are now inundated by Lake Powell. The flycatcher also bred along the Virgin River in the St. George area and along the San Juan River. Recent surveys have found the flycatcher absent as a breeding species on the Green and Colorado rivers in the Canyonlands National Park area, on the San Juan River (west of the New Mexico state line), and in portions of the Manti-La Sal National Forest. Flycatchers have recently bred in small numbers along the Virgin River near St. George, and single territories have been located at sites in the Panguitch Lake area and within Bryce Canyon National Park (USF&WS 2002e).

Threats. The reasons for the decline of the southwestern willow flycatcher and the current threats it faces are numerous, complex, and interrelated. The primary cause of the flycatcher's decline is loss and modification of habitat. Its riparian nesting habitat tends to be uncommon, isolated, and widely dispersed. Historically, these habitats have always been dynamic and unstable in place and time, due to natural disturbance and regeneration events such as floods, fire, and drought. With increasing human populations and the related industrial, agricultural, and urban developments, these habitats have been modified, reduced, and destroyed by mechanisms such as dams and reservoirs, diversions and ground water pumping, channelization and bank stabilization, phreatophyte control, livestock grazing, recreation, fire, agricultural development, and urbanization. Other factors include changes in abundance of other species (i.e., exotic plant species and brood parasitism), vulnerability of small populations (i.e., demographic effects and genetic effects), and migration and winter range stresses (USF&WS 2002e).

Critical Habitat. Critical habitat has been designated for this species in Arizona, California, and New Mexico (62 FR 39129–39147 [1997]); there is no designated critical habitat in Utah.

Occurrences in the Project Area. The UDWR database contained two records of southwestern willow flycatchers in two areas potentially affected by project activities. There was a reported but unconfirmed sighting of the southwestern willow flycatcher in 1998 in Grand County within the Moab quad that contains the Moab site (UDWR 2003b). There was a reported sighting in San Juan County in the vicinity of the slurry pipeline corridor in the La Sal West quad (UDWR 2003b). There is no information on the date of the reported sighting or on whether the sighting was confirmed.

The southwestern willow flycatcher has been identified as potentially occurring in the Matheson Wetlands Preserve and also several miles downstream from 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, after 3 years of study (1999 to 2001), that willow flycatchers were migrating through the area but were not breeding, and continued monitoring was recommended. On May 12, June 24, and July 10, 2004, DOE and UDWR conducted field surveys in the tamarisk habitat located along the easternmost boundary of the Moab site. This area had been historically identified as the only area on site containing potentially suitable flycatcher habitat. No flycatchers were detected, and UDWR concluded that this tamarisk constitutes only marginal nesting habitat at best (UDWR 2004).

Findings—Nesting Habitat. Based on the above studies, willow flycatchers occur in the vicinity of the Moab tailings pile and may occur in the vicinity of the White Mesa Mill site. Although it is unclear whether these birds belong to the listed southwestern, or *traillii,* subspecies, the former should be assumed in order to be conservative. Based on the above descriptions of nesting habitat dominated by exotic plants (USF&WS 2002e) and the 2004 field surveys conducted by DOE and UDWR (UDWR 2004), the tamarisk at the Moab tailings site should be considered marginally suitable nesting habitat.

Because riparian vegetation typically occurs in floodplain areas that are prone to periodic disturbance, suitable habitats will be ephemeral and their distribution dynamic in nature. Suitable habitat patches may become "unsuitable" (habitat that does not have the potential for developing into suitable habitat, even with extensive management) through maturation or disturbance (though this may be only temporary, and patches may cycle back into suitability). Therefore, it is not realistic to assume that any given suitable habitat patch (occupied or unoccupied) will remain continually occupied and/or suitable over the long term. Unoccupied suitable habitat will therefore play a vital role in the recovery of the flycatcher, because it will provide suitable areas for breeding flycatchers to (1) colonize as the population expands (numerically and geographically) and (2) colonize following loss or degradation of existing breeding sites. Indeed, many sites will likely pass through a stage of being suitable but unoccupied before they become occupied. "Potential" habitats (habitat that does not currently have all the components needed to provide suitable nesting habitat, but could, if managed appropriately, develop these components over time) that are not currently suitable will also be essential for flycatcher recovery, because they are the areas from which new suitable habitat develops as existing suitable sites are lost or degraded; in a dynamic riparian system, all suitable habitat starts as potential habitat. Further, even unsuitable habitats used as migration stopover areas may be critically important resources affecting productivity and survival (USF&WS 2002e).

Consequently, based on the above discussion of the dynamic nature of habitat suitability, removal of the currently marginally suitable tamarisk at the Moab site would result in temporary habitat loss for the southwestern willow flycatcher. However, this would not be the case if it were determined in the future (USF&WS 2003d) that the breeding range of the subspecies lies south of the Moab site (USF&WS 2002e). However, once remediation was completed, the lost tamarisk would be replaced with native riparian plant species of equal or higher functional value for the southwestern willow flycatcher. This would compensate for the habitat loss on the site.

Further, the size of the tamarisk stand at the Moab site (50 acres) is close to the mean patch size of breeding sites supporting 10 or more southwestern willow flycatcher territories (62.2 acres) (USF&WS 2002e). Consequently, the tamarisk habitat at the Moab site could be utilized by one or more pairs of the subspecies for nesting and/or during migration. Use of this habitat should be determined by field surveys during the most recent nesting and/or migration period(s) prior to its removal. If southwestern willow flycatchers were present during nesting and/or migration, and if impacts to the subspecies could not be avoided by removing habitat outside these periods, additional Section 7 consultation would be required.

Findings—Exposure to Contaminants in Surface Water. If the southwestern willow flycatcher occurs in the near vicinity of the Moab tailings pile, the most prevalent route of exposure to chemical and radioactive constituents would likely be from ingestion of prey and surface water in the nearshore environment. The potential for chronic effects from ingestion of chemical contaminants in surface water was evaluated for the No Action alternative using the rough-winged swallow (*Stelgidopteryx serripennis*) as a surrogate species (see Appendix A2 of the EIS). None of the maximum surface water concentrations of any of the chemical constituents exceeded NOAEL-based drinking water benchmarks for the rough-winged swallow (Sample et al. 1996). Consequently, no adverse effects to the southwestern willow flycatcher would be expected from surface water consumption within the nearshore environment of the contaminated portion of the river.

Any potential effects to the southwestern willow flycatcher that could arise from exposure to radionuclides in surface water would be negligible (see Section A1–8.2 of this BA and Appendix A2 of the EIS).

Findings—Exposure to Contaminants in Soils. Because the known diet of the southwestern willow flycatcher consists primarily of insects without aquatic life stages, exposure to chemical contaminants originating in surface water via ingestion of prey would be relatively minor. In contrast, some of these insects could have extensive contact with contaminants in surface soils. However, potential impacts associated with this route of exposure cannot be evaluated in the absence of soil contaminant data.

Exposure to chemical contaminants originating in soils could also arise from consumption of the berries and seeds of plants that accumulate such contaminants (see the evaluation of the potential effects of metals in the freshwater aquifer to terrestrial plants in Section A1−8.2). Further, exposure could arise from consumption of the terrestrial invertebrates that feed on the berries and seeds. However, potential impacts associated with these two routes of exposure cannot be evaluated in the absence of soil contaminant data.

Findings—Exposure to Contaminants at the Evaporation Pond(s). The southwestern willow flycatcher could be affected due to contaminant exposure at the evaporation pond(s) via ingestion of contaminated prey and water, dermal uptake of contaminated water and airborne contaminants, and inhalation of airborne contaminants.

The evaporation pond(s) would be built sufficiently high on the floodplain to withstand a 100-year flood event. The evaporation pond(s) would thus be located away from the river shoreline at an as-yet-unspecified distance. For this reason, and because estimated breeding territory sizes for the southwestern willow flycatcher are relatively small (generally from approximately 0.25 to 5.7 acres) (USF&WS 2002e), the evaporation pond(s) would likely be located well outside any breeding territories that could be located in association with riparian shoreline vegetation. The evaporation pond(s) would also be located in an area where project activities and site maintenance operations would create continual disturbance. Because of distance, disturbance, and the fact that the evaporation pond(s) would be located in an area that has been previously disturbed and is generally devoid of vegetation (in and over which the species generally forages [USF&WS 2002e]), the likelihood of visits from the southwestern willow flycatcher would be small. However, during the nesting period, adult southwestern willow flycatchers are known to sometimes fly outside their territory to gather food for their nestlings. Southwestern willow flycatchers may also use a larger area than their initial territory after their young are fledged and may use nonriparian habitats adjacent to the breeding area (USF&WS 2002e).

The evaporation pond(s) would be qualitatively monitored for general wildlife use, regardless of the potential presence of the southwestern willow flycatcher. Consequently, if it were determined that southwestern willow flycatchers were frequenting the evaporation pond(s), techniques to minimize or eliminate use would be identified and implemented. Techniques could include noise (e.g., propane boom cannons), visual deterrents (e.g., reflectors, silhouettes, effigies, water color), or obstruction (e.g., netting).

A1−8.1.8 Black-Footed Ferret

Historical Information. The black-footed ferret is the only ferret species native to North America. The historical range of the species, based on specimen collections, extends over 12 western states (Arizona, Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming) and the Canadian provinces of Alberta and Saskatchewan.

Significant reductions in prairie dog numbers and distribution occurred during the last century due to widespread poisoning of prairie dogs, the conversion of native prairie to farmlands, and outbreaks of sylvatic plague. This resulted in near extinction of the black-footed ferret in the wild by the early 1970s. The species was believed extinct until 1981, when a small population was discovered near Meeteetse, Wyoming. In 1985 and 1986, the Meeteetse population declined to only 18 animals. Following this decline, the remaining individuals were taken into captivity in 1986 and 1987 to serve as founders for a captive propagation program.

Reintroductions. Since the late 1980s, highly successful captive breeding efforts have provided the basis for ferret reintroductions over a broad area of their formerly occupied range (Wyoming in 1991, South Dakota and Montana in 1994, Arizona in 1996, Montana in 1997, Colorado/Utah in 1999, South Dakota in 2000, and Mexico in 2001). The only black-footed ferrets currently occurring in the wild are believed to be the result of these reintroductions. Of all these reintroduction efforts, populations may have become self-sufficient at only one site in South Dakota.

The only ferret reintroduction in Utah was a nonessential experimental population in 1999. The experimental population area consisted of all of Uinta and Duchesne counties. (For purposes of Section 7 of the ESA, nonessential experimental populations are treated as species proposed for listing if they are located outside the National Wildlife Refuge System or National Park System). It was considered highly unlikely that ferrets could disperse outside the experimental area due to the area's large size, the absence of suitable surrounding habitat (lack of prairie dog towns), and the presence of vegetative and topographical barriers (63 FR 52824–52841 [1998]).

Dependence on Prairie Dogs. 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. Historically, ferrets have been reported from black-tailed prairie dog (*Cynomys ludovicianus*), white-tailed prairie dog (*Cynomys leucurus*), and Gunnison's prairie dog (*Cynomys gunnisoni*) towns (67 FR 57558–57567 [2002]). Black-footed ferrets require prairie dog colonies of at least 100 to 150 acres in size (USF&WS 1988). Some of the white-tailed prairie dog colonies found from the Crescent Junction area southward toward the Klondike Flats alternative disposal site satisfy this size requirement (see Section A1−8.1.11).

Critical Habitat. No critical habitat has been designated for this species (USF&WS 2003a).

Known Occurrences in the Project Area. For reasons stated above, it is highly unlikely that black-footed ferrets reintroduced in Uinta and Duchesne counties in 1999 could occur on or in the vicinity of any of the project areas. However, unconfirmed sightings of naturally occurring ferrets persist throughout eastern Utah (UDWR 2003b). UDWR reported numerous but unconfirmed sightings of the black-footed ferret in the vicinity of the following project sites, with the year of the most recent observation provided parenthetically: Floy Wash Borrow Area (1989), Crescent Junction disposal site and Crescent Flat borrow area (1989), Courthouse Syncline borrow area and Klondike Flats disposal site (1989), and at five locations along the pipeline between the Moab site and the north IUC borrow area (1968 [Rill Creek quad], 1967 [Photograph Gap quad], 1996 [Monticello North quad], and 1996 [Monticello South quad]) (UDWR 2003b). Finally, there were confirmed sightings in the vicinity of the White Mesa Mill site in 1937 (UDWR 2003b).

Not all of the potential project areas have been fully surveyed for prairie dogs. However, surveys were 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. It is believed that the colonies at the other proposed project sites are also too small to support ferrets.

Findings. It is unlikely that there are prairie dog colonies of sufficient size to support black-footed ferrets at any of the proposed project locations. However, this would be determined on a site-specific basis, since all project locations would be surveyed for white-tailed prairie dogs prior to disturbance (see Section A1−8.1.11). In addition, despite occasional unconfirmed sightings, it is believed that all black-footed ferrets currently in the wild are the result of the federal reintroduction program, and none of the reintroduced ferrets or their offspring are likely to now reside within the project areas.

A1−8.1.9 Western Yellow-Billed Cuckoo

General Distribution. The historical range of the western yellow-billed cuckoo included all states west of the Rocky Mountains and extended into southern British Columbia at the northern extent and into the northwestern states of Mexico at the southern limit. The cuckoo's population and range have been largely diminished since the subspecies was first described in 1877. Currently, the range of the cuckoo is limited to disjunct fragments of riparian habitats from northern Utah, western Colorado, southwestern Wyoming, and southeastern Idaho southward into northwestern Mexico and westward into southern Nevada and California.

Distribution in Utah. Historically, cuckoos were probably a common to uncommon summer resident in Utah and across the Great Basin. The current distribution of yellow-billed cuckoos in Utah is poorly understood, though they appear to be an extremely rare breeder in lowland riparian habitats statewide (UDWR 2003b). There are at least two recent breeding records in Utah: one from the Ouray National Wildlife Refuge on the Green River in 1992 and one from the Matheson Wetlands Preserve in 1994.

Reproduction. The western yellow-billed cuckoo is one of the latest migrants to arrive and breed in Utah. They arrive in late May or early June, breed in late June through July, and start their southerly migration to northern South America by late August or early September. Yellow-billed cuckoo nesting behavior may be closely tied to food abundance. In years of low food abundance, cuckoos may forgo nesting; in years when the food supply is abundant, cuckoos may lay a large number of eggs (UDWR 2003b). Clutch size may consist of up to eight eggs but is usually two or three, and development of the young is very rapid, with a breeding cycle of 17 days from egg-laying to fledging. Although yellow-billed cuckoos usually raise their own young, they are facultative brood parasites, occasionally laying eggs in nests of other yellow-billed cuckoos or of other bird species.

Diet. Yellow-billed cuckoos feed almost entirely on large insects gleaned from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits (UDWR 2003b).

Nesting Habitat. Nesting habitat is classified as dense lowland riparian woodlands characterized by a dense subcanopy or shrub layer (regenerating canopy trees, willows, or other riparian shrubs) within 333 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 habitats are 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 2003b).

Threats. Threats to the yellow-billed cuckoo and its habitat in Utah include habitat loss and fragmentation from flooding and dewatering, encroachment by non-native tamarisk, grazing, recreational impacts, and oil and gas development.

Known Occurrences in the Project Area. Yellow-billed cuckoos have been known to nest in the Matheson Wetlands Preserve across the river from the Moab site (66 FR 38611–38626 [2001]). However, the UDWR (2003a) does not have records of cuckoo occurrence near any of the project sites, and other recent surveys (Johnson 2002) have not detected cuckoos near the Moab

site. There are no known stands of suitable habitat large enough to support nesting cuckoos at or near any of the alternate disposal sites, borrow areas, or transportation corridors, except in the Matheson Wetlands Preserve near the Moab site. Habitat at the Moab site is probably insufficient to support nesting cuckoos, although cuckoos could forage on the Moab site.

Findings—Foraging Habitat and Human Disturbance. Yellow-billed cuckoos may occur in the Matheson Wetlands Preserve across the river from the Moab tailings pile. Removal of the approximately 50 acres of tamarisk on the Moab site may reduce the value of the area for foraging but would not likely remove suitable nesting habitat. Increased noise and lighting could affect yellow-billed cuckoos. However, the nearest nesting sites (Matheson Wetlands Preserve) would probably be at least one-half mile from the construction activities at the Moab site. At that point, the maximum noise levels would be approximately 65 dBA, which is comparable to normal daytime noise levels in the town of Moab.

Findings—Exposure to Contaminants in Surface Water. The yellow-billed cuckoo is unlikely to spend much time near the Moab tailings pile, since it nests across the river in the Matheson Wetlands Preserve. However, if it does occur near the tailings pile, the most prevalent route of exposure to chemical and radioactive constituents would likely be from ingestion of prey and surface water in the nearshore environment. The potential for chronic effects from ingestion of chemical contaminants in surface water was evaluated for the No Action alternative using the American robin (*Turdus migratorius*) as a surrogate. Of the surrogate species available (Sample et al. 1996), the robin most closely approximated the diet and body size of the yellow-billed cuckoo. None of the maximum surface water concentrations of any of the chemical constituents exceeded NOAEL-based drinking water benchmarks for the robin (Sample et al. 1996). Consequently, no adverse effects to the yellow-billed cuckoo would be expected from surface water consumption within the nearshore environment.

Any potential effects to the yellow-billed cuckoo that could arise from exposure to radioactive constituents would be discountable (see Section A1–8.2 of this BA and Appendix A2 of the EIS).

Findings—Exposure to Contaminants in Soils. Because the known diet of the yellow-billed cuckoo consists of insects without aquatic life stages, there would be no exposure to chemical contaminants originating in surface water through ingestion of prey. In contrast, some of these food items could have extensive contact with contaminants in surface soils. Further exposure to chemical contaminants originating in soils could also arise from consumption of the berries and seeds of plants that accumulate such contaminants. However, the nature and extent of any effects that could result from exposure by the latter two pathways that are linked to soils are unknown and probably are relatively unimportant compared with the potential effects of habitat destruction.

Findings—Exposure to Contaminants at the Evaporation Pond(s). The yellow-billed cuckoo could potentially be affected by contaminant exposure at the evaporation pond(s) through ingestion of contaminated prey and water, dermal uptake of contaminated water and airborne contaminants, and inhalation of airborne contaminants.

The evaporation pond(s) would be located well outside any yellow-billed cuckoo breeding territories, since nesting would occur in the Matheson Wetlands Preserve on the opposite side of the river. Thus, it is unlikely that yellow-billed cuckoos would spend much time in the vicinity of the evaporation pond(s). Further, the evaporation pond(s) would also be located in an area where project activities and site maintenance operations would create continual disturbance. Because of distance, disturbance, and the fact that the evaporation pond(s) would be located in an area that has been previously disturbed and is generally devoid of vegetation (from which the species generally gleans its prey [UDWR 2003b]), the likelihood of visits from the yellow-billed cuckoo would be small.

The evaporation pond(s) would be qualitatively monitored for general wildlife use, regardless of the potential presence of the yellow-billed cuckoo. Consequently, if it were determined that yellow-billed cuckoos were frequenting the evaporation pond(s), techniques to minimize or eliminate use would be identified and implemented. Techniques could include noise (e.g., propane boom cannons), visual deterrents (e.g., reflectors, silhouettes, effigies, water color), or obstruction (e.g., netting).

A1−8.1.10 Gunnison Sage Grouse

Distribution. The Gunnison sage grouse is a newly identified species that is rare in Utah. It formerly occurred in areas of Utah, Colorado, Arizona, New Mexico, and Oklahoma (UDWR 2003b). The distribution of the species has been reduced to less than 25 percent of its historical range (67 FR 40657–40679 [2002]). It now occurs only in parts of southeastern Utah and southwestern Colorado. In Utah, the Gunnison sage grouse currently occurs only in eastern San Juan County near the Colorado state line.

Habitat, Diet, and Reproduction. The Gunnison sage grouse prefers sagebrush and sagebrush/grassland habitats. It feeds primarily on sagebrush and other plant material, although it also consumes insects. It is a colonial breeder that mates in the spring. Females lay a clutch of approximately eight eggs that hatch in about 1 month, and young can fly at 1 to 2 weeks of age (UDWR 2003b).

Threats. The distribution of the Gunnison sage grouse and quality of its habitat has been reduced in part by habitat loss and fragmentation (67 FR 40657–40679 [2002]); habitat loss appears to be the major threat (UDWR 2003b).

Known Occurrences in the Project Area. The Gunnison sage grouse has been observed in San Juan County in the vicinity of the proposed pipeline corridor between Moab and the White Mesa Mill site. Occurrences have been documented in the Monticello North and Monticello South quads in 1999 (UDWR 2003b), and there was a confirmed sighting with no date in the Devil Mesa quad in the vicinity of the proposed pipeline corridor (UDWR 2003b). Much of the area near the proposed slurry pipeline route between Moab and White Mesa is part of a Gunnison sage grouse conservation area (Sage Grouse Working Group 2000).

Findings. Habitat destruction is the greatest potential impact of the proposed project activities on the Gunnison sage grouse. However, most of the proposed pipeline route follows existing, already disturbed rights-of-way; therefore, relatively little habitat would likely be lost in those areas. Portions of the proposed pipeline that are not part of existing rights-of-way would be surveyed prior to development. If significant sage grouse habitat features were identified, an

appropriate mitigation plan would be developed to minimize impacts. Sage grouse could also be disturbed by noise or human presence during critical periods of the year, especially during courtship, breeding, and nesting. To minimize these impacts, if a slurry pipeline option were selected, construction within potential sage grouse habitat would be scheduled to occur during portions of the year when these activities would not be disrupted.

A1−8.1.11 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. This species is considered here both because it is under candidate review and because another species considered here (the black-footed ferret) is closely tied to the white-tailed prairie dog in Utah.

Habitat and Distribution. The white-tailed prairie dog inhabits grasslands and shrublands ranging from southern Montana through Wyoming and into Colorado and eastern Utah. In Utah, the Gap Analysis indicates that critical value habitat is located in Rich County, much of Uinta County, southeastern Duchesne County, and the central portions of Grand and Emory counties.

Threats. Major threats to the white-tailed prairie dog are habitat loss, poisoning, and sylvatic plague (UDWR 2003b).

Known Occurrences in the Project Area. White-tailed prairie dog colonies are known to occur at the Crescent Junction alternative disposal site. Numerous colonies occur around the Crescent Junction area and extend south toward the Klondike Flats alternative disposal site, forming a complex of colonies ranging in size from 10 to 2,445 acres (Seglund 2004). BLM (1995) reported a number of colonies at the Klondike Flats site, most of which were fairly small and concentrated in drainage bottoms with more silt soil and more vegetation. White-tailed prairie dogs are also likely to occur at Floy Wash, Tenmile, Courthouse Syncline, and Blue Hills Road borrow areas, and potentially in the general vicinity of the Moab site, as well as along transportation corridors between the sites. The area from Moab south along US-191 toward the White Mesa Mill site supports colonies of Gunnison's prairie dog (Seglund 2004); this area could also support white-tailed prairie dogs, since their ranges overlap in this region.

Findings. Development of any of the sites north of Moab would likely disturb some white-tailed prairie dog colonies. Impacts would be possible, but apparently less likely, if sites south of Moab were developed for this project.

Prior to development of any of the proposed project sites or transportation routes, the areas would be surveyed and the potential effects to white-tailed prairie dogs evaluated. DOE, in coordination with BLM, USF&WS, and UDWR, would develop reasonable and appropriate mitigation plans to minimize adverse impacts. If the white-tailed prairie dog became listed as threatened or endangered under the ESA prior to completion of project activities, and if impacts were identified and could not be avoided, additional Section 7 consultation would be required.

A1−8.2 Potential Effects of Proposed Actions on Terrestrial Species

The impacts described below would be applicable at the Moab site, under either on-site or off-site disposal alternatives.

