RECLAMATION
Managing Water in the West

DRAFT ENVIRONMENTAL IMPACT STATEMENT

ASPINALL UNIT OPERATIONS

ASPINALL UNIT—COLORADO RIVER STORAGE PROJECT
GUNNISON RIVER, COLORADO

VOLUME I

U.S. Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Western Colorado Area Office
Grand Junction, Colorado

January 2009

Mission Statement:

The Mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American Public.

ASPINALL UNIT OPERATIONS: ASPINALL UNIT— COLORADO RIVER STORAGE PROJECT GUNNISON RIVER, COLORADO
Draft Environmental Impact Statement

Cooperating Agencies:

U.S. Department of the Interior
- Bureau of Reclamation (lead agency)
- Fish and Wildlife Service
- National Park Service

State of Colorado
- Colorado Department of Natural Resources
  - Colorado Water Conservation Board
  - Colorado Division of Water Resources
  - Colorado Division of Wildlife

U.S. Department of Energy
- Western Area Power Administration

Colorado River Water Conservation District
Southwestern Water Conservation District
Platte River Power Authority

Abstract:

The Secretary of the Interior, acting through the Bureau of Reclamation, proposes to implement a plan to avoid jeopardy to four endangered fish in the Gunnison and Colorado rivers downstream from the Wayne N. Aspinall Unit, a Colorado River Storage Project facility in western Colorado. The plan focuses on modifying the operation of the Aspinall Unit to provide sufficient releases of water at times, quantities, and duration necessary to avoid jeopardy and adverse modification to designated critical habitat, while maintaining authorized purposes of the Aspinall Unit. Four action alternatives are presented to address Flow Recommendations developed by the Upper Colorado River Endangered Fish Recovery Program for downstream endangered fish and are compared to the No Action Alternative. A preferred alternative is identified. This draft environmental impact statement has been prepared pursuant to the National Environmental Policy Act.

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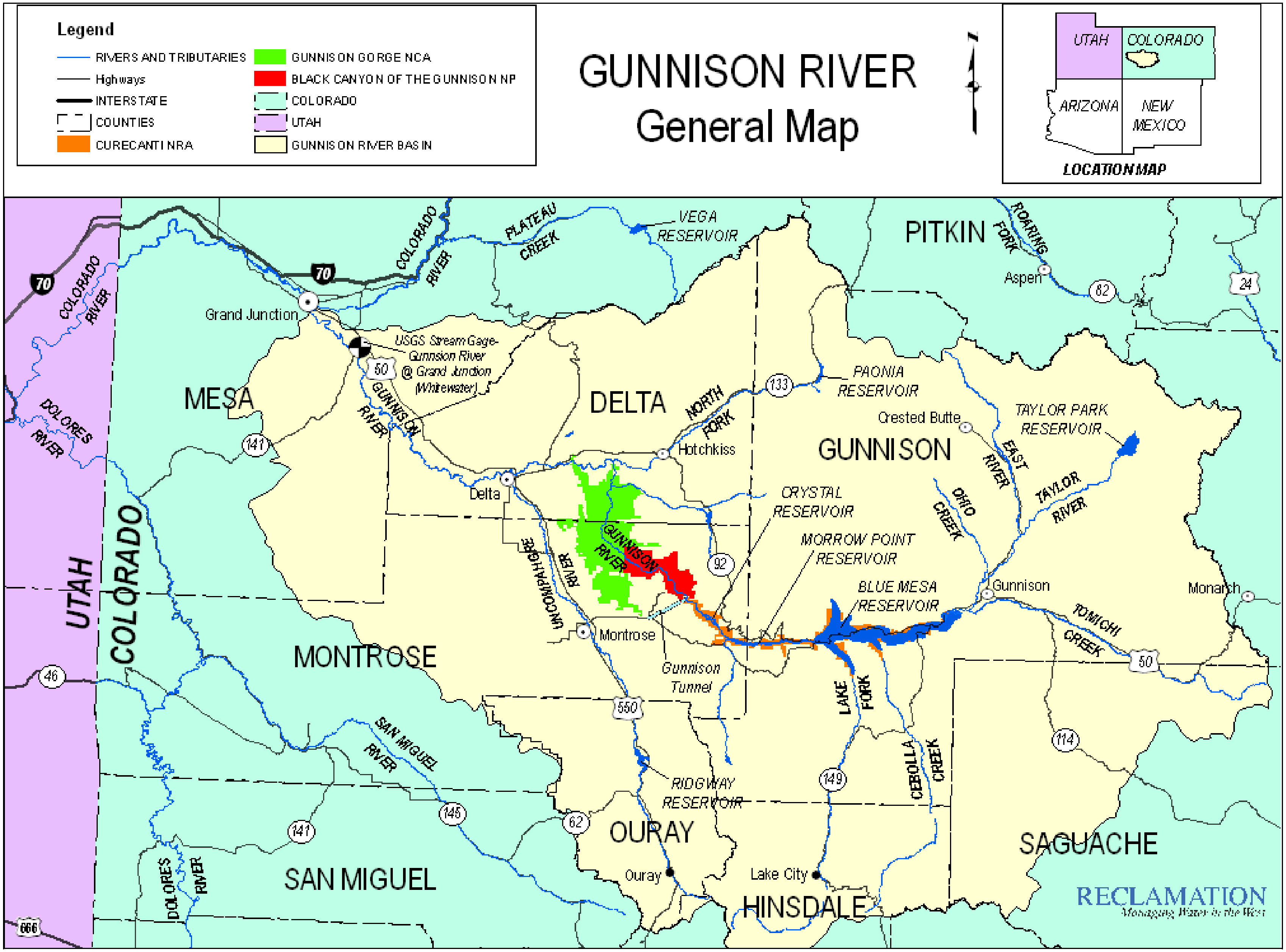

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Acronyms 07-02 Update

A

ACOE	Army Corps of Engineers
af	acre foot
Aspinall Unit	Wayne N. Aspinall Unit

B

BA	biological assessment
Black Canyon NP	Black Canyon of the Gunnison Nation Park
BLM	Bureau of Land Management
BO	Biological Opinion

C

CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDWR	Colorado Division of Water Resource
CFR	Code of Federal Regulations
cfs	cubic feet per second
CRSP	Colorado River Storage Project
Curecanti NRA	Curecanti National Recreation Area

D

dB	decibel
db(A)	daily average decibel level
DEIS	draft environmental impact statement

E

EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act

F

FEIS	final environmental impact statement
Flow Recommendations	*Flow Recommendations to Benefit the Endangered Fishes in the Gunnison and Colorado Rivers*

ft	feet

I

IMPLAN	an economic computer-based modeling program
Indian	American Indian
ITAs	Indian Trust Assets

K

kW	kilowatt
kWh	kilowatthour

M

M&I	municipal and industrial
mg/l	milligrams per liter
MOA	memorandum of agreement
MOU	memorandum of understanding
MW	megawatt
MWh	megawatt-hour

N

NCA	National Conversation Area
NEPA	National Environmental Policy Act
NEV	Net Economic Value
NIWQP	National Irrigation Water Quality Program
NOA	notice of availability
NOI	notice of intent
NP	National Park
NPS	National Park Service
NRA	National Recreation Area

O

O&M	operation and maintenance

P

P.L.	Public Law
PM	particulate matter
Ppb	parts per billion
ppm	parts per million

R

Reclamation	U.S. Bureau of Reclamation
Recovery Program	Upper Colorado River Basin Endangered Fish Recovery Program
RM	river mile
RV	recreational vehicle
RWCP	Redlands Water and Power Company

S

Secretary	Secretary of the U.S. Department of the Interior
Service	U.S. Fish and Wildlife Service
SLCA/IP	Salt Lake City Area Integrated Projects

T

TCWCD	Tri-County Water Conservancy District

U

UGRWCD	Upper Gunnison River Conservancy District
USC	United States Code
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UVWUA	Uncompahgre Valley Water Users Association

W

Western	Western Area Power Administration

Symbols

μg/g	micrograms per gram
μg/l	micrograms per liter

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CHAPTER 1. INTRODUCTION: PURPOSE OF AND NEED FOR THE ACTION

1.1. Introduction

1.1.1 General

This draft environmental impact statement (DEIS) addresses water operations of the Wayne N. Aspinall Unit (Aspinall Unit) related to downstream endangered fish. The Aspinall Unit is located in Gunnison and Montrose Counties, Colorado, along a 40-mile reach of the Gunnison River as shown on the frontispiece map. Downstream from the Aspinall Unit, the Gunnison River also flows through Delta and Mesa Counties. The Aspinall Unit consists of a series of three dams and reservoirs: Blue Mesa, Morrow Point, and Crystal. The Aspinall Unit is operated by the Bureau of Reclamation (Reclamation); and was authorized by the Colorado River Storage Project Act of 1956 (CRSP Act) along with the Glen Canyon, Flaming Gorge, and Navajo Units.

1.1.2 Proposed Action

Reclamation proposes to operate the Aspinall Unit to avoid jeopardy to downstream endangered fish species while maintaining and continuing to meet all of the congressionally authorized purposes. Reclamation would implement the Proposed Action by modifying the operations of the Unit, to the extent possible, to help achieve river flows recommended by the Upper Colorado River Endangered Fish Recovery Program (Recovery Program). Changes in operations are based on Flow Recommendations determined by the Recovery Program and discussed later.

This change in Aspinall Unit operations would assist in conserving endangered fish in the Gunnison and Colorado rivers and would maintain congressionally authorized purposes.

The DEIS describes and analyzes environmental effects resulting from the proposed operational changes to the Aspinall Unit. The DEIS has been prepared according to provisions of the National Environmental Policy Act of 1969 (NEPA) and other laws and mandates listed at the end of this chapter.

1.1.3 Scope of the Proposed Action

The effects of the proposed action would encompass the Aspinall Unit (including Blue Mesa, Morrow Point, and Crystal dams, powerplants, and reservoirs) and upstream resources, Curecanti National Recreation Area (Curecanti NRA), the Gunnison River downstream to its confluence with the Colorado River, and the downstream Colorado River in western Colorado.

The Aspinall Unit begins approximately 5 miles west of Gunnison, Colorado and about 75 miles southeast of Grand Junction, Colorado. Other communities in the area include Montrose, Delta, Austin, and Fruita, Colorado.

1.1.4 Purpose of and Need for the Proposed Action

The purpose of modifying the operations of the Aspinall Unit is to provide sufficient releases of water at times, quantities, and duration necessary to avoid jeopardy to endangered fish species and adverse modification of their designated critical habitat in the lower Gunnison River while maintaining the congressionally authorized purposes of the Aspinall Unit.

The Upper Colorado River Basin at one time was inhabited by 14 native fish species, four of which are now endangered. These four fish are the Colorado pikeminnow, razorback sucker, bonytail, and humpback chub; they exist only in the Colorado River Basin. The four fish are endangered because of adverse impacts to their habitat over the last 125 years. The two types of habitat impacts that appear to have the greatest effect have been water development and introduction of non-native fish (Recovery Program 2008).

Reclamation is required to comply with the Endangered Species Act (ESA) for operation of the facilities of the Colorado River Storage Project (CRSP), which includes the Aspinall Unit. Within the exercise of its discretionary authority, Reclamation must avoid jeopardizing the continued existence of listed species and destroying or adversely modifying designated critical habitat. A list of discretionary and non-discretionary actions for the Aspinall Unit is included in the biological assessment in Appendix B. The operation of the Aspinall Unit is a key element of the Recovery Program described later.

1.1.5 Authority

The following paragraphs describe the Department of the Interior's basis and authority for implementing the new operations at the Aspinall Unit. The authority to implement the operations is found in Section 1 of CRSP. This section states:

> "*In order to initiate the comprehensive development of the water resources of the Upper Colorado River Basin, for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for states of the Upper Basin to utilize, consistently with the provisions*

of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for the reclamation of arid and semi-arid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes, the Secretary of the Interior is hereby authorized (1) to construct, operate, and maintain the following initial units of the Colorado River storage project, consisting of dams, reservoirs, powerplants, transmission facilities and appurtenant works…"

The Colorado River Compact of 1922 established an Upper Basin and a Lower Basin within the Colorado River system and apportioned the exclusive beneficial consumptive use of Colorado River water in perpetuity to the Upper and Lower Basins. The Upper Colorado River Basin Compact of 1948 apportioned the Upper Basin's share of the Colorado River system among the states of Colorado, Utah, Arizona, Wyoming, and New Mexico. The CRSP Act was enacted in 1956 to facilitate the development of the water and power resources of the Upper Basin consistent with the Compacts.

The Recovery Program (discussed later) was developed to facilitate the continued development of States' Compact apportionments in light of Endangered Species Act concerns. The goal of the Recovery Program, therefore, is to conserve Upper Colorado River Basin populations of endangered fish species consistent with the recovery goals of the species published by the Service, while proceeding with the continued operation and development of water resources/projects of the Colorado River Basin. All Recovery Program participants recognized that recovery to the point of de-listing would both facilitate and ensure the continued development of water resources and agreed with the principles and goals of the Recovery Program through their participation in and support of program activities. In addition to its recovery objectives, the Recovery Program includes an agreement on principles for conducting ESA Section 7 consultations, wherein program actions and sufficient progress toward recovery constitute a Reasonable and Prudent Alternative for existing and future water resource management and development activities that are likely to jeopardize the continued existence of endangered fish species or cause the destruction of or adverse modification of critical habitat of those species.

The Flow Recommendations for the Gunnison River, in concert with other program actions, are intended to avoid jeopardy and assist in recovery. By implementing actions that assist in meeting the Flow Recommendations, Reclamation is taking the steps necessary to avoid jeopardizing the continued existence of the endangered fish by operation of the Aspinall Unit and to voluntarily and cooperatively take steps to facilitate recovery of the fish. In turn these actions support the continued and further utilization of the Federal facilities to aid in the development of the states' Compact apportionments. Thus, consistent with the authorized purposes of CRSP, implementation of the proposed operation supports the States in the utilization of their Compact apportionment while assisting in the recovery of endangered species. Moreover, that specific authorized purposes of the Aspinall Unit may not be fully maximized for limited durations in certain year types does not invalidate the actions of the Secretary, as long as the overall purposes of CRSP are met and Reclamation expects in this instance, these purposes will be met.

This action is limited to the proposition that both avoiding jeopardy and making progress toward recovery of listed fish facilitate the ability of the Upper Basin States to continue utilizing and further developing their Colorado River apportionments. It does not follow that CRSP generally authorizes the release of water for fish and wildlife purposes. In these particular and unique circumstances, therefore, we conclude the implementation of an operations regime consistent with the EIS alternatives is deemed to be within the authorization contained in Section 1 of the CRSP Act.

1.2 Background

1.2.1 Aspinall Unit

Construction of the Aspinall Unit took place between 1963 and 1977. Table 1.2 1 summarizes statistics on the facilities. Primary water storage occurs in the uppermost and largest reservoir, Blue Mesa. Water can be released from the reservoirs through the powerplants and/or river outlets (bypasses). Spillway use is normally limited to periods when the reservoirs are at/or near full and when the powerplant and outlet tube capacities are exceeded.

Table 1.2 1—Aspinall Unit Statistics.

Capacities (af)	Blue Mesa Reservoir	Morrow Point Reservoir	Crystal Reservoir
Dead storage	111,200	165	7,700
Inactive storage	81,070	74,905	4,650
Active storage	748,430	42,120	12,890
Live storage	829,500	117,025	17,540
Total storage	940,700	117,190	25,240
Outlet capacities (cubic feet-per-second)	**Blue Mesa Dam and Powerplant**	**Morrow Point Dam and Powerplant**	**Crystal Dam and Powerplant**
Powerplants (max)	2,600-3,400	5,000	2,150
Powerplant bypass	4,000-5,100	1,400-1,600	1,900-2,200
Combined powerplant and bypass(max)	6,100	6,500	4,350
Spillway	34,000	41,000	41,350

-Live storage is the combination of the active and inactive storage. It represents storage that physically can be released from the reservoir.
-Blue Mesa Reservoir shares one penstock for both river outlet and powerplant releases; the combined releases of these two are constrained to about 6,100 cfs.
-The hydraulic capacities shown in the table assume full reservoir conditions. At lower elevations the hydraulic capacity would be less. Also system efficiencies may affect the hydraulic capacity.
-Full capacity may not always be available due to scheduled maintenance**,** equipment malfunction, or power system reserve requirements.
-There are no specific recreation or fishery pools in the reservoirs.

Reclamation manages water within certain sideboards that include annual snowpack conditions, downstream senior water rights, minimum downstream flow requirements, powerplant and outlet capacities, reservoir elevation goals, fishery management recommendations, dam safety considerations, and others. Certain sideboards can be considered non-discretionary such as honoring senior water rights and flood control, while others such as reservoir elevation criteria to reduce landslides are given a high priority. To conserve water for later use and to provide drought protection, an operational goal is to fill Blue Mesa Reservoir by the end of July. Another operational goal is to draw Blue Mesa Reservoir down to an elevation of 7,490 by December 31 to provide space for the next spring's runoff and to avoid icing damage upstream. In general, operation of the Aspinall Unit has changed the natural river flow pattern by storing spring runoff and increasing flows during the remainder of the year.

The powerplants at the three dams of the Aspinall Unit are capable of generating up to 283 megawatts of power. Morrow Point Powerplant is the most significant—its generators produce over twice as much power as those at the Blue Mesa Powerplant. The Western Area Power Administration (Western) markets power generated in conjunction with power from Glen Canyon and Flaming Gorge Dams and other plants as part of an integrated system that provides power to seven states. The upstream powerplants (Blue Mesa and Morrow Point) are critical in that they are operated to provide peaking power. Crystal Reservoir then serves as a run of the river facility to stabilize flows in the Gunnison River. Peaking operations help Western meet demands for power that change on an hourly, daily, and weekly basis. The flexibility offered by Blue Mesa and Morrow Point Dams is very important for meeting peaking, automation generation control, and reserve sharing obligations of CRSP.

Public recreational use and resource protection of Aspinall Unit lands and water are managed through agreements with the National Park Service (NPS) as the Curecanti NRA. Blue Mesa Reservoir supports around 1,000,000 recreation visitor days per year. Fishing, boating, and camping are primary recreation uses.

Approximately 3 miles downstream from Crystal Dam, the Black Canyon of the Gunnison National Park (Black Canyon NP) begins and extends 14 miles along the Gunnison River. Downstream from the Black Canyon NP, lands are administered by the Bureau of Land Management (BLM) as the Gunnison Gorge National Conservation Area (NCA). The downstream river includes a designated wilderness, an eligible Wild and Scenic River segment, and a gold medal trout fishery.

Measures have been adopted to mitigate losses of big game and fishery habitat associated with initial inundation by the Aspinall Unit reservoirs. Reclamation has completed acquisition and development of wildlife areas—Cimarron State Wildlife Area, Gunnison State Wildlife Area, and portions of the Billy Creek State Wildlife Area—and has acquired public fishing access in the Gunnison Gorge NCA and on streams upstream and downstream of the Aspinall Unit. The areas are managed by the Colorado Division of Wildlife, the Bureau of Land Management, and/or the City of Gunnison.

1.2.2 Initial Operation

After completion of the Aspinall Unit, water releases from the Unit focused primarily on allowing Upper Basin states to develop Colorado River Compact apportioned waters, storing water for beneficial use, controlling flooding, maintaining stable river flows, and generating hydropower. However, native[1] fish populations and their habitat have been adversely affected by, among other things, the operation of the Aspinall Unit and by the operation of other federal and private water developments within the Gunnison River Basin. Other factors adversely affecting these native fish include the introduction of non-native fish[2], interruption of fish migration by diversion structures, channel modifications, and possibly water quality changes.

When operation of Blue Mesa Dam began in 1966, minimum recommended downstream flows of 100 cubic feet-per-second (cfs) were called for, primarily to support downstream water rights. With the construction of Crystal Dam in 1976, this minimum was increased to 200 cfs in dry years and 400 cfs in wet years. In 1985, based on results of studies to protect the gold medal trout fishery, Reclamation, the Colorado Division of Wildlife, the Nature Conservancy, and the Colorado Water Conservation Board worked together in increasing the minimum recommendation to 300 cfs. Consequently, the Colorado Water Conservation Board holds a downstream instream flow right of 300 cfs.

From 1969 to 1991, the Aspinall Unit was operated to maximize water storage and hydropower production, and minimize flow variations in the Gunnison River below Crystal Dam. Operations reduced the magnitude of peak spring flows and supplemented flows in other seasons. The difference between this operation and the historical pre-dam hydrograph is depicted in Figure 1.2-1, which shows the 1911-37 pre-dam hydrograph, the 1938-1965 pre-Aspinall Unit hydrograph (post-Taylor Park Dam), the 1969-91 historical operation post-dam hydrograph (representing the period of dam operations from 1969 to the beginning of the endangered fish test releases in 1992), and the 1992 to 2003 period, which reflects modified releases that mimic a natural hydrograph. Over the last decade, the a pattern for releasing water from the Aspinall Unit has been modified to accommodate endangered fish research and general environmental goals in the Gunnison River while continuing to meet authorized purposes.

1.2.3 Previous ESA Consultations

The catalyst for changing Aspinall Unit operation criteria came about from the development of flow recommendations (see Section 1.2.5), from consultation with the Fish and Wildlife Service (Service), and from the Recovery Program. During the 1970’s and 1980’s, the Service rendered jeopardy biological opinions for the Dallas Creek and Dolores Projects identifying upstream operations of the Aspinall Unit or other sources to offset depletion effects as the reasonable and prudent alternative to jeopardy.

[1] Fish that are indigenous to the Colorado River Basin.
[2] Fish evolved in basins outside the Colorado River Basin but were purposely or accidentally introduced to this Basin.

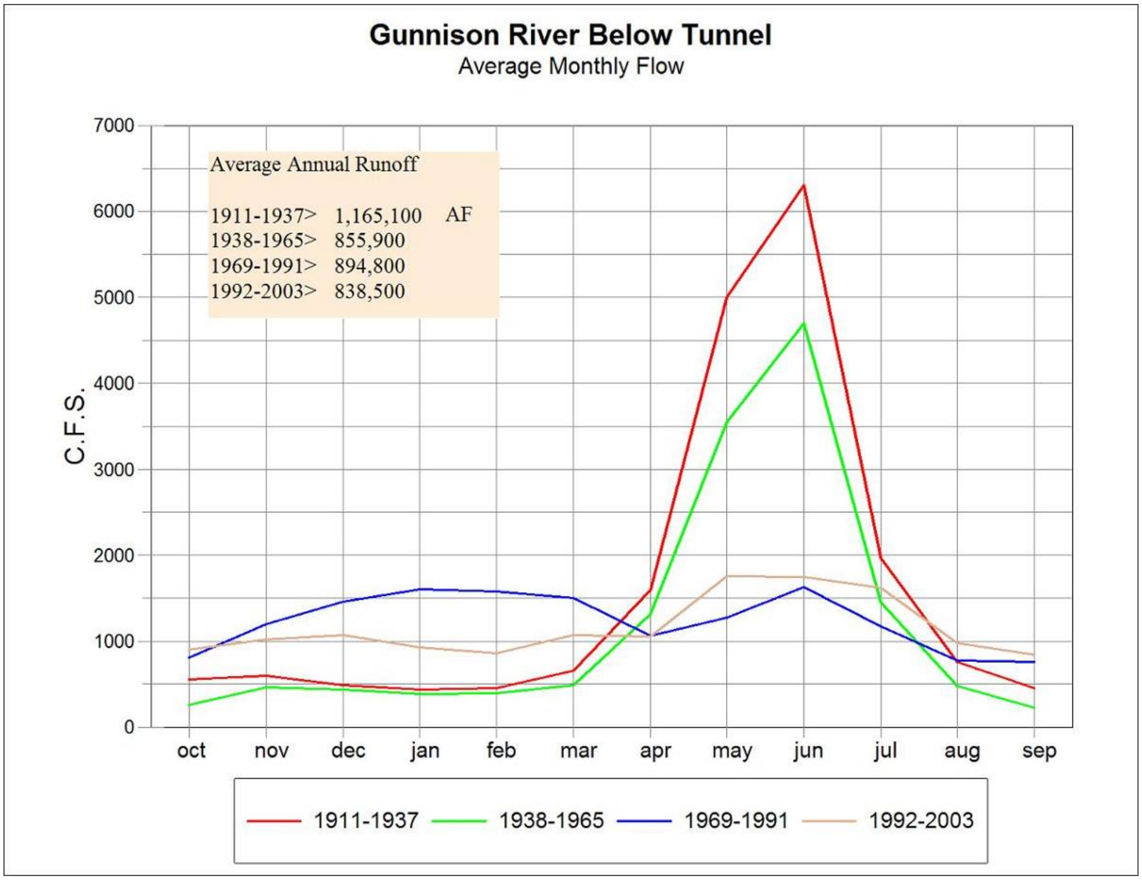

Figure 1.2- 1—Gunnison River below Gunnison Tunnel, Colorado – U.S. G.S. average daily flow (compares pre-dam, post-Taylor Park Dam, post-Aspinall Unit, and natural flow mimicry hydrographs.

Additional consultations on private and public projects that followed relied on the Recovery Program as a reasonable and prudent alternative to avoid jeopardy to the endangered Colorado River fishes.

1.2.3.1 Dallas Creek Project

On November 2, 1979, Reclamation requested formal consultation on the Dallas Creek Project. The Dallas Creek Project in the Uncompahgre River Basin in western Colorado included the construction of Ridgway Dam and Reservoir on the Uncompahgre River to provide water for supplemental irrigation and municipal and industrial uses.

On November 19, 1979, the Service issued a biological opinion for the Dallas Creek Project (Service 1979). The biological opinion determined that the Dallas Creek Project would likely jeopardize the continued existence of the Colorado squawfish (pikeminnow), and the humpback chub. The opinion recommended the following as the reasonable and prudent alternative:

> *"The most serious problem posed by the Dallas Creek Project and related water developments is the loss of water from the Gunnison River and the Colorado*

River. We know of only one alternative which would allow the proposed project to be constructed and operated without jeopardizing the Colorado squawfish and humpback chub. That alternative is the release of water from the Dallas Creek Project or from other projects that regulate flows in the Gunnison River and Colorado River in order to replace the depletions caused by the Dallas Creek Project. This release could provide for essential life stages of the endangered fishes. The Curecanti Project, (Apinall Unit) *may be the best source of water for such releases.*

The Dallas Creek Project would deplete 17,200 af of water in an average year. To compensate for this loss of water from the river system, it may be necessary that an equal volume be released to the Gunnison River from one or more projects. This alternative would prevent the Dallas Creek Project itself from jeopardizing the existence of the fishes of concern. We are intensively studying the endangered Colorado River fishes, but at present we cannot recommend specific flows that should be released. However, our studies may reveal that flow releases totaling less than 17,200 af annually are adequate for the fish to survive in the areas and in the numbers that we believe necessary for recovery."

Reclamation will reinitiate consultation on the Dallas Creek Project as part of the Unit operations biological assessment. This consultation will complete ESA compliance on the Dallas Creek Project.

1.2.3.2 Dolores Project

On March 12, 1980, Reclamation requested formal consultation on the Dolores Project. The Dolores Project in southwest Colorado diverts water from the Dolores River Basin to the San Juan River Basin. The project includes McPhee Dam and Reservoir on the Dolores River, providing water for irrigation and municipal and industrial purposes.

On June 9, 1980, the Service issued a biological opinion for the Dolores Project (Service 1980). The biological opinion determined that the Dolores Project would likely jeopardize the continued existence of the Colorado squawfish (pikeminnow), bonytail chub, and humpback chub. The opinion recommended the following as the reasonable and prudent alternative:

"The most serious problem posed by the Dolores Project is the loss of water from the Colorado River below the confluence with the Dolores River. We know of only one alternative which would allow the proposed project to be constructed and operated without jeopardizing the Colorado squawfish, humpback chub, and bonytail chub. That alternative is the release of water from the Dolores Project, or from other projects that regulate flows in the Colorado River, to replace the depletions causes by the Dolores Project.

> *I believe, based upon available data that WPRS[1] needs to retain the existing seasonal flow pattern below the Dolores River confluence to ensure that construction of this project does not jeopardize these endangered fish.*
>
> *The Dolores Project would deplete 131,000 af of water in an average year. To compensate for this loss of water from the river system, it may be necessary that an equal volume be releases to the Colorado River from one or more projects. This alternative would prevent the Dolores Project itself from jeopardizing the existence of the fishes of concern.*
>
> *"We are intensively studying the endangered Colorado River fishes, but at present we cannot recommend specific flows that should be released. However, our studies may reveal that flow releases totaling less than 131,000 af annually are adequate for the fishes to survive in the areas and the numbers that we believe necessary for recovery.*
>
> *When our Colorado River Fisheries Investigations (CRFI) is completed, we will recommend flows for specific habitat areas of the Colorado River in order to promote conservation of the species. In the interim, we request WPRS to make whatever preparations are necessary so that flow adjustments related to project operations can be made after our study results are in and flow recommendations made."*

Reclamation will reinitiate consultation on the Dolores Project as part of the Unit operations biological assessment. This consultation will complete ESA compliance on the Dolores Project.

1.2.3.3 Upper Gunnison Subordination Agreement

In 2000, a contract entitled "Agreement among the United States of America, the Colorado State Engineer, the Colorado River Water Conservation District (River District) and the Upper Gunnison River Water Conservancy District for the administration of water pursuant to the subordination of Wayne N. Aspinall Unit Water Rights within the Upper Gunnison Basin" (Contract No. 00-WC-40-6590) was executed. The agreement is commonly referred to as the Upper Gunnison Subordination Agreement.

Under the agreement, the United States agreed to subordinate[2] the Aspinall Unit water rights up to 10,000 af of annual water depletions in the Gunnison River Basin drainage between Crystal and Morrow Point dams, and 10,000 af of such depletions in the drainage between Blue Mesa Dam and Morrow Point Dam to the water users represented by the River District, and to subordinate the Aspinall Unit rights up to 40,000 acre feet of annual water depletions in the drainage above Blue Mesa Dam to the water users represented by the Upper Gunnison District and to the Upper Gunnison District rights.

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[1] Bureau of Reclamation was designated the Water and Power Resources Service (WPRS) at that time.
[2] Subordination is the voluntary relinquishment of a water right's priority to selected or all junior water rights. For example, a large water right may subordinate its water rights to protect in-basin water rights.

By subordinating to the rights of such water users, the United States agreed that such water users may continue to divert when a call is placed on the Gunnison River by the United States under the Aspinall rights, subject to the limits of the stated subordination in the separate drainages.

Reclamation informally consulted with the Service on the Upper Gunnison Subordination Agreement on May 17, 1999. The Service concurred with Reclamation's "No Effects" determination in its August 10, 1999 Memorandum (Fish and Wildlife Service 1999). The concurrence was based on two conditions:

1) The 60,000 acre-foot depletion will be consulted on during the upcoming Aspinall Unit consultation; and

2) During the interim, all new Federal actions that deplete water will be consulted on.

1.2.3.4 Redlands Diversion Dam Fish Ladder and Contract Consultation

The Recovery Program constructed a fish ladder on the Gunnison River at the Redlands Water and Power Company (RWPC) Diversion Dam in 1995 to allow native and endangered fish access upstream of the Diversion Dam. A 5-year contract was executed between Reclamation, the U.S. Fish and Wildlife Service and the Colorado Water Conservation Board to maintain 300 cfs in the Gunnison River below the RWPC Diversion Dam for fish migration flows during the period of July through October. The Service concurred with Reclamation's "No Effects" determination for the Colorado endangered fishes for the construction, operation and maintenance of the fish ladder and execution of the water service contract. The contract included the following language to address water shortages:

> *"The operating plan and water release schedule will be dependent upon current hydrologic conditions and the available water supply. For the terms of this agreement the operating plan shall completely remove the need for administrative calls by downstream Gunnison River mainstem users senior in priority to the Aspinall Unit, unless such plan would cause Blue Mesa Reservoir to drop below the 400,000 acre-foot total storage level at the end of the current calendar year. In such event, the parties jointly agree to reduce the 300 cfs release amount otherwise protected pursuant to this MOA in order to minimize the administrative calls which would occur from water rights downstream and senior to the Aspinall Unit and its decrees."*

The contract was extended for an additional 5-year period and expired on August 16, 2005. Since that time, Reclamation has attempted to informally provide migration flows as part of normal operations.

1.2.3.5 Redlands Canal Fish Screen Consultation

In 2005, the Recovery Program constructed a fish screen in the Redlands Canal to reduce the potential of canal entrainment of Colorado pikeminnow and razorback sucker. Reclamation and the Service conducted a Section 7 consultation that included the 1) construction, operation, and maintenance of the fish screen, 2) operation and maintenance of the fish ladder, and 3) 11,737 af of historic depletion by RWPC. The Service issued a biological opinion dated May 11, 2004 (Consultation No. ES/GJ-6-CO-04-F-003) which concluded that the annual depletion of water from the Colorado River Basin may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail, and razorback sucker and may adversely affect their critical habitat (Fish and Wildlife Service 2004). The biological opinion identifies the Recovery Program as the reasonable and prudent alternative.

During the consultation, Reclamation committed to implement the following conservation measure:

> *"Reclamation will to the extent allowable under State and Federal Law, attempt to release from the Aspinall Unit sufficient water to maintain a minimum flow of 300 cfs during the months of July, August, September, and October in the Gunnison River from the Redlands Diversion Dam to the confluence of the Gunnison River with the Colorado River. Said flows include water necessary to maintain fish access to critical habitat in the Gunnison River below Redlands Diversion Dam for authorized fish and wildlife purposes (providing suitable endangered fish habitat). During periods of drought when the 300 cfs below Redlands cannot be met, Reclamation will work with the Service and water users to attempt to maintain flows lower than 300 cfs below Redlands for endangered fish. The operation will remain in place until the Aspinall Operations Environmental Impact Statement is complete and Reclamation has issued a Record of Decision on Aspinall Operations to address endangered fish flows in the Gunnison and Colorado rivers. Operations developed through the environmental impact statement and Endangered Species Act Section 7 consultation process will address long term flow requirements below the Redlands Diversion Dam."*

1.2.3.6 Other Reclamation Aspinall Unit Consultations

Reclamation has conducted 69 ESA consultations involving various water service contracts for the Aspinall Unit. The majority of these consultations are for minor amounts of augmentation water. To date, Reclamation has entered into fifty-four, 40-year contracts for a total of 650 af of depletions, thirteen 25 year-contracts for 130 af of depletion, and two, 10-year contracts for 37 af of depletion for water service contracts from the Aspinall Unit. In addition, one, 2-year contract for 1 af of depletion and five, 1-year contracts for 5,538 af were issued for the Aspinall Unit and all one- and two-year contracts have expired. These active Aspinall Unit water service contracts total up to 963 af of depletions from the Gunnison River.

1.2.4 Upper Colorado River Endangered Fish Recovery Program

In 1988, the Governors of Colorado, Utah and Wyoming; the Secretary of the Interior; and the Administrator of Western Area Power Administration entered into a cooperative agreement to initiate the Upper Colorado River Endangered Fish Recovery Program. The Recovery Program is an interagency partnership created to recover the endangered Colorado pikeminnow, razorback sucker, humpback chub and bonytail while allowing continued and future water development.

Recovery Program elements include:

- Habitat management including identifying and acquiring instream flows, changing operations of Federal dams, and operating other reservoirs in a coordinated manner to benefit endangered fish.
- Habitat development including restoring floodplain/wetland habitats, constructing fish passageways around dams and other barriers in the river, and constructing fish screens in major canal diversions.
- Native fish propagation and genetic management involving establishing facilities to hold adult brood stock to prevent extinction of these rare fish and maintain their genetic resources; develop growout ponds; conduct research to improve survival of endangered fish raised in captivity and stocked in the wild; and support appropriate stocking and reintroduction efforts.
- Managing nonnative species and sport fishing in habitat considered "critical" to endangered fish. This also involves educating and distributing information to anglers to reduce accidental capture of endangered fish.
- Research, monitoring, and data management provides information about what these fish need to survive, grow, and reproduce in the wild. Efforts include compiling data on the number, sizes, and locations of endangered fish; monitoring endangered fish population trends; and making river flow recommendations.

1.2.5 Flow Recommendations

In response to directions from the Recovery Program, a series of hypotheses that addressed effects of flow regulation on endangered fish in the Colorado and Gunnison rivers were developed. Studies designed to test these hypotheses were developed by investigators from the Service, Colorado Division of Wildlife, Utah Division of Wildlife, U.S. Geological Survey (USGS), University of Colorado, and private contractors. These studies were conducted as a group of investigations funded by the Recovery Program under a scope of work entitled "A five year study to investigate the effects of Aspinall Unit operations on endangered fishes in the Colorado and Gunnison rivers." Field work was conducted from 1992 through 1996, with individual studies requiring anywhere from two to five years of field work to complete.

The Aspinall Unit investigations were conducted in conjunction with modifications to historical release patterns. A series of target flows for the study period were developed that provided a variety of runoff patterns to facilitate comparison of years.

Flow Recommendations for the Colorado and Gunnison rivers (McAda 2003) were developed using a lines-of-evidence approach similar to that used to develop Flow Recommendations for the Green River (Muth et al. 2000). Specific relationships between biological responses were considered (e.g., sediment transport that improved hatching success or increased primary production). Creation and maintenance of riverine habitats that are critical to the endangered fishes (e.g., backwaters and floodplains) also weighed heavily in the recommendations. The fundamental basis of the Flow Recommendations reflects general guidelines for river restoration proposed by recognized experts. Partial restoration of natural functions through mimicking of a natural hydrograph benefits the riverine ecosystem and was hypothesized to benefit the four endangered fish as well.

In general, the recommendations concentrate on a more natural hydrograph with high spring peak flows and moderate base flows; the peak flow recommendations vary from year to year based on snowpack or forecasted spring runoff. The “target” for the recommendations is measured at the USGS gaging station at Whitewater on the Lower Gunnison River (Gunnison River near Grand Junction). In addition recommendations for the Colorado River are targeted for measurement at the USGS Colorado-Utah Stateline gaging station. Flow Recommendations are summarized in the biological assessment in Appendix B and can be found at
http://www.usbr.gov/uc/wcao/rm/aspeis/pdfs/GunnCoFlowRec.pdf

While habitat needs of the endangered fish vary between species, spring peak flows benefit all the species by accomplishing several physical goals in addition to providing cues for migration and spawning:

- Maintain complex in-channel habitats
- Provide access to floodplains
- Minimize vegetation encroachment, channel narrowing, and vertical accretion thus protecting side-channel habitats
- Form low-velocity habitats for staging, feeding, resting during runoff
- Inundate and maintain connections to floodplains and off-channel habitat to provide warmer water, food-rich conditions for larval and adult fish
- Provide clean spawning substrates and adequate interstitial spaces for periphyton and aquatic invertebrates

Pitlick et al. (1999) summarized the importance of spring flows:

> *“The single most important thing that can be done to maintain habitats used by the endangered fishes is to assure that the sediment supplied to the critical reaches continues to be carried downstream. Sediment that is not carried through will accumulate preferentially in low velocity areas, resulting in further channel simplification and narrowing.”*

Pitlick et al. (1999) also provided specific flow targets based on Gunnison River field studies:

> *"Flows equal to or greater than one-half the bankfull discharge are needed to mobilize gravel and cobble particles on a widespread basis and to prevent fine sediment from accumulating in the bed. Flows greater than one-half the bankfull discharge thus provides several important geomorphic functions, assuming they occur with sufficient regularity. Flows equal to bankfull discharge are also important because they fully mobilize the bed and thereby maintain the existing bankfull hydraulic geometry."*

Based on 54 different cross sections along the Gunnison River in critical habitat, the median value for half-bankfull flows is 8,070 cfs with the range from 4,660 to 12,700 cfs. The median value for bankfull flows is 14,350 cfs with a range of 7,352 to 28,000 cfs.

Bottomland or floodplain habitats provide important habitat to several life stages of endangered fish. Irving and Burdick (1995) studied bottomlands on the Gunnison River. In 1993, 48 bottomland sites were identified on the Gunnison River with a total potential area of 3,227 acres. Of this total, approximately 828 acres were inundated at spring flows (of approximately 14,000 cfs) and 161 acres at lower fall flows (approximately 2,400 cfs). Limited inundation of floodplains began around 5,000-6,000 cfs; however, substantial inundation did not occur until flows reached 10,000-15,000 cfs. Bottomlands included terraces, depressions, gravel pits, oxbows, side channels, and canyon mouths.

The majority of the floodplain habitat within critical habitat in the Gunnison River is located between Delta and the confluence with Roubideau Creek; and limited small floodplain areas are located downstream from that point. The greatest potential for flooded habitat occurs at the Escalante State Wildlife Area (River Mile [RM] 50-52) where the greatest relative gain in flooded habitat occurs as flows increase to 10,000 cfs. McAda and Fenton (1998) evaluated available habitat in Escalante State Wildlife Area in relation to flow and determined that little relative gain occurs between 981 and 5,560 cfs; but substantial increases occur between 5,560 and 13,330 cfs and diminish again at higher levels. The Johnson Boys slough (RM 52-54) is another important site.

Downstream from Roubideau Creek the river is primarily in canyons, although there are some potentially important bottomland sites in the Well's Gulch area reach (RM 35-41). The river enters a broader valley in the Whitewater area where railroad construction and other developments have restrained the river in the main channel since the late 19^{th} century. However, the Recovery Program has modified a flooded gravel pit (Craig Pond) near Whitewater to serve as a backwater. Water begins to enter this site as flows reach 4,500 to 5,000 cfs.

Overall, the Flow Recommendations are driven by peak flows in the spring, with relatively high base flows in wet years and relatively lower base flows in drier years. Flow targets are based on meeting half-bankfull and bankfull discharges to reach or exceed thresholds for sediment movement with higher instantaneous peaks in some years.

To incorporate natural variation in the river system, Flow Recommendations were developed for six hydrological categories based on April-July flows. An indication of the variability of water availability in the Gunnison River is the range of April-July flows at Whitewater – 281,000 af in 1977 and 3,147,000 af in 1984. The six hydrological categories, based on 1937-1997 data for the Gunnison River, are:

- Wet years-April thru July runoff volume has been equaled or exceeded 10 percent of the time during the study period.
- Moderately wet years- April thru July runoff volume has been equaled or exceeded 10-30 percent of the time during the study period.
- Average wet years- April thru July runoff volume has been equaled or exceeded 30-50 percent of the time during the study period.
- Average dry years- April thru July runoff volume has been equaled or exceeded 50-70 percent of the time during the study period.
- Moderately dry years- April thru July runoff volume has been equaled or exceeded 70-90 percent of the time during the study period.
- Dry years- April thru July runoff volume has been equaled or exceeded 90 percent of the time during the study period.

The Flow Recommendations are targeted at Whitewater. It should be noted that only about one-half of the water at that point comes from the basins upstream of the Aspinall Unit. Water inflow to Blue Mesa Reservoir for the six categories was estimated by McAda (2003):

- Wet years-inflow of 1,123,000 af or greater
- Moderately wet years-inflow between 871,000 af and 1,123,000 af
- Average wet years-inflow between 709,000 af and 871,000 af
- Average dry years-inflow between 561,000 af and 709,000 af
- Moderately dry years-inflow between 381,000 af and 561,000 af
- Dry years-inflow less than 381,000 af

The Flow Recommendations adopted Pitlick et al. (1999) recommendations which conclude that to maintain habitat conditions in the Gunnison and Colorado rivers, half-bankfull and bankfull flows should occur with a long-term average duration equal to what occurred during 1978-1997 and that to improve habitat, the threshold flows should occur with a long-term average equal to what occurred during 1993-1997. "Pitlick et al.'s (1999) recommendation to maintain habitat conditions would mean that over the long term, flows should exceed 8,070 cfs for an average of 20 days per year and exceed 14,350 cfs for an average of four days per year. Recommendations to improve habitat conditions require that, over the long term, flows should exceed 8,070 cfs for an average of 32 days per year and exceed 14,350 cfs for an average of seven days per year (McAda 2003)." While target durations are based on geomorphology studies, durations of higher flows are also important for maintaining use of floodplain and backwater habitats.

Table 1.2 2 presents one of the possible scenarios by which Flow Recommendations for the Gunnison River could have been derived from Pitlick's work (McAda 2003).

Table 1.2 2—Flow Recommendations for the Gunnison River-Number of Days per Years the Flows Should Exceed Half-Bankfull and Bankfull.

Hydrologic Category	Expected Occurrence	Flow Target and Duration		Instantaneous Peak Flows cfs
		Days/Year > or = To 8,070 cfs*	Days/Year > or = to 14,350 cfs*	
Wet	10%	60-100	15-25	15-23,000
Moderately Wet	20%	40-60	10-20	14,350-16,000
Average Wet	20%	20-25	2-3	≥14,350
Average Dry	20%	10-15	0-0	≥8,070
Moderately Dry	20%	0-10	0-0	≥2,600
Dry	10%	0-0	0-0	~900-4,000
Long Term Weighted Average		20-maintenance 32-improvement	4-maintenance 7-improvement	

*Lower value in each range is for maintenance, higher value in each range is for improvement

Peak flows in the Gunnison River are recommended to occur between May 15 and June 15 and should be managed, to the extent possible, by matching peak flows of the North Fork of the Gunnison with peak releases from the Aspinall Unit.

Peak Flow Recommendations were developed in a similar manner for the Colorado River measured at the Colorado-Utah Stateline (see Appendix B and McAda 2003).

A minimum base flow for the Gunnison River (as measured at Whitewater gage) of at least 1,050 cfs is recommended in all but moderately dry and dry years in order to protect low velocity water habitats for the fish and provide migration flows to the Redlands Diversion Dam Fish Ladder (Redlands Fish Ladder). Included would be flows of 100 cfs to operate the fish ladder. It has been recommended that the ladder be operated from April 1 through September 15 (Burdick 2001). During dry and moderately dry years, Flow Recommendations call for flows decreasing below 1,050 cfs after the Colorado pikeminnow migration period. During wetter periods, base flow recommendations are higher.

The Flow Recommendations recognize uncertainties in understanding the biology of the fishes and the response of the fish and their habitat to flow changes. For that reason, the recommendations call for using adaptive management to respond to new knowledge and using monitoring to evaluate the physical response of the habitat and biological response of the fish to the flow regimes. It is expected that any refinements in operation of the Aspinall Unit would be within the scope of the current proposed action and that implementation of refinements would occur with appropriate Section 7 consultation as necessary.

Physical uncertainties discussed in the recommendations include:

- While relationships among initial motion, significant motion and streamflow are well defined, duration of flows necessary to accomplish habitat work is not completely known. Because flow duration recommendations were developed based on a wet period, the recommended durations require a large volume of water that may not always be available. According to the Flow Recommendations, "…the duration of flows necessary to accomplish in-channel and out-of-channel habitat maintenance objectives is not known."[1]
- Water availability may limit the ability of the Gunnison River to meet the Flow Recommendations under certain conditions.
- Because of timing and other differences in runoff patterns of the Colorado and Gunnison rivers, it is difficult to predict the effect of Gunnison River flow changes on the Colorado River.
- Flow Recommendations for wet periods may cause flooding problems for which management activities may be necessary to prevent potential problems.

In summary, the Flow Recommendations call for peak flows to periodically prepare cobble and gravel spawning areas, to connect backwaters, and to maintain channel diversity; and sufficient flows to cue and allow migration. Base flows that promote growth and survival of young fish during summer, fall, and winter are also provided.

1.3 Issues of Concern

Issues raised in the public meetings held in 2004 and in written comments and internal scoping are discussed in Chapter 5 and Appendix E. Briefly, the major concerns centered on possible effects to the following: water rights, water quality, recreation, fish and wildlife, endangered species, vegetation and wetlands, flood control, hydropower, maintenance, socioeconomics, Black Canyon, Gunnison Gorge NCA, Curecanti NRA, transmountain diversions, and a biological opinion.

1.4 Cooperating Agencies

Coordination and consultation with cooperating Federal, State, and local agencies were conducted concurrently with the development of alternatives and preparation of the DEIS and are described in greater detail in Chapter 5. Federal agencies and local and State governments with appropriate expertise or jurisdiction elected to participate in the NEPA process as cooperating agencies. They include:

[1] Research under the Recovery Program is ongoing in the Gunnison River. Under one sediment-monitoring project the primary objective "…is to address key uncertainties in priority reaches of the Colorado, Gunnison, and Green Rivers relevant to the role of streamflows and sediment transport on the formation and maintenance of backwater habitats and spawning bars. A secondary objective is to collect the necessary sediment data to aide in the evaluation of Service Flow Recommendations for the Aspinall Unit and Flaming Gorge Reservoir." (Fish and Wildlife Service 2006).

State of Colorado
- Department of Natural Resources
- Division of Water Resources
- Division of Wildlife
- Water Conservation Board

Colorado River Water Conservation District
National Park Service
Platte River Power Authority
Southwestern Water Conservation District
U.S. Fish and Wildlife Service
Western Area Power Administration

1.5 Connected and Related Actions

Aspinall Unit operations constitute a connected action to other water resource activities in the Gunnison and Colorado river basins, such as the Dallas Creek and Dolores Projects; Redlands Diversion Dam, Fish Ladder and Fish Screen; Upper Gunnison Subordination Agreement; and Aspinall Unit Water service contracts. This connection stems from (1) past ESA consultations which relied on the Recovery Program and the re-operation of the Aspinall Unit to avoid jeopardy to the endangered species in question, 2) Flow Recommendations developed and approved by the Recovery Program, and 3) Reclamation's previous commitment to operate the Aspinall Unit for the benefit of endangered fish in the Gunnison Basin.

Other actions related to the operation of the Aspinall Unit include the following:

- 1975 Taylor Park-Aspinall Unit Exchange Agreement
- Black Canyon NP Federal Reserved Water Right
- Ridgway-Gunnison Tunnel Exchange
- Curecanti Resource Protection Study

The Federal reserved water right for the Gunnison River through the Black Canyon is nearing quantification. In general, the right will call for higher flows in the spring similar to flow recommendations for endangered fish. Thus the reserved right and the preferred alternative for Aspinall Unit operations will have similar impacts on resources. The Secretary of Interior's exercise of the federal reserved right will be with due regard for, and shall be coordinated with, implementation of the Aspinall Unit's reoperation. To the extent practicable, this water right will be exercised so that it is coordinated with implementation of the preferred alternative to achieve a single peak flow, subject to Aspinall Unit authorized purposes, including, but not limited to, flood control to protect human health and safety and prevent the loss of property along the Gunnison River.

1.6 Responsibilities and Compliance

The Aspinall Unit is one of four initial units of the CRSP which were constructed to provide for the comprehensive development of the water resources in the Upper Colorado River Basin. The Aspinall Unit is operated in accordance with the CRSP Act and other applicable Reclamation and Federal and State laws. Authorities and functions of the Aspinall Unit are shown in Table 1.6 1.

The United States has ESA and other responsibilities in the Gunnison Basin associated with the operation of the Aspinall Unit. The laws and policies listed below and in Table 1.6 1 may affect the operation of the Aspinall Unit. No special permits are needed to implement the proposed action.

1.6.1 Environmental

Clean Water Act of 1972 (33 USC 1251 et seq.)
Endangered Species Act of 1973 (16 USC 1532 et seq.)
Fish and Wildlife Coordination Act (48 Stat., as amended; 16 USC 661)
National Environmental Policy Act of 1969 (42 USC 4321 et seq.)
Wild and Scenic Rivers Act of 1968 (16 USC 4321 et seq.)
Executive Order 11988, Floodplain Management, 1977
Executive Order 11990, Protection of Wetlands, 1977
Executive Order 11991, Protection and Enhancement of Environmental Quality, 1977

Table 1.6 1—Various Authorities under which the Aspinall Unit was Constructed and Operated[1].

Function	Law
Municipal, industrial and other beneficial purposes	1939 Reclamation Project Act (P.L. 76-260), 1956 CRSP Act (P.L. 84-485)
Flood Control	1939 Reclamation Project Act, 1956 CRSP Act, and Flood Control Act of 1944
Improving navigation	1939 Reclamation Project Act, 1956 CRSP Act
Regulating the flow of the Colorado River	1956 CRSP Act
Reclamation of arid lands	1956 CRSP Act
Generation and sale of electric power	1956 CRSP Act
Fish, wildlife and Recreation	Section 8 of 1956 CRSP Act (construction only); 1958 Fish and Wildlife Coordination Act (P.L. 85-624); Endangered Species Act

[1]The Federal authorized purposes are described in Section 1 of the 1956 CRSP Act

1.6.2 Cultural Preservation

Archeological and Historic Preservation Act (16 USC 469 et seq.)
Archeological Resources Project Act of 1979 (16 USC 470 et seq.)
Historic Sites, Buildings, and Antiquities Act (16 USC 461 et seq.)
National Historic Preservation Act (16 USC 470 et seq.)
Executive Order 11593, Protection and Enhancement of the Cultural Environment, 1971

1.6.3 American Indian

American Indian Religious Freedom Act of 1978, as amended (42 USC 1996)
Native American Graves Protection and Repatriation Action of 1990 (25 USC 3001 et seq.)
Religious Freedom Restoration Act of 1993 (P.L. 13-141)
Executive Order 13007 (Indian Sacred Sites)
Secretarial Orders 3175, 3206, and 3215 on Indian Trust Assets

1.6.4 Other

Executive Order 12898, Environmental Justice in Minority Populations and Low Income Populations, 1994

Applicable State laws implementing the Federal laws identified above

1.7 Document Review

Reclamation's Notice of Intent to prepare this DEIS was published in the *Federal Register* on January 21, 2004. Scoping meetings were conducted on February 24, 25, and 26, 2004 in Gunnison, Delta, and Grand Junction, Colorado, respectively. The responses were reviewed by Reclamation and incorporated when they were within the scope of the Federal Action. A Notice of Availability (NOA) of the DEIS for 60-day public review and comment period will be published in the *Federal Register*, which will include an announcement of public hearings.

During the public review and comment period, oral testimony and written comments will be received. Written responses to comments will be published in the FEIS. A NOA will be published in the *Federal Register* announcing the availability of the FEIS. Release of a Record of Decision will conclude the NEPA process.

Volumes I and II of this DEIS will be available at Reclamation's Western Colorado Area Office in Grand Junction, Colorado; the Upper Colorado Regional Office, Salt Lake City, Utah; and Technical Services Center, Denver, Colorado; and at public libraries and at other locations noted in Chapter 5. Volumes I and II will also be available at www.usbr.gov/uc/wcao/rm/aspeis. A distribution of documents will also be made to those on the DEIS list in Chapter 5.

1.8 Document Organization

A description of the alternatives, an analysis of resources potentially impacted, an assessment of those impacts, and an evaluation of options to avoid or mitigate impacts are included in the following Volume I chapters.

- *Executive Summary*

- *Chapter 1, Introduction, Purpose of and Need for the Action,* discusses the purpose of and need for the proposed action, objectives of the DEIS, key issues, legal and other requirements, and the review process.

- *Chapter 2, Proposed Action and Alternatives,* introduces planning concepts and provides information related to the development and analysis of the alternatives, including the No Action Alternative. Those alternatives considered but eliminated from further consideration are also identified. Chapter 2 contains a description of the alternatives that were selected for full environmental evaluation in Chapter 3, a description of the preferred alternative, and a table that summarizes the environmental impacts of viable alternatives retained for further analysis.

- *Chapter 3, Affected Environment and Environmental Consequences*, identifies the impacts that could occur to a wide array of resource areas with changes in the operation of the Aspinall Unit and gives particular attention to resources adversely affected. Each resource topic identifies the affected environment and potential environmental consequences (impacts).

- *Chapter 4, Environmental Commitments and Mitigation Measures*, addresses environmental commitments and mitigation measures associated with modifying the operations of the Aspinall Unit.

- *Chapter 5*, *Consultation and Coordination*, presents a summary of the public involvement process, a listing of principal issues and concerns identified by the public, a summary of consultation and coordination activities, and the DEIS distribution list.

- List of Preparers

- Bibliography

The Contents of Volume II include:

Technical/Background Material

-Appendix A—Aspinall Hydrology Report
-Appendix B—Biological Assessment
-Appendix C—Methodology for Analyzing the Impacts of Aspinall EIS Alternatives on Power Economics
-Appendix D—Economic Analysis
-Appendix E—Scoping Summary Report
-Appendix F— National Park Service Analysis of Aspinall Reoperations Alternatives (Black Canyon)

The Contents of Volume III in the FEIS will include responses to DEIS Comments.

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CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES

2.1. Introduction

This chapter describes the alternatives analyzed in this draft environmental impact statement (DEIS), including the No Action Alternative. Each alternative represents a different manner of operating the Aspinall Unit. In other words the timing and magnitude of water releases from the Aspinall Unit vary in each alternative. Certain operations are non-discretionary and cannot be modified by alternatives; however, there are discretionary operations that can be modified. Using this discretion was the key element in developing a range of alternatives. This chapter also explains the criteria for selecting alternatives and discusses alternatives that were considered but not analyzed in detail.

Based on descriptions of the affected environment and environmental consequences in Chapter 3, this chapter also presents a summary comparison of the predicted environmental effects of the selected alternatives on the quality of the human environment.

2.2 Alternative Formulation

2.2.1 Formulation and Evaluation Criteria

The range of alternatives developed for this EIS was initially formulated and subsequently evaluated using hydrologic modeling, operational discretion, and considerations for the following criteria input:

- Authorized purposes of the Aspinall Unit
- Applicable water rights, contracts, law, interstate compacts, court decrees, and various rules, regulations, policies, and directives
- Goals of the Upper Colorado River Endangered Fish Recovery Program and the *Flow Recommendations to Benefit Endangered Fishes in the Colorado and Gunnison Rivers* (Flow Recommendations) (McAda 2003) which

recommend increasing spring flows and providing base and duration flows. (Appendix B)

- Public scoping meetings and public contacts (Appendix E)
- Coordination with cooperating agencies and interagency consultations
- Informal consultation with the Fish and Wildlife Service under the Endangered Species Act
- Flood control procedures for the Aspinall Unit established by the U.S. Army Corp of Engineers to provide flood protection for areas along the Gunnison River downstream to Grand Junction, Colorado

The Aspinall Unit operations were modeled with the scope encompassing the Gunnison River Basin from Blue Mesa Reservoir to the confluence with the Colorado River. RiverWare, a software modeling tool developed by CADSWES (University of Colorado) for the Bureau of Reclamation and the Tennessee Valley Authority for operations and planning studies of river basins and river systems, was used. The daily planning model, developed for initial analysis in 2002-2003 was updated in 2007. Various operations of the Aspinall Unit were modeled. The modeling period originally utilized a single 26-year period from January 1975 through December 2000. The modeling period for this new analysis has been extended through December 2005 and now consists of a single 31 year trace. The model is used as a comparison and planning tool and will not be used for actual operations. Further description of the model and related assumptions can be found in Chapter 3 of Volume I and the Hydrology Appendix A in Volume II.

2.3 Selected Alternatives

The analysis used to select alternatives is described in Section 2.4. From the analysis of initial alternatives, a representative range was selected to evaluate in detail in the EIS. Informal consultation was held with the Service to develop model runs that better met peak, duration, and base flow needs of endangered fish while protecting Aspinall Unit purposes. This section provides a description of the four alternatives selected. Each of the alternatives is described in terms of its operating parameters. The effects of implementing each alternative are summarized later in this chapter. Based on the results of modeling, the initial alternatives were refined to better meet endangered fish needs and Aspinall Unit purposes. The following alternatives were selected to be considered in detail in the EIS (Appendix A contains detailed information on the hydrologic impacts of implementing the alternatives).

2.3.1 No Action Alternative

The **No Action Alternative** represents a projection of current operating practices to the most reasonable future conditions that would occur without any action alternatives being implemented. The No Action Alternative should not automatically be considered the same as the existing or past conditions, since reasonably foreseeable future actions may take place whether or not any of the project action alternatives are chosen and because the environment is not static and environmental consequences would still occur. Under the No Action Alternative, elements of the Recovery Program would continue—for example, stocking of endangered fish, non-native fish control, operation of the Redlands Fish Ladder and Screen, management of backwaters, and monitoring. However, altering operations of the Aspinall Unit to specifically assist in meeting the 2003 Flow Recommendations for endangered fish in the Gunnison and Colorado rivers would not occur.

The No Action Alternative would include the following elements in addition to elements common to all alternatives discussed later: Aspinall Unit in place, regulating the river using current operating practices as a guide, and operating for authorized Aspinall Unit purposes under a full range of annual inflow conditions. These current operational practices include:

- Filling Blue Mesa Reservoir at end of runoff season would be a goal. Full reservoir is 7519.4 feet; however, operations are designed to reach around 7517 feet (or less, dependent on forecast) which provides a safety factor for controlling the reservoir in case of sudden high inflow events due to thunderstorms or high rate of snowmelt.

- Whether a spring peak could be provided would be determined annually by Reclamation with input received from the Aspinall operations meetings. “Excess water” (water that is projected to bypass Crystal Powerplant) would be shaped[1] into a spring peak for general environmental purposes (for example channel maintenance in Gunnison Gorge NCA and Black Canyon NP, control of riparian vegetation encroachment, cottonwood regeneration, downstream recreation, fisheries, channel maintenance in Delta area, etc)**.** The peak would be planned to occur during the spring-early summer period. From January through April the goal would be to operate the Aspinall Unit to release all forecasted excess water through powerplants and to reduce future bypasses of powerplants while still giving priority to filling Blue Mesa Reservoir (flood control may occasionally require early bypasses). The Crystal Powerplant bypasses, if any, identified based on the May 1 forecast would be used to shape the peak without intentionally bypassing Morrow Point and Blue Mesa powerplants. It is recognized that if the May 1 forecast proves to be higher than the actual inflow, there is some risk of not filling Blue Mesa Reservoir. Adjustments would also be made in the spring peak plan if the May 15 forecasted inflow changes significantly upward or downward.

- Existing spring flood control operations would be continued by using discretion and being proactive to keep 14,000 cubic feet per second (cfs), or normally considerably less in the Gunnison River, above the Uncompahgre River confluence at Delta. The flood control manual requires that efforts be made to keep flows below 15,000 cfs.

[1] Shaping would involve “compressing or consolidating” bypass flows into peak.

- A reserved water right for the downstream Black Canyon NP is in the process of being quantified and will become part of No Action along with other established senior water rights when quantification is complete. The Secretary's exercise of the federal reserved water right for Black Canyon of the Gunnison National Park will be coordinated with the implementation of any of the Aspinall action alternatives. To the extent practicable, this water right shall be exercised to achieve a single peak flow, subject to all Aspinall Unit authorized purposes.

- The Aspinall Unit will be operated in accordance with Colorado State Water Law including but not limited to bypassing downstream senior water rights as necessary.

- Crystal Reservoir would continue to regulate peaking power releases from Morrow Point Dam in order to provide stable downstream flows. Changes in releases from Crystal Dam would be ramped to avoid sudden flow changes. Guidelines would be ramping up at a maximum rate of 15 percent of existing releases or 500 cfs per day and down at 15 percent or 400 cfs per day whichever is greater. Ramping can be accomplished with more than one change per day.

- Gunnison Gorge flow decreases that could damage redds (fish nests) after October 15th for brown trout recruitment would be avoided when practical. Flow decreases would be also avoided after April 15th to protect rainbow trout spawning when practical. Flow decreases can lead to dewatering or ice damage to eggs.

- Consistent with the authorized purposes of the Aspinall Unit, operations would assist in meeting a target of 100 cfs for the Redlands Fish Ladder from April through September and 40 cfs for the fish screen from March through November**,** using storage water if necessary. Special releases of storage to meet migration flows of 300 cfs are not guaranteed under No Action. It should be recognized that adequate flows to operate the fish screen and provide adequate migration flows would be present much of the time due to normal flow conditions, even in the absence of specific water deliveries.

2.3.2 Risk of Spill Alternative-Alternative A

Alternative A is based on managing water that is in excess of Aspinall Unit needs. The excess water is managed primarily for spring peaks.

2.3.2.1 May-June Time Frame

This alternative includes No Action elements with the following changes:

- Water forecasted to be bypassed or spilled at Crystal Reservoir, based on the May 1 forecast and May 1 Blue Mesa Reservoir content, is managed for a spring peak between May 15 and June 15.
- Spring peak is timed to match North Fork peak, subject to flood control.
- Adds use of storage in Average Dry and Average Wet years to increase peaks/duration.
- Criteria for Peak:

Forecasted Bypass Volume	Maximum 1-day Release
>0 – 75,000 af	4,150 cfs from Crystal Dam
>75,000 – 300,000 af	5,000 cfs from Morrow Point Dam
>300,000 af	6,500 cfs from Morrow Point Dam

- In addition, if North Fork of the Gunnison flows are less than 3,000 cfs and Morrow Point's spillway release is greater that 1,000 cfs, the total release from Morrow Point will be increased to 10,000 cfs using a combination of powerplants, bypasses, spillways. Model results show this situation occurring in mid to late June or early July due to particularly wet hydrologic conditions. Releases from Morrow Point over 4,100 cfs will likely cause Crystal Reservoir to spill.
- This alternative could be further modified to target a peak release in selected dry years.
- 100 cfs is provided to the Redlands Fish Ladder April through September, and 40 cfs for fish screen March thru November.

2.3.2.2 Ramping Rates

Similar ramping rate guidelines for release changes are provided under Alternative A and other action alternatives as follows:

- Daily ramping rates on the ascending limb will be the maximum of 500 cfs or 25 percent of flow in the Black Canyon on the previous day. Ramping can be accomplished with more than one change per day.
- Ramping rate guidelines on the descending limb remain unchanged from No Action.
- Ramping up will begin five days prior to the estimated peak flow date on the North Fork of the Gunnison River.
- Crystal Dam releases reregulate peaking releases from Morrow Point Dam throughout the year to produce stable downstream flows.

2.3.2.3 Base Flows

Similar base flows are provided under Alternative A and other action alternatives and can vary under different hydrologic conditions. Additional releases to maintain minimum base flows at Whitewater will be set each year based on discussions with the Service. In most years, a base flow of 1,050 cfs will be maintained at the Whitewater gage; however, these targets will be reduced in dry or moderately dry years.

Table 2.3 1 summarizes base flow targets as outlined in the Flow Recommendations. As footnoted, additional releases will be made to provide 100 cfs to the Redlands Fish Ladder as needed in April through September and 40 cfs for the Redlands Fish Screen from March through November, using storage water if necessary. Base flows would normally provide adequate migration flows downstream from the Redlands Diversion Dam.

Table 2.3 1—Base Flow Targets (cfs) at Whitewater Gage under the Action Alternatives.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	1050	1050	1050	1050	1050	1500	1500	1500	1050	1050	1050	1050
Mod Wet	1050	1050	1050	1050	1050	1500	1500	1500	1050	1050	1050	1050
Avg Wet	1050	1050	1050	1050	1050	1500	1500	1050	1050	1050	1050	1050
Avg Dry	1050	1050	1050	1050	1050	1500	1500	1050	1050	1050	1050	1050
Mod Dry*	750	750	750/790	750/890	750/890	1050	1050	1050	750/890	750/790	750/790	750
Dry*	750	750	750/790	750/890	750/890	1050	1050	750/890	750/890	750/790	750/790	750

*During March through November in Moderately Dry and Dry type years, additional releases will be made as necessary to provide flows above the 750 cfs anticipated to be diverted by the Redlands Water and Power Company, for the fish ladder and fish screen as shown.

2.3.3 Fish Peak w/ Duration Alternative-Alternative B

This alternative includes No Action elements with modifications discussed below in terms of time frames. Alternative B is based on operating the Aspinall Unit to meet specific downstream flow targets.

2.3.3.1 January-March Time Frame

Water would be released using the most recent April through July inflow forecast and downstream water demands with the goal of achieving a March 31st Blue Mesa Reservoir content target (determined from the January, February, and March 1st forecasted April-July Blue Mesa Reservoir inflow) and with the goal of higher releases during January for power purposes. The March 31st target is intended to optimize Aspinall Unit operations for storage, flood control, and hydropower production.

The minimum downstream release for instream flow through the Black Canyon is 300 cfs, but can be higher based on the previous year’s operations that consider factors such as the fall brown trout spawn or downstream senior water rights. Maximum releases are limited to the 2,150 cfs Crystal Powerplant capacity in most years. Generally the above release patterns would meet downstream base flow needs for endangered fish; if not, releases would be adjusted accordingly.

2.3.3.2 April-July Time Frame

Reclamation will not bypass the powerplant at Crystal Dam from April 1st through May 10th, thus making more water available for a spring peak and/or duration flows (However, in order to reduce flooding risk, Reclamation may bypass the powerplant during this time period if Blue Mesa Reservoir's forecasted inflow indicates that the Year Type is in a "Wet" category). This has the effect of holding water for 40 days that may have been bypassed unnecessarily if the runoff was over-forecasted that year. In addition to making water available for peak releases, it also may improve the chance of filling Blue Mesa Reservoir, with a slight risk of increasing flood frequency at Delta.

Peak Releases will be made in an attempt to match the peak from the North Fork in order to maximize the potential of meeting a desired peak at Whitewater. Releases may be reduced if the Gunnison River at Delta approaches 14,000 cfs in an attempt to reduce flooding. Peak releases would typically be made between May 10th and June 1st. However, this time frame could be altered to May 1st to June 15th if appropriate for endangered species and other resource concerns.

The magnitude of the desired peak at Whitewater is determined based on the "Year Type" category, as defined in the Flow Recommendations, in conjunction with the most recent inflow forecast information as shown in Figure 2.3-1 and Table 2.3 2. Releases will be made from the Aspinall Unit using the necessary combination of available powerplants**,** bypasses and spillways, while attempting to reach the spring peak flow target. Reclamation's ability to meet a desired peak is limited by the physical constraints/availability of the Aspinall Unit outlet features in some years. For example, Blue Mesa Reservoir water surface elevation may not be high enough to use its spillway.

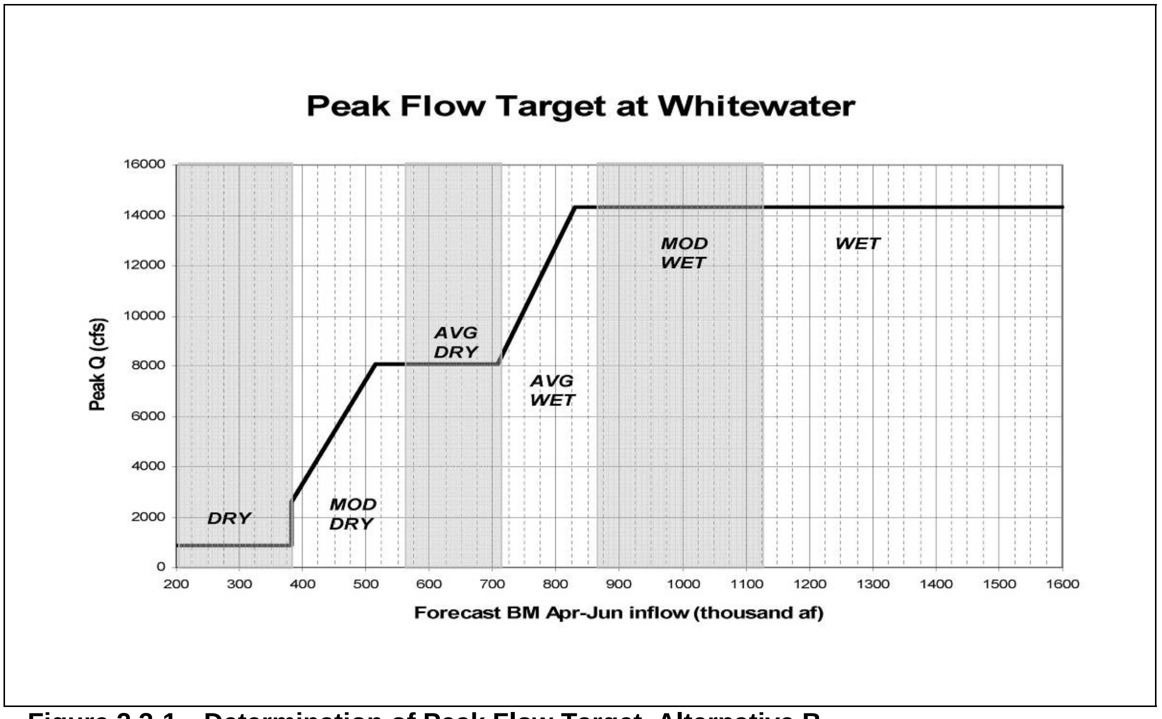

Figure 2.3-1—Determination of Peak Flow Target, Alternative B.

Table 2.3 2—Spring Peak and Duration Targets for Range of Forecasted Inflows, Alternative B.

Blue Mesa Forecasted April-July Inflow	Desired Peak at Whitewater	Duration of Half-Bank *(8,070 cfs)*	Duration of Bankfull *(14,350 cfs)*
Af	**cfs**	**Days**	**Days**
< 381,000	900	0	0
381,000 to 516,000	2,600 to 8,070	0	0
516,001 to 709,000	8,070	10	0
709,001 to 831,000	8,070 to 14,350	20	2
831,001 to 1,123,000	14,350	40	10
>1,123,000	14,350	60	15

After a peak flow release is made, high releases may continue in an attempt to maintain flows at half-bankfull or bankfull levels. Releases for duration of higher flows in conjunction with the desired peak at Whitewater will be made if it is possible to reach 90 percent of the desired peak. The length of duration of flows is dependent on the "Year Type" category in the Flow Recommendations. Minimum duration is targeted and may be exceeded at times.

Crystal Dam releases, and releases from Morrow Point and Blue Mesa Dam as needed, would begin to be ramped up approximately 5 days prior to the predicted North Fork peak.

2.3.3.3 August-December Time Frame

Releases will be set utilizing the most recent forecast of August through December inflow and downstream water demands, with the goal of having Blue Mesa Reservoir at or below an elevation of 7,490 feet (580,000 af-live storage) by December 31st to minimize the potential for upstream icing. The minimum release criteria of 300 cfs for downstream resources will still apply, in addition to existing downstream senior water right demands.

2.3.3.4 Ramping Rates

Ramping rate guidelines for release changes under Alternatives B are the same as Alternative A as described previously in 2.3.2.2. Crystal Dam releases will reregulate releases from Morrow Point Dam throughout the year to produce stable downstream flows.

2.3.3.5 Base Flows

Base flows provided under Alternative B and are the same as Alternative A and described previously in 2.3.2.3.

2.3.4 Fish Peak— w/ Increased Duration-Alternative C

This alternative is similar to the Fish Peak with Duration Alternative (Alternative B) except that the peak duration targets are increased as shown below in Table 2.3 3.

Table 2.3 3—Spring Peak and Duration Targets, Alternative C.

Blue Mesa Forecasted Inflow	Desired Peak @Whitewater	Duration of Half-Bank *(8,070 cfs)*	Duration of Bankfull *(14,350 cfs)*
Af	cfs	days	days
< 381,000	900	0	0
381,000 to 516,000	2,600 to 8,070	10	0
516,001 to 709,000	8,070	15	0
709,001 to 831,000	8,070 to 14,350	25	3
831,001 to 1,123,000	14,350	60	20
> 1,123,000	14,350	100	25

2.3.5 Fish Peak –w/ Revised Target Alternative-Alternative D

This alternative is similar to Alternative B except that peak targets are determined as shown in Figure 2.3.2 and Table 2.3.4.

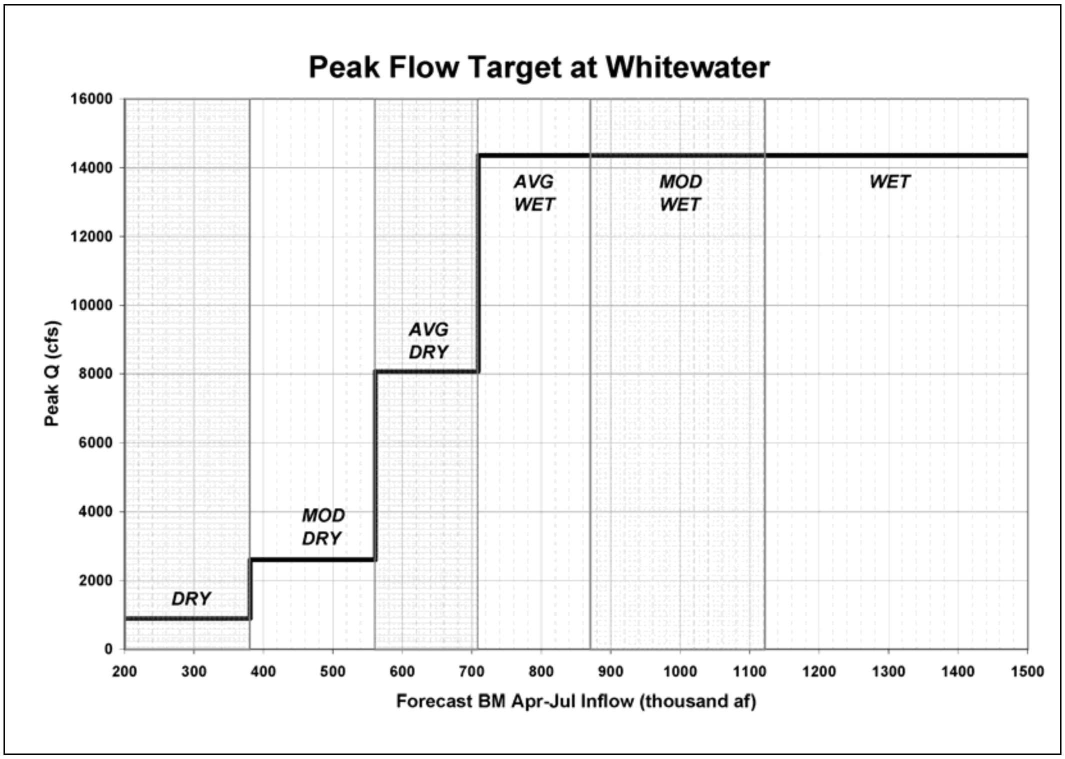

Figure 2.3-2—Peak Flow Determination, Alternative D.

Table 2.3 4— Spring Peak and Duration Targets, Alternative D.

Blue Mesa Forecasted Inflow	Desired Peak @Whitewater	Duration of Half-Bank *(8,070 cfs)*	Duration of Bankfull *(14,350 cfs)*
Af	**cfs**	**days**	**days**
< 381,000	900	0	0
381,000 to 561,000	2,600	0	0
561,001 to 709,000	8,070	10	0
709,001 to 871,000	14,350	20	2
871,001 to 1,123,000	14,350	40	10
> 1,123,000	14,350	60	15

2.3.6 Characteristics Common to all Selected Alternatives

2.3.6.1 General

Flow recommendations developed for use by the Recovery Program are intended to be evaluated, and revised through an adaptive management process. It is difficult to apply the flow recommendations to all hydrologic conditions and meet authorized purposes. The flow recommendations are based on the best information at the time. The Recovery Program has recognized that: "… it is uncertain to what extent these [flow] recommendations can be met and what flow regimes will be necessary to meet the life history needs of the [species]". The flow recommendations state: "This table [4.5] represents one possible way of achieving the long-term weighted average for sediment transport."

The operation of the Aspinall Unit under the action alternatives, including the preferred alternative, is intended to meet the Gunnison River flow recommendations to the extent Reclamation can do so while maintaining authorized purposes. Reclamation's operations to assist in meeting the flow recommendations shall be implemented consistent with the authorized purposes of the Aspinall Unit. This allows flexibility to adjust management actions as additional understanding is gained and in the face of changing hydrologic conditions allows decision makers at each juncture to make the best decisions they can with the information available at that time. For example, Reclamation will review and respond to forecasts as they become available, consistent with the authorized purposes. Real-time release decisions will be made daily as conditions change. To the extent possible, peaks from the North Fork of the Gunnison that are projected to occur earlier or later than May 15 to June 1 of each year will be considered and utilized to contribute to spring peaks at Whitewater.

While the recovery goals for the endangered fish do not require specific flow regimes in the Gunnison River[1], Reclamation is assisting in recovering the endangered fish through actions that are consistent with the Recovery Program's Recovery Action Plan (RIPRAP). Flow recommendations are one aspect of the larger habitat management elements of the Recovery Program, which Reclamation, along with the states and stakeholders, supports. Reclamation and the cooperating agencies will work within the

[1] The Gunnison River is included in the Upper Colorado River subbasin as referenced in the Recovery Goals.

Recovery Program to continue to work toward recovery of the endangered fish species while exploring flow and non-flow actions that will allow for this recovery consistent with authorized purposes.

2.3.6.2 Adaptive Management

Adaptive management is a systematic approach for improving resource management by learning from management outcomes. Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become understood. Essentially, the long-term responses of endangered fish to new operations and other Recovery Program actions are uncertain and future monitoring will be needed to make adjustments in implementing operations and the overall Recovery Program.

Uncertainties of endangered fish response to management actions exist throughout the Recovery Program and adaptive management principles are integral to addressing them. The Recovery Program acts both as a scientific clearing house on the technical side of adaptive management and as a vehicle for agencies (such as the state of Colorado, Western, Reclamation, the Service, and others) to identify and coordinate research and monitoring in the presence of other stakeholders.

There are uncertainties related to the response of endangered fish populations and critical habitat to the flow modifications proposed under the Aspinall Unit reoperation. For that reason, the Flow Recommendations Report (McAda 2003) suggested using adaptive management principles, including monitoring responses of fish and their habitat to the new flow regime, to address uncertainties.

Uncertainties identified in the Flow Recommendations Report by McAda (2003) include:

- Determination of the amount and location of floodplain habitat necessary for recovery of species.
- Determination of relationship of reproductive success of pikeminnow and humpback chub to increased spring flows. Effect of new flow regime on nonnative fishes that adversely affect native fish.
- Determination of the frequency (recurrence interval) and duration (number of days) that flows need to exceed half-bankfull and bankfull discharge to maintain habitats required by the endangered fishes.
- Determination of response of primary and secondary production in the rivers to new flow regime.
- Consideration of the trade-off between high spring flows and base flows needed during the mid-to late summer.

Other uncertainties include whether elevated selenium concentrations and other water quality elements affect the recovery of the endangered fish in the Gunnison and other basin rivers. As discussed in biological assessment (Appendix B), the effect of selenium levels on fish recovery in the Gunnison and Colorado rivers is not clear. Long-term trends in selenium concentrations have not been determined but appear downward in recent years. Clarifying these effects is a necessary first step in addressing these uncertainties.

Reclamation and the Service will work together and with the Recovery Program to develop study plans to evaluate endangered fish populations and their habitat and their response to the new flow regime. This coordination will occur within one year of the finalization of the biological opinion and Record of Decision on the reoperation. Reclamation and the Service will also work through the Recovery Program to implement the study plans**.** This would include (1) identifying appropriate monitoring and research to evaluate effects of Aspinall reoperation and (2) including these activities in the Recovery Program's RIPRAP as necessary to identify the potential for modifying or refining flows from the Aspinall Unit. These plans may include research-driven requests for flows to answer questions identified in the study plan.

New information developed by the Recovery Program from these activities will be presented to Reclamation to determine operational flexibility available to address the new information. It is expected that any refinements in operation of the Aspinall Unit would be within the scope of the current proposed action and that implementation of refinements would occur with appropriate Section 7 consultation as necessary.

2.3.6.3 Extreme Conditions, Maintenance, and Emergencies

Flow Recommendations address drought years by basing peak flow targets on annual inflow conditions. Also in severe drought years such as 1977 and 2002 no special peak releases would be made for endangered fish. Severe droughts, with anticipated shortages to Aspinall Unit water uses, will also be addressed through shortage sharing. Operational changes could include temporary modifications to normal operations of the reservoir and potential short-term modifications in the target flows in the selected alternatives. In periods of extreme, multi-year droughts, releases from the Aspinall Unit may have to be reduced to match the inflow to the reservoir during part of the year.

Fish peak alternatives (B, C and D) would include certain specific drought rules:

- In Wet, Moderately Wet, and Average Wet years, following a Dry year and the previous December 31 Blue Mesa Reservoir content was less than 522,000 af and if March 31 content is less than 400,000 af, half-bankfull targets are reduced to the next lower category.
- During Dry and Moderately Dry years, if Blue Mesa Reservoir content drops below 600,000 af, Whitewater base flow target is reduced from 1,050 cfs to 900 cfs until Blue Mesa Reservoir content exceeds 600,000 af.
- If a Moderately Dry year follows a Dry or Moderately Dry year, decrease peak target to 5,000 cfs if Blue Mesa Reservoir content is less than 400,000 af on March 31 or April 30.

Operations may be modified due to special maintenance or replacement needs at the Aspinall Unit which may limit outlet capacities or require special downstream flows for repairs and inspections. Special flows may also be needed at some time in the future for repairs or replacement of the Gunnison Tunnel Diversion Dam, located a short distance downstream from Crystal Dam.

Emergencies are not predictable but may be associated with dam safety, personal safety of individuals or groups associated with recreation or other activities on the river, power system conditions, or oil/chemical spills. Emergencies associated with dam safety could include unforeseen high or low releases or operations to protect dam structures. Emergencies concerning the safety of individuals may be associated with river rescue or recovery operations. Power emergencies could include insufficient short-term generation capacity, transmission maintenance, and other factors. Emergency operations are typically of short durations as a result of emergencies occurring at the dam or within the transmission network. In the case of emergencies, Reclamation will immediately address the problem and then contact the Service, Council of Environmental Quality, EPA, state agencies and interested organizations as appropriate and as determined by regulation or policy in as timely manner as practical for advice on measures to minimize the effects; and formal consultation, if needed, will be conducted in accordance with Section 7 emergency consultation procedures.

2.3.6.4 Coordination of Operations

Reclamation will continue to conduct Aspinall Unit operations meetings three times per year. The purpose of operation meetings-- held in January, April, and August-- is to share information between Reclamation and Aspinall stakeholders regarding issues in the Gunnison Basin related to the operation of the Aspinall Unit. The meetings are used to coordinate activities among agencies, water users, and other interested parties concerning the Gunnison River. Reclamation considers the information exchange at these meetings in preparing operation plans for the Aspinall Unit. The projected operation of the Aspinall Unit is used by Reclamation in the development of the overall 24-month Study, a comprehensive planning model for the operation of Reclamation projects in the Upper and Lower Colorado River Basins, and includes operating plans for Glen Canyon, Flaming Gorge, and Navajo Units, as well as the Aspinall Unit. Operation of the Aspinall Unit considers projected hydrologic factors, authorized Aspinall Unit purposes, existing water rights, target elevations for reservoirs, implementing the preferred alternative for endangered fish, and other factors.

Reclamation will communicate with appropriate agencies/organization prior to scheduled operation meetings, or as needed, to gather information useful in developing proposed operation plans to be present at the meetings.

2.3.6.5 Climate Change

In determining what future effects are reasonably certain to occur, Reclamation must determine the difference between future effects that are speculative, and effects that are likely to occur under the No Action Alternative as compared to the proposed actions. The hydrologic and water quality models included variability designed to reflect conditions likely to occur in the future based on the period of record. However, future climatic conditions could be warmer, wetter, cooler, or drier than the modeled conditions.

There is some general consensus among the scientific community that the West will experience warmer temperatures, longer growing seasons, earlier runoff of snowmelt, and more precipitation occurring as rain rather than snow. Specific predictions for the Gunnison Basin are highly speculative; however, predictions for the overall Colorado River Basin natural flows have ranged between reductions of 6 to 45 percent over the next 50 years (Reclamation 2007). Recent reports (Ray et al 2008) suggest continued warming in Colorado with less clear trends in annual precipitation, although in general lower and earlier runoff is predicted.

In the long-term, the timing and quantity of runoff into the Aspinall Unit may be affected and may affect expected results from implementation of the preferred alternative either in a positive or negative manner. It is possible that the frequency of dry and moderately dry type years will increase, thus reducing the ability of the rivers to move sediment and maintain or improve habitat conditions. Conversely the magnitude of runoff events could become more variable and extreme and still provide conditions for sediment movement.

The hydrology modeling for this EIS does not project future inflows, but rather relies on the historic record to analyze a range of inflows. As discussed elsewhere in this EIS, the inflow to the Aspinall Unit has historically been highly variable and operations under the action alternatives are planned to address this variability. The study period used in this analysis includes drought periods and both extremely dry and extremely wet years. Because the action being considered does not involve new construction of storage facilities or outlet features, sizing of facilities in relation to future climate is not a consideration. In addition the alternatives are not viewed as having any effect on climate.

The action alternatives also include an adaptive management process, supported by Recovery Program monitoring, to address new information about the subject endangered fish, their habitat, reservoir operations, and river flows. Reclamation will also continue to support multi-faceted research on climate change (Reclamation 2007). If climate results in effects to the listed species or critical habitats that were not considered in this EIS, then Reclamation would reconsult with the Service.

2.3.6.6 Other

The following elements would be included in all alternatives:

- The Corps of Engineers flood control manual requires that efforts are made to keep flows below 15,000 cfs in the Gunnison River above the confluence with the Uncompahgre River. Existing spring flood control operations would be continued using discretion and coordinating with the City and County of Delta in an effort to maintain flows below levels which may cause damage.

- Blue Mesa Reservoir's winter icing elevation target, 7490 feet at end of December (established through various studies, reports, and correspondence), would be met to reduce chances of ice jams causing upstream flooding in the Gunnison area, for example in the Dos Rios subdivision area.

- Peaking power operations conducted at Morrow Point and Blue Mesa powerplants would continue with flows downstream from Crystal Dam regulated through uniform releases to offset impacts of peaking operations upstream. Blue Mesa Reservoir power releases would range from 0 to 3,400 cfs and Morrow Point Reservoir power releases from 0 to 5,000 cfs. During Crystal Reservoir spills, Morrow Point Reservoir peaking releases would be reduced to avoid large daily fluctuations downstream from Crystal Dam.

- Reclamation's historic operations would continue to meet a minimum flow of 300 cfs downstream from the Gunnison Tunnel except in certain cases of significant drought (significant drought determined from reservoir elevations, projected needs, forecasted inflow, and coordination with the State of Colorado) and during Aspinall Unit emergencies when flows may be reduced to 200 cfs as measured at the USGS Gage below the Gunnison Tunnel Diversion Dam. Except in cases of emergency operations, such a decision would be made only after coordinating with the State of Colorado and other interested parties.

- Morrow Point and Crystal reservoirs' daily fluctuations would be limited by landslide criteria.

- Alternatives would honor existing contracts and agreements; would include provisions for operations during emergencies, maintenance activities, and extraordinary maintenance; and would include provisions for operations in extreme conditions of drought and flooding.

- Existing water and power contracts from the Aspinall Unit would be included (note that CRSP power contracts are not "unit specific" but apply to integrated project facilities). Water contracts have flexibility under water shortage conditions. Reclamation would continue to assist Western in meeting contract needs while following relevant laws and regulations.

- Alternatives would continue to meet power system requirements of the North American Electrical Reliability Council and the Western Electricity Coordinating Council such as generation control, voltage regulation, black start capability, and reserves. For example, Aspinall Unit operations--such as Morrow Point Powerplant peaking--can be used in emergency situations to prevent major power problems in the West.

- Consistent with authorized purposes, the Aspinall Unit would be operated subject to water laws and water rights as decreed under Colorado water law and the Law of the River.

- Reasonably foreseeable future depletions would be included (i.e. modeled as being depleted at the point of use).

- Existing depletions in the Gunnison River basin from the exercise of private and public water rights under Colorado law (including evaporation, diversions, transpiration, etc) would continue. Future depletions of 3,500 af during the study period, in addition to depletions discussed below, are also projected.

- The estimated portion of the 60,000 af subordination (Aspinall rights subordinated to water uses in the Gunnison Basin upstream from Crystal Dam) being used at this time [8,600 af +/- in place now]. Reasonably foreseeable future uses of the subordination during the study period would be included for a total of 30,800 af. Alternatives would recognize that up to a total of 60,000 af may be used in the future under the subordination agreement and its use would not be precluded by alternatives. In the alternatives, the unused portion of the 60,000 af would continue to be stored or go downstream on an interim basis, until such waters are developed and utilized for beneficial consumptive use purposes pursuant to the subordination agreement.

- For purposes of analysis, it is assumed that projected water uses with completed ESA and NEPA compliance would occur. This would include full Dallas Creek and Dolores Project depletions.

- Alternatives also recognize that one of the purposes of the Aspinall Unit is "…storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compacts, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Compact, respectively…". This use is compatible with the Recovery Program which has a goal of fish recovery and water development.

  Under all Alternatives "Remaining project yield" (not precisely known, but approximately 300,000 af, minus subordination water use and existing water contracts) will continue to be stored or go downstream on an interim basis and be modeled as such. It will be recognized that this remaining water may very well be developed in the future, upstream or downstream from the Unit, pursuant to the Colorado River and Upper Colorado River Basin Compacts, and subject to and consistent with the Unit's authorized purposes and other applicable laws.

The State of Colorado has identified significant needs through the SWSI process and has significant consumptive use depletions remaining for use under the Colorado River Compact of 1922 and the Upper Colorado River Basin Compact and a portion of this would legally be available for development using sources in the Gunnison Basin. [1] Under all Alternatives, the unused portion of the Unit yield would not be relied on as part of any permanent solution that seeks to provide releases for flow recommendations or any subsequent modifications to them.

The potential use of remaining Unit yield is not modeled because specific foreseeable proposals are not available. Alternatives would recognize that consumptive use up to a total of 300,000 af of project yield may be used in the future under Colorado's compact entitlements and its use would not be precluded by any of the alternatives. When future water sales or uses of portions of the "remaining project yield" from the Unit are proposed, the proposals will be evaluated under NEPA.

If Reclamation determines the proposed sale or use may adversely affect a listed species, formal ESA consultation will commence. If the Recovery Program has made sufficient progress implementing the Recovery Action Plan, then implementation of the Recovery Program may serve as reasonable and prudent measures or reasonable and prudent alternatives, as appropriate. The Section 7 Consultation, Sufficient Progress, and Historic Projects Agreement for the Upper Colorado River Basin Recovery Implementation Program, as revised in 2000, provides information on ESA compliance for future projects, such as use of Aspinall Unit yield.

- Alternatives would include Taylor Park 1975 and 1991 agreements and Taylor Park refill right in place. Aspinall Unit would be operated to protect Uncompahgre Project water stored in Blue Mesa Reservoir under the Taylor Park Exchange Agreement. The Uncompahgre Project's Gunnison Tunnel and Dallas Creek Project's Ridgway Reservoir exchange would continue in place.

2.4 Alternative Development and Alternatives Considered but Rejected

2.4.1 Preliminary Alternatives

A preliminary range of alternative concepts was developed prior to selecting alternatives to review in detail. Preliminary alternatives included No Action and three types of action alternatives:

[1] It is recognized that future uses can occur downstream of the Unit and therefore releases could serve dual purposes of fish recovery and consumptive beneficial uses.

No Action Alternative

- No Action Alternative (Operations projected into future without specific plans to assist in meeting Flow Recommendations).

  Goals include filling Blue Mesa Reservoir, honoring downstream senior water rights, and avoiding releases that bypass powerplants. Water in excess of these needs is released as a moderate spring peak for general environmental benefits.

Action Alternatives

Three general types of action alternatives (listed below) were initially considered. When compared to the No Action Alternative, the action alternatives were intended to mimic a more natural hydrograph with higher spring releases compensated by lower releases later in the year.

- Risk of Spill Alternatives

  Goals include filling Blue Mesa Reservoir and avoiding, to the extent possible, releases that bypass powerplants. Water in excess of these needs (termed risk of spill water) would be managed to provide a spring peak using various combinations of bypasses and powerplants. Base flows could also be provided.

- Meeting Downstream Targets

  Goals include filling Blue Mesa Reservoir; however water could be managed in late winter to increase the elevation of Blue Mesa Reservoir and the volume of a spring peak.

  Targets could include spring peaks, duration, and/or base flows recommended for downstream endangered fish.

  Storage water could be used to increase the volume available for meeting downstream targets.

- Dedicating set amount of storage for downstream endangered fish. A set amount of storage would be set aside in Blue Mesa Reservoir for spring peak flows and possibly base flows for endangered fish.

During the scoping process and the initial alternatives formulation and evaluation process, some potential ideas were considered to have serious flaws either in meeting the project purpose and need or in technical/physical constraints. Accordingly, they were eliminated from further consideration and were not carried over for full evaluation.

Concepts initially eliminated included decommissioning the Aspinall Unit or portions of it because this alternative would not meet the CRSP purposes. Structural changes in the Aspinall Unit, such as additional powerplants, bypass or spillway capacity, or additional storage were likewise not considered because they were not considered practical and were outside the scope of this EIS which considers only operational changes. Dedicating a set amount of storage for downstream fish was also eliminated for several reasons. The highly variable inflow to Blue Mesa Reservoir made this concept impractical in extreme wet or dry water years, and it was found that goals of this concept could be met by alternatives designed to meet downstream targets.

2.4.2 Initial Alternatives

The preliminary alternatives were refined based on modeling and further consideration of operational capabilities (see Table 1.2 1) of the Aspinall Unit. In addition a "base run" was developed to represent operations prior (pre-1991) to Reclamation's program of managing excess water as a moderate spring peak for general environmental benefits. The initial alternatives were:

- Initial Alternative 1: No Action Alternative
- Initial Alternative 2: Base run
- Initial Alternative 3: Risk of Spill Alternative
- Initial Alternative 4: Risk of Spill with base flows Alternative
- Initial Alternative 5: Peak Release Alternative
- Initial Alternative 6: Peak Release with base flows
- Initial Alternative 7: Peak Releases with duration flows
- Initial Alternative 8: Peak Release with base flows and duration flows

2.4.2.1 Initial Alternatives Descriptions

No Action Alternative-1

The **No Action Alternative** represents a projection of current operating practices to the most reasonable future conditions that would occur without any action alternatives being implemented and is described in Section 2.3.1.

Base Run-2

For informational purposes a **base conditions** model run was developed. This run represents operational conditions before efforts were made to "bundle" surplus spill or bypass water into spring peaks for general environmental purposes and before any water was provided to the Redlands Fish Ladder. Filling Blue Mesa Reservoir at end of runoff season would be a goal.

Spills and bypasses would still occur under this alternative; however, there would be no effort to manage this water for specific peak conditions. To the extent possible, water projected to be spilled or bypassed would be released through the Crystal Dam bypass. Essentially, the Aspinall Unit would be operated to maximize water storage and hydropower production, and minimize flow variations in the Gunnison River below Crystal Dam.

Initial Action Alternatives

When compared to the No Action Alternative, the action alternatives are intended to better mimic a natural hydrograph at the Whitewater gage with higher spring releases and moderate base flows. Based on the Flow Recommendations and Aspinall Unit purposes, six action alternatives were initially developed.

> ***Initial Risk of Spill Alternative-3***—This alternative uses Blue Mesa Reservoir's May 1 elevation and May-July inflow forecast to decide whether to provide a spring peak. The goal of the January – May operations would be to limit the probability of releases that would bypass Crystal Powerplant by means of late winter/early spring increased releases. Filling Blue Mesa Reservoir at the end of runoff season would be a priority. The volume available for a spring peak would be determined by a formula:
>
> > Forecasted Blue Mesa Reservoir inflow May thru July minus (May-July downstream releases of 2,100 cfs, volume needed to fill Blue Mesa Reservoir, volume needed to fill Taylor Park and other upstream demands) equals volume available for spring peak.
>
> If there is water available for a peak, the volume would be shaped into a spring peak. If the volume available for a peak is between 1 and 75,000 af, the release would use full powerplant and bypass at Crystal Dam (4,150 cfs) and if it were above 75,000 af the release would use full powerplant and bypass at Morrow Point Dam (6,500 cfs).
>
> The peak would be designed to match the North Fork peak to the extent possible and would occur in the May 15-June 15 timeframe. Releases of 10,000 cfs would be attempted from Morrow Point Reservoir once it is spilling and the North Fork tributary flow is less than 3,000 cfs. Ramping rates would be 25 percent on the ascending and descending limbs of the hydrograph.
>
> Provision of 100 cfs for the Redlands Fish Ladder in the April – September period would be made.
>
> **Initial Risk of Spill Alternative with Base Flow Protection-4—**This alternative would be similar to Alternative 3; however, storage water in Blue Mesa Reservoir would be used, when needed, to maintain recommended endangered fish base flows of 1,050 cfs in the lower Gunnison River during summer months.
>
> **Initial Peak Alternative-5—**This alternative gives operation priority to create a one day peak at the Whitewater gage on the Lower Gunnison. Operations would be designed to attempt to reach a specific one-day peak at the Whitewater gage by bypassing inflow. Storage water would not be directly used for the peak;

however, bypassing inflow would reduce the amount of spring runoff stored in Blue Mesa Reservoir. The desired peak would be based on the type of water year as follows:

Wet, Moderately wet, and average wet years	---14,350 cfs goal
Moderately dry and average dry years	--- 8,070 cfs goal
Dry years	--- no peak goal

After the peak was reached for one day, Aspinall Unit releases would begin to be ramped down.

To assist in reaching the peak, the March 31 Blue Mesa Reservoir target would be increased by avoiding powerplant bypasses in the April-May period. Also, under this alternative, 100 cfs would be released for Redlands Fish Ladder in the April-September time period. Ramping rate would be increased to 30 percent on the ascending limb and maintained at 25 percent on the descending limb.

Initial Peak with Base Flows Alternative-6—This alternative is similar to Alternative 5; however, meeting base flow targets in the lower Gunnison River is included. Base flows are normally 1,050 cfs but may be higher or lower in wet and dry year categories.

Initial Peak with Duration Flows Alternative-7—This alternative emphasizes a spring peak and also maintains greater duration of high flows at the Whitewater gage. Operations would be designed to attempt to reach a specific peak at Whitewater as in Alternative 5 using bypassed inflow; however, the peak would be maintained over a multi-day period. The desired peak would be based on the type of water year as in Alternative 5, and desired peaks could range from 900 cfs in dry years to over 14,350 cfs in wet years. To assist in reaching the peak, the March 31 Blue Mesa Reservoir target would be increased. Ramping rate increased to 30 percent on the ascending limb and maintained at 25 percent on the descending limb.

Initial Peak with Base Flows and Duration Flows Alternative-8—This alternative emphasizes a spring peak and also maintains greater duration of high flows and base flows at the Whitewater gage and is basically a combination of Alternatives 6 and 7.

Summary—Alternatives 1 through 8 were modeled at an appraisal level and some of the key results are shown in Table 2.4 1.

Table 2.4 1— Initial Action Alternatives Comparison During 31-Year Study Period.

	Alt. 1	Run 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Years flows >14,000 cfs (Whitewater)	5	5	6	6	8	8	8	8
Avg. annual days flows >14,000 cfs (Whitewater)	2.8	3.1	3.1	3.3	3.6	3.6	3.5	3.5
Years flows >8,000 cfs (Whitewater)	16	15	17	17	19	19	21	21
Avg. annual days flows >8,000 cfs (Whitewater)	16	15.7	16.5	16.3	16.7	16.6	19.5	19.5
Years flows > 15,000 cfs at Delta	5	5	4	4	4	4	4	5
Maximum number of days in a year flows >15,000 cfs at Delta	5	5	7	7	5	5	5	5
Blue Mesa Reservoir storage, avg maximum content (1,000 af)	743	751	745	738	734	727	690	671
Avg annual days flows <400 cfs Black Canyon (May-Sept)		31.5	31.5	25.6	36	25.9	42.2	28.8
Years flows >5,000 cfs Black Canyon	8	7	10	9	16	17	17	18

2.5 Hydrology Considerations

Determining viable alternatives for operating the Aspinall Unit required modeling complex relationships, including fluctuating tributary inflow and flow depletions associated with multiple diversions. A requirement of the modeling was the ability to assess water resources system responses over the long term.

2.5.1 Hydrology Model

Riverware was the simulation software selected by Reclamation for use in the development of a hydrology model to be used to evaluate alternatives. The model was originally developed by Reclamation in support of assessing the effects of the Black Canyon NP water right on the Aspinall Unit. It has been significantly improved and serves as a tool to analyze effects of the proposed alternatives. This model was developed solely for this purpose and Reclamation does not expect the model to be used as an operations model.

For this DEIS, three basic model configurations were developed to simulate future conditions: the No Action Alternative; Risk of Spill Alternative; and the Peak Release Alternative. The Risk of Spill and Peak Release Alternatives were modified to include base flows and or duration flows to evaluate their ability to better meet the Flow Recommendations.

The Aspinall Unit hydrologic model was configured to simulate hydrologic conditions by including all current depletions and all depletions that could occur without further Federal action (primarily exercise of some, but not all, State water rights not presently being used in Colorado). To simulate reservoir releases under the No Action Alternative, the model uses operation rules representing how the dams would have been operated using a single-trace data-set generated from the historic hydrology which occurred between 1975 and 2005. The No Action Alternative depletions total about 450,000-500,000 af per year from the Gunnison River at the Whitewater Gage. Also included are all depletions which are considered reasonably foreseeable. Such depletions include 17,200 af per year for the Dallas Creek Project (assumes total build-out of the project), 131,000 af per year for the Dolores Project, 30,800 af per year for the Upper Gunnison area, and 3,500 af per year for other depletions.

The following is a general description of how the model works:

Weekly Determination—Forecasted inflows, estimated demands and target contents are used to determine preliminary operational releases. On the 1st, 8th, 15th, and 22nd of each month the model makes an estimate of operational volume to release between the current date and the end of forecast period. The operational volume can be defined as the water in excess of estimated demands (filling Blue Mesa Reservoir and identified releases).

The operational release volume is changed to a flow rate based on the remaining days in the forecast period. This operational release rate remains constant until the next estimate is made. The model may modify the operational release under the following circumstances:

- Factors are applied in January, April, October, and November to increase power in January and reduce flows during trout spawn periods.
- Operational releases June 15 to July 31 may be increased at the expense of Blue Mesa Reservoir storage if it is anticipated that higher operational releases will be needed from August through December to reach the December 31 elevation target.
- Operational releases in August through October, which would result in bypass of Crystal Powerplant, are reduced if it is determined this water could be run through the powerplant in November and December.

Daily Determination—Aspinall target release is then set equal to Gunnison Tunnel plus Operational Release plus minimum Black Canyon Flow (300 cfs, or minimum trout target hydrograph) and adjusted if necessary.

Aspinall target release may be modified under the following conditions:

- Bypasses of inflow (Blue Mesa Reservoir is not allowed to store when it is anticipated that storing water would result in less than 750 cfs at the Redlands Diversion Dam).
- Release may be increased if current operations anticipate Blue Mesa Reservoir content to exceed 820,000 af within 7 days.
- Release may increase if current rate of fill indicates Blue Mesa Reservoir will reach elevation of 7,518 ft or greater within 20 days.
- Release will increase if Blue Mesa Reservoir has encroached on required flood control storage according to Flood Control Diagram. Normal ramping rates may be exceeded in these instances.
- Decrease release based on Gunnison River at Delta flows exceeding 14,000 cfs.

- January through March: Crystal Reservoir releases are limited to the amount which can be utilized in the powerplant.

2.6 Preferred Alternative and Environmentally Preferred Alternative

Alternative B is the preferred alternative and environmentally preferred Alternative because it avoids jeopardy to downstream endangered fish while still meeting Aspinall Unit authorized purposes. It also protects multiple resources, such as agriculture, recreation, and sport fisheries, which the public has cited as important concerns.

2.7 Summary Table

Table 2.7 1 compares No Action and action alternatives selected for detailed analysis in this DEIS. Details are found in Chapter 3.

Table 2.7 1—Summary Comparison of No Action and Action Alternatives Selected for Analysis.

Resource	No Action	Alt A Risk of Spill	Alt B Fish Peak w/Duration	Alt C Fish Peak w/Increased Duration	Alt D Fish Peak w/Revised Target
Qualitative Summary (range from +5 to -5)					
Blue Mesa Reservoir Content	Neutral	-1	-1	-2	-1
Hydropower	Neutral	-1	-1	-2	-1
Black Canyon NP	Neutral	+1	+2	+3	+2
Flood Control	Neutral	-2	-1	-1	-1
Endangered Species	Neutral	+1	+3	+3	+2
Recreation	Neutral	-1	-2	-3	-2
Water Users	Neutral	+1	+1	+1	+1
Quantitative Summary					
Blue Mesa Reservoir Avg. End of August Content (1,000 af)	668.9	657.2	635.9	558.6	645.2
Curecanti NRA Visits/Year (Mean for Study period)	948,038	-12,908	-68,700	-184,200	-44,800
Avg. Storage usage over No Action--Jan-Mar (af)	NA	1,543	1,378	948	1,399
Avg. Storage usage over No Action--Apr-Max fill date (af)	NA	3,252	19,130	39,074	8,889
Avg. Storage usage over No Action--Max fill date-Dec 31 (af)	NA	4,033	3,220	4,301	3,372

Resource	No Action	Alt A Risk of Spill	Alt B Fish Peak w/Duration	Alt C Fish Peak w/Increased Duration	Alt D Fish Peak w/Revised Target
Quantitative Summary (continued)					
Hydropower Avg. Annual Volume through Plants (1,000 af)	2,862.1	2,847.9	2,807.9	2,699.1	2,818.7
Hydropower Avg. Annual Economic Value (change)	NA	-0.03%	-1.48%	-4.88%	-1.15 %
Avg. Annual Spillway Usage (days)					
Blue Mesa Dam	1.7	1.8	2.2	4.3	2.0
Morrow Point Dam	1.9	2.1	2.5	4.4	2.4
Crystal Dam	9.0	13.0	16.1	23.2	15.5
Black Canyon Percent of Years Peaks Exceed					
>10,000 cfs	12.9	12.9	9.6	9.6	6.4
> 8,000 cfs	12.9	12.9	16.1	16.1	12.9
> 5,000 cfs	25.8	41.9	54.8	48.4	45.2
Black Canyon Avg. Aug-Oct Flows (cfs)	794	801	753	708	771
Black Canyon Avg. Annual Days at 300 cfs (May-Oct)	23.1	23.6	28.7	33.9	26.7
Delta-Number of Days Flows >12,000 cfs for Study period	79	103	104	126	104
Delta-Number of Days Flows >15,000 cfs for Study period	11	18	12	12	12
Critical Habitat Avg. Annual Days					
> 5,000 cfs	35.2	34.1	36.3	41.3	34.6
> 7,000 cfs	21.6	20.6	24.2	29.5	23.7
> 8,070 cfs	16.0	16.2	17.2	18.7	17.4
>10,000 cfs	8.6	9.4	10.9	12.0	10.9
>12,000 cfs	5.6	6.2	7.1	8.2	7.3
>14,350	2.8	3.3	3.0	3.1	3.0
Downstream from Redlands Diversion Dam Avg. Days Apr-Sept					
<300 cfs	28.5	28.3	32.2	35.5	30.2
<100 cfs	3.7	4.0	4.4	5.1	4.1
Blue Mesa Reservoir Fishery Average % Change in End of Summer Surface Area	NA	-1.1%	-2.6%	-9.3%	-1.9%

Resource	No Action	Alt A Risk of Spill	Alt B Fish Peak w/Duration	Alt C Fish Peak w/Increased Duration	Alt D Fish Peak w/Revised Target
Quantitative Summary (continued)					
Curecanti NRA Blue Mesa Reservoir Avg. Annual End of Aug Surface Area (acres)	8,225	8,137	8,011	7,457	8,069
Gunnison Gorge NCA Avg. Annual Day Rafting/Fishing Flows in Desirable 700-1,000 cfs Range May-Sept	20.9	22.7	22.6	22.9	21.8
Gunnison Gorge NCA Annual Days in Summer Recreation Season (May-Sept) < 400 cfs >3,000 cfs	21.3 17.2	22.9 16.0	24.8 19.8	30.5 27.2	23.8 19.1
Gunnison Gorge NCA Trout Fishery (% of Years Adequate Recruitment Conditions)	87+%	87+%	95+%	87+%	95+%
Austin Trout Fishery (% Increase in Low Flow Conditions)	NA	8%	16%	43%	17%
Indian Trust Assets	No Change	No Change	No Change	No Change	No Change
Environmental Justice	No Change	No Change	No Change	No Change	No Change
Cultural Resources Max. Reservoir Basin Dewatered (acres)	4,532	4,535	4,533	5,722	4,535
Water Users Avg. Number of Days/Yr Potential RWPC Call for Study period	20	11	12	14	11

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

This chapter presents a description of the affected environment and how it may be impacted under the No Action and action alternatives. This chapter is organized by resource topic. Under each resource is a summary overview; the overview is followed by a discussion of the affected environment and the impact analysis. As described in Chapter 2, the No Action Alternative does not necessarily represent existing conditions, but represents a continuation of conditions from 1992-2005 into the future.

The impact analyses present long term effects on resources. The resources described first are those potentially affected by or central to changes in the operation of the Aspinall Unit—hydrology, endangered species, water rights, hydropower, trout and native fisheries, flood control, recreation, socioeconomics, and others. Those resources determined to be minimally affected or not affected are described at the end of this chapter.

Potential measures to mitigate adverse impacts of changing Aspinall Unit operations on fish and wildlife and other resources with statutory requirements to consider mitigation are presented and described in Chapter 4.

3.2 Setting

For purposes of the impact analysis, the study area includes Taylor Park Reservoir, the Taylor River and its floodplain, the Gunnison River and its floodplain from its origin at the confluence of the East and Taylor Rivers at Almont downstream to the Gunnison River's confluence with the Colorado River, and the Colorado River and its floodplain from the Gunnison River confluence downstream to below the Dolores River confluence. This includes Blue Mesa, Morrow Point, and Crystal reservoirs. Under some resource topics—for example, economics and social factors—the study area includes a larger geographic area in order to reflect the scope of impacts to those resources.

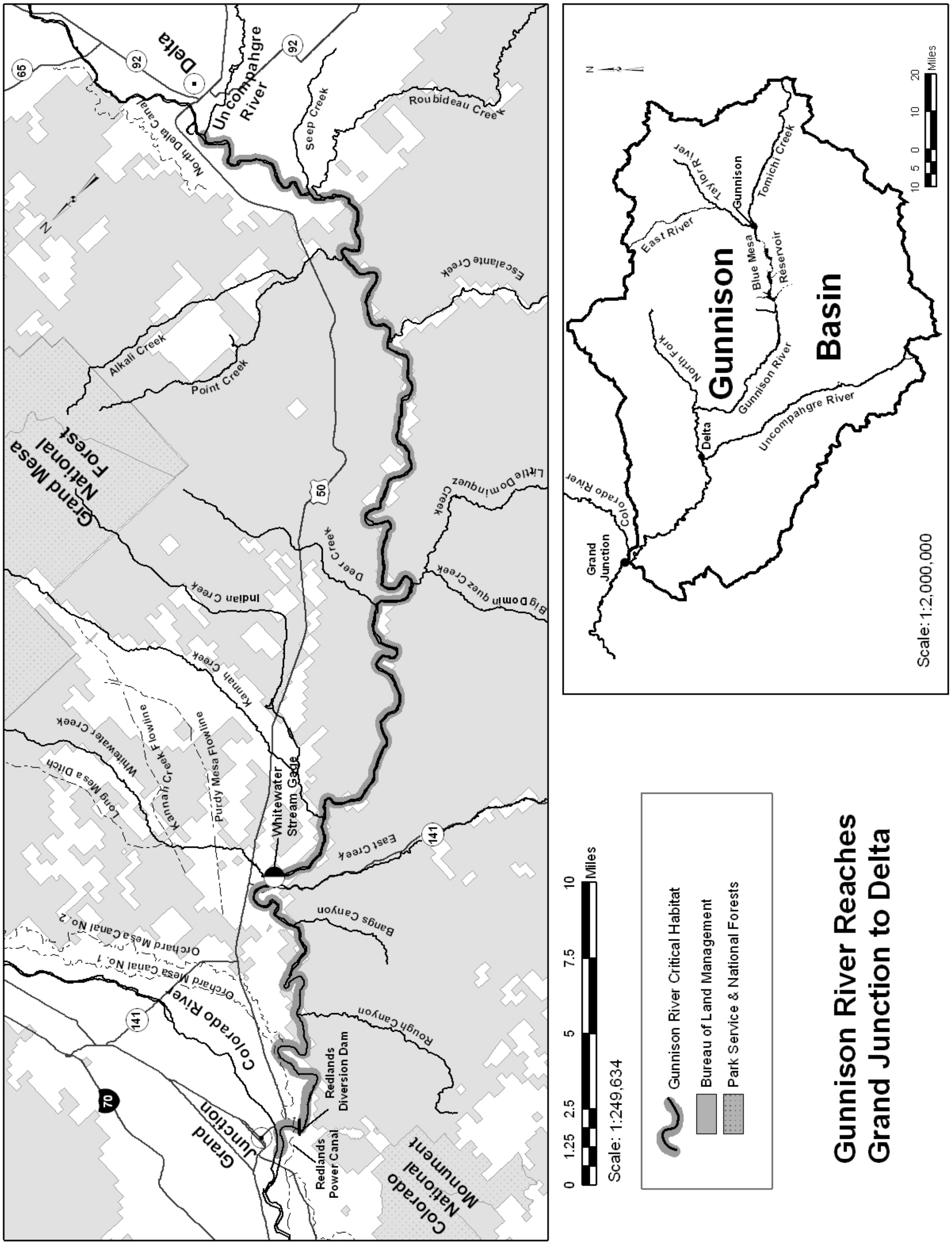

Figure 3.2-1—Gunnison River Reaches, Grand Junction to Delta.

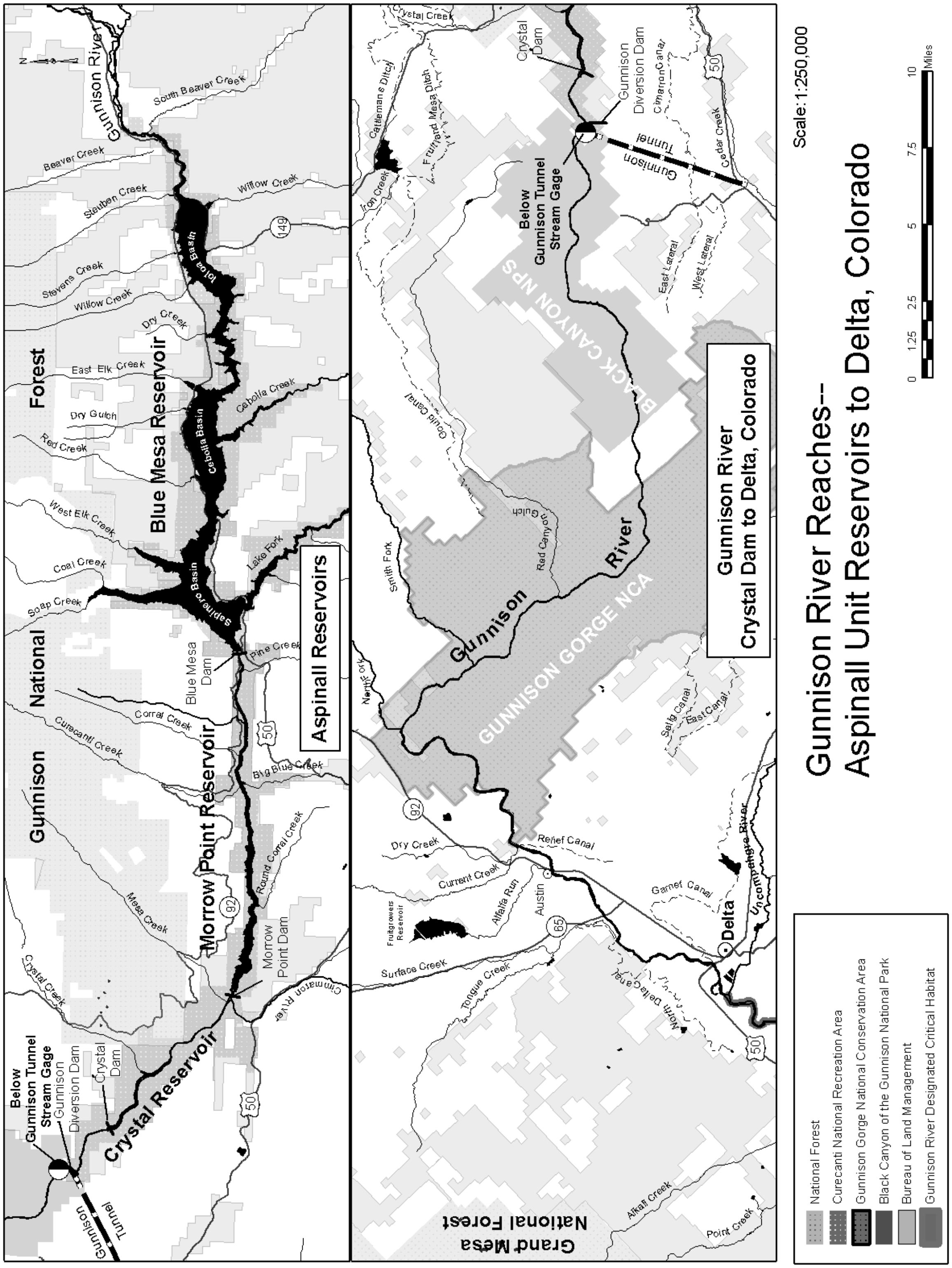

Figure 3.2- 2—Gunnison River Reaches, Aspinall Unit to Delta.

The Gunnison River Basin encompasses approximately 8,000 square miles with headwaters in the Elk, Sawatch, and San Juan Mountains. The study area includes about 20 miles of the Taylor River, 169 miles of the Gunnison River and 75 miles of the Colorado River from the Gunnison River to the Dolores River confluence.

The upper portion of the Gunnison River Basin is characterized by mountainous landscape with perennial mountain streams that peak during spring snow melt. The basin area is moderately wet to semi-arid; the major part of this area being greater than 6,000 feet in elevation. Major tributaries include the East and Taylor Rivers, Tomichi Creek, the Lake Fork, and Cimarron Creek (Figure 3.2-1). Vegetation ranges from mixed conifer and aspen in the mountain areas to sagebrush communities in the valleys. Predominant riparian vegetation consists of narrowleaf cottonwood, box elder, willows, spruce, and other conifers. The town of Gunnison is the major community in the upper basin.

The lower (western) portion of the Gunnison River Basin is characterized by desert landscape with two major tributaries-the North Fork of the Gunnison River and the Uncompahgre River (Figures 3.2-1 and Figure 3.2.2). There are also small perennial tributaries and intermittent washes that carry significant sediment loads during periodic thunderstorms. The area is semiarid to arid; the major part of this area is less than 6,000 feet in elevation and receives less than 8 inches of precipitation annually. Vegetation ranges from pinyon-juniper on mesa tops to desert shrubs and grasses near the lower Gunnison and Colorado rivers. These rivers support riparian vegetation such as cottonwood, willow, and non-native salt cedar and Russian olive. The Black Canyon NP and the Gunnison Gorge NCA have been designated downstream from Crystal Dam. The small town of Austin and the cities of Delta and Grand Junction are located along the lower Gunnison River.

3.3 Resources

The following resources are addressed in Chapter 3:

- Water Uses and Resources
- Hydropower
- Operations and Maintenance
- Agriculture
- Aquatic Resources
- Vegetation and Wildlife Resources
- Special Status Species
- Recreation
- Socioeconomics
- Lands (Including Special Designations)
- Environmental Justice and Indian Trust Assets
- Cultural and Paleontological Resources
- Geology and Soils
- Other Resources

3.3.1 WATER USES AND RESOURCES

This section addresses the potential impacts to water resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered. The Gunnison River model simulates Aspinall Unit Operations for each alternative based on historic hydrology from 1975 to 2005. This period of study was selected because it is the most complete historical dataset available for model analysis. The initial conditions of the Gunnison River model were selected to be the state of the Aspinall Unit and Gunnison River system at the start of January of 1975. Then the Gunnison River model runs a single trace for the 31-year study period between 1975 and 2005. Further explanation can be found in Appendix A.

Issue: How would the No Action and action alternatives affect water resources, including Aspinall Unit Reservoirs, Gunnison River, Colorado River, water rights, water quality, flooding, and future water uses?

Overview

Scope

The scope includes the water resources and their use in the Aspinall Unit and the downstream Gunnison River. Surface hydrology, water quality, and water rights are considered.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by changes in dam releases as a result of the alternatives:

- Substantial changes in reservoir surface area and content.
- Substantial increases in calls by senior water right holders.
- Increases in water quality constituents such as selenium.
- Increased monitoring or regulation of point source discharge permits holders.
- Significant increases in high flows, above 12,000 cfs at Delta, Colorado and 20,000 cfs at Whitewater, Colorado.

Summary of Impacts

Reoperation of the Aspinall Unit for the Flow Recommendations will create differences in the historic release pattern of water from the Aspinall Unit reservoirs. Higher releases during May for spring peaks and higher flows of extended duration will result in lower releases during other months. During dry periods, extended releases for base flow targets may result in lower releases in later months when releases would have been historically higher.

Storage Impacts - On average**,** the No Action Alternative results in the highest end-of-month reservoir content at Blue Mesa over the course of the year while Alternative C results in the lowest reservoir content. In addition, over the 31-year study period, the average annual storage used from Blue Mesa Reservoir beyond the No Action during the period between April 1st and the date of maximum fill of the reservoir is nearly 40,000 af for Alternative C and 20,000 af for Alternative B. The increase in use of storage for Alternatives A and D is not considered significant.

Water Rights Impacts - Alternatives A, B, C, and D attempt to meet the base flow targets identified in the Flow Recommendations. The No Action Alternative does not. In most years, a base flow of 1,050 cfs will be maintained at the Whitewater gage; however, this target is reduced in dry or moderately dry years. By operating to meet the base flow targets, the number of days which senior water right holders, mainly the Redlands Water and Power Company (RWPC), would potentially be calling out junior water rights is actually reduced over the 31-year study period in each of the action alternatives as compared to the No Action. Therefore significant negative impacts on water rights are not expected under the action alternatives.

Water Quality Impacts – Discharge Permits - By operating to attempt to meet the Flow Recommendations, average monthly flows in non-peak and duration months (September – April) will be generally less than the No Action Alternative, but minimum base flows will be higher in order to meet target requirements at Whitewater. One of the criteria the State of Colorado uses in assessing discharge permit requirements is the annual minimum monthly flow average. Lower minimum values might require Point Source Discharge permit holders, such as the wastewater treatment plant at Delta, to monitor effluent and river loading more often to ensure they are not in violation of their permit. The most significant change in annual minimum monthly average during the 31-year study period occurs in 1979 when Alternatives B, C, and D cause this average to drop by 50 percent from over 900 cfs to around 450 cfs. In general, Alternative C has the most effect by decreasing the annual minimum monthly average by over 20 to 50 percent in 7 years of the 31-year study period. These reductions from Alternative C could result in flows low enough to possibly warrant a change in permitting requirements for the Delta Wastewater Treatment Plant.

Water Quality Impacts – Selenium - No change in the total annual selenium loading will occur due to selection and implementation of any alternative. However, lower average monthly flows during non-peak and duration months could increase the likelihood of higher concentrations of selenium and other constituents during these periods. As shown in section 3.3.1.1E, the lower the flow below 4,000 cfs the greater the likelihood of higher concentrations of selenium. Over the 31-year study period, flows under Alternative C result in over 700 more days of flows less than 2,000 cfs and over 200 more days of flows less than 1000 cfs than the No Action Alternative. Alternative B increases the days of flows less than 1,000 cfs by 54 days over the study period, while Alternatives A and D actually decrease the number of days. Alternative C is most likely to adversely affect water quality by increasing concentrations of constituents due to higher instances of lower flows.

Flood Impacts –Over the 31-year study period each alternative results in slightly more years of flow occurrences above 12,000 cfs at Delta than the No Action Alternative. Alternative A results in one additional year of flows greater that 12,000 cfs, while Alternatives B, C, and D result in three each. The number of years with flows above 14,000 cfs is five for the No Action and Alternatives B, C, and D and six for Alternative A. For flows greater than 16,000 cfs, the No Action and Alternatives B and D result in five years of occurrence while Alternatives A and C result in six and four years respectively. Overall, Alternative A increases the number of years of flows above 12,000 cfs, 14,000 cfs, and 16,000 cfs.

According to the USGS the 100 year flood at Whitewater near Grand Junction is rated at about 39,000 cfs. Flooding on this lower reach begins to occur in the 20,000 cfs range. Alternative B and the No Action have about a 12 percent chance of exceedance of 20,000 cfs while the remaining alternatives have about an 8 or 9 percent chance of exceedance. In other words, within the hydrologic circumstances of this period of study, there is an 88 percent chance that flows at Whitewater will be less than 20,000 cfs for the No Action and B Alternatives, while under the remaining alternatives there is a 91 or 92 percent chance that flows at Whitewater will be less than 20,000 cfs. This means Alternative B creates about the same chance of flooding at Whitewater as the No Action while the chance of flooding under the remaining alternatives is slightly less.

3.3.1.1 Affected Environment

3.3.1.1A. General

The Gunnison River originates at the confluence of the East and Taylor Rivers near Almont, Colorado, in Gunnison County (Frontispiece). From that point, the river flows 25 miles to Blue Mesa Reservoir and on through Morrow Point and Crystal reservoirs. From Crystal Reservoir, it flows approximately two miles to the Gunnison Tunnel. From the Gunnison Tunnel, the river flows 29 miles to the confluence with the North Fork of the Gunnison (North Fork). It then travels 75 miles to its confluence with the Colorado River at Grand Junction, Colorado.

The area of the watershed upstream from the Aspinall Unit is approximately 4,000 square miles. At the USGS gage downstream from the Gunnison Tunnel and Crystal Dam, historical average annual flows have been 1,320 cfs and mean daily flow extremes pre-Aspinall Unit ranged from a few days of no flows to 19,000 cfs. Another important measurement point on the river is the Whitewater gage, 14 miles upstream from the Colorado River confluence. At this point the drainage area is roughly 8,000 square miles, average monthly flows are approximately 2,600 cfs, and pre-Aspinall Unit extremes ranged from 106 cfs to over 35,000 cfs.

Development of water resources in the Gunnison Basin began in the late 19^{th} Century, primarily for irrigation. Storage reservoirs were generally small and spring peak flows, while slightly reduced, remained high. The extensive irrigation diversions significantly reduced summer and fall base flows and probably increased summer water temperatures. Construction of storage reservoirs, including the Aspinall Unit, increased significantly in the second-half of the 20th century and greatly reduced spring peak flows while tending to increase base flows from early 20th century levels. Tyus and Saunders (2001) concluded that construction of the Aspinall Unit resulted in extreme alteration of historic flows in the Gunnison River.

The Aspinall Unit has not significantly changed the annual volume of water flowing downstream but has changed the flow pattern. The Aspinall Unit's operation has tended to increase flows from August through April and to reduce flows in May through July. Extreme low flows in the lower Gunnison have largely been eliminated. Prior to operation of the Aspinall Unit, average monthly flows at Whitewater were often below 900 cfs and occasionally below 200 cfs.

There are no significant water imports to or exports from the Gunnison Basin. Annually, approximately 1,600 af are imported and 3,500 af are exported. This excludes consideration of the RWPC diversion (approximately 510,000 af) and the Grand Junction water system (approximately 7,000 af), both located near the mouth of the Gunnison River at Grand Junction.

3.3.1.1B. Aspinall Unit Reservoirs

Most of the annual streamflow in the Gunnison Basin above the confluence with the North Fork is provided by runoff of melting snow from the northern San Juan and southern Elk and West Elk Mountain ranges. Blue Mesa Reservoir is the primary storage reservoir of the Aspinall Unit and it stores water during spring runoff for later release to meet downstream needs. Blue Mesa Reservoir elevations have fluctuated from a minimum elevation of 7427.71 feet above sea level on April 16th, 1984 to a maximum elevation of 7519.64 on July 8, 1970. Reservoir elevation fluctuations are the result of inflow volumes that do not coincide with reservoir release volumes over a particular time period. Typically during the spring and early summer, inflow volumes exceed release volumes, resulting in increased reservoir elevations. The pattern is reversed during the fall and winter when release volumes exceed inflow volumes. Reservoirs are intended to operate this way so water can be stored when inflows are high and then released when water supplies are low and demand is high. Crystal and Morrow Point reservoirs are used primarily for hydropower production and downstream river regulation. Relatively small daily fluctuations on these reservoirs occur due to fluctuations in power demand.

Stored water is water that is captured behind an impoundment, pursuant to Colorado Water Law, for future beneficial use. Blue Mesa Reservoir has a water storage right of 940,755 af with a 1957 priority and has a total physical capacity of 940,700 af. In addition to this storage right, Blue Mesa Reservoir has a refill right. The total capacity of Blue Mesa Reservoir is comprised of "dead" storage, the capacity that cannot be evacuated by gravity; "inactive" storage above the dead storage, from which stored water is not normally available due to operating restrictions or agreements; and "active" storage, the capacity normally usable for storage and regulation of reservoir inflows to meet established operating requirements. The capacity of the reservoir that can be withdrawn by gravity is called “live” storage. This capacity is the total storage minus the dead storage, or for Blue Mesa Reservoir, the active plus the inactive storage combined. Table 3.3 1 below gives the numeric values for the different storage capacities.

Table 3.3 1— Blue Mesa Reservoir Storage Capacities.

Blue Mesa Reservoir Storage Capacities	Af
Dead	111,200
Inactive	81,070
Active	748,430
Live	829,500
Total	940,700

Water flowing into Blue Mesa Reservoir is either stored or “passed through.” The reasons for not storing water include: 1) it cannot be stored under Colorado Water Law and is required to be bypassed for downstream senior water right holders, 2) it is passed through for delivery to the Gunnison Tunnel as a storage release from Taylor Park Dam upstream, 3) Blue Mesa Reservoir is physically full and cannot store anymore, therefore it is passed through, or 4) it is used to generate power by utilizing the direct flow water rights for Blue Mesa, Morrow Point, and Crystal powerplants.

Because storage and hydrologic conditions vary considerably from year to year, the active capacity of 748,430 af in Blue Mesa Reservoir does not always fill and therefore the amount available for downstream release and consumptive uses varies.

Many different terms describing the yield of Blue Mesa Reservoir have been used, including “firm,” “marketable,” “reliable,” and “safe”. “Yield” is defined as the quantity of water that can be collected for a given use from surface or subsurface sources; “Firm yield” is the maximum quantity of water that can be guaranteed with some specified degree of confidence during a specific critical period. The critical period is that period in a sequential record that requires the largest volume from storage to provide a specified yield; “Safe yield” is defined as the annual quantity of water that can be taken from a source of supply over a period of years without depleting the source beyond its ability to be replenished in wet years. For the purposes of this EIS, future reference will use safe yield.

The safe yield from the Aspinall Unit has not been officially determined but is often referred to as “up to 300,000 af”. This includes 60,000 af of water rights which the Aspinall Unit will be subordinated to, according to prior agreement. Therefore, it is often considered there is up to 240,000 af of safe yield available for sale from Blue Mesa Reservoir storage for upstream or downstream development. At the present time, water service contracts totaling less than 1,000 af are in place to use the safe yield of Blue Mesa Reservoir.

As part of the discussion on alternatives in the Aspinall Unit EIS process, the term "use of storage" for downstream endangered fish habitat is used. This use of storage can be broken down into three general categories:

1. Risk of Spill or Water Bundling Alternatives: These alternatives provide spring peaks with water estimated to be in excess of Unit releases downstream and filling Blue Mesa Reservoir; therefore, it appears they do not use storage. However, in actuality the spring peak release is made prior to Blue Mesa Reservoir filling and is, at least partially, a storage release. The key point is it is anticipated that this type of storage release will be replenished later in the runoff and is designed so there is a low probability that the safe yield will be affected.

2. Storage Alternatives: These alternatives provide spring peaks with storage water from the safe yield. For example, if an alternative includes adding some volume of storage to generate a spring peak, the water comes out of the safe yield of Blue Mesa Reservoir.

3. Any combination of the above two.

Figures 3.3.1 and 3.3-2 display Blue Mesa Reservoir content and surface area in wet (1997), dry (1990), and average (1987) years under No Action while Figure 3.3.43 in the cultural resource section displays reservoir elevation during the history of the reservoir.

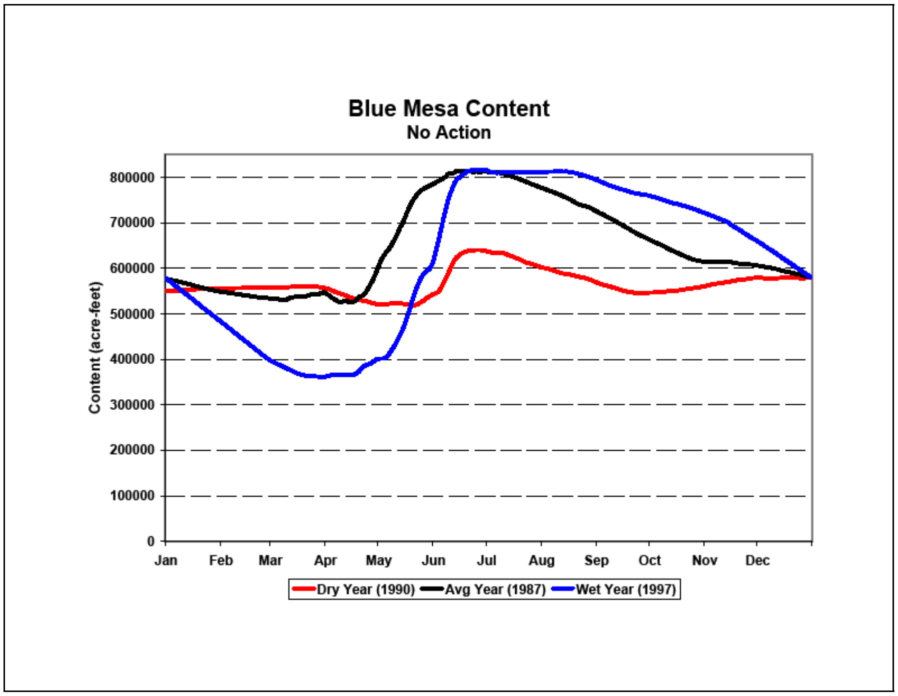

Figure 3.3- 1—Blue Mesa Reservoir Content – Dry, Average, and Wet Years.

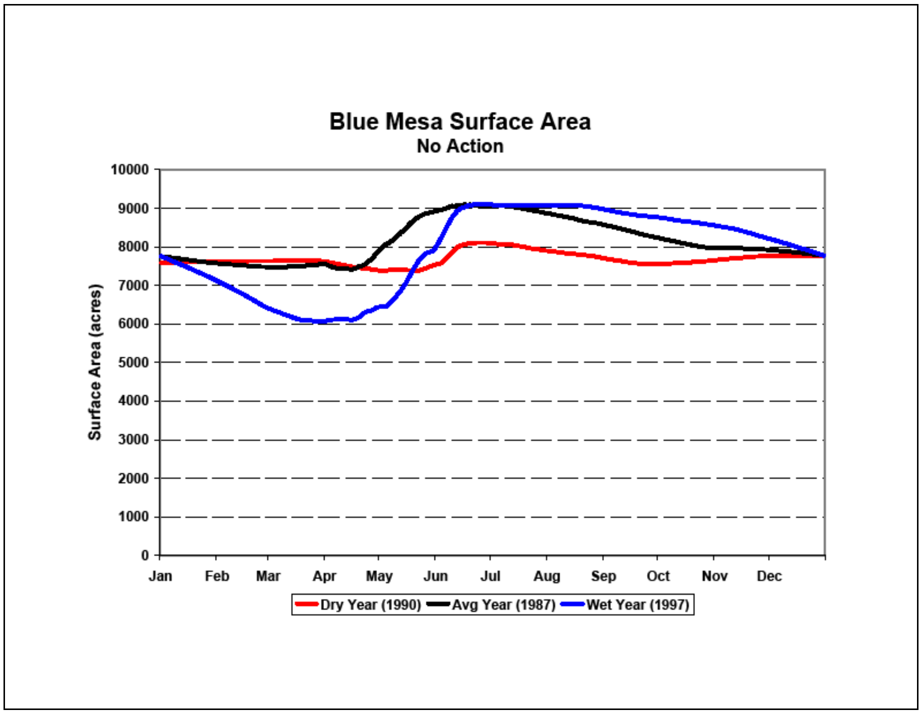

Figure 3.3- 2—Blue Mesa Reservoir Surface Area – Dry, Average, and Wet Year.

3.3.1.1C. Gunnison River

Runoff from the Gunnison Basin upstream of the USGS Gunnison Tunnel Gage comprises approximately ½ of the total river flow. Runoff in the North Fork originates from the north side of the West Elk Mountains, and the south side of the Grand Mesa. Below the town of Delta, runoff from the Uncompahgre Plateau can contribute significant springtime flows. Prior to the construction of the Aspinall Unit, the hydrograph was dominated by spring peak flows from snowmelt runoff and low fall and winter base flows. The pre-Aspinall spring flow typically peaked by early June and receded by mid-July. The pre-Aspinall annual average monthly peak flows in the Black Canyon below the Gunnison Tunnel were typically around 6,300 cfs while base flows were in the 500 cfs range (See Figure 3.3-3). Extremes ranged from periods of no flow to flows over 19,000 cfs.

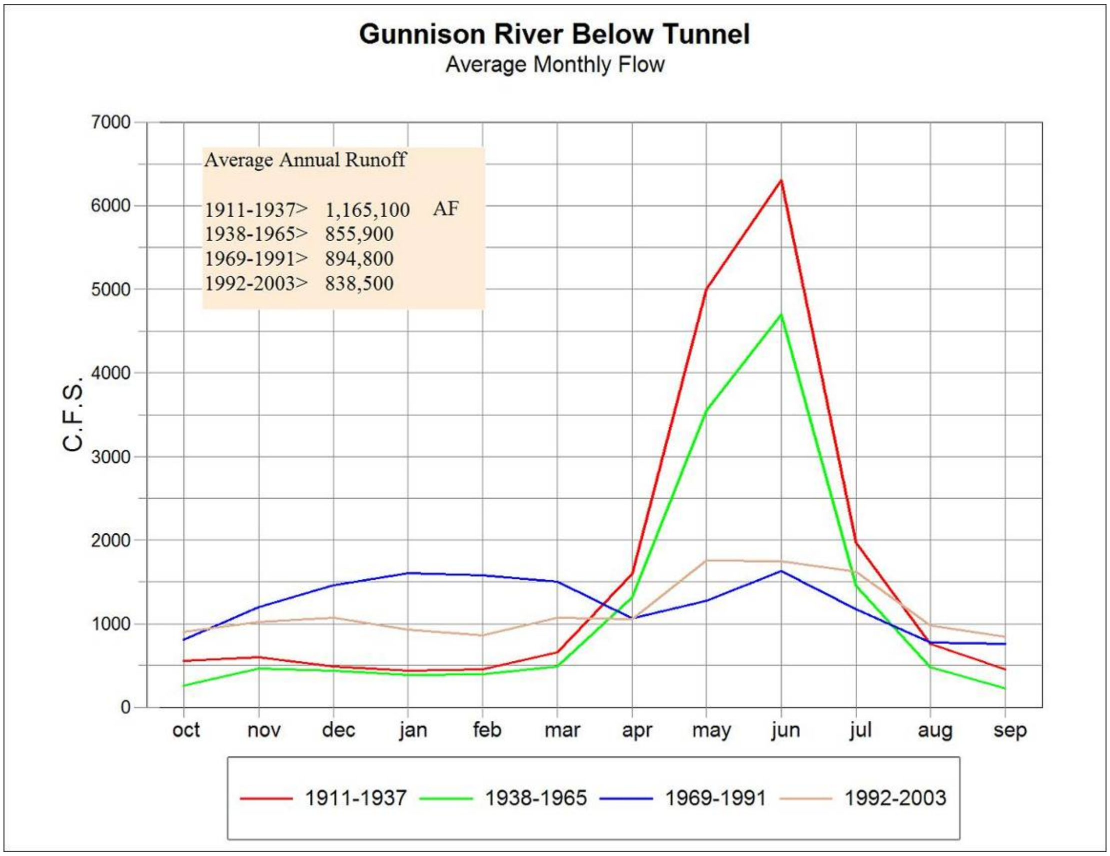

Figure 3.3- 3—Monthly Flow Below Gunnison Tunnel.

Long-term changes in climatic conditions, along with increased diversions for irrigation explain some of the differences in annual runoff below the Gunnison Tunnel. For example, the average annual natural flow of the Gunnison River at the Gunnison Tunnel between 1938 and 1965 was 185,940 af less than the period between 1911 and 1937. Overall, the 1992-2003 period was drier than the other periods. In addition, average Gunnison Tunnel irrigation diversions increased by about 83,000 af per year in the same 1938-1965 period. However, changes in the seasonal distribution pattern of flows depicted by the hydrographs are due mostly to reservoir storage patterns.

Since 1965 Aspinall Unit regulation has reduced Gunnison River flows during runoff and increased flows during the non-runoff months. However, operations since 1992 have had the effect of somewhat returning the shape of the hydrograph to mimic the more natural, seasonal flow patterns represented by the pre-project hydrograph. Even with regulation, however, flows vary with the amount of snowfall. For example, annual flows through the Black Canyon averaged 396 cfs during 1977 and 2,943 cfs during 1984.

The Aspinall Unit allows water to be stored during spring runoff and released when needed to meet downstream needs. Tables 3.3 2 and 3.3 3 present modeled peak flows and average monthly flows for the period of study at the Whitewater and Gunnison Tunnel gages assuming the Aspinall Unit and other water projects in place and operating.

Table 3.3 2—No Action River Flows (Average Monthly cfs), Gunnison River at Whitewater, for Period of Record used in EIS Analysis assuming Aspinall Unit and Other Water Projects and Uses in Place and Operating.

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Peak Daily Mean
1975	766	741	1076	3176	6386	5461	3628	1929	2044	1961	1647	1610	8924
1976	1127	1197	1059	1660	3422	2509	1712	1088	1494	1604	1094	835	5125
1977	791	755	730	761	843	755	789	742	770	882	868	753	1573
1978	744	675	840	3470	6143	5721	2418	1282	1337	821	943	1110	10662
1979	1667	2702	2745	4528	9170	6877	2876	1643	1706	1608	1480	1378	15161
1980	1115	2492	1870	4213	9886	7170	2306	1281	1272	992	1319	1498	13882
1981	964	591	879	1328	1540	1387	1014	916	1179	1455	1082	822	3771
1982	1089	1216	1146	3448	6955	4746	2473	2048	2763	2713	2480	2418	9135
1983	1424	1350	1855	2772	8558	13646	7741	3090	2204	2461	2259	2554	20481
1984	2846	2629	2578	4918	13734	13727	6665	2789	2516	2997	2952	3178	20744
1985	2793	2241	2011	6718	10468	10096	3258	1554	2303	2701	2531	2626	16498
1986	2418	1655	3793	5771	8355	6438	4984	1973	2736	3353	3207	3273	10353
1987	1976	1794	2017	5173	6749	5851	1984	2047	2334	1822	1543	1533	9713
1988	1052	1210	1145	2281	2194	1903	1501	952	1312	1116	907	835	3434
1989	922	1182	1699	2559	1802	1601	1430	1080	1236	1146	969	891	2462
1990	772	702	791	1006	1640	1633	1274	888	1153	1352	1028	1032	2566
1991	880	829	958	1850	4992	4200	1929	1632	2032	1908	1663	1770	8409
1992	1109	931	1148	3251	3651	2739	2075	1654	1742	1927	1677	1352	6050
1993	984	1235	2847	4958	12947	9248	3699	2207	2346	2630	2215	1938	20489
1994	1328	1215	1490	2154	3528	2726	1551	1199	1515	1732	1535	1469	4909
1995	1043	966	2614	3781	8889	13764	12588	3009	2691	2770	2808	2733	19506
1996	1665	2155	2751	4039	5817	3357	1889	1500	2032	1930	1952	2045	7857
1997	2697	2714	2743	4407	8641	9059	3153	2410	3223	3178	2812	2717	11993
1998	1575	1462	2135	3578	7127	3121	2284	1501	1856	2021	1810	1697	9852
1999	1079	1069	1375	1371	3276	4550	2785	2810	2744	2454	2214	2170	6857
2000	1446	1455	1600	2698	2682	1783	1646	1095	1396	1586	1205	1086	4766
2001	971	835	1091	1516	2976	2187	1801	1501	1807	1662	1371	1323	3491
2002	970	826	868	1082	917	723	692	822	1094	1153	882	748	1170
2003	704	698	786	1168	2995	1800	613	751	1230	1020	858	752	5310
2004	753	730	1116	2038	2406	1462	1153	867	1330	1304	980	886	3411
2005	943	1451	1300	4312	8020	4548	2175	1439	1658	1927	1504	1191	13572
Ave	**1310**	**1345**	**1647**	**3096**	**5700**	**4993**	**2777**	**1603**	**1841**	**1877**	**1671**	**1620**	

Table 3.3 3—No Action river flows (average monthly cfs), Gunnison River below the Gunnison Tunnel, for Period of Record used in EIS Analysis assuming Aspinall Unit and Other Water Projects and Uses in Place and Operating.

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Peak Daily Mean
1975	428	415	707	2191	3062	1505	1567	1181	1106	835	791	1007	3323
1976	685	689	547	601	342	777	1166	526	578	504	496	365	1293
1977	327	336	394	448	421	425	423	427	434	309	331	371	450
1978	387	384	424	1543	1822	1654	1143	827	571	398	334	418	3602
1979	1179	2130	2142	2227	2647	1917	1346	1024	907	671	652	759	3655
1980	520	2004	1356	2089	2958	2220	1157	996	781	699	762	976	3564
1981	601	479	472	380	300	352	359	388	303	299	300	306	438
1982	483	734	353	1413	2342	1283	1247	876	1160	1350	1582	1723	3559
1983	875	859	859	1149	1782	4239	4011	1769	1197	1280	1378	1763	10750
1984	2150	2150	2018	3044	4322	7328	4685	1563	1335	1464	2029	2384	10990
1985	2105	1699	985	1972	2885	6257	1932	1093	1078	1131	1575	1869	11743
1986	1766	911	2117	1604	2469	2146	3244	1042	1207	1370	1760	2215	5028
1987	1156	980	866	1083	1710	3546	1165	922	946	817	804	954	5856
1988	515	680	514	595	324	533	1023	498	361	386	309	334	1042
1989	385	536	764	346	298	626	1024	474	502	299	300	300	1051
1990	322	373	401	354	298	443	685	362	313	299	370	496	699
1991	518	440	504	658	1934	2231	1215	1057	1017	946	837	1119	4144
1992	543	539	539	855	545	857	1171	806	837	784	737	774	1382
1993	486	682	2002	2519	3447	4049	2145	1152	1166	1107	1195	1164	5666
1994	706	704	704	590	318	1166	1140	558	517	559	811	896	1944
1995	554	423	1392	2048	3455	5573	7889	1661	1239	1413	1678	1972	12156
1996	953	1355	1819	1841	2687	1556	1177	868	727	712	1033	1402	3204
1997	2131	2118	1618	1420	2637	4682	1942	1127	1277	1332	1818	1931	7682
1998	873	843	842	945	1983	762	1154	734	728	604	788	935	3364
1999	440	527	698	369	430	2146	1535	1216	1365	1458	1561	1675	3991
2000	932	920	919	791	393	758	1126	460	410	469	375	492	1140
2001	462	380	512	345	485	1140	1153	614	832	636	589	717	1660
2002	464	432	390	370	391	409	438	436	335	299	301	303	439
2003	351	372	387	354	357	354	438	438	331	299	301	329	951
2004	358	395	349	299	298	489	813	386	317	299	300	300	840
2005	300	885	582	995	1570	573	1098	533	532	420	611	589	3527
Ave	773	851	909	1143	1578	2000	1633	839	787	756	861	995	

3.3.1.1D. Water Rights

Gunnison River Basin water use began in the 19th century with the establishment of numerous irrigation water rights by individuals, organizations, and government agencies. There are more than 5,000 water rights for direct flow diversions presently in use on the river and its tributaries. Significant senior diversion rights include the Gunnison Tunnel of the Uncompahgre Project (1,300 cfs, 1913 adjudication) and the RWPC diversion (670 cfs, 1912; 80 cfs, 1959; 100 cfs, 1994). The Colorado State Engineers Office uses a combination of adjudication dates, “previous” adjudication dates, and appropriation dates to determine senior priority. In the case of the Gunnison Tunnel and the RWPC diversion, this determination actually results in the Gunnison Tunnel as the senior water right despite having a later adjudication date. A federal reserved instream flow right for the Black Canyon NP is currently being quantified. Since the construction of the Aspinall Unit, mainstem calls have been very infrequent. During the irrigation season, the Gunnison Tunnel can call out a significant portion of the Upper Gunnison Basin, but because of storage in Taylor Park and Blue Mesa Reservoirs through the 1975 exchange agreement, this has rarely occurred, most recently in the 2002 and 2003 droughts. The RWPC diversion is a year-round diversion for power generation and irrigation. This 1912 water right can call out numerous upstream diversions and storage rights.

In addition to water rights for direct diversions and instream flows, there are significant storage rights in place on the Gunnison River. The largest single perfected storage right is for Blue Mesa Reservoir. The hydropower and storage rights of the Aspinall Unit (1960 adjudication date) can call some diversions out in the Upper Gunnison Basin, but a subordination agreement allows up to 60,000 af of junior in-basin depletions above the Aspinall Unit to be protected from an Aspinall Unit call. There are also numerous small reservoirs and several larger Reclamation project reservoirs on tributaries with storage rights: Taylor Park Reservoir on the Taylor River, Silver Jack Reservoir on Cimarron Creek, Crawford Reservoir on the Smith Fork, Paonia Reservoir on Muddy Creek, a tributary of the North Fork of the Gunnison, Ridgway Reservoir on the Uncompahgre River, and Fruitgrowers Reservoir on Alfalfa Run.

3.3.1.1E. Water Quality

Upper Gunnison Water Quality – Population growth and changes in land-use practices have the potential to affect water quality in the upper Gunnison River basin. In 1995, the USGS, in cooperation with local sponsors—City of Gunnison, Colorado River Water Conservation District, Crested Butte South Metropolitan District, Gunnison County, Mount Crested Butte Water and Sanitation District, NPS, Town of Crested Butte, and Upper Gunnison River Water Conservancy District—established a water-quality monitoring program in the upper Gunnison River basin to characterize current water-quality conditions and to assess the effects of increased urban development and other land-use changes on water quality (Spahr 2004). Table 3.3 4 summarizes water quality concerns and trends for several categories and gaging stations upstream of Blue Mesa Reservoir. The station immediately above Blue Mesa Reservoir, Gunnison River at County Road 32, shows low levels of concern except for phosphorous loading; however an upward trend is recognized for conductance, hardness, calcium, and magnesium.

Aspinall Unit Water Quality – The USGS and the NPS conducted a water-quality investigation from April through December 1999 at the Aspinall Unit. Various constituents were sampled and analyzed including phytoplankton, chlorophyll-*a*, total nitrogen and phosphorus. Total nitrogen and phosphorus concentrations in the reservoirs were low. Median concentrations were less than 0.4 and 0.06 milligram per liter,

Table 3.3 4—Upper Gunnison Water Quality Summary*

[Alk, Alkalinity; BOD, Biochemical Oxygen Demand; Ca, Calcium; Cd, Cadmium; Cl, chloride; Conductance, specific conductance; Cu, Copper; DO, Dissolved Oxygen; *E. Coli, Escherichia Coli*; Fe, iron; Mg, magnesium; Mn, Manganese; Ortho, Orthophosphate; SO_4, sulfate; Zn, Zinc]

Station name and number from figure 1	Nutrients[1]	Metals / Trace Elements	pH, Dissolved Oxygen	BOD	*E. Coli.*	Trend
Slate River above Coal Creek near Crested Butte 385240106583600	Low Concern	Low Concern	Low Concern	No Data	Low Concern	Conductance, calcium, magnesium: None DO, pH, Nitrite + Nitrate: Down
Coal Creek at mouth near Crested Butte 385224106590100	Low Concern	High Concern: Cd, Al Concern: Cu, Zn	Low Concern	No Data	Low Concern	Insufficient Data
Washington Gulch below Woods Creek at Mount Crested Butte 385325106581200	High Concern: Total Phosphorus Concern: Nitrate	No Data	Low Concern	No Data	Low Concern	Insufficient Data
Slate River near Crested Butte 09115500	Concern: Total Phosphorus	Concern: Zn and Mn if water-supply standard used	Low Concern	Low Concern	Low Concern	pH, Ammonia, Ammonia + organic, dissolved Phosphorus, Ortho: None DO, nitrite + nitrate: Down Total Phosphorus and conductance: Up
East River above Crested Butte 385408106543600	Low Concern	No Data	Low Concern	No Data	Low Concern	pH, Conductance: None Nitrite + Nitrate, DO: Down
East River above Slate River near Crested Butte 384950106544200	Low Concern	No Data	Low Concern	Low Concern	Low Concern	DO, pH, Conductance: None Nitrite + Nitrate: Down
East River below Cement Creek 09112200	Low Concern	No data in water year 02	Low Concern	No Data	Low Concern	DO, pH, Conductance, Sediment, Alk, SO_4: None Nitrite + Nitrate: Down Cl: Up
East River at Almont 09112500	Low Concern	No Data	Low Concern	Low Concern	Low Concern	pH: None; DO, Nitrite + nitrate: Down Conductance: Up
Ohio Creek above mouth near Gunnison 09113980	High Concern: Total Phosphorus	No Data	Low Concern	Low Concern	Low Concern	pH, Conductance, Ortho, Total Phosphorus: None DO: Down
Gunnison River at Gunnison 09114500	Low Concern	No Data	Low Concern	Low Concern	Low Concern	pH, BOD: None DO: down; Conductance: Up
Quartz Creek below Pitkin 383604106312400	Low Concern	Low Concern	Low Concern	Low Concern	Low Concern	Insufficient Data
Tomichi Creek below Cochetopa Creek 383126106475600	Concern: Total Phosphorus	Low Concern	Low Concern	Low Concern	Low Concern	Insufficient Data
Tomichi Creek at Gunnison 09119000	Concern: Total Phosphorus	Concern : Mn if water-supply standard used	Low Concern	Low Concern	Low Concern	pH, Conductance, Phosphorus, Ortho, Total Phosphorus: None; DO: Down
Gunnison River at County Road 32 below Gunnison 383103106594200	Concern: Total Phosphorus	Low Concern	Low Concern	Low Concern	Low Concern	DO, pH, Total Phosphorus, Fe, Mn,: None Conductance, hardness, Ca, Mg: Up

[1]Toal phosphorus concern levels are based on the USEPA recommendations of 0.1 milligrams per liter (mg/L) for water not directly flowing into a lake or reservoir.

*From: Comparison of 2002 Water Year and Historical Water-Quality Data, Upper Gunnison River Basin, Colorado, USGS N.E. Spahr 2004

respectively. Nutrient concentrations for most summer and fall samples collected at depth were greater than photic-zone samples. The phytoplankton community and density in each reservoir were affected by water temperature, nutrients, and water residence time.

Seasonally, both Blue Mesa and Morrow Point reservoirs had their lowest phytoplankton densities during summer when inorganic nitrogen was not detected and was fully utilized by biota. Density in Crystal Reservoir was highest during summer when orthophosphate was fully utilized and inorganic nitrogen was not. Because there are no major impoundments directly upstream of Blue Mesa Reservoir, nutrient inflows vary seasonally, with a lower nutrient supply occurring after spring snowmelt. For Morrow Point and Crystal reservoirs there was a steady inflow of nutrients during the sampling period. Nutrient concentrations in the deep-discharge waters from the respective upstream impoundment were fairly consistent and nutrient concentrations were mostly dependent on upstream reservoir conditions rather than seasonal stream inflows.

Among the physical properties and nutrient constituents studied for the inflows for all three reservoirs, only total phosphorus concentrations were elevated; other parameters including dissolved oxygen, pH, and nitrogen constituents were within water-quality standards for the State of Colorado. A comparison of the 1999 and historical chlorophyll-*a* and nutrient data revealed that productivity in Blue Mesa Reservoir has not changed over time, and the reservoir has not become more enriched with nutrients (USGS Water-Resources Investigations Report 02-4199).

Outstanding Waters Designation - The NPS has monitored the quality of water of Curecanti NRA and Black Canyon NP for nearly 15 years. Initial investigations showed water that was of high quality and that could possibly meet the stringent criteria for an Outstanding Waters designation. Since 2001, data have been collected and analyzed to specifically address the feasibility of this designation. Data suggest that all rivers, streams, and reservoirs being sampled meet the criteria for Outstanding Waters, and in some cases have quality that is 100 times better than existing standards.

Lower Gunnison River Water Quality - Butler (2000) summarized water quality data for the lower Gunnison River. Three parameters were reported to exceed State water-quality standards (for which 85^{th} percentile concentrations exceeded numeric standards) for the Gunnison River: sulfate, total iron, and selenium (Table 3.3 5). High total-iron concentrations are probably associated with high suspended-sediment concentrations in the river, which occur during periods of runoff.

Other constituents occasionally exceed standards but the 85^{th} percentiles were less than the standards. The North Fork and Uncompahgre rivers are major sources of some constituents to the Gunnison River. Concentrations of sulfate, nitrogen, manganese, and selenium from the North Fork were higher than those of the Gunnison River upstream from the North Fork. The Uncompahgre River is a major source of nitrogen, sulfate, and selenium because of higher concentrations found in the Uncompahgre River relative to the Gunnison River at Delta. The Uncompahgre River also has higher levels of fecal coliform, total iron, and manganese than the Gunnison River at Delta. As shown in Table 3.3 6, water released from the Aspinall Unit is of very high quality and tends to dilute concentrations of sulfate, dissolved-solids, and selenium from tributaries such as the North Fork and Uncompahgre rivers.

Mining in the headwaters and uncontrolled grazing in early settlement years affected water quality and streamflows, while large-scale irrigation in valleys underlain by Mancos shale resulted in return flows with increased salinity and selenium levels.

Selenium concentrations are of particular concern to fish and wildlife resources. It is estimated that percolation of water from irrigation and irrigation systems contribute about 90 percent of the ground water that mobilizes selenium in the basin (Bureau of Reclamation 2006b). It is estimated that 60 percent of the selenium loading results from the Uncompahgre Irrigation Project; the remainder from private, other federal projects and natural inputs. Figure 3.3-4 shows dissolved selenium concentrations from 132 samples taken at various flows between 1976 and 1998 at the Whitewater Gage. The flow-duration curves show the distribution of daily mean streamflow for the period. The bottom axis is the percentage of time daily mean streamflow was equal to or greater than the streamflow value indicated on the left axis. The graph shows a very general inverse correlation between flowrate and selenium concentration. However, the corresponding selenium concentration varied widely at flowrates less than 4,000 cfs. For instance, the

Table 3.3 5—Lower Gunnison Water Quality Data*.

Parameter	State Standard	USGS Data			STORET Data		
		Number of Samples	85th Percentile	Number of Exceedences	Number of Samples	85th Percentile	Number of Exceedences
Gunnison River at Delta (USGS Station 09144250, STORET Station 000056)							
Fecal coliform (col/100 mL)	200	11	*51	2	146	*37	31
Un-ionized ammonia (mg/L)	0.02	13	0.002	0	127	0.007	2
Sulfate (mg/L)	250	20	300	8	144	240	20
Iron, Total (µg/L)	1,000	11	4,200	5	0	--	--
Selenium (µg/L)	5	20	5.5	7	[1]56	3	4
Gunnison River near Grand Junction (USGS Station 09152500, STORET Station 000054)							
Fecal coliform (col/100 mL)	200	108	*34	24	176	*76	71
Un-ionized ammonia (mg/L)	0.02	142	0.003	1	144	0.014	15
Sulfate (mg/L)	480	337	598	84	62	650	18
Cadmium (mg/L)	3.1	65	2	3	0	--	--
Iron, Total (µg/L)	2,300	28	1,900	4	0	--	--
Lead, Total (µg/L)	24	65	6	2	0	--	--
Maganese (µg/L)	50	170	33	9	0	--	--
Selenium (µg/L)	[2]8	132	9	35	[1]58	12	21

* Parameters exceeding the 85th percentile or had occasional exceedances of State Standards from "Evaluation of Water_Quality Data, Lower Gunnison River Basin and Colroado River Downsream from the Aspinall Unit, Colorado" (Butler 2000).

[Chemicals constituents are dissolved unless otherwise noted; ammonia for USGS data at Statio 09144250 is combined dissolved and total data; *, geometric mean concentration for fecal coliform data; number of exceedences, number of samples that were equal to or greater than the numeric standard; col/100 mL, colonies per 100 millileters; mg/L, milligrams per liter; µg/L, microgram per liter; <, less than; - -, no data]

[1]Data are for total selenium

[2]Standard was temporarily modified to 8 µg/L and the modification expired in August 2002, Eighty-one USGS samples and 32 STORET samples were equal to or greater than 5 µg/L.

Table 3.3 6—Mean Annual Streamflow and Mean Annual Sulfate, Dissolved-Solids, and Selenium Loads below the Aspinall Unit, Water Years 1977-1998.

Location	Average Streamflow (cfs)	Sulfate Load (tons per year)	Dissolved Solids (tons per year)	Selenium Load (pounds per year)
Gunnison River @ Tunnel	1,321	23,600	145,000	1,300
Gunnison River @ Delta	2,232	254,000	632,000	13,000 [1]
Uncompahgre River @ Delta	336	176,000	313,000	8,600
Gunnison @ Whitewater	2,838	633,000	1,227,000	24,700
Colorado River @ Stateline	7,034	1,315,000	3,239,000	52,000

[1]Selenium loads for this station could have significant uncertainty. Loads for water years 1977-98 based on only 21 selenium samples collected from 1987 to early 1999. Estimated annual selenium load 10,200 pounds for water years 1987-98.

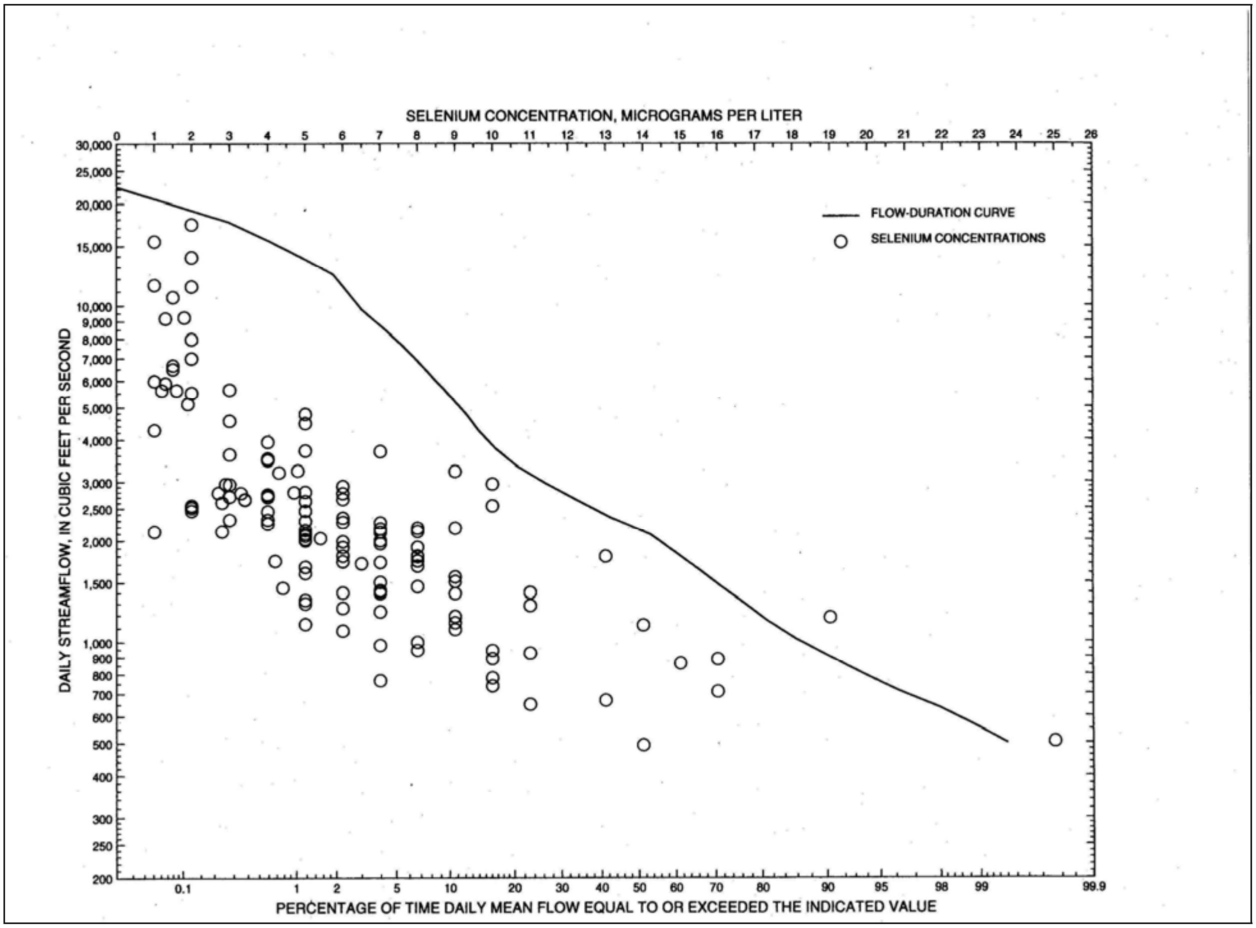

Figure 3.3- 4—Low-Exceedance Curve and Dissolved-Selenium Concentrations in Samples Collected by the USGS between 1976 and 1998 for Station 09152500 Gunnison River near Grand Junction.

maximum recorded selenium concentration corresponding to flows greater than 4,000 cfs was 3 µg/liter while at flows between 2,000 cfs and 3,000 cfs selenium concentrations varied from 1 to 10 µg /liter. The median value for these samples was 5 µg /liter as compared to the Colorado chronic water quality standard for selenium of 4.6 µg /liter.

Point-Source Dischargers - There are two primary point-source discharges downstream of the Aspinall Unit which could be affected by changes in Aspinall Unit operation. A wastewater treatment plant operated by the City of Delta discharges effluent (treated wastewater) into the Gunnison River about 1 mile downstream from the mouth of the Uncompahgre River. The Persigo wastewater treatment plant is operated jointly by Mesa County and City of Grand Junction, and its discharge point is into Persigo Wash, a tributary to the Colorado River about 6.5 miles below the confluence with the Gunnison. As of 2000 these permit holders stated their discharge was within the designated discharge limits for all constituents except for selenium. The permits for point-source discharges are developed by the Colorado Division of Public Health and Environment (CDPHE) and are based on effluent loads and loads in the river, which are computed using 3-year, 1-day, and 30-day low-flow data for the streams receiving the effluent. The CDPHE updates the low-flow values about every 5 years. Increased duration or magnitude of low-flows might require permit holders to monitor effluent and river loading more often to ensure they are not in violation of their permit.

Water Temperature - Early irrigation diversions and return flows probably tended to increase water temperatures in the Gunnison River and its major tributaries year-round compared to pre-settlement conditions. Later, construction and operation of the Aspinall Unit has tended to lower downstream temperatures in the summer and raise them in the winter, due to hypolimnion (deep water) releases from the reservoirs. Stanford and Ward (1983) reported that the river immediately downstream from the Aspinall Unit was several degrees warmer in the winter and 7-10 ^{o}C cooler in the summer compared to pre-Aspinall conditions. Before reservoir regulation, annual degree days increased from 2895 to 4132 between the East Portal and Whitewater; and after regulation increased from 1361 to 3432. Table 3.3 7 presents temperature data from the Gunnison River collected under the Recovery Program. There is a general inverse correlation between flow and water temperature at Delta and Whitewater with higher releases resulting in lower water temperatures (for example, see 1993, 1995, and 1997 in Table 3.3 7), although this is not always true as other variables such as tributary flow and weather affect the temperatures as well. Spring and summer water temperatures in areas such as backwaters would be expected to be higher than in main channel areas.

Table 3.3 7—Mean Summer Water Temperature (Degrees C) of the Gunnison River at the Delta and Whitewater Gages, 1992-2000 (from McAda, 2003)*

Year/Month/Mean Flow at Whitewater+	Gunnison River at Delta	Gunnison River at Whitewater	Year/Month/Mean Flow at Whitewater+	Gunnison River at Delta	Gunnison River at Whitewater
1992			**1997**		
Jun 2,819 cfs	16.1	17.9	Jun 8,184 cfs	13.2	12.6
Jul 1,806 cfs	17.6	20.3	Jul 3,595 cfs	16.2	18.1
Aug 1,716 cfs	17.5	20.6	Aug 2,474 cfs	17.7	19.7
Sep 1,570 cfs	15.4	17.9	Sep 3,257 cfs	15.8	17.1
1993			**1998**		
Jun 9,054 cfs		13.2	Jun 3,273 cfs	14.3	16.2
Jul 3,279 cfs		18.1	Jul 1,913 cfs	19.0	21.7
Aug 2,157 cfs		19.3	Aug 1,472 cfs	18.0	
Sep 2,377 cfs		16.1	Sep 1,879 cfs	15.7	
1994			**1999**		
Jun 2,567 cfs		19.0	Jun 3,549 cfs	15.0	
Jul 1,263 cfs		21.7	Jul 2,423 cfs	18.4	
Aug 1,276 cfs		21.8	Aug 3,418 cfs	16.5	
Sep 1,701 cfs		17.1	Sep 3,172 cfs	14.6	
1995			**2000**		
Jun 13,050 cfs	11.4	12.0	Jun 1,941 cfs	16.5	19.5
Jul 11,950 cfs	13.5	13.7	Jul 1,520 cfs	18.6	21.6
Aug 3,162 cfs	17.7	19.5	Aug 1,792 cfs	18.1	20.8
Sep 2,399 cfs	15.5	17.0	Sep 1,799 cfs	15.7	17.0
1996					
Jun 4,034 cfs	14.8				
Jul 2,283 cfs	17.7				
Aug 1,391 cfs	18.6				
Sep 2,022 cfs	15.0				

*Data were compiled from thermographs maintained by the Recovery Program
+Monthly mean flow at USGS gage at Whitewater

According to Butler (2000), the discharge from the Aspinall Unit is one of several variables affecting stream temperature in the Gunnison River. Weather conditions, air temperature, solar radiation and other factors have a major influence on water temperature. As shown in Figure 3.3-5, the Aspinall Unit probably has a moderating effect on Gunnison River temperature, cooling in the summer and warming in the winter.

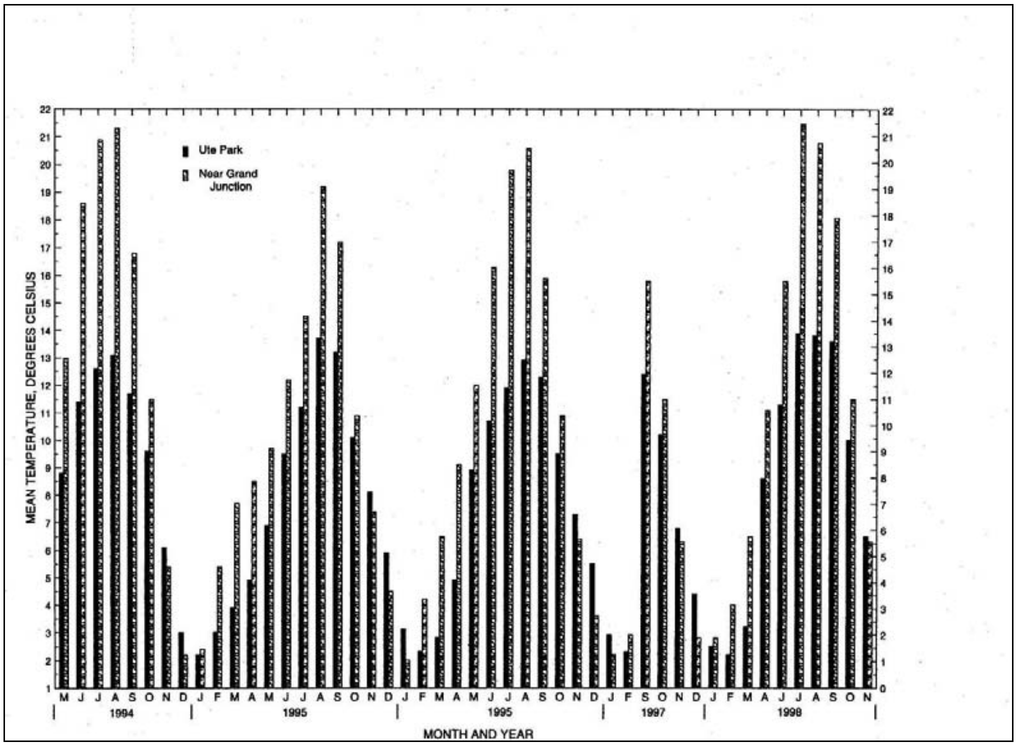

Figure 3.3- 5—Mean Water Temperature, Degrees Celsius at Ute Park in the Gunnison Gorge NCA and Whitewater, 1994 – 1998.

3.3.1.1F Flood Control

All past major flooding along the Gunnison River has occurred as the result of snowmelt. Anecdotally, the largest flood occurred in June and July of 1884 when, after a cool spring, a general rainstorm enveloped the entire western slope of Colorado. Rain on the snowpack along with warmer temperatures accelerated the melt causing widespread flooding downstream through the Uncompahgre and Grand valleys. The two major flood prone areas downstream of the Aspinall Unit are near the cities of Delta and Grand Junction. According to the 1999 Buckhorn Geotech Needs Assessment for Floodplain Map Revision, following the floods of 1983 and 1984 Delta County sought federal flood assistance (Buckhorn Geotech 1999) for 3 major areas: the Gunnison River at Delta, North Fork at Paonia, and the Uncompahgre River at Delta. The most severe damage was related to erosion along the Gunnison River in the vicinity of the Highway 50 Bridge at Delta. Peak flows at Delta in 1984 were about 25,500 cfs.

According to the Corp of Engineers 1988 Water Control Manual for Blue Mesa Reservoir (ACOE 1988), the floodplain area near Delta has a maximum of 2,500 acres and the area at Grand Junction consists of 60 acres of land owned by the Department of

Energy. There is one flood prone area on the Colorado River that can be affected by flows from the Gunnison River; it extends from the confluence of the Colorado and Gunnison rivers 16 miles downstream to 5 miles below Fruita, Colorado.

The criterion for flood control operation at Blue Mesa Dam and Reservoir is detailed in the Water Control Manual. The necessity for flood control releases occur whenever the required space for flood control storage is greater than the actual empty space in the reservoir as determined by the Flood Control Diagram. This space is dependent on the current date and projected snowmelt runoff volume. Flood control releases will be made as rapidly as possible without causing flows in the Gunnison River at Delta to exceed 15,000 cfs, if possible.

Aspinall Unit operations provide flood control benefits, both upstream and downstream of the reservoirs. One of the operational sideboards for high water years is to reduce flooding through the Delta area during spring runoff. Coordination of the Aspinall Unit and Taylor Park operations reduce upstream flooding. During the winter months, Blue Mesa Reservoir is drawn down approximately 30 feet from full to elevation 7490 to help reduce problems with ice jams and winter flooding upstream from the reservoir near the City of Gunnison. Spring flood control operations include the goal of filling Blue Mesa Reservoir around July 1 without causing a spill.

The highest area of concern for the City of Delta is the area around the U.S. Highway 50 Bridge where authorities must be vigilant to watch for dislodged cottonwood trees which hang up on bridges or sandbars. Debris accumulation on the bridge could result in loss of the bridge severing a major US highway, and also creating substantial delays in emergency services to residents of North Delta (part of the City of Delta). The City and the County have both encountered problems from debris collecting on bridges during past high water events. Irrigation diversion structures along the river are also exposed to such risks. Recent dike construction around the wastewater treatment plant is designed to protect the facility up to a 100 year flood, which based on the 1999 Buckhorn Report, is in excess of 33,000 cfs.

During the 2008 spring high water season, the City of Delta reported that at flows around 12,000 cfs there was no damage to structures or buildings. However these flows did inundate a small private lake east of the Highway 50 Bridge, damaged a berm located on the south side of the river east of the bridge, inundated trails in the northwest corner of Confluence Park and caused the closing of a backwater prevention device at the Delta Hardware and Big O Tire parking lot. In addition, the river was close to overtopping the dike near this location and very small areas of commercial improvements north of the river on either side of Highway 50 were briefly inundated but not damaged other than a walkway which was washed out.

High flows between Delta and Whitewater can impact small irrigation diversions, farmland, some minor structures**,** and cause bank erosion along the railroad. Major structures near the mouth of the Gunnison River of significant concern consist of the Highway 141 Bridge at Whitewater and the Redlands Diversion Dam and Fish Ladder near Grand Junction. The main flooding concern at these locations is debris accumulation.

High water from the Gunnison River coupled with high flows from the Colorado River can affect areas along the Colorado River downstream of the confluence, as well. In 1984, the combination of flows of the two rivers caused extreme bank erosion causing the loss of one or two homes in the Rosevale Road area of the Redlands. Peak flows at the Colorado-Utah State line in 1984 were in excess of 68,000 cfs occurring in late May. These high flows caused closure of Interstate 70 between Fruita and Loma, Colorado due to water covering the traffic lanes and debris buildup on the Skippers Island bridges. During the high water period of 2008 the same section of Highway was closed on May 22nd for debris control on the Skippers Island bridges. Flows on that day were peaking in the 38,000 cfs range at the Colorado-Utah State line and coincided with the peak on the Gunnison River at Whitewater of 14,500 cfs.

3.3.1.2. Impact Analysis

Riverware is the simulation software selected by Reclamation for use in the development of a hydrology model to evaluate alternatives. The model was originally developed by Reclamation in support of assessing the effects of the Black Canyon NP Water Right on the Aspinall Unit. It has been significantly improved and serves as a tool to analyze effects and determine relative performance of the proposed alternatives. This model was developed solely for this purpose and Reclamation does not expect the model to be used as an operations model or forecasting tool.

Basically the model simulates the operations of the Aspinall Unit under varying hydrologic conditions caused by the implementation of the proposed alternatives over a 31-year study period (1975-2005). This period of record was selected as the most complete historical dataset at the time model analysis began and it is adequately representative of the past hydrological conditions of the basin containing both the driest and wettest periods for which data is available. Statistical analysis, conducted by Reclamation (2005) compared 1906-2005, 1937-1997, and 1975-2005 periods of records and concluded there is “no basis for presuming the 3 periods of hydrological record are statistically different”. In addition, selection of a period of record containing years prior to 1975 would require significant data synthesis as daily records are incomplete in these earlier years. The model uses a single trace over the 31 year study period. This is adequate for this analysis because the ratio of average annual inflow to live storage for Blue Mesa Reservoir is so large. Flaming Gorge and Glen Canyon EIS’s both used iterative trace methods of analysis, however their ratio of inflow to live storage is in the 40% range. Blue Mesa’s ratio at average flow to storage is nearly 100% which means an average year’s runoff into Blue Mesa is about equal to the reservoir’s active storage capacity. Consequently, if managed properly, the reservoir can easily “re-set” itself in a “less-than-average” year.

Output of the model consists of daily data describing reservoir elevations, volumes, releases and estimated Gunnison River flows at key locations downstream of the Aspinall Unit including the Gunnison Tunnel, Delta, and Whitewater. Appendix A contains detailed analysis and explanation of the hydrologic evaluation and modeling methodologies.

3.3.1.2A Reservoir Surface Area and Content

Each alternative was simulated with the Riverware Computer model over the study period to determine a range of reservoir elevations and associated reservoir content. Reservoir elevations occurring under each model run were analyzed to compare differences between alternatives. All model output depicts the results of each alternative's rule-sets applied to past hydrology and forecasts during the study period.

Figure 3.3-6 shows the average surface area for Blue Mesa Reservoir which would occur under each alternative at the end of April, and mid and late summer. Reservoir elevations are typically at their lowest level in the early spring in anticipation of the spring and summer runoff. During late summer, reservoir elevations are typically at their highest level of the year as a result of storing a portion of the spring runoff in order to achieve the goal of filling the reservoir in July. Figure 3.3-7 illustrates the average end of month content of Blue Mesa Reservoir under each alternative. In general, the No Action Alternative results in the highest end-of-month content over the course of the year while Alternative C is the lowest.

Operation under Alternative C has the greatest effect on Blue Mesa Reservoir resulting in a slightly lower volume and reservoir surface area over the study period. This is because peak flow duration targets are increased in Alternative C thus using more storage from the reservoir. The other action alternatives do not cause significant effects on reservoir surface area or elevation.

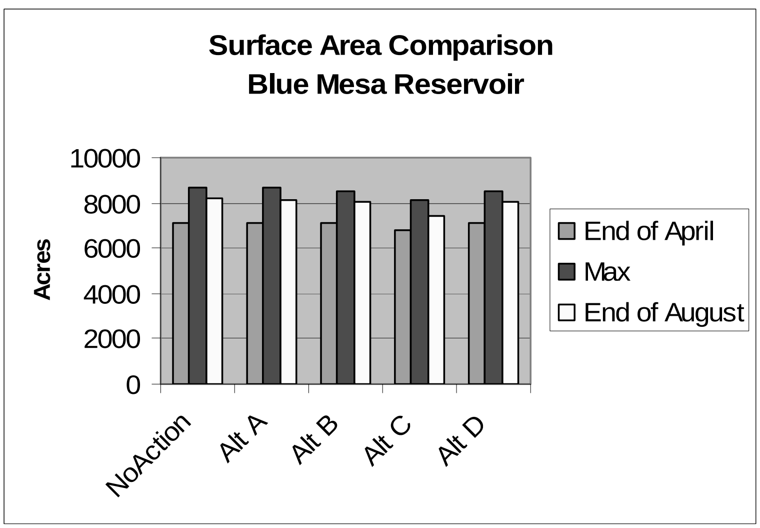

Figure 3.3- 6—Average Surface Area Comparison, Blue Mesa Reservoir.

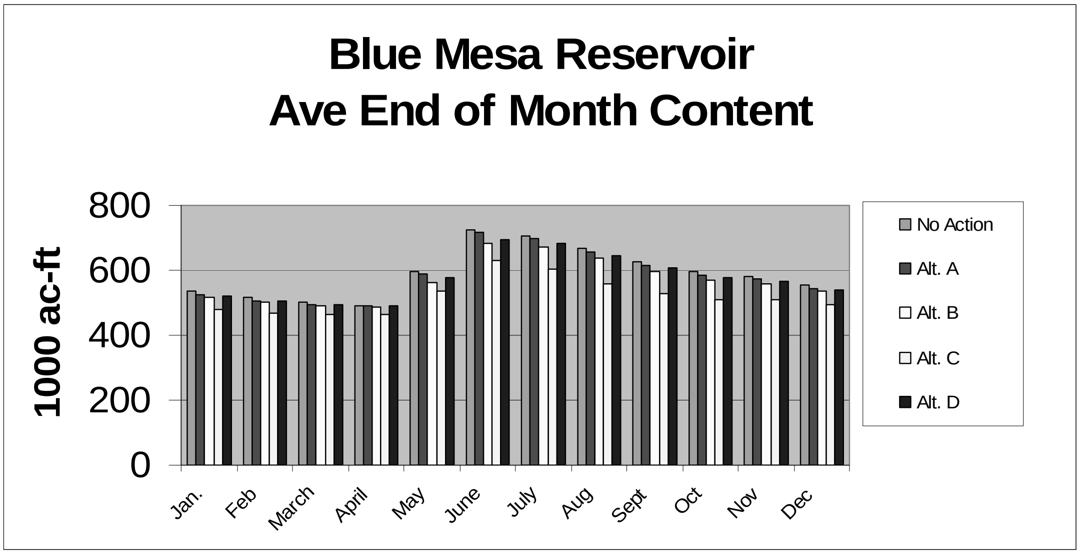

Figure 3.3- 7—Average End of Month Content of Blue Mesa Reservoir for Each Alternative.

Figure 3.3-8 shows the average additional storage used from Blue Mesa Reservoir beyond the No Action Alternative for different periods of the year for each alternative. These volumes may or may not be recovered through the course of the water year. The Figure merely depicts the difference in storage content from the No Action at the end of the identified period.

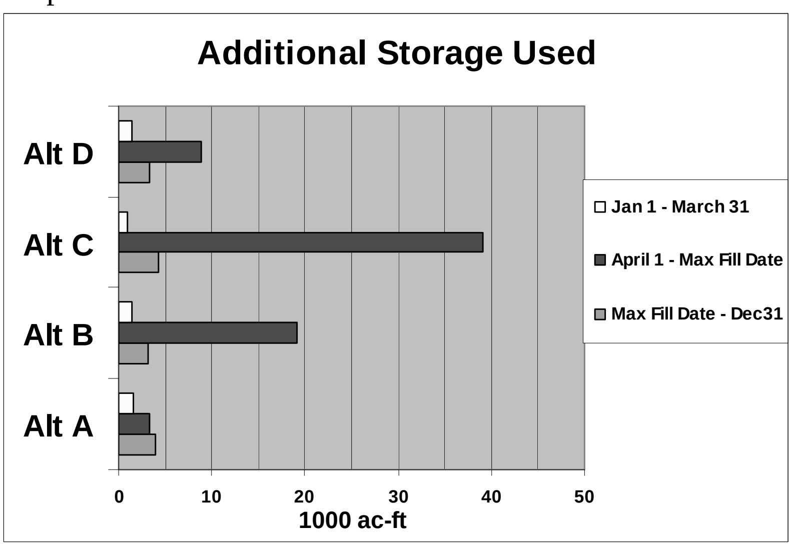

Figure 3.3- 8—Additional Storage Used from Blue Mesa Reservoir, Beyond No Action.
(Volumes may or may not be recovered through the course of the year.)

3.3.1.2B River Flows

Flows through the Black Canyon –Figure 3.3-9 summarizes the mean monthly flows at the USGS gage located below the Gunnison Diversion Tunnel modeled under the alternatives for each month of the year. Compared to the No Action, in general each of the alternatives, to some degree utilizes a portion of the water which may have otherwise been released in the early months of the year and instead releases it in May or June in an attempt to produce a peak at Whitewater.

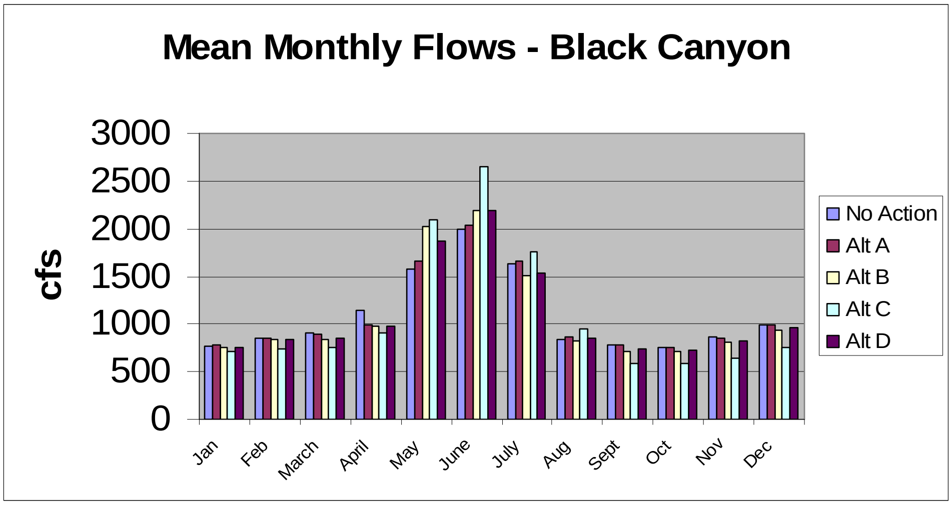

Figure 3.3- 9—Mean Monthly Flows, Black Canyon.

The distributions of peak flows occurring in May through the Black Canyon for each alternative are shown in Figure 3.3-10. It again shows that all the proposed action alternatives provide higher peak flows in May than does the No Action Alternative. For example, Alternative B will provide flows in May exceeding about 2,400 cfs 80 percent of the time, while the No Action provides flows in May exceeding only about 500 cfs 80 percent of the time.

Annual peak flows in the Black Canyon are further described in Appendix A—Aspinall Hydrology Report where they are divided into two categories (May and June-July) because of how operations at the Aspinall Unit dictate the timing of spring peak flows. Typically annual peaks during the month of May are a result of operational releases from the Aspinall Unit intended to create a spring peak in the lower Gunnison River. When the annual peak occurs during the months of June or July, it is usually a result of very wet hydrologic conditions that have caused the Aspinall Unit reservoirs to fill completely and spill excess water that cannot be stored.

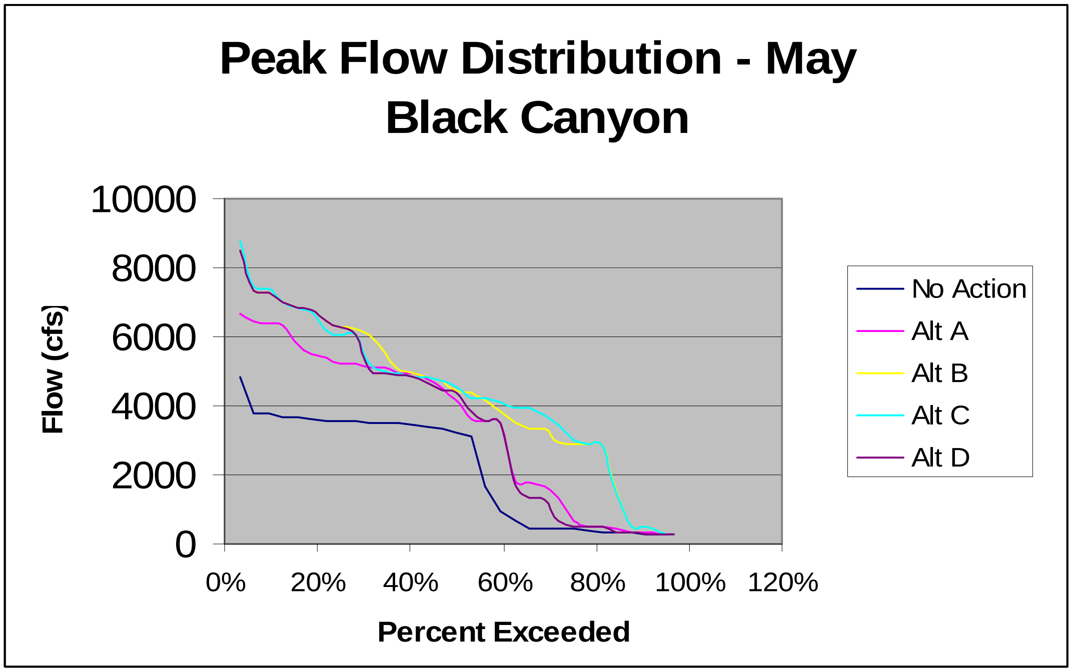

Figure 3.3- 10—Peak Flow Distribution for May, Black Canyon

As a consequence of increased releases from the Aspinall Unit in May, June and July the likelihood of additional spills from Crystal Reservoir increases as well. Figure 3.3-11 shows the number of years over the study period above the No Action Alternative which Crystal Reservoir would spill.

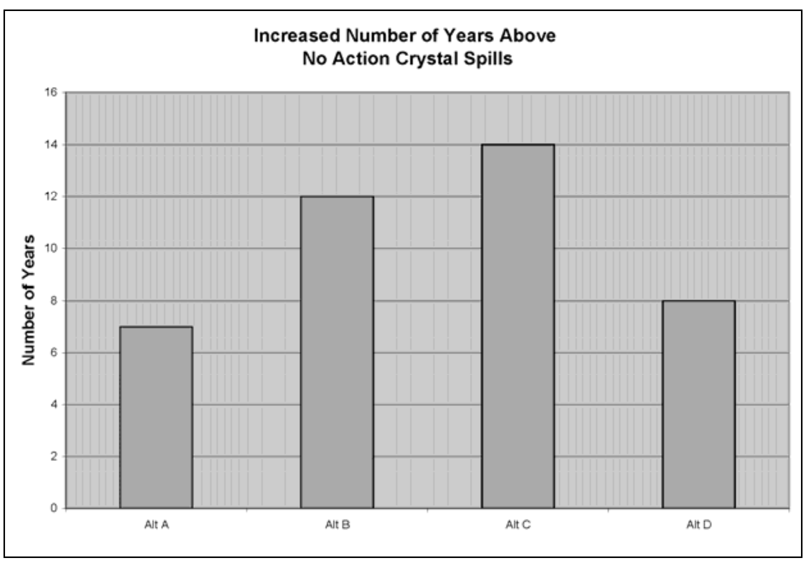

Figure 3.3- 11—Crystal Reservoir Spills, Increased Number of Years Above No Action During the 31-Year Study period.

Flows at Delta –Figure 3.3-12 shows the mean monthly flows at the USGS gage near Delta modeled under the alternatives for each month of the year. In general, flows generated by the action alternatives are somewhat higher than the No Action Alternative in the months of May and June while slightly lower in other months.

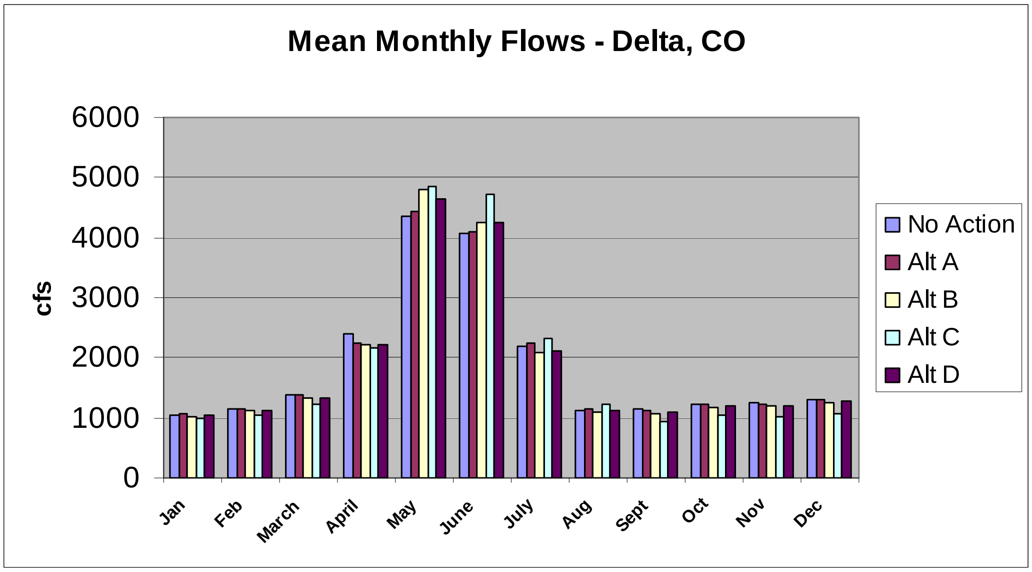

Figure 3.3- 12—Mean Monthly Flows, Delta, CO.

Figure 3.3-13 shows the peak flow distribution occurring in May at Delta. The chances of flows under Alternatives B and C at this location being above 4,000 cfs are about 20 percent greater than the other alternatives, while chances of flows being above 14,000 cfs are slightly greater for all action alternatives than the No Action.

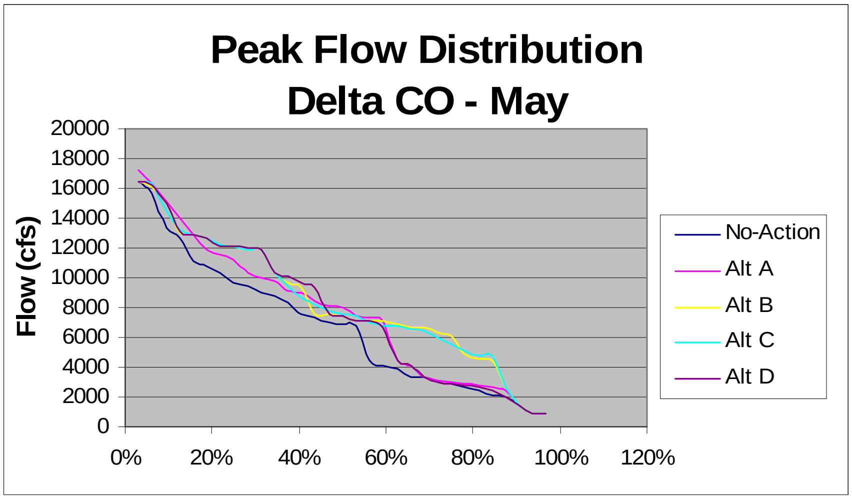

Figure 3.3- 13—May Peak Flow Distribution, Delta, CO.

Flows at Whitewater –Figure 3.3-14 shows the annual peak flow distribution under each alternative at Whitewater. All alternatives result in higher peak flows than the No Action. Of particular note, in the 6,000 to 8,000 cfs range, Alternative B results in a higher occurrence than all other alternatives.

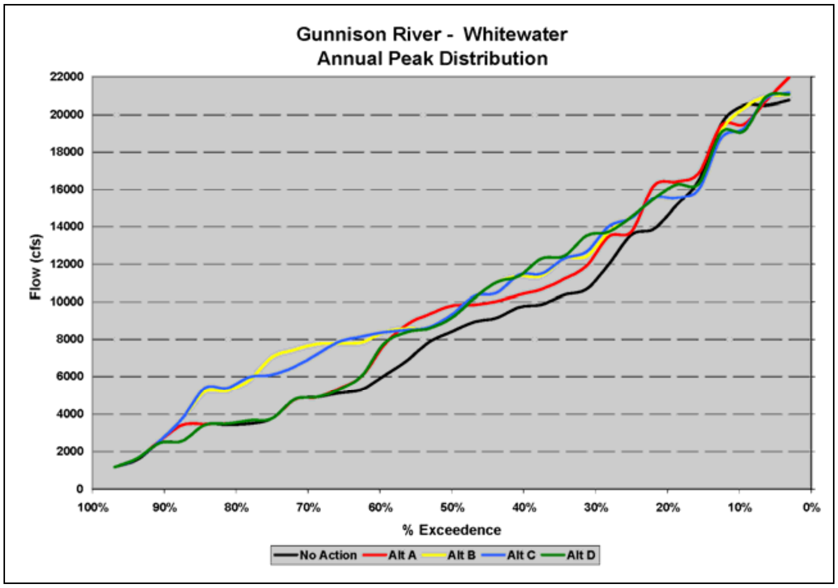

Figure 3.3- 14—Annual Peak Distribution at Whitewater

3.3.1.2C Water Rights

Each alternative under consideration will operate under the applicable water rights, contracts, law, interstate compacts, court decrees, and various rules, regulations, policies, and directives in place. No specific storage releases are modeled for downstream senior water rights in any alternative.

Each action alternative sets a minimum downstream release for instream flow in the Black Canyon of generally 300 cfs, but can be higher based on the previous year's operations which consider factors such as the fall brown trout spawn or downstream senior water rights.

Base flow releases attempt to meet fish flow targets from the Flow Recommendations as measured at Whitewater and are provided under each of the action alternatives and can vary under different hydrologic conditions. In most years, a base flow of 1,050 cfs will be maintained at the Whitewater gage; however, these targets will be reduced in dry or moderately dry years.

Table 2.3 2 in Chapter 2 previously summarized base flow targets. Additional releases will be made to provide 100 cfs to the Redlands Fish Ladder as needed in April through September and 40 cfs for the Redlands Fish Screen from March through November, using storage water if necessary.

The RWPC's water rights senior to the Aspinall Unit total 750 cfs. Occurrences of flows below 750 cfs over the 31-year study period in the action alternative models, as shown in Figure 3.3.15, can be attributed to the lag between the time the model recognizes flows are dropping below 750 cfs at Whitewater and the time releases are adjusted and reach Whitewater. Actual operation should provide more foresight of flows dropping thus reducing the days below 750 cfs even further. By operating to the base flow targets, the days which the RWPC Diversion would potentially be calling are actually reduced over the period of record in each of the action alternatives as compared to the No Action. Therefore significant negative impacts on water rights are not expected under the action alternatives.

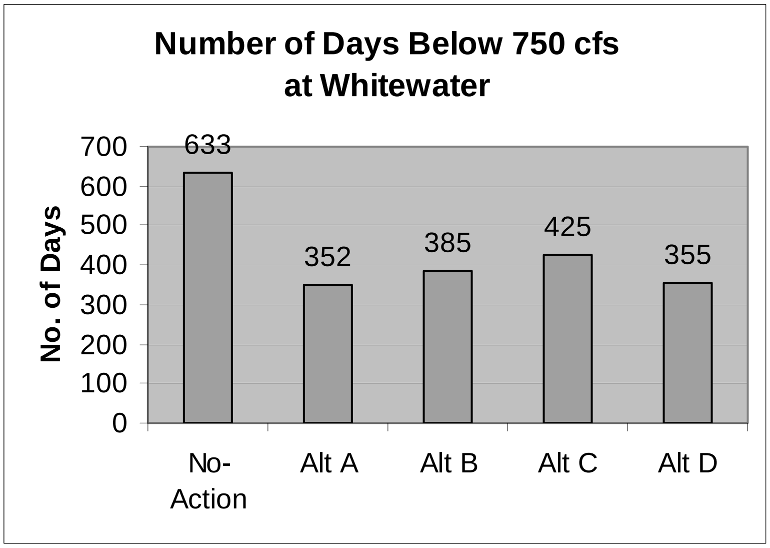

Figure 3.3- 15—Number of Days Below 750 cfs at Whitewater over the 31-Year Study period.

3.3.1.2D Water Quality

Upper Gunnison and Aspinall Unit Water Quality Impacts – In general, water quality in Upper Gunnison basin will not be affected by any of the proposed alternatives.

Lower Gunnison River Water Quality Impacts – Because the overall volume of water released from the Aspinall Unit remains unchanged, achieving higher spring peaks and duration flows can result in lower average monthly flows than the No Action Alternative during certain times of the year.

Decreased flows might cause the State of Colorado to require permit holders, such as the wastewater treatment plant at Delta, to monitor effluent and river loading more often to ensure they are not in violation of their permit. Lower river flows could adversely affect permit holders if longer duration low streamflows resulted in more restrictive discharge permit levels. Colorado Water Quality Regulations specify the use of low flow conditions when establishing water quality effluent limitations, one being the chronic low flow criteria. The chronic low flow, identified by the CDPHE, represents the 30-day average low flow recurring in a three-year interval. Figure 3.3-16 shows the annual minimum monthly flow at Delta for each alternative. This gives an indication of the change in low flows associated with each alternative and possible related effluent permit issues. As can be seen from Figure 3.3-16 Alternative C has the greatest potential to negatively impact water quality when considering minimum monthly average flows.

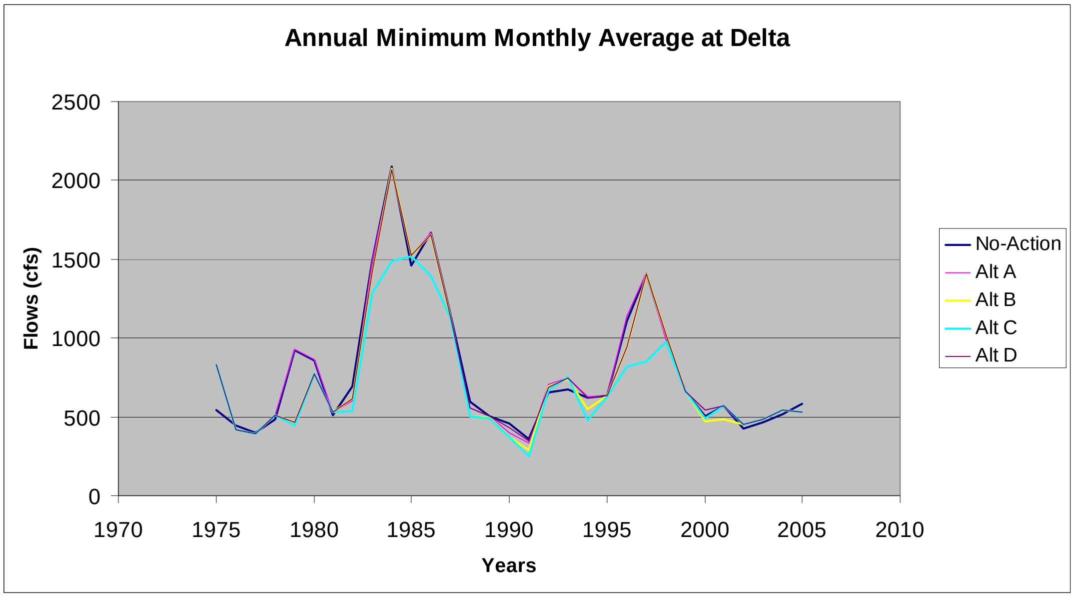

Figure 3.3- 16—Annual Minimum Monthly Average at Delta.

Figure 3.3 – 17 shows, for the four lowest years occurring in the study period (1976, 1989, 1990, and 2000), the average minimum monthly flows at Delta which recur within a three year time interval. The largest difference in the minimum average monthly flow from the No Action occurs in 1990 for all alternatives with Alternatives B and C being about 80 cfs less than the No Action, Alternative A 59 cfs and Alternative D 25 cfs.

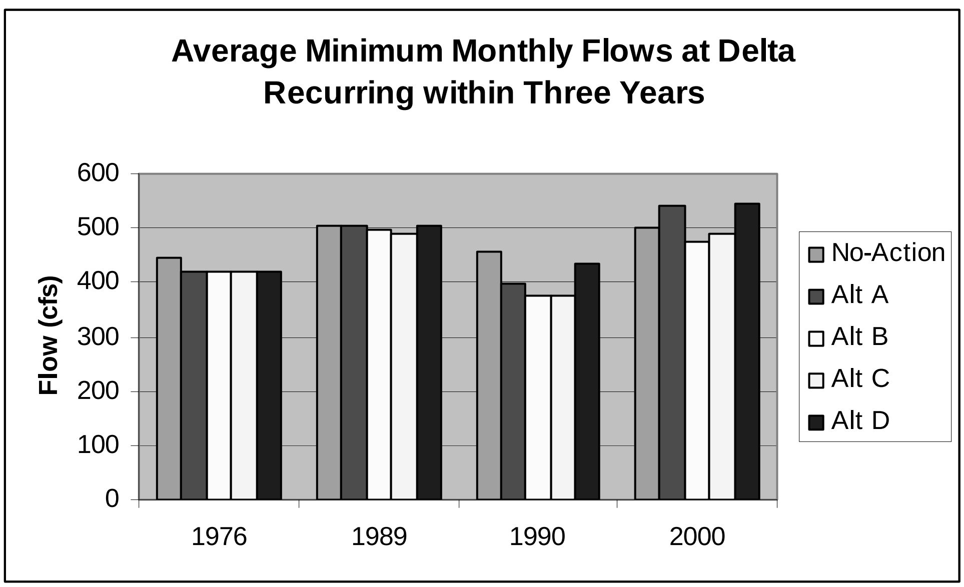

Figure 3.3- 17— Average Minimum Monthly Flows, Lowest Four Occurring Years in Study Period.

Figure 3-3-18 shows the percentage difference of annual minimum average monthly flow from the No Action Alternative for each alternative. Alternatives B, C, and D all show a significant decrease in annual minimum average monthly flow of about 50 percent from

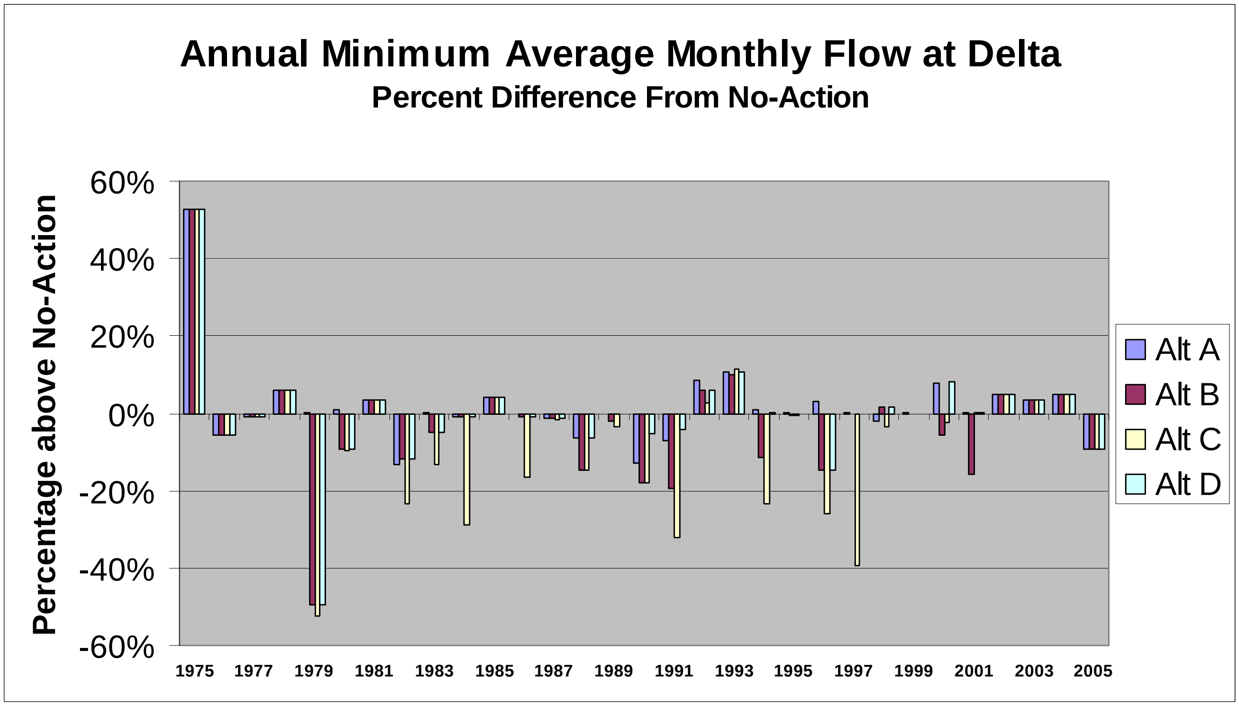

Figure 3.3- 18—Percent Difference from No Action - Annual Average Minimum Monthly Flows at Delta, Colorado.

the No Action in 1979. Alternative C results in decreases ranging from 20 percent to 50 percent in 7 of the 31 year study period.

No difference in annual selenium loading will occur due to selection and implementation of the No Action or action alternatives. However under the action alternatives, lower flows during non-peak and duration months (September through April) could increase the likelihood of higher concentrations during these periods.

As previously shown in Figure 3.3-4, one-hundred and thirty-two samples of dissolved selenium concentrations were taken at various flows at the Whitewater gage. Selenium concentrations at flows greater than 4,000 cfs were less than 3 ppb while concentrations at lower flows could be up to 10 µg/L. Figure 3.3-4 also showed that it can be concluded that the lower the flow below 4,000 cfs the greater the likelihood of higher concentrations of selenium. Figure 3.3-19 shows for each alternative, the increase or decrease in the number of days flow at Whitewater are expected to be less than 1000 cfs over the 31 year study period. For example Alternative B results in 54 additional days of flows less than 1000 cfs at Whitewater over the 31 year study period. In addition, Figure 3.3-20, shows the increase or decrease in the number of days flows at Whitewater would be less than various indicated flow rates over the 31 year period of record. For example, flows under Alternative C result in over 700 more days of flows less than 2,000 cfs than the No Action. While under the same alternative there are more than 100 fewer days less than 4,000 cfs than in the No Action. Overall Alternatives B and particularly C may adversely affect water quality by increasing concentrations of constituents due to higher instances

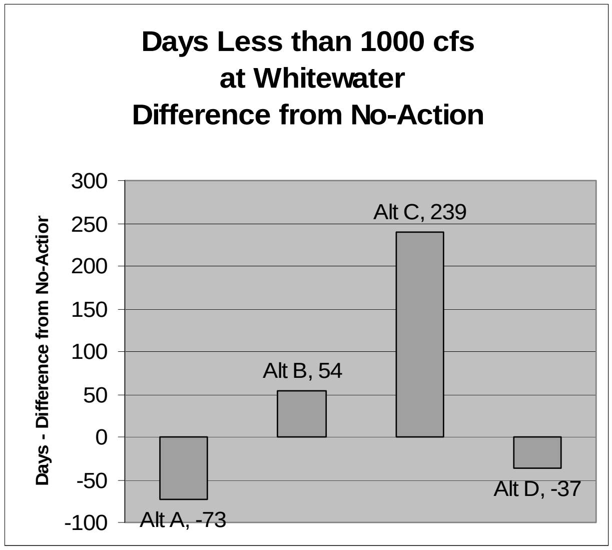

Figure 3.3- 19—Additional Days Flow Less than 1000 cfs at Whitewater over the 31 Year Study Period, Difference from No Action.

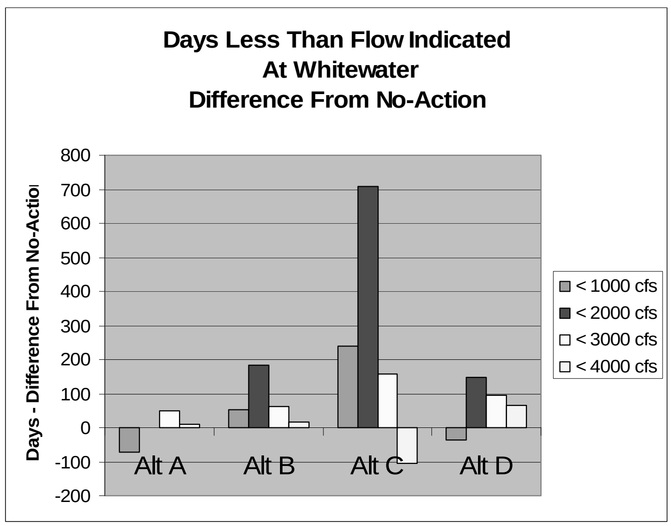

Figure 3.3- 20— Additional Days Flows Less than Various Levels at Whitewater over the 31 Year Study Period, Difference from No Action.

of lower flows. Conversely, Alternatives A and D may reduce the number of days of lower water quality.

In order to further verify this conclusion, Reclamation modified and populated a constituent loading model, “Loadest”, provided by the USGS. The model uses actual flow and selenium concentration data collected at the Whitewater gage to generate daily selenium concentration curves for each alternative at the same location.

Figures 3.3-21 and Table 3.3 8, respectively, show the annual maximum average monthly projected selenium concentration and the projected number of days per year the selenium concentration threshold of 4.6 ppb is exceeded for each alternative at the Whitewater gage. Figure 3.3.21 depicts a downward trend in selenium concentrations

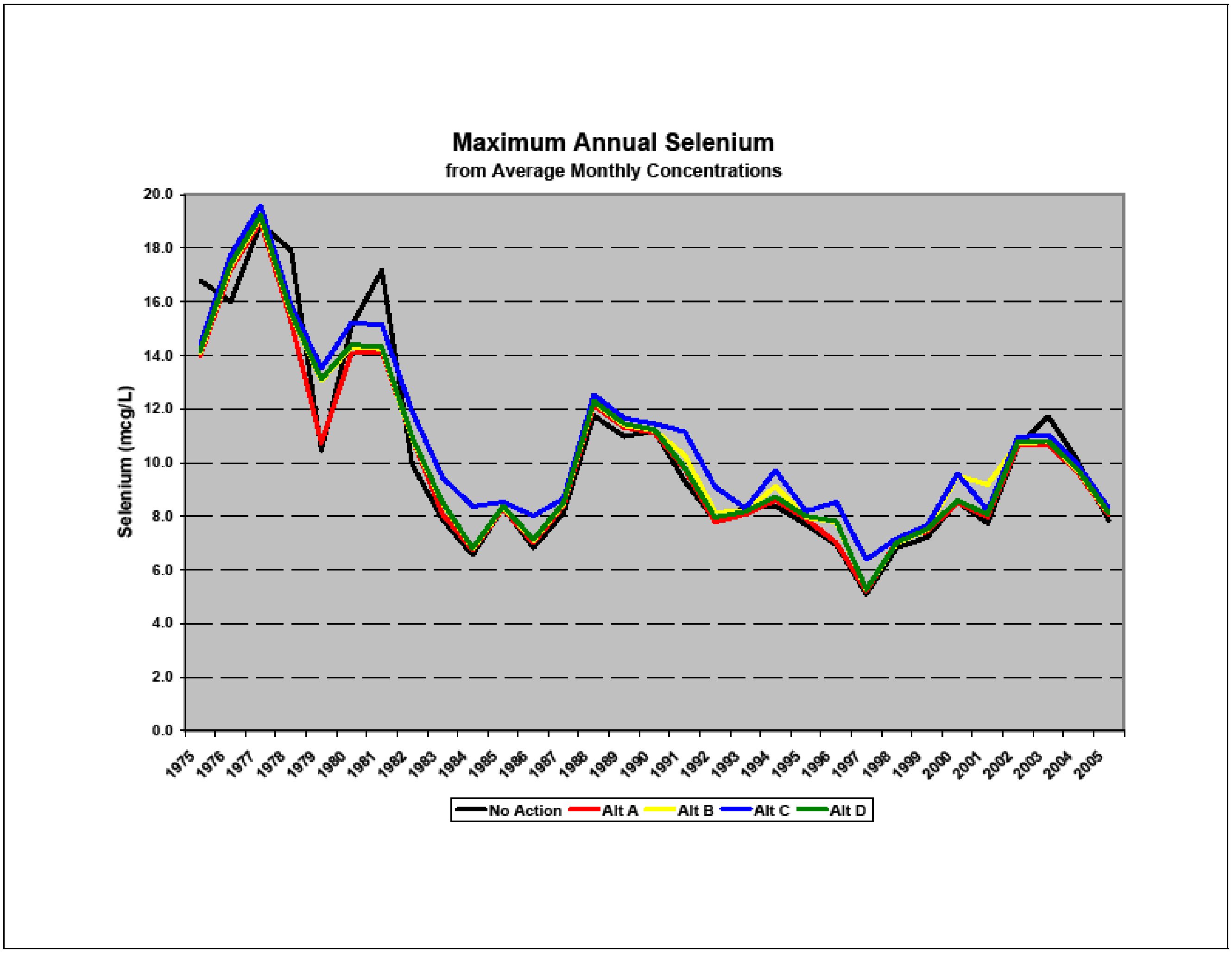

Figure 3.3- 21—Projected Annual Maximum Average Monthly Selenium Concentrations at the Whitewater Gage.

over the course of the study period. This is probably due to a variety of factors including urbanization and implementation of salinity/selenium control programs which are known to reduce selenium loading to the Gunnison River. These changes in the Uncompahgre Valley are expected to continue, resulting in a continued gradual reduction in selenium concentrations. In most years Alternative C causes a slightly higher annual maximum average monthly selenium concentration at the Whitewater gage. Alternative B is higher in only one year (2001). Close analysis of the model runs revealed that in 2000, by attempting to reach the peak flow target at Whitewater over 9 days under Alternative B versus 7 days in the other alternatives, enough storage was used to bring Blue Mesa Reservoir elevation down below the winter target elevation of 7490.0. Consequently, in 2001, Alternative B releases less water in the early part of the year in order to recover from the use of storage in the previous year resulting in higher selenium concentrations at Whitewater.

Table 3.3 8 shows the projected number of days per year the selenium concentration is projected to be greater than 4.6µg/L. The average number of days per year increases slightly over the No Action for each action alternative with Alternative C resulting in the greatest increase.

Table 3.3 8— Days Selenium Concentration Threshold of 4.6 ppb exceeded at the Whitewater Gage.

Gunnison River @ Whitewater Se					
		Days > 4.6 ppb			
	No Action	**Alt A**	**Alt B**	**Alt C**	**Alt D**
1975	308	321	325	325	325
1976	356	351	346	341	346
1977	365	365	365	365	365
1978	279	293	294	293	294
1979	274	277	276	262	276
1980	285	290	290	282	290
1981	363	363	363	363	363
1982	282	282	291	296	292
1983	253	256	256	255	256
1984	190	203	202	199	207
1985	240	252	257	266	258
1986	195	216	219	228	219
1987	259	260	261	272	261
1988	327	332	330	322	333
1989	320	322	316	318	323
1990	352	355	356	357	356
1991	289	292	295	300	295
1992	282	286	287	291	287
1993	225	226	225	228	226
1994	286	290	296	307	292
1995	169	175	176	184	178
1996	212	211	218	227	218
1997	77	97	106	164	107
1998	241	244	244	246	244
1999	243	254	263	278	262
2000	286	289	287	294	289
2001	300	307	319	313	307
2002	365	365	365	365	365
2003	325	327	327	329	327
2004	300	302	303	302	306
2005	259	265	266	271	265
Average	**274.4**	**279.6**	**281.4**	**285.3**	**281.7**

Additionally, Figure 3.3 -22 is an exceedance curve which shows the distribution of projected average monthly selenium concentrations. This figure shows there is a consistently slightly higher probability that Alternative C would produce slightly higher selenium concentrations than the other alternatives.

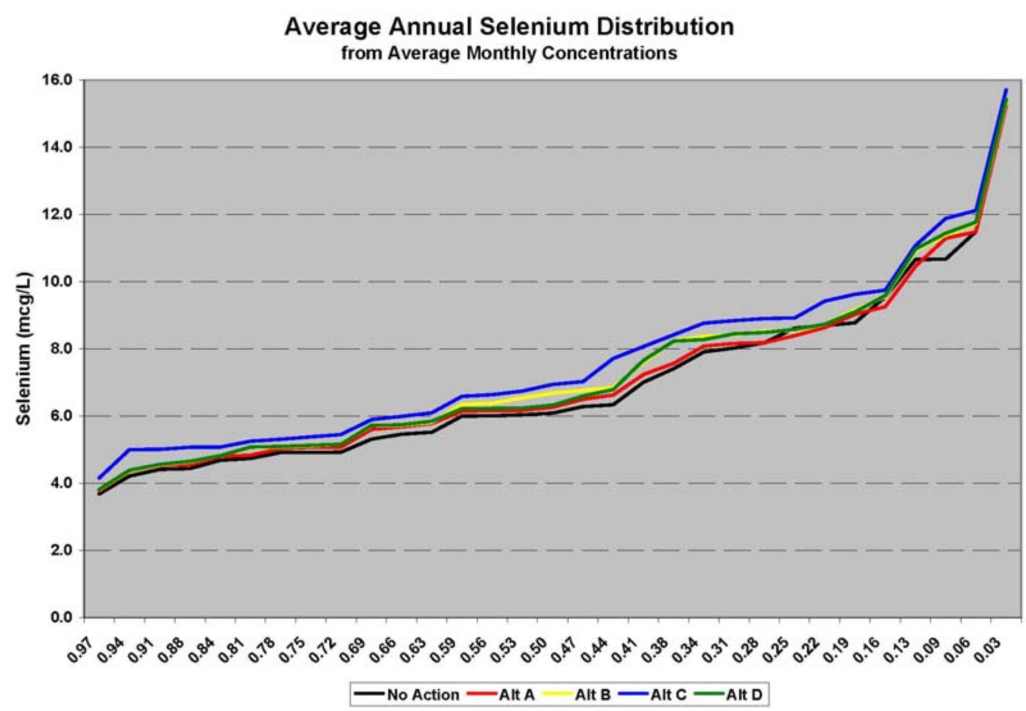

Figure 3.3- 22— Projected Average Annual Monthly Selenium Distribution at Whitewater gage.

Water Temperature - There are a wide range of variables that have a major effect on water temperature in the lower Gunnison River including air temperature, solar radiation, and other weather conditions. Tributary inflows and groundwater discharge also affect water temperature. Discharge from the Aspinall Unit has a moderating effect on Gunnison River temperature, a cooling effect in the summer and warming effect in the winter. However, the USGS (Butler 2000) draws no direct correlation between streamflow and water temperature further downstream at the Whitewater gage near Grand Junction. Further, the multiple weather, tributary, and ground water related variables combined with those associated with hydrology and runoff will make temperature effects due to alternative selection difficult to detect. Reclamation (Boyer and Cutler 2004) developed a model to depict reservoir release water temperatures resulting from the U.S. Fish and Wildlife Service “Flow Recommendations”.

This model's output was then plotted with the actual historic temperatures in Figure 3.3-23 which shows that overall, release water temperatures under the Flow Recommendations or other similar operation will be very similar to those under historic conditions. Additional discussions of temperature effects on other resources are included in each section.

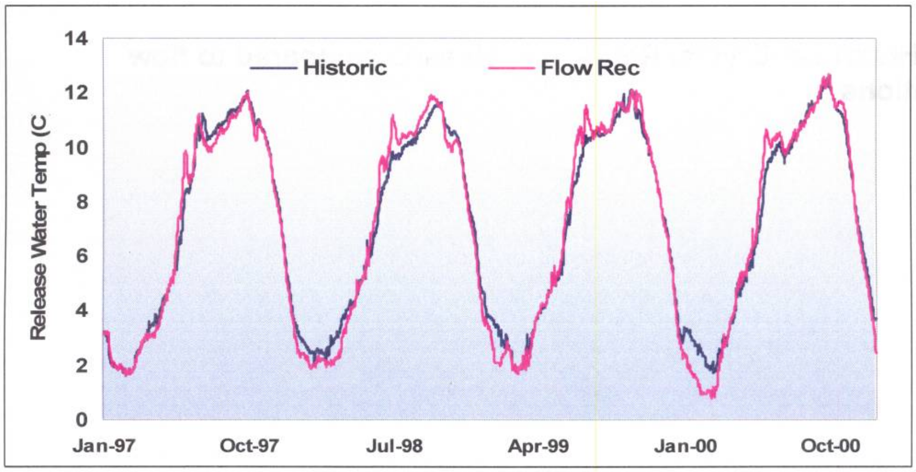

Figure 3.3- 23—Modeled verses Historic Water Temperature.

3.3.1.2E Flood Impacts

Each action alternative promotes higher spring releases to match the peak of the North Fork of the Gunnison in an effort to increase peaks and duration flows at Whitewater. None of the alternatives will supersede the direction of the Corp of Engineers Flood Control Manual described above or Executive Order 11988, 10 CFR 1022 calling on agencies to minimize impacts of floods or human safety, health and welfare. Under each of the alternatives, existing spring flood control operations would be continued by using discretion and being proactive to keep 14,000 cfs, or normally considerably less, in the Gunnison River measured at the gage above the Uncompahgre River confluence.

Upper Gunnison – Since none of the proposed alternatives contemplate changes in operation of Taylor Park Reservoir or existing December Blue Mesa Reservoir elevation targets, flood impacts upstream of the Aspinall Unit will remain unchanged.

Delta – Figure 3.3-24 shows each alternative result in slightly more years of flow occurrences above 12,000 cfs at Delta than the No Action Alternative (a maximum of 3 years during the 31-year study period). While the number of years resulting in flows above 14,000 cfs and 16,000 cfs increase or decrease slightly with each alternative. Compared to the No Action Alternative, Alternative A results in an additional year of flows above both 14,000 and 16,000 cfs. Alternatives B, C, and D result in the same number of years above 14,000 cfs as the No Action; Alternatives B and D have the same number of years above 16,000 cfs as the No Action while Alternative C actually results in one year less.

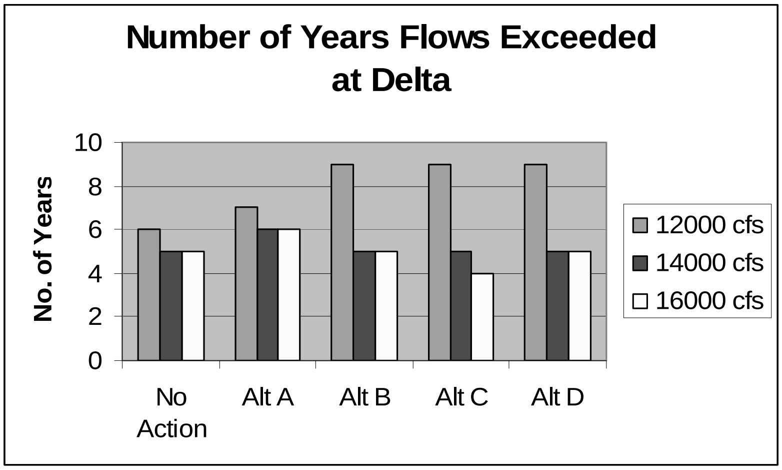

Figure 3.3- 24—Number of Years Flow Exceeded at Delta.

Whitewater - Some small irrigation diversions, farmland and minor structures could be affected by high water in the reach between Delta and Whitewater. According to the USGS, the 100 year flood near Grand Junction is rated at about 39,000 cfs. Flooding on this lower reach begins to occur in the 20,000 cfs range as was the case in 1984 when flows reached 26,200 cfs on June 8th. However, it should be noted that the operations shed located at the Redlands Fish Ladder did experience some damage from inundation in 2008 at flows of around 14,000 cfs. Figure 3.3-25 shows the annual peak flow distribution at Whitewater as a result of each alternative. At extremely high flows, around 20,000 cfs, Alternative B and the No Action have about a 12 percent chance of exceedance while the remaining alternatives have about an 8 or 9 percent chance of exceedance. In other words, within the hydrologic circumstances of this period of study, there is an 88 percent chance that flows at Whitewater will be less than 20,000 cfs for the No Action and B Alternatives, while under the remaining alternatives there is a 91 or 92 percent chance that flows at Whitewater will be less than 20,000 cfs. This means Alternative B creates about the same chance of flooding at Whitewater as the No Action while the chance of flooding under the remaining alternatives is slightly less.

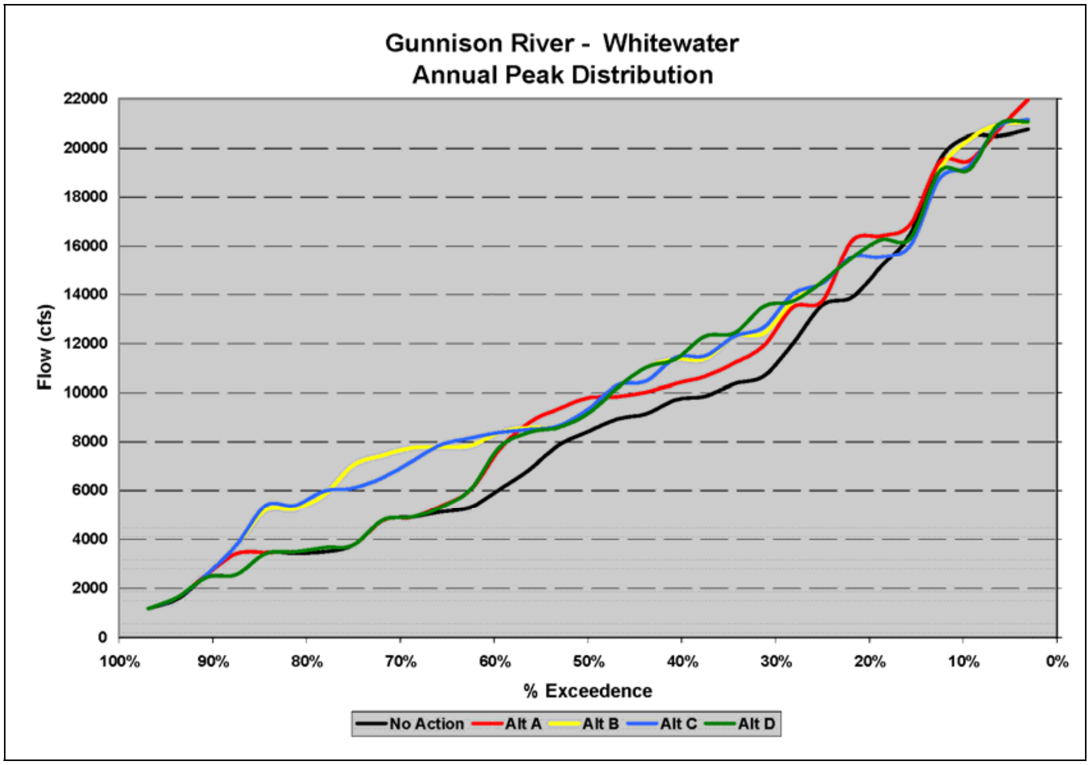

Figure 3.3- 25—Annual Peak Distribution at Whitewater.

3.3.2 HYDROPOWER

This section addresses the potential impacts to electrical power (i.e., hydropower) generation and power marketing.

Issue: How would the No Action and action alternatives affect the amount of electrical power generated and the ability to provide system regulation assistance; economic value of the electrical power produced; and the rate CRSP customers pay for power?

Overview

Scope

The scope of analysis considers the seven Western states area that receives power generated at the Aspinall Unit power facilities.

Impact Indicators

The indicator used to determine impact on hydropower is the economic loss caused by changes in Aspinall Unit releases as a result of the alternatives and the associated change in the rate CRSP customers pay for power.

Summary of Impacts

In comparison to the No Action Alternative, all alternatives result in a loss of electric generation as well as an economic loss from the Aspinall power system when considered on an average annual basis. The annual average economic impact of Alternatives A, B, and D is small. Alternative C shows an annual average economic loss of $ 2.050 million which is nearly a five percent reduction in economic value when compared to the economic value produced by the Aspinall Unit each year and is considered a significant impact. The alternatives differ significantly in the monthly patterns of water release and electrical generation. Monthly variations in generation and seasonal variations in power prices could make it necessary for Western to purchase replacement power to meet contract commitments. Power revenues available for deposit in the Basin Fund could be reduced and thus impact the amount of funding available for operation and maintenance of facilities, including support for environmental programs, and also reduce repayment capability of the Basin Fund. Appendices C and D contain additional information on hydropower. Using data from the economic analysis, the greatest impact to the Salt Lake City Area Integrated Projects rate could be an increase of 0.53 mills/kilowatt-hour for Alternative C.

3.3.2.1. Affected Environment

3.3.2.1A Power Generation

Hydropower generation is directly related to the net effective head on the generating units and the quantity of water flowing through the turbines. The net effective head is the difference between the elevation of the reservoir and the elevation of the water in the tailrace below the dam. The head and the quantity of water flowing through the turbines influence the maximum power output capacity of the powerplant; capacity is the total powerplant generation capability at any point in time, measured in kilowatts (kw) or megawatts (MW). In general, the powerplant capacity increases as a function of increasing head. However, turbine capacities or other equipment limitations may limit powerplant output levels.

Electrical power is measured in terms of capacity and energy. Electricity must be available the instant consumers need it. Capacity is important to meet consumers' instantaneous demand as they turn on lights, appliances and motors. Energy is the amount of electricity delivered over time and is measured in kilowatt-hours or megawatt-hours. One kilowatt-hour of energy delivered over one hour requires one kilowatt of capacity.

The capacity of each Aspinall Unit facility and historic average annual energy generation is summarized below:

Facility	Average Annual Capacity (MW)	Average Annual Generation (MWH)
Blue Mesa Powerplant	86.4	264,329
Morrow Point Powerplant	165.0	343,450
Crystal Powerplant	31.5	167,771

3.3.2.1B Power System Operations

Reclamation and the Western Area Power Administration (Western) work together on a daily basis in scheduling water releases and in coordinating maintenance outages. Western dispatches power generation at each facility to ensure compliance with minimum and maximum flow requirements, and comply with other constraints set by Reclamation in consultation with other Federal, State, and local entities. The CRSP Act requires that CRSP facilities, including the Aspinall Unit, "be operated in conjunction with other Federal powerplants, present and potential, so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates…"

In dispatching power generation, Western must also consider its power system responsibilities associated with North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council (WECC) criteria. WECC, as a regional council of the NERC, has responsibility for coordinating and promoting electric system reliability in the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 western states in between.

NERC and WECC operating criteria require Western and Reclamation to meet scheduled load changes by ramping the generators up or down beginning at 10 minutes before the hour and ending at 10 minutes after the hour. Ramping is the change in the water release from the reservoir through the turbine to meet the electrical load (or power demand).

Both scheduled and unscheduled ramping are crucial in load following, ancillary services, power system regulation, emergency situations, and variations in real time (what actually happens compared to what was scheduled) operations.

Typically, power demand increases during the daylight hours as residences, commercial establishments, agriculture and industry put electricity to use. Hydropower generation can react instantaneously to the load – a pattern called load following. By comparison, coal- and nuclear-based resources have a relatively slow response time; consequently, they generally have limited load following capability in the WECC.

As a control area operator, Western regulates the transmission system within a prescribed geographic area. Western is required to react to moment-by-moment changes in electrical demand within this area, adjusting the electrical power output of hydroelectric generators within the area in response to changes in the generation and transmission system to maintain the scheduled level of generation in accordance with prescribed NERC criteria. Automatic Generation Control (AGC) is a process whereby the control system automates the water releases in a manner that follows the power system's actual dynamic demands on a moment-to-moment (typically a four-second-interval) basis.

Regulation depends on being able to ramp releases up or down quickly in response to system conditions. In addition, each utility is required to have sufficient generating capacity – in varying forms of readiness – to continue serving its customer load, even if the utility loses all or part of its own largest generating unit or largest capacity transmission line. This reserve capacity ensures electrical service reliability and an uninterrupted power supply.

Generating capacity that is connected to the power system and is in excess of the load on the system is called spinning reserve. Spinning reserves are used to quickly replace lost electrical generation resulting from a forced outage, such as the sudden loss of a major transmission line or generating unit. Additional off-line generating units are also used to replace generation shortages, but they cannot replace lost generation capacity as quickly as spinning reserves.

The two uppermost powerplants of the Aspinall Unit (Blue Mesa and Morrow Point) are critical to Western's operations in that they can be operated to provide load following to meet peak power demands. Blue Mesa and Morrow Point powerplants operate in a load following mode with large hourly fluctuations in power production over the course of a day with potential ranges from zero to maximum capacity in one hour. Crystal Reservoir serves as a regulation reservoir to stabilize flows to the Gunnison River; consequently, fluctuations in power generation at Crystal Powerplant are minimal. The flexibility offered by the three dams of the Aspinall Unit is very important for meeting peaking, automation generation control, and reserve sharing obligations of CRSP.

3.3.2.1C Power Marketing

Interconnecting transmission lines, both public and private, carry the power from generating facilities to major metropolitan areas and rural areas throughout the West. Western's power marketing responsibility, in most cases, begins at the switchyard of Federal hydroelectric power facilities and includes Federal transmission systems, while the hydroelectric plants are operated by Reclamation. Any power surplus or deficit affects all CRSP power customers since the CRSP marketing area is within the WECC region, which is one large interconnected system.

Western markets CRSP power and administers the power contracts for power generated from Reclamation-owned and operated hydropower facilities in the Upper Colorado Region except for a small amount of power used on Reclamation projects. Marketing of electricity is based on capacity and energy. Energy and capacity are important to meeting consumers' continuing need for electricity. With the delivery of electricity, capacity and energy are both present; however, they can be marketed and billed separately. Western's power rates usually include individual charges for capacity and energy. Currently, a CRSP power customer pays $4.70 per kilowatt–month for electrical capacity. This capacity fee is paid every month regardless of the electricity a customer actually buys. It is a fee to reserve an amount of capacity that can be called upon by the customers to generate the electricity the customer may call upon during the month. Additionally, a CRSP power customer pays 11.06 mills per kWh for electrical energy delivered. While these two charges are not additive, for informational purposes, a "combined rate" is calculated. This is not an additional charge to the customer. The "combined rate" for energy and capacity is 26.80 mills per kilowatt hour.

Power is marketed in terms of firm and non-firm power. Firm power is capacity and energy that is guaranteed to be available to the contractor, in accordance with the terms of the contract. A sufficient portion of the generation capacity is held in reserve to enable continued delivery of firm power even if an outage occurs at a powerplant. The amount of power that is held in reserve is established by various power pooling agreements and reliability criteria. The majority of CRSP power is sold under long-term firm power contractual arrangements.

Non-firm power is capacity and energy that is not guaranteed to be available to the contractor. Non-firm power is sold to wholesale customers that would rather purchase non-firm energy that is less expensive than the cost of their own generation or cost of alternative sources of supply. Non-firm energy is usually sold with the requirement that the sale can be stopped on short notice and the buyer must have the resource available to meet its own load. Rates for non-firm energy only include a charge for the energy delivered, since the customer has the capacity to meet its loads, if necessary. Western does not sell non-firm power on a long-term basis. CRSP power in excess of that needed to meet long-term contractual requirements can be sold on a short term basis to wholesale customers as either firm or non-firm power.

Western allocates long-term firm capacity and energy from the various Federal powerplants, including the Aspinall Unit powerplants, in the Western States. The SLCA/IP is a group of Reclamation hydroelectric facilities marketed by Western which includes CRSP power and power from the Rio Grande Project and the Collbran Project. Electric capacity and energy from these hydropower plants, along with power purchased by Western, is provided to Western's power customers under contracts. Most such agreements are long-term firm contracts that specify the amounts of capacity and energy that Western agrees to deliver to its customers. Currently, the twenty year contracts for SLCA/IP power expire in 2024.

Western markets SLCA/IP power, through its CRSP – Management Center Office in Salt Lake City, that serves approximately 5.8 million retail customers in rural areas and small towns in Wyoming, Utah, Nevada, Arizona, New Mexico, Colorado and Nebraska. CRSP power customers purchasing wholesale electricity from Western are: 1) small and medium-sized towns that operate publicly owned electrical systems, 2) irrigation cooperatives and water conservation districts, 3) rural electrical associations or generation and transmission co-operatives who are wholesalers to these associations, 4) federal facilities such as Air Force bases, 5) universities and other state agencies and 6) Indian tribes. The reliance on CRSP power varies considerably among customers, with some customers receiving virtually all of their electrical service from the CRSP, to utilities in which CRSP resource is a small percentage of their total needs.

SLCA/IP customers are allowed, under the terms of their contracts, to schedule electrical energy to respond to changes in electrical use within their service territories. Western specifies the maximum amount of electrical energy that can be used by a customer within a month, the maximum amount that can be called upon in any given hour and the minimum amount that must be scheduled by a customer "around the clock". Otherwise, SLCA/IP customers schedule electrical power to meet the needs of its retail customers.

Firm capacity and energy levels are guaranteed to the customer. If Western is unable to supply contracted amounts of firm capacity or energy from Reclamation hydroelectric resources, it must purchase the deficit from other (primarily non-hydropower) resources for delivery. Depending on the type of service offered, expense for this purchased power is either shared by all contractors, leading to a general increase in the overall rate, or it is passed through to individual customers. In addition, customers may choose to purchase some or all of this deficit on their own, in which case there would be financial impacts to the customers above and beyond those impacts shared by the CRSP customers or passed through by Western.

3.3.2.1D Upper Colorado River Basin Fund

The Upper Colorado River Basin Fund (Basin Fund) was established under Section 5 of the CRSP Act. The CRSP Act "authorized a separate fund in the Treasury of the United States to be known as the Upper Colorado River Basin Fund . . . for carrying out provisions of this Act other than Section 8". Money appropriated for construction of CRSP facilities and Section 8 funding is credited in the Basin Fund. Revenues derived from operation of the CRSP and participating projects are deposited in the Basin Fund. Most of the revenues come from sales of hydroelectric power and transmission services. The Basin Fund also receives revenues from M&I water service sales, rents, salinity funds from the Lower Colorado Basin (as a pass-through for the Colorado River Basin Salinity Control Program), and miscellaneous revenues collected in connection with the operation of the CRSP and participating projects. Revenues and appropriated funds are accounted for separately in the Basin Fund.

Basin Fund revenues must first be used to repay costs associated with the operation, maintenance, and replacements of, and emergency expenditures for, the CRSP initial units. The fund is then used to repay the United States Treasury Department for the following:

- The construction costs of the CRSP initial units allocated to the power purpose (with interest thereon);
- The construction costs of the CRSP initial units allocated to irrigation;
- A portion of salinity investment and operation costs; and
- The construction costs of the participating projects allocated to the irrigation investment and above the irrigator's ability to pay.

The Basin Fund also supports the following:

- Cost sharing for Colorado River Basin Salinity Control Program (approximately $2.0 million annually);
- The major portion of the cost of the Glen Canyon Adaptive Management Program (currently almost $9.5 million annually);
- Cost sharing for the Upper Colorado and San Juan Endangered Fish Recovery Implementation Programs (currently approximately $7 million annually);
- Water quality studies; and
- Consumptive use studies.

The approximately $16.5 million per year of power revenues expended for the Glen Canyon Adaptive Management Program, the Upper Colorado River Recovery Implementation Program, and the San Juan Basin Recovery Program are expenses that are not built into the firm power rates. This arrangement benefits the programs in that they do not need to seek annual appropriations from Congress for these funds. However, this does have an impact to Western in times when firming power purchase expenses are high (due to drought or experimentation) because the moneys are transferred to the program and are not available to purchase the power needed to meet contractual requirements.

The Basin Fund is managed by Western. Approximately $120 million in revenue is needed each year to fund Reclamation and Western operation and maintenance (O&M) needs. Western is responsible for transmission and marketing of CRSP power, collecting payment for the power, and transfer of revenues for repayment to the United States Treasury Department. A change in the amount of available capacity or energy could potentially affect the revenue derived from the sale of energy and the contributions to the Basin Fund, or rates charged to power customers.

3.3.2.2. Impact Analysis

3.3.2.2A Power Generation Impacts

Hydropower generation analyses are based on two methodologies. The first is an economic analysis that represents the effects on a national perspective for each alternative. The results from the economic analysis provide values that reasonably represent national economic benefits. These economic impacts are a result of changes in the operation of the Aspinall Unit facilities. They represent a change in national economic benefits. However, these economic impacts are borne by SLCA/IP customers who receive the electrical power produced at these facilities. Once the economic impacts are identified, the second step is to identify the impact to those who are affected by them. The second analysis is referred to as a financial analysis. It represents the impact to the wholesale rates paid by the utility customers who purchase the electricity generated by the SLCA/IP powerplants and thus describes the effect of the national economic analysis financially, for those who pay a SLCA/IP rate.

3.3.2.2B Economic Analysis Methodology

The economic value of operating an existing hydroelectric powerplant varies considerably with time of day. The cost of meeting demand varies on a second-by-second basis depending on the load, the mix of powerplants being operated to meet load, and their output levels. During off-peak periods, demand is typically satisfied with lower-cost coal, run-of-river hydropower, and nuclear units. During on-peak periods, the additional load is met with more expensive sources such as gas turbine units. Consequently, the economic value of hydropower is greatest during the hours when the demand for electricity, and the variable cost of meeting demand, is the highest. In evaluating alternatives, consideration was given only to the change in power generation from the Aspinall Unit without looking at the potential impact to other generation facilities. In this analysis, power, or electrical generation, refers to both capacity and energy.

This analysis used a computer model developed by Argonne National Laboratories. The model uses an estimate of the quantity of energy injected into the power grid along with a 2007 forecasted hourly electricity spot price (market price) to determine the economic value for each alternative. The model simulates hourly hydropower generation at each of the three Aspinall Unit powerplants. It determines the hourly operation schedule over a one-week period that maximizes the economic value of Aspinall Unit hydropower resources. The operation schedule produced by the model is within the physical limitations of each powerplant and associated reservoir. It also complies with all environmental and institutional constraints. Crystal Reservoir operations were modeled such that fluctuations in the Gunnison River were minimal. Because Crystal Reservoir regulates flows in the Gunnison River, fluctuations in releases through Morrow Point and Blue Mesa powerplants can be made to follow power demands and, thus, releases may fluctuate widely. However, during periods when Crystal Reservoir is spilling, release fluctuations through Morrow Point and Blue Mesa powerplants may be restricted so as to minimize fluctuations in the Gunnison River below Crystal Dam. The hydrology input provided by Reclamation consisted of a 31-year period (1975 to 2005) of projected daily releases under the action and No Action alternatives. The same hydrology trace was used to evaluate all alternatives. For a detailed description of the methodology used in the analysis, refer to Appendix C.

Hourly market prices for the model were generated based on energy prices that were current at the time when the study was initially conducted in the summer of 2007. Average seasonal on-peak and off-peak prices were obtained from Prebon which, along with NYMEX natural gas futures, were used to estimate monthly prices. Pricing data can be found in Appendix D.

3.3.2.2C Economic Impacts

The impact of the alternatives on the production of power, or electrical generation, at the Aspinall Unit power system is shown in Table 3.3 9. This table illustrates the average impact over the 31 years modeled for this economic analysis.

The base year used for economic analysis purposes in this EIS is 2008 and the power impacts occur over a 31-year period. As further described in Appendix D, additional calculations were carried out to express hydropower economic impacts on a 2008 present value basis. The power prices used in this analysis are from 2007. These values were escalated to 2008 dollars using an escalation rate of 2.2 percent. Observations occurring after 2008 were escalated by 2.2 percent per year and then discounted by 4.875 percent, the current Federal discount rate. This process places the estimated power economic impacts, which occur in different years, on a commensurate 2008 present value basis. The economic results, measured in 2008 dollar terms, are reported in the narrative and results tables which follow.

For each alternative, Table 3.3 9 shows changes from No Action. Calculations were made from modeled average annual results of the economic impact, the Aspinall Unit generation, the release of water through the Aspinall powerplants (power release), the release of water that bypassed the powerplant (bypass tubes and spillway), and the total release. A negative number denotes a reduction as compared to No Action. A positive number denotes an increase as compared to No Action.

As shown in Table 3.3 9, all alternatives result in a loss in electric generation as well as an economic loss from the Aspinall power system relative to No Action when considered on an average annual basis. The economic losses recorded in column two of Table 3.3 9 are especially influenced by the “retiming” of electrical generation. Generally, all of the alternatives, to one degree or another, move water release and subsequently, electrical generation, to the spring (May). The added water release in the spring required that water be moved from other months of the year including those with a greater demand – or economic value – for electrical power.

Table 3.3 9— Impact of Alternatives on the Aspinall Unit Power System (Difference from No Action).

Alternative	Annual Average Economic Impact (Thousands of 2008$)	Average Annual Generation (GWh)	Power Releases (TAF)	Average Annual Non-Power Releases (TAF)
A	-$11	-1.181	-7.277	7.890
B	-$622	-9.914	-41.089	41.969
C	-$2,050	-37.690	-140.892	142.979
D	-$484	-7.360	-31.117	31.873

As displayed in Table 3.3 9, the average economic impact of Alternative A is well within the error of the analysis and is considered insignificant at $11 thousand when compared to the economic value of around $42 million produced by the Aspinall Unit each year. The economic impacts of Alternatives B and D are larger at $622 thousand and $484 thousand, respectively, on an average annual basis and are also considered insignificant. The impact of Alternative C, reported as an economic loss on an average annual basis of $2.050 million, is nearly a five percent reduction in economic value and is considered significant. The 30-year impact of Alternative C would be over $63 million.

The economic impact to the Aspinall power system on an average annual basis is a measure of impact that can overlook significant variations that occur on a year-to-year basis. Thirty one years were modeled for the power analysis of the alternatives. The variation among years of the economic impact within an alternative is more pronounced than the average difference between any two alternatives. Economic impacts for Alternatives A, B and D that are considered insignificant on an average basis can show significant impacts, both positive and negative, in a subset of years as compared to No Action.

Table 3.3 10 shows a summary of the results of the modeling of the alternatives on electrical generation for each of the 31 years analyzed. Annual values displayed for each of the four action alternatives as compared to the No Action Alternative. As shown in Table 3.3 10, the impact of the action alternatives on electrical generation at the Aspinall Unit varies significantly among alternatives. In 1975, for example, Alternative A produces more electrical generation than the No Action Alternative (approximately 14,000 MWh), while Alternatives B, C and D produce almost 9,000 MWh less. In comparison, on an average basis, the alternatives all produce slightly less electricity than the No Action Alternative. Since the amount of water released in a given year is the same for all alternatives modeled, including the No Action case, the generation differences would be the result of production efficiency, i.e., releasing water through the Aspinall powerplants when the reservoirs are at higher elevation.

Table 3.3 11 displays the impact of the alternatives in terms of economic cost or economic value. The alternatives differ significantly from each other when looked at annually. For example, in 1978, in comparison to the No Action Alternative, Alternative

A decreases the value of electrical generation, Alternatives B and D increase the value of electrical generation by $1.26 million and Alternative C increases the value of electrical generation by nearly $5 million.

The differences between alternatives are affected by the economic value of power. This is because generation is not valued the same in each month of the year. An alternative that produces considerably more electrical power in May could have this increased power generation offset by a slight decrease of electrical power in August. This is because the value of power in August is considerably higher than in May.

Table 3.3 10—Impacts of Alternatives on Total Aspinall Electrical Generation by Year (Difference from No Action),

	Total Generation (MWh)			
Year	**Alt A**	**Alt B**	**Alt C**	**Alt D**
1975	13,784	(8,816)	(8,816)	(8,816)
1976	290	2,718	13,622	2,718
1977	25,236	24,606	23,436	24,606
1978	(3,960)	34,785	87,311	34,784
1979	(15,682)	(110,449)	(77,463)	(110,449)
1980	(180)	(43,127)	(99,396)	(43,127)
1981	13,250	13,708	(13,066)	13,708
1982	(10,895)	(28,300)	(291,448)	(28,300)
1983	(2,340)	(11,489)	(23,406)	(4,429)
1984	(7,400)	(4,205)	(134,734)	(5,338)
1985	2,067	2,330	(26,014)	2,161
1986	(3,070)	(17,693)	(102,853)	(17,686)
1987	(1,953)	(490)	(4,361)	(490)
1988	3,520	9,080	27,359	3,990
1989	1,717	1,700	(9,845)	(2,431)
1990	(3,810)	(11,910)	(18,596)	696
1991	(3,632)	(13,543)	(40,046)	(5,173)
1992	(21)	(5,430)	(14,756)	560
1993	(18,183)	(20,632)	(39,960)	(16,141)
1994	16	(7,111)	(26,091)	(126)
1995	(21,537)	(10,755)	(157,020)	(11,835)
1996	4,477	(45,469)	(69,070)	(45,573)
1997	675	2,523	(85,348)	2,523
1998	(2,134)	3,183	(2,602)	3,183
1999	(13)	(13,563)	(39,460)	(7,994)
2000	(21)	4,298	(6,838)	(334)
2001	(47)	(43,290)	(6,228)	(531)
2002	19,366	15,771	16,417	18,874
2003	50,963	64,412	80,347	46,209
2004	(5,844)	13,498	41,779	(6,195)
2005	(71,258)	(103,680)	(161,232)	(67,219)
Total	(36,622)	(307,341)	(1,168,377)	(228,174)
Average	**(1,181)**	**(9,914)**	**(37,690)**	**(7,360)**

Table 3.3 11—Impacts of Alternatives on Total Aspinall Economic Value by Year (Difference from No Action). 2008 Dollars

	Difference from No Action			
Year	**Alt A**	**Alt B**	**Alt C**	**Alt D**
1975	$1,649,043.44	($744,574.41)	($744,576.30)	($744,576.30)
1976	($445,804.58)	($560,867.64)	($107,327.92)	($560,867.08)
1977	$1,844,412.82	$1,796,962.53	$1,705,736.43	$1,796,961.66
1978	($222,690.11)	$1,260,991.69	$4,820,656.54	$1,260,989.39
1979	($993,932.22)	($7,261,204.67)	($4,523,834.30)	($7,261,205.03)
1980	$116,354.85	($2,516,619.69)	($6,076,651.05)	($2,516,619.25)
1981	$843,837.83	$886,874.68	($908,066.40)	$886,875.72
1982	($693,226.66)	($2,068,096.52)	($18,096,299.04)	($2,068,097.12)
1983	($141,413.45)	($722,601.02)	($1,381,020.53)	($429,663.95)
1984	($445,689.33)	($236,907.31)	($6,972,752.65)	($297,485.91)
1985	($68,616.63)	($125,902.35)	($1,605,533.75)	($136,668.54)
1986	($214,650.35)	($1,390,622.62)	($6,089,356.61)	($1,390,106.55)
1987	($98,192.42)	($41,589.48)	($305,964.36)	($41,566.36)
1988	$230,955.01	$407,206.28	$1,048,137.35	$256,430.18
1989	$92,905.80	($69,469.28)	($862,513.27)	($85,643.14)
1990	($162,958.51)	($597,131.55)	($955,909.01)	$76,281.78
1991	($176,027.75)	($714,234.43)	($2,067,896.77)	($326,745.61)
1992	$6,079.16	($332,466.64)	($1,028,165.10)	$36,504.81
1993	($734,214.32)	($828,785.33)	($1,618,107.80)	($625,551.13)
1994	$3,761.35	($476,742.40)	($1,590,130.58)	($5,412.26)
1995	($942,069.78)	($456,825.34)	($6,071,368.46)	($510,836.03)
1996	$120,867.95	($2,202,669.54)	($3,394,304.06)	($2,206,548.35)
1997	($23,613.11)	$11,545.35	($3,723,665.91)	$11,547.74
1998	($138,832.36)	$149,557.65	($127,873.65)	$149,543.02
1999	($36,425.20)	($708,437.84)	($1,834,257.18)	($465,762.88)
2000	$13,913.36	($159,791.16)	($373,465.51)	$6,690.98
2001	($2,248.41)	($1,777,892.43)	($350,989.44)	($20,619.98)
2002	$751,099.73	$630,365.26	$650,594.48	$732,627.73
2003	$1,982,426.67	$2,423,555.58	$2,943,264.53	$1,824,406.00
2004	($177,706.17)	$435,544.10	$1,298,832.53	($192,370.56)
2005	($2,275,176.01)	($3,283,608.79)	($5,213,926.40)	($2,151,539.97)
Total	($337,829.40)	($19,274,437.32)	($63,556,734.19)	($14,999,026.99)
Average	($10,897.72)	($621,756.04)	($2,050,217.23)	($483,839.58)
Percent Difference	-0.03%	-1.47%	-4.86%	-1.15%

Impacts analyzed on an annual average basis can hide the effect of monthly changes in electrical generation. In order to release water through the Aspinall powerplants over the course of a year, the releases are patterned over the year in terms of monthly targets. The alternatives differ significantly regarding the monthly pattern over a year of water release and electrical generation. This monthly variation in releases, coupled with seasonal variations in the economic value of power, can mask detrimental economic impacts within a given year even though the average annual impact appears to be of little significance. Such monthly or annual variations in available generation could make it necessary for Western to purchase replacement power to meet contract commitments. Power revenues available for deposit in the Basin Fund could be reduced and thus impact the amount of funding available for Operation and Maintenance of facilities, including support for environmental programs, and also reduce repayment capability of the Basin Fund.

3.3.2.2D Financial Analysis Method and Results

Hydropower is generally less expensive to produce than alternative technologies since there is no fuel cost. The SLCA/IP rates include assistance to water development projects. Currently, about one third of future revenues projected in the SLCA/IP rate are programmed to financially assist with development and construction repayment costs of authorized water projects.

The SLCA/IP electrical power is marketed on a cost-based basis. While the SLCA/IP rate for wholesale power is relatively inexpensive, retail rates of SLCA/IP electrical coop and irrigation customers are typically higher than in privately owned utility service areas. This is the case, to a great extent, because rural areas require larger investments in transmission and distribution lines for each commercial, industrial or residential load served.

Western sells SLCA/IP power under long-term firm contract. It charges for capacity contracted and for energy used. These are separate charges. Often, for ease of display or understanding, Western reports a “composite” rate – a combination of the capacity and energy prices charged. The financial impacts are reported as changes in the composite rate.

Table 3.3 12 displays the impact of the alternatives on the SLCA/IP firm-power rate. A positive number indicates an increase in the SLCA/IP rate as a result of the implementation of an alternative. A negative number indicates a decrease in this rate as a result of an alternative. The rate change in Table 3.3 12 is shown in mills (one thousandth of a dollar) per kilowatt hour. All but one of the alternatives (Alternative A) could require an increase in the SLCA/IP rate.

Table 3.3 12—Impacts to the SLCA/IP Rate.

Alternative	Change in SLCA/IP rate (mills/kWh)
No Action	0.00
Alternative A	- 0.03
Alternative B	0.16
Alternative C	0.53
Alternative D	0.14

3.3.3 OPERATION AND MAINTENANCE

This section addresses the potential impacts to operation and maintenance (O&M) and facility safety at the Aspinall Unit.

Issue: How would the No Action and action alternatives affect the O&M and safety of Aspinall Unit facilities? What increase in costs might be expected?

Overview

Scope

The scope includes the dam, reservoirs, powerplants, and other facilities of the Aspinall Unit.

Impact Indicators

A change in how water is released from Aspinall Unit facilities could result in degradation of structural features such as spillways, tunnels, and plunge pools. With such change, increased monitoring and maintenance might be needed to ensure the structural integrity of the facilities. The indicators used to determine impacts on O&M centered on whether increased spillway use and consequent increased costs would be caused by changes in dam releases as a result of the alternatives.

Summary of Impacts

Increased O&M cost as a result of attempting to meet the Flow Recommendations is directly related to the increased use of spillways and bypasses at Aspinall Unit facilities. Spillway/plunge pool inspections, following a spill, range from around $7,500 per inspection at Morrow Point Dam to $85,000 per inspection at Crystal Dam. The cost of concrete repairs depends on the amount of damage caused by increased spilling; one such repair at Morrow Point Dam in 1996 cost nearly $195,000. Crystal Dam is most susceptible because of the effect of spillway spray on the power transformer; therefore, the greatest impact to O&M is most likely to occur at Crystal Dam and Powerplant with an associated maintenance cost estimated at $200,000 per spill occurrence. In terms of number of years of use over the study period, the No Action Alternative, Alternative A and Alternative D would require less spillway use than Alternatives B and C. For instance, the percent of years over the study period which the Crystal Spillway is used jumps from 32 percent for the No Action to 71 percent for Alternative B and 77 percent for Alternative C. In addition, because of the increased duration component, Alternative C requires spillway use a significant number of additional days per use over all alternatives. Overall, in comparison to the No Action Alternative, Alternative C would likely have the greatest impact to O&M costs and potential risk to dam safety.

3.3.3.1. Affected Environment

Facilities that could be affected by a change in operation are described as follows:

3.3.3.1A Blue Mesa Dam and Powerplant

Blue Mesa Dam, completed in 1965, is a 785 foot long zoned earth-fill structure with a crest width of 30 feet. Blue Mesa Dam has the capability of releasing a total of 40,100 cfs through the combined capacities of the powerplant, river outlet works, and spillway. The penstock carries water to the two turbines in the powerplant and also carries water for the outlet works. The single penstock branches to carry between 2,600 and 3,400 cfs to the turbines and between 4,000 and 5,100 cfs to the outlet works with a maximum combined capacity of 6,100 cfs. The spillway consists of a concrete intake structure with two 25-feet by 33.5-foot radial gates, a concrete lined tunnel, and a concrete flip bucket structure. The maximum discharge of the spillway is 34,000 cfs.

3.3.3.1B Morrow Point Dam and Powerplant

Morrow Point Dam is a 720-foot long double-curvature, thin-arch, concrete structure with a maximum height of 468 feet above the foundation. Water is conveyed from the reservoir to the turbines by two 13.5-foot-diameter steel penstocks, installed in 18 foot diameter tunnels through the left abutment. The powerplant has a maximum capacity of 5,000 cfs. The river outlet works consists of a stainless steel-lined conduit through the center of the dam with gates that regulate the flow through the conduit. The river outlet works has a capacity of 1,500 cfs and discharges into the spillway plunge pool. The spillway includes four openings near the top of the dam controlled by four fixed wheel gates. Water flowing through these openings falls approximately 400 feet into a reinforced concrete lined plunge pool. The spillway has a maximum capacity of 41,000 cfs.

3.3.3.1C Crystal Dam and Powerplant

Crystal Dam is a 635-foot long thin-arch, double curvature concrete structure with a height of 323 feet above the lowest point of the foundation. Water is conveyed through a single penstock to the powerplant; the powerplant has a maximum hydraulic capacity of 2,150 cfs. The outlet works carry water through two conduits and have a total capacity of between 1,900 and 2,200 cfs. The spillway consists of an ungated ogee (S-shaped) crest on the right side of the dam and a rock lined plunge pool at the toe of the dam. The spillway has a maximum capacity of 41,350 cfs.

3.3.3.2. Impact Analysis

3.3.3.2A No Action Alternative

The spillways are used to release water from the reservoirs in amounts that exceed the combined release capacity of the river outlet works and the powerplants. Historically, spillway use has occurred with the following frequency since initial operation:

Facility	Percent of All Years	Number of Days Per Year
Blue Mesa Dam	8	5 – 19
Morrow Point Dam	8	6 – 22
Crystal Dam	33	1 – 99

Under the No Action Alternative, future use of the spillway can be expected to occur at each facility according to the following frequency:

Facility	Percent of All Years	Number of Days Per Year
Blue Mesa Dam	16	1 – 23
Morrow Point Dam	16	2 – 25
Crystal Dam	32	4 – 78

3.3.3.2B Action Alternatives

Under the action alternatives, the frequency of spillway use is likely to increase over what would be expected under the No Action Alternative. An estimate of this increased usage during the 31-year study period for each dam is provided in Figure 3.3-26.

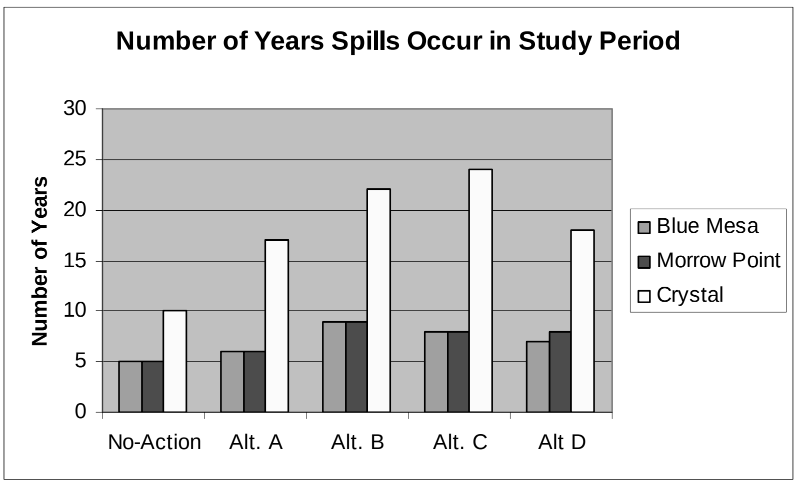

Figure 3.3- 26—Years Spillways Used for each Dam in the Aspinall Unit.

Spillway usage, expressed in terms of maximum number of days per year, is shown in Table 3.3 13.

Table 3.3 13— Spillway Use: Maximum Number of Days per Year.

Facility	Alternatives				
	No Action	A	B	C	D
Blue Mesa Dam	23	26	23	46	23
Morrow Point Dam	25	28	25	44	26
Crystal Dam	78	79	80	104	80

With increased spillway use, there is greater possibility for degradation of spillway plunge pools. Also, there may be degradation of concrete in the Blue Mesa spillway tunnel. Should damage to the spillway tunnel become excessive, repairs would be made or use of the spillway would be limited to when hydrologically necessary. While difficult to quantify, O&M costs associated with greater use of spillway and outlet works would increase. The potential for dam safety risk may also increase because of more frequent use.

At Blue Mesa Dam, anticipated costs associated with implementation of alternatives that increase spillway use include the following:

1. Rocks and debris can be expected to fall into the spillway inlet structure and flip bucket. During a spillway release, such materials, if not removed, could damage the structure. Therefore, prior to each period of spillway use, where practicable, rocks and debris should be removed from the spillway inlet structure and flip bucket. The estimated cost of this work is $7,500 per occurrence.

2. Following each period of spillway use of at least 3,500 cfs for about a week or more, it may be necessary to inspect the steep portion of the spillway tunnel using high-angle rope work techniques. The underwater portion of the spillway would be inspected either by draining the area or with underwater techniques. It is estimated that one spillway inspection would cost up to $12,000. Any needed repair would require cutting out existing concrete sections and replacing these sections with new concrete; working conditions would be difficult given the steep incline of the spillway tunnel.

If significant rock-fall into the plunge pool is suspected at Morrow Point Dam, rocks and debris should be removed before further using the spillway or outlet works. Approximately every six years, the plunge pool should be inspected for damage to the lining at an estimated cost of approximately $7,000 per inspection. If future inspections show plunge pool degradation, possibly from increased spilling, then more frequent inspections may be necessary. The cost of any concrete repairs would depend on the amount of damage. The cost of one such repair in 1996 was nearly $195,000.

The condition of the Crystal Dam plunge pool was assessed in 2008. Based on that assessment, it was concluded that the plunge pool should be inspected, either by sonar mapping or dive inspection, approximately every six years. If the sonar mapping shows significant changes from the last mapping, a dive inspection would be necessary to assess the actual damage. In order to conduct an inspection, it is necessary to discontinue the release of water to the river for up to three hours. Environmental concerns associated with conducting an inspection include safety of personnel involved and the general public and the protection of a fishery resource between the dam and the North Fork confluence. If future inspections show plunge pool degradation, possibly from increased spilling, then more frequent inspections may be necessary. The cost of one such inspection conducted by divers in March 2008 was approximately $85,000.

Because of water spray on the transformers when Crystal spills, additional maintenance of transformer bushings will be necessary following extended periods of spilling. During this period of maintenance, a complete powerplant outage would be required for up to 5 days. The outlet tubes would be used to bypass water to maintain flow in the river. The estimated cost of maintenance and the loss of power generation associated with the bypassed water would be around $200,000 for each occurrence.

Under any alternative, the greatest impact to O&M would most likely occur at Crystal Dam and Powerplant. For all facilities, Alternatives A and D would require less spillway use than Alternatives B and C, with Alternative C requiring spillway use more days per year than Alternative B. Overall, in comparison to the No Action Alternative, Alternative C would likely have the greatest impact to O&M costs of the Aspinall Unit and potential risk to dam safety.

3.3.4 AGRICULTURE

This section addresses the potential impacts to agricultural resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect agricultural resources?

Overview

Scope

The scope includes the agricultural resources within the Gunnison Basin.

Impact Indicators

The indicators used to determine impacts on agriculture caused by changes in dam releases as a result of the alternatives:

- Increased cost of maintenance on irrigation diversion dams such as the Uncompahgre Valley Water Users Association Tunnel Diversion.
- Increased calls by senior water right holders could impact storage and diversions by irrigators.
- Increased erosion and consequent loss of farmland from higher peak flows adjacent to the Gunnison River near Delta, Colorado.

Summary of Impacts

Reoperation of the Aspinall Unit for the Flow Recommendations will create differences in the historic release pattern of water from the Aspinall Unit reservoirs. Higher releases during May for spring peaks and higher flows of extended duration will result in lower releases during other months.

Irrigation Diversions – Increased magnitude and frequency of peak flows will increase the O&M costs of irrigation diversions such as the Uncomphagre Valley Water Users (UVWUA) Gunnison Tunnel Diversion. The UVWUA have noted from past experience that there is a direct correlation between increased annual O&M costs and spills occurring at Crystal Reservoir. Over the 31-year study period Alternative C increases the frequency of Crystal Reservoir Spills by fourteen years over the No Action Alternative, Alternative B by twelve years and Alternatives A and D, seven and eight years respectively. Increases associated with Alternatives B and C could be considered significant since they represent a 25 – 30 percent increase in frequency over the No Action Alternative.

Irrigation Calls - Since the base flow targets and existing agreements and contracts satisfy the senior water rights most likely to impact other basin diverters if shorted, it is unlikely that implementation of any of the action alternatives will have a negative impact on water rights and consequently agriculture production in the Gunnison Basin.

However, because the No Action Alternative does not make releases to meet minimum base flow targets, implementation of this alternative would result in about 630 days of potential RWPC calls (see Figure 3.3-15 in the Water Uses and Resources Section) over the study period.

Erosion Impacts - Increased frequency of flows in excess of 12,000 cfs could cause minor damage to agricultural land adjacent to the Gunnison River. As described in the Water Uses and Resources Flood Impacts Section, Alternative A results in one additional year of flows over 12,000 cfs, while Alternatives B, C, and D result in 3 each. The number of years resulting in flows above 14,000 cfs is 5 for the No Action and Alternatives B, C, and D and 6 for Alternative A. For flows greater than 16,000 cfs, the No Action, Alternatives B and D; result in 5 years of occurrence while Alternatives A and C result in 6 and 4 years respectively. Overall, Alternative A is most likely to increase the frequency of erosion because it increases the number of years of flows above 12,000 cfs, 14,000 cfs, and 16,000 cfs.

3.3.4.1 Affected Environment

The majority of agriculture lands in the study area are located in Gunnison, Montrose, and Delta Counties in west central Colorado. The total area of the three counties is about 6,600 square miles or about 6 percent of the total land area of the State of Colorado (104,185 sq. mi) and is inhabited by only 1.75 percent of the total State population (U.S. Census Bureau, Table 3.3 14). The majority of each county is comprised of Federal land managed by the U.S. Forest Service, Bureau of Land Management, or NPS. According to the USDA National Agricultural Statistics Service (NASS 2008) in the three counties, the 2002 total cropland area is 244,355 acres while the total irrigated area is 171,000 acres (a 16 percent decrease from 1997).

Table 3.3 14—Study Census Information.

	Gunnison	Montrose	Delta
Land Area (square miles)	3,239	2,243	1,149
Irrigated Area (sq. miles)	64.4	117.9	84.7
Population 2006 Estimate	14,331	38,559	30,401

According to the 2000 U.S. Census of Population, rural dwellers in the three counties made up 62 percent of the total population compared with 69 percent in 1990. The number of farms in Colorado has remained around 30,000 for the past 10 years with the average farm size being about 1,000 acres. The counties account for 7 percent of the total number of farms in the State.

Agriculture has been, and continues to be, a significant contributor to the economies, not just for the crops and livestock they produce, but also because of the beautiful scenery that ensures the quality of life in the area.

Irrigation is necessary in the three counties in order to produce viable agriculture. In Delta and Montrose Counties, the majority of the irrigated area is located between 5,000 and 6,200 feet in elevation with annual precipitation ranging from about 8.5 to 9.75 inches. The irrigation season begins in early to mid April and continues through the end of October.

The valley located east of the town of Delta along the North Fork and the Gunnison rivers receives prevailing mild and arid winds that emanate from the desert-like plateau region to the west. This mild wind results in an annual average precipitation in the area of 15.37 inches and an average frost-free period of 160 days a year. The beneficial climate and irrigation water supplies produce valued agricultural products such as apples, peaches, and cherries, as well as forage for a substantial local cattle and dairy industry.

In Gunnison County most of the agricultural production takes place in the valley floors at elevations ranging from 7,000 to about 9,000 feet and receive an average of about 10 inches of precipitation annually at the lower elevation and 24 inches at higher elevations.

The threat of calls from downstream senior water right holders are a concern for irrigators in the Gunnison Basin. A “call” occurs when a senior water right holder does not have sufficient water to meet his/her water right. When this occurs, junior water right holders are “called-out” meaning their diversions must be stopped. Each junior water right holder is called-out in order of priority (most junior first) until the senior water right is satisfied. Two senior water rights having a potentially significant impact on upstream water rights are the RWPC located near the mouth of the Gunnison River near Grand Junction, and the UVWUA Gunnison Tunnel which carries water to about 80,000 acres of irrigated land in the Uncompahgre Valley. In the drought years of 2002 and 2003, the Gunnison Tunnel called, which severely limited existing water uses in the Upper Gunnison Basin. Future downstream calls can impact all water uses in the basin including irrigation. These impacts can affect both storage and direct flow water rights.

The Gunnison Tunnel was constructed beginning in July 1904, and the first water for irrigation was available during the season of 1908 from the Gunnison River. The Gunnison Tunnel was completed in 1909, and the Gunnison Diversion Dam was completed in January 1912. The project was transferred to the UVWUA for O&M in 1932. The Gunnison Diversion Dam on the Gunnison River, about 12 miles east of Montrose, is a timber-crib weir with concrete wings and a removable crest. The dam has a structural height of 16 feet. It diverts Gunnison River direct flows, as well as releases from the Taylor Park Dam into the Gunnison Tunnel. The Gunnison Tunnel is 5.8 miles long and has a capacity of approximately 1,135 cfs.

Since its completion in the early 1900’s the Gunnison Diversion Dam has experienced significant peak flows, some exceeding 15,000 cfs. High flows can cause excessive pressure and wear on the structure and logs and debris can become lodged on the structure and cause damage. The UVWUA performs annual maintenance on the 100 year old structure by replacing the wooden timbers. Completion of the Aspinall Unit has reduced the magnitude and frequency of these peak flows and consequently reduced the associated maintenance.

There are several other major and minor diversion dams and pumping structures downstream from the Aspinall Unit that could potentially be affected by changes in water operations. These include permanent-type diversions such as the Redlands Diversion Dam and diversions constructed from riverbed material which require frequent maintenance or replacement. Pumping systems, used to divert water from the river are located sporadically along the Gunnison River between the confluence with the North Fork and Grand Junction. These include a wide-variety of installations. Some can be temporary portable type installations, which can be moved up or down the bank to follow the water levels of the river. Others may be permanent facilities, consisting of large concrete or steel structures.

3.3.4.1A Census of Agriculture Data

Census of Agriculture data for Delta, Montrose, and Gunnison Counties was available up to the year 2002 (Table 3.3 15). In 2002 there were 2,164 farms encompassing over 760,000 acres (1,187 sq miles) for an average farm size of about 350 acres. The 1997 Census of Agriculture showed the total number of farms at 2,206 with an average farm size of about 370. The estimated 2002 average market value of land and buildings in Gunnison County was $1.47 million, $498,000 in Montrose County, and $540,000 in Delta County. Market values remained fairly level between 1997 and 2002. Table 3.3 16 shows the 2006 County Crop Statistics for Gunnison, Montrose, and Delta Counties. This table summarizes the crop yields and cattle inventory for the previous year. Table 3.3 17 compares the same information over a five-year timeframe (NASS 2008).

The primary crops produced in Gunnison County are alfalfa (1,700 acres) and grass hay (23,300 acres). Although some hay is sold, over 75 percent of the hay grown in the county is used by ranchers for winter feeding of their own livestock. An estimated 90 percent of the hay production in Gunnison County is dependent upon irrigation. Since hay and pasture production are so dependent on irrigation, there would be no practical way to continue year-round livestock production in the county if agricultural water supplies were to become significantly limited (Upper Gunnison Water Conservancy District 2006).

Primary crops in Delta and Montrose Counties consist of alfalfa (36,300 acres) and grass hay (19,400 acres) and corn (8,700 acres). Other crops include dry beans, barley, and wheat. Over half of the irrigated cropland in Montrose and Delta Counties is located in the federal Uncompahgre Project. Water is generally turned into the canals and laterals in early April. A water year in the Uncompahgre Project is considered 120 days of ordered water which will yield three cuttings of alfalfa hay on a normal year and four cuttings in a year with a temperate spring and fall. Canals are generally shut down for the season on October 31 each year (RHN Water Resources Consultants 2005).

Table 3.3 15—Crop Census Information*.

	Gunnison	Montrose	Delta
Number of Farms (2002)	186	915	1063
Land in Farms (2002) (acres)	165,488	334,747	262,443
Ave. Size of Farm (2002) (acres)	890	366	247
Total Cropland (2002) (acres)	58,608	106,613	79,134
Irrigated Cropland (2002) (acres)	41,219	75,459	54,184
Market Value of Production			
2002 Crops	$0.98 Million	$21 Million	$14.4 Million
1997 Crops	$0.91 Million	$19.6 Million	$15.1 Million
2002 Livestock	$8.1 Million	$37 Million	$24.7 Million
1997 Livestock	$7.5 Million	$68.6 Million	$23.9 Million
Market Value of Production Average per Farm (2002)	$49,133	$63,378	$36,761
Average Value of Land and Buildings 2002	$1,467,593	$497,854	$540,121
Average Value of Land and Buildings 1997	$1,435,569	$507,508	$482,853
Agriculture Land Use			
Pasture	52%	48%	51%
Woodland	10%	10%	12%
Cropland	35%	32%	30%
Other	3%	10%	7%

*1997 & 2002 Census (NASS 2008)

Table 3.3 16—County Crop and Livestock Statistics*.

	Gunnison	Montrose	Delta
Barley	N/A	45,000 bu/500 acres	15,000 bu/200 acres
Wheat	N/A	22,000 bu/300 acres	13,500 bu/400 acres
Corn	N/A	990,000 bu/ 5,500 acres	610,000 bu/3,200 acres
Cattle and Calves	22,000	42,500	23,000

*2006 County Crop Statistics (NASS 2008)

Table 3.3 17—Montrose, Gunnison & Delta County Crop Yield.

Montrose County						
Crop	**2002**	**2003**	**2004**	**2005**	**2006**	**5-Year Average**
Barley (bu/ac)	43.0	85.0	N/A	N/A	90.0	N/A
Corn (bu/ac)	144.0	154.5	171.0	166.5	180.0	163.2
Dry Beans (cwt/ac)	20.2	19.0	20.2	20.9	23.5	20.8
Alfalfa Hay (tons/ac)	3.15	3.7	3.5	3.6	4.1	3.6
Other Hay (tons/ac)	2.2	1.95	N/A	2.15	2.45	N/A
Cattle & Calves Inventory (1000)	48	33.5	41	42.5	45	42
Gunnison County						
Crop	**2002**	**2003**	**2004**	**2005**	**2006**	**5-Year Average**
Alfalfa Hay (tons/ac)	0.8	1.80	2.0	2.0	3.65	2.05
Other Hay (tons/ac)	1.0	1.4	1.55	1.65	1.55	1.43
Cattle & Calves Inventory (1000)	16	16	19	22	19	18.4
Delta County						
Crop	**2002**	**2003**	**2004**	**2005**	**2006**	**5-Year Average**
Barley (bu/ac)	100.0	NA	NA	NA	75.0	N/A
Corn (bu/ac)	189.5	159.0	165.0	177	190.5	176.2
Dry Beans (cwt/ac)	16.3	16.7	NA	18	15.4	N/A
Alfalfa Hay (tons/ac)	2.4	2.75	2.55	3.2	3.55	2.89
Other Hay (tons/ac)	1.7	2.2	2.05	2.05	1.8	1.96
Cattle & Calves Inventory (1000)	37	26	23	23	22	26.2

3.3.4.1B Colorado Agricultural Statistics

Agricultural information for Gunnison, Delta, and Montrose Counties was obtained from the annual Colorado Agricultural Statistics publication. This source was also used to obtain information about crop yields and pricing. Between 1997 and 2000 the overall market value of production increased 8 percent in Gunnison County, 2 percent in Delta County, and decreased 34 percent in Montrose County. The reduction in Montrose County was attributed to the large value of livestock sales in 1997. Crop sales have remained relatively level during the 1997 to 2002 period.

3.3.4.1C Colorado Prime Farmland

Prime farmland is available land that has the best combination of physical characteristics for producing food, feed, forage, fiber and oil seed crops.

Colorado had approximately 1,696,800 acres of nonfederal prime farmland recorded in 1997. This represents over 2 percent of the state’s total land area or 4 percent of the nonfederal land in Colorado. Nationally 64 percent of soils classified as prime farmland are being used for cropland. In Colorado, 93 percent of the soils classified as prime farmland are being utilized as cropland.

There has been a gradual loss overall of prime farmlands in Colorado. Approximately 53,300 acres of prime farmland were converted through urban or rural development between 1982 and 1997 or an average of 3,550 acres per year.

The NRCS map entitled 1979 Important Farmlands of Delta County Colorado (NRCS 1979) tabulates 58,560 acres of Prime or Unique farmland in the County. The soil survey for Montrose County has not yet been published and, under the definition, there is no Prime Farmland in Gunnison County due to the colder climate and shortened growing season.

3.3.4.2 Impact Analysis

Since most agriculture in the Gunnison Basin is dependent on irrigation diversions, it is important to look at the impacts of implementing action alternatives on water rights. The two water rights with the most potential to affect diversions in the Gunnison Basin are the RWPC (670 cfs, 1912 adjudication; 80 cfs, 1959; 100 cfs, 1994) near Grand Junction and the UVWUA Gunnison Tunnel (1,300 cfs, 1913). The Gunnison Tunnel diverts most of its water during the irrigation season, although it is also used in the off-season to fill Fairview Reservoir under exchange with the Tri-County Water Conservancy District for domestic purposes. The RWPC can divert water year-round for irrigation and power generation.

Reoperation of the Aspinall Unit will change the timing of flows in the Gunnison Basin and there is concern this could cause shortages to these senior water rights thus resulting in a call which would shut off other diversions in the Basin. However, one of the goals outlined in the Flow Recommendations is to provide higher base flows as measured at Whitewater. Analysis of this efforts shows the potential for calls placed by RWPC will actually decrease with implementation of any of the action alternatives (see Figure 3.3-15 in the Water Rights of Water Uses and Resources in this chapter).

The Gunnison Tunnel has the potential to call out a significant number of diverters in the Upper Gunnison Basin, but because of the storage available in Taylor Park and Blue Mesa reservoirs through the 1975 exchange agreement this has rarely occurred. Use of UVWUA storage for implementation of the Flow Recommendations is not contemplated so there will be no additional impact on diverters.

In addition, the existing 60,000 af subordination agreement which protects junior Upper Gunnison in-basin depletions from Aspinall Unit calls will not be affected by alternatives being considered.

3.3.4.2A Spring Peaks

Since one of the goals of the Flow Recommendations is to create higher peak flows there is a possibility that their implementation may cause increased damage or maintenance costs to irrigation diversion structures. For example, the UVWUA estimate that that annual maintenance costs increase by about $10,000 (in 2008 dollars) in years which Crystal Reservoir spills. Other diversions located on the Gunnison River could experience similar results.

Figure 3.3-27 shows the number of additional years which Crystal Dam would spill beyond the No Action under each alternative during the 31-year study period. As modeled in the 31-year study period, Alternative C increases the number of Crystal Reservoir Spills by fourteen years over the No Action Alternative, Alternative B increases by twelve years and Alternatives A and D, increase by seven and eight years respectively. Therefore it is estimated that UVWUA costs will increase under action alternatives, with the largest increase under Alternative C.

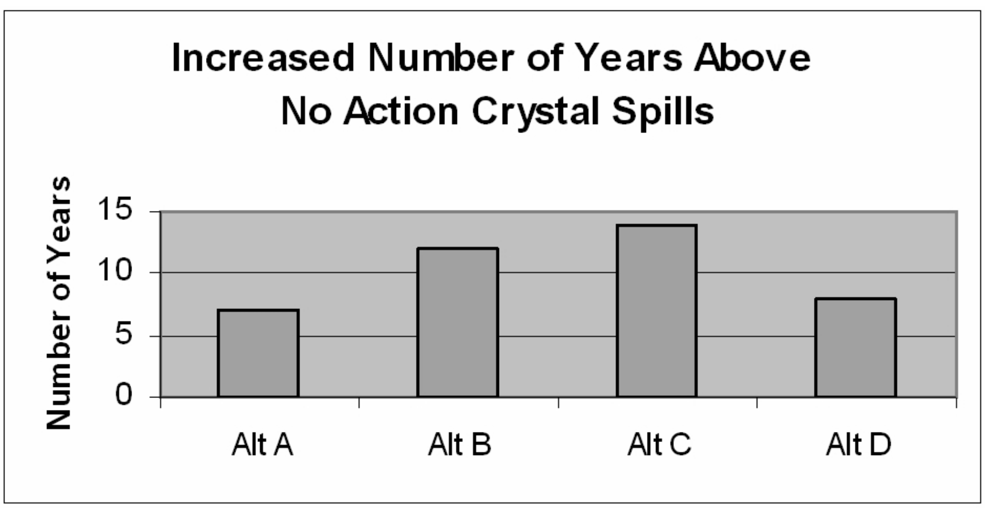

Figure 3.3- 27—Increased Number of Years Above No Action Crystal Reservoir Spills.

In addition, increased peaks and their duration could cause increased river bank erosion and loss or damage to associated farmland. It is estimated there are approximately 2,000 acres of Prime Farmland adjacent to the Gunnison River in Delta County. The City and County of Delta believe that when flows exceed 12,000 cfs at Delta, bank erosion and inundation of pasture and corrals begins to take place. Figure 3.3-28 shows the number of years flows exceed various elevated flowrates at Delta during the study period. When compared to the No Action Alternative, Alternatives B, C, and D result in 3 more years of 12,000 cfs. However, Alternative A results in only one. While higher flowrates, above 14,000 cfs, are seen about the same or less often in Alternatives B, C and D, and slightly more often in Alternative A.

In summary, since the base flow recommendations and existing agreements and contracts satisfy the senior water rights most likely to impact other basin diverters if shorted, it is unlikely that implementation of any of the action alternatives will have a negative impact on water supply and consequently agriculture production in the Gunnison Basin. However, increased frequency of flows in excess of 12,000 cfs could cause minor damage to agricultural land adjacent to the river and increased maintenance and replacement costs to irrigation diversions.

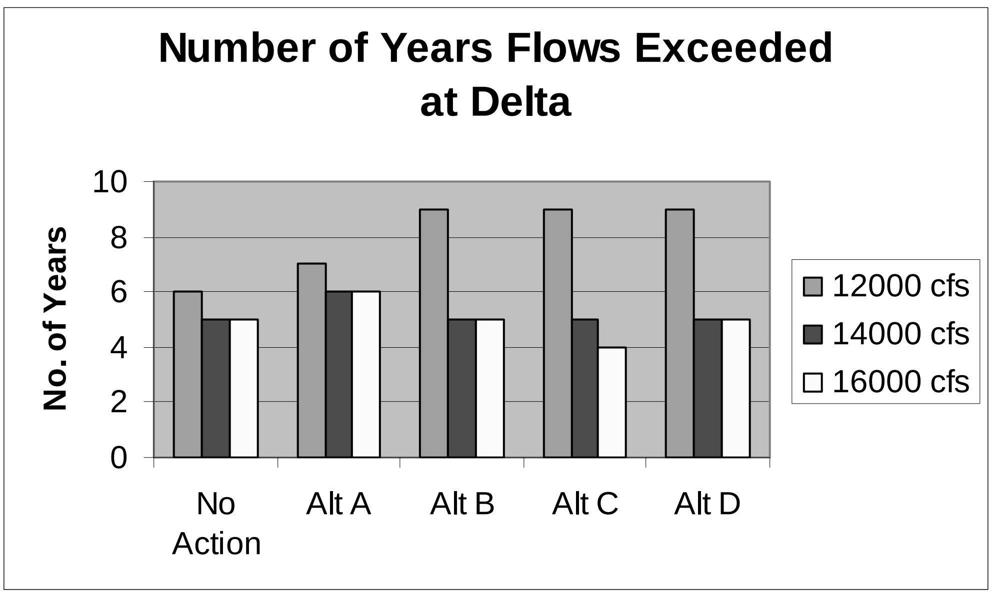

Figure 3.3- 28—Number of Years Flows Exceeded at Delta.

3.3.5 AQUATIC RESOURCES

This section addresses the potential impacts to aquatic resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect aquatic resources?

Overview

Scope

The scope includes native and non-native fish in Aspinall Unit reservoirs and in the Gunnison River and its major tributaries upstream and downstream from the reservoirs. Endangered and special status species are discussed in a separate section.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by operation changes under the alternatives:

- Significant changes in Blue Mesa Reservoir productivity.
- Significant changes in river flows affecting fishery recruitment or adult habitat.

Summary of Impacts

Under the No Action Alternative, aquatic habitat conditions would be adequate to maintain existing aquatic resources. Minor adverse impacts would be expected at the Aspinall Unit Reservoirs and in the Gunnison River tailwater fishery under Alternatives A, B and D. The Gold Medal fishery would be maintained. Alternative C has the greatest potential of reducing reservoir productivity and habitat in the downstream Gunnison River.

3.3.5.1 Affected Environment

3.3.5.1A General

Prior to development of the Gunnison River in the late nineteenth century, the river upstream from the Black Canyon supported Colorado River cutthroat trout along with speckled dace, flannelmouth and bluehead suckers, and less common roundtail chubs and perhaps mottled sculpin (Wiltzius 1978); however, by 1900 native cutthroat had been largely replaced in the river and major tributaries by rainbow, brook, and brown trout due to stocking programs and habitat changes. Early in the twentieth century, the upper Gunnison already was considered a “world-renowned” trout fishery. The lower Gunnison River supported Colorado pikeminnow, razorback suckers, flannelmouth and bluehead suckers, roundtail chubs, speckled dace, sculpin, and perhaps humpback chub.

The razorback and perhaps the pikeminnow were common in the lower river as late as the 1950's (Burdick 1995).

3.3.5.1B Upper Gunnison Area

The fishery of the Gunnison River and its major tributaries upstream from the Aspinall Unit are generally in good condition at the present time - based on existing streamflows, water quality, and angler use - with rainbow, brown, and brook trout populations. Native cutthroat trout occur in isolated high elevation tributaries. Taylor Park Reservoir supports a rainbow and brown trout, lake trout, and northern pike fishery. The 1975 Taylor Park Exchange Agreement coordinates Taylor Park and Blue Mesa Reservoir operations and has benefited fisheries of the Taylor and upper Gunnison rivers along with that of Taylor Park Reservoir itself. Fall migration runs of kokanee salmon from Blue Mesa Reservoir to the Roaring Judy Hatchery on the East River support increasing recreational use.

3.3.5.1C Reservoirs

Blue Mesa, Morrow Point, and Crystal reservoirs are managed by the Colorado Division of Wildlife (CDOW) as sport fisheries. Public use and active management are limited at Crystal and Morrow Point reservoirs due to the limited access; however, the sport fishery at Blue Mesa Reservoir is one of the largest and most valuable in Colorado. At first Blue Mesa Reservoir was managed primarily for rainbow trout, and rainbows remain an important part of the fishery; however, kokanee salmon have become the key recreation species. Lake trout were stocked beginning in 1968 for 6 years (Johnson and Koski 2005) but have not been stocked in recent years; however, natural reproduction is occurring. Kokanