United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
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WEST VALLEY CITY, UTAH 84119

In Reply Refer To
6-UT-04-F-008

Mr. Don Metzler, Moab Project Manager
U.S. Department of Energy
2597 B¾ Road
Grand Junction, Colorado 81503

Dear Mr. Metzler:

Subject: Biological Opinion on the Surface and Ground Water Remediation at the Moab, Utah. Uranium Mill Tailings Radiation Control Act (UMTRCA) Site

In accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), this transmits the Fish and Wildlife Service's final biological opinion for impacts to federally listed endangered species for Department of Energy's (DOE) proposed action to remediate surface and ground water contamination at the Moab Site. Reference is made to your August 30, 2004, correspondence (received in our Utah Field office on August 31, 2004) which transmitted a biological assessment for our approval and requested initiation of formal consultation for the subject project. Our letter of September 20, 2004 approved the biological assessment as final and initiated formal consultation.

This biological opinion is based on information presented in the August 2004 biological assessment, the November 2004 Draft Environmental Impact Statement, the December 2003 Site Observational Work Plan, and other sources of information. I concur that aspects of the ground water remediation component of the proposed action may adversely affect the endangered Colorado pikeminnow *(Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*) and critical habitat.

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat. Section 3(5)(A) of the Act defines critical habitat as: (i) the specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features, (I) essential to the conservation of the species, and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. "Conservation" means the use of all methods and procedures that are necessary to bring an endangered or a threatened species to the point at which listing under the Act is no longer necessary.

Based on the information provided in the biological assessment, I concur that the proposed action may affect but is not likely to adversely affect, the threatened bald eagle (*Haliaeetus leucocephalus*), the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), the threatened Mexican spotted owl (*Strix occidentalis lucida*), the endangered Black-footed ferret (*Mustela nigripes*), the candidate yellow-billed cuckoo (*Cocyzus americanus*), and the candidate Gunnison sage grouse (*Centrocercus minimus*). 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. At the Crescent Junction disposal site 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.

In addition, I concur with the determination of no effect for the threatened Jones' cycladenia (*Cycladenia jonesii*), the threatened Navajo sedge (*Carex specuicola*), and the endangered clay phacelia (*Phacelia argillosa*) as these species are not known to occur in the project areas.

CONSULTATION HISTORY

The Atlas Moab Mill is located on the west bank of the Colorado River about 3.7 km (2.3 mi) northwest of Moab, Utah. The property and facilities were originally owned by the Uranium Reduction Company and regulated by the Atomic Energy Commission, precursor to the NRC. The mill and site were acquired by Atlas Corporation in 1962. Atlas activities at the Moab Mill site were covered by NRC Source Material License SUA-917, which was renewed in 1988. The mill ceased ore milling operations in 1984 and has been dismantled except for one building that DOE currently uses for maintenance and storage.

The USFWS=s Utah Field Office has been involved with the proposed reclamation of the Atlas mill tailings since 1979. At that time, the Department of Interior provided comments which were included in the Final Environmental Statement for the Atlas site. These comments included reference to the proposed critical habitat designation for two endangered fish, the humpback chub and Colorado pikeminnow.

In 1983, the USFWS identified in a letter to the Assistant Regional Director regarding a review of the Emergency and Remedial Response Information System Inventory, that the only site which may aversely affect threatened or endangered species was the Atlas Mineral Corporation mill tailings pile at Moab, Utah. The USFWS identified likely effects to Colorado pikeminnow and razorback sucker.

On August 28, 1992, the USFWS provided the Nuclear Regulatory Commission (NRC) with a letter identifying the presence of four endangered fishes in the Colorado River. This letter recommended that reclamation plans ensure that mill tailings material never enter the Colorado

River system, particularly over the long term when there may not be personnel or equipment to deal with problem situations. For example, in the middle 1980's the river level rose to the base of the tailings pile and equipment operators were barely able to keep the pile from sloughing into the river. At that time the USFWS advised the NRC that any depletion of water from the Colorado River system, including water used in dust suppression, is considered a Amay affect@ on the endangered Colorado River fish.

On May 13, 1994, the USFWS sent a letter to the Secretary, NRC, providing review and comment on the Notice of Intent to prepare an Environmental Impact Statement. In this letter, the USFWS identified and attached our August 1993 memoradum from our Regional Office in Denver that provided extensive comments on the Environmental Assessment. Issues included water depletion from the Colorado River; groundwater contamination; release of toxic elements; the lack of a discussion of laboratory practices for chemical analyses of toxic elements; selenium in surface water; radiological hazards to wildlife and Atake@ under the Migratory Bird Treaty Act; the lack of contaminant studies in fish, and whether the area would truly be a maintenance free closed system for 200--1,000+ years.

On November 2, 1994, the USFWS provided an updated list of species that may be affected by the reclamation of the Atlas mill tailings, this time to Oak Ridge National Laboratory, Tennessee. Oak Ridge was a consultant working for the NRC on preparation of the Environmental Impact Statement for the proposed action. In this letter the USFWS identified that, not only were four endangered Colorado River fishes (Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub) likely to occur in the vicinity of the proposed project site, but that the peregrine falcon (*Falco peregrinus*) and Jones cycladenia (*Cycladenia humilis* var. *jonesii*) also may be present. The USFWS reiterated that indirect effects could result from water depletions associated with the project. Water depletions, including water used for construction activities such as dust suppression, drilling, and mixing of concrete, from the upper Colorado River Basin is considered a jeopardy and an adverse modification of designated critical habitat for the endangered Colorado River fishes.

On January 11, 1995, the USFWS provided comments on the Preliminary Draft Environmental Impact Statement (PDEIS). In these comments the USFWS identified that it did not agree with the conclusions drawn in the PDEIS regarding tailings contamination of the Colorado River. The PDEIS concluded minimal impact on water quality and minimal toxicity effects to wildlife. The USFWS identified that some contaminants of concern can bioaccumulate to harmful levels in wildlife even when contaminant levels remain below water quality standards, and that sampling of aquatic biota is the best way to determine if contaminants are bioaccumulating in the food chain. Dilution by the Colorado River was not an effective means of mitigation for contaminants being carried into the river from the Atlas mill tailings pile. Selenium contamination was a concern and the literature indicated detrimental effects on fish and waterfowl from selenium levels of 1-3 Fg/L in water (Peterson and Nebeker 1992; Hamilton and Waddell 1994; Skorupa and Ohlendorf 1991). Furthermore, USFWS comments identified inadequate sediment and biota sampling in the river and in the Scott M. Matheson Wetlands Preserve across the river channel and recommended sampling benthic invertebrates, aquatic plants, and nonendangered fish. The PDEIS provided inadequate radiological hazard evaluation, and an inadequate examination of the environmental impacts of a tailings pile failure.

In April 1995, contaminants staff from the USFWS=s Utah Field Office participated in a 2-day meeting in Moab to determine necessary studies to characterize the tailings pile constituents and to determine what leachates, if any, were escaping from the pile into the Colorado River. At this meeting the Federal representatives developed a list of recommended objectives and protocols for the Atlas/NRC study of the Colorado River below the Atlas tailings pile. The USFWS expressed a need for additional data at the site in order to make informed decisions on environmental impacts. These recommendations were submitted to the NRC and their consultants. For a variety of reasons, most of the recommended data collections were not conducted.

On November 2, 1995, the USFWS received the biological assessment on the proposed reclamation of the Atlas mill tailings from the NRC with a request for formal consultation pursuant to the Endangered Species Act of 1973, as amended. Review of the biological assessment prompted the USFWS to request additional materials and analysis in a letter dated February 15, 1996. The limited data did not accurately assess potential impacts to the endangered fish species in the Colorado River, and required additional analyses.

On March 28, 1996, the USFWS forwarded comments on the Draft Environmental Impact Statement to the National Park Service. The National Park Service coordinated Department of the Interior comments on the Draft document. After having fully reviewed the Draft Environmental Impact Statement and the Biological Assessment and receiving the results of some additional analyses, the USFWS provided the NRC with a letter, on July 22, 1996, which related its ongoing concerns regarding the paucity of data on toxic elements released into the Colorado River system from the Atlas mill tailings pile, as well as the inconsistency in data results. Additionally, the USFWS recommended a meeting between the USFWS, the NRC, and Atlas Corporation to discuss additional data needs.

On August 15, 1996, the USFWS met with the NRC and Atlas Corporation to discuss data needs and USFWS comments on the Draft Environmental Impact Statement. The Atlas consultants, Harding-Lawson Associates, presented some additional data concerning the hydrology of the region and the studies that had been conducted to date.

On October 21, 1996, USFWS staff again met with Atlas Corporation and the NRC to discuss regional hydrogeology, surface water quality issues, the potential effects of the tailings pile on the Colorado River and NRC requirements for the Ground Water Corrective Action Plan.

One additional meeting was held with USFWS staff, Atlas Corporation, NRC, and Department of Interior personnel to discuss the Departments= comments on the Draft Environmental Impact Statement and Atlas=s response to these comments. This meeting was held on December 17 and 18, 1996.

On January 14, 1997, the USFWS provided the NRC with a letter which detailed ongoing issues relating to the section 7 consultation and the National Environmental Policy Act process including: completion of the National Environmental Policy Act process prior to completion of the section 7 consultation; the possible impacts to endangered species from the contaminated groundwater underneath the tailings pile; impacts to listed species from the relocation of Moab Wash; evaluation of the analytical methods used to characterize the leachate from the pile; the lack of data characterizing the tailings pile itself; high concentrations of ammonia at and below the Atlas site, and the presence of southwestern willow flycatcher habitat at the site. The southwestern willow flycatcher had not been included in earlier species lists provided by the USFWS because the species was not listed as endangered until February 27, 1995.

On January 30, 1997, the USFWS received the supplemental biological assessment on the proposed reclamation of the Atlas mill tailings, with a cover letter requesting formal section 7 consultation pursuant to the Act.

On February 3, 1997, the USFWS received a letter from Atlas Corporation transmitting Atlas=s perspective on several of the procedural or process and technical issues identified in the USFWS=s January 14, 1997, letter to the NRC.

On February 6, 1997, the USFWS received a revised letter from Atlas Corporation requesting that the USFWS replace the February 3, 1997, letter with this new letter. There were no substantive changes or alterations.

On February 18, 1997, the USFWS sent a letter to the NRC acknowledging receipt of the supplemental biological assessment and request for formal consultation. In that letter the USFWS identified that it would provide the NRC with a biological opinion by June 15, 1997.

On March 27, 1997, the USFWS received a letter from Atlas Corporation providing Colorado River water depletions information and proposed actions for the Ground Water Corrective Action Plan.

On June 26, 1997, the USFWS released its Draft Jeopardy Biological Opinion for the proposed reclamation of the Atlas mill tailings site in Moab, Utah. Comments on the Draft Biological Opinion were received from the NRC, dated August 12, 1997, and Atlas Corporation and their consultants, dated August 6, 1997.

On September 9, 1997, USFWS staff participated in a meeting arranged by the Grand Canyon Trust, with staff from Oak Ridge National Laboratory/Grand Junction, the National Park Service, USFWS, the State of Utah (by phone), and Grand Canyon Trust, to discuss the potential effects of contaminated groundwater discharge to the Colorado River from the Atlas pile. The Oak Ridge National Laboratory/Grand Junction was assigned the task of developing a sampling scheme to more accurately delineate the content and width of the contaminant plume. A proposal was distributed September 19, 1997.

Given the differing opinions concerning the USFWS=s Draft Jeopardy Biological Opinion, the entire matter was elevated to the Council of Environmental Quality and the Office of the Secretary of Interior. The Council of Environmental Quality approved the Oak Ridge National Laboratory/Grand Junction study proposal.

On October 23, 1997, a meeting was held in the USFWS=s Denver office to address the status of the Oak Ridge National Laboratory/Grand Junction study proposal and refine the work plan. Participants included the USFWS, Oak Ridge National Laboratory/Grand Junction, NRC, Atlas Corporation, and Atlas=s consultants, Harding-Lawson Associates. At the meeting Oak Ridge

National Laboratory/Grand Junction agreed to perform the work and provide a report 60 days following the awarding of funds. Subsequently, Atlas Corporation, the NRC, and the USFWS agreed that following receipt of the Oak Ridge National Laboratory/Grand Junction report, the USFWS would issue a revised draft biological opinion within 30 days. The NRC and Atlas Corporation would have 10 days to review the revised draft biological opinion and provide comments to the USFWS. The USFWS would then have an additional 30 days to finalize the biological opinion. On November 10, 1997, Oak Ridge National Laboratory/Grand Junction began work on the approved study and on January 9, 1998, submitted the final report to the USFWS (received on January 12, 1998) and the NRC.

Upon receipt and review of the January 9, 1998, Oak Ridge National Laboratory/Grand Junction (1998a, 1998b) studies, the USFWS determined that additional modeling would be necessary to determine the long term impacts of leaving the tailings pile in place as opposed to moving it. An additional study that supplemented the earlier modeling effort was agreed to by the NRC and Atlas Corporation and conducted by Oak Ridge National Laboratory/Grand Junction (1998c). Shortly into this modeling effort, the NRC decided that a further modeling effort, one which modeled the long term contaminant levels in the Colorado River, was necessary. On February 5, 1998, USFWS staff met with the NRC, Atlas Corporation, Harding-Lawson Associates, and Oak Ridge National Laboratory/Grand Junction to discuss future modeling needs. At this meeting Oak Ridge National Laboratory/Grand Junction presented the completed supplemental modeling requested by the USFWS. After hearing the presentation, the NRC determined that additional future modeling was not necessary. All parties agreed to proceed with a revised draft biological opinion, to be delivered to the NRC by March 2, 1998.

In a letters to NRC dated March 2, 1998 and March 11, 1998, Atlas Corporation granted a 30-day extension for issuance of the USFWS=s revised draft biological opinion. The letter from Atlas Corporation stated that the length of this extension would be determined pursuant to discussions to be immediately undertaken among Atlas, the NRC, and the USFWS. This consultation timeline was in part dependent on a response from the USFWS whether the NRC could require Atlas Corporation to move the tailings pile out of the Colorado River floodplain. The USFWS provided said response in a letter dated March 11, 1998, which stated that the NRC did not have the authority to make Atlas Corporation move the pile.

On April 14, 1998, the USFWS issued a Revised Draft Biological Opinion. Numerous comments were received on the Revised Draft Biological Opinion from the NRC and Atlas Corporation. These comments facilitated a meeting that was held between the NRC, the USFWS, and Atlas Corporation on May 21 and 22, 1998 followed by subsequent conference calls. All parties agreed that upon receipt of a letter from Atlas Corporation identifying several specific time frames for completion of proposed actions, the USFWS would issue a final biological opinion within 30 days. The USFWS received said letter on May 29, 1998.

In a letter dated June 30, 1998, the parties agreed to an additional extension. The USFWS agreed to complete and transmit a draft final biological opinion to the NRC and Atlas Corporation by July 10, 1998, and the final biological opinion by July 20, 1998. On July 9, 1998, the USFWS completed and transmitted the draft final biological opinion.

In a conference call on July 16, 1998, the parties agreed to extend the date of issuance of the final biological opinion to July 24, 1998. Letters from Atlas and the NRC agreeing to the extension were received by the USFWS on July 20, 1998.

The USFWS issued its Final Biological Opinion on July 29, 1998. At that time, it was the USFWS'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; a reasonable and prudent alternative is summarized below:

1. Develop a revised groundwater corrective action plan necessary to reduce leaching from the pile and other sources such that the fish are no longer jeopardized and the habitat is no longer adversely modified.
2. Assure that ammonia levels will be reduced to levels avoiding future jeopardy to the endangered fish. The NRC shall incorporate, whether by order or through the request of Atlas Corporation, ammonia as a new constituent in the license held by Atlas Corporation.
3. In order to more effectively determine cleanup levels required to remove jeopardy to listed species, the Service initiated previously planned bioassay studies. These bioassay studies will be conducted by the Columbia Laboratory of the Biological Resources Division, U.S. Geological Survey and shall be initiated in July 1998. In order to effectively conduct these studies the Service, and other personnel participating in the study, will require access to the Atlas property to carry out the study. The NRC shall ensure that access is permitted to the site for purposes of conducting the study.
4. The NRC shall consult with the Service, pursuant to section 7, before establishing alternate concentration limits, and exceptions thereto, at the site.
5. Depletion impacts for 154.3 ac-ft (ac-ft) of Colorado River water were addressed through the Recovery Program.

The Final Biological Opinion provided a set of reasonable and prudent measures that would help to minimize take. The USFWS also concluded that the proposed action would not jeopardize the southwestern willow flycatcher and provided reasonable and prudent measures and terms and conditions to minimize take of that species. The peregrine falcon was not addressed in the Biological Opinion.

NRC published its final EIS in 1999. In March 1999, a trust was created to fund future reclamation and site closure. Atlas was released from all future liability with respect to the uranium mill facilities and tailings impoundment at the Moab Site. The bankruptcy court appointed NRC and the Utah Department of Environmental Quality (UDEQ) beneficiaries of the Atlas bankruptcy trust. Later, the beneficiaries selected PricewaterhouseCoopers to serve as trustee. In October 2000, the Floyd D. Spence National Defense Authorization Act (Floyd D. Spence Act) for fiscal year (FY) 2001 (Public Law 106-398) amended UMTRCA Title I (which expired in 1998 for all other sites except for ground water remediation and long-term radon management), giving DOE responsibility for remediation of the Moab Site. That act also mandates that the Moab Site be remediated in accordance with UMTRCA Title I "subject to the availability of appropriations for this purpose" and requires that DOE prepare a remediation plan to evaluate the costs, benefits, and risks associated with various remediation alternatives. The act further stipulates that the draft plan be presented to the National Academy of Sciences (NAS) for review. NAS is directed to provide "technical advice, assistance, and recommendations" for remediation of the Moab Site.

Under the act, the Secretary of Energy is required to consider NAS comments before making a final recommendation on the selected remedy. If the Secretary prepares a remediation plan that is not consistent with NAS recommendations, the Secretary must submit a report to Congress explaining the reasons for deviating from those recommendations. DOE's *Preliminary Plan for Remediation* (DOE 2001) for the Moab Site was completed in October 2001 and forwarded to NAS. After reviewing the draft plan, NAS provided a list of recommendations on June 11, 2002, for DOE to consider during its assessment of remediation alternatives for the Moab Site. DOE addressed the NAS recommendations in their internal scoping for the project EIS and in their draft EIS which was made available for public comment on November 5, 2004. Ultimately, DOE will need to finalize their RAP, which will need to be approved by the NRC. The RAP would provide the detailed engineering reclamation design and incorporate a ground water compliance strategy and corrective actions. DOE indicates that the RAP would likely follow issuance of a NEPA Record of Decision.

In letters dated, April 25, 2000 and June 28, 2000, the USFWS requested the NRC to reinitiate Endangered Species Act Section 7 consultation based on new information relating to higher than anticipated fish mortality from contaminated ground water entering the Colorado River and delays in submitting a ground water corrective action and dewatering plans. NRC responded on May 25, 2000 and September 22, 2000, with a request that the USFWS answer questions and issues raised by counsel for the trustee including the necessity and appropriateness for the reinitiation. On December 7, 2000 the USFWS again requested the NRC to reinitiate consultation due to the profound and fundamental changes in the proposed remediation plan resulting from passage of the Floyd D. Spence Act, which required that the site be turned over to the DOE and authorized the trustee to undertake ground water remediation at the Atlas site in the interim. In their final response dated December 20, 2000, NRC declined to reinitiate consultation with USFWS and instead requested informal Section 7 consultation.

In a letter dated February 8, 2001, the USFWS indicated that they could not engage in informal consultation once formal consultation has been completed and withdrew the Final Biological Opinion. In that same letter the USFWS informally consulted on actions the NRC and the DOE had agreed needed to be accomplished prior to official transfer of the site. Responsibility for the mill site was officially transferred to DOE prior to October 30, 2001.

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 USFWS concerning threatened and endangered species that may be affected by these activities. These consultations, and DOE determinations, resulted in concurrences by USFWS 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 adversely affect 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 USFWS in March 2003. USFWS 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 USFWS 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 USFWS, 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, USFWS and DOE met in Salt Lake City to further discuss applicable risk-based criteria and standards to ensure the protection of endangered fish. On November 3, 2003, the draft BA was forwarded to USFWS for comment. DOE received initial comments on the BA in early December 2003. Following receipt of the comments, a meeting occurred on December 15, 2003. Additional comments were transmitted by USWFS in early January 2004, followed by telephone conferences to clarify issues and concerns.

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

On August 10, 2004, USFWS provided formal comments to DOE on the final draft BA. DOE incorporated those comments and on August 30, 2004, sent a BA and a cover letter requesting our approval of that version as final. USFWS responded with a letter on September 20, 2004 accepting the latest version of the BA as final and committed to having a draft BO to DOE by January 31, 2005.

On January 31, 2005 the USFWS sent a letter requesting an extension on the draft BO due date until March 17, 2005. DOE agreed to that extension, via email on February 14, 2005.

On April 6, 2005, DOE announced their preferred alternatives for tailings disposition and ground water remediation. Off-site disposal at the Crescent Junction site was selected as the preferred disposal location for the tailings, and transportation by rail was the preferred transportation mode. DOE also selected active ground water remediation at the Moab site as its preferred ground water compliance strategy.