Habitat Destruction. Habitat loss would likely be the greatest and most obvious impact to terrestrial species under any of the EIS alternatives, the extent of which would depend on the alternative selected. At the Moab site, approximately 439 acres would be directly affected. However, only approximately 50 acres currently support vegetation, and most of this is dominated by tamarisk. Development of borrow areas could disturb 100 to 550 acres of desert vegetation spread over at least three locations. If an alternative disposal site were selected, an additional 350 to 500 acres of desert vegetation could be affected. Under the on-site or off-site disposal alternatives, up to 60 acres of land could be affected by construction of one or more evaporation ponds and an associated small support facility near the Moab tailings pile. However, it is likely that the evaporation pond(s) would be located in an area that has been previously disturbed and thus supports little vegetation.

Traffic Mortality. Truck transportation of tailings materials from the Moab site to one of the alternative disposal sites would significantly increase the amount of truck traffic on US-191 either north or south of Moab. Normal traffic on US-191 north of Moab consists of approximately 2,800 to 3,000 vehicles per day, of which approximately 30 percent (840 to 1,000) are trucks. Transporting tailings would add another 200 to 400 truck round trips per day, an increase of from about 7 to 15 percent over the normal number of vehicles. This increase in traffic would likely lead to a marginal increase in traffic-related wildlife mortalities in the vicinity of US-191.

Noise. Noise from site construction and operations and from increased truck or rail transport could have adverse impacts on terrestrial biota in the vicinity of the Moab site as well as at the alternate disposal sites, borrow areas, and transportation corridors. Man-made noise can affect wildlife by inducing physiological changes, nest or habitat abandonment, or behavioral modifications. It may also disrupt communications required for breeding or defense (Larkin 1996). However, wildlife may also habituate to man-made noise (Larkin 1996). Much of the available data on noise effects focus on noise sources that are much 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 due to the proposed activities is possible without specific knowledge about the locations of species relative to the noise source and without specific data on the responses of these same species to construction noises.

The maximum noise level generated by construction equipment at the Moab site or at an alternative disposal site is estimated to be approximately 95 dBA measured at 49 ft. This noise level would decrease with distance, until it reached a level of approximately 65 dBA at 1,476 ft from the source (65 dBA is the normal daytime background level in Moab). At the more isolated sites, this noise level would attenuate over a distance of approximately 6 miles until it reached the quiet desert background level of approximately 30 dBA. At the Moab site, noise effects on local wildlife would likely be minimal, because the available habitat would be removed during the remediation process. However, there could be detectable elevated sound levels in habitats downstream and across the Colorado River resulting from work near the periphery of the Moab site.

The increased truck traffic along US-191 resulting from transport of materials from the Moab site to an alternative disposal site would likely increase ambient noise levels by approximately 5 dB (measured at 49 ft). Although the highway noise (average baseline approximately 70 dBA) may be detected over distances of 6 to 7 miles, the additional noise due to the additional trucks would not be perceptible (at least to humans) beyond several hundred yards.

Other Disturbances. Other potential impacts could result from increased human presence during remediation activities, such as those from supplemental lighting that could be employed for dual-shift or 24-hour operations at the Moab and alternative disposal sites. To the extent practicable, activities and worker presence near the periphery of the sites should be limited to minimize potential harassment of wildlife. If supplemental lighting were employed, the lights would be directed and/or sheltered to minimize the amount of light escaping the work site.

Chemical/Radiological Impacts. The potential for adverse effects resulting from wildlife and plant exposures to chemical and radiological constituents would be greater under the No Action alternative, which does not include ground water treatment, than under the on-site or off-site disposal alternatives that include ground water treatment. Consequently, the following summary of potential impacts to wildlife focuses on chemical and radiological constituents in surface water under the No Action alternative. A small section discussing potential impacts at the evaporation pond(s) is also included.

Chemical Impacts—Wildlife. At the Moab site, wildlife could be exposed to contaminants through ingestion of prey, water, and soil; dermal uptake; and inhalation of airborne contaminants. The primary pathway for wildlife exposure to contaminants would likely be through ingestion of prey in the riparian zone and prey and water in the surface waters of the nearshore environment.

The potential for chronic effects through ingestion of prey and water within the surface waters of the nearshore environment was evaluated as part of the process of selecting preliminary contaminants of potential concern in surface water. The selection process involved comparing maximum concentrations of 28 contaminants with detection limits, background concentrations, and toxicological benchmarks. Toxicological benchmarks consisted of drinking water and food/water benchmarks that would result in NOAEL and LOAEL for selected wildlife species (Sample et al. 1996).

Two of the 28 original contaminants, mercury and selenium, were identified as preliminary contaminants of potential concern because they had maximum concentrations that exceeded detection limits, background concentrations, and wildlife toxicological benchmarks (Sample et al. 1996) (see Appendix A2 of the EIS). The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are the only consultation species considered to be potentially present at the Moab site. The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are similar in lifestyle to three of the benchmark species. Consequently, potential impacts to the bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are discussed in relation to these benchmark species in Sections A1−8.1.4, A1−8.1.7, and A1−8.1.9, respectively. In addition, the nine metals in the freshwater aquifer that are of potential concern to plants (discussed below) could become translocated to plant parts consumed by wildlife or terrestrial invertebrates that are in turn consumed by wildlife. The only consultation species that could be exposed to contaminants via this route are the southwestern willow flycatcher and western yellow-billed cuckoo. Potential impacts to the southwestern willow flycatcher and

western yellow-billed cuckoo from this route of exposure are discussed briefly in Sections A1−8.1.7 and A1−8.1.9, respectively.

Chemical Impacts—Plants. Plants may be exposed to contaminants through root or dermal uptake of contaminants. Of these, root uptake would likely be the primary exposure pathway. Further, only root uptake is considered, since only phytotoxicity benchmarks based on root uptake were available. Of the contaminants listed for the freshwater aquifer in the SOWP (DOE 2003a), soil solution phytotoxicity benchmarks were available only for the metals (Efroymson et al. 1997). Maximum and mean concentrations of metals in the freshwater aquifer were obtained from the SOWP (DOE 2003a) and screened on the basis of their exceedance of these phytotoxicity benchmarks (see Appendix A2 of the EIS).

The following nine metals had maximum concentrations that exceeded maximum background concentrations and were slightly less than or exceeded phytoxicity benchmarks: aluminum, arsenic, cobalt, copper, iron, manganese, mercury, molybdenum, and vanadium (Appendix A2 of the EIS). Four of these metals had mean concentrations that were slightly below or above phytotoxicity benchmarks: arsenic, manganese, molybdenum, and vanadium (Appendix A2 of the EIS). These nine metals, but particularly the latter four, could cause phytotoxic effects, assuming that plants had root access to the freshwater aquifer or associated soil water above it.

However, there would be no potential phytotoxic effects to consultation plant species (Jones' cycladenia, Navajo sedge, and clay phacelia), since these are not known to occur at or near the Moab tailings pile (see Sections A1−8.1.1, A1−8.1.2, and A1−8.1.3, respectively).

Radiological Impacts—Wildlife and Plants. The following constituents have been monitored as contributors to radiological dose to terrestrial organisms in surface waters at the Moab site: lead-210, polonium-210, radium-226, radium-228, radon-222, 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 total radiological dose to populations of generic (not species-specific) terrestrial (including riparian) animals and generic terrestrial (including riparian) plants based on maximum and mean concentrations of uranium-238, uranium-234, and radium-226 in surface water (DOE 2002b). These isotopes represent the highest values analyzed for radionuclides from 2000 to 2002.

The total radiological dose was estimated using the default parameters (e.g., bioaccumulation factors) provided in the RESRAD Biota Code, since such site-specific data were lacking. The total estimated radiological dose was compared to the applicable DOE dose limits or standards designed to protect populations of generic terrestrial animals and generic terrestrial plants.

The total radiological dose to a population of generic terrestrial plants based on maximum surface water concentrations was 9.87×10^{-6} rad/day, about 6 orders of magnitude below the DOE dose standard of 1 rad/day. The total radiological dose to a population of generic terrestrial animals based on maximum concentrations was 0.14 rad/day, slightly above the DOE dose standard of 0.1 rad/day. This could be of potential concern if riparian animals' total exposure occurred at the location where the maximum-concentration sample was taken. However, riparian vertebrates integrate their exposure over a much larger area. The total radiological dose to a population of generic terrestrial animals based on mean concentrations was 0.013 rad/day, about 1 order of magnitude below the DOE dose standard.

Consequently, there is no potential risk of radiotoxic effects to a population of generic riparian plants, and the risk of potential radiotoxic effects to a population of generic riparian vertebrates would be minimal from these radioactive constituents in surface water. Consequently, it follows that there would be minimal risk to the bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo, the only consultation species thought to be potentially present at the Moab site (see Sections A1−8.1.4, A1−8.1.7, and A1−8.1.9, respectively).

The results of the RESRAD assessment indicate that the actual dose rates to terrestrial animals are below a population-level effect. There are no guidelines for radiological effects to individuals, which is important in evaluating impacts to threatened and endangered species. The studies resulting in the 0.1-rad/day criterion for terrestrial animals were based on exposures to organisms for 1 year, and then normalized to a dose rate based on a day. One could interpret these results to mean that a dose rate of 0.1 rad/day, if sustained for a year, would have an effect on some individuals but not on the population as a whole. Based on the results of the RESRAD assessment and on the fact that the bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo would be present at the Moab site only seasonally, if at all, radionuclides are not expected to adversely affect these species.

Evaporation Pond(s). Potential impacts that could result from the construction and operation of one or more evaporation ponds include contaminant impacts to wildlife. The evaporation pond(s) could attract wildlife that could be affected due to contaminant exposure through ingestion of contaminated prey and water, dermal uptake of contaminated water and airborne contaminants, and inhalation of airborne contaminants. The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are the only terrestrial consultation species considered to be potentially present at the Moab site. Potential impacts to these species in connection with the evaporation pond(s) are discussed in Sections A1−8.1.4, A1−8.1.7, and A1−8.1.9, respectively.

A1−9.0 Determinations and Conclusions

The potential impacts of the action alternatives and the No Action alternative include physical, chemical, and/or radiological impacts as assessed in Sections A1−7.2 and A1−8.2. The degree and duration of the impacts would vary depending upon location, remediation methods, remediation goals, remediation period, transportation modes, and the potential presence of species and habitats.

DOE has made determinations regarding effects to federal threatened, endangered, and candidate species based on the information and assessment presented in Sections A1−7.0 and A1−8.0. This information was obtained in consultation with USF&WS and other federal and State agencies (e.g., BLM, UDWR). Because DOE's on-site and off-site remediation alternatives propose improvements to the existing environment, the determinations are made based on DOE's proposed actions and not on the effects of existing impacts (No Action alternative). It is emphasized that DOE's proposed action alternatives would mitigate existing risks to endangered species caused by historical surface and ground water contamination.

The determinations were made using the guidance provided in Chapter 3 of the USF&WS *Endangered Species Consultation Handbook* (USF&WS 1998b). These determinations serve as the basis for USF&WS to reach a jeopardy, or no jeopardy, finding in the Biological Opinion

(Appendix A3). They also serve as the basis for USF&WS to authorize a "take," if applicable. A "take" may be authorized if an action will not jeopardize the continued existence of a species.

As defined in the guidance (USF&WS 1998b), the three categories of effects that are considered in this BA are:

No Effect—There is sufficient evidence that the species and habitat (including critical and potentially suitable habitat) would not be affected. This determination is based on consultation with USF&WS and other federal and State agencies (e.g., BLM, UDWR).

May affect, not likely to adversely affect—Effects to species and critical habitat are discountable, insignificant, or completely beneficial. In most cases, in this BA, this determination would be a result of discountable effects. Discountable effects are those that are extremely unlikely to occur.

May affect, likely to adversely effect—Adverse effects to species and critical habitat are direct or indirect, including interrelated and interdependent actions.

Three plant species (Navajo sedge, Jones' cycladenia, and clay phacelia), and the California condor are not known or suspected to occur at any of the proposed project sites or within transportation corridors. DOE has determined that the proposed alternatives, including the No Action alternative, would have "no effect" on these species. DOE has not made a determination for the white-tailed prairie dog based on the current status (candidate review) of this species. Therefore, these species are not discussed further.

In addition, DOE has made a determination of "no effect" for all species for proposed remediation of vicinity properties. These locations have been historically disturbed and are located in urbanized areas (e.g., private residences and commercial properties) in the vicinity of the Moab site. No aquatic species would be present on vicinity properties, and suitable habitat does not exist for avian or terrestrial species at vicinity property locations.

Section A1−9.1 discusses determinations for the on-site surface disposal alternative. Section A1−9.2 discusses determinations for the off-site surface disposal alternatives. Section A1−9.3 discusses determinations for the ground water remediation aspects of both the on-site and off-site alternatives. Section A1−9.4 discusses determinations for the No Action alternative. Section A1−9.5 summarizes the conclusions and determinations.

A1−9.1 Determinations for the On-Site Disposal Alternative

Table A1−5 summarizes DOE's determinations for aquatic and terrestrial species for the on-site disposal alternative and the effects at borrow locations and haul routes for borrow materials.

These determinations would be associated with short-term surface remediation activities (within 5 to 10 years of the ROD). Once remediation was complete, there would be "no adverse effect" to any of these species. Effects associated with ground water remediation are addressed in Section A1−9.3.

Table A1−5. Summary of DOE Determinations for the On-Site Surface Disposal Alternative

Species	Scientific Name	On-Site Effects	Borrow Location and Haul Route Effects
BIRDS			
Bald eagle	*Haliaeetus leucocephalus*	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Gunnison sage grouse	*Centrocercus minimus*	No effect	No effect
Mexican spotted owl	*Strix occidentalis lucida*	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Southwestern willow flycatcher	*Empidonax traillii extimus*	May affect, not likely to adversely affect	No effect
Western yellow-billed cuckoo	*Coccyzus americanus*	May affect, not likely to adversely affect	No effect
MAMMALS			
Black-footed ferret	*Mustela nigripes*	No effect	May affect, not likely to adversely affect
FISH			
Bonytail	*Gila elegans*	May affect, not likely to adversely affect	No effect
Colorado pikeminnow	*Ptychocheilus lucius*	May affect, not likely to adversely affect	No effect
Humpback chub	*Gila cypha*	May affect, not likely to adversely affect	No effect
Razorback sucker	*Xyrauchen texanus*	May affect, not likely to adversely affect	No effect

On-site Effects

The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo have been reported near the Moab site, but their presence is seasonal and likely infrequent due to their migratory nature. Potential habitat exists for the Mexican spotted owl west of the site, although not close to the site. Therefore, potential effects on these species would be considered discountable.

Endangered fish species are not likely to be affected by physical or mechanical disturbances and noise associated with the preparation of the on-site disposal cell. Therefore, potential effects would be discountable.

Borrow Locations and Haul Routes

Bald eagles are not known to occur close to the borrow locations and haul routes, although potential high-quality wintering habitat is reported to be in the vicinity. Although potentially suitable habitat for the Mexican spotted owl has been identified to the west of the haul routes, it is of sufficient distance to preclude disturbance above that caused by common recreational vehicle use in the area. Therefore, potential effects on these species would be considered discountable.

The black-footed ferret has been confirmed as not being present at the Moab site. However, there is potentially suitable habitat, based on the location and size of prairie dog colonies, relatively close to some borrow locations and haul routes. Final selection of borrow areas would exclude any sites that would adversely affect endangered species.

Endangered fish species are not present at the borrow locations. Some of the haul routes do cross the Colorado River, and accidental spills could introduce a small quantity of borrow material into the Colorado River. However these effects would be discountable or insignificant.

Disposal Cell Failure From Natural Phenomena

DOE has determined that catastrophic failure of the disposal cell from sudden or catastrophic lateral migration of the Colorado River into the Moab site for the pile design period of 200 to 1,000 years does not pose a realistic hazard. DOE has evaluated the hydrologic and geologic conditions of the northwestern portion of Spanish Valley and the Colorado River corridor at Moab (See Sections 3.1.1, 3.1.6, and 3.1.7 of the EIS). Given the known geologic and hydrologic context, the likelihood of catastrophic failure, though not statistically quantified, is considered extremely unlikely. Consequently, on-site disposal may affect, but is not likely to adversely affect, endangered fish species in the Colorado River. However, in the extremely unlikely event that a catastrophic failure occurred, the impacts would likely adversely affect endangered fish species in the Colorado River from the Moab site to Lake Powell (see Section A1−7.2).

If mitigated, long-term failure would not likely result in negative impacts to aquatic biota. DOE's 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, expanded, and/or modified in the future should river migration encroach on the site and the disposal cell. Consequently, on-site disposal may affect, but is not likely to adversely affect, endangered fish species in the Colorado River. However, in the unlikely event that long-term failure occurred, the impacts would likely adversely affect endangered fish species in the Colorado River adjacent to the Moab site.

There would be short-term adverse effects to the endangered fish if natural processes caused a catastrophic failure of the on-site disposal cell at the Moab site. Long-term failure of the on-site disposal alternative may affect, but is not likely to adversely affect, the endangered fish. While the contaminant load to the water and sediment is likely to increase, the effects of sediment loading is likely to be offset by new habitat being created in other locations.

A1−9.2 Determinations for the Off-Site Disposal Alternative

Table A1−6 summarizes DOE's determinations for terrestrial and aquatic species for the off-site disposal alternative. The determinations consider on-site effects related to preparation of tailings for transportation, effects associated with transportation to the off-site disposal location, and effects at the off-site disposal location. If a species may be affected either at the Moab site, at an off-site disposal location, or along a transportation route, a "may affect" determination is indicated.

Table A1−6. Summary of DOE Determinations for the Off-Site Surface Disposal Alternative

Species	Scientific Name	On-Site Effects	Off-Site Effects		
			Klondike Flats	Crescent Junction	White Mesa
BIRDS					
Bald eagle	*Haliaeetus leucocephalus*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Gunnison sage grouse	*Centrocercus minimus*	No effect	No effect	No effect	May affect, not likely to adversely affect
Mexican spotted owl	*Strix occidentalis lucida*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Southwestern willow flycatcher	*Empidonax traillii extimus*	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect
Western yellow-billed cuckoo	*Coccyzus americanus*	May affect, not likely to adversely affect	No effect	No effect	No effect
MAMMALS					
Black-footed ferret	*Mustela nigripes*	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
FISH					
Bonytail	*Gila elegans*	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect
Colorado pikeminnow	*Ptychocheilus lucius*	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect
Humpback chub	*Gila cypha*	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect
Razorback sucker	*Xyrauchen texanus*	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect

These determinations would be associated with short-term surface remediation activities (within 5 to 10 years of the ROD). Once remediation was complete, there would be "no adverse effect" to any of these species. Effects associated with borrow locations and borrow haul routes have been addressed in Section A1−9.1 and are not addressed again in this section. Effects associated with ground water remediation are addressed in Section A1−9.3.

On-site Effects Associated with Tailings Preparation

If an off-site disposal site were selected in the ROD, remediation activities would still occur at the Moab site (i.e., those associated with preparing the tailings for transportation). The potential effects to the bald eagle, Mexican spotted owl, southwestern willow flycatcher, and western yellow-billed cuckoo, as well as for the endangered fish species, would be similar to those described for the on-site surface disposal alternative under Section A1−9.1 and are therefore considered discountable.

Klondike Flats Alternative

At this proposed disposal cell location, the only species of concern are the bald eagle and black-footed ferret due to the possible occurrence of associated suitable habitat. Based on available information, it is unlikely that these species are present; therefore, potential adverse effects would be considered discountable.

The bald eagle, Mexican spotted owl, and black-footed ferret are the species of concern along the three proposed transportation corridors (truck, rail, and pipeline) due to the possible occurrence of associated suitable habitat. Based on available information, it is unlikely that these species are present; therefore, potential adverse effects would be considered discountable.

Endangered fish species are not present at Klondike Flats, and the routes for transporting material to the location do not cross critical habitat. Therefore, there would be "no effect."

Crescent Junction Alternative

At this proposed disposal cell location, the only species of concern are the bald eagle and black-footed ferret due to the possible occurrence of associated suitable habitat. Based on available information, it is unlikely that these species are present; therefore, potential adverse effects would be considered discountable.

For the three transportation corridors, the potential effects would be similar to those described for the Klondike Flats alternative and would therefore be considered discountable.

Endangered fish species are not present at Crescent Junction, and the routes for transporting material to the location do not cross critical habitat. Therefore, there would be "no effect."

White Mesa Mill Alternative

At the White Mesa Mill disposal cell location, no effects are anticipated because the White Mesa mill is an operating site under an NRC license. The "may effect" determinations in Table A1−6 are based on potential effects associated with the two transportation corridors (truck and pipeline). Transportation by rail is not included as an alternative in the EIS and therefore was not considered in making the determinations in Table A1−6.

The species listed in Table A1−6 are not expected to be adversely affected by use of the truck corridor, since it is currently a state highway. If species were present close to the highway, the effects would be considered discountable.

With the exception of the western yellow-billed cuckoo, all the species listed in Table A1−6, or associated suitable habitat, could be present along the pipeline corridor. Because of the diversity of vegetation and life zones, this corridor presents the greatest potential for species presence or the presence of potentially suitable habitat. As a result, this corridor presents the greatest potential for adverse effects.

The potential for adverse impacts to the bald eagle and southwestern willow flycatcher exists wherever riparian areas are present along the slurry pipeline corridor, particularly where the route would cross the Colorado River. Based on available information, it is unlikely that these

species are present; therefore, potential adverse effects would be considered discountable. There is the potential for the Gunnison sage grouse and associated habitat to be present along the pipeline corridor. However, there is no indication that the route would cross any essential habitat areas (e.g., "leks"). Therefore, if the species was present, these effects would be considered insignificant. Potentially suitable habitat for the Mexican spotted owl also exists in the vicinity of the pipeline corridor. Based on available information, it is unlikely that this species is present; therefore, potential adverse effects would be considered discountable.

Although the potential exists for black-footed ferret habitat to occur in the vicinity of some segments of the pipeline corridor, such occurrence is unlikely. Therefore, potential effects are considered discountable.

Endangered fish species are not present at the White Mesa Mill. However, the routes for transporting material to the location cross critical habitat in the Colorado River. There is the possibility that an accidental spill of contaminated soil could introduce material into the river. However, these effects would be discountable.

A1−9.3 Determinations for Ground Water Remediation

Active ground water remediation is proposed for the on-site and the three off-site alternatives. All remediation activities would occur within the existing millsite boundary. Determinations are based on meeting the remediation goals stated in Section A1−4.3.2 and implementation and operation schedules stated in Section A1−4.3.5. The active remediation system would extract and treat ground water for 75 to 80 years (depending on whether an off-site or on-site remediation alternative were implemented) to maintain surface water quality goals. The length of the remediation period required to achieve compliance under off-site disposal would be about 5 years shorter than under on-site disposal (Table A1−7). The contaminant concentrations in the ground water would thus be reduced to acceptable risk levels prior to entry into the Colorado River. Active remediation would cease only after ground water and surface water monitoring confirmed that long-term remediation goals were achieved and after appropriate consultation and concurrence with USF&WS. This information is summarized in Table A1−7 for the three major post-ROD project phases. It assumes that remediation goals would not be fully met as a result of the initial and interim actions described in Section A1−4.3.3.

Table A1−7. Schedule for Meeting Ground Water Remediation Goals

Post-ROD Project Phase	Remediation Goals Achieved ?	
	On-site Alternative	Off-site Alternative
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

Table A1−8 summarizes DOE determinations for effects to terrestrial and aquatic species, as a result of ground water remediation, for both the on-site and off-site disposal alternatives. For terrestrial receptors, determinations are based on (1) disturbances associated with ground water remediation activities and (2) exposure to concentrated contaminants that could occur in an evaporation pond if a pond were used during ground water remediation.

Table A1−8. Summary of DOE Ground Water Remediation Determinations

Common Name	Scientific Name	Pre-Remediation	During Remediation	Post-Remediation
BIRDS				
Bald eagle	*Haliaeetus leucocephalus*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Gunnison sage grouse	*Centrocercus minimus*	No effect	No effect	No effect
Mexican spotted owl	*Strix occidentalis lucida*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Southwestern willow flycatcher	*Empidonax traillii extimus*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Western yellow-billed cuckoo	*Coccyzus americanus*	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
FISH				
Bonytail	*Gila elegans*	May affect, **likely** to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Colorado pikeminnow	*Ptychocheilus lucius*	May affect, **likely** to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Humpback chub	*Gila cypha*	May affect, **likely** to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Razorback sucker	*Xyrauchen texanus*	May affect, **likely** to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
MAMMALS				
Black-footed ferret	*Mustela nigripes*	No effect	No effect	No effect

There would be no effect on the Gunnison sage grouse or black-footed ferret from ground water remediation construction and operation or from an evaporation pond, since neither of these species or associated suitable habitat is present at the Moab site.

The bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo are the only consultation species considered to be potentially present at the Moab site. If present, they could be affected by ground water remediation construction and operation and by an evaporation pond. However, disturbance resulting from ground water remediation would probably be less than that resulting from surface remediation under the on-site disposal alternative. Because the potential effects of surface remediation under the on-site disposal alternative are considered discountable (see Section A1−9.1), the potential effects of ground water remediation should also be considered discountable. Potential effects on the bald eagle, southwestern willow flycatcher, and yellow-billed cuckoo from an evaporation pond would be considered discountable due primarily to a lack of habitat nearby for these species, as explained in Sections A1−8.1.4, A1−8.1.7, and A1−8.1.9, respectively.

The Mexican spotted owl is not considered to be potentially present at the Moab site, based solely on distance to critical habitat (located a few miles south of the site) and potential habitat (located within the first 7 miles north of the site). Further, in the very unlikely event that the spotted owl were to occur at the Moab site, it would be unlikely to use the area where ground water remediation construction and operation would occur (within the millsite boundary) and the environs of the evaporation pond. The spotted owl primarily consumes rodents, and these would be unlikely to occur within the millsite boundary and the area where the evaporation pond would be constructed, since both areas have been previously disturbed and support little to no vegetation. Consequently, potential effects on the Mexican spotted owl due to ground water remediation activities and the presence of an evaporation pond are considered discountable.

If an evaporation pond were used as part of ground water remediation, it would be qualitatively monitored for general wildlife use. If any species that are the subject of this BA frequented the evaporation pond, DOE would consult with USF&WS to develop reasonable and prudent measures to discourage or prevent those species from using the pond. There would be no adverse evaporation pond effects upon completion of remediation (see "post-remediation" in Table A1−8).

During the pre-remediation phase (Table A1−8)), critical habitat for all four endangered fish species would likely continue to be adversely affected by historical contamination. As discussed in Section A1−7.2. As discussed in Section A1−7.1, the following endangered fish species and their life stage are most likely to be directly and adversely affected by site-related contamination: pikeminnow (all life stages with emphasis on drifting larvae and young-of-the-year), razorback sucker (stocked juveniles and adults, and naturally produced larvae and young-of-the-year) and bonytail (stocked juveniles and adults, and naturally produced larvae and young-of-the-year) (USF&WS 2004a). The closest population of humpback chub is downriver in Cataract Canyon and would be affected in the event of disposal cell failure, but this population is not affected by site-related contamination.

DOE, in consultation with USF&WS, has implemented and will continue to implement initial and interim actions to reduce the potential for "take" until the selected remedial action and methods are fully implemented. The time frame required for the selection and implementation of remedial actions and methods, during which the take could occur, is anticipated to be a maximum of 10 years from the date of the ROD (see pre-remediation phase in Table A1−7). As stated in Section A1−4.3.3, a reduction in contaminant concentrations in surface water could be observed significantly sooner than the 10-year time frame as a result of interim actions.

During the remediation and post-remediation phases in Table A1−8, effects on fish species and associated critical habitat would likely be insignificant or beneficial. Ground water and surface water would be monitored to determine if remediation goals were being met. USF&WS would be consulted at least annually on the results of monitoring. Long-term effects are consistent with the goals of the Upper Colorado River Endangered Fish Recovery Program.

A1−9.4 Determinations for the No Action Alternative

Selection of the No Action alternative would result in the continued contamination of the Colorado River at the Moab site, which is critical habitat for four endangered fish species. Terrestrial species that use riparian areas along the eastern boundary of the site would continue to be exposed to elevated contaminant concentrations in surface water.

Potential impacts to the bald eagle, southwestern willow flycatcher, and western yellow-billed cuckoo from elevated contaminant concentrations in surface water are discussed in Sections A1−8.1.4, A1−8.1.7, and A1−8.1.9, respectively. Under the No Action alternative, potential effects on all three species are considered unlikely and therefore discountable.

Elevated contaminant concentrations in the Colorado River are likely to adversely affect the Colorado pikeminnow, razorback sucker, bonytail, humpback chub, and designated critical habitat for all four species under the No Action alternative. Adverse impacts would continue to occur until ground water concentrations naturally attenuate to acceptable risk levels in the river. This is estimated to be 75–80 years after the ROD (Figure A1−9).

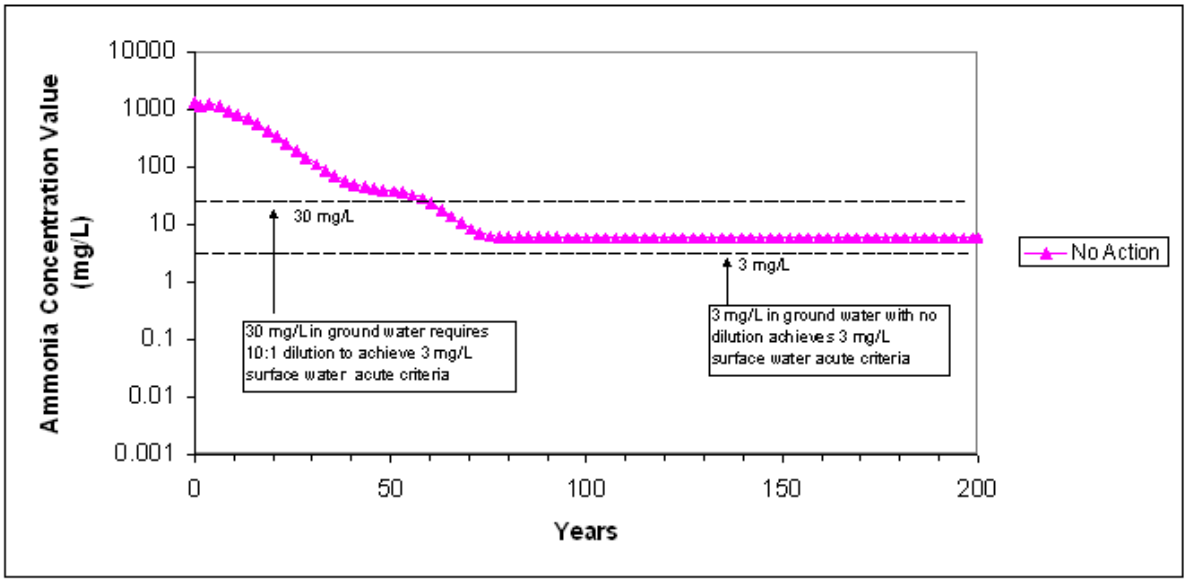

Figure A1−9. Predicted Maximum Ammonia Concentrations in Ground Water for the No Action Alternative

No species would be adversely affected at proposed off-site disposal locations, at borrow areas, or in the proposed transportation corridors under the No Action alternative.

A1−9.5 Conclusions

When the Moab site was assigned to DOE (October 2000) for remediation under UMTRCA, DOE considered the effects of existing contaminated media at the Moab site and determined that ground water is the only medium providing an exposure pathway. DOE further determined that ground water contamination reaching the Colorado River is presenting unacceptable risk to endangered species and critical habitat—in this case, four endangered fish species. Therefore, the conclusions presented below compare remediation alternatives considered in this BA and in the EIS in light of the determinations presented in Sections A1−9.1 through A1−9.4 for aquatic and terrestrial species.

On-Site and Off-Site Surface Disposal Alternatives

For the on-site surface disposal alternative, DOE has concluded that the proposed action would have no effect, or would be unlikely to adversely affect, terrestrial and aquatic consultation species.

For the off-site surface disposal alternatives, DOE has concluded that remediation activities at the proposed disposal locations and along transportation routes would result in no effect, or would be unlikely to adversely affect, terrestrial and aquatic consultation species. DOE may need to complete additional biological investigations and field surveys for terrestrial species, depending on the disposal location and transportation corridor selected in the ROD.

Of the off-site disposal locations, the White Mesa Mill site would be the least likely to affect terrestrial consultation species. The Klondike Flats site also would present minimal potential impacts. BLM has conducted extensive studies in this area, and none of the consultation species are known to occur in the vicinity. Further, placing a disposal facility at the Klondike Flats site would be consistent with existing land uses (e.g., county landfill). The Crescent Junction site is similar to the Klondike Flats site in that none of the consultation species are known to occur in the vicinity.

Of the transportation options, the slurry pipeline would present the greatest potential for affecting terrestrial consultation species, due to the need for new disturbance associated with pipeline construction, operation, and removal. Of the three pipeline corridors, the corridor to the White Mesa Mill site would present the greatest potential for adverse effects due to the diversity of habitat types present (see Section A1−8.1). It would also be the corridor requiring the greatest level of effort for additional field surveys and biological investigations.

In a comparison of the disposal alternatives, the on-site alternative would be less likely to affect terrestrial and aquatic consultation species. In the near term (75–80 years), the effect on aquatic species is similar for the on-site and off-site disposal alternatives; ammonia concentrations in ground water will exceed ammonia criteria unless ground water remediation takes place. By moving the tailings pile to an off-site location, ground water concentrations are predicted to fall below federal and state criteria in 75 years, about 5 years sooner than if the pile remains on site.

Ground Water Remediation

DOE is proposing ground water remediation under both the on-site and off-site disposal alternatives. Based on consultation with USF&WS and other cooperating agencies, the long-term benefits to endangered fish species as a result of remediation would outweigh the potential discountable short-term effects on terrestrial consultation species.

During the pre-remediation phase (within 10 years of the ROD), DOE would continue interim actions to reduce the risk to endangered fish. DOE projects that remedial actions would reduce concentrations of contaminants to levels that would no longer pose a risk that could result in a "take." This would require from 10 to 80 years following the ROD for on-site disposal, and from 10 to 75 years following the ROD for off-site disposal. Remedial actions would continue until contaminant concentrations no longer posed a risk under natural conditions. This post-remediation phase is currently projected to commence at approximately 80 years after the ROD for on-site disposal and approximately 75 years after the ROD for off-site disposal.

In a comparison of ground water remediation under the disposal alternatives, off-site disposal would be slightly more favorable for aquatic consultation species.

No Action Alternative

No adverse effects on terrestrial species would be likely to occur at off-site disposal or borrow locations or along transportation routes under this alternative. No adverse impacts to terrestrial species would be likely to occur as a result of historical site operations (i.e., elevated contaminant concentrations in surface water). However, adverse impacts caused by historical site operations would continue to affect endangered fish species and critical habitat. This unmitigated effect would likely result in a long-term "take" and would not be consistent with USF&WS recovery plans.

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- Utah Department of Wildlife Resources, Moab

- U.S. Fish and Wildlife Service, Salt Lake City
- Utah Department of Wildlife Resources, Price

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Appendix A2

Screening of Contaminants to Aquatic and Terrestrial Resources

A2−1.0 Introduction

Environmental consequences to aquatic and terrestrial species near the Moab site northwest of Moab, Utah, were assessed using data collected to estimate contaminant concentrations in the surface waters of the nearshore environment adjacent to and immediately downstream of the tailings pile. Contaminant data from the freshwater aquifer that underlies the tailings pile were also used to understand the source of contaminants in the surface water.

The assessment involved determining which contaminants of potential concern exceed detection limits and background samples, assessing the relevance of the sample location to biotic exposure, and comparing the contaminant concentrations to ecotoxicological screening benchmarks. Environmental consequences to aquatic biota are discussed first, followed by terrestrial biota.

Results of this assessment are used to support the BA of federally listed threatened and endangered species (Appendix A1). However, the species evaluated here are relatively common species of wildlife and fish for which toxicological benchmarks were available. Similar toxicity data are generally not available for threatened and endangered species. Consequently, in cases where threatened or endangered species may be exposed to contaminants, the BA utilizes species evaluated here as surrogates.

Results of this assessment are also used to support alternative evaluations of environmental consequences in Chapter 4.0 of the EIS.

A2−1.1 Screening of Contaminant Data for Aquatic Biota Assessment

The aquatic environment at the Moab site is mainly associated with the Colorado River. The Moab site is a former uranium-ore processing facility located on the west bank of the Colorado River at the confluence with Moab Wash, an ephemeral stream that runs from the northwest to the southeast, bisecting the site (Figure A2−1). The wash is adjacent to or near the eastern edge of the tailings pile on the site. The tailings pile and other decommissioned facilities on the site are the source of chemical contamination discharging into the Colorado River.

There are two principal plumes in the ground water from past activities at the Moab site: the millsite area plume, and the tailings area plume. The millsite plume is contaminated from mill wastes buried near the river upstream of the Moab Wash. The tailings area plume moves contaminants to the ground water from leachate that comes from the pile. The primary exposure route for contaminants to the aquatic environment is through the ground water.

The analysis for screening of contaminants for impacts to aquatic biota is divided into chemical and radiological impacts. Chemical contaminants have toxicological effects based on the activity of the contaminant in the organism. Radiological impacts have effects based on the energy released from the radioisotope when the organism uptakes that element. A contaminant may have both a chemical and radiological impact.

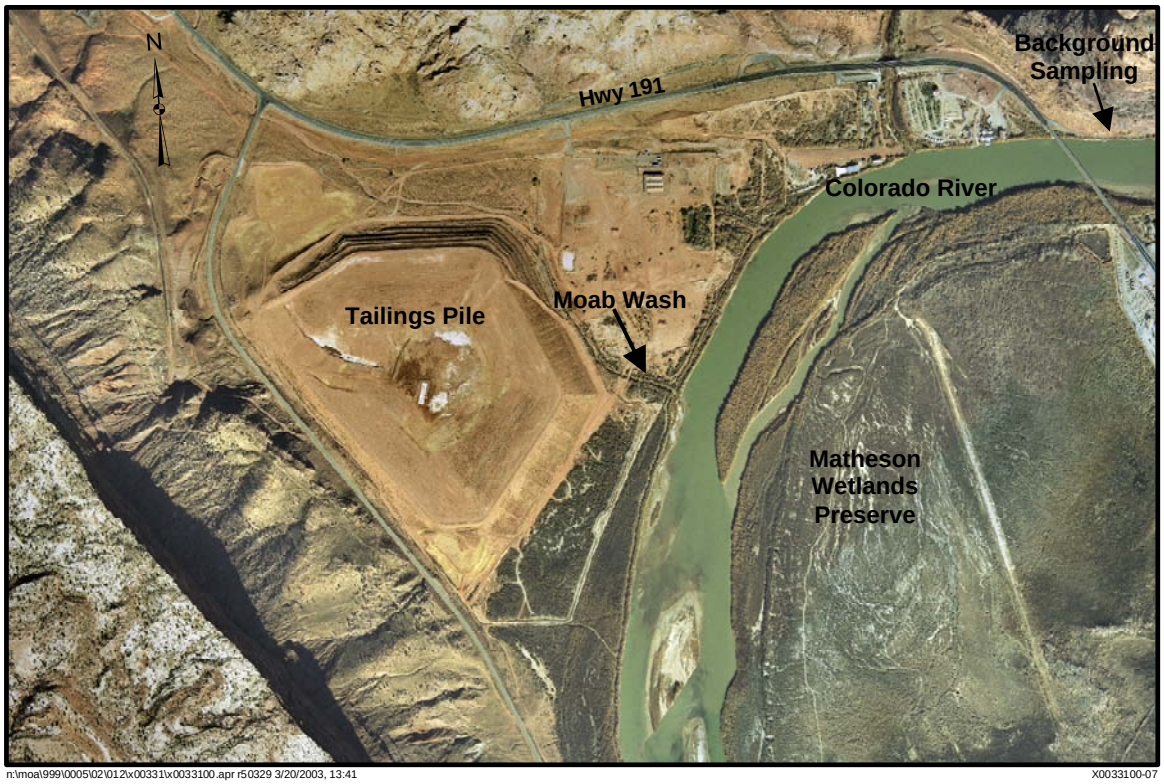

Figure A2−1. Aerial view of the Moab site in 2001 identifying the locations of the tailings pile, Moab Wash, Colorado River, upstream background sampling location, and the Matheson Wetlands Preserve

Chemical Impacts. The aquatic environment near the site has been characterized (Chapter 3.0). Monitoring programs have included sampling sediment, fish tissue, and surface water near the Moab site and upstream environment. Sediment samples of the Colorado River were collected from 1995 through 1997; however, those samples were not considered in this analysis based on 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 the fish tissue samples also were not considered in this analysis based on comments of data quality similar to those made about sediment samples in the Final Biological Opinion of NRC's final EIS (NRC 1999). Based on an evaluation of the means and standard deviation for all the combined fish tissue data, the results do 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 presented in this section is based on surface water samples collected by 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* (SOWP) (DOE 2003). USGS collected water sample data from 1998 through 2000; these data 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 data evaluation.

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, the NRC EIS (NRC 1999), and the Notice of Intent for this EIS published in the *Federal Register* (67 FR 77969 [2003]). Surface water monitoring data were evaluated to determine if estimated concentrations were above detection limits, background levels, and federal and state criteria for surface water quality (i.e., benchmarks) (Figure A2−2). Data on background ground water samples were taken from information provided in Chapter 5.0 and Appendix C of the SOWP (DOE 2003).

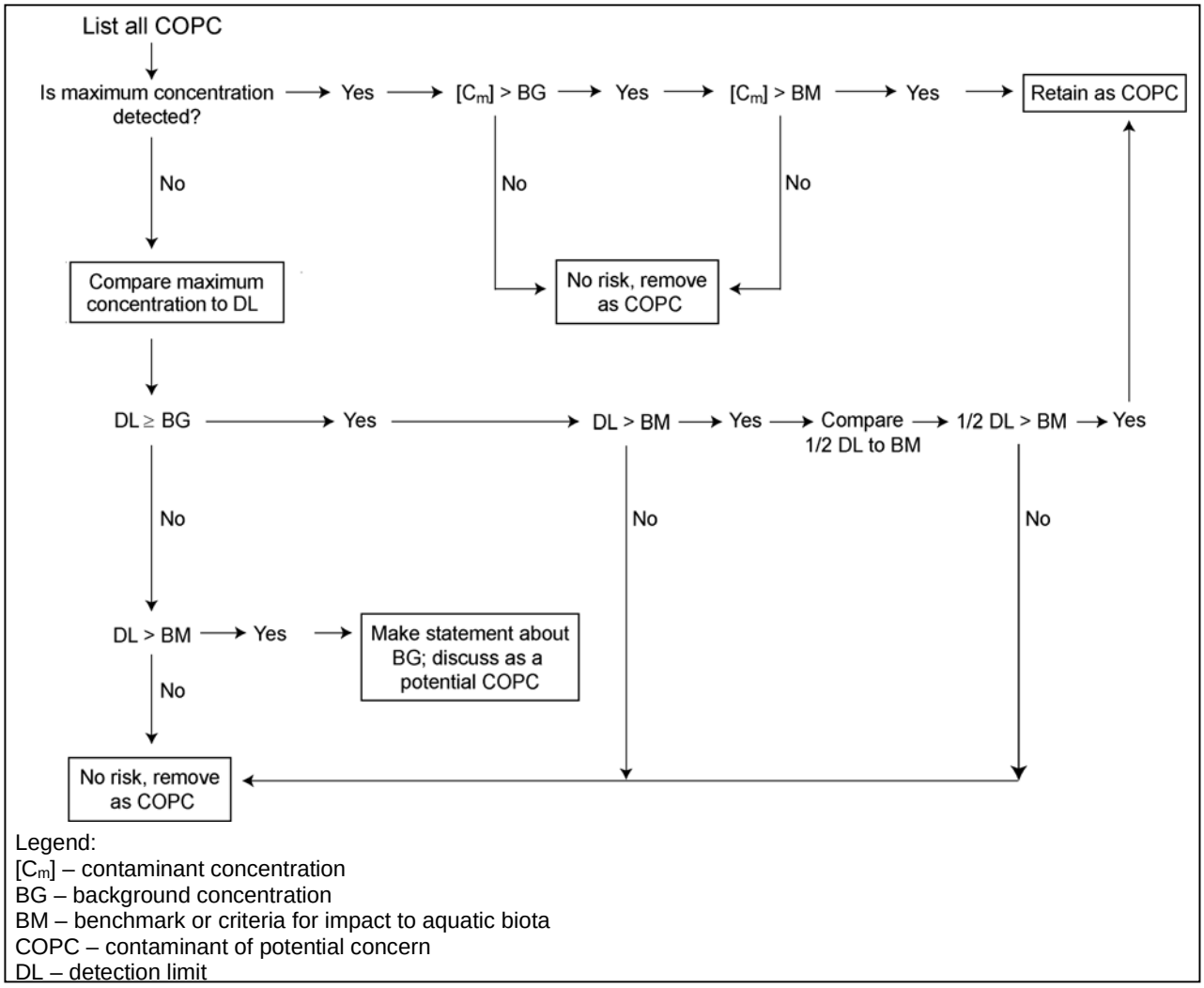

Figure A2−2. Evaluation of Contaminants of Potential Concern for Chemical Impacts to Aquatic Biota at the Moab Site

The 2000 through 2002 chemical constituent surface water data set was examined first to determine which sample results exceeded the detection limit set by the laboratory (Figure A2−2). If an analyte was not detected, the laboratory reported a value equal to the method detection limit. Analytes not detected were assessed using values corresponding to one-half the method detection limit, based on EPA protocol (EPA 2001a, 2001b). The maximum concentration for the contaminant at any location or time was then compared to the maximum background

concentration (Table A2−1). Two upstream locations were considered as background stations for the Moab site. These background stations were within 15 ft of each other (see Figure A2−1). If a given contaminant was not detected in any background sample, then one-half the reported detection limit was used in the evaluation. Finally, the maximum concentration above background was compared to benchmarks for evaluating impacts to aquatic biota (Table A2−2).

Benchmarks for the contaminants at the Moab site included the NWQC (EPA 2002) and proposed State of Utah water quality criteria (UAC 2003). Water quality standards are the foundation of a water-quality-based control program. Standards are mandated by the Clean Water Act (33 U.S.C. 1251 et seq.). Water quality standards define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. Utah's water quality standards are applicable to "waters of the State." Utah water quality standards apply to all waters within the state, with the exception of those waters that are within Indian Country, as defined in 18 U.S.C. Section 1151. Thus, the standards set for Utah, including the federal standards, were used for this assessment. However, the contaminants of potential concern included contaminants for which neither federal nor state criteria are established; therefore, criteria established by Suter and Tsao (1996) for aquatic biota were used. Suter and Tsao (1996) provide a compilation of aquatic toxicity values, including National Ambient Water Quality Criteria, derived Tier II values (secondary chronic and acute values), and chronic values from a variety of other government sources.

Impacts to aquatic organisms can result from either acute or chronic exposures to contaminants of potential concern. 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. As mentioned above, 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 a smaller data set than required by EPA in the NWQC. Also, they developed estimated lowest chronic values for fish extrapolated from laboratory studies. Therefore, the standards from Suter and Tsao (1996) can be overly conservative and could not always be used for this analysis. These limits are discussed within the constituent-by-constituent discussions that follow.

The 2000 through 2002 surface water data were compared to the ecotoxicological screening benchmarks (Table A2−3). This comparison further pared the list of contaminants of potential concern for assessing potential impacts to aquatic biota. Contaminants were not considered further when (1) the maximum concentration and maximum background concentration were below detection and below all benchmarks, and (2) the maximum concentration was less than all the benchmarks (Table A2−3). The contaminants that were retained were further evaluated based on the number of samples, location of the samples, and the relevance of the flow regime at the time of sampling in comparison to the potential for exposure to aquatic biota.

Table A2−1. Minimum, Maximum, Background Range, Total Number of Samples, and Number of Samples Above Detection Limit for Contaminants of Potential Concern at the Moab Site, Utah (2000–2002 data)

Contaminant of Potential Concern	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)	Background Concentration Range (mg/L)	Total Number of Samples	Number of Samples above Detection Limit
Aluminum	0.005	0.348[a]	0.008–0.14	182	84
Ammonia[b]	0.05	1440	0.05–0.134	266	266
Antimony	<0.001	0.0005[c]	0.0005[c]	62	0
Arsenic	<0.006	0.002[d]	<0.0006–0.002	71	42
Barium	0.002	0.211	0.051–0.14	186	185
Beryllium	<0.0001	0.00005[c]	0.00005[c]	3	0
Bismuth	<0.001	0.0005[c]	0.0005[c]	3	0
Boron	0.064	1.74	<0.0801–0.123	76	65
Cadmium	<0.0001	0.004	<0.00005[c]	114	11
Chloride	22	17300	25–172	301	301
Chromium	<0.0005	0.0005[c]	<0.0005–<0.0013	62	1
Copper	<0.00049	0.051[a]	<0.0006–<0.0014	182	61
Gross Alpha	1.1	665.45	7.31–13.82	93	
Iron	<0.003	7.23	0.0075–4.17	119	73
Lead	<0.0008	0.0005[c]	0.00005[c]	104	0
Lithium	0.0552	0.31[d]	0.057[d]	18	15
Manganese	0.0005	12	<0.003–0.076	260	147
Mercury	<0.0002	0.002[a]	0.00005[c]	96	1
Molybdenum	<0.001	1.91	<0.0028–0.007	290	275
Nickel	<0.0006	0.052	<.0006–0.002	56	19
Nitrate	0.829	21.7	1.86–5.51	76	75
pH	6.83	8.89	7.38–8.6	423	NA
Selenium	<0.0005	0.026	0.0013–0.0079	216	206
Silver	<0.00005	0.0025[c]	0.000025–0.00005[c]	63	0
Strontium	0.005	10.2	0.965–1.63	136	133
Sulfate	72	14400	84.1–439	301	290
Thallium	<0.001	0.0005[c]	0.0005[c]	63	21
Uranium	0.0013	5.12	0.0023–0.008	331	331
Vanadium	0.0003	0.249	0.00073–0.0031	148	132
Zinc	<0.0008	0.023	<0.0017–0.006	112	50

[a]Analyte is estimated, based on laboratory qualifier.
[b]All ammonia samples were converted for this assessment to total ammonia as nitrogen.
[c]All analytes were below detection; maximum value based on one-half of detection limit.
[d]Analytes in data set represent multiple detection limits. Analytes above this value are below detection limits.

Table A2−2. Chemical Benchmarks for Assessing Potential Impacts to Aquatic Organisms From Inorganic Contaminants of Potential Concern at the Moab Site, Utah (2000–2002 data)

Contaminant of Potential Concern	National Recommended Water Quality Criteria[a]		Utah State Water Quality Criteria[b]		Suter and Tsao (1996)		
	Acute	Chronic	Aquatic Wildlife 3B-Acute	Aquatic Wildlife 3B-Chronic	Tier II Acute	Tier II Chronic	Lowest Chronic
Milligrams per liter (mg/L) unless otherwise noted							
Aluminum	0.75[c]	0.087[c]	0.75[c]	0.087[c]			3.288
Ammonia	[d]	[e]	[d]	[e]			1.7
Antimony					0.18	0.03	1.6
Arsenic	0.34[g]	0.15[g]	0.34[f,g]	0.15[f,g]	0.066	0.0031	0.892
Barium					0.11	0.004	
Beryllium					0.035	0.00066	0.057
Bismuth							
Boron					0.03	0.0016	
Cadmium	0.002[g,h]	0.00025[g,h]	0.0039[g,h]	0.0011[g,h]			0.0017
Chloride	860	230					
Chromium[i]	0.016[g]	0.011[g]	0.016	0.011			0.07318
Copper	0.013[g,h]	0.009[g,h]	0.018[g,h]	0.012[g,h]			0.0038
Gross Alpha			15 pCi/L	15 pCi/L			
Iron[j]		1	1	1			1.3
Lead	0.065[g,h]	0.0025[g,h]	0.082[g,h]	0.0032[g,h]			0.01888
Lithium					0.26	0.014	
Manganese					2.3	0.12	1.78
Mercury	0.0014[g]	0.00077[g]	0.0024	0.000012		0.0013	< 0.00023
Molybdenum					16	0.37	
Nickel	0.47[g,h]	0.052[g,h]	1.40[g,h]	0.16[g,h]			< 0.035
Nitrate			4	4			
pH			6.5–9.0	6.5–9.0			
Selenium		0.005[k]	0.0184[g]	0.0046[g]			0.08832
Silver	0.0032[g,h]		0.0041[g,h]			0.00036	0.00012
Strontium					15	1.5	
Sulfate							
Thallium					0.11	0.012	
Uranium					0.046	0.0026	0.142
Vanadium					0.28	0.02	0.08
Zinc	0.12	0.12	0.12	0.12			0.03641

[a]National Recommended Water Quality Criteria are based on EPA 2002 except for ammonia, which is based on EPA 1999.
[b]Changes and updates to the Utah State Water Quality Standards as of November 2003 (UAC 2003).
[c]Aluminum is expressed in terms of total recoverable metal in the water column.
[d]Refer to EPA 1999 and UAC 2003 for calculation of pH and life-stage-dependent chronic ammonia benchmarks.
[e]Refer to EPA 1999 and UAC 2003 for calculation of pH, temperature, and life-stage-dependent chronic ammonia benchmarks.
[f]Arsenic values based on arsenic V.
[g]Criteria for metals are expressed in terms of dissolved metal in the water column.
[h]Criteria are expressed as a function of hardness. The value listed corresponds to a hardness of 100 mg/L.
[i]Chromium values based on chromium (VI).
[j]Criteria are for dissolved iron.
[k]Criteria for selenium are expressed in terms of total recoverable metal in the water column.

Table A2−3. Comparison of Contaminants of Concern to Associated Benchmarks for Aquatic Biota at the Moab Site (page 1 of 2)

Contaminant of Potential Concern	Sample Location for Maximum Concentration	Maximum Concentration (in mg/L)	Number of samples above Acute NWQC Benchmark [a]	Number of samples above Chronic NWQC Benchmark [a]	Number of Samples above Utah Wildlife 3B-Acute Benchmark [b]	Number of Samples above Utah Wildlife 3B-Chronic Benchmark [b]	Number of samples above Acute Tier II Benchmark [c]	Number of samples above Chronic Tier II Benchmark [c]	Number of samples above Lowest Chronic Benchmark [c]	Comments on Contaminant of Potential Concern
Aluminum	CR2-BX	0.348 [d]	0	2	0	2	NA	NA	0	Measured Concentration above background and NWQC chronic benchmark. Background above Chronic Tier II. Retain as COPC.
Ammonia	CR2-BX	1440	[e]	[f]	[e]	[f]	NA	NA	[f]	Measured concentrations above background and benchmarks. Retain as COPC.
Antimony	NA	0.0005 [g]	NA	NA	NA	NA	0	0	NA	Measured concentration and background are below detection limits. Half detection limit is below all benchmarks. Not retained as COPC.
Arsenic	CR2-BX	0.002 [h]	0	0	0	0	0	0	0	Two samples above detection limit and background. Measured concentration below all benchmarks. Not retained at COPC.
Barium	Moab Wash	0.211	NA	NA	NA	NA	4	4	NA	Measured concentration above background and Tier II acute and chronic benchmark. Background above Acute and Chronic Tier II. Retain as COPC.
Beryllium	NA	0.00005 [g]	NA	NA	NA	NA	0	0	NA	Measured concentration and background are below detection limits. Half detection limit is below all benchmarks. Not retained as COPC.
Bismuth	NA	0.0005 [g]	NA	NA	NA	NA	NA	NA	NA	Measured concentration and background are below detection limits. Measured concentration detection limit is the same as the background detection limit. Not retained as COPC.
Boron	0206	1.74	NA	NA	NA	NA	9	9	NA	Measured concentration above background and Tier II acute and chronic benchmark. Background above Acute and Chronic Tier II. Retain as COPC.
Cadmium	CR2BX	0.004	3	10	1	4	NA	NA	3	Measured concentration above background and multiple acute and chronic benchmarks. All background is below detection limit. Half detection limit for background samples is below all benchmarks. Retain as COPC.
Chloride	0206	17300	13	13	NA	NA	NA	NA	NA	Measured Concentration above background and NWQC acute and chronic benchmark. Retain as COPC.
Chromium	NA	0.0005 [g]	0	0	0	0	NA	NA	0	Measured concentrations below detection limit and below background. Not retained as COPC.
Copper	CR2-BX	0.051 [d]	9	16	5	9	NA	NA	21	Measured concentration above background and multiple acute and chronic benchmarks. Retain as COPC.
Iron	CRD	7.23	NA	13	13	13	NA	NA	13	Measured Concentration above background and all benchmarks. Background above all benchmarks. Retain as COPC.
Lead	NA	0.0005 [g]	0	0	0	0	NA	NA	0	Measured concentration and background are below detection limits. Half detection limit is below all benchmarks. Not retained as COPC.
Lithium	CR2B	0.31 [h]	NA	NA	NA	NA	1	11	NA	Measured concentration above background and Tier II acute and chronic benchmark. Background above Chronic Tier II. Retain as COPC.
Manganese	CR2B	12	NA	NA	NA	NA	10	15	10	Measured concentration above background and all benchmarks. Retain as COPC.

[a] NWQC (National Recommended Water Quality Criteria) is based on EPA 2002 except for Ammonia, which is based on EPA 1999.
[b] Utah State Water Quality Criteria is based on UAC 2003.
[c] Suter and Tsao, 1996
[d] Refer to references for calculation of pH and life-stage-dependent chronic ammonia benchmarks.
[e] Refer to references for calculation of pH, temperature and life-stage-dependent chronic ammonia benchmarks.
[f] Analyte is estimated, based on laboratory qualifier.
[g] All analytes were below detection; maximum value based on one-half of detection limit.
[h] Analytes in data set represent multiple detection limits. Analytes above this value are below detection limits.

Table A2−3. Comparison of Contaminants of Concern to Associated Benchmarks for Aquatic Biota at the Moab Site (page 2 of 2)

Contaminant of Potential Concern	Sample Location for Maximum Concentration	Maximum Concentration (in mg/L)	Number of samples above Acute NWQC Benchmark[a]	Number of samples above Chronic NWQC Benchmark[a]	Number of Samples above Utah Wildlife 3B-Acute Benchmark[b]	Number of Samples above Utah Wildlife 3B-Chronic Benchmark[b]	Number of samples above Acute Tier II Benchmark[c]	Number of samples above Chronic Tier II Benchmark[c]	Number of samples above Lowest Chronic Benchmark[c]	Comments on Contaminant of Potential Concern
Mercury	NA	0.002[f]	NA	NA	1	85	NA	1	1	One sample with a measured concentration above the detection limit, background and all benchmarks. Measured concentration in all other samples and background are below detection limits. Half detection limit is above Utah State Chromic wildlife benchmark. Retain as COC.
Molybdenum	CR2-BX	1.91	NA	NA	NA	NA	0	10	NA	Measured concentration above background and Tier II chronic benchmark. Retain as COC.
Nickel	CR2-BX	0.052	0	1	0	0	NA	NA	1	Measured concentration above background and NWQC chronic benchmark. Retain as COC.
Nitrate	CR2B	21.7	NA	NA	36	36	NA	NA	NA	Measured concentration above background and Utah State acute and chronic benchmark. Background above Utah State acute and chronic benchmark. Retain as COC.
Selenium	CR3-10	0.026	NA	7	1	7	NA	NA	0	Measured Concentration above background and above NWQC chronic benchmark and Utah State chronic and acute benchmarks. Background above NWQC chronic and Utah state chornic benchmarks. Retain as
Silver	NA	0.0025[g]	1	NA	1	NA	NA	2	33	Measured concentrations and background are below detection limit. Half detection limit for one sample is above Tier II chronic and lowest chronic benchmarks. Half detection limit in remaining samples and background are below all benchmarks. Retain as COC.
Strontium	CR3-001	10.2	NA	NA	NA	NA	0	19	NA	Measured concentration above background and Tier II chronic benchmark. Background above chronic Tier II. Retain as COC.
Sulfate	CR2-BX	14400	NA	NA	NA	NA	NA	NA	NA	Measured concentration above background. Retain as COC
Thallium	CRBA	0.0005[g]	NA	NA	NA	NA	0	0	NA	Measured concentration and background are below detection limits. Half detection limit is below all benchmarks. Not retained as COC.
Thorium	CR4	1.7[i]	NA	NA	NA	NA	NA	NA	NA	Measured concentration is below background and all benchmarks. Not retained as COC.
Uranium	Moab Wash	5.12	NA	NA	NA	NA	42	263	16	Measured Concentration above background and above Tier II acute and chronic benchmarks and lowest chronic benchmark. Background above Tier II chronic benchmark. Retain as COC.
Vanadium	MWSeep	0.249	NA	NA	NA	NA	0	2	2	Measured concentration above background and above Tier II chronic and lowest chronic benchmarks. Retain as COC.
Zinc	CR2-BX	0.023	0	0	0	0	NA	NA	0	Measured concentration above background and below all benchmarks. Not retained as COC.

[a]NWQC (National Recommended Water Quality Criteria) is based on EPA 2002 except for ammonia, which is based on EPA 1999.
[b]Utah State Water Quality Criteria is based on UAC 2003.
[c]Suter and Tsao 1996
[d]Refer to references for calculation of pH and life-stage-dependent chronic ammonia benchmarks.
[e]Refer to references for calculation of pH, tenperature and life stage dependent chronic ammonia benchmarks.
[f]Analyte is estimated, based on laboratory qualifier.
[g]All analytes were below detection; maximum value based on one-half of detection limit.
[h]Analytes in data set represent multiple detection limits. Analytes above this value are below detection limits.
[i]Analyte detected in both the sample and the associated blank.

The 1998 through 2000 data summarized 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) were also examined. Results presented in the USGS report indicate that the pile represents a localized source of ground water input containing elevated levels of contaminants, including copper, manganese, zinc, and radiochemicals. These contaminants were measured at levels that exceeded benchmarks during the low-water hydrologic period ranging from August through March. Based on the results of this study, USGS summary data for copper, manganese, zinc, and total alpha were evaluated using the process previously described (see Figure A2−2). These results are discussed where applicable within the constituent-by-constituent discussions that follow.

Toxicity of contaminants of potential concern is often related to water quality. The following discussions summarize water quality parameters that are considered in further discussions on the contaminants of potential concern.

Water Quality Parameters

pH. The measure of pH is an indicator of overall water quality. Aquatic organisms can be sensitive to large fluctuations in pH. However, gradual changes in pH may not affect organisms except to change the potential toxicity of other contaminants (e.g., ammonia). Twenty-nine surface water samples were collected at background locations; sample pH ranged from 7.38 to 8.6. Surface water samples near the Moab site had a pH between 6.83 and 8.89. The range of pH is within the State of Utah water quality criteria (UAC 2003). Continued monitoring of pH during the collection of surface water would be necessary to ensure protection of aquatic biota.

Temperature. Surface water temperature varies seasonally and diurnally, especially at low-flow conditions. There were 269 measures of temperature for surface water samples collected from 2000 to 2002. The temperature measurements ranged from 3.0 to 34.6 ^{o}C (37.4 to 94.3 ^{o}F). The maximum temperature for the Moab reach of the Colorado River was 27 ^{o}C (UAC 2003). Forty-two measurements along the shoreline near the tailings pile were above the standard for maximum temperatures. Most measurements were recorded during a 2-day period in July 2000; a few were made in April through August. The measurements were often in shallow pools along the edge of the river and islands in the river (e.g., CRBBY1; see locations in Figure A2–3). Continued monitoring of temperature during the collection of surface water samples would be necessary to ensure protection of aquatic biota.

Hardness. In general, hardness is a measure of the divalent metallic ions in surface water. The primary contributors to hardness are typically calcium and magnesium; however, the geological system can contribute other ions that are measured by a total hardness analysis. Hardness is related to the toxicity of many heavy metals; as hardness increases, the effect of the toxicity due to the metal decreases (EPA 2002). Examples of such metals include cadmium, copper, and nickel. USGS measured total hardness as part of its site-specific assessment of the effect of ammonia on endangered fish in the Colorado River adjacent to the Moab site. The measurements were made during three sampling events in September 1999, February 2000, and August 2000. The background locations had a range of total hardness from 140 to 700 mg/L as $CaCO_3$, and an average of 416 mg/L as $CaCO_3$. Total hardness as $CaCO_3$ in samples collected along the shoreline near the Moab site ranged from 320 to 512 mg/L and averaged 378 mg/L. Continued monitoring of hardness during the collection of surface water samples would be necessary to ensure protection of aquatic biota.

Total Dissolved Solids. Salinity alone can be toxic to many aquatic species. Total dissolved solids in excess of 15,000 mg/L are considered unsuitable for freshwater fish (NRC 1999). The toxicity of salinity depends on the ionic composition that produces the salinity (NRC 1999). Pimentel and Bulkley (1983) reported salinity concentrations that were avoided by juvenile Colorado pikeminnow, humpback chub, and bonytail. They found that Colorado pikeminnow avoided total dissolved solids above 4,400 mg/L, humpback chub avoided concentrations above 5,100 mg/L, and bonytail avoided concentrations above 6,600 mg/L. The background surface water concentration for total dissolved solids ranges from 430 to 1,060 mg/L (12 samples). Background ground water concentrations range from 677 to 97,014 mg/L total dissolved solids. The mean ground water concentration in the fresh Qal facies is 4,450 mg/L, and the mean concentration in the brine Qal facies is 51,400 mg/L. Concentrations of total dissolved solids in 29 of the 76 surface water samples collected near the Moab site were above the maximum background surface water concentration. Four of the 29 samples had concentrations that were above the levels found to cause avoidance behavior. The proposed State of Utah water quality standards (UAC 2003) provide for total dissolved solids in the surface water to be at background. Continued monitoring of total dissolved solids during active ground water remediation would be necessary to ensure protection of aquatic biota.

Contaminants of Potential Concern

The following is an evaluation of each contaminant of potential concern retained after the evaluation of surface water sampling results (Table A2−3).

Aluminum. Aluminum is a heavy metal with numerous valence states that vary according to the environment (e.g., pH and oxygen concentration). At a pH similar to that of Colorado River water near the Moab site (ranging from 6.8 to 8.9), aluminum is not very toxic to aquatic biota such as fish and amphibians (Hoffman et al. 1995). Aluminum was not detected in background ground water samples. Twelve background surface water samples were collected from 2000 to 2002 with values ranging from 0.008 to 0.14 mg/L (DOE 2003 and Chapter 3.0 of the EIS). Only two of 182 surface water samples had aluminum concentrations that exceeded the NWQC and State of Utah chronic benchmarks; the maximum background concentration also exceeded the State of Utah chronic benchmark. The State of Utah chronic criterion does not apply to waters with a pH equal to or greater than 7.0 and hardness equal to or greater than 50 mg/L as $CaCO_3$ in the receiving water after mixing. The pH and hardness values for Colorado River water near the Moab site indicate that aluminum is regulated by the acute aluminum criteria, which were not exceeded. Based on (1) the lower toxicity of aluminum in waters with high pH and hardness, (2) the low number of samples with aluminum concentrations that exceeded chronic benchmarks, and (3) the background surface water concentration, an acute or chronic effect resulting from aluminum only from the Moab site is not likely. Thus, the potential impacts to aquatic resources from exposure to aluminum are small, and further assessment is not warranted.

Ammonia. Ammonia is a form of nitrogen that is highly toxic to aquatic biota. The toxicity of ammonia is related to the ammonia ionization, which is a function of pH and temperature. Ionized ammonia (NH_4^+) is not as toxic as the un-ionized form (NH_3) (Hoffman et al. 1995). Short exposures of fish to high concentrations of ammonia (acute conditions) can cause increased gill ventilation, hyperexcitability, convulsions, and death. These effects are likely a direct effect of ammonia on the central nervous system. Long-term exposure of fish to lower concentrations of ammonia (chronic conditions) can cause histological changes, decreased reproductive capacity, decreased growth and morphological development, and increased

susceptibility to disease in fish (Rand and Petrocelli 1985). Ammonia in the ground water at the Moab site is from operations associated with the extraction of uranium.

Concentrations of ammonia in surface water samples exceed acute and chronic benchmarks at numerous locations along the shoreline at the Moab site. Acute criteria for ammonia vary as a function of pH, and the chronic criteria for ammonia vary as a function of pH and temperature. The federal and state criteria are calculated on the basis of the presence or absence of salmonids (i.e., salmon or trout) and early life stages of fish. The most applicable calculations for ammonia and aquatic organisms in the Colorado River are for the absence of salmonids and the presence of early life stages of fish. Table A2−2 does not include numerical values for federal or state criteria because the benchmark for ammonia can vary greatly according to temperature and pH, which can change dramatically during even a 1-day period. Temperature and pH measurements taken simultaneously with samples for ammonia analysis from 2000 to 2002 produced federal acute criteria that ranged from 1.06 to 39.0 mg/L total ammonia. The same process resulted in federal chronic criteria that ranged from 0.29 to 5.34 mg/L total ammonia. Further information on the calculation of ammonia criteria is discussed in Appendix D of the SOWP (DOE 2003). Figure A2−3 shows the distribution of total ammonia in the surface water at the Moab site.

USGS conducted a site-specific risk assessment to determine if ground water entering the Colorado River from beneath the tailings pile could affect the endangered Colorado pikeminnow and razorback sucker (USGS 2002). Results indicate that during the low-flow period from August to March, ammonia levels exceed State of Utah standards. The area of contamination varies with hydrologic regime but in general is confined to an area less than 6,000 square yards (yd^2). USGS found that the highest observed concentrations of ammonia occur at river flows of less than 5,000 cfs during the late summer, fall, and winter months. Flows above 5,000 cfs dilute ammonia concentrations to levels below those of toxicological concern.

Toxicity tests performed as part of the USGS risk assessment indicated that Colorado pikeminnow, razorback sucker, and fathead minnow had a 28-day lowest observed effect concentration (LOEC) value for mortality ranging from 2.19 to 4.35 mg/L total ammonia (pH = 8.25 and temperature = 25 °C). USGS estimated effects on individuals at concentrations as low as 0.17 mg/L un-ionized ammonia. Toxicity tests also indicate there were no differences in toxicity across pH within a given temperature. They found that Colorado pikeminnow were more sensitive to ammonia at lower temperatures (8 °C) than at an average condition (18 °C). On-site toxicity tests demonstrated that site waters were directly toxic to both the endangered Colorado pikeminnow and the fathead minnow.

USGS also conducted surveys above and below Moab Wash to determine if ammonia or other ground water constituents were influencing the invertebrate food resources. Results indicate that the benthic invertebrate community distribution was not affected by ammonia concentrations.

Comparisons of laboratory and field results indicate that ammonia is the primary contaminant of concern due to high exposure and rapid onset of toxicity. Metals and radiochemicals, although sometimes elevated above benchmarks, did not contribute to toxicity. Continued monitoring of ammonia levels during ground water remediation would be necessary to ensure protection of aquatic biota. Ammonia would be assessed further during proposed active ground water remediation.

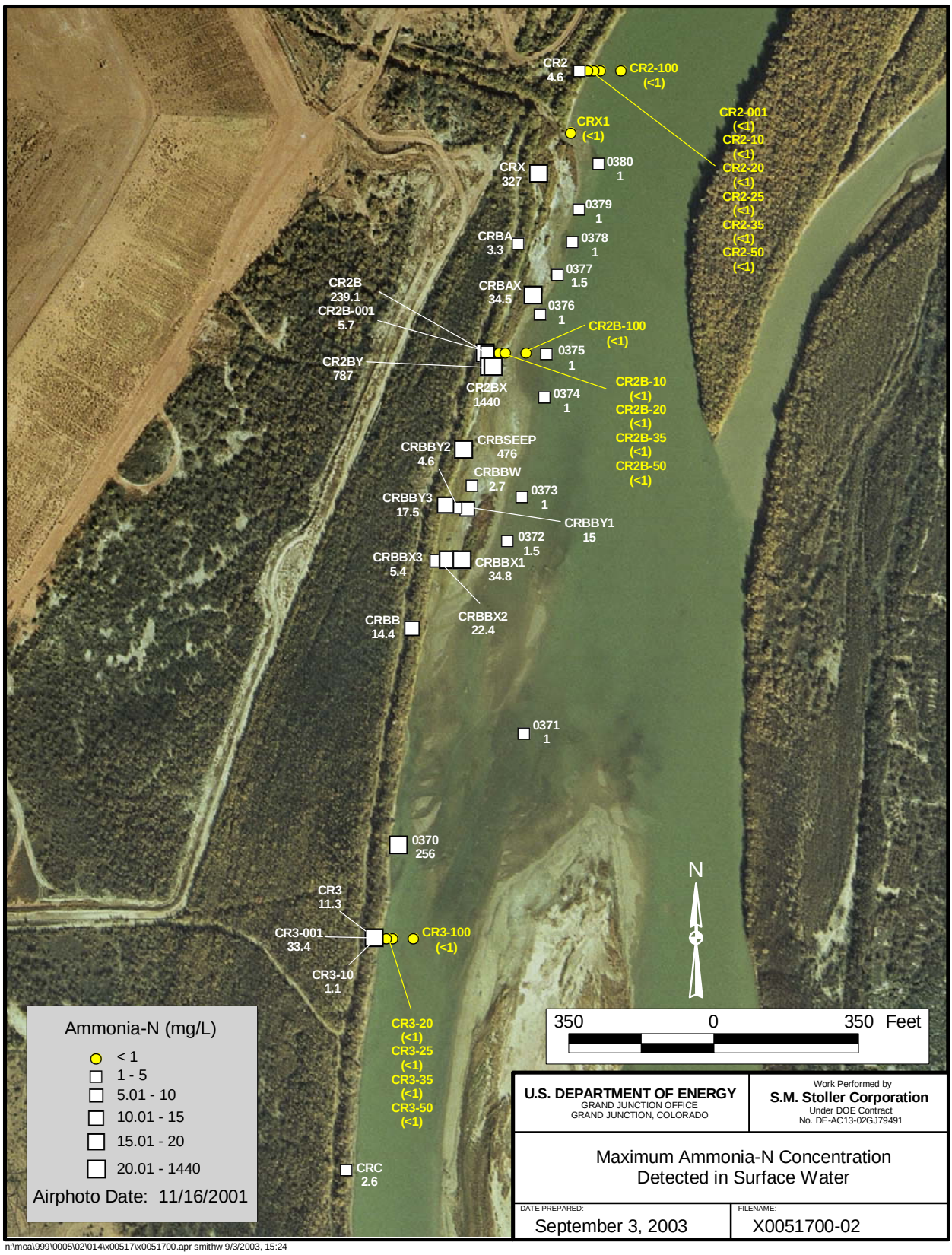

Figure A2−3. Sampling Results for Ammonia in Surface Water at the Moab Site

Barium. Barium is a silvery-white metal that reacts readily with water to form barium hydroxide ($Ba(OH)_2$) and hydrogen gas. The toxicity of barium to fish is not well documented. The toxicity of barium to mammals ranges from muscular paralysis to cardiovascular effects (EPA 2003). Barium is concentrated in the bone, the choroids of the eye, and the lung of mammals (Hope et al. 1996). Background ground water concentrations near Moab range from 0.0222 to 0.121 mg/L. The mean concentration in the fresh Qal facies is 0.028 mg/L, and the mean concentration in the brine Qal facies is 0.076 mg/L (DOE 2003 and Chapter 3.0 of the EIS). There are no federal or state surface water quality criteria for protection of aquatic species for barium. Maximum background ground water concentrations exceed Tier II chronic criteria. Background surface water concentrations range from 0.051 to 0.14 mg/L. All 13 of the background surface water samples exceed Tier II chronic criteria, and one of the samples exceeds Tier II acute criteria. Four of the 186 surface water samples taken near Moab had barium concentrations that were above background and Tier II acute and chronic criteria. Of these four samples, three were taken from the river and one was taken from a seep. One of the river samples (0.182 mg/L) was taken from a 4-ft by 5-ft pool with no flow. The remaining two samples were found near backwater areas during the time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of barium that would cause a chronic impact are unlikely due to changes in river flow. Also, the concentrations in these two samples (0.152 mg/L and 0.155 mg/L) were not substantially different from maximum background concentrations (0.14 mg/L). Based on the background ground water and surface water concentrations, an acute or chronic effect resulting from barium only from the Moab site is not likely. Thus, the potential impacts to aquatic resources from exposure to barium are small, and further assessment is not warranted.

Boron. Boron is widely distributed in the environment and has been found to be essential for the early embryonic development of frogs and may be required for reproduction in some fish (Loewengart 2001). At high doses, it has been reported to be teratogenic in mammals; at lower doses, it has been shown to be an essential micronutrient in vascular plants and lower vertebrate animals (Loewengart 2001). Surface water concentrations in the United States, Canada, and the United Kingdom have mean concentrations from 0.10 to 0.16 mg/L boron (Loewengart 2001). In the western United States, 5 to 15 mg/L may be found in surface waters because of weathering of boron-rich formations and deposits (Loewengart 2001). Background ground water concentrations near the Moab site range from 0.106 to 1.33 mg/L (DOE 2003). Background surface water samples near the Moab site have boron concentrations that range from 0.0801 to 0.123 mg/L. One of the 10 background surface water samples (0.123 mg/L) is above Tier II acute and chronic criteria. Nine of the 76 surface water samples near the Moab site were above background and Tier II acute and chronic criteria. The highest concentration of boron (1.74 mg/L) was collected in January in a seep downstream of the tailings pile. Three of the samples were collected near backwater areas during the time when juvenile endangered fish might be in the region. The five remaining samples were in areas not considered backwater habitat. The conditions necessary for aquatic biota to be exposed to elevated levels of boron that would cause a chronic impact are unlikely due to changes in river flow. Hamilton examined the acute toxicity of boron on swim-up fry and juvenile Colorado pikeminnow, razorback sucker, and bonytail (Hamilton 1995). He found a mean 96-hour lethal concentration 50 (LC_{50}) of 337 mg/L boron. The most sensitive fish life stage was juvenile fish (0.4 to 2.0 grams) of all species with 96-hour LC_{50}s of greater than 100 mg/L boron. Based on the background ground water and surface water concentrations, as well as species-specific laboratory testing, an acute or chronic effect resulting from boron only from the Moab site is not likely. Thus, the potential impacts to aquatic resources from exposure to boron are small, and further assessment is not warranted.

Cadmium. Cadmium is a silvery-white metal that is relatively rare in the environment. It is an essential micronutrient for plants but can be toxic to aquatic organisms at concentrations just slightly higher (EPA 2001c). Toxic effects include pericardial and abdominal edema, reduced growth, and poor yolk utilization in larval and juvenile fish (Rand and Petrocelli 1985). A variety of factors modify the toxicity of cadmium to aquatic organisms. These factors include the species, size, and age of the organism; water hardness; pH; and the other constituents in the water (EPA 2001c). Background ground water concentrations at the Moab site range from less than 0.0001 to 0.014 mg/L. Background surface water concentrations are below detection limits (12 samples collected). Six of the 114 surface water samples collected have cadmium levels above benchmarks. Three of these were above acute NWQC and the State of Utah acute criteria, and six were above the NWQC and State of Utah chronic criteria. Two of the samples above the acute and chronic criteria were collected in the river during July and August. The other sample above acute criteria was collected in a seep in April. The remaining three samples above chronic criteria were collected in the river and in seeps during January and April.

If the NWQC acute criteria for cadmium were corrected for the minimum total hardness determined by USGS from 1999 to 2000 (320 mg/L as $CaCO_3$), then the acute cadmium criteria would increase from 0.002 to 0.006 mg/L cadmium. The State of Utah acute criteria would increase from 0.0039 to 0.013 mg/L cadmium (UAC 2003). A correction for the minimum total hardness for the NWQC chronic criteria would increase from 0.00025 to 0.00055 mg/L cadmium (EPA 2002). The State of Utah chronic criteria would increase from 0.0011 to 0.0024 mg/L cadmium. With these criteria corrected for total hardness, none of the samples collected exceeded the NWQC or State of Utah acute criteria. Five of the samples exceeded the corrected NWQC chronic criteria, and one exceeded the corrected State of Utah chronic criteria. The conditions necessary for aquatic biota to be exposed to elevated levels of cadmium that would cause a chronic impact are unlikely due to changes in river flow.

The mean background ground water concentration measured in the brine Qal facies of the aquifer is 0.004 mg/L cadmium, which is equal to the highest surface water sample concentration. The mean background ground water concentration measured in the fresh Qal facies is 0.0017 mg/L. These ground water concentrations are likely to be contributing to the surface water sample concentrations. Studies have shown that pre-exposure to cadmium leads to an elevation of the acute toxic concentration (Wicklund et al. 1990). Aquatic organisms in the Colorado River have likely been pre-exposed to these elevated levels of cadmium from natural levels in the ground water. The natural ground water concentration, small number of samples with concentrations above benchmarks, and the sample locations and dates indicate that impacts to aquatic resources from cadmium are likely to be small. Thus, the potential impacts to aquatic resources from exposure to cadmium are small, and further assessment is not warranted.

Chloride. Chloride is an anion. The effects of chloride are primarily associated with the complexes of chloride and heavy metals, and in high concentrations, as the main contributor to salinity. The background ground water concentration for chloride ranges from 135 to 52,388 mg/L. The mean background concentration in the fresh Qal facies is 1,990 mg/L, and the mean background concentration in the brine Qal facies is 29,200 mg/L. A shallow ground water sample in the Matheson Wetlands Preserve across the river from the site has concentrations of chloride exceeding 29,000 mg/L (DOE 2003). These concentrations occurring naturally in the ground water are well above the acute NWQC. Chloride was detected in all 20 background surface water samples, with concentrations ranging from 25 to 172 mg/L. Fifty-one surface water samples collected near the Moab site had concentrations above background surface water

concentrations. Thirteen of these samples had concentrations above the acute NWQC, and concentrations in 27 are above the chronic NWQC. Fourteen of the samples with concentrations that exceed benchmarks were collected in pools with little or no flow. The sample with the maximum concentration (17,300 mg/L) was collected in January from a seep. This high concentration indicates that ground water near the Moab site and the Matheson Wetlands Preserve may be influencing surface water concentrations. In the Colorado River Basin, the influence of chloride from natural sources is likely (DOE 2003). Studies indicate that aquatic biota acclimate to increased salinity due to high concentrations of chloride or other anions (Buttner et al. 1993). Aquatic organisms in the Colorado River have likely been pre-exposed to these elevated levels of chloride from natural levels in the ground water. Impacts to aquatic resources from chloride are likely to be small. Thus, the potential impacts to aquatic resources from exposure to chloride are small, and further assessment is not warranted.

Copper. Copper is a micronutrient and an essential component of numerous metabolic pathways and enzymes (Rand and Petrocelli 1985, Magos and Suzuki 1996). Ingestion of copper in excess of nutritional needs can lead to accumulation in the liver, anorexia, edema, disorientation, and scale protrusion (Rand and Petrocelli 1985, Wedemeyer et al. 1976). A variety of factors modify the toxicity of copper to aquatic organisms. These factors include the species, size and age of the organism, water hardness, pH, and the other constituents in the water. Fish, invertebrates, and aquatic plants appear to be equally sensitive to chronic toxicity (EPA 2003). Copper was detected in three of the 13 background surface water samples, with concentrations ranging from 0.0006 to 0.0014 mg/L. Background concentrations in the ground water range from 0.0004 to 0.007 mg/L. Background surface water and ground water concentrations are below all benchmarks. Five of the 182 samples collected for copper had concentrations above acute NWQC and State of Utah acute criteria. Eight had concentrations above chronic NWQC and State of Utah chronic criteria. Three of the samples above the benchmarks were collected in seeps, and the remaining five were collected in the river. The samples were collected near backwater areas during the time when juvenile endangered fish might be in the region.

If the criteria for copper were corrected for the minimum total hardness determined by USGS from 1999 to 2000 (320 mg/L as $CaCO_3$), then the NWQC acute copper criteria would increase from 0.013 to 0.040 mg/L copper (EPA 2002). The State of Utah acute criteria would increase from 0.018 to 0.051 mg/L copper (UAC 2003). A correction for the minimum total hardness for the NWQC chronic criteria would increase from 0.009 to 0.024 mg/L copper (EPA 2002). The State of Utah chronic criteria would increase from 0.012 to 0.030 mg/L copper. With these criteria corrected for total hardness, only one of the samples exceeded the NWQC and State of Utah acute or chronic criteria.

USGS analyzed surface water samples for metals in August 1998, February 1999, and 2000. Results indicate that copper concentrations exceeded the State of Utah water quality criteria at several locations during each sampling event. However, USGS concluded that "concentrations of these constituents [copper and zinc] are transient and do not approach levels demonstrated in the laboratory as acutely toxic to razorback suckers or Colorado pikeminnow" (USGS 2002).

Copper has been found to be the primary toxic component of mixtures of contaminants similar to those found at the Moab site (Buhl and Hamilton 1996). Copper has also been implicated as a potential site-related contaminant in previous discussions and in correspondences with USF&WS (NRC 1999). In addition, process knowledge from the site indicates that copper was likely a contaminant in the pile and waste areas (DOE 2003). Continued monitoring of copper levels

during ground water remediation would be necessary to ensure protection of aquatic biota. Copper would be assessed further during active ground water remediation.

Iron. Iron is a micronutrient and is essential in a variety of biochemical reactions. However, in higher concentrations, iron can be toxic to aquatic biota (Magos and Suzuki 1996). Ingestion of iron in excess of nutritional needs can lead to accumulation in the liver (Magos and Suzuki 1996). A variety of factors modify the toxicity of iron to aquatic organisms. These factors include the species, size and age of the organism, water hardness, pH, and the other constituents in the water. Background surface water concentrations range from 0.0075 to 4.17 mg/L (nine samples collected). Background concentrations in the ground water range from 0.0008 to 22.3 mg/L. The mean concentration in the fresh Qal facies is 0.009 mg/L and from the brine Qal facies is 9.14 mg/L. The mean concentration in the brine Qal facies is above the chronic NWQC and the acute and chronic State of Utah water quality criteria. Fourteen of the 119 surface water samples collected had copper concentrations that were above the chronic NWQC and the acute and chronic State of Utah water quality criteria. These samples were taken in August 2002 during a sampling event where paired samples (one filtered and one unfiltered) were collected. Results indicate that the iron is bound to a particulate that can be removed with a filter. Iron was the only analyte from that sampling event in which filtering the sample before analysis lowered the concentration by more than an order of magnitude. In the state of Utah, filtered samples are the only samples that should be used for comparison to benchmarks (UAC 2003). The one filtered sample above benchmarks was collected from the river in August. Though it was collected in the river during a time when juvenile endangered fish might be in the region, it was not in an area with backwater habitat. Conditions necessary for fish to be exposed to chronic conditions are unlikely. Natural ground water concentrations and the small number of samples with concentrations above the benchmarks indicate that impacts to fish resulting from iron contamination related to the Moab site are unlikely. Thus, the potential impacts to aquatic resources from exposure to iron are small, and further assessment is not warranted.

Lithium. There is very little in the literature on the toxicity of lithium to aquatic organisms. A study by Hamilton (1995) indicated that lithium is as toxic to fish as selenite and uranium, especially at early life stages. Background ground water concentrations range from 0.0278 to 1 mg/L. The mean concentration in samples from the fresh Qal facies is 0.0873 mg/L, and the mean concentration in samples from the brine Qal facies is 0.143 mg/L, which is above the Tier II chronic benchmark. Three background surface water samples have been collected; lithium concentrations in two were below detection limit and the other had a concentration of 0.057 mg/L. One of the 18 surface water samples collected near the Moab site had a lithium concentration above the Tier II acute benchmark, and 14 samples had concentrations above the Tier II chronic benchmark. All of these samples were collected in the river during the time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of lithium that would cause a chronic impact are unlikely due to changes in river flow.

Hamilton (1995) examined the acute toxicity of lithium on swim-up fry and juvenile Colorado pikeminnow, razorback sucker, and bonytail. He found a mean 96-hour LC_{50} of 42 mg/L lithium. The most sensitive fish life stage was the swim-up fry (10 to 31 days old) of all species, with 96-hour LC_{50}s ranging from 17 to 25 mg/L lithium. Background ground water concentrations, as well as species-specific laboratory testing, indicate that impacts to fish resulting from lithium contamination related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to lithium are small, and further assessment is not warranted.

Manganese. Manganese is a metallic element that occurs naturally in rock and soils/sediments weathered from rock. It is most abundant in areas of metamorphic and sedimentary rock. Dissolution from rock and soils/sediments into ground water and surface water has resulted in the presence of varying levels of manganese in natural waters (Reimer 1999). It is an essential trace element for microorganisms, plants, and animals and is therefore present in almost all organisms (Magos and Suzuki 1996). Manganese is a constituent in a variety of enzymes and is an essential part of enzyme systems that metabolize proteins and energy in all animals (Reimer 1999, Magos and Suzuki 1996). A variety of factors modify the toxicity of manganese to aquatic organisms. These factors include the species, size and age of the organism, water hardness, pH, and the other constituents in the water. Toxic effects include anemia, reduced growth, reduction in reproductive potential in fish, and anemia (Srivastava and Agrawal 1983, Stubblefield et al. 1997, Reimer 1999).

Background ground water concentrations range from 0.0001 to 38.5 mg/L. The mean ground water concentration in the fresh Qal facies is 0.0057 mg/L, and the mean concentration in the brine Qal facies is 11.7 mg/L, which is above the Tier II acute benchmark. Eight of the 18 background surface water samples had concentrations above detection, ranging from 0.003 to 0.076 mg/L. Ten of the 260 surface water samples collected had concentrations above the Tier II acute benchmark and the lowest chronic benchmark. Twenty-six of the samples had concentrations above the Tier II chronic benchmark. Thirteen of the samples with concentrations above the benchmarks were collected in pools with little or no flow. The two samples with the highest concentration of manganese were collected from a 4-ft by 5-ft pool with no flow. The ground water concentrations are likely to be contributing to the surface water sample concentrations.

USGS analyzed surface water samples for metals in August 1998, February 1999, and 2000. Results indicate that manganese concentrations exceeded the State of Utah water quality criteria at several locations during each sampling event. However, the concentrations varied spatially with no obvious relationship to the location of the tailings pile (USGS 2002).

Studies have shown that pre-exposure of fish to manganese leads to an elevation of the acute toxic concentration (Stubblefield et al. 1997, Reimer 1999). Aquatic organisms in the Colorado River have likely been pre-exposed to these elevated levels of manganese from natural levels in the ground water.

At least half of the manganese samples were collected in the river during the time when juvenile endangered fish might be in the region. In addition, manganese has been implicated as a potential site-related contaminant in previous discussions and correspondences with USF&WS (NRC 1999). Manganese is known to be part of process knowledge and is likely in high concentrations in the waste and tailings pile (DOE 2003). Continued monitoring of manganese levels during ground water remediation would be necessary to ensure protection of aquatic biota. Manganese would be assessed further during active ground water remediation.

Mercury. Mercury is a dense silver-white metal that is liquid at room temperature (Hoffman et al. 1995). The environmental effects of mercury vary with its form, dose, pathway of exposure, and life stage of the affected organism (EPA 2003). Mercury concentrations in all background ground water, background surface water, and surface water samples near the Moab site were below the detection limit. DOE reviewed existing data for mercury in preparation for additional sampling during July 2002. Mercury was detected in 3 of 30 ground water samples collected in

previous monitoring rounds. Only one ground water sample had a concentration (0.003 mg/L) that exceeded the maximum concentration limit of 0.002 mg/L. Review of historical process data and experience at other Uranium Mill Tailings Radiation Control Act (UMTRCA) sites indicate that mercury is not used in the milling process (Stoller 2002). On the basis of process knowledge and the low frequency of detection in ground water, it is unlikely that mercury is a site-related contaminant. The potential impacts to aquatic resources from exposure to mercury are small, and further assessment is not warranted.

Molybdenum. Molybdenum is a cofactor to many enzymes essential to aquatic organisms (Magos and Suzuki 1996; Reid 2002). It is generally considered nontoxic to aquatic organisms. In aquatic systems, it readily forms organometallic complexes (Reid 2002). Toxicity estimates of molybdenum to freshwater fish range from 70 to greater than 3,000 mg/L, depending on the species, size of fish, and test conditions (Reid 2002). Acute sublethal effects include increased ventilation, fused gill lamellae, and hemorrhaging of the gut and pyloric caeca (Reid 2002). The background ground water concentration in the fresh Qal facies ranges from 0.0018 to 0.01 mg/L (mean concentration = 0.0037 mg/L). The ground water concentration in the brine Qal facies was below detection limits. Seventeen of the 18 background surface water samples had concentrations above detection limits, ranging from 0.0028 to 0.007 mg/L. Ten of the 290 surface water samples collected had concentrations above the chronic Tier II benchmark. Three of these samples were collected from seeps, and seven were collected from the river. Two of the samples collected from the river were taken from a 4-ft by 5-ft pool with no flow. The river samples were all collected during a time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of molybdenum (e.g., to cause a chronic impact) are unlikely due to changes in river flow. The low toxicity of molybdenum as well as the surface water sample locations indicate that impacts to fish resulting from molybdenum contamination are not likely. Thus, the potential impacts to aquatic resources from exposure to molybdenum are small, and further assessment is not warranted.

Nickel. Pure nickel is a hard, silvery-white metal and is abundant in the environment. Nickel combined with other elements occurs naturally in the earth's crust, primarily combined with oxygen (oxides) or sulfur (sulfides), and is found in all soils (EBI 2003). Toxic effects in aquatic systems include tissue damage, genotoxicity, and growth reduction (EPA 2003). A variety of factors modify the toxicity of nickel to aquatic organisms. These factors include the species, size and age of the organism, water hardness, pH, and the other constituents in the water. Background ground water concentrations range from 0.0006 to 0.0647 mg/L. The mean ground water concentration in the fresh Qal facies is 0.0022 mg/L, and the mean concentration in the brine Qal facies is 0.0327 mg/L. The background surface water concentration ranges from 0.003 to 0.076 mg/L (10 samples collected). Ground water and surface water concentrations are below all benchmarks. One of the 56 surface water samples collected had a concentration above the chronic NWQC, State of Utah chronic criteria, and the lowest chronic benchmark.

If the criteria for nickel were corrected for the minimum total hardness determined by USGS from 1999 to 2000 (320 mg/L as $CaCO_3$), then the NWQC acute nickel criteria would increase from 0.47 to 1.25 mg/L nickel (EPA 2002). The State of Utah acute criteria would increase from 1.40 to 3.79 mg/L nickel (UAC 2003). A correction for the minimum total hardness for the NWQC chronic criteria would increase from 0.052 to 0.139 mg/L nickel (EPA 2002). The State of Utah chronic criteria would increase from 0.16 to 0.420 mg/L nickel. With these criteria

corrected for total hardness, none of the samples had concentrations that exceeded the NWQC and State of Utah acute or chronic criteria for nickel.

The one sample that exceeded the chronic benchmark without a correction for hardness was collected in the river during a time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of nickel that would cause a chronic impact are unlikely due to changes in river flow. The low number of samples with concentrations that are above benchmarks indicates that impacts to fish resulting from nickel related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to nickel are small, and further assessment is not warranted.

Nitrate. Ammonia, nitrite, and nitrate are interrelated through the process of nitrification. Nitrification is the biological process during which nitrifying bacteria convert toxic ammonia to less harmful nitrate. Nitrate is considered essentially nontoxic to aquatic organisms (Rand and Petrocelli 1985). Toxic effects include disruption of normal osmoregulatory ability (Rand and Petrocelli 1985). Background ground water concentrations range from 1.22 to 15.9 mg/L. The mean ground water concentration in the fresh Qal facies is 7.58 mg/L, and the mean concentration in the brine Qal facies is 0.0346 mg/L. The mean concentration in the fresh Qal facies is above the acute and chronic State of Utah water quality criteria. The background surface water concentration ranges from 1.86 to 5.51 mg/L. Two of the five background surface water samples had concentrations above the acute and chronic State of Utah water quality criteria. Thirty-eight of the 76 surface water samples collected had concentrations above the acute and chronic State of Utah water quality criteria. At least half of these samples were collected in the river during the time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of nitrate such as to cause a chronic impact are unlikely due to changes in river flow. Background ground water concentrations, background surface water concentrations, and the relatively low toxicity of nitrate indicate that impacts to fish resulting from nitrate related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to nitrate are small, and further assessment is not warranted.

Selenium. Selenium is a metalloid that occurs ubiquitously in nature but is rarely found in concentrations over 100 mg/L in aquatic systems (Cleveland et al. 1993). Selenium is required in the diet of fish at concentrations of 1.0 to 0.5 micrograms per gram (µg/g) dry weight (Lemly 1998). It is necessary for the formation of enzymes involved in normal cellular and organ metabolism (Lemly 1998). At dietary concentrations 7 to 39 times those required, it becomes toxic (Lemly 1998). Toxic effects include reduced growth, reproductive failure, liver damage, and chromosomal aberrations (Cleveland et al. 1993, EPA 2003).

Background ground water concentrations range from 0.0091 to 0.0266 mg/L. The mean ground water concentration in the fresh Qal facies is 0.0164 mg/L, and the mean concentration in the brine Qal facies is 0.00171 mg/L. The mean concentration in the fresh Qal facies is above the chronic NWQC and the chronic State of Utah water quality criteria. The background surface water concentration ranges from 0.0013 to 0.0079 mg/L. Six of the 15 background surface water samples had concentrations above the chronic NWQC and chronic State of Utah water quality criteria. Seven of the 216 surface water samples collected near the Moab site had concentrations above background, the chronic NWQC, and chronic State of Utah water quality criteria. The selenium level in one of these samples exceeded the acute State of Utah water quality criteria.

Four of these seven samples were collected in pools with little or no flow, and two were collected from seeps.

USGS analyzed surface water samples for metals in August 1998, February 1999, and 2000. Results indicate that selenium concentrations range from 0.001 to 0.004 mg/L as total selenium. However, USGS concluded that the data "provides no indication that selenium from the Atlas Mill Tailings Pile is elevated to levels of localized concern" (USGS 2002).

Background ground water and surface water concentrations, the sample locations, and low number of samples with concentrations above benchmarks indicate that impacts to fish resulting from selenium related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to selenium are small, and further assessment is not warranted.

Silver. Silver may biomagnify in some aquatic invertebrates and is highly toxic to aquatic organisms. Elevated levels of silver can cause larval mortality, developmental abnormalities, and reduced larval growth in fish (EPA 2003). Silver concentrations in all background ground water, background surface water, and surface water samples near the Moab site were below the analytical detection limits. One-half the reported detection limit (EPA 2001a, 2001b) was used to assess these samples. A variety of factors modify the toxicity of nickel to aquatic organisms. These factors include the species, size and age of the organism, water hardness, pH, and the other constituents in the water. One sample collected in the surface water near the Moab site could be above the acute NWQC and State of Utah acute criteria. Two samples could be above the chronic Tier II benchmark, and 33 could be above the lowest chronic benchmarks. The mean concentration of silver in the tailings pore water is 0.0009 mg/L (DOE 2003). This value is below all benchmarks except the "lowest chronic" benchmark.

If the criteria for silver were corrected for the minimum total hardness determined by USGS from 1999 to 2000 (320 mg/L as $CaCO_3$), then the NWQC acute silver criteria would increase from 0.0032 to 0.024 mg/L silver (EPA 2002). The State of Utah acute criteria would increase from 0.0041 to 3.79 mg/L silver (UAC 2003). With these criteria corrected for total hardness, none of the samples had concentrations that exceeded the NWQC and State of Utah acute criteria for silver.

The lack of elevated silver in the tailings pore water and the low number of samples with concentrations above benchmarks indicate that impacts to fish resulting from silver related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to silver are small, and further assessment is not warranted.

Strontium. Strontium is a soft, silver-gray metal that is commonly found in soils. It behaves similarly to calcium in living organisms (Peterson et al. 2002). The uptake of strontium through an organism and through the food chain is affected by the presence of calcium in the system (Driver 1994). The concentration of strontium in the bone and muscle of trout was found to be inversely related to calcium concentrations in the water. Because of its chemical similarity to calcium, strontium is deposited in the bones of vertebrates (Driver 1994). Background ground water concentrations at the Moab site range from 2.25 to 65 mg/L. The mean ground water concentration in the fresh Qal facies is 3.79 mg/L, and the mean concentration in the brine Qal facies is 36.8 mg/L. The mean concentration in the fresh Qal facies is above the chronic Tier II benchmark, and the mean concentration in the brine Qal facies is above the acute and chronic Tier II benchmarks. The background surface water concentration ranges from 0.965 to

1.63 mg/L. Concentrations in two of the 10 background surface water samples are above the chronic Tier II benchmark. Twenty of the 136 surface water samples collected near the Moab site had concentrations above the maximum background surface water concentration and the chronic Tier II benchmark. Sixteen of these samples were collected from pools with little or no flow. The natural ground water concentrations are likely to be contributing to the surface water sample concentrations. At least half of these samples were collected in the river during a time when juvenile endangered fish might be in the region. However, the conditions necessary for aquatic biota to be exposed to elevated levels of strontium that would cause a chronic impact are unlikely due to changes in river flow. Elevated natural ground water concentrations, elevated background surface water concentration, and surface water sample locations indicate that impacts to fish resulting from strontium related to the Moab site are not likely. Thus, the potential impacts to aquatic resources from exposure to strontium are small, and further assessment is not warranted.

Sulfate. Sulfate is an anion, and the effects of sulfate are primarily associated with the complexes of sulfate and heavy metals. There are no established benchmarks for sulfate. The background ground water concentrations for sulfate range from 180 to 6,000 mg/L. The mean background concentration in the fresh Qal facies is 772 mg/L, and the mean background concentration in the brine Qal facies is 3,520 mg/L. The surface water background concentrations range from 84.1 to 439 mg/L (20 samples). Fifty-three of the 301 surface water samples collected near the Moab site had concentrations above background. Four of the 53 samples with above background concentrations were collected in seeps. Twenty-eight of the 53 samples were collected in pools with little or no flow, and these samples also had elevated levels of other contaminants of potential concern. Sulfate was used extensively in processing the ore at the Moab site and is a common contaminant at other UMTRCA sites (DOE 2003). Continued monitoring of sulfate levels during ground water remediation would be necessary to ensure protection of aquatic biota. Sulfate would be assessed further during active ground water remediation.

Uranium. Uranium is a silver-colored heavy metal that is nearly twice as dense as lead. It is the heaviest naturally occurring element in nature. Uranium can pose a hazard from its chemical toxicity as well as from its radiological toxicity (internal alpha emission) in biota. However, because of its low specific activity, uranium primarily poses a chemical hazard rather than a radiological hazard in biota (Wrenn et al. 1985; Bosshard et al. 1992). The toxicity of uranium to fish varies with water quality, particularly total hardness and alkalinity (Driver 1994). It accumulates in soils and 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). Therefore, bottom-feeding fish species have been found to accumulate the highest concentration of uranium, relative to piscivorous fish (Waite et al. 1988; Swanson 1983, 1985).

Information regarding the accumulation and distribution of uranium in freshwater fish is limited. Available data indicate that the primary sites of uranium accumulation are the bones, scales, gonads, gills, gastrointestinal tract, kidney, and liver (Cooley and Klaverkamp 2000; Swanson 1985; Waite et al. 1988; Holdway 1992). Studies by Cooley et al. (2000) and Holdway (1992) suggest that the liver and kidney may be a significant site for uranium toxicity in fish, causing lesions and malformations.

Uranium in samples from 2000 to 2002 ranged from 0.0013 to 5.12 mg/L (Figure A2−4). Background ground water concentrations range from 0.0042 to 0.0269 mg/L uranium. The mean ground water concentration in the fresh Qal facies is 0.0127 mg/L, and the mean concentration in

the brine Qal facies is 0.00768 mg/L. The mean uranium concentrations in the fresh Qal facies and the brine Qal facies are above the Tier II chronic benchmark. The background surface water concentration ranges from 0.0023 to 0.008 mg/L uranium. Eighteen of the 20 background surface water samples had concentrations above the Tier II chronic benchmark. One hundred seventy-four of 331 surface water samples collected near the Moab site had concentrations above the maximum background surface water concentration and the Tier II chronic benchmark. Forty-two surface water samples had concentrations above the Tier II acute benchmark. Sixteen samples had concentrations above the lowest chronic benchmark.

The calculated criteria by Suter and Tsao (1996) were used to evaluate uranium in surface water because there are no federal or State of Utah standards. The values for the Tier II acute and chronic benchmarks appear to be very low and not reproducible when the published data are recalculated using their methodology. They also developed estimated lowest chronic 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, razorback sucker, and bonytail (Hamilton 1995).

Hamilton (1995) examined the acute toxicity of uranium on swim-up fry and juvenile Colorado pikeminnow, razorback sucker, and bonytail. He found a mean 96-hour LC_{50} of 46 mg/L of uranium for all species. Results do not indicate a difference in uranium sensitivity between life stages or species.

Continued monitoring of uranium levels during ground water remediation would be necessary to ensure protection of aquatic biota. Uranium would be assessed further during active ground water remediation.

Vanadium. Vanadium is a steel-gray, corrosion-resistant metal that is likely an essential element to living organisms (Barceloux 1999). There is little information about the toxicity of vanadium to aquatic resources. Background ground water concentrations range from 0.00061 to 0.135 mg/L vanadium. The mean ground water concentration in the fresh Qal facies is 0.00534 mg/L, and the mean concentration in the brine Qal facies is 0.0418 mg/L, which is above the Tier II chronic benchmark. The background surface water concentration ranges from 0.00073 to 0.0031 mg/L. Two of the 148 surface water samples collected near the Moab site had concentrations above the Tier II acute and chronic benchmarks. These two samples were collected from seeps in April, when juvenile endangered fish are not likely to be in the region. The conditions necessary for aquatic biota to be exposed to elevated levels of vanadium that would cause a chronic impact are unlikely due to changes in river flow. Thus, the potential impacts to aquatic resources from exposure to vanadium are small, and further assessment is not warranted.

Synergistic Effects. The list of analytes for the Moab site monitoring of surface water from 2000 to 2002 includes chemicals that may act together to cause synergistic impacts to the listed fish. Mixtures of inorganic metals can be hazardous because metals in a mixture may be present at concentrations below their individual toxic thresholds but sufficiently high to interact additively or synergistically with other inorganics and cause a toxic response in aquatic organisms (Hamilton 1995). Numerous studies have documented additive effects on aquatic organisms,

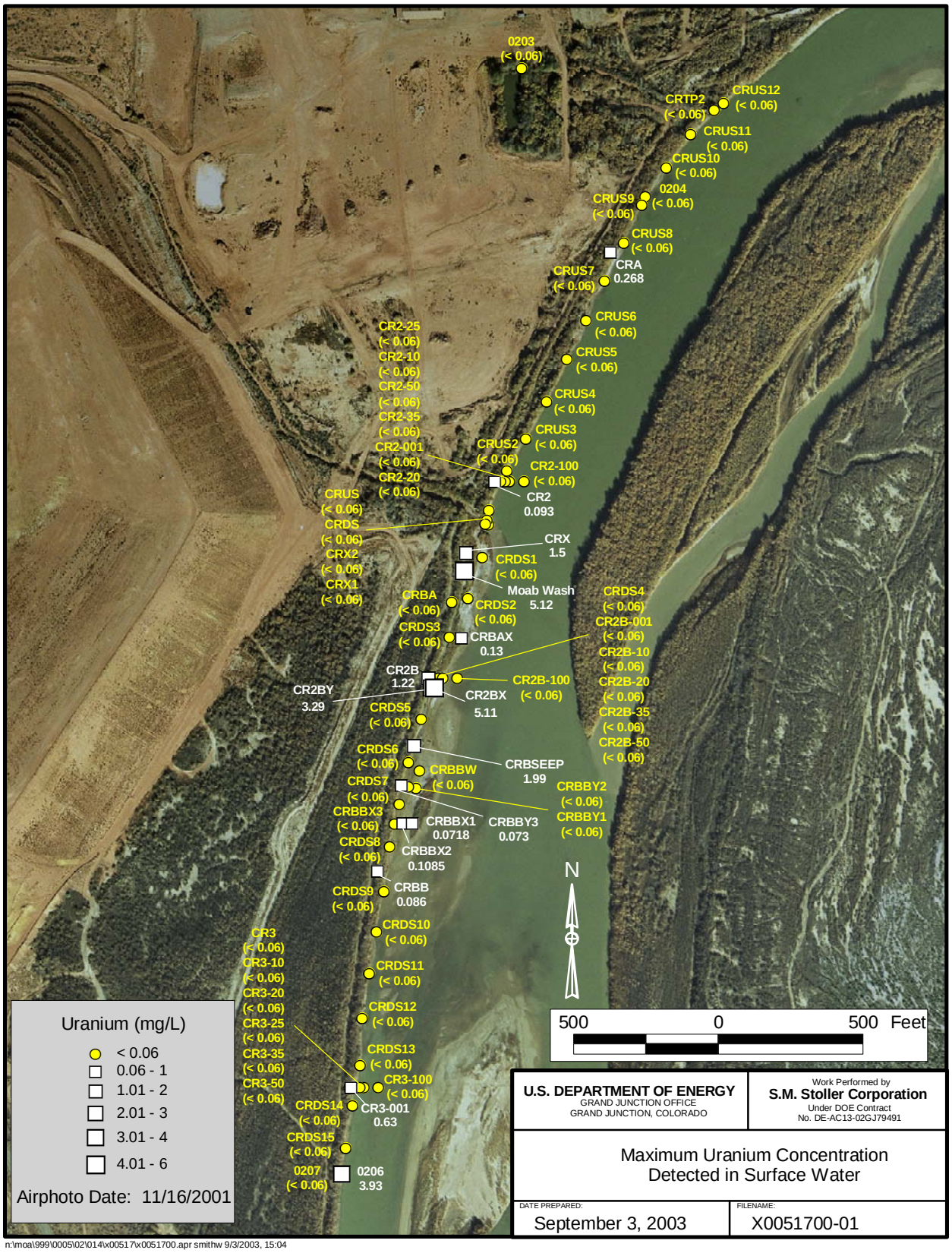

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Figure A2−4. Sampling Results for Uranium in Surface Water at the Moab Site

including the Colorado pikeminnow, razorback sucker, and bonytail. Hamilton (1995) found that waterborne concentrations of boron, selenium, and zinc each cause an adverse effect in young Colorado pikeminnows, razorback suckers, and bonytails. In addition, the mixture of these metals with vanadium and uranium increased the toxicity to the fish, yet by themselves, vanadium and uranium were not hazardous. Buhl and Hamilton (1996) considered effects from waterborne mixtures of arsenate, boron, copper, molybdenum, selenate, selenite, uranium, vanadium, and zinc to early life stages of Colorado pikeminnow, razorback sucker, and bonytail. Results indicate that chronic exposure to the mixtures showed a synergistic effect that was species- and life-stage specific. Hamilton et al. (2000) found that mixtures of copper, selenium, and zinc have toxic effects on razorback suckers and bonytails. The results of the USGS site-specific study with the Colorado pikeminnow and the razorback sucker indicate that ammonia toxicity was not affected when ammonia was mixed with other contaminants found in the Colorado River (USGS 2002). Potential impacts to aquatic resources from synergistic effects of ammonia with other contaminants are not likely. Synergistic effects between other metals are possible but are difficult to quantify.

Chemical Impacts to Aquatic Biota. Based on the evaluation of contaminants of potential concern, the chemical contaminants that would require future assessment and continued monitoring during proposed active ground water remediation activities for the Moab site are ammonia, copper, manganese, sulfate, and uranium. The proposed ground water extraction near the Colorado River and the use of freshwater injection would decrease the maximum concentrations of these contaminants of concern in the nearshore environment to levels below acute and chronic benchmarks. Potential synergistic effects between contaminants would be reduced through ground water remediation. For these contaminants of concern, for both acute and chronic benchmarks, continued monitoring during ground water remediation activities would be necessary to ensure acceptable conditions for protection of aquatic biota.

Radiological Impacts to Aquatic Biota. The primary route by which radioactive contamination enters the aquatic environment at the Moab site is through ground water. The routes of exposure for the radioactive contaminants are the same as those for chemical impacts. The contributors to radiological dose to the aquatic organisms at the Moab site that have been monitored include lead-210, polonium-210, radium-226, radium-228, radon-222, thorium-230, uranium-234, and uranium-238, and the general indicator 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 2002). These isotopes represent the highest values analyzed for radionuclides in 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 guidance level associated with the 1.0-rad-per-day criterion adopted by DOE for screening dose rates to aquatic organisms.

The 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.

Ground water extraction near the Colorado River and the use of freshwater injection would further decrease the maximum concentrations of radionuclides along the shoreline of the Moab site. These activities would be necessary to reduce 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.

Long-term impacts would depend on the cover design and cover effectiveness to maintain radioactive contaminants below their current concentrations. As long as the dose rate to aquatic biota from radioactive contaminants remained below that measured from 2000 to 2002, there would be no impacts to individuals or populations.

Gross Alpha. Gross alpha is a screening assay to measure all the alpha activity present in a sample, regardless of the specific radionuclide source. Such measurements are used as a method to screen samples for relative levels of radioactivity (INEEL 2001). The alpha-emitting radionuclides at the Moab site are uranium-238, radon-222, radium-226, and polonium-210. The State of Utah water quality standard for gross alpha is 15 pCi/L (UAC 2003). A total of 93 surface water samples were analyzed for gross alpha from 2000 to 2002; seven samples were collected at background locations; concentrations ranged from <7.3 to 13.82 pCi/L. Gross alpha activity in surface water samples near the Moab site ranged from 8 to 665 pCi/L; the maximum activity was detected in a sample from location CR2B (Figure A2–4). Samples with gross alpha activity that exceeded the State of Utah water quality standard (37 samples) were located in regions where uranium concentrations were highest. Overall, radiochemicals do not appear to be a concern to aquatic biota in the Colorado River adjacent to the site. USGS concluded that there would be "no significant biological impacts to fish populations caused by radionuclide concentrations sampled in the Colorado River and sediments." They 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). Continued monitoring of uranium levels would be appropriate for addressing impacts to the aquatic biota and directly evaluating proposed activities to remediate the site.

A2−2.0 Screening for Terrestrial Biota

Chemical Impacts to Wildlife. Samples of nonradiological constituents in surface water were collected by SMI and USGS between 2000 and 2002. The rationale for screening the original 28 contaminants to select two contaminants of potential concern for wildlife (mercury and selenium) was the same as the process described above for aquatic biota (involving comparison of maximum contaminant concentrations in surface water with detection limits, background concentrations, and toxicological benchmarks), except that different toxicological benchmarks were used.

Wildlife could be exposed to contaminants through ingestion of prey and water and through incidental soil ingestion, inhalation of airborne contaminants, and dermal uptake. The primary

pathway for wildlife exposure to contaminants would likely be through ingestion of prey in the riparian zone and of prey and water in the surface waters of the nearshore environment.

The selection of contaminants of potential concern could not be based on ingestion of prey in the riparian zone because contaminant data for local riparian biota were not available for comparison with tissue concentration benchmarks (milligrams per kilogram [mg/kg]) based on ingestion. Consequently, in addition to the process described above for aquatic biota, the selection of contaminants of potential concern was based on the potential for chronic effects via ingestion of prey and water within the surface waters of the nearshore environment. This was evaluated by comparing contaminant concentrations in surface water with mammalian and avian drinking water benchmarks (mg/L) that would result in NOAELs (mg/kg/day) and LOAELs (mg/kg/day), and with piscivorous mammalian and avian food/water benchmarks (mg/L) that would result in NOAELs (mg/kg/day) and LOAELs (mg/kg/day). NOAEL benchmarks are values believed to be nonhazardous. LOAEL benchmarks are threshold values for which chronic adverse effects are likely to become evident.

Sample et al. (1996) provides drinking water benchmarks for 9 mammalian wildlife species (cottontail rabbit, little brown bat, meadow vole, mink, red fox, river otter, short-tailed shrew, white-footed mouse, and whitetail deer) and 11 avian wildlife species (American robin, American woodcock, barn owl, barred owl, belted kingfisher, Cooper's hawk, great blue heron, osprey, red-tailed hawk, rough-winged swallow, and wild turkey). The lowest mammal and bird NOAEL- and LOAEL-based drinking water benchmarks (Tables A2−4 and A2−5, respectively) were used to select contaminants of potential concern. In addition, Sample et al. (1996) provides food/water benchmarks for two piscivorous mammals (river otter and mink) and three piscivorous birds (belted kingfisher, great blue heron, and osprey). The lowest of the piscivorous mammal and the lowest of the piscivorous bird NOAEL- and LOAEL-based food/water benchmarks were also used to select contaminants of potential concern (Tables A2−4 and A2–5, respectively).

Drinking water and/or food/water toxicity benchmarks that were exceeded by maximum contaminant concentrations are identified by an asterisk in tables A2-4 and A2-5 (i.e., aluminum, cadmium, mercury, molybdenum, and selenium). However, for some constituents (i.e., iron, molybdenum, and silver), there were no existing drinking water or food/water toxicity benchmarks (Sample et al. (1996). For these constituents, these benchmarks were derived using the methodology presented in Sample et al. (1996) and supporting data from the toxicological literature, where such was available. However, for some of these constituents (i.e., ammonia, chloride, nitrate, and sulfate), there was insufficient data from the toxicological literature to support derivation of the benchmarks. In such cases, these constituents were evaluated on the basis of other rationale, such as exceedance of livestock drinking water standards. These 11 constituents are considered preliminary contaminants of potential concern and are identified by an asterisk in Table A2−6. The evaluation of these preliminary contaminants of concern are discussed in the following paragraphs in terms of their exclusion or retention as final contaminants of concern (i.e., mercury and selenium).

Table A2−4. Surface Water Concentrations of Contaminants With Minimum Mammal NOAEL- and LOAEL-Based Drinking Water Benchmarks and Piscivorous Mammal NOAEL- and LOAEL-Based Food/Water Benchmarks.

(All mammal NOAEL- and LOAEL-based drinking water benchmarks were for the white-tailed deer, except for mercury, which was for the river otter, with multiple benchmarks separated by commas. Piscivorous mammal NOAEL- and LOAEL-based food/water benchmarks are provided, in order, for river otter and mink, with multiple benchmark values for each species separated by commas and enclosed in parentheses. Benchmark values exceeded by maximum concentrations are denoted with an asterisk and are of potential concern and are therefore discussed in the text.)

Constituent	Min. (mg/L or pCi/L)	Mean (mg/L or pCi/L)	Max. (mg/L or pCi/L)	Background range or maximum (mg/L or pCi/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)
Aluminum	0.005	0.02164	0.348[a]	0.008–0.14	4.474	44.738	0.018*, 0.025*	0.183*, 0.253*
Ammonia[b]	0.05		1,440	0.05–0.134	N/A[c]	N/A	N/A	N/A
Antimony			0.0005[d]	0.0005[d]	0.290	2.898	0.161, 0.220	1.607, 2.204
Arsenic			0.002[e]	<0.0006–0.002	0.292	2.921	0.016, 0.022	0.156, 0.216
Barium	0.002		0.211	0.051–0.14	23.1	84.8	N/A	N/A
Beryllium			0.00005[d]	0.00005[d]	N/A	N/A	N/A	N/A
Bismuth			0.0005[d]	0.0005[d]	N/A	N/A	N/A	N/A
Boron	0.064		1.74	<0.0801–0.123	120	401	N/A	N/A
Cadmium	<0.0001	0.00095	0.004	<0.00005[d]	4.132, 68.135	41.323	3.162E-04*, 4.367E-04*	3.162E-03*, 4.367E-03
Chloride	22		17,300	25–172	N/A	N/A	N/A	N/A
Chromium			0.0005[d]	<0.0005–<0.0013	14.05 (Cr+6), 11725 (Cr+3)	56.29 (Cr+6)	3.593 (Cr+6), 4.947 (Cr+6)	14.394 (Cr+6), 19.817 (Cr+6)
Copper	<0.00049		0.051[a]	<0.0006–<0.0014	65.2	85.8	0.213, 0.294	0.280, 0.387
Iron[f]	<0.003	0.098	3.08	0.0075–0.0178	N/A	N/A	N/A	N/A
Lead			0.0005[d]	0.00005[d]	34.27	342.72	0.711, 0.982	7.115, 9.823
Lithium	0.0552		0.31[e]	0.057[e]	40.3	80.5	N/A	N/A
Manganese	0.0005		12	<0.003–0.076	377	1217	N/A	N/A
Mercury	<0.0002	N/A	0.002[a]	0.00005[d]	0.111	0.186	1.576E-06*, 3.924E-06*	2.626E-06*, 6.540E-06*
Molybdenum	<0.001	0.05195	1.91	<0.0028–0.007	0.6*	6.03	N/A	N/A
Nickel	<0.0006		0.052	<.0006–0.002	171.36	342.72	1.524-2.104	3.048-4.209
Nitrate	0.829		21.7	1.86–5.51	2719	6061	N/A	N/A
Selenium	<0.0005	0.00446	0.026	0.0013–0.0079	0.857	1.414	2.363E-04*, 4.318E-04*	3.899E-04*, 7.12E-04*
Silver	<0.005		0.0025[d]	0.00005[d]	N/A	N/A	N/A	N/A
Strontium	0.005		10.2	0.965–1.63	1127	N/A	N/A	N/A
Sulfate	72		14400	84.1–439	N/A	N/A	N/A	N/A
Thallium			0.0005[d]	0.0005[d]	0.032	0.320	0.001	0.009, 0.012
Uranium	0.0013		5.12	0.0023–0.008	6.995	13.996	N/A	N/A
Vanadium	0.0003		0.249	0.00073–0.0031	0.835	8.352	N/A	N/A
Zinc			0.023	<0.0017–0.006	685.4	1370.9	0.673, 0.929	1.346, 1.858

[a]Concentration is estimated, based on laboratory qualifier.
[b]All ammonia samples were converted for this assessment to total ammonia as nitrogen.
[c]N/A = not available.
[d]All concentrations were below detection; maximum value based on one-half of detection limit.
[e]Values in data set represent multiple detection limits. This is the highest value in the data that was above its respective detection limit.
[f]Values reported for this constituent are based only on unfiltered samples in order to conform to UAC (2003).
*Benchmark exceeded by maximum contaminant concentration.

Table A2−5. Surface Water Concentrations of Contaminants with Minimum Bird NOAEL- and LOAEL-Based Drinking Water Benchmarks and Piscivorous Bird NOAEL- and LOAEL-Based Food/Water Benchmarks.

(All bird NOAEL- and LOAEL-based drinking water benchmarks were for the rough-winged swallow, with multiple benchmarks separated by commas. Piscivorous bird NOAEL- and LOAEL-based food/water benchmarks are provided, in order, for belted kingfisher, osprey, and great blue heron, with multiple benchmarks values for each species separated by commas and enclosed in parentheses. Benchmark values exceeded by maximum concentrations are denoted with an asterisk and are of potential concern and are therefore discussed in the text.)

Constituent	Min. (mg/L or pCi/L)	Mean (mg/L or pCi/L)	Max. (mg/L or pCi/L)	Background mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)
Aluminum	0.005	0.02164	0.348[a]	0.008–0.14	471.4	191.2	0.936, 2.372, 2.699	0.380, 0.962, 1.095
Ammonia[b]	0.05		1440	0.05–0.134	N/A[c]	N/A	N/A	N/A
Antimony			0.0005[d]	0.0005[d]	N/A	N/A	N/A	N/A
Arsenic			0.002[e]	<0.0006–0.002	10.6, 22.1	31.7, 55.2	(0.282, 0.589), (0.713, 1.489), (0.811, 1.695)	(0.846, 1.472), (2.138, 3.720), (2.434, 4.235)
Barium	0.002		0.211	0.051–0.14	89.4	179.2	N/A	N/A
Beryllium			0.00005[d]	0.00005[d]	N/A	N/A	N/A	N/A
Bismuth			0.0005[d]	0.0005[d]	N/A	N/A	N/A	N/A
Boron	0.064		1.74	<0.0801–0.123	124	430	N/A	N/A
Cadmium	<0.0001	0.00095	0.004	<0.00005[d]	6.23	85.95	2.307E-04*, 0.001*, 0.001*	3.183E-03*, 8.0E-03, 9.0E-03
Chloride	22		17300	25–172	N/A	N/A	N/A	N/A
Chromium			0.0005[d]	<0.0005–<0.0013	4.30 (Cr+3)	21.49 (Cr+3)	N/A	N/A
Copper	<0.00049		0.051[a]	<0.0006–<0.0014	202	265.1	0.32, 0.81, 0.921	0.420, 1.063, 1.210
Iron[f]	<0.003	0.098	3.08	0.0075–0.0178	N/A	N/A	N/A	N/A
Lead			0.0005[d]	0.00005[d]	4.86, 16.54	48.56	0.049, 0.125, 0.142	0.493, 1.248, 1.421
Lithium	0.0552		0.31[e]	0.057[e]	N/A	N/A	N/A	N/A
Manganese	0.0005		12	<0.003–0.076	4284	N/A	N/A	N/A
Mercury	<0.0002	N/A	0.002[a]	0.00005[d]	0.028, 1.93	0.275, 3.87	4.527E-07*, 1.147E-06*, 1.305E-06*	4.527E-06*, 1.147E-05*, 1.305E-05*
Molybdenum	<0.001	0.05195	1.91	<0.0028–0.007	15.04	151.69	N/A	N/A
Nickel	<0.0006		0.052	<.0006–0.002	332.61	459.81	1.438, 3.642, 4.145	1.988, 5.035, 5.731
Nitrate	0.829		21.7	1.86–5.51	N/A	N/A	N/A	N/A
Selenium	<0.0005	0.00446	0.026	0.0013–0.0079	1.719, 2.149	3.438, 4.297	3.795E-04*, 9.614E-04*, 1.094E-03*	7.589E-04*, 1.923E-03*, 2.188E-03*
Silver	<0.005		0.0025[d]	0.00005[d]	N/A	N/A	N/A	N/A
Strontium	0.005		10.2	0.965–1.63	N/A	N/A	N/A	N/A
Sulfate	72		14400	84.1–439	N/A	N/A	N/A	N/A
Thallium			0.0005[d]	0.0005[d]	N/A	N/A	N/A	N/A
Uranium	0.0013		5.12	0.0023–0.008	68.8	N/A	N/A	N/A
Vanadium	0.0003		0.249	0.00073–0.0031	48.989	N/A	N/A	N/A
Zinc			0.023	<0.0017–0.006	62.3	562.9	0.030, 0.075, 0.085	0.268, 0.678, 0.771

[a]Concentration is estimated, based on laboratory qualifier.
[b]All ammonia samples were converted for this assessment to total ammonia as nitrogen.
[c]N/A = not available.
[d]All concentrations were below detection; maximum value based on one-half of detection limit.
[e]Values in data set represent multiple detection limits. This is the highest value in the data that was above its respective detection limit.
[f]Values reported for this constituent are based only on unfiltered samples in order to conform to UAC (2003).
*Benchmark exceeded by maximum contaminant concentration.

Table A2−6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks

Constituent	Max. (mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)	Approach for the EIS and BA
Aluminum	0.348[a]	0	0	0	0	0	0	17*	2*	Maximum concentration is above background and piscivorous mammal NOAEL- and LOAEL-based benchmarks. Retained as preliminary COPC.*
Ammonia	1440	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Antimony	0.0005[b]	N/A	N/A	N/A	N/A	0	0	0	0	Maximum concentration is equal to background and both are below detection limits. Half detection limit is below all benchmarks. Not retained as preliminary COPC.
Arsenic	0.002[c]	0	0	0	0	0	0	0	0	Maximum concentration is equal to highest background concentration. Maximum and background concentrations are both below all benchmarks. Not retained as preliminary COPC.
Barium	0.211	0	0	N/A	N/A	0	0	N/A	N/A	Maximum concentration is above background concentration. Maximum and background concentrations are both below all benchmarks. Not retained as preliminary COPC.
Beryllium	0.00005[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Measured concentrations and background concentrations are below detection limits. Measured concentration detection limit is equal to background detection limit. (No wildlife benchmarks available.) Not retained as preliminary COPC.

Table A2−6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks (continued)

Constituent	Max. (mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)	Approach for the EIS and BA
Bismuth	0.0005[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Measured concentrations and background concentrations are below detection limits. Measured concentration detection limit is equal to background detection limit. (No wildlife benchmarks available.) Not retained as preliminary COPC.
Boron	1.74	0	0	N/A	N/A	0	0	N/A	N/A	Maximum concentration above background. Maximum concentration and background below all benchmarks. Not retained as preliminary COPC.
Cadmium	0.004	0	0	8*	1*	0	0	8*	1*	Maximum concentration above background and above picscivorous bird and picscivorous mammal NOAEL- and LOAEL-based benchmarks. Retained as preliminary COPC.*
Chloride	17300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Chromium	0.0005[b]	0	0	N/A	N/A	0	0	0	0	Maximum concentration equal to low background. Maximum concentration and background below all Cr+6 and Cr+3 benchmarks. Not retained as preliminary COPC.
Copper	0.051[a]	0	0	0	0	0	0	0	0	Maximum concentration is above background. Maximum concentration is below all benchmarks. Not retained as preliminary COPC.

Table A2−6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks (continued)

Constituent	Max. (mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)	Approach for the EIS and BA
Iron	3.08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Lead	0.0005[b]	0	0	0	0	0	0	0	0	Maximum concentration is above background and both are below detection limits. Half detection limit of maximum concentration is below all benchmarks. Not retained as preliminary COPC.
Lithium	0.31[c]	0	0	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration is above background. Maximum concentration is below detection limits. Half detection limit is below all benchmarks. Not retained as preliminary COPC.
Manganese	12	0	N/A	N/A	N/A	0	0	N/A	N/A	Maximum concentration is above background. Maximum concentration is below all benchmarks. Not retained as preliminary COPC.
Mercury	0.002[a]	0	0	85*	85*	0	0	85*	85*	Maximum concentration is above background. Maximum concentration is above piscivorous mammal and piscivorous bird NOAEL- and LOAEL-based benchmarks. Retained as preliminary COPC.*
Molybdenum	1.91	0	0	N/A	N/A	8*	0	N/A	N/A	Maximum concentration is above background and above mammal NOAEL-based drinking water benchmark. No piscivorous wildlife benchmarks available. Retained as preliminary COPC.*

Table A2−6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks (continued)

Constituent	Max. (mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)	Approach for the EIS and BA
Nickel	0.052	0	0	0	0	0	0	0	0	Maximum concentration is above background. Maximum concentration is below all benchmarks. Not retained as preliminary COPC.
Nitrate	21.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration is above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Selenium	0.026	0	0	193*	193*	0	0	201*	193*	Maximum concentration is above background. Maximum concentration is above piscivorous mammal and piscivorous bird NOAEL- and LOAEL-based benchmarks. Retained as preliminary COPC.*
Silver	0.0025[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration is above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Strontium	10.2	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A	Maximum concentration above background. Maximum concentration below all benchmarks. Not retained as preliminary COPC.
Sulfate	14400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Maximum concentration above background. No wildlife benchmarks available. Retained as preliminary COPC.*
Thallium	0.0005[b]	N/A	N/A	N/A	N/A	0	0	0	0	Maximum concentration equal to background. Maximum concentration is below all benchmarks. Not retained as preliminary COPC.
Uranium	5.12	0	N/A	N/A	N/A	0	0	N/A	N/A	Maximum concentration above background. Maximum concentration below all benchmarks. Not retained as preliminary COPC.

Table A2−6. Maximum Concentrations of Contaminants in Surface Water With the Number of Sample Values (not including background) at or Above Minimum Mammalian and Avian NOAEL- and LOAEL-Based Drinking Water Benchmarks and Minimum Piscivorous Mammal and Bird NOAEL- and LOAEL-Based Food/Water Benchmarks (continued)

Constituent	Max. (mg/L or pCi/L)	Lowest bird NOAEL-based drinking water benchmark (mg/L)	Lowest bird LOAEL-based drinking water benchmark (mg/L)	Piscivorous bird NOAEL-based food/water benchmarks (mg/L)	Piscivorous bird LOAEL-based food/water benchmarks (mg/L)	Lowest mammal NOAEL-based drinking water benchmark (mg/L)	Lowest mammal LOAEL-based drinking water benchmark (mg/L)	Piscivorous mammal NOAEL-based food/water benchmarks (mg/L)	Piscivorous mammal LOAEL-based food/water benchmarks (mg/L)	Approach for the EIS and BA
Vanadium	0.249	0	N/A	N/A	N/A	0	0	N/A	N/A	Maximum concentration above background. Maximum concentration below all benchmarks. Not retained as preliminary COPC.
Zinc	0.023	0	0	0	0	0	0	0	0	Maximum concentration above background. Maximum concentration below all benchmarks. Not retained as preliminary COPC.

[a]Analyte is estimated, based on laboratory qualifier.
[b]All analytes were below detection; maximum value based on one-half of detection limit.
[c]Analytes in data set represent multiple detection limits. This is the highest value in the data that was below its respective detection limit.
*Number of samples whose concentrations exceeded the corresponding wildlife toxicity benchmarks. Asterisks also identify contaminants retained as contaminants of potential concern

Aluminum. The maximum aluminum concentration was about 2 to 3 times the uppermost background value and exceeded by about 1 order of magnitude the food/water benchmarks, resulting in NOAELs for the river otter and mink (Table A2–4). A total of 17 sample values (excluding background) exceeded the river otter NOAEL-based food/water benchmark (Table A2–6). The maximum aluminum concentration exceeded slightly the food/water benchmarks resulting in LOAELs for the river otter and mink (Table A2–4), and only two sample values exceeded the river otter LOAEL-based food/water benchmark (Table A2–6).

Adverse effects would be unlikely to result from food/water consumption at these two sample locations, because the river otter and mink very likely consume food and water over a much larger area. The average aluminum concentration in the sampled area slightly exceeds the food/water benchmarks resulting in NOAELs for the river otter and is slightly less than the food/water benchmarks resulting in NOAELs for the mink (Table A2–4). Consequently, adverse effects would also be unlikely to result from food/water consumption over the entire sampled area. Thus, the potential impacts, if any, to piscivorous mammalian wildlife from exposure to aluminum in surface water would be small, and further assessment is not warranted.

The maximum aluminum concentration did not exceed either the avian drinking water or piscivorous bird food/water benchmarks. Thus, further assessment of avian exposure to aluminum in surface water is not warranted.

Ammonia. The maximum ammonia concentration was 4 to 5 orders of magnitude above background and the mean concentration (19.39 mg/L) was about 2 orders of magnitude above background (Table A2–4). There are currently no wildlife drinking water or food/water benchmarks (the only types of benchmarks that can be compared with contaminant concentrations in surface water) available for this constituent (Tables A2–4 and A2–5). Sample et al. (1996) provide methodology for deriving such benchmarks from other types of toxicological data. However, most experimental toxicological work concerning the oral route of administration has centered on ammonium chloride (Arnold et al. 1997, Crookshank et al. 1973, Fukushima et al. 1986, Goldman and Yakovac 1964, Shibata et al. 1989). Few studies have attempted to identify the role of ammonia in the effects (World Health Organization 1986). Consequently, no benchmarks could be derived for ammonia using the methodology provided in Sample et al. (1996) due to the lack of other toxicological data in the literature. Further, EPA has not provided an oral reference dose factor (for humans) for ammonia (http://www.epa.gov/iris/subst/0422.htm#reforal), nor is there a human drinking water standard. The lack of toxicological data suggests that the occurrence of ammonia in food and drinking water is generally considered not to pose potentially significant toxic effects for terrestrial organisms. This precludes further screening of wildlife exposure to ammonia in surface water.

Cadmium. The maximum cadmium concentration was about 2 orders of magnitude above background and exceeded the food/water benchmarks that resulted in NOAELs for the river otter and mink by about 1 order of magnitude (Table A2–4). A total of eight sample values exceeded the river otter NOAEL-based food/water benchmark (Table A2–6). The maximum cadmium concentration was slightly greater than the food/water benchmarks that resulted in LOAELs for the river otter and slightly less than the food/water benchmarks that resulted in LOAELs for the mink (Table A2–4). No sample values other than the maximum exceeded the LOAEL-based river otter food/water benchmark (Table A2–6).

The maximum cadmium concentration exceeded by about 1 order of magnitude the food/water benchmark resulting in a NOAEL for the belted kingfisher and exceeded by about one-half an order of magnitude that of the osprey and great blue heron (Table A2–5). A total of eight sample values exceeded the belted kingfisher NOAEL-based food/water benchmark (Table A2–6). The maximum concentration exceeded only slightly the food/water benchmark resulting in a LOAEL for the belted kingfisher and was less than that of the osprey and great blue heron (Table A2–5). No sample values other than the maximum exceeded the LOAEL-based belted kingfisher food/water benchmark (Table A2–6).

Adverse effects to the river otter and belted kingfisher would be unlikely to result from food/water consumption at the location of the maximum sample value, because these species very likely consume food and water over a much larger area. The average cadmium concentration in the sampled area slightly exceeds the river otter and belted kingfisher NOAEL-based food/water benchmarks but does not exceed associated LOAEL-based food/water benchmarks (Tables A2–4 and A2–5). Consequently, adverse effects would also be unlikely to result from food/water consumption by these species over the entire sampled area. Thus, the potential impacts, if any, to piscivorous mammalian and avian wildlife from exposure to cadmium in surface water would be small, and further assessment is not warranted.

Chloride. The maximum chloride concentration was about 2 orders of magnitude above background concentration, and the mean concentration (255.08 mg/L) ranged from about 1.5 to 10 times background (Table A2–4). There are currently no wildlife drinking water or food/water benchmarks available for this constituent (Tables A2−4 and A2−5). Sample et al. (1996) provide methodology for deriving such benchmarks from other types of toxicological data. However, no benchmarks could be derived for chloride using this methodology due to the lack of other toxicological data in the literature. Further, there is also no human drinking water standard for chloride. The lack of toxicological data suggests that the occurrence of chloride in drinking water is generally considered not to pose potentially significant toxic effects for terrestrial organisms (compounds that include chloride are likely to be more toxic to terrestrial organisms than chloride alone). This precludes further screening of wildlife exposure to chloride in surface water.

Iron. The August 2002 samples include some that were not filtered. In the state of Utah, only filtered samples should be used for comparison to benchmarks (UAC 2003). Thus, the unfiltered August 2002 samples were removed and only filtered iron samples (Tables A2−4 and A2−5) are used in this analysis.

The maximum and mean iron concentrations were about 2 orders and about 1 order of magnitude, respectively, above the highest background concentration (Table A2−4). There are currently no published wildlife drinking water or food/water benchmarks available for this constituent. Consequently, drinking water benchmarks were derived for the 9 mammal and 11 bird species listed above using the methodology provided in Sample et al. (1996). The derived NOAEL-based drinking water benchmarks were then used to derive food/water benchmarks for piscivorous mammals and birds. A brief outline of the methodology used for deriving drinking water benchmarks follows.

First, mammal and bird NOAELs were either obtained from the results of laboratory experiments summarized in the literature or estimated from acute toxicity benchmarks summarized in the literature. A mammalian NOAEL of 120 mg/kg/day, with mice as test organisms and weight loss

as the endpoint, was obtained from Parametrix (2001). Because an avian NOAEL was unavailable, an avian LD_{50} of greater than 4,500 mg/kg/day, with quail as the test organism and no endpoint specified, was used (Parametrix 2001). Because the precise avian LD_{50} was not specified but was given as being an unknown value greater than 4,500 mg/kg/day, 4,500 mg/kg/day was used to be conservative. No standardized mathematical relationship exists between an LD_{50} and a NOAEL (Sample et al. 1996). Exposure levels associated with NOAELs may range from 1/10 to 1/10,000 of the acutely toxic dose (Sample et al. 1996). Consequently, a high and a low NOAEL were estimated by applying these factors to the avian LD_{50}, resulting in high and low avian NOAELs of 450 and 0.45 mg/kg/day, respectively.

The literature-based mammalian and avian NOAELs were used to derive NOAELs for the 9 mammal and 11 bird species listed above by adjusting for differences in body weight (kg) between the test organism and target species (Sample et al. 1996). These derived NOAELs (mg/kg/day) were then used to derive drinking water equivalents (mg/L) using the body weight of the target species and its rate of water consumption (L/day) (Sample et al. 1996). The lowest mammal drinking water benchmark was for white-tailed deer (278 mg/L), 2 orders of magnitude above the maximum iron surface water concentration (3.08 mg/L) (Table A2−4). The lowest of the high and low avian drinking water benchmarks were for the rough-winged swallow (3,517 and 3.5 mg/L, respectively). These values were 3 orders of magnitude above and just slightly above the maximum iron surface water concentration (Table A2−4), respectively, and about 2 orders of magnitude above the mean concentration (0.098 mg/L) (Table A2−4). Thus, adverse impacts to the 9 mammalian and 11 avian receptors are not expected from consumption of iron in surface water via drinking only. No further evaluation of wildlife exposure to iron in surface water via drinking is warranted.

The above derived NOAEL-based drinking water benchmarks were then used to derive NOAEL-based food/drinking water benchmarks for the two piscivorous mammals (mink and river otter) and three piscivorous birds (belted kingfisher, great blue heron, and osprey) using the body weight of the species, its rate of water and food (kg/day) consumption, and biological accumulation factor (BAF) (Sample et al. 1996). The BAF is the ratio of the concentration of a contaminant in tissue (mg/kg) to its concentration in water (mg/L), where both the organism and its prey are exposed, and is expressed as liters per kilogram. For most inorganic compounds, the BAF is assumed to equal the biological concentration factor (BCF). The BCF is the ratio of the concentration of a contaminant in food to its concentration in water (i.e., [mg/kg]/[mg/L] = L/kg) (Sample et al. 1996). A BAF of 200 reported for the edible parts of fish in a critical review of bioaccumulation factors in aquatic systems by Karlsson et al. (2002) was used in this analysis.

The lowest NOAEL-based piscivorous mammal food/drinking water benchmark was 18.18 mg/L for mink. The maximum iron concentration (3.08 mg/L) (Table A2-4) is about six times lower than this benchmark. Consequently, since this derived NOAEL was not exceeded by the maximum iron concentration, piscivorous mammals would be unlikely to be adversely affected by consumption of iron in surface water and associated prey. No further evaluation of piscivorous mammal exposure to iron in surface water and associated prey is warranted.

The low NOAEL-based piscivorous bird food/drinking water benchmarks were 0.04 mg/L for the belted kingfisher, 0.13 mg/L for the osprey, and 0.15 mg/L for the great blue heron. The maximum iron concentration (3.08 mg/L) (Table A2-4) is about 2 orders of magnitude higher than the kingfisher benchmark, and about a factor of 20 higher than the osprey and heron benchmarks. However, since piscivorous birds would integrate their exposure by foraging over a

much larger area than the point where the maximum surface water concentration was taken, the average iron concentration is more applicable than the maximum. The average iron concentration (0.098 mg/L) (Table A2-4) is only about two times higher than the kingfisher benchmark and is slightly lower than the osprey and heron benchmarks.

Thus, the kingfisher is the only species of the three whose NOAEL-based food/drinking water benchmark was exceeded by the average iron concentration. However, it is exceedance of a LOAEL, not a NOAEL, that implies potential adverse effects. There is no LOAEL-based food/water benchmark for piscivorous bird species, and one cannot be derived because there is no standard relationship that applies when extrapolating from a NOAEL and a LOAEL (because the LOAEL is the point where adverse effects begin, and the NOAEL could be anywhere below it). Consequently, it is uncertain whether exceedance of the low kingfisher NOAEL-based food/drinking water benchmark by the average iron concentration could result in potential adverse effects. The following two discussion points serve to diminish such a possibility.

First, the high NOAEL-based food/drinking water benchmark for the belted kingfisher was 42.72 mg/L. The average iron concentration (0.098 mg/L) (Table A2-4) is about 2.5 orders of magnitude below this benchmark. Thus, in this case, adverse effects would be very unlikely. Second, the fact that the maximum iron concentration is suspect further diminishes the possibility of potential adverse effects under the low NOAEL-based food/drinking water benchmark, as follows.

The maximum iron concentration (3.08 mg/L) (Table A2−4) is somewhat anomalous in that it is the only sample that is 2 to 3 orders of magnitude above the rest of the values, including background. When this value is removed, the new maximum from the sampled area becomes 0.04 mg/L and the new mean (0.007 mg/L [N=33, SD=0.006]) is slightly less than the mean background concentration (0.012 mg/L [N=3, SD=0.005]). This new mean iron concentration is about 1 and 4 orders of magnitude below the low and high kingfisher food/drinking water benchmarks, respectively. In summary, potential adverse effects to the kingfisher from iron in surface water and associated prey appear unlikely, and further assessment of this species is not warranted.

Mercury. The maximum mercury concentration was about 2 orders of magnitude above background and exceeded by about 3 orders of magnitude the food/water benchmarks resulting in NOAELs and LOAELs for the river otter and mink (Table A2–4).

The maximum mercury concentration exceeded by about 4 orders of magnitude the food/water benchmark resulting in a NOAEL for the belted kingfisher and exceeded by about 3 orders of magnitude the food/water benchmarks resulting in NOAELs for the osprey and great blue heron (Table A2–5). Further, the maximum mercury concentration exceeded by about 3 orders of magnitude the food/water benchmark resulting in a LOAEL for the belted kingfisher and exceeded by about 2 orders of magnitude the food/water benchmarks resulting in LOAELs for the osprey and great blue heron (Table A2–5).

Mercury was undetected in the rest of the mercury samples other than the maximum, including background, some of the samples had a detection limit of 0.0002 mg/L and the others had a detection limit of 0.0001 mg/L. Results of these samples in which mercury was undetected were assigned a value of one-half the corresponding detection limit. Eighty-five of these sample values (excluding background sample values) exceeded all the piscivorous mammal and bird

LOAEL-based food/water benchmarks (Table A2–6) by 1 to 2 orders of magnitude (Tables A2–4 and A2–5). The 15 background sample values similarly exceeded all the piscivorous mammal and bird LOAEL-based food/water benchmarks.

Adverse effects would be unlikely to result from food/water consumption at the location where the maximum mercury concentration was obtained, because the river otter, mink, belted kingfisher, osprey, and great blue heron very likely consume food and water over a much larger area. However, adverse effects to these species could potentially result if food/water consumption occurred largely within the sampled area, based on the above evaluation of samples in which mercury was undetected. Nonetheless, because the actual concentrations of mercury are unknown over most of the sampled area, further assessment is warranted. This might include analytical methods and instrumentation that provide lower detection limits.

Molybdenum. The maximum molybdenum concentration was about 3 orders of magnitude above the uppermost background value and was about 3 times greater than the drinking water benchmark resulting in a NOAEL for white-tailed deer (Table A2–4). A total of eight sample values exceeded the white-tailed deer NOAEL-based drinking water benchmark, but none, including the maximum, exceeded the associated LOAEL-based drinking water benchmark (Table A2–6). The maximum molybdenum concentration did not exceed the avian NOAEL- or LOAEL-based drinking water benchmarks (Table A2–5). Thus, adverse impacts to the 9 mammalian and 11 avian receptors are not expected from consumption of molybdenum by drinking surface water, and further assessment is not warranted.

There are currently no published piscivorous wildlife food/water benchmarks available for this constituent (Tables A2−4 and A2−5). Consequently, piscivorous mammal (mink and river otter) and bird (belted kingfisher, great blue heron, and osprey) food/water benchmarks were derived using the methodology provided in Sample et al. (1996). A brief outline of the methodology used for deriving these benchmarks follows.

First, piscivorous mammal and bird drinking water NOAELs were obtained from Sample et al. (1996). These drinking water NOAELs were used to derive the piscivorous mammal and bird food/water NOAELs using the species' body weight (kg), its rate of food (kg/day) and water (L/day) consumption, and BAF (Sample et al. 1996). A BAF of 10, with a 10-fold error likely according to other data, was reported for the edible parts of fish in a critical review of BAFs in aquatic systems by Karlsson et al. (2002). Consequently, three food/drinking water NOAELs were derived for each piscivorous mammal and bird species, one for each BAF of 1, 10, and 100.

The lowest NOAEL-based piscivorous mammal food/drinking water benchmark was 0.08 mg/L for mink, derived using a BAF of 100. The maximum molybdenum concentration (1.91 mg/L) (Table A2-4) is more than 1 order of magnitude higher than this benchmark. However, since piscivorous mammals would integrate their exposure by foraging over a much larger area than the point where the maximum surface water concentration was detected, the average molybdenum concentration is more applicable. The average molybdenum concentration (0.05 mg/L) (Table A2-4) is slightly less than this benchmark. Consequently, since this derived NOAEL was not exceeded by the average molybdenum concentration, piscivorous mammals would not likely be adversely affected by consumption of molybdenum in surface water and associated prey.

The lowest NOAEL-based piscivorous bird food/drinking water benchmark was 0.64 mg/L for belted kingfisher, derived using a BAF of 100. The maximum molybdenum concentration (1.91 mg/L) (Table A2-4) is about three times higher than this benchmark. However, since piscivorous birds would integrate their exposure by foraging over a much larger area than the point where the maximum surface water concentration was detected, the average molybdenum concentration is more applicable. The average molybdenum concentration (0.05 mg/L) (Table A2-4) is about 1 order of magnitude below this benchmark. Consequently, since this derived NOAEL was not exceeded by the average molybdenum concentration, piscivorous birds would not likely be adversely affected by consumption of molybdenum in surface water and associated prey.

Further assessment of piscivorous avian and mammalian exposure to molybdenum in surface and associated prey is not warranted.

Nitrate. The maximum nitrate concentration was about 4 times the maximum background concentration (Table A2−4). There are currently no published wildlife drinking water or food/water benchmarks available for this constituent (Tables A2−4 and A2−5). Sample et al. (1996) provide methodology for deriving such benchmarks from other types of toxicological data. However, no benchmarks could be derived for nitrate using this methodology due to the lack of other toxicological data in the literature.

Consequently, drinking water standards for livestock were used. Guidelines for levels of nitrate in drinking water for livestock are as follows: 0 to 440 mg/L is considered safe; 440 to 1,300 mg/L is a cautionary level where the additive effect of nitrate in feed should also be considered; and over 1,300 mg/L is considered potentially toxic (Bagley et al. 1997). The maximum nitrate concentration (Table A2−4) falls near the bottom of the range of values considered safe for livestock. Thus, based on livestock drinking water standards, further assessment of wildlife exposure to nitrate in surface water is not warranted.

Selenium. The maximum selenium concentration was about 1 order of magnitude above background and exceeded by about 2 orders of magnitude the food/water benchmarks resulting in NOAELs and LOAELs for the river otter and mink (Table A2–4). The maximum selenium concentration exceeded by about 1 to 2 orders of magnitude the food/water benchmarks resulting in NOAELs and LOAELs for the belted kingfisher, osprey, and great blue heron (Table A2–5). The mean selenium concentration exceeded the river otter and mink NOAEL and LOAEL food/water benchmarks by 1 order of magnitude (Table A2–4), and the belted kingfisher, osprey, and great blue heron NOAEL and LOAEL food/water benchmarks by 1 order of magnitude or less (Table A2–5).

Thus, adverse effects to these species would be unlikely to result from food/water consumption at the location where the maximum selenium concentration was obtained because they would not obtain all their food/water from one location. However, adverse effects could potentially result from the mean selenium concentration if food/water consumption occurred largely within the sampled area. However, the mean selenium concentration (0.00446 mg/L [N=193, SD=0.0026]) in this area is virtually the same as the mean background concentration (0.00441 mg/L [N=15, SD=0.0021]). Thus, any adverse effects may not be attributable to the Moab site. Nevertheless, two samples (0.012 and 0.014 mg/L) from the contaminated portion of the river have selenium concentrations that are greater than two standard deviations above the mean (Table A2−4), and one sample concentration (0.026 mg/L) is greater than eight standard

deviations above the mean. These three samples were all collected on April 12, 2000, and there is no detection limit reported for them. Because of the uncertainty surrounding these high values and the associated potential for adverse effects to piscivorous mammals and birds at the three locations where they were obtained, further assessment is warranted.

Silver. Silver was undetected in all of the samples, and various silver detection limits were associated with the samples. The maximum silver detection limit (0.005 mg/L) was associated with only one sample, and it was higher than the maximum background silver detection limit (0.0001 mg/L) by a factor of 50 (Table A2–4). There are currently no published wildlife drinking water or food/water benchmarks available for this constituent (Tables A2–4 and A2–5). Consequently, as was done above for iron, drinking water benchmarks were derived for 9 mammal and 11 bird species using the methodology provided in Sample et al. (1996). The derived NOAEL-based drinking water benchmarks were then used to derive food/water benchmarks for piscivorous mammals and birds. A brief outline of the methodology used for deriving drinking water benchmarks follows.

First, mammal and bird NOAELs were either obtained from the results of laboratory experiments summarized in the literature or estimated from acute toxicity benchmarks summarized in the literature. A mammalian NOAEL of 222.2 mg/kg/day, with rats as test organisms and weight loss as the endpoint, was obtained from Ratte (1999) and Parametrix (2001). Because an avian NOAEL was unavailable, an avian LD_{50} of greater than 4,500 mg/kg/day, with quail as the test organism and no endpoint specified, was used (Parametrix 2001). Because the precise avian LD_{50} was not specified but was given as being an unknown value greater than 4,500 mg/kg/day, 4,500 mg/kg/day was used to be conservative. No standardized mathematical relationship exists between an LD_{50} and a NOAEL (Sample et al. 1996). Exposure levels associated with NOAELs may range from 1/10 to 1/10,000 of the acutely toxic dose (Sample et al. 1996). Consequently, a high and a low NOAEL were estimated by applying these factors to the avian LD_{50}, resulting in high and low avian NOAELs of 450 and 0.45 mg/kg/day, respectively.

The literature-based mammalian and avian NOAELs were used to derive NOAELs for the 9 mammal and 11 bird species listed above by adjusting for differences in body weight (kg) between the test organism and target species (Sample et al. 1996). These derived NOAELs (mg/kg/day) were then used to derive drinking water equivalents (mg/L) using the body weight of the target species and its rate of water consumption (L/day) (Sample et al. 1996). The lowest mammal drinking water benchmark was for white-tailed deer (952 mg/L), at least 5 orders of magnitude above the maximum silver detection limit (0.005 mg/L) (Table A2−4). The lowest of the high and low avian drinking water benchmarks were for the rough-winged swallow (3,517 and 3.5 mg/L, respectively). These values were between 5 and 6 and between 2 and 3 orders of magnitude, respectively, above the maximum silver detection limit (0.005 mg/L) (Table A2−4). Thus, adverse impacts to the 9 mammalian and 11 avian receptors are not expected from consumption of silver in surface water via drinking alone. No further evaluation of wildlife exposure to silver in surface water via drinking is warranted.

The above derived NOAEL-based drinking water benchmarks were then used to derive NOAEL-based food/drinking water benchmarks for the two piscivorous mammals (mink and river otter) and three piscivorous birds (belted kingfisher, great blue heron, and osprey) listed using the body weight of the species, its rate of water and food (kg/day) consumption, and BAF (Sample et al. 1996). Two BAFs of 5 and 10, each with a 10-fold error likely according to other data, were reported for the edible parts of fish in a critical review of BAFs in aquatic systems by Karlsson et al. (2002). Consequently, five food/drinking water NOAELs were derived for each piscivorous mammal and bird species, one for each BAF of 0.5, 1, 5, 10, and 100.

The lowest NOAEL-based piscivorous mammal food/drinking water benchmark was 123.97 mg/L for mink. The maximum silver detection limit (0.005 mg/L) (Table A2–4) is about 4 orders of magnitude lower than this benchmark. Consequently, since this derived NOAEL was not exceeded by the maximum silver detection limit, piscivorous mammals would be unlikely to be adversely affected by consumption of silver in surface water and associated prey. No further evaluation of piscivorous mammal exposure to silver in surface water and associated prey is warranted.

The lowest of the low NOAEL-based piscivorous bird food/drinking water benchmarks was 0.09 mg/L for the belted kingfisher. The maximum silver detection limit (0.005 mg/L) (Table A2–4) is about 1 order of magnitude lower than this benchmark. Consequently, since this derived NOAEL was not exceeded by the maximum silver detection limit, piscivorous birds would be unlikely to be adversely affected by consumption of silver in surface water and associated prey. No further evaluation of piscivorous bird exposure to silver in surface water and associated prey is warranted.

Sulfate. The maximum sulfate concentration was about 2 orders of magnitude above background (Table A2–4). There are currently no wildlife drinking water or food/water benchmarks available for this constituent (Tables A2–4 and A2–5). Sample et al. (1996) provide methodology for deriving such benchmarks from other types of toxicological data. However, no benchmarks could be derived for sulfate using this methodology due to the lack of other toxicological data in the literature.

Consequently, drinking water standards for livestock were used. Guidelines for levels of sulfate in drinking water for livestock are as follows. Sulfate levels up to 1,500 mg/L produce slight effects on livestock (objectionable taste); levels from 1,500 to 2,500 mg/L produce temporary diarrhea; and levels above 4,500 mg/L should not be used (Bagley et al. 1997).

The maximum sulfate concentration (Table A2−4) is about 3 times this maximum level (4,500 mg/L). Wildlife species would likely consume their water over a much broader area than from the location where the maximum sulfate sample was obtained. Thus, any effects would more likely be incurred by water consumption over the entire sampled area. The mean sulfate concentration (609.65 mg/L) in the sampled area could therefore produce slight effects on wildlife, based on the above guidance. This precludes further screening of wildlife exposure to sulfate in surface water. (Note that compounds that include sulfate are likely to be more toxic to terrestrial organisms than sulfate alone).

Summary of Chemical Impacts to Wildlife. From the 28 original contaminants, 11 preliminary contaminants of potential concern (aluminum, ammonia, cadmium, chloride, iron, mercury, molybdenum, nitrate, selenium, silver, and sulfate) were selected for further assessment. From

these, nine were excluded and two potential contaminants of concern were selected: mercury and selenium. These two were selected because they could potentially cause chronic adverse effects to piscivorous mammalian and avian species consuming food/water within the surface waters of the nearshore environment within the contaminated portion of the river.

Chemical Impacts to Plants. Plants may be exposed to contaminants via root or dermal uptake of contaminants. Of these, root uptake would likely be the primary exposure pathway. Soil contaminant data were available for only a limited area of the Moab site, at some temporary monitoring wells just northeast of the tailings pile. The soil samples were taken at a depth of from 0 to 1 ft at these locations (DOE 2003). It is currently estimated that 309 acres of contaminated soils at an average depth of from 12 to 18 inches would be removed (under the on-site and off-site disposal alternatives) from the Moab site and be replaced with 6 inches of borrowed reclamation soil. Thus, the sampled soil layer would be excluded as a source of potential impacts to plants, which themselves would be absent until the site was revegetated or otherwise recolonized following reclamation. Consequently, the existing soil contaminant data were not used to evaluate chemical impacts to plants. Instead, contaminants in the freshwater aquifer were used because they were considered more representative of the entire Moab site and because they will remain as a source of potential impacts to plants much longer than the top layer of soil.

Only root uptake is considered, since only phytotoxicity benchmarks based on root uptake were available. Maximum and mean concentrations of contaminants in the freshwater aquifer were obtained from Chapter 5.0 of the SOWP (DOE 2003) and screened based on their exceedance of available phytotoxicity benchmarks (Table A2–7). Soil solution phytotoxicity benchmarks were available only for the metals (Efroymson et al. 1997).

The following nine metals had maximum concentrations that exceeded maximum background concentrations and were slightly less than or exceeded phytoxicity benchmarks: aluminum, arsenic, cobalt, copper, iron, manganese, mercury, molybdenum, and vanadium (Table A2–7). Four of these metals had mean concentrations that were slightly below or above phytotoxicity benchmarks: arsenic, manganese, molybdenum, and vanadium. These nine metals, but particularly the latter four, could cause phytotoxic effects, assuming that plants had root access to the freshwater aquifer or associated soil water above it. In addition, these metals could become translocated to plant parts consumed by herbivorous wildlife or by terrestrial invertebrates that are in turn consumed by wildlife. Consequently, these metals could potentially cause toxic effects to wildlife. However, the nature and extent of such effects, if any, are unknown.

Radiological Impacts to Wildlife and Plants. Samples of radioactive constituents in surface water were collected by SMI, DOE, and the USGS between 2000 and 2002. Of the 10 radioactive contaminants sampled (excluding gross alpha and gross beta), 3 are evaluated here (uranium-238, uranium-234, and radium-226), since only these were included in the library of constituents of the RESRAD Biota Code (Version 1.0 Beta 3, June 3, 2003) (DOE 2002) used in this evaluation.

The RESRAD Biota Code was used to screen the radiological dose rate to generic (not species-specific) riparian animals and generic terrestrial plants based on the maximum observed concentrations of uranium-238, uranium-234, and radium-226 in surface water. The total radiological dose was estimated using the default parameters (e.g., BAFs) provided in the RESRAD Biota Code, since such site-specific data were lacking.

The total estimated radiological dose was divided by the applicable DOE dose limits or standards designed to protect the terrestrial (including riparian) environment, including populations of animals and plants. These dose limits or standards are 0.1 rad/day for terrestrial (including riparian) animals and 1 rad/day for terrestrial (including riparian) plants (DOE 2002). A quotient greater than 1 indicates exceedence of such a dose limit or standard and thus a potential risk of radiotoxic effects. Where a quotient exceeded 1, the RESRAD Biota Code was used to screen the dose rate based on the mean observed concentrations of uranium-238, uranium-234, and radium-226, since vertebrates integrate their exposure over a much larger area than the location from which the maximum concentration was obtained. Input maximum and mean concentrations and the corresponding quotients are provided in Table A2–8.

Table A2−7. Background Range and On-Site and Downgradient Range and Mean Concentrations of Metals in the Freshwater Aquifer and Soil Solution Phytoxicity Benchmarks

Constituent	Background Range (mg/L)	On-Site and Downgradient Range (mg/L)	On-Site and Downgradient Mean (mg/L)	Soil Solution Phytotoxicity Benchmark (mg/L)
Aluminum	<0.0076–<0.051	0.002–0.29	0.0207	0.3
Antimony	<0.0001–<0.011	<0.0001–<0.0029	0.000534	N/A[a]
Arsenic	0.00018–0.0015	<0.0001–0.361	0.0109	0.001
Barium	0.0222–0.033	<0.01–0.108	0.0362	N/A
Beryllium	0.002–0.002	<0.001–0.0021	0.000775	0.5
Bismuth	<0.011–<0.011	<0.001–<0.011	0.00158	20
Cadmium	<0.0001–<0.0017	<0.0001–0.0208	0.0018	0.1
Chromium	<0.0005–<0.011	<0.0005–<0.003	0.000638	0.05
Cobalt	<0.0013–0.002	0.00055–0.064	0.00755	0.06
Copper	<0.0004–0.005	<0.0004–0.068	0.0102	0.06
Iron	<0.0008–<0.05	<0.0008–17.1	1.28	10
Lead	<0.0001–<0.0055	<0.0001–<0.0055	0.000355	0.02
Lithium	0.0278–1	0.0201–1.71	0.373	3
Manganese	<0.0001–0.0157	<0.01–14.5	3.1	4
Mercury	<0.0001–<0.0002	<0.0001–0.003	0.000488	0.005
Molybdenum	<0.0018–0.01	<0.001–10.8	0.844	0.5
Nickel	<0.0006–0.015	<0.0006–0.089	0.0185	0.5
Selenium	0.0091–0.0266	<0.0001–0.205	0.032	0.7
Silver	<0.0001–<0.0055	<0.0001–<0.0055	0.000309	0.1
Thallium	<0.0001–<0.011	<0.0001–<0.011	0.000451	0.05
Uranium	0.0042–0.0259	<0.0001–23.3	2.76	40
Vanadium	0.00061–0.0164	<0.0003–7.1	0.154	0.2
Zinc	<0.0006–0.011	<0.0006–0.16	0.0129	0.4

N/A = not available.

Table A2−8. Maximum and Mean Concentrations of Radioactive Constituents Evaluated Using the RESRAD Biota Code and Corresponding Quotients

Constituent	Maximum Concentration (pCi/L)	Riparian Animal Quotient	Riparian Plant Quotient	Mean Concentration (pCi/L)	Riparian Animal Quotient	Riparian Plant Quotient
Uranium-238	413	1.4	9.87E-06	28.7	1.3E-01	[a]
Uranium-234	396			29.5		
Radium-226	1.27			0.21		

[a]The terrestrial plant quotient was not calculated for the mean concentrations of the radionuclide constituents, since the terrestrial plant quotient calculated for the maximum concentrations did not exceed 1.

The quotient of riparian plants based on maximum surface water concentrations was 6 orders of magnitude below 1 (Table A2–8). The quotient for riparian animals based on maximum concentrations slightly exceeded 1 and thus could be of minor concern if riparian organisms were to get all their exposure at the location where the maximum sample was taken. However, riparian vertebrates integrate their exposure over a much larger area, and the quotient for riparian animals based on mean concentrations was about 1 order of magnitude below 1 (Table A2–8). Consequently, there is no potential risk of radiotoxic effects for either riparian vertebrates or plants from these radiological constituents in surface water.

A2−3.0 References

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Appendix A3

Biological Opinion

(under development by USF&WS)