BACKGROUND

The Atlas tailings pile is about 0.8 km (0.5 mile) in diameter and 28.65 m (94 feet) high. It rises to an elevation of 1237 m (4058 ft) above mean sea level. The pile is located 3.7 km (2.3 mi) northwest of Moab, Utah and occupies about 53 ha (130 acres) of land about 230 m (750 ft) from the Colorado River. It consists of an outer compact embankment of coarse tailings and an inner impoundment of both coarse and fine tailings. An interim cover of uncontaminated earth covers the tailings. The amount of tailings is estimated to total 9.5 million metric tons (10.5 million tons).

Initial tailings pond construction was completed in 1956, and with the exception of brief periods, tailings were disposed in the pond continuously from initial startup in October 1956 until the mill ceased operations and was placed on standby status in 1984. The pile has five embankments that were raised to their present elevation of 1,237 m (4,058 feet) above mean sea level after Atlas's 1979 license renewal. A 5.5 m (18 foot) raise in embankment elevation to a projected final elevation of 1,242 m (4,076 feet) was reviewed and approved under License Amendment No. 7 dated June 30, 1982. However, the embankment raise was never initiated because the added capacity was not needed when the mill subsequently entered a long-term shutdown status.

During early operations Atlas utilized an acid leach process for uranium milling. During this period, lime was added to the mill tailings to help neutralize the tailings. In 1961 an alkaline leach process was initiated. In 1967 a new acid leach circuit was installed and, for a period of time, both the acid circuit and an alkaline circuit were operated. From 1982 through 1984, only an acid leach process was used with no neutralization of process water because a recycle process was in use.

To collect water draining from the tailings pile embankments, two sump pits were excavated in the 1980's, one on the northeast side of the pile and the other on the south end of the pile. Pumps were installed to collect the seepage water and pump it to an evaporation pond on top of the tailings pile. Water did not collect in the pits for several years, and the pumps were subsequently removed. The NRC amended Atlas=s license to allow disposal of radioactive contaminated solid waste in the south sump pit.

The 1982-1984 phase of operations appears to have resulted in increased metals mobilization as a result of the lower pH of the water and tailings associated with the acid leach circuit. After the NRC conformed its groundwater regulations to the Environmental Protection Agency=s, they required Atlas to initiate a compliance monitoring and corrective action program by July 1990. A revised program was prepared by Atlas and found acceptable with modification. The program included the establishment of groundwater quality standards, point-of-compliance wells, a background well, sampling frequency, groundwater sampling points, selected constituents for which the groundwater was to be analyzed, and enhanced drying of the tails. Wells were drilled into the tailings to pump water to an evaporative pond on the top of the tailings pile.

Atlas conducted cleanup of windblown tailings and other contaminated soils in several areas on the site. These areas were along the west side of State Route (S.R.) 279, between the tailings pile and the highway, an area northwest of the tailings pile, and an area of about 3 ha (7 acres) southeast of the tailings pile. Cleanup involved excavating the windblown tailings and contaminated soil and placing them on the tailings pile.

Since DOE took over responsibility for the site in 2001, they have instituted environmental controls and interim actions to minimize potential adverse effects to human health and the environment in the short term. Controls have included storm water management, dust suppression, pile dewatering activities, and placement of an interim cover on the tailings to prevent movement of contaminated and windblown materials from the pile. Interim actions have included restricting site access, monitoring ground water and surface water, and managing and disposing of legacy chemicals. A pilot-scale ground water extraction system was implemented in summer 2003, which has intercepted a portion of the ground water contaminants discharging into the Colorado River. Contaminated ground water is pumped to the top of the pile for evaporation.

DESCRIPTION OF THE PROPOSED ACTION

DOE is proposing to remediate contaminated soils and materials and contaminated ground water at the Moab Site. In addition, DOE has determined properties in the vicinity of the Moab Site (vicinity properties) may contain contamination and require remediation. These properties include portions of the state highway and railroad rights-of-way, BLM property, and Arches National Park. Surface contamination at the Moab Site and vicinity properties would be consolidated at the Moab Site prior to transportation by railroad to a disposal site near Crescent Junction, Utah. The ground water remediation goal is to reduce concentrations of five contaminants reaching the Colorado River to acceptable risk levels within 10 years of the ROD. Ground water remediation, as proposed, seeks to reduce concentrations of ammonia reaching the Colorado River surface waters to protective levels. DOE presumes that by reducing ammonia concentrations the other contaminants will be reduced to protective levels as well. Following informal consultation with the Utah Field Office in 2003 and 2004 DOE implemented initial and interim actions to begin reducing ammonia concentrations prior to full implementation of proposed ground water remediation.

The following description of the proposed action is based on information provided in the biological assessment, the DEIS and the SOWP (DOE 2003a) and technical appendices to those documents.

Disposal Cell Recountouring, Stabilization, and Capping – Figure 1 provides a conceptual cross-section of the final condition of the disposal cell. The figure also illustrates the types and approximate dimensions of the materials that would be placed on the sides and top of the pile to contain radon emissions and stabilize the cell. This is a conceptual design and diagram only. The conceptual design is strictly intended to establish a reasonable basis for evaluating environmental impacts between the alternatives associated with this component of site remediation and reclamation. This assumed design is not intended to commit DOE to any specific cover design. A detailed design would be developed in DOE's Remedial Action Plan (RAP) following the ROD.

Should the final design differ substantially from the design considered here, DOE would assess the significance of these changes as they relate to the decision-making process and the requirements of NEPA and ESA.

Remediation of Surface Contamination: Disposal at the Crescent Junction Site

The tailings pile, contaminated on-site soils and materials not yet in the existing pile, and contaminated materials from the vicinity properties would be transported to the Crescent Junction Site. Contaminated materials would be transported by rail. Activities under the proposed action will therefore occur at the Moab Site as well as at the off-site disposal site: Crescent Junction.

Activities at the Moab Site 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, DOE has estimated that about 98 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 Crescent Junction Site.

In addition to the surface disturbance at the Moab Site, an additional 1200 acres would be subject to disturbance at the Crescent Junction site, borrow areas and for transportation. Additional activities at the disposal site would include preparing the disposal cell and constructing similar support facilities as at the Moab Site.

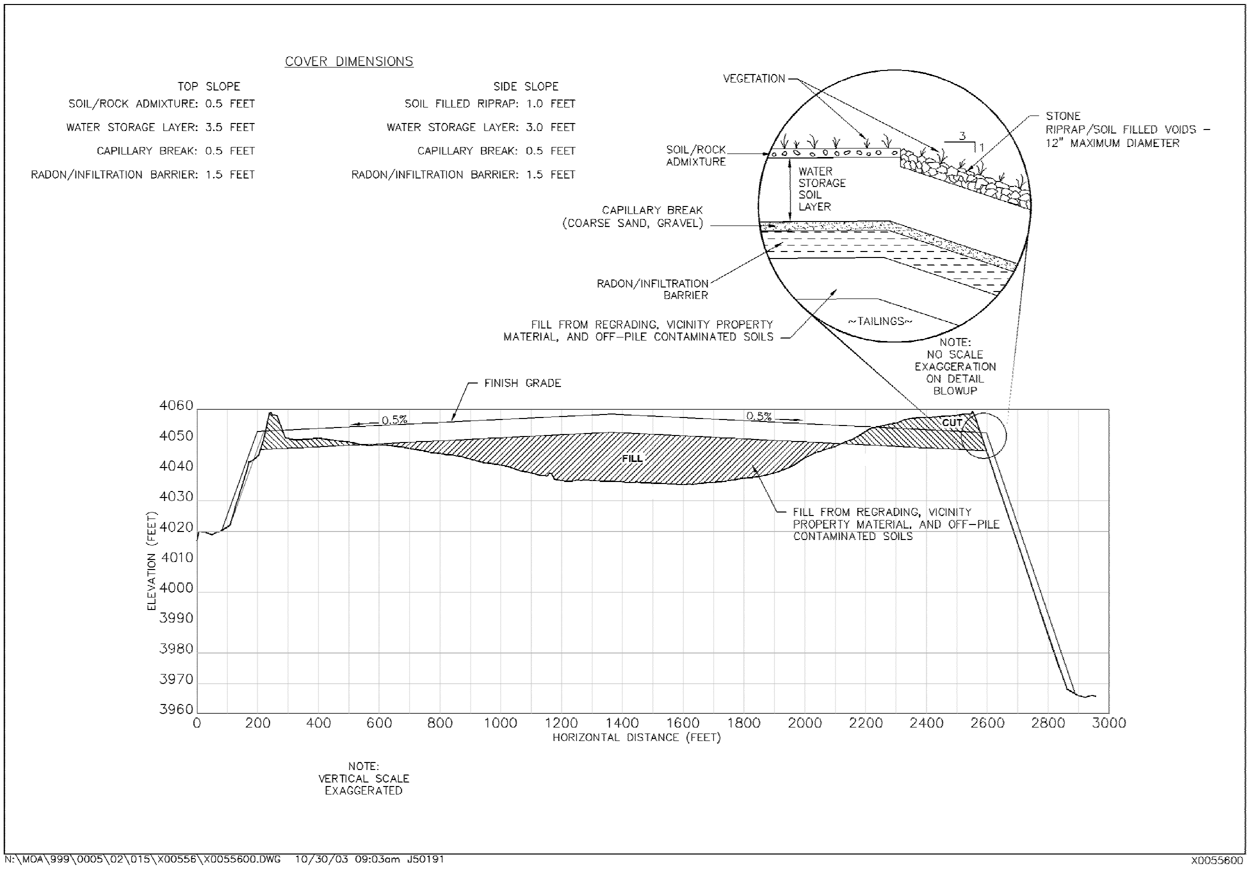

Figure 1. Cross Section of Disposal Cell designed for the Moab Site. Presented here as a conceptual design for the Crescent Junction Site. (reproduced from DEIS)

Table 1 shows areas of disturbance at borrow areas. The degree of disturbance would depend upon the borrow areas actually used and would be included in the RAP.

Rail transport would require construction of a loading facility at the Moab Site and some additional track and unloading facilities at the Crescent Junctin site.

Information provided in DOE's DEIS offers a more detailed description of activities associated with surface remediation: construction and operation at the Moab Site, characterization and remediation of vicinity properties, construction and operation at the borrow areas, preparation of contaminated materials for transport, final site reclamation and water depletions. These project details were reproduced from the DEIS.

Construction and Operations at the Moab Site -

Contaminated materials from vicinity properties would be transported to the Moab Site, stockpiled on site and prepared for transportation to an off-site disposal site. DOE projects surface remediation activities at the Moab Site would be complete in the year 2012 provided construction begins as proposed in 2007.

Preparation of contaminated materials for transport off-site - Before it could be transported by rail, the material in the tailings pile would have to be excavated and dried to a specified moisture content by drying in a process bed and mixing with drier material. To accomplish this, approximately 32 acres at the northwest and east base of the pile and an additional 14 acres around the top perimeter of the pile would be used as drying or processing areas. These areas would be accessed by temporary haul roads. There would be approximately seven separate 6- to 7-acre process beds in the areas. DOE has previous experience successfully moving wet tailings, including saturated slimes, at other UMTRCA sites such as at the Riverton (Wyoming), Rifle (Colorado), Monument Valley (Arizona), and Grand Junction (Colorado) sites.

Once the process beds and haul roads were constructed, pile excavation would begin. An excavating machine located on the perimeter of the pile would excavate from the center of the pile outward. The excavating machine would drag slimes from the center and pull them over and into the perimeter sands, providing some mixing during the excavation. The coarser tailings sands at the outer perimeter of the pile would be excavated and moved to the process beds using scrapers. This method would allow a progressive top-down excavation sequence that would maintain the stability of the perimeter tailings dike surrounding slimes and also allow continuous use of the perimeter area material for processing. As saturated slimes were excavated from the center of the pile, the material would be loaded onto trucks and taken to the process beds for mixing and drying. A tractor would turn and dry the graded material until it reaches a consistent moisture content suitable for truck or rail transport. Assuming dry tailings were available for mixing with wet tailings, the mixing and drying process for a load of excavated material would take approximately 3 days; if dry tailings were not available for mixing, the material would be processed for 7 days prior to shipment. The approximate maximum daily volume of material that could be placed for processing would be 15,500 yd^3 in each process bed of approximately 6 to 7 acres. Should tailings drying take additional time, slightly greater areas for drying would be necessary to allow sufficient inventory of tailings to be dried and transported according to the planned schedule. Once the material was sufficiently dry, it would transported by a conveyor system and loaded onto waiting gondola cars.

After excavation of the pile reached the assumed original grade, it would continue until the cleanup criterion had been met. On the basis of limited existing data, DOE estimates that subpile excavation to a depth of 2 ft would be required.

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

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

DOE estimates that all 8,867,400 yd^3 of source materials (uranium mill tailings, pile surcharge, subpile soils, off-pile contaminated soils, and vicinity property materials) weighing approximately 12,000,000 tons would need to be hauled off site. Estimates of the time to transport contaminant offsite range from: 3.3. years if four round trips are completed per day to 1.6 years if 8 round trips are completed daily. DOE provides preliminary details addressing the wide ranging considerations of infrastructure needed at the Moab Site, at the Crescent Junction Site and points between in their DEIS.

Water Depletions - DOE estimates that on average of 130 - 235 ac-ft would be depleted annually for approximately 5 years to implement the preferred alternatives and transportation mode.

Conservation Measures:

1. Moab Wash would be reconstructed in its general present alignment. The channel would be lined with riprap and designed to carry the estimated runoff volume for a 200-year flood. Larger flows would be allowed to flood into channel overbank areas.
2. DOE's contractor would verify that radium-226 concentrations in soil within the Moab Site boundary did not exceed EPA standards in 40 CFR 192. The entire site would then be graded and re-contoured. The water storage ponds would be backfilled to original grades prior to reclamation. Approximately 425,000 yd^3 of fine-grained silty- to sandy-loam reclamation soil excavated from the Floy Wash borrow area (or other suitable site) would be imported as backfill for the Moab Site.

Remediation of Ground Water Contamination:

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 (see below). These actions would be in addition to the initial and interim actions described below. 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. DOE claims 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. 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 DOE's preferred ground water remediation alternative (Figure 2). More detailed information is presented in Section 2.3 of the EIS.

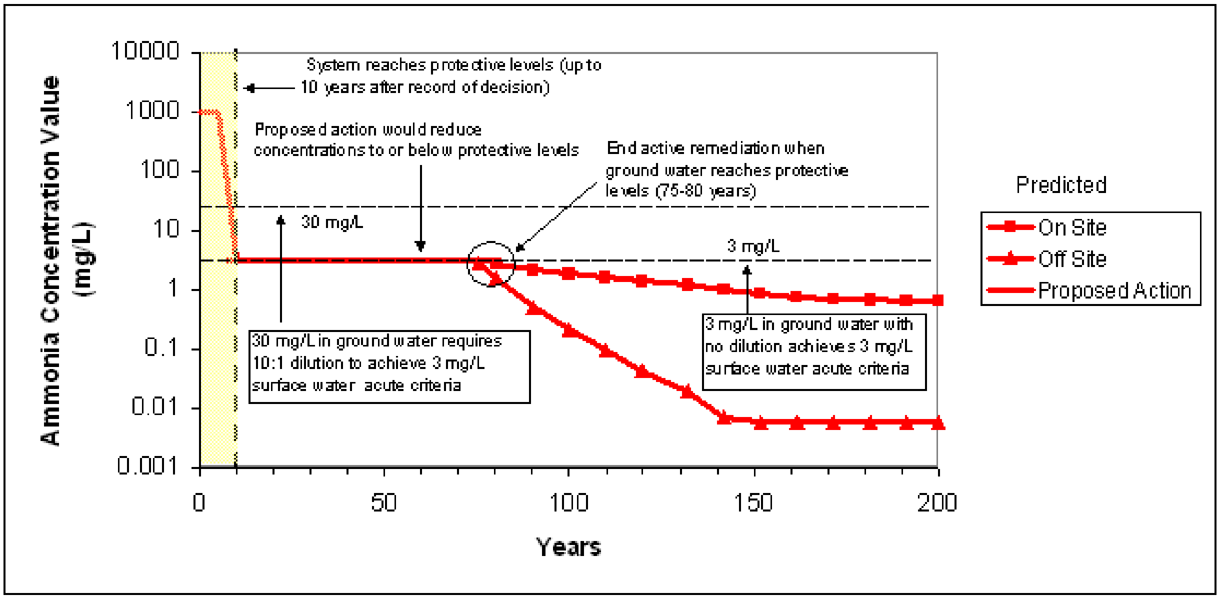

Figure 2. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation

Supplemental standards (40 CFR 192), would also be applied to ground water at the site. The uppermost aquifer at the Moab Site contains a highly saline (salty) water, often referred to as brine, which can be as thick as 400 ft, overlain with a thin layer of less salty water. Because ground water in the major portion of the uppermost aquifer has a TDS content exceeding 10,000 milligrams per liter (mg/L), the aquifer meets the definition of a limited-use aquifer as described in EPA's *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy* (EPA 1988). Supplemental standards are regulatory standards that may be applied when the concentration of certain constituents (in this case, total dissolved solids [TDS]) exceeds the normally applicable standards (e.g., MCLs; see 40 CFR 192, Subpart C for further explanation) for reasons unrelated to site contamination.

Remediation Goals for Contaminants of Concern: Aquatic goals - Remediation goals are based on the contaminants of concern identified in Appendix A2 of the EIS (refer to Table 2). In Appendix A2 of the EIS, *Screening of Contaminants to Aquatic and Terrestrial Resources*, DOE 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, 2005a). 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 of all contaminants of concern at levels protective of aquatic species.

Table 2 . 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	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.

Remediation Goals for Contaminants of Concern: Terrestrial goals -
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. Limited potential is based on 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 DOE would inform USFWS, and reasonable and prudent measures would be agreed upon and implemented in order to minimize take. If adverse effects could not be avoided, DOE has committed to additional Section 7 consultation.

Initial and Interim Actions at the Moab Site as Related to the Proposed Action - Upon accepting responsibility for the Moab Site, DOE initiated consultations with USFWS. Based on these consultations, and after reviewing historical surface water quality studies and data, DOE and USFWS 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, USFWS 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. It is anticipated that the initial action would be phased out as the interim and subsequent ground water remediation actions reduce ammonia to safe concentrations.

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 1) 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, USFWS 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 2) 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.

As reported in DOE's *Fall 2004 Performance Assessment of the Ground Water Interim Action Well Fields at the Moab, Utah, Project Site* (DOE 2005b) the Phase 1 well field removed an estimated total volume of 5,246,106 gallons of ground water between June and October of 2004. The estimated total masses of ammonia and uranium removed by Phase 2 wells during this period were 16,700 and 55 kg, respectively. During September and the first week in October of 2004, Phase 2 extraction wells removed an estimated total ground water volume of 821,583 gallons. The mass withdrawals of ammonia and uranium associated with this extraction volume were 3,130 and 7 kg, respectively.

Ground Water Remediation Options – DOE proposes that 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 3 shows the area of proposed ground water remediation. Final selection of the most appropriate option(s) would be documented in DOE's remedial action plan (RAP) and would depend upon which surface disposal alternative is selected. These options, which are described in detail in Section 2.3 of the EIS include:

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

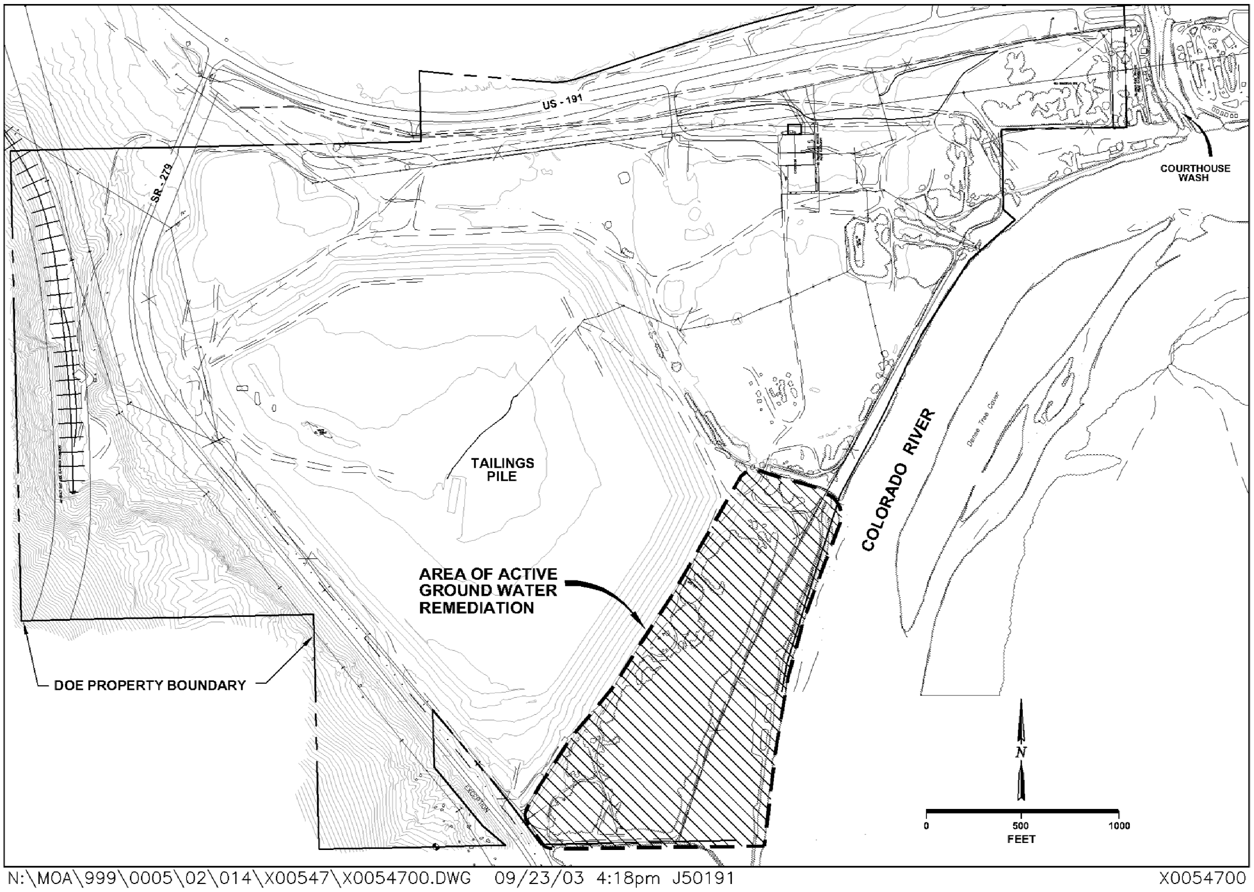

Figure 3. Area of Proposed Active Ground Water Remediation

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 was included in more detail in the 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 USFWS.

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, or 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, Leadville Limestone, 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): Under this scenario, 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.

DOE will fully describe their final approach to ground water remediation in the RAP, which the Service will review to determine the need for additional Section 7 consultation.

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 USFWS. 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 USFWS. In addition, DOE would provide monitoring data and remediation results annually to USFWS.

DOE's Groundwater Remediation 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. 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. DOE's model predictions, supported by site-specific data, indicate that long-term ground water concentrations adjacent to the river 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.

Ground Water Remediation Conservation Measures

On the basis of site-specific data and its study of site conditions, DOE claims, in their BA, to possess 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:

1. DOE would monitor the ground water and surface water systems, and report the results to the USFWS annually, by January 30 for the preceding year.
2. DOE would hold regular consultations with USFWS, on at least an annual basis.
3. DOE commits to conduct active remediation, which would continue throughout the projected 75-year remedial action period to achieve the target goal of 3 mg/L ammonia or less in ground water and into the post-remedial action confirmation monitoring period. This is anticipated to meet acute and chronic standards in surface water, combined with 10-fold dilution.
4. If an evaporation pond were used as part of ground water remediation, DOE commits to qualitative monitoring for general wildlife use. If any listed species frequented the evaporation pond, DOE would consult with USFWS to develop reasonable and prudent

Description of the Project Area

DOE's 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 Crescent Junction site. However, before developing any disposal site, DOE, in consultation with USFWS, 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.

Moab Site: 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.

Moab Site: 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 and Gardner and Solomon (2004) 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 (USFWS 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 (USFWS 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; USFWS 2002a). Chapter 3.0 of the EIS describes the aquatic setting further.

Off-Site Disposal Site: 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. 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. The State of Utah Division of Wildlife Resources in their DEIS comment letter to DOE, dated January 31, 2005, identified concerns for several state sensitive species at this site, including the white tailed prairie dog. In addition, some herpetile species may be dependent on ephemeral wash habitats.

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.

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.

Borrow Areas – DOE's 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 USFWS 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. See the DEIS for a contemporary description of ten proposed borrow areas.

STATUS OF THE SPECIES/CRITICAL HABITAT

Colorado Pikeminnow

Species/Critical Habitat Description

The Colorado pikeminnow is the largest cyprinid fish (minnow family) native to North America and evolved as the main predator in the Colorado River system. It is an elongated pike-like fish that during predevelopment times may have grown as large as 6 feet in length and weighed nearly 100 pounds (Behnke and Benson 1983). Today, Colorado pikeminnow rarely exceed 3 feet in length or weigh more than 18 pounds; such fish are estimated to be 45-55 years old (Osmundson et al. 1997). The mouth of this species is large and nearly horizontal with long slender pharyngeal teeth (located in the throat), adapted for grasping and holding prey. The diet of Colorado pikeminnow longer than 3 or 4 inches consists almost entirely of other fishes (Vanicek and Kramer 1969). Males become sexually mature earlier and at a smaller size than do females, though all are mature by about age 7 and 500 mm (20 inches) in length (Vanicek and Kramer 1969, Seethaler 1978, Hamman 1981). Adults are strongly countershaded with a dark, olive back, and a white belly. Young are silvery and usually have a dark, wedge-shaped spot at the base of the caudal fin.

Critical habitat, as defined in section 3(5)(A) of the Act, means: A(I) the specific areas within the geographical area occupied by the species at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed . . . , upon a determination by the Secretary that such areas are essential for the conservation of the species.@

Designated critical habitat for the endangered Colorado River fishes includes those portions of the 100-year floodplain that contain constituent elements. The constituent elements are those physical and biological features that the USFWS considers essential for the conservation of the species and include, but are not limited to, the following items: (1) Space for individual and population growth, and for normal behavior; (2) Food, water, air, light, minerals, or other nutritional or physiological requirements; (3) Cover or shelter; (4) Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally (5) Habitats that are protected from disturbance or are representative of the historical geographical and ecological distributions of the species. The primary constituent elements determined necessary for the survival and recovery of the four endangered Colorado River fishes include, but are not limited to:

> Water - A quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, lack of contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species;
>
> Physical Habitat - Areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursing, feeding, and rearing, or corridors between these areas. In addition to river channels these areas also include bottom lands, side channels, secondary channels, oxbows, backwaters, and other areas in the 100-year floodplain, which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats;
>
> Biological Environment - Food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although considered normal components of this environment, are out of balance due to introduced nonnative fish species in many areas.

Designated critical habitat makes up about 29% of the species' original range and occurs exclusively in the Upper Colorado River Basin. Critical habitat has been designated within the 100-year floodplain of the Colorado pikeminnow's historical range in the following sections of the Upper Basin, excluding the San Juan River Basin (59 FR 13374).

> Colorado, Moffat County. The Yampa River and its 100-year floodplain from the State Highway 394 bridge in T. 6 N., R. 91 W., section 1 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
>
> Utah, Uintah, Carbon, Grand, Emery, Wayne, and San Juan Counties; and Colorado, Moffat County. The Green River and its 100-year floodplain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (Salt Lake Meridian).
>
> Colorado, Rio Blanco County; and Utah, Uintah County. The White River and its 100-year floodplain from Rio Blanco Lake Dam in T. 1 N., R. 96 W., section 6 (6th Principal Meridian) to the confluence with the Green River in T. 9 S., R. 20 E., section 4 (Salt Lake Meridian).
>
> Colorado, Delta and Mesa Counties. The Gunnison River and its 100-year floodplain from the confluence with the Uncompahgre River in T. 15 S., R. 96 W., section 11 (6th Principal Meridian) to the confluence with the Colorado River in T. 1 S., R. 1 W., section 22 (Ute Meridian).
>
> Colorado, Mesa and Garfield Counties; and Utah, Grand, San Juan, Wayne, and Garfield Counties. The Colorado River and its 100-year floodplain from the Colorado River Bridge at exit 90 north off Interstate 70 in T. 6 S., R. 93 W., section 16 (6th Principal Meridian) to North Wash, including the Dirty Devil arm of Lake Powell up to the full pool elevation, in T. 33 S., R. 14 E., section 29 (Salt Lake Meridian).

Status and Distribution

Based on early fish collection records, archaeological finds, and other observations, the Colorado pikeminnow was once found throughout warmwater reaches of the entire Colorado River Basin down to the Gulf of California, and including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, and the Gila River system in Arizona (Seethaler 1978). Colorado pikeminnow apparently were never found in colder, headwater areas. The species was abundant in suitable habitat throughout the entire Colorado River Basin prior to the 1850s (Seethaler 1978). By the 1970s they were extirpated from the entire lower basin (downstream of Glen Canyon Dam) and portions of the upper basin as a result of major alterations to the riverine environment. Having lost some 75 to 80 percent of its former range due to habitat loss, the Colorado pikeminnow was federally listed as an endangered species in 1967 (Miller 1961, Moyle 1976, Tyus 1991, Osmundson and Burnham 1998). Full protection under the Act of 1973 occurred on January 4, 1974.

Colorado pikeminnow are presently restricted to the Upper Colorado River Basin and inhabit warmwater reaches of the Colorado, Green, and San Juan rivers and associated tributaries. The Colorado pikeminnow recovery goals (USFWS 2002a) identify occupied habitat of wild Colorado pikeminnow as follows: the Green River from Lodore Canyon to the confluence of the Colorado River; the Yampa River downstream of Craig, Colorado; the Little Snake River from its confluence with the Yampa River upstream into Wyoming; the White River downstream of Taylor Draw Dam; the lower 89 miles of the Price River; the lower Duchesne River; the upper Colorado River from Palisade, Colorado, to Lake Powell; the lower 34 miles of the Gunnison River; the lower mile of the Dolores River; and 150 miles of the San Juan River downstream from Shiprock, New Mexico, to Lake Powell.

Recovery goals for the Colorado pikeminnow (USFWS 2002a) were approved on August 1, 2002. According to these recovery goals, downlisting can be considered if, over a 5-year period:

- a genetically and demographically viable, self-sustaining population is maintained in the Green River subbasin such that (a) the trends in separate adult (age 7+; > 450 mm total length) point estimates for the middle Green River and the lower Green River do not decline significantly, and (b) mean estimated recruitment of age-6 (400–449 mm total length) naturally produced fish equals or exceeds mean annual adult mortality for the Green River subbasin, and (c) each population point estimate for the Green River subbasin exceeds 2,600 adults (2,600 is the estimated minimum viable population needed to ensure long-term genetic and demographic viability); and

- a self-sustaining population of at least 700 adults (number based on inferences about carrying capacity) is maintained in the upper Colorado River subbasin such that (a) the trend in adult point estimates does not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality; and

- a target number of 1,000 age-5+ fish (> 300 mm total length; number based on estimated survival of stocked fish and inferences about carrying capacity) is established through augmentation and/or natural reproduction in the San Juan River subbasin; and

- certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.

Delisting can be considered if, over a 7-year period beyond downlisting:

- a genetically and demographically viable, self-sustaining population is maintained in the Green River subbasin such that (a) the trends in separate adult point estimates for the middle Green River and the lower Green River do not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality for the

Green River subbasin, and (c) each population point estimate for the Green River subbasin exceeds 2,600 adults; and

- either the upper Colorado River subbasin self-sustaining population exceeds 1,000 adults or the upper Colorado River subbasin self-sustaining population exceeds 700 adults and San Juan River subbasin population is self-sustaining and exceeds 800 adults (numbers based on inferences about carrying capacity) such that for each population (a) the trend in adult point estimates does not decline significantly, and (b) mean estimated recruitment of age-6 naturally produced fish equals or exceeds mean annual adult mortality; and

- certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.

Life History

The Colorado pikeminnow is a long-distance migrator; adults move hundreds of miles to and from spawning areas, and require long sections of river with unimpeded passage. Adults require pools, deep runs, and eddy habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, form gravel and cobble deposits used for spawning, and rejuvenate backwater nursery habitats. Spawning occurs after spring runoff at water temperatures typically between 18 and 23ºC. After hatching and emerging from spawning substrate, larvae drift downstream to nursery backwaters that are restructured by high spring flows and maintained by relatively stable base flows. Flow recommendations have been developed that specifically consider flow-habitat relationships in habitats occupied by Colorado pikeminnow in the upper basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes. The following is a description of observed habitat uses in the Upper Colorado River Basin.

Colorado pikeminnow live in warm-water reaches of the Colorado River mainstem and larger tributaries, and require uninterrupted stream passage for spawning migrations and dispersal of young. The species is adapted to a hydrologic cycle characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows. High spring flows create and maintain in-channel habitats, and reconnect floodplain and riverine habitats, a phenomenon described as the spring flood-pulse (Junk et al. 1989; Johnson et al. 1995). Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in nearshore areas of main river channels (Tyus and McAda 1984; Valdez and Masslich 1989; Tyus 1990, 1991; Osmundson et al. 1995). In spring, however, Colorado pikeminnow adults use floodplain habitats, flooded tributary mouths, flooded side canyons, and eddies that are available only during high flows (Tyus 1990, 1991; Osmundson et al. 1995). Such environments may be particularly beneficial for Colorado pikeminnow because other riverine fishes gather in floodplain habitats to exploit food and temperature resources, and may serve as prey. Such low-velocity environments also may serve as resting areas for Colorado pikeminnow. River reaches of high habitat complexity appear to be preferred.

Because of their mobility and environmental tolerances, adult Colorado pikeminnow are more widely distributed than other life stages. Distribution patterns of adults are stable during most of the year (Tyus 1990, 1991; Irving and Modde 2000), but distribution of adults changes in late spring and early summer, when most mature fish migrate to spawning areas (Tyus and McAda 1984; Tyus 1985, 1990, 1991; Irving and Modde 2000). High spring flows provide an important cue to prepare adults for migration and also ensure that conditions at spawning areas are suitable for reproduction once adults arrive. Specifically, bankfull or much larger floods mobilize coarse sediment to build or reshape cobble bars, and they create side channels that Colorado pikeminnow sometimes use for spawning (Harvey et al. 1993).

Colorado pikeminnow spawning sites in the Green River subbasin have been well documented. The two principal locations are in Yampa Canyon on the lower Yampa River and in Gray Canyon on the lower Green River (Tyus 1990, 1991). These reaches are 42 and 72 km long, respectively, but most spawning is believed to occur at one or two short segments within each of the two reaches. Another spawning area may occur in Desolation Canyon on the lower Green River (Irving and Modde 2000), but the location and importance of this area has not been verified. Although direct observation of Colorado pikeminnow spawning was not possible because of high turbidity, radiotelemetry indicated spawning occurred over cobble-bottomed riffles (Tyus 1990). High spring flows and subsequent post-peak summer flows are important for construction and maintenance of spawning substrates (Harvey et al. 1993). In contrast with the Green River subbasin, where known spawning sites are in canyon-bound reaches, currently suspected spawning sites in the upper Colorado River subbasin are at six locations in meandering, alluvial reaches (McAda 2000).

After hatching and emerging from the spawning substrate, Colorado pikeminnow larvae drift downstream to backwaters in sandy, alluvial regions, where they remain through most of their first year of life (Holden 1977; Tyus and Haines 1991; Muth and Snyder 1995). Backwaters and the physical factors that create them are vital to successful recruitment of early life stages of Colorado pikeminnow, and age-0 Colorado pikeminnow in backwaters have received much research attention (e.g., Tyus and Karp 1989; Haines and Tyus 1990; Tyus 1991; Tyus and Haines 1991; Bestgen et al. 1997). It is important to note that these backwaters are formed after cessation of spring runoff within the active channel and are not floodplain features. Colorado pikeminnow larvae occupy these in-channel backwaters soon after hatching. They tend to occur in backwaters that are large, warm, deep (average, about 0.3 m in the Green River), and turbid (Tyus and Haines 1991). Recent research (Day et al. 1999a, 1999b; Trammell and Chart 1999) has confirmed these preferences and suggested that a particular type of backwater is preferred by Colorado pikeminnow larvae and juveniles. Such 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 chute channels are deep and may persist even when discharge levels change dramatically. An optimal river-reach environment for growth and survival of early life stages of Colorado pikeminnow has warm, relatively stable backwaters, warm river channels, and abundant food (Muth et al. 2000).

Threats to the Species

Major declines in Colorado pikeminnow populations occurred during the dam-building era of the 1930s through the 1960s. Behnke and Benson (1983) summarized the decline of the natural ecosystem, pointing out that dams, impoundments, and water use practices drastically modified the river's natural hydrology and channel characteristics throughout the Colorado River Basin. Dams on the mainstem broke the natural continuum of the river ecosystem into a series of disjunct segments, blocking native fish migrations, reducing temperatures downstream of dams, creating lacustrine habitat, and providing conditions that allowed competitive and predatory nonnative fishes to thrive both within the impounded reservoirs and in the modified river segments that connect them. The highly modified flow regime in the lower basin coupled with the introduction of nonnative fishes decimated populations of native fish.

The primary threats to Colorado pikeminnow are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (USFWS 2002a). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. These impairments are described in further detail below.

Stream flow regulation includes mainstem dams that cause the following adverse effects to Colorado pikeminnow and its habitat:

- block migration corridors,
- changes in flow patterns, reduced peak flows and increased base flows,
- release cold water, making temperature regimes less than optimal,
- change river habitat into lake habitat, and
- retain sediment that is important for forming and maintaining backwater habitats

In the Upper Basin, 435 miles of Colorado pikeminnow habitat has been lost by reservoir inundation from Flaming Forge Reservoir on the Green River, Lake Powell on the Colorado River, and Navajo Reservoir on the San Juan River. Cold water releases from these dams have eliminated suitable habitat for native fishes, including Colorado pikeminnow, from river reaches downstream for approximately 50 miles below Flaming Gorge Dam and Navajo Dam. In addition to main stem dams, many dams and water diversion structures occur in and upstream from critical habitat that reduce flows and alter flow patterns, which adversely affect critical habitat. Diversion structures in critical habitat divert fish into canals and pipes where the fish are permanently lost to the river system. It is unknown how many endangered fish are lost in irrigation systems, but in some years, in some river reaches, majority of the river flow is diverted into unscreened canals. High spring flows maintain habitat diversity, flush sediments from spawning habitat, increase invertebrate food production, form gravel and cobble deposits important for spawning, and maintain backwater nursery habitats (McAda 2000; Muth et al. 2000). Peak spring flows in the Green River at Jensen, Utah, have decreased 13–35 percent and base flows have increased 10–140 percent due to regulation by Flaming Gorge Dam (Muth et al. 2000).

Predation and competition from nonnative fishes have been clearly implicated in the population reductions or elimination of native fishes in the Colorado River Basin (Dill 1944, Osmundson and Kaeding 1989, Behnke 1980, Joseph et al. 1977, Lanigan and Berry 1979, Minckley and Deacon 1968, Meffe 1985, Propst and Bestgen 1991, Rinne 1991). Data collected by Osmundson and Kaeding (1991) indicated that during low water years nonnative minnows capable of preying on or competing with larval endangered fishes greatly increased in numbers.

More than 50 nonnative fish species were intentionally introduced in the Colorado River Basin prior to 1980 for sportfishing, forage fish, biological control and ornamental purposes (Minckley 1982, Tyus et al. 1982, Carlson and Muth 1989). Nonnative fishes compete with native fishes in several ways. The capacity of a particular area to support aquatic life is limited by physical habitat conditions. Increasing the number of species in an area usually results in a smaller population of most species. The size of each species population is controlled by the ability of each life stage to compete for space and food resources and to avoid predation. Some life stages of nonnative fishes appear to have a greater ability to compete for space and food and to avoid predation in the existing altered habitat than do some life stages of native fishes. Tyus and Saunders (1996) cite numerous examples of both indirect and direct evidence of predation on razorback sucker eggs and larvae by nonnative species.

Threats from pesticides and pollutants include accidental spills of petroleum products and hazardous materials; discharge of pollutants from uranium mill tailings; and high selenium concentration in the water and food chain (USFWS 2002a). Accidental spills of hazardous material into critical habitat can cause immediate mortality when lethal toxicity levels are exceeded. Pollutants from uranium mill tailings cause high levels of ammonia that exceed water quality standards. High selenium levels may adversely affect reproduction and recruitment (Hamilton and Wiedmeyer 1990; Stephens et al. 1992; Hamilton and Waddell 1994; Hamilton et al. 1996; Stephens and Waddell 1998; Osmundson et al. 2000a).

Management actions identified in the recovery goals for Colorado pikeminnow (USFWS 2002a) to minimize or remove threats to the species included:

- provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations;
- provide passage over barriers within occupied habitat to allow adequate movement and, potentially, range expansion;
- investigate options for providing appropriate water temperatures in the Gunnison River;
- minimize entrainment of subadults and adults in diversion canals;
- ensure adequate protection from overutilization;
- ensure adequate protection from diseases and parasites;
- regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries;
- control problematic nonnative fishes as needed;
- minimize the risk of hazardous-materials spills in critical habitat; and
- remediate water-quality problems.

Razorback sucker

Species/Critical Habitat Description

Like all suckers (family Catostomidae, meaning "down mouth"), the razorback sucker has a ventral mouth with thick lips covered with papillae and no scales on its head. In general, suckers are bottom browsers, sucking up or scraping off small invertebrates, algae, and organic matter with their fleshy, protrusible lips (Moyle 1976). The razorback sucker is the only sucker with an abrupt sharp-edged dorsal keel behind its head. The keel becomes more massive with age. The head and keel are dark, the back is olive-colored, the sides are brownish or reddish, and the abdomen is yellowish white (Sublette et al. 1990). Adults often exceed 3 kg (6 pounds) in weight and 600 mm (2 feet) in length. Like Colorado pikeminnow, razorback suckers are long-lived, living 40-plus years.

Critical habitat was designated for razorback sucker on March 21, 1994 (59 FR 13374). Designated critical habitat makes up about 49% of the species' original range and occurs in both the Upper and Lower Colorado River Basins (USFWS 1994). The primary constituent elements are the same as those described for Colorado pikeminnow.

Critical habitat has been designated within the 100-year floodplain of the razorback sucker's historical range in the following sections of the Upper Basin, excluding the San Juan River Basin (59 FR 13374).

> Colorado, Moffat County. The Yampa River and its 100-year floodplain from the mouth of Cross Mountain Canyon in T. 6 N., R. 98 W., section 23 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
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> Utah, Uintah County; and Colorado, Moffat County. The Green River and its 100-year floodplain from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to Sand Wash in T. 11 S., R. 18 E., section 20 (6th Principal Meridian).
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> Utah, Uintah, Carbon, Grand, Emery, Wayne, and San Juan Counties. The Green River and its 100-year floodplain from Sand Wash at river mile 96 at T. 11 S., R. 18 E., section 20 (6th Principal Meridian) to the confluence with the Colorado River in T. 30 S., R. 19 E., section 7 (6th Principal Meridian).
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> Utah, Uintah County. The White River and its 100-year floodplain from the boundary of the Uintah and Ouray Indian Reservation at river mile 18 in T. 9 S., R. 22 E., section 21 (Salt Lake Meridian) to the confluence with the Green River in T. 9 S., R 20 E., section 4 (Salt Lake Meridian).
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> Utah, Uintah County. The Duchesne River and its 100-year floodplain from river mile 2.5 in T. 4 S., R. 3 E., section 30 (Salt Lake Meridian) to the confluence with the Green River in T. 5 S., R. 3 E., section 5 (Uintah Meridian).
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> Colorado, Delta and Mesa Counties. The Gunnison River and its 100-year floodplain from the confluence with the Uncompahgre River in T. 15 S., R. 96 W., section 11 (6th Principal Meridian) to Redlands Diversion Dam in T. 1 S., R. 1 W., section 27 (Ute Meridian).

Colorado, Mesa and Garfield Counties. The Colorado River and its 100-year floodplain from Colorado River Bridge at exit 90 north off Interstate 70 in T. 6 S., R. 93 W., section 16 (6th Principal Meridian) to Westwater Canyon in T. 20 S., R. 25 E., section 12 (Salt Lake Meridian) including the Gunnison River and its 100-year floodplain from the Redlands Diversion Dam in T. 1 S., R. 1 W., section 27 (Ute Meridian) to the confluence with the Colorado River in T. 1 S., R. 1 W., section 22 (Ute Meridian).

Utah, Grand, San Juan, Wayne, and Garfield Counties. The Colorado River and its 100-year floodplain from Westwater Canyon in T. 20 S., R. 25 E., section 12 (Salt Lake Meridian) to full pool elevation, upstream of North Wash, and including the Dirty Devil arm of Lake Powell in T. 33 S., R. 14 E., section 29 (Salt Lake Meridian).

Status and Distribution

On March 14, 1989, the USFWS was petitioned to conduct a status review of the razorback sucker. Subsequently, the razorback sucker was designated as endangered under a final rule published on October 23, 1991 (56 FR 54957). The final rule stated “Little evidence of natural recruitment has been found in the past 30 years, and numbers of adult fish captured in the last 10 years demonstrate a downward trend relative to historic abundance. Significant changes have occurred in razorback sucker habitat through diversion and depletion of water, introduction of nonnative fishes, and construction and operation of dams” (56 FR 54957). Recruitment of razorback suckers to the population continues to be a problem.

Historically, razorback suckers were found in the mainstem Colorado River and major tributaries in Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming, and in Mexico (Ellis 1914; Minckley 1983). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and, further, that commercially marketable quantities were caught in Arizona as recently as 1949. In the Upper Basin, razorback suckers were reported in the Green River to be very abundant near Green River, Utah, in the late 1800s (Jordan 1891). An account in Osmundson and Kaeding (1989) reported that residents living along the Colorado River near Clifton, Colorado, observed several thousand razorback suckers during spring runoff in the 1930s and early 1940s. In the San Juan River drainage, Platania and Young (1989) relayed historical accounts of razorback suckers ascending the Animas River to Durango, Colorado, around the turn of the century.

Currently, the largest concentration of razorback sucker remaining in the Colorado River Basin is in Lake Mohave on the border of Arizona and California. Estimates of the wild stock in Lake Mohave have fallen precipitously in recent years from 60,000 as late as 1991, to 25,000 in 1993 (Marsh 1993, Holden 1994), to about 9,000 in 2000 (USFWS 2002b). Until recently, efforts to introduce young razorback sucker into Lake Mohave have failed because of predation by non-native species (Minckley et al. 1991, Clarkson et al. 1993, Burke 1994). While limited numbers of razorback suckers persist in other locations in the Lower Colorado River, they are considered rare or incidental and may be continuing to decline.

In the Upper Colorado River Basin, above Glen Canyon Dam, razorback suckers are found in limited numbers in both lentic (lake-like) and riverine environments. The largest populations of razorback suckers in the upper basin are found in the upper Green and lower Yampa rivers (Tyus

1987). In the Colorado River, most razorback suckers occur in the Grand Valley area near Grand Junction, Colorado; however, they are increasingly rare. Osmundson and Kaeding (1991) reported that the number of razorback sucker captures in the Grand Junction area has declined dramatically since 1974. Between 1984 and 1990, intensive collecting effort captured only 12 individuals in the Grand Valley (Osmundson and Kaeding 1991). The wild population of razorback sucker is considered extirpated from the Gunnison River (Burdick and Bonar 1997).

Razorback suckers are in imminent danger of extirpation in the wild. As Bestgen (1990) pointed out:

> "Reasons for decline of most native fishes in the Colorado River Basin have been attributed to habitat loss due to construction of mainstream dams and subsequent interruption or alteration of natural flow and physio-chemical regimes, inundation of river reaches by reservoirs, channelization, water quality degradation, introduction of nonnative fish species and resulting competitive interactions or predation, and other man-induced disturbances (Miller 1961, Joseph et al. 1977, Behnke and Benson 1983, Carlson and Muth 1989, Tyus and Karp 1989). These factors are almost certainly not mutually exclusive, therefore it is often difficult to determine exact cause and effect relationships."

The virtual absence of any recruitment suggests a combination of biological, physical, and/or chemical factors that may be affecting the survival and recruitment of early life stages of razorback suckers. Within the Upper Basin, recovery efforts endorsed by the Recovery Program include the capture and removal of razorback suckers from all known locations for genetic analyses and development of discrete brood stocks. These measures have been undertaken to develop refugia populations of the razorback sucker from the same genetic parentage as their wild counterparts such that, if these fish are genetically unique by subbasin or individual population, then separate stocks will be available for future augmentation. Such augmentation may be a necessary step to prevent the extinction of razorback suckers in the Upper Basin.

Recovery goals for the razorback sucker (USFWS 2002b) were approved on August 1, 2002. According to these recovery goals, downlisting can be considered if, over a 5-year period:

- genetically and demographically viable, self-sustaining populations are maintained in the Green River subbasin and either in the upper Colorado River subbasin or the San Juan River subbasin such that (a) the trend in adult (age 4+; > 400 mm total length) point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 (300–399 mm total length) naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 5,800 adults (5,800 is the estimated minimum viable population needed to ensure long-term genetic and demographic viability); and

- a genetic refuge is maintained in Lake Mohave of the lower basin recovery unit; and

- two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit (e.g., mainstem and/or tributaries) such that (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 5,800 adults; and

- certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.

Delisting can be considered if, over a 3-year period beyond downlisting:

- genetically and demographically viable, self-sustaining populations are maintained in the Green River subbasin and either in the upper Colorado River subbasin or the San Juan River subbasin such that (a) the trend in adult point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 5,800 adults; and

- a genetic refuge is maintained in Lake Mohave; and

- two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit such that (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 5,800 adults; and

- certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.

<u>Life History</u>

McAda and Wydoski (1980) and Tyus (1987) reported springtime aggregations of razorback suckers in off-channel habitats and tributaries; such aggregations are believed to be associated with reproductive activities. Tyus and Karp (1990) and Osmundson and Kaeding (1991) reported off-channel habitats to be much warmer than the mainstem river and that razorback suckers presumably moved to these areas for feeding, resting, sexual maturation, spawning, and other activities associated with their reproductive cycle. Prior to construction of large mainstem dams and the suppression of spring peak flows, low velocity, off-channel habitats (seasonally flooded bottomlands and shorelines) were commonly available throughout the Upper Basin (Tyus and Karp 1989; Osmundson and Kaeding 1991). Dams changed riverine ecosystems into lakes by impounding water, which eliminated these off-channel habitats in reservoirs. Reduction in spring peak flows eliminates or reduces the frequency of inundation of off-channel habitats.

The absence of these seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in their native environment (Tyus and Karp 1989; Osmundson and Kaeding 1991). Wydoski and Wick (1998) identified starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats which provide adequate zooplankton densities for larval food as one of the most important factors limiting recruitment.

While razorback suckers have never been directly observed spawning in turbid riverine environments within the Upper Basin, captures of ripe specimens (in spawning condition), both males and females, have been recorded (Valdez et al. 1982a; McAda and Wydoski 1980; Tyus 1987; Osmundson and Kaeding 1989; Tyus and Karp 1989; Tyus and Karp 1990; Osmundson and Kaeding 1991; Platania 1990) in the Yampa, Green, Colorado, and San Juan rivers. Sexually mature razorback suckers are generally collected on the ascending limb of the hydrograph from mid-April through June and are associated with coarse gravel substrates (depending on the specific location).

Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (Tyus 1987; Tyus and Karp 1989; Osmundson and Kaeding 1989; Valdez and Masslich 1989; Osmundson and Kaeding 1991; Tyus and Karp 1990).

Habitat requirements of young and juvenile razorback suckers in the wild are not well known, particularly in native riverine environments. Prior to 1991, the last confirmed documentation of a razorback sucker juvenile in the Upper Basin was a capture in the Colorado River near Moab, Utah (Taba et al. 1965). In 1991, two early juvenile (36.6 and 39.3 mm total length (TL)) razorback suckers were collected in the lower Green River near Hell Roaring Canyon (Gutermuth et al. 1994). Juvenile razorback suckers have been collected in recent years from Old Charley Wash, a wetland adjacent to the Green River (Modde 1996). Between 1992 and 1995 larval razorback suckers were collected in the middle and lower Green River and within the Colorado River inflow to Lake Powell (Muth 1995). In 2002, eight larval razorback suckers were collected in the Gunnison River (Osmundson 2002b). No young razorback suckers have been collected in recent times in the Colorado River.

<u>Threats to the Species</u>

A marked decline in populations of razorback suckers can be attributed to construction of dams and reservoirs, introduction of nonnative fishes, and removal of large quantities of water from the Colorado River system. Dams on the mainstem Colorado River and its major tributaries have segmented the river system, blocked migration routes, and changed river habitat into lake habitat. Dams also have drastically altered flows, temperatures, and channel geomorphology. These changes have modified habitats in many areas so that they are no longer suitable for breeding, feeding, or sheltering. Major changes in species composition have occurred due to the introduction of numerous nonnative fishes, many of which have thrived due to human-induced changes to the natural riverine system. These nonnative fishes prey upon and compete with razorback suckers.

The primary threats to razorback sucker are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; and pesticides and pollutants (USFWS 2002b). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to razorback sucker are essentially the same threats identified for Colorado pikeminnow.

Management actions identified in the recovery goals for razorback sucker (USFWS 2002b) to minimize or remove threats to the species included:

- provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations;
- provide passage over barriers within occupied habitat to allow unimpeded movement and, potentially, range expansion;
- investigate options for providing appropriate water temperatures in the Gunnison River;
- minimize entrainment of subadults and adults in diversion/out-take structures;
- ensure adequate protection from overutilization;
- ensure adequate protection from diseases and parasites;
- regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries;
- control problematic nonnative fishes as needed;
- minimize the risk of hazardous-materials spills in critical habitat;
- remediate water-quality problems; and
- minimize the threat of hybridization with white sucker.

Humpback chub

Species/Critical Habitat Description

The humpback chub is a medium-sized freshwater fish (less than 500 mm) of the minnow family. The adults have a pronounced dorsal hump, a narrow flattened head, a fleshy snout with an inferior-subterminal mouth, and small eyes. It has silvery sides with a brown or olive colored back.

The humpback chub is endemic to the Colorado River Basin and is part of a native fish fauna traced to the Miocene epoch in fossil records (Miller 1946; Minckley et al. 1986). Humpback chub remains have been dated to about 4000 B.C., but the fish was not described as a species until the 1940s (Miller 1946), presumably because of its restricted distribution in remote white water canyons (USFWS 1990). Because of this, its original distribution is not known. The humpback chub was listed as endangered on March 11, 1967.

Until the 1950s, the humpback chub was known only from Grand Canyon. During surveys in the 1950s and 1960s humpback chub were found in the upper Green River including specimens from Echo Park, Island Park, and Swallow Canyon (Smith 1960, Vanicek et al. 1970). Individuals were also reported from the lower Yampa River (Holden and Stalnaker 1975b), the White River in Utah (Sigler and Miller 1963), Desolation Canyon of the Green River (Holden and Stalnaker 1970) and the Colorado River near Moab (Sigler and Miller 1963).

Critical habitat was designated for humpback chub on March 21, 1994 (59 FR 13374). Designated critical habitat makes up about 28% of the species' original range and occurs in both the Upper and Lower Colorado River Basins. The primary constituent elements are the same as those described for Colorado pikeminnow.

Critical habitat has been designated within the humpback chub's historical range in the following sections of the Upper Basin (59 FR 13374).

> Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
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> Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the southern boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).
>
> Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumners Amphitheater in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).
>
> Utah, Grand County; and Colorado, Mesa County. The Colorado River from Black Rocks in T. 10 S., R. 104 W., section 25 (6th Principal Meridian) to Fish Ford in T. 21 S., R. 24 E., section 35 (Salt Lake Meridian).
>
> Utah, Garfield and San Juan Counties. The Colorado River from Brown Betty Rapid in T. 30 S., R. 18 E., section 34 (Salt Lake Meridian) to Imperial Canyon in T. 31 S., R. 17 E., section 28 (Salt Lake Meridian).

Status and Distribution

Failure to recognize *Gila cypha* as a species until 1946 complicated interpretation of historic distribution of humpback chubs in the Green River (Douglas et al. 1989, 1998). Best available information suggests that before Flaming Gorge Dam, humpback chubs were distributed in canyon regions throughout much of the Green River, from the present site of Flaming Gorge Reservoir downstream through Desolation and Gray canyons (Vanicek 1967; Holden and Stalnaker 1975a; Holden 1991). In addition, the species occurred in the Yampa and White rivers. Pre-impoundment surveys of the Flaming Gorge Reservoir basin (Bosley 1960; Gaufin et al. 1960; McDonald and Dotson 1960; Smith 1960) reported both humpback chubs and bonytails from the Green River near Hideout Canyon, now inundated by Flaming Gorge Reservoir.

Historic collection records of humpback chub exist from the Yampa and White rivers, both tributaries to the Green River. Tyus (1998) verified the presence of seven humpback chubs in collections of the University of Colorado Museum, collected from the Yampa River in Castle Park between 19 June and 11 July 1948. A single humpback chub was found in the White River near Bonanza, Utah, in June 1981 (Miller et al. 1982b), and a possible bonytail-humpback chub intergrade was also captured in July 1978 (Lanigan and Berry 1981).

Present concentrations of humpback chub in the Upper Basin occur in canyon-bound river reaches ranging in length from 3.7 km (Black Rocks) to 40.5 km (Desolation and Gray Canyons). Humpback chubs are distributed throughout most of Black Rocks and Westwater Canyons (12.9 km), and in or near whitewater reaches of Cataract Canyon (20.9 km), Desolation and Gray Canyons (65.2 km), and Yampa Canyon (44.3 km), with populations in the separate canyon reaches ranging from 400 to 5,000 adults (see population dynamics). The Utah Division of Wildlife Resources has monitored the fish community in Desolation and Gray Canyons since 1989 and has consistently reported captures of age-0, juvenile, and adult *Gila,* including humpback chub, indicating a reproducing population (Chart and Lentsch 1999b). Distribution of humpback chubs within Whirlpool and Split Mountain Canyons is not presently known, but it is believed that numbers of humpback chub in these sections of the Green River are low.

The Yampa River is the only tributary to the Green River presently known to support a reproducing humpback chub population. Between 1986 and 1989, Karp and Tyus (1990) collected 130 humpback chubs from Yampa Canyon and indicated that a small but reproducing population was present. Continuing captures of juveniles and adults within Dinosaur National Monument indicate that a population persists in Yampa Canyon (T. Modde, U.S. Fish and Wildlife USFWS, personal communication). Small numbers of humpback chub also have been reported in Cross Mountain Canyon on the Yampa River and in the Little Snake River about 10 km upstream of its confluence with the Yampa River (Wick et al. 1981; Hawkins et al. 1996).

Recovery goals for the humpback chub (USFWS 2002c) were approved on August 1, 2002. According to these recovery goals, downlisting can be considered if, over a 5-year period:

- the trend in adult (age 4+; > 200 mm total length) point estimates for each of the six extant populations does not decline significantly; and

- mean estimated recruitment of age-3 (150–199 mm total length) naturally produced fish equals or exceeds mean annual adult mortality for each of the six extant populations; and

- two genetically and demographically viable, self-sustaining core populations are maintained, such that each point estimate for each core population exceeds 2,100 adults (2,100 is the estimated minimum viable population needed to ensure long-term genetic and demographic viability); and

- certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.

Delisting can be considered if, over a 3-year period beyond downlisting:

- the trend in adult point estimates for each of the six extant populations does not decline significantly; and

- mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each of the six extant populations; and

- three genetically and demographically viable, self-sustaining core populations are maintained, such that each point estimate for each core population exceeds 2,100 adults; and

- certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.

Life History

Unlike Colorado pikeminnow and razorback sucker, which are known to make extended migrations of up to several hundred miles to spawning areas in the Green and Yampa rivers, humpback chubs in the Green River do not appear to make extensive migrations (Karp and Tyus 1990). Radio-telemetry and tagging studies on other humpback chub populations have revealed strong fidelity by adults for specific locations with little movement to areas outside of home canyon regions. Humpback chubs in Black Rocks (Valdez and Clemmer 1982), Westwater Canyon (Chart and Lentsch 1999a), and Desolation and Gray Canyons (Chart and Lentsch 1999b) do not migrate to spawn.

Generally, humpback chub show fidelity for canyon reaches and move very little (Miller et al. 1982a; Archer et al. 1985; Burdick and Kaeding 1985; Kaeding et al. 1990). Movements of adult humpback chub in Black Rocks on the Colorado River were essentially restricted to a 1-mile reach. These results were based on the recapture of Carlin-tagged fish and radiotelemetry studies conducted from 1979 to 1981 (Valdez et al. 1982) and 1983 to 1985 (Archer et al. 1985; USFWS 1986; Kaeding et al. 1990).

In the Green River and upper Colorado River, humpback chubs spawned in spring and summer as flows declined shortly after the spring peak (Valdez and Clemmer 1982; Valdez et al. 1982; Kaeding and Zimmerman 1983; Tyus and Karp 1989; Karp and Tyus 1990; Chart and Lentsch 1999a, 1999b). Similar spawning patterns were reported from Grand Canyon (Kaeding and Zimmerman 1983; Valdez and Ryel 1995, 1997). Little is known about spawning habitats and behavior of humpback chub. Although humpback chub are believed to broadcast eggs over mid-channel cobble and gravel bars, spawning in the wild has not been observed for this species. Gorman and Stone (1999) reported that ripe male humpback chubs in the Little Colorado River aggregated in areas of complex habitat structure (i.e., matrix of large boulders and travertine masses combined with chutes, runs, and eddies, 0.5–2.0 m deep) and were associated with deposits of clean gravel.

Chart and Lentsch (1999b) estimated hatching dates for young *Gila* collected from Desolation and Gray Canyons between 1992 and 1995. They determined that hatching occurred on the descending limb of the hydrograph as early as 9 June 1992 at a flow of 139 m^3/s and as late as 1 July 1995 at a flow of 731 m^3/s. Instantaneous daily river temperatures on hatching dates over all years ranged from 20 to 22ºC.

Newly hatched larvae average 6.3–7.5 mm TL (Holden 1973; Suttkus and Clemmer 1977; Minckley 1973; Snyder 1981; Hamman 1982; Behnke and Benson 1983; Muth 1990), and 1-month-old fish are approximately 20 mm long (Hamman 1982). Unlike Colorado pikeminnow and razorback sucker, no evidence exists of long-distance larval drift (Miller and Hubert 1990; Robinson et al. 1998). Upon emergence from spawning gravels, humpback chub larvae remain in the vicinity of bottom surfaces (Marsh 1985) near spawning areas (Chart and Lentsch 1999a).

Backwaters, eddies, and runs have been reported as common capture locations for young-of-year humpback chub (Valdez and Clemmer 1982). These data indicate that in Black Rocks and Westwater Canyon, young utilize shallow areas. Habitat suitability index curves developed by Valdez et al. (1990) indicate young-of-year prefer average depths of 2.1 feet with a maximum of 5.1 feet. Average velocities were reported at 0.2 feet per second.

Valdez et al. (1982) Wick et al. (1979) and Wick et al. (1981) found adult humpback chub in Black Rocks and Westwater Canyons in water averaging 50 feet in depth with a maximum depth of 92 feet. In these localities, humpback chub were associated with large boulders and steep cliffs.

<u>Threats to the Species</u>

Although historic data are limited, the apparent range-wide decline in humpback chubs is likely due to a combination of factors including alteration of river habitats by reservoir inundation, changes in stream discharge and temperature, competition with and predation by introduced fish species, and other factors such as changes in food resources resulting from stream alterations (USFWS 1990).

The primary threats to humpback chub are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; parasitism; hybridization with other native *Gila* species; and pesticides and pollutants (USFWS 2002c). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to humpback chub in relation to flow regulation and habitat modification, predation by nonnative fishes, and pesticides and pollutants are essentially the same threats identified for Colorado pikeminnow.

The humpback chub population in the Grand Canyon is threatened by predation from nonnative trout in the Colorado River below Glen Canyon Dam. This population is also threatened by the Asian tapeworm reported in humpback chub in the Little Colorado River (USFWS 2002c). No Asian tapeworms have been reported in the upper basin populations.

Hybridization with roundtail chub (*Gila robusta*) and bonytail, where they occur with humpback chub, is recognized as a threat to humpback chub. A larger proportion of roundtail chub have been found in Black Rocks and Westwater Canyon during low flow years (Kaeding et al. 1990; Chart and Lentsch 2000), which increase the chances for hybridization.

Management actions identified in the recovery goals for humpback chub (USFWS 2002c) to minimize or remove threats to the species included:

- provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations,
- investigate the role of the mainstem Colorado River in maintaining the Grand Canyon population,
- investigate the anticipated effects of and options for providing warmer water temperatures in the mainstem Colorado River through Grand Canyon,
- ensure adequate protection from overutilization,
- ensure adequate protection from diseases and parasites,
- regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries,
- control problematic nonnative fishes as needed,
- minimize the risk of increased hybridization among *Gila* spp, and
- minimize the risk of hazardous-materials spills in critical habitat.

Bonytail

Species/Critical Habitat Description

Bonytail are medium-sized (less than 600 mm) fish in the minnow family. Adult bonytail are gray or olive colored on the back with silvery sides and a white belly. The adult bonytail has an elongated body with a long, thin caudal peduncle. The head is small and compressed compared to the rest of the body. The mouth is slightly overhung by the snout and there is a smooth low hump behind the head that is not as pronounced as the hump on a humpback chub.

The bonytail is endemic to the Colorado River Basin and was historically common to abundant in warm-water reaches of larger rivers of the basin from Mexico to Wyoming. The species experienced a dramatic, but poorly documented, decline starting in about 1950, following construction of several mainstem dams, introduction of nonnative fishes, poor land-use practices, and degraded water quality (USFWS 2002d).

Currently, no self-sustaining populations of bonytail are known to exist in the wild, and very few individuals have been caught anywhere within the basin. An unknown, but small number of wild adults exist in Lake Mohave on the mainstem Colorado River. Since 1977, only 11 wild adults have been reported from the upper basin (Valdez et al. 1994).

A total of 499 km (312 miles) of river has been designated as critical habitat for the bonytail in the Colorado River Basin, representing about 14% of the species' historic range (59 FR 13374). The primary constituent elements are the same as those described for the Colorado pikeminnow.

Critical habitat has been designated within the bonytail's historical range in the following sections of the Upper Basin (59 FR 13374).

> Colorado, Moffat County. The Yampa River from the boundary of Dinosaur National Monument in T. 6 N., R. 99 W., section 27 (6th Principal Meridian) to the confluence with the Green River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian).
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> Utah, Uintah County; and Colorado, Moffat County. The Green River from the confluence with the Yampa River in T. 7 N., R. 103 W., section 28 (6th Principal Meridian) to the boundary of Dinosaur National Monument in T. 6 N., R. 24 E., section 30 (Salt Lake Meridian).
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> Utah, Uintah and Grand Counties. The Green River (Desolation and Gray Canyons) from Sumner's Amphitheater (river mile 85) in T. 12 S., R. 18 E., section 5 (Salt Lake Meridian) to Swasey's Rapid (river mile 12) in T. 20 S., R. 16 E., section 3 (Salt Lake Meridian).
>
> Utah, Grand County; and Colorado, Mesa County. The Colorado River from Black Rocks in T. 10 S., R. 104 W., section 25 (6th Principal Meridian) to Fish Ford in T. 21 S., R. 24 E., section 35 (Salt Lake Meridian).
>
> Utah, Garfield and San Juan Counties. The Colorado River from Brown Betty Rapid in T. 30 S., R. 18 E., section 34 (Salt Lake Meridian) to Imperial Canyon in T. 31 S., R. 17 E., section 28 (Salt Lake Meridian).

Status and Distribution

The bonytail is the rarest native fish in the Colorado River. Little is known about its specific habitat requirements or cause of decline, because the bonytail was extirpated from most of its historic range prior to extensive fishery surveys. It was listed as endangered on April 23, 1980. Currently, no documented self-sustaining populations exist in the wild. Formerly reported as widespread and abundant in mainstem rivers (Jordan and Evermann 1896), its populations have been greatly reduced. Remnant populations presently occur in the wild in low numbers in Lake Mohave and several fish have been captured in Lake Powell and Lake Havasu (USFWS 2002d). The last known riverine area where bonytail were common was the Green River in Dinosaur National Monument, where Vanicek (1967) and Holden and Stalnaker (1970) collected 91 specimens during 1962-1966. From 1977 to 1983, no bonytail were collected from the Colorado or Gunnison rivers in Colorado or Utah (Wick et al. 1979, 1981; Valdez et al. 1982; Miller et al. 1984). However, in 1984, a single bonytail was collected from Black Rocks on the Colorado River (Kaeding et al. 1986). Several suspected bonytail were captured in Cataract Canyon in 1985-1987 (Valdez 1990). Current stocking plans for bonytail identify the middle Green River and the Yampa River in Dinosaur National Monument as the highest priority for stocking in Colorado and the plan calls for 2,665 fish to be stocked per year over the next six years (Nesler et al. 2003).

Recovery goals for the bonytail (USFWS 2002d) were approved on August 1, 2002. According to these recovery goals, downlisting can be considered if, over a 5-year period:

- genetically and demographically viable, self-sustaining populations are maintained in the Green River subbasin and upper Colorado River subbasin such that (a) the trend in adult (age 4+; > 250 mm total length) point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 (150–249 mm total length) naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 4,400 adults (4,400 is the estimated minimum viable population needed to ensure long-term genetic and demographic viability); and

- a genetic refuge is maintained in a suitable location (e.g., Lake Mohave, Lake Havasu) in the lower basin recovery unit; and

- two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit (e.g., mainstem and/or tributaries) such that (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 4,400 adults; and

- certain site-specific management tasks to minimize or remove threats have been identified, developed, and implemented.

Delisting can be considered if, over a 3-year period beyond downlisting:

- genetically and demographically viable, self-sustaining populations are maintained in the Green River subbasin and upper Colorado River subbasin such that (a) the trend in adult point estimates for each of the two populations does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each of the two populations, and (c) each point estimate for each of the two populations exceeds 4,400 adults; and

- a genetic refuge is maintained in the lower basin recovery unit; and

- two genetically and demographically viable, self-sustaining populations are maintained in the lower basin recovery unit such that (a) the trend in adult point estimates for each population does not decline significantly, and (b) mean estimated recruitment of age-3 naturally produced fish equals or exceeds mean annual adult mortality for each population, and (c) each point estimate for each population exceeds 4,400 adults; and

- certain site-specific management tasks to minimize or remove threats have been finalized and implemented, and necessary levels of protection are attained.

Life History

The bonytail is considered a species that is adapted to mainstem rivers, where it has been observed in pools and eddies (Vanicek 1967; Minckley 1973). Spawning of bonytail has never been observed in a river, but ripe fish were collected in Dinosaur National Monument during late June and early July suggesting that spawning occurred at water temperatures of about 18ºC (Vanicek and Kramer 1969). Similar to other closely related *Gila* species, bonytail probably spawn in rivers in spring over rocky substrates; spawning has been observed in reservoirs over rocky shoals and shorelines. It has been recently hypothesized that flooded bottomlands may provide important bonytail nursery habitat. Of five specimens captured most recently in the upper basin, four were captured in deep, swift, rocky canyons (Yampa Canyon, Black Rocks, Cataract Canyon, and Coal Creek Rapid), but the fifth was taken in Lake Powell. Since 1974, all bonytails captured in the lower basin were caught in reservoirs.

Threats to the Species

The primary threats to bonytail are stream flow regulation and habitat modification; competition with and predation by nonnative fishes; hybridization with other native *Gila* species; and pesticides and pollutants (USFWS 2002d). The existing habitat, altered by these threats, has been modified to the extent that it impairs essential behavior patterns, such as breeding, feeding, and sheltering. The threats to bonytail in relation to flow regulation and habitat modification, predation by nonnative fishes, and pesticides and pollutants are essentially the same threats identified for Colorado pikeminnow. Threats to bonytail in relation to hybridization are essentially the same threats identified for humpback chub.

Management actions identified in the recovery goals for bonytail (USFWS 2002d) to minimize or remove threats to the species included:

- provide and legally protect habitat (including flow regimes necessary to restore and maintain required environmental conditions) necessary to provide adequate habitat and sufficient range for all life stages to support recovered populations;
- provide passage over barriers within occupied habitat to allow unimpeded movement and, potentially, range expansion;
- investigate options for providing appropriate water temperatures in the Gunnison River;
- minimize entrainment of subadults and adults at diversion/out-take structures;
- investigate habitat requirements for all life stages and provide those habitats;
- ensure adequate protection from overutilization;
- ensure adequate protection from diseases and parasites;
- regulate nonnative fish releases and escapement into the main river, floodplain, and tributaries;
- control problematic nonnative fishes as needed;

- minimize the risk of increased hybridization among *Gila* spp.;
- minimize the risk of hazardous-materials spills in critical habitat; and
- remediate water-quality problems.

Analysis of the species/critical habitat likely to be affected

In summary, the four species of endangered Colorado River fish and their critical habitat are likely to be adversely affected by components of the proposed action. These species will be considered further in the remaining sections of this biological opinion.

ENVIRONMENTAL BASELINE

The environmental baseline includes the status of the species within the action area (the Colorado River near Moab, Utah) as well as the factors affecting the environment of the species or critical habitat in the action area. The baseline includes; State, tribal, local and private actions already affecting the species or that will occur contemporaneously with the consultation in progress; unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation; and Federal and other actions within the action area that may benefit listed species or critical habitat. The environmental baseline does not include the effects of the action under review in the consultation.

Status of the Species Within the Action Area

Colorado pikeminnow

Colorado pikeminnow are distributed throughout the Colorado River from Price Stubb Dam, an impassible barrier at the upper end of the Grand Valley (RM 188.3), downstream to Lake Powell (Osmundson and Burnham 1998). The Recovery Program is scheduled to provide passage at the structure, but it currently remains an obstacle to fish movement.

Although Colorado pikeminnow use the entire river, there are distinct differences in distribution among age classes. In general, most adults are found in the upper reaches of the river and most subadults, juveniles, and YOY are found in the lower reaches (Valdez et al. 1982a; Archer et al. 1985; McAda and Kaeding 1991b; Osmundson et al. 1997). This corresponds to the general distribution of different age classes in the Green River as well (Tyus 1991). Osmundson and Burnham (1998) conducted an intensive river-wide study using mark-recapture to estimate the population size of subadult (250–500 mm long) and adult Colorado pikeminnow (>500 mm long) in the Colorado River. They divided the river into two subreaches — Westwater Canyon to Price Stubb Dam (RM 125–188) and confluence with Green River to Westwater Canyon (RM 0–113; Westwater Canyon itself was not sampled). They estimated that the average population size in 1991–1994 was 253 (95% CI, 161–440) for the upper reach and 344 (95% CI, 196–604) for the lower reach. They noted that almost all fish captured in the upper reach were adults (i.e. >500 mm), whereas most fish captured from the lower reach were subadults.

Although most adults were captured from the upper river, they were not distributed equally throughout the reach. Catch rates in two segments of the upper reach — known as the 18-mile reach (RM 154–171) and the 15-mile reach (RM 171–185) — were five to six times higher than in the lower third of the reach (Osmundson 2000). These reaches contain 8 to 10 times more adult Colorado pikeminnow per mile than the lower 100 mile of the Colorado River.

Osmundson (2002a) repeated the population estimate for the 1998–2000 period using the same techniques used by Osmundson and Burnham (1998). He also revised the previous estimate using length criteria for adults corresponding to recovery goals established in 2002 (USFWS 2002c; ≥450 mm total length [TL]) and provided a river-wide estimate. Average population size for the Colorado River was 503 adult Colorado pikeminnow for 1992–1994 and 604 for 1998–2000 (Osmundson 2002a). Although the average point estimate increased for the second period, the difference was not significant because of wide confidence intervals. An increase in the adult population during the 1990s was also suggested by an increasing catch rate during spring ISMP electrofishing (Figure 3.6; McAda 2002a). However, electrofishing catch rates dropped off in 1999 and 2000, whereas population estimates did not.

Density and distribution of YOY Colorado pikeminnow have been monitored in the Colorado River since 1982 (McAda and Ryel 1999). Density has been highly variable over that period, but YOY have been captured every year since monitoring began. Highest density of YOY Colorado pikeminnow occurred in 1985, 1986, and 1996 and lowest density occurred in 1984, 1995, and 1997. Young-of-the-year Colorado pikeminnow were found throughout the Colorado River downstream from the confluence with the Gunnison River, but were most abundant in the 65 mile between Moab and the mouth of the Green River. Although larval Colorado pikeminnow were collected upstream of the mouth of the Gunnison River in 1982 (McAda and Kaeding 1991b) and in 1995 (Anderson 1999), no YOY and only one yearling have ever been captured there (Osmundson and Burnham 1998). The number of YOY captured in the river between the mouth of the Gunnison River and Westwater Canyon has decreased since the mid 1980s, with no YOY Colorado pikeminnow captured upstream from Westwater Canyon during autumn ISMP surveys since 1992 and only one captured each year from 1988 to 1992 (McAda and Ryel 1999). However, more intensive seining collections than done under ISMP captured one YOY Colorado pikeminnow in 1997 and one in 1998 in the Grand Valley downstream from the Gunnison River (K. Bestgen, personal communication).

Density of YOY Colorado pikeminnow was greatest in the lowest gradient reaches of the Colorado River, similar to distributional patterns in the Green River (Tyus and Haines 1991). This lower 60 miles of the river has a large number of backwaters and embayments (although not the largest, or the highest concentration of backwaters) and the warmest water temperatures in the Colorado River upstream from Lake Powell (Osmundson 1999). Backwaters are warmer and more productive than the rest of the river (Wydoski and Wick 1998), and they provide important nursery habitat for small Colorado pikeminnow during the first year of their life (Tyus and Haines 1991).

On December 19, 2001, UDWR personnel 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.

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).

Razorback Sucker

In the Colorado River upstream from Lake Powell, most razorback suckers have been captured in the Grand Valley (Loma, Colorado to Palisade, Colorado) near the confluence of the Gunnison and Colorado rivers. However, their abundance has decreased to the point that they are only infrequently captured there. During intensive efforts specifically targeted at known concentration areas, Kidd (1977) and McAda and Wydoski (1980) captured a combined total of 54 razorback suckers in 1974 and 204 in 1975 from two gravel-pit ponds connected to the Colorado River near Grand Junction. These numbers reflect the combined total of independent collections, but probably include some recaptures of the same fish because sampling was done in the same areas and Kidd (1977) did not mark fish before release. All of these fish were adults that exhibited signs of old age such as large size, missing eyes, and heavy scarring (C. McAda, personal observation).

A variety of investigators have sampled the Colorado River in subsequent years, but sampling effort varied considerably and sampling did not always target razorback sucker. The high numbers of razorback suckers captured in 1975 were not repeated in subsequent years (summarized by Osmundson and Kaeding 1991). The highest number captured in later years was 30 fish that were collected in 1982 from the same gravel-pit ponds sampled by Kidd (1977) and McAda and Wydoski (1980). Total fish captured declined dramatically after 1975, and few wild razorback suckers have been captured in recent years. Only 11 wild razorback suckers have been collected in the Grand Valley since 1990 despite intensive sampling in some years (Osmundson and Kaeding 1991; CDOW and USFWS, unpublished data). All of these fish were removed from the river to support propagation activities for the Recovery Program (M. Baker, unpublished data).

Although most razorbacks suckers have been collected in the Grand Valley, they have also been collected both up and downstream of the area. Kidd (1977) reported 22 razorback suckers from the Colorado River near DeBeque, Colorado (RM 209.7) in 1974–1975. No razorbacks have been collected from that reach since then (Valdez et al. 1982b; Burdick 1992). Burdick (1992) captured one razorback sucker from a gravel pit pond along the river at RM 234.8 and discovered a small population in another gravel-pit pond at RM 204.5. About 75 razorback suckers were captured from the second pond, but DNA analysis revealed that they were siblings. They were probably offspring from two or three razorback suckers trapped in the pond during the high-water years of 1983 or 1984. Three razorback suckers from this pond were incorporated into the propagation program, but their close relationship precluded extensive use in the brood-stock program. Forty-five razorback suckers from this pond were equipped with radio transmitters and stocked into the Colorado and Gunnison rivers as part of an experimental stocking; six of those fish were confirmed alive at the end of the 2-yr study (Burdick and Bonar 1997).

Few razorback suckers have been captured downstream from the Grand Valley, between Loma and Lake Powell. Taba et al. (1965) captured eight juveniles in backwaters of the Colorado River downstream of Moab. One adult was captured near Salt Wash (RM 144.2) in 1988 (McAda et al. 1994b). Further downstream, Valdez et al. (1982b) captured two razorback suckers within 2 mileof the confluence with the Green River, and Valdez (1990) captured one more in the same area.

The only small razorback suckers reported from the Colorado River were captured by Taba et al. (1965), who found eight juveniles (90–115 mm TL) in “quiet backwater areas” during a 2-yr survey of the river between Moab and Dead Horse Point. That observation is consistent with collections of juveniles from the Green River. Gutermuth et al. (1994) captured two age-0 juveniles in backwaters along the lower Green River in 1991, and Modde (1996) found two in similar habitats in the middle Green River in 1993. Most recently, Modde (1996) found age-0 juveniles in an experimental flooded bottomland (Old Charlie Wash) along the middle Green River when it was drained at the end of the growing season — 28 in 1995 and 45 in 1996.

Although razorback suckers have declined dramatically in abundance in recent years, the Recovery Program considers the Colorado and Gunnison rivers to be suitable habitat for razorback suckers and has begun a reintroduction program to restore populations in the two rivers (Burdick 1992; Nesler 1998; Hudson, et al. 1999).

The Recovery Program is still building a broodstock for future use, but about 19,000 razorback suckers have been stocked into the Gunnison River near Delta and about 44,000 razorbacks have been stocked into the Colorado River upstream from Grand Junction (Burdick 2003; C. McAda, personal communication). Initial surveys indicate that some of the stocked fish are surviving in the Gunnison and Colorado rivers near their stocking location, and others have moved and are surviving further downstream in the Colorado River (Burdick 2003). In 2003, USFWS 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 (USFWS 2004b). USFWS 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 (USFWS 2004c). This reintroduction program is scheduled to continue until a self-sustaining population of at least 5,800 individuals is established in the Gunnison and upper Colorado Rivers (USFWS 2002d). Some of the stocked razorback suckers have survived to adulthood and spawned successfully — a total of eight larval razorback suckers were captured from the Gunnison River in 2002 (Osmundson 2002b).

Bonytail

Few bonytails have been captured from the upper Colorado River since intensive sampling began in the 1970s, even though anecdotal and photographic evidence suggest that they were common in the river early in this century (Quartarone 1993). Valdez et al. (1982b) did not capture bonytails during an intensive 3-yr study of the Colorado River between Rifle and Lake Powell. Kaeding et al. (1986) captured one adult at Black Rocks near the Colorado-Utah state line, and Valdez (1990) captured 14 *Gila* spp. from Cataract Canyon that were suspected to be bonytails (1 YOY, 7 juveniles, and 6 adults).

The Recovery Program began a reintroduction program in 1996 and has stocked about 84,600 bonytails into the Colorado River since then (Badame and Hudson 2003). Developing a self-sustaining bonytail population in the upper Colorado River will require accomplishments in all phases of the Recovery Program including nonnative fish control, habitat restoration, and instream flow protection. Recaptures of these stocked individuals have been increasing in recent years throughout the river, including near the Moab Site (USFWS 2004a). In 2003, a stocked adult bonytail was captured by USFWS at river mile 66.2, just upstream of the Moab Site (USFWS 2004b). In 2004, a stocked adult was captured at river mile 69.2. (USFWS 2004c). Recovery goals call for a self-sustaining population of 4,400 adults in the upper Colorado River (USFWS 2002a).

Because of its extreme rarity, little is known about the habitat requirements of bonytail in the upper Colorado River. However, all four of the endangered fish evolved together in the Colorado River ecosystem, and flow recommendations and water quality needs based on habitat requirements of the more common species and basic river restoration principals (Stanford et al. 1996) should also benefit bonytail.

Humpback Chub

Two major populations of humpback chub are found in the upper Colorado River — Black Rocks, a 1-mile long reach just upstream from the Colorado-Utah state line, and Westwater Canyon, an 18-mile long canyon-bound reach of rapids, deep pools, and violent eddies. The two populations are generally considered to be distinct because they are separated by about 11 mi, but movement between the two populations has been documented (Valdez and Clemmer 1982; Kaeding et al. 1990; Chart and Lentsch 1999a; McAda 2002b).

Both populations have been sampled regularly since the late 1970's and were generally considered to be stable, with annual reproduction and regular recruitment of young fish to the adult population (Valdez and Clemmer 1982; Kaeding et al. 1990; McAda et al. 1994b; Chart and Lentsch 1999a). However, quantitative population estimates have not been attempted until recently. Chart and Lentsch (1999a) sampled Westwater Canyon during 1993–1996 and made population estimates based on year-to-year recaptures at three discrete sites within the canyon. Sampling was restricted to the three sites because rapids and violent eddies made sampling very difficult in the rest of the canyon. The average annual population estimate for the three sites combined was 6,985 adults (Chart and Lentsch 1999a). A more intensive, mark recapture estimate conducted from 1998–2000 period determined the population declined from 4,744 adults to 2,201 adults in 2001 (Hudson and Jackson 2003). The average adult population size for Black Rocks during 1998–2000 was estimated to be about 740 individuals (McAda 2002b). Decline in catch rates suggest that the population has decreased, but annual population estimates are not significantly different from each other (McAda 2002b).

Adult humpback chubs in the upper Colorado River are relatively sedentary and generally remain within a small area (Valdez and Clemmer 1982; Kaeding et al. 1990; Chart and Lentsch 1999a). Displacement of radiotagged humpback chubs in Black Rocks averaged 0.5– 0.9 mile (Valdez and Clemmer 1982; Kaeding et al. 1990), and displacement of fish tagged with carlin tags averaged 0.7–1.0 mile(Valdez and Clemmer 1982; Kaeding et al. 1990).

Thirty-two percent of the humpback chubs tagged and recaptured by Kaeding et al. (1990) were recaptured at their release site, and 80% were recaptured within 0.3 mile of it. However, they recaptured two humpback chubs that had originally been tagged in Westwater Canyon, about 14 mile downstream. Valdez and Clemmer (1982) also reported movement of a humpback chub from Westwater Canyon upstream to Black Rocks.

The majority (82%) of fish tagged and recaptured by Chart and Lentsch (1999a) in Westwater Canyon showed no net movement, although some fish moved among the three sampling sites. Among others, they recaptured two fish only 2 d after being tagged at Black Rocks. The abrupt downstream movement may have been precipitated by handling stress (Chart and Lentsch 1999a). In addition, seven humpback chubs originally tagged in Westwater Canyon by Chart and Lentsch (1999a) were recaptured in Black Rocks (McAda 2002b). Intervals between tagging and recapture varied from 1 to 6 yr; there is no way to determine how long the fish had been in Black Rocks or how long it took them to move 14 mile upstream. One of these fish was recaptured a second time in Black Rocks 1 yr after its first recapture (C. McAda, unpublished data).

A third population, the Cataract Canyon population is located some 70 miles downstream in Canyonlands National Park. Densities of humpback chubs in Cataract Canyon are much lower than those reported from Black Rocks or Westwater Canyon. Three weeks of sampling in Cataract Canyon during the fall of 2003 resulted in the capture of 32 individual humpback chub (Valdez et al 2003).

Young-of-the-year humpback chubs have been collected from a variety of low-velocity habitats within Westwater Canyon, including shorelines, backwaters, and embayments (Chart and Lentsch 1999a). They used low-velocity habitats as they were available with very little selection of specific habitats (Chart and Lentsch 1999a). In Black Rocks, small humpback chubs were collected from backwaters as well as small, quiet pockets along the steep rock walls (Valdez and Clemmer 1982).

Factors Affecting the Species Environment Within the Action Area

Designated critical habitat for both Colorado pikeminnow and razorback sucker includes the Colorado River and its 100-year floodplain throughout the project area. Designated critical habitat for the humpback chub and bonytail is located approximately 50 miles upstream of the project and approximately 60 miles downstream. Primary constituent elements include, but are not limited to, water (in sufficient quantity and quality to sustain all life stages), physical habitat, and the biological environment (including competition and predation with nonnative species).

Impoundments and diversions have reduced peak discharges in various river reaches throughout the Upper Colorado River Basin since the 1890's, while increasing base flows in other reaches. These depletions, along with a number of other factors, including the introduction of nonnative fishes and increases in salinity and contaminants in the system, have resulted in such drastic reductions in populations of Colorado pikeminnow, humpback chub, razorback sucker and bonytail chub that the USFWS has listed these species as endangered, designated their critical habitats, and has implemented programs to prevent them from becoming extinct.

The numerous impoundments in the upper Colorado River, including Granby, Dillon, Blue Mesa and McPhee Reservoirs, have altered the natural hydrograph of the Colorado River. Reductions in water quantity and changes in flow regime have resulted from upstream developments (USFWS 1993a). A comparison of the frequency of the $Q_{1.5}$ peak flow (a river flow that was equaled or exceeded in 2 out of 3 years) at the Colorado River at the USGS gage near Cisco, Utah (the closest upstream gage) for three development periods (1914-1936, 1937-1965, and 1966-1997) declined from 37,200 cfs to 27,900 cfs to 21,600 cfs (summarized in McAda 2003). Changes in the hydrologic regime through the closure of main stem impoundments has altered sediment transport and resulted in channel degradation (Lyons 1989). Changes in the hydrograph can also lead to changes in the channel geometry. Reduction in channel width has increased the average velocity in the main channel and decreased the number of low-velocity backwaters (Wick et al. 1982). Important backwater habitats and low-velocity shoreline habitats have been eliminated through siltation and subsequent vegetative growth (Wick et al. 1982). In particular, river shorelines have been altered by establishment of the exotic plant tamarisk (*Tamarisk chinensis*). For example, in Canyonlands National Park, the establishment of tamarisk on islands, sandbars, and river shorelines has decreased channel width by an average of 25 percent (Graff 1978). All these species can be found to varying degrees in the project area.

The impoundment of tributaries and mainstem waters also has led to the stocking of a number of nonnative sport and bait fishes for use by local residents and visitors to the basin. While the acceptance of these fishes has been generally favorable to the public, their presence has led to predation, competition, and the general demise of native species (Tyus 1990, Tyus and Saunders 1996). The stocking of nonnative warm water fishes such as channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieu*), and walleye (*Stizostedion vitreum*) have resulted in the continuing high probability of predation on native fishes. Red shiners (*Cyprinella lutrensis*), for example, have been documented as preying on larval suckers, including razorbacks (Rupert et al. 1993, Modde 1997). Other exotics such as sand shiners (*Notropis stramineus*) and fathead minnows (*Pimephales promelas*) compete for food and space in remaining habitats. Some scientists believe (Tyus and Saunders 1996) that changes in the biological environment as a result of fish introductions may currently be the most significant threat to the native fish fauna of the Colorado River basin.

Water quality has been altered in the Colorado River Basin and also has been identified as a factor resulting in the decline of the endangered fishes. Both the Draft Razorback Sucker Recovery Plan (USFWS 1997) and Colorado Squawfish (name later changed to Colorado pikeminnow) Recovery Plan (USFWS 1991) identify changes in water quality and introduction of environmental contaminants as factors in the decline of the endangered fish. While several general trends in water quality changes have been identified for the Colorado River system (for example, increasing pH and decreasing turbidity), the water quality parameters and environmental contaminants of concern to the endangered fish tend to be site specific. In the USFWS's Recovery Goals for the Colorado pikeminnow, razorback sucker, and bonytail (USFWS 2002a-c) the Atlas Mill tailings are recognized as posing two significant threats: a). toxic discharge of pollutants, particularly ammonia, and b). the risk of catastrophic pile failure that could bury important nursery areas. Quantifiable criteria required to downlist these species include:

> Task E-2.1.- Identify actions to remediate groundwater contamination from the Atlas Mills tailings pile located near Moab, Utah, in order to restore water quality of the Colorado River in the vicinity of the pile in accordance with State of Utah and Environmental Protection Agency (EPA) water quality standards for fish and wildlife.

Quantifiable criteria required to delist these species include:

> Task E-2.2.- Implement actions (as determined under Task E-2.1) to remediate groundwater contamination from the Atlas Mill tailings pile.

The nearest U.S. Geological Survey water quality monitoring station on the mainstem Colorado River to the Atlas site is approximately 31 river miles upstream near Cisco, Utah. The site is located on the left bank of the Colorado River one mile downstream of the Dolores River confluence, 11 miles south of Cisco, Utah, 36 miles downstream from the Utah-Colorado state line. This site has been continuously monitored by the U.S. Geological Survey since 1928. Baseline water quality data for the Colorado River upstream of the Atlas site, at the Cisco station, is included in Table 3 below. While the data is included as baseline, it should be noted that several washes (Salt, Negro Bill, and Courthouse), and Creeks (Onion, Professor, Stearns, and Castle) contribute flows to the Colorado River between the Cisco station and the Atlas site. Therefore, water quality in the Colorado River just above the Atlas site may, at times, be slightly different than that reported for Cisco.

Table 3. Baseline water quality data for the Colorado River, recorded at Cisco, Utah (Water Year 2000).

Date	Discharge (Inst. CFS)	Sulfate Dissolved (mg/l as SO4)	Chloride Dissolved (mg/l as CL)	Nitrogen NO2+NO3 Dissolved (mg/l as N)	Nitrogen Ammonia Dissolved (mg/l as NH4)	Arsenic Dissolved (ug/l as AS)	Beryllium Dissolved (ug/l as BE)	Cadmium Dissolved (ug/l as CD)	Manganese Dissolved (ug/l as MN)	Molybdenum Dissolved (ug/l as MO)	Selenium Dissolved (ug/l as SE)	Uranium Natural Dissolved (ug/l as U)
11/02/99	5920	240	72	0.289	--	<2	--	--	--	--	4	--
12/01/99	3900	260	100	0.500	--	--	--	--	--	--	4	--
12/16/99	3770	250	95	0.530	--	<2	<1.0	<1.0	17.0	5.6	3	5.7
03/29/00	3970	240	110	0.356	0.05	<2	<1.0	<1.0	1.5	6.8	4	4.4
04/27/00	8080	120	41	0.317	--	--	--	--	--	--	<2	--
05/23/00	10200	120	36	0.270	--	<2	<1.0	<1.0	<1.0	2.8	--	2.6
06/27/00	5950	170	59	0.319	--	<2	--	--	--	--	3	--
07/20/00	3930	250	83	0.668	0.03	<2	--	--	--	--	4	--
08/28/00	3760	310	75	0.784	--	--	<1.0	<1.0	<1.0	7.2	5	6.6
09/07/00	3760	290	81	0.700	--	--	--	--	--	--	4	--

The following constituents were detected at DOE's background monitoring site CR-1(located upstream of the Moab Site and upstream of the Hwy 191 bridge; at the cement boat ramp): aluminum, ammonia, arsenic (very low), barium, boron, calcium, chloride, fluoride, gross alpha, gross beta, iron (unfiltered only), lithium, magnesium, manganese, molybdenum (very low), nickel (very low), nitrate, polonium-210, potassium, radium-226 (low), selenium, sodium, strontium, sulfate, TDS, uranium, vanadium, and zinc (very low). Constituents that were analyzed but not detected included antimony, beryllium, bismuth, cadmium, chromium, cobalt, elemental lead, lead-210, mercury, radium-228, radon-222, silver, thallium, thorium-230, phosphate, and tungsten. Detectable constituents and concentration ranges at background locations for samples collected during SMI and DOE sampling events from April 2000 through December 2002 are presented in Table 4 (reproduced from DOE 2003).

Table 4. Constituent concentration ranges collected immediately upstream of the Moab Site.

Constituent	Frequency of Detection	Range (mg/L except as noted)
Major Ions		
Calcium	16/16	46.3–141
Chloride	20/20	25.1–172
Magnesium	16/16	12.9–41
Potassium	16/16	2.1–5.3
Sodium	17/17	30.5–125
Sulfate	20/20	84.1–439
Total Dissolved Solids	12/12	430–1060
Minor Constituents		
Aluminum	9/12	0.008–0.14
Ammonia, total as N	9/20	Nd–0.134
Arsenic	8/11	Nd–0.002
Barium	13/13	0.051–0.14
Boron	4/10	Nd–0.123
Copper	3/13	Nd–0.0014
Fluoride	3/3	0.3–0.504
Gross Alpha	1/7	Nd–13.82*pCi/L
Gross Beta	2/7	Nd–13.78**pCi/L
Iron	6/9	Nd–4.17**
Lithium	1/3	Nd–0.0557
Manganese	8/18	Nd–0.076
Molybdenum	17/18	Nd–0.007
Nickel	7/10	Nd–0.002
Nitrate as NO3	6/6	0.776–5.51
Polonium-210	2/5	Nd–0.1142 pCi/L
Radium-226	5/5	0.12–0.23 pCi/L
Selenium	15/15	0.0013–0.0079
Strontium	10/10	0.965–1.63
Uranium	20/20	0.0023–0.008
Vanadium	11/11	0.0007–0.0031
Zinc	5/12	Nd–0.006

EFFECTS OF THE PROPOSED ACTION

Current Conditions

Surface contamination

In 2001, DOE began radiometric characterization of soils on the millsite. To date, the area north and northeast of the tailings pile have been assessed. Most of the site exhibits soil contamination exceeding EPA standards for radium-226. Exceptions are some small areas north of the tailings pile and one larger area northwest of the pile where a borrow pit was excavated and soils were used for pile surcharge (i.e., weight on the pile to squeeze out moisture) and for the interim cover. Shallow contamination was also identified north of US-191 on DOE property extending to the property line with Arches National Park.

Depths of contamination range from 6 to 120 inches. The area outside the tailings pile (i.e., the area of windblown contamination) is estimated to contain 71,000 yd^3 of contaminated soils. Measuring the depth of contamination with surface scanning and downhole logging instruments has inherent uncertainties; experience at other UMTRCA sites suggests that the final volume could exceed the volume characterized by a range of 50 to 100 percent.

On the basis of site knowledge and past UMTRCA site experience, DOE estimates that 11.9 million tons (8.9 million yd^3) of contaminated materials exist at the Moab Site and vicinity properties. Table 5 presents a summary of the contaminated materials and quantities present at the Moab Site and nearby vicinity properties. Additional investigations confirmed that most of the slimes are located in the center of the pile and are surrounded by sandy tailings.

Table 5. Contaminated Material Quantities

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

The tailings pile at the Moab Site contains waste residuals from the milling operation. Milling involved both acid and carbonate processing methods (i.e., circuits). Lime was added to the tailings to neutralize the acid-milled tailings. Chemicals used in the processing, including acids, ammonia, and solvents, are incorporated with the silicate grains. Many other minerals, including sulfates and sulfides, are also present in lesser amounts. It is difficult to determine the residence time of the contaminants, although there is evidence that some exist as siliceous mixtures, and others may exist as sulfides, selenides, molybdates, and uranium minerals. Contaminants are also likely to be adsorbed to minerals, especially iron oxyhydroxides.

Bulk chemical analysis of the tailings solids indicates that high concentrations of ammonia, uranium, and radium-226 are present. The mean radium-226, ammonia (as N), and uranium concentrations for the tailings are 516 pCi/g, 423 milligrams per kilogram (mg/kg), and 84 mg/kg, respectively. The finer grained (slimes and silt) fractions have more radium-226 and uranium but less ammonia as (N) than the sand fraction. Other constituents, including iron, manganese, copper, lead, molybdenum, selenium, and vanadium, are present in lesser amounts. The pH values of the tailings are near neutral but have zones of pH values as low as 2.5 and as high as 10. The tailings have a small amount of acid-generating capacity in the form of sulfide minerals. The oxidation-reduction potential is not well defined by existing data, and conditions may vary spatially from relatively oxidizing to relatively reducing.

Mean tailings pore water concentrations for radium-226 and uranium are 61.1 picocuries per liter (pCi/L) and 15.1 mg/L, respectively. The average tailings pore water concentration for ammonia (as N) is 1,100 mg/L. Pore water is a mixture of residual milling fluids and water that infiltrated later into the tailings. The pore water appears to be relatively oxidized, although few data are available to assess oxidation-reduction potential. The pH value of the pore water is near neutral, and the mean TDS concentration is 23,500 mg/L. Values of pH, oxidation state, and availability of soluble minerals in the tailings are the main parameters that affect the composition of pore water. Concentrations of organic constituents used in the mill processing circuit are negligible in the pore water. Concentrations of all constituents are much higher in samples of water collected in a shallow-depth sump fed by pore water extracted from the tailings through wick drains than in any of the pore water samples collected from deeper SRK (2000) wells. Analyses of samples collected from the sump indicate the presence of a salt layer in the upper portion of the pile (DOE 2003).

Two underground septic tanks (size unknown) that supported past operations but are no longer used are located inside the radioactively contaminated portion of the site northeast of the historical warehouse. It is unknown if there are buried leach fields associated with these tanks. Organic contamination in soil and ground water samples was not detected by DOE in an analysis performed as part of the site characterization for the SOWP (DOE 2003a).

<u>Ground water contamination</u>

Ground water occurs in the bedrock formations and unconsolidated Quaternary material deposited on the floor of Moab and Spanish Valleys. The Navajo Sandstone, Kayenta Formation, and Wingate Sandstone of the Glen Canyon Group contain the principal bedrock aquifer in the region and locally are present only upgradient at the northern boundary of the site. The Navajo Sandstone of the Glen Canyon aquifer ranges in thickness from 300 to 700 ft (Doelling et al. 2002) and is the shallowest and most permeable formation in the Glen Canyon Group. Wells located 7 to 8 miles southeast of the site produce in excess of 1,000 gpm of high-quality water from the Navajo Sandstone for the city of Moab water supply.

Most of the freshwater in the basin-fill aquifer enters the site from Moab Wash and along geologic contacts between the alluvium and the Glen Canyon Group bedrock present at the north boundary of the site. The bedrock in this area is highly fractured and faulted from incipient collapse of the Moab anticline caused by dissolution of the underlying Paradox Formation salt core of the anticline.

Ground water elevation contours east of the Colorado River in the Matheson Wetlands Preserve based on March 2003 water elevation measurements indicate ground water flow toward the river. Elevation contours indicate that freshwater entering the site at the northern boundary flows south toward the river over the top of a deeper natural brine zone.

The deeper brine water results mostly from dissolution of the underlying salt beds of the Paradox Formation present beneath most of the site. Figure 4 presents a conceptual model of the subsurface hydrogeology along a representative streamline showing the interface between the deeper saltwater system and the overlying freshwater system. The saltwater interface is defined at the 35,000-mg/L TDS boundary. The transition from the saltwater to the freshwater system occurs over a short vertical distance and is, therefore, referred to as being “sharp.” The vertical position of the interface is in equilibrium because the buoyant force exerted by the brine is balanced by the weight of the overlying freshwater. In natural systems, little, if any, freshwater penetrates saltwater at the interface. The freshwater can be thought of as a liquid that “floats” upon a buoyant saltwater liquid. At the Moab Site, the interface extends across the site in a wedge shape, in which the deepest part of the interface is near the northwest boundary, and the shallowest depth is near the river. The position of the interface near the river is in dynamic equilibrium and probably shifts laterally and vertically in response to evapotranspiration by the tamarisk plant communities and the stage of the Colorado River. The interface may also shift vertically upward as a result of pumping from the shallow freshwater (e.g., during a pump-and-treat remediation) and cause the saltwater to rise to a higher elevation and intrude the freshwater. Saltwater intrusion would result in degradation of the overlying freshwater, which could adversely affect the tamarisk plant communities which are presumed to provide some beneficial phytoremediation at the site.

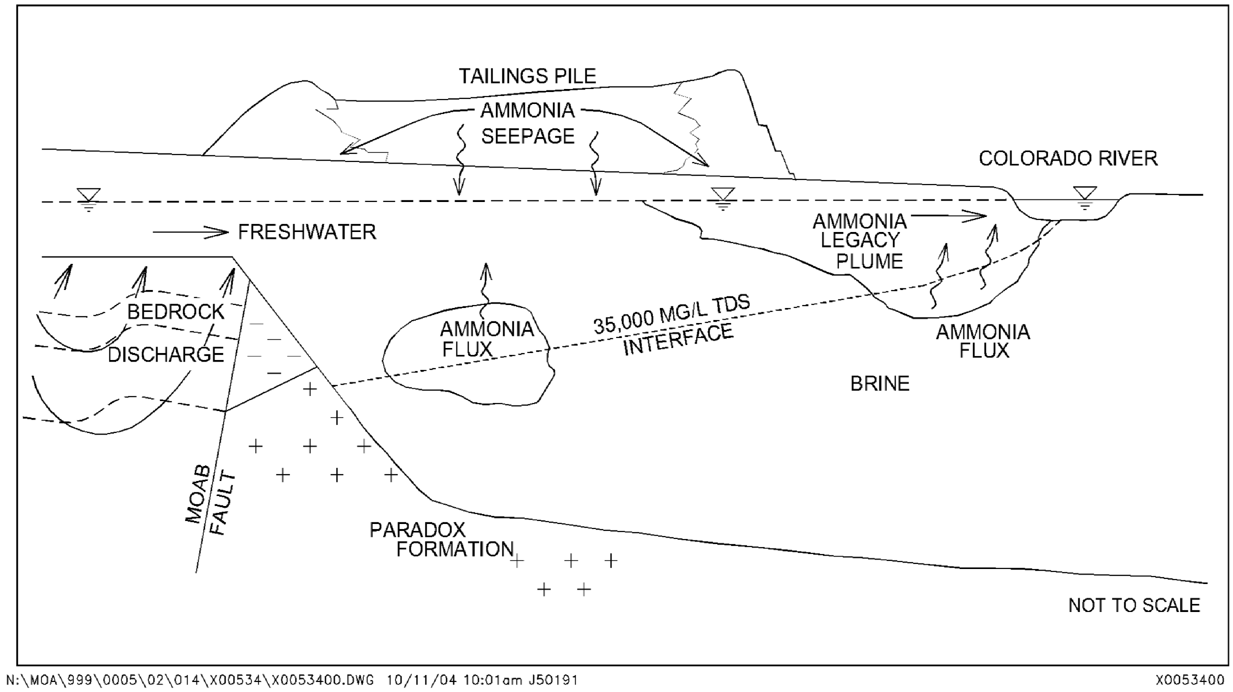

Figure 4. Conceptual Model, Saltwater/Freshwater Interface

Rising saltwater may also bring higher ammonia and salt concentrations to the surface and cause added contamination flux to the river. Low pumping rates and proper extraction well construction and pump location may prevent saltwater intrusion. Additional information on the hydrogeology of the site is presented in the SOWP (DOE 2003a).

Additional recharge to the site occurs through precipitation. The Paradox Formation is believed to be an impermeable boundary (bedrock aquitard) and does not contribute to the site water budget. An estimate of the annual steady-state water budget for each hydrologic component of the system is presented in Table 6. Short-term transient effects such as the small positive contribution to bank storage by recharge from the Colorado River during periods of high flow are not included. The estimates are represented with a large range of individual values, and the ranges of the total inflow and total outflow do not overlap, reflecting the uncertainty of the values and suggesting that the true water budget might lie between the two ranges. The SOWP (DOE 2003a) provides additional discussion of the ground water hydrology and water budget of the site.

Table 6**. Estimated Annual Water Budget for the Moab Site**

Flow Component	**Inflow (gpm)**	**Outflow (gpm)**
Areal Precipitation	16–65	N/A
Moab Wash	0.5–33	N/A
Glen Canyon Group	28–280	N/A
Tailings Pile	20	N/A
Evapotranspiration	N/A	200–500
Colorado River	N/A	300–600
Total	**65–400**	**500–1,100 (rounded)**

N/A = not applicable.

Ground Water Quality - The basin-fill aquifer underlying the site is divided into three hydrochemical facies: (1) an upper fresh to moderately saline facies (fresh Quaternary alluvium [Qal]) that has concentrations of TDS up to 10,000 mg/L, (2) an intermediate facies of very saline water (saline Qal), having TDS concentrations between 10,000 and 35,000 mg/L, and (3) a lower briny facies (brine Qal) that has TDS concentrations greater than 35,000 mg/L. All three facies existed beneath the site prior to milling activities. The SOWP (DOE 2003a) provides additional discussion of ground water geochemistry and water quality at the site.

The freshwater quickly becomes mixed with more saline water in the basin-fill aquifer as it enters the site from Moab Wash and flows toward the Colorado River. Salinity naturally increases with depth and distance from the freshwater source contribution from Moab Wash. Mixing of the two background water types (fresh upgradient water with the deeper depth saline water) influences the background water quality at the site. The result is a background water quality in the basin-fill aquifer that is highly variable both vertically and horizontally across the site.

Background conditions in the upper fresh Qal facies are characterized by low concentrations of uranium and other trace metals that are all below the EPA standards in 40 CFR 192. TDS concentrations range from 677 to 7,820 mg/L, which classifies the water quality as fresh to slightly saline. Background alkalinity as calcium carbonate ranges from 137 to 189 mg/L. There is no EPA standard for ammonia in 40 CFR 192. Ammonia–N concentrations are less than 1 mg/L. Sulfate concentrations range from 180 to 1,140 mg/L. Calcium concentrations range from 47 to 294 mg/L. Magnesium concentrations range from 31 to 188 mg/L. On average, the pH value of the upper fresh Qal facies is near neutral (7.7), and the redox condition is slightly oxidizing (oxidation-reduction potential is 186 millivolts [mV]).

Ground water concentration limits for arsenic, barium, cadmium, chromium, lead, mercury, molybdenum, nitrate, selenium, silver, uranium (combined U-234 and U-238), gross alpha (excluding radon and uranium), and radium (combined radium-226 and radium-228) are regulated by EPA standards (40 CFR 192). Of these constituents, the maximum concentrations detected for arsenic, cadmium, uranium, radium, gross alpha, nitrate, selenium, and molybdenum exceed EPA standards. The remaining regulated constituents (barium, chromium, lead, mercury, and silver) are all present at relatively low concentrations below EPA standards.

The areal distribution of uranium concentrations greater than 0.044 mg/L, interpolated and contoured on the upper surface of the ground water, were presented in the DEIS and depicted in Figure 3-10 of that document. The highest uranium concentrations are in the shallow ground water in the former millsite area. Cross-sectional views of the uranium plume and additional isoconcentration maps of uranium as a function of depth are provided in the SOWP (DOE 2003a). SMI (2001) suggested that the high uranium concentrations beneath the millsite are caused by waste leaking from the former wood chip disposal areas. Although the uranium plume is in an area where wood chip disposal was likely to have occurred, lithologic logs of borings installed in this area of the site do not indicate that they penetrated through the wood chip pits. Another possible source of the high uranium concentrations is the uranium ore stockpiles; however, samples collected from monitor wells nearest the largest known ore stockpiles have lower uranium concentrations. Whether the source of the high uranium concentrations in ground water samples is the wood chip pits, the ore stockpiles, or some other millsite-related release, it seems that some of the ground water contamination originates in the millsite area, independently of the tailings pile.

Although ammonia has no EPA standard in 40 CFR 192, it occurs at concentrations significantly greater than natural background, is one of the most prevalent contaminants in the ground water, and is the constituent of greatest ecological concern that is discharging to the Colorado River in backwater areas adjacent to the site. The areal distribution of ammonia concentrations greater than 50 mg/L, interpolated and contoured on the upper surface of the ground water, is presented in the DEIS and depicted in Figure 3-11 of that document. The highest concentrations in the shallow ground water, greater than 500 mg/L, appear near the down gradient edge of the pile and extend to and discharge to the Colorado River. The highest ammonia concentrations in surface water samples are detected in samples collected closest to the riverbank adjacent to the tailings pile and immediately downstream of Moab Wash. A comparison of ground water data with surface water data shows that, with few exceptions, concentrations of site-related constituents are much lower in the surface water than in the ground water. Ammonia concentrations in the river are approximately 2 orders of magnitude lower than in the ground water. Although available data are not adequate to establish an accurate dilution factor, these data do suggest that at least order-of-magnitude decreases in constituent concentrations can be expected as ground water discharges to the river. DOE recognizes that isolated pools or very shallow areas may be exceptions to this dilution, and claim that these may not be important aquatic habitats, as they are frequently cut off from the river and dry up, and fish mortality would be as likely from habitat limiting factors (e.g. physical factors and predation). The USFWS considers shallow areas ($\geq$2.5cm in depth) in backwaters and along the margin of flowing channels as habitats used by young native fish. If these shallow habitats are not subject to habitat limiting factors, they can potentially be very important to early life stages of endangered fish and therefore lower dilution rates could be harmful.

Relatively high ammonia concentrations in ground water also occur at depth beneath the tailings pile. During milling operations, the tailings pond contained fluids with TDS concentrations ranging from 50,000 to 150,000 mg/L. Because these salinities exceed 35,000 mg/L, they had sufficient density to migrate vertically downward through the freshwater system and into the brine. This downward migration of the tailings pond fluids into the saltwater system is believed to have created a reservoir of ammonia that now resides below the saltwater interface. This ammonia plume below the interface probably came to rest at an elevation where it was buoyed by brine having a similar density. Under present conditions, the ammonia plume beneath the saltwater interface represents a potential long-term source of ammonia to the freshwater system. The conceptual model presented in Figure 4 illustrates the ammonia source at the saltwater interface (basal flux), the legacy plume, and seepage of ammonia from tailings pore fluids.

Surface water contamination

Analytical results of samples collected adjacent to the site were compared to background concentrations and aquatic benchmarks to develop a list of contaminants of potential concern. The analytical results confirmed that ground water discharge from the Moab Site has caused localized degradation of surface water quality. As a result of that evaluation, ammonia, copper, manganese, sulfate, and uranium are considered contaminants of concern.

Concentrations of contaminants of potential concern in surface water samples vary widely, depending on sampling locations and river flow conditions. Concentrations are most likely to be elevated during periods of average to low river stages in areas where water is shallow and slow moving or pooled. Concentrations are also highest immediately adjacent to the riverbank. The constituents with concentrations that are most consistently elevated in samples from the Colorado River are ammonia and uranium. These will be discussed as indicators of site-related contamination. DOE reports ammonia concentrations as high as 300 mg/l detected in samples from areas next to the riverbank immediately downstream of Moab Wash.

Low river flows expose greater portions of the Moab Wash sandbar, creating increased backwater areas that allow for higher concentrations of ammonia in the surface water. However, a study completed in 2000 (SMI 2001) determined that during high flows, backwater areas are eliminated near the site, and ammonia concentrations near the shore are diluted to protective levels (within EPA's recommended total ammonia protection criteria), or loading is temporarily stopped by river water flowing into the aquifer because of the seasonally high river stage. This finding suggests that snowmelt runoff periods (May and June) may temporarily reduce the ammonia concentration in the Colorado River.

Because ground water gradients on both sides flow toward the river, it is likely that the presence of the ground water brine affects surface water quality. However, because process fluids disposed of in the former tailings pond contained some of the same constituents that occur in natural brines, distinguishing between naturally occurring constituents and site-related constituents in surface water is not straightforward. Increases in sodium, chloride, or dissolved solids content of river water (among other constituents) in the vicinity of the site, compared to background concentrations, could be a result of discharge of either site-related contaminated ground water or natural brines.

Toxic effects of ammonia

The toxic effects of ammonia to aquatic species are well documented. Thurston et al. (1983) documented that acute toxicity, as the 96-hour median lethal concentration (LC50), occurred in fathead minnow (*Pimephales promelas*) at ammonia concentrations ranging from 0.75 to 3.4 mg/l un-ionized ammonia (34-108 mg/l total ammonia nitrogen). DeGraeve et al. (1980) reported a 96-hour LC50 of 1.59 mg/l un-ionized ammonia for fathead minnow. Ammonia toxicity has been reported for numerous other nonsalmonid fishes. LC50's ranged from 0.14 to 4.2 mg/l un-ionized ammonia for these fishes (Thurston et al. 1983).

The documented chronic effects of ammonia toxicity include reduced growth rate (Rice and Bailey 1980, Burkhalter and Kaya 1977, Broderius and Smith 1979, McCormick et al. 1984, Robinette 1976, Smith 1972, Smith and Piper 1975, Smith et al. 1984, Swigert and Spacie 1983), reduced gamete production, body deformities and malformations (Smith 1984), and degenerative gill and kidney appearance and function (Burkhalter and Kaya 1977, Fromm 1970, Smart 1976, Thurston et al. 1978). Reported ammonia concentrations found to reduce growth rates, retard growth, reduce gamete production, or decrease body weight, ranged from 0.0024 mg/l, to 0.49 mg/l.

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 (yd2). 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 ^{o}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^{o} C) than at an average condition (18^{o} C). On-site toxicity tests in low or no flow areas demonstrated that site waters were directly toxic to both the endangered Colorado pikeminnow and the fathead minnow.

Analyses for Effect of the Action and Species Response to the Proposed Action

DOE has indicated that many of the details of their preferred alternative will be determined after filing a Record of Decision and therefore the following effects analysis is based on DOE’s characterization of project effects as presented in their biological assessment.

We relied heavily on supplemental information presented in the EIS (DOE 2004) and SOWP (DOE 2003a) documents to assist in our analysis. In addition, we relied on information provided through the Upper Colorado River Endangered Fish Recovery Program, studies conducted by USGS (USGS 2002), University of Utah (Gardner and Solomon 2003, 2004) and comments provided by various agencies on the DEIS to complete our analyses.

Actions at the Moab Site:

Mechanical Disturbance. The impact to aquatic species due to construction and operations at the Moab Site would be from mechanical disturbances and loss of vegetation along the shoreline of 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 of the tailings pile, consisting primarily of tamarisk, would be removed in order to excavate and remove contaminated materials (i.e., soils contaminated with residual radioactive material). 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 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 two of the endangered fish: Colorado pikeminnow and razorback sucker. 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 diminish the quantity and quality (amount of available food items) of nursery habitats for endangered fish. Other fish, macroinvertebrates, and emergent plants associated with the backwater areas are also likely to be affected by erosion and siltation. DOE intends to prevent or reduce the effects of erosion by minimizing shoreline disruption, replacing vegetation, and installing erosion control devices. The USFWS sees these effects to physical habitat as short term in nature. Whereas, a temporary loss of a specific nursery habitat could result in some level of take of the species, we would assume displacement downstream to the next suitable habitat alone (i.e. without the added impact of exposure to elevated levels of surface water contamination) would not adversely affect these early life stages.

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 Depletions. Water depletion in the Colorado River as a result of remediation of the Moab Site would jeopardize the endangered Colorado River fishes. In accordance with the Cooperative Agreement to implement the “Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin” (USFWS 1987) all Section 7 consultations address depletion impacts. A key element of the program requires a one-time contribution of $16.30 per ac-ft (adjusted annually for inflation) based on the average annual depletion through activities at the site, to be paid to USFWS. DOE has identified an average annual depletion of 235 ac-ft / year. Depletions less than 4500 ac-ft/yr are considered “small depletions” by the Recovery Implementation Program. Depletion impacts to the Colorado River endangered fish from the proposed action will be addressed in the Conclusion section of this biological opinion.

<u>Effects of Off-site Disposal at the Crescent Junction Site</u>

We concur with DOE’s determination that their off-site disposal alternative (excluding the ground water remediation component) may affect but is not likely to adversely affect the Colorado River fish with the exception of the effects associated with the Colorado River depletions. Water depletions reduce the ability of the river to create and maintain important habitats and reduce the frequency and duration of availability of these habitats. Food supply, predation, and competition are important elements of the biological environment. Food supply is a function of nutrient supply and productivity. High spring flows inundate bottomland habitats and increase the nutrient supply and productivity of the river environment. Reduction of high spring flows from water storage reservoirs that store water during spring peak flows may reduce food supply. The effects of Colorado River depletions will be addressed separately in the Conclusion section.

DOE compared and contrasted the relative effects to the environment from disposing surface contamination on-site versus off-site in their DEIS. Several uncertainties were associated with capping the mill tailings onsite, including: the threat of the release of contaminants due to river flooding and river migration; the future dissolution of ammonia salts associated with the pile. As portrayed in the DEIS those uncertainties would be significantly reduced under an off-site disposal alternative. The USFWS recognizes that even after surface contaminants at the Moab Site were removed and the Moab Site was reclaimed to EPA standards future river channel avulsion could result in the release of some contamination to the surface flows of the Colorado River. However the USFWS believes that off-site disposal of surface contamination at the Moab Site, as proposed by DOE, represents the most conservative approach to protecting listed species and their habitat.

In their biological assessment, DOE indicates that further study of the site and the transportation method selected would be required to fully address all endangered species concerns. As DOE continues to develop their RAP, the USFWS will determine if further Section 7 consultation is needed.

Effects Associated with the Ground Water Remediation Program

DOE proposes an active ground water remediation program as part of their preferred alternative. All remediation activities would occur within the existing millsite boundary. DOE estimates that the active remediation system would extract and treat ground water for 75 years to maintain surface water quality goals.

DOE and the USFWS, in discussions during the summer of 2003, agreed to an ammonia-based groundwater remediation goal of 3mg/l. The USFWS conferred with the USGS on this ground water remediation target in January, 2004. In his email response to our inquiry dated January 8, 2004, Mr. James Fairchild, USGS, Research Ecologist, concurred that the 3mg/l ammonia target was reasonable based on information that suggested the ground water pH would be around 7.2 which should decrease the uninonzed fraction. In addition there should be some microbial activity to oxidize the ammonia to nitrate. Mr. Fairchild's concern, however, was that a "goal" is not the same as a statutory criteria. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and is expected to result in a corresponding decrease in surface water concentrations. The overall groundwater remediation goal is expected to put DOE in compliance with the acute and chronic benchmarks based on ambient pH and temperature as stipulated in the National Recommended Water Quality Criteria (NWQC) (EPA 2002) and currently proposed Utah Water Quality Standards (UAC 2003, UDEQ 2003). The groundwater target, coupled with DOE's estimated average 10-fold dilution as groundwater mixes with surface water is expected to result in compliance with both acute and chronic ammonia standards in the river everywhere adjacent to the site. 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.

DOE has determined, and the Service concurs, that during the pre-remediation phase, critical habitat for the Colorado pikeminnow and the razorback sucker would likely continue to be adversely modified by historical contamination. The following endangered fish species and their life stages are most likely to be directly and adversely affected by site-related contamination: Colorado 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) (USFWS 2004a). The closest population of humpback chub occurs 60 miles downriver in Cataract Canyon and could be affected by a large release of surface contaminants. Under the most extreme catastrophic release of surface contaminants (prior to completion of off-site disposal) the USFWS believes there could be lethal effects in Cataract Canyon. Conversely, we do not believe current levels of ground water contamination are causing measureable effects there.

DOE, in consultation with USFWS, 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. 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.

DOE predicts that during the remediation and post-remediation phases of ground water remediation effects on fish species and associated critical habitat would likely be insignificant or neutral. The USFWS will rely on ground water and surface water monitoring to determine if remediation goals are met. USFWS would be consulted at least annually on the results of monitoring.

In their biological assessment, DOE addressed the effects of flooding on ground water remediation. Catastrophic flooding could 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. 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 and monitoring systems would be quickly restored after the flood waters receded. In the event of any disruption in groundwater remediation operations DOE will notify the USFWS and both agencies will determine how to proceed.

The Service and DOE recognize several areas of uncertainty associated with ground water remediation. DOE's conceptual model does not account for site related contaminants affecting habitats on the south side of the river, i.e. the Matheson Wetland Preserve. In a recent effort to describe the water budget at the Scott M. Matheson Wetland Preserve, Gardner and Solomon (2004) developed studies to quantify and investigate: (1) sources of water to the wetland, (2) seasonal changes in hydrologic patterns, (3) bulk wetland evapotranspiration, and (4) the hydrologic connection between the wetland an the Moab Mill Tailings. Field studies were conducted from the fall of 2002 to the spring of 2004. Uranium and ammonia concentrations were sampled along with an analysis of tritium, oxygen, and deuterium isotopic ratios to explore groundwater connectivity between the wetland and the mill tailings directly across the river. Gardner and Solomon concluded that brines sourced from across the river had migrated beneath the river in the highly permeable channel gravels. They claimed that brine migration was further substantiated by the uranium distribution, which was coincident with equivalent freshwater head gradients (EFH) during the summer of 2003. Dr. Solomon (personal communication via electronic mail of May 3, 2005) recognized uncertainty in their EFH analysis and in their report the authors were uncertain whether the passage of fluids beneath the river through highly conductive channel deposits is ongoing or a response to discontinuous driving forces (seasonal or otherwise). Regardless, they concluded that fluids, at some point in time, migrated from north to south beneath the Colorado River.

The DOI referenced Gardner and Solomon's report in our comments to DOE on their draft EIS. DOE provided a critique of Gardner and Solomon (2004) in their response to DOI's comments. In their critique, DOE took exception to the author's conclusions based on their own investigations into groundwater flow at the Moab Site. DOE does, however, agree with the authors of the report and the USFWS that this is an area of uncertainty that warrants further investigation.

The State of Utah DEQ maintains that there is sufficient information currently available to support a ground water remediation goal that is consistent with the chronic ammonia standard of 0.6 mg/l total N as opposed to the acute standard of 3 mg/l. In their EIS comment letter to DOE dated February 17, 2005, they explain their position as follows:

> <u>*Mixing Zone Premise: Lack of Turbulent Flow*</u> *– acute standards are applied to surface water quality problems under the assumption that 1) open channel turbulence will provide for a mixing zone to dilute or otherwise reduce the contaminant concentrations from a point source discharge, and 2) the mixing zone will be limited in its dimensions relative to the river's channel, i.e., less wide than the river channel and limited in longitudinal length (see Utah Water Quality Rules, UAC R317-2-5). However, the backwater areas in question only access the river channel at the habitat's downstream end. Hence, there is no open channel turbulence inside the backwater area. Instead, the backwater areas are recharged by infiltrating groundwater from the bank, or by river water infiltrating thru the barrier sand bar. Both of these sources of recharge constitute laminar flow and not turbulent conditions. Hence the acute standard is not applicable to an environment where water flow is largely laminar.*
>
> <u>*Avoidance Behavior Assumption*</u> *– another critical assumption in the application of acute standards to surface water quality problems is that adult fish can avoid the toxicity of the mixing zone by swimming around it (avoidance behavior). However in the case of the backwater areas in questions, larval fish that will be deposited there by the currents do not have the capability to resist moving water. Consequently, they cannot exhibit any avoidance behavior. Given these circumstances only the chronic standard is appropriate, 0.6 mg/l.*
>
> <u>*Exposure Time and Dilution Criteria*</u> *– the acute standards are designed for a 1-hour exposure to the fish (see Utah Water Quality Rules, UAC R317-6-2, Table 2.14.2). In contrast the chronic standard is designed for a 4-hour exposure period (ibid.). In the case of the backwater areas, the habitat will serve as a nursery for the larval fish in question. Consequently, they will reside there for weeks if not months. As a result, only the chronic standard, 0.6 mg/l, is applicable. For these reasons, the chronic ammonia-nitrogen*

> *standard must be applied to the backwater habitats in question. We understand that water quality monitoring of these backwater areas is challenging, largely due to their transient nature; and that therefore it is preferred to monitor groundwater quality as a means of verifying compliance. We have also concluded that the DOE evaluation of the transfer mechanism between groundwater and the backwater areas is incomplete. Errors have also been found in DOE's claim for a 10-fold groundwater to surface water dilution factor. These errors are discussed in detail below. Until these errors are resolved, and without confirmation on how dilution, dispersion, retardation, or biologic decay will reduce the ammonia concentrations during this groundwater to surface water transition, it is conservative and protective of the environment to apply the chronic (0.6 mg/l) standard as a groundwater cleanup goal.*

In their EIS comments, UDEQ called into question DOE's calculations of the dilution factor. UDEQ suggested that a better understanding of the time dependent dynamic between ground water / surface water interactions as a function of river stage is required. It was UDEQ's contention that insufficient quality assurances were applied to the data used to develop the dilution factor. UDEQ further cautioned that the amount of variability associated with the data used to develop the dilution factor in backwater habitats was considerable and suggested non-normal distribution. They advised further study of these issues.

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

Another basic premise of DOE's groundwater remediation program is the assumption that if ammonia concentrations are reduced to protective levels the other contaminants of concern will be reduced as well. In their comments on the EIS, USEPA points out that this assumption remains relatively untested and that the other constituents of concern have different solution chemistries and sorptive characteristics and consequently are likely to have different fate and transport projections. The USFWS agrees that this assumption warrants further investigation, which we address in our Incidental Take Statement.

Cumulative Effects

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to secton 7 of the Endangered Species Act. In the action area, the Colorado River flows mostly through federal land. We are unaware of future state or private actions that are in the planning that would not require Section 7 consultation. For this reason, no cumulative effects are anticipated on the endangered species or designated critical habitat in the action area.

CONCLUSION

Project Depletions of the Colorado River

After reviewing the current status of the Colorado River fish, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the USFWS's biological opinion that average annual depletions of 235 ac-ft of Colorado River water will jeopardize the continued existence of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker will likely result in destruction or adverse modification of critical habitat. The USFWS has developed the following reasonable and prudent alternative to deal with water depletion impacts to the four endangered Colorado River fishes.

Reasonable and Prudent Alternative

On January 21-22, 1988, the Secretary of the Interior; the Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration were cosigners of a Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (USFWS 1987). An objective of the Recovery Program was to identify reasonable and prudent alternatives that would ensure the survival and recovery of the listed species while providing for new water development in the Upper Basin.

The following excerpts are pertinent to the consultation because they summarize portions of the Recovery Program that address depletion impacts, section 7 consultation, and project proponent responsibilities:

"All future Section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to the USFWS by water project proponents in the amount of $10.00 per ac-ft based on the average annual depletion of the project . . . . This figure will be adjusted annually for inflation [the current figure is $16.30 per ac-ft] . . . . Concurrently with the completion of the Federal action which initiated the consultation, e.g., . . . issuance of a 404 permit, 10 percent of the total contribution will be provided. The balance will be …due at the time the construction commences . . . ."

It is important to note that these provisions of the Recovery Program were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. The Recovery Program further states:

". . . it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to ensure instream flows . . . . Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, <u>the USFWS will consider these elements under Section 7 consultation as offsetting project depletion impacts</u>."

Thus, the USFWS has determined that project depletion impacts, which the USFWS has consistently maintained are likely to jeopardize the listed fishes, can be offset by (a) the water project proponent's one-time contribution to the Recovery Program in the amount of $16.30 per ac-ft of the project's average annual depletion, (b) appropriate legal protection of instream flows pursuant to State law, and accomplishment of activities necessary to recover the endangered fishes as specified under the Recovery Implementation Program Recovery Action Plan. The USFWS believes it is essential that protection of instream flows proceed expeditiously, before significant additional water depletions occur.

With respect to (a) above (i.e., depletion charge), the applicant will make a one-time payment which has been calculated by multiplying the project's average annual depletion (235 ac-ft) by the depletion charge in effect at the time payment is made. At the time of this consultation, DOE has identified a range of depletions (130-235 ac-ft) associated with the proposed action; a final depletion figure will be developed as they develop their RAP. We recommend that DOE pay the depletion charges as soon as the final depletion amount is determined. For Fiscal Year 2005 (October 1, 2004, to September 30, 2005), the depletion charge is $16.30 per ac-ft for the average annual depletion which equals a total payment of $ 3,830.50 for this project. This amount will be adjusted annually for inflation on October 1 of each year based on the previous year's Composite Consumer Price Index. The USFWS will notify the applicant of any change in the depletion charge by September 1 of each year. Ten percent of the total contribution ($383), or total payment, will be provided to the USFWS's designated agent, the National Wildlife Foundation at the time of issuance of the Federal approvals from the Department of Energy. The balance will be due at the time the construction commences. The payment will be included by the DOE as a permit stipulation. Fifty percent of the funds will be used for acquisition of water rights to meet the instream flow needs of the endangered fishes (unless otherwise recommended by the Implementation Committee); the balance will be used to support other recovery activities for the Colorado River endangered fishes. All payments should be made to the National Fish and Wildlife Foundation.

National Fish and Wildlife Foundation
28 Second Street, 6th Floor
San Francisco, California 94105

Each payment is to be accompanied by a cover letter that identifies the project and biological opinion that requires the payment, the amount of payment enclosed, check number, and any special conditions identified in the biological opinion relative to disbursement or use of the funds (there are none in this instance). The cover letter also shall identify the name and address of the payor, the name and address of the Federal Agency responsible for authorizing the project, and the address of the USFWS office issuing the biological opinion. This information will be used by the Foundation to notify the payor, the lead Federal Agency, and the USFWS that payment has been received. The Foundation is to send notices of receipt to these entities within 5 working days of its receipt of payment.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the Recovery Program, an additional section 7 agreement and Recovery Plan addressing section 7 consultation on depletion impacts was developed (USFWS 1993b). The section 7 agreement establishes a framework for conducting all future section 7 consultations on depletion impacts related to new projects and those associated with historic projects in the Upper Basin. Procedures outlined in the section 7 agreement will be used in conjunction with the Recovery Plan to determine if sufficient progress is being accomplished in the recovery of the endangered fishes to enable the Recovery Program to serve as a reasonable and prudent alternative to avoid jeopardy. The Recovery Plan was finalized on October 15, 1993, and is reviewed annually.

In accordance with the agreement, the USFWS has agreed to assess impacts of projects that require section 7 consultation and determine if progress toward recovery has been sufficient for the Recovery Program to serve as a reasonable and prudent alternative. If sufficient progress is being achieved, biological opinions will be written to identify activities and accomplishments of the Recovery Program that support it as a reasonable and prudent alternative. If sufficient progress in the recovery of the endangered fishes has not been achieved by the Recovery Program, actions from the Recovery Plan will be identified which must be completed to avoid jeopardy to the endangered fishes. For historic projects, these actions will serve as the reasonable and prudent alternative as long as they are completed according to the schedule identified in the Recovery Plan. For new projects, these actions will serve as the reasonable and prudent alternative so long as they are completed before the impact of the project occurs. The Atlas mill tailings reclamation project is considered a new project.

The evaluation by the USFWS to determine if sufficient progress has been achieved considered (a) actions which result in a measurable population response, a measurable improvement in habitat for the fishes, legal protection of flows needed for recovery, or a reduction in the threat of immediate extinction; (b) status of fish populations; adequacy of flows; and (d) magnitude of the project impact. In addition, the USFWS considered support activities (funding, research, information and education, etc.) of the Recovery Program if they help achieve a measurable population response, a measurable improvement in habitat for the fishes, legal protection of flows needed for recovery, or a reduction in the threat of immediate extinction. The USFWS evaluated progress separately for the Colorado River and Green River subbasins; however, it gave due consideration to progress throughout the Upper Basin in evaluating progress toward recovery.

Based on current Recovery Program accomplishments and the expectation that the Recovery Plan will be fully implemented in a timely manner, the USFWS determined that sufficient progress has been achieved under the Recovery Program so that it could serve as the reasonable and prudent alternative to avoid jeopardy to the endangered fishes by the impacts caused by the water depletion associated with this permit. For historic projects, the responsibility for implementation of all elements of the reasonable and prudent alternative rests with the Recovery Program participants, not the individual project proponent. All actions must be implemented according to the time schedule specified in the Plan. For new projects, the responsibility for implementation of elements of the reasonable and prudent alternative is shared by the Recovery Program and the applicant. Recovery Program participants are responsible for carrying out activities outlined in the Recovery Plan.

The USFWS should condition the permit to retain jurisdiction in the event that the Recovery Program is unable to implement the Recovery Plan in a timely manner. In that case, as long as the lead Federal Agency has discretionary authority over the project, reinitiation of section 7 consultation may be required so that a new reasonable and prudent alternative can be developed by the USFWS.

The above Reasonable and Prudent Alternative involves time frames that must be met to avoid jeopardy to the endangered fish. Because these time frames are critical to meeting the stipulations for removing the jeopardy to the endangered fish, the DOE shall reinitiate consultation if any of the time frames are not met.

Off-Site Disposal of Surface Contamination at the Crescent Junction Site and Ground Water Remediation at the Moab Site

After reviewing the current status of the Colorado River fish, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the USFWS's biological opinion that this proposed action alternative will not likely jeopardize the continued existence of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker and is not likely to result in destruction or adverse modification of critical habitat. The USFWS concludes that the proposed action to dispose of tailings (i.e. surface contamination) off-site would reduce negative effects associated with the ongoing contamination of the Colorado River near the Moab Site, and eliminate the potential for future catastrophic events associated with river flooding and river migration The proposed action for ground water remediation at the Moab Site would address the effects of ground water contaminants impacting endangered fish in the Colorado River. There would be adverse effects associated with the current levels of groundwater contamination until ground water remediation is fully implements, assuming the effects are not minimized by existing interim actions. The USFWS has determined that the amount of take that is occurring in the near shore habitats will not jeopardize the Colorado River fish. Previous research has shown that drifting larval Colorado River fish are equally distributed throughout the river channel. The Service believes that only a small percentage of the drifting larval contingent would be exposed to unsafe contaminant levels, and that DOE has already reduced impacts through implementation of the interim remedial actions.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Harass is defined by the USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are nondiscretionary, and must be undertaken so that they become binding conditions of any Federal discretionary activity, for the exemption in section 7(o)(2) to apply. The participating Federal Agencies have a continuing duty to monitor the activity covered by this Incidental Take Statement. If the DOE 1) fails to assume and implement the terms and conditions or 2) fails to retain oversight to ensure compliance with the terms and conditions, the protective coverage of section 7(o)(2) may lapse for the projects covered by this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE

The listed Colorado River fish (Colorado pikeminnow, humpback chub, bonytail, and razorback sucker) are the only species covered under this Incidental Take Statement and only take associated with the groundwater remediation component of the proposed action is covered. Recent studies have demonstrated that ammonia concentrations in near shore habitats exceed acute and chronic standards for the protection of aquatic species from ammonia toxicity. A report of dead and dying fish (nonnative cyprinids) in a backwater immediately downstream of Moab Wash was transmitted to the USFWS in November, 2004. DOE was not able to make a strong cause /effect relationship based on available water quality data, but we (DOE and USFWS) assume the incident was contaminant related.

DOE has proposed the development and implementation of a groundwater remediation program that will reduce ammonia concentrations to protective levels in all surface water habitats. Based on data collected and analyzed by DOE and others, DOE assumes that by reducing near surface groundwater ammonia concentrations to 3 mg/l they will be able to achieve chronic standards (0.6 mg/l ammonia) in all habitats. The USFWS is operating under the same assumption.

DOE has projected that within 5 years of issuing a Record of Decision that design, procurement, testing, construction, and implementation of an active ground water remediation system would be complete. Following implementation of the system, 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. In this Incidental Take Statement, the USFWS is covering incidental take of Colorado River fish associated with exposure to non-protective concentrations of contaminants in near shore habitats along the north bank of the Colorado River at and downstream of the Moab Site for ten years from finalization of the biological opinion. In their compliance documents DOE suggests, based on preliminary results from their interim ground water remediation program, that contaminant levels may be reduced to protective levels in less than 10 years. The USFWS will work closely with DOE to implement an effective ground water remediation program sooner than 10 years if possible.

During each year of this ten year period, the USFWS anticipates that as many as three (3) Age-0 Colorado pikeminnow, one (1) Age-0 humpback chub, one (1) Age-0 razorback sucker, and one (1) Age-0 bonytail could be taken in low velocity shoreline habitats within a 0.5 five mile reach of the Colorado River (Moab Wash as the upstream terminus) as result of this proposed action. The Service considers Age-0 to be $\leq$ 40 mm Total Length. The incidental take is expected to be in the form of harm (death or injury) due to exposure to non-protective levels of contamination (most likely ammonia) or due to entrainment at DOE's Colorado River pumps. No take of older life stages is anticipated, based on data that indicate harmful concentrations are most likely to occur in backwater or other low velocity habitats and larger fish would be more capable of avoiding entrainment. Low velocity habitats are used preferentially by early life stages of the endangered species, and less so by older / larger fish.

EFFECT OF THE TAKE

In the accompanying biological opinion, the USFWS determined that the anticipated and declining level of incidental take associated with groundwater contamination at the Moab Site for ten years following finalization of this biological opinion is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

Based on DOE's analyses, our review of the subject documents and recent comments from the DOI and other agencies on the DEIS, the USFWS recognizes several uncertainties associated with the proposed ground water remediation program. Until protective levels of contamination are achieved in all surface water habitats in the Colorado River the Service believes some level of take of the endangered Colorado River fish species will occur. The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the endangered Colorado River fishes:

1. Monitor backwater habitats near the Moab Site for any indication of fish being affected by surface water contamination.

2. Evaluate the effectiveness of their initial action (diluting non-protective contaminant concentrations in backwater habitats by pumping clean river water).

3. Address uncertainties associated with the ground water remediation program.

4. Reduce effects of surface water contamination in habitats along the south bank of the Colorado River if necessary.

5. Reduce the effects of entrainment at all project pumping sites.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the DOE must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To implement Reasonable and Prudent Measure (1): DOE in coordination with the USFWS will develop a biota monitoring plan (within six months of the ROD) for the purpose of observing and reporting dead or stressed fish to state and federal fish and wildlife offices (contact information below). Observations should occur from Moab Wash downstream approximately 1200 feet. If professional biologists are unavailable we require DOE or other on-site personnel to preserve specimens (25 fish or 10% of the total estimated number of dead fish; whichever is greater) in alcohol (50% isopropyl – rubbing alcohol) or on ice, but not frozen. Contact information:

   Utah Division of Wildlife Resources
   Moab Field Station
   1165 South HWY 191
   Moab, Utah 84532
   435-259-3780

   USFWS Utah Field Office
   2369 West Orton Circle, Suite 50
   West Valley City, Utah 84119
   801-975-3330

2. To implement Reasonable and Prudent Measure (2): DOE has the infrastructure in place to implement an “initial action” (pumping water from the flowing river into affected backwaters), which the USFWS agrees may be a reasonable, immediate measure to minimize take should water quality monitoring data indicate non-protective levels of contamination in backwater habitats during critical period of the summer. DOE will develop protocols and parameters (within 12 months of the ROD) that address timing and field techniques to implement the initial action. These protocols shall seek to minimize potential adverse effects associated with the initial action itself: temperature shock, re-suspension of fine sediments, elevated BOD, turbulence, etc. The development of these protocols and any field studies needed to support them shall be identified in the Water Quality Study Plan (see RPM #3; T&C #3).

3. To implement Reasonable and Prudent Measure (3): DOE, in coordination with USFWS, will develop data quality objectives within 6 months of the ROD, and will develop a Water Quality Study Plan (WQSP) within 18 months of the finalization of the ROD that evaluates / determines: 1) the effectiveness of current and expanded ground water remediation efforts; 2) the validity of the purported 10-fold ground water to surface water dilution factor; 3) compliance with achieving the target goal of 3 mg/L acute in ground water which is anticipated to meet chronic ammonia standards (0.6 mg/l) in all habitats

adjacent to the Moab site; assuming background does not exceed 0.6 mg/L. Background concentrations will be defined as those found in habitats upstream of the Hwy 191 bridge; 4) the validity of the assumption that by reducing concentrations of ammonia the other constituents of concern (manganese, sulfate, uranium, copper, and selenium) will also be reduced to protective levels; 5) the requirements and schedule for DOE's reporting to the USFWS; 6) if refinement of the conceptual model is necessary; and 7) issues identified in T&C No. 2 and 4. The Service will require a third party review of the WQSP.

4. To implement Reasonable and Prudent Measure (4): Independent studies conducted by Gardner and Solomon (University of Utah) do not support DOE's data and studies regarding the effects of Moab site contaminants on the Matheson Wetland Preserve. DOE will continue to investigate the potential for contaminants to be affecting the Matheson Wetland Preserve. Should data indicate that contaminants are, or are likely to affect surface water habitats on the south side of the river, DOE would consult with the USFWS concerning the need to expand ground water remediation efforts. Monitoring of the south side of the river will need to be addressed in the WQSP (see T&C No. 3).

5. To implement Reasonable and Prudent Measure (5): To reduce the likelihood of entraining young of the year native fish, DOE will continue to screen all pump intakes with ¼" diameter mesh material. DOE will avoid drawing water from low velocity habitats from June 1 through August 31.

CONSERVATION RECOMMENDATIONS

If the USFWS determines that ground water remediation as proposed is not effective in achieving the targeted goal, alternative approaches to reduce take may need to be considered. In preparation for that unlikely event, the USFWS recommends that DOE work closely with USFWS to evaluate the following options.

1. Reduce threats associated with surface water contamination at the Moab Site through dilution, i.e. increased base flows. The USFWS believes that a plausible alternative solution to the threat of ground water contamination would be to increase Colorado River flows upstream of the Moab Site throughout the summer, autumn and winter base flow period. DOE would need to identify an upstream source(s) of water and then secure that flow to the Moab Site through purchase, lease, or other agreement (if available). By increasing base flows secondary and primary productivity would presumably increase throughout the river. Increased productivity could potentially result in increased larval endangered fish production. In addition, an increase in base flows, over the baseline conditions would result in some dilution effect at the Moab Site.

2. If river dilution were pursued, DOE should also explore options to reduce threats of surface water contamination in low velocity habitats adjacent to the Moab Site by reducing endangered fish access to those habitats. DOE and the Service should consider, among other options, manipulating access to potentially dangerous habitats near the

Mr. Donald Metzler

Moab Site and compensate for that loss of nursery habitat area on a 1:1 basis at a nearby location.

REINITIATION NOTICE

This concludes formal consultation on the subject action. As provided in 50 CFR sec. 402.16, reinitiation of formal consultation is required for projects where discretionary Federal Agency involvement or control over the action has been retained (or is authorized by law) and under the following conditions:

1. The amount or extent of take specified in the Incidental Take Statement for this opinion is exceeded.

2. New information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion. In preparing this opinion, the USFWS describes the positive and negative effects of the action it anticipates and considered in the section of the opinion entitled "EFFECTS OF THE ACTION." New information would include, but is not limited to, not achieving contaminant levels that are protective of aquatic life.

3. The section 7 regulations (50 CFR 402.16 (c)) state that reinitiation of consultation is required if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion.

4. The USFWS lists new species or designates new or additional critical habitat, where the level or pattern of depletions covered under this opinion may have an adverse impact on the newly listed species or habitat. If the species or habitat may be adversely affected by depletions, the USFWS will reinitiate consultation on the biological opinion as required by its section 7 regulations.

If we can be of any further assistance, please contact me at Tom Chart at (801)975-3330 extension 124 or extension 144, respectively.

Sincerely,

Henry R. Maddux
Field Supervisor

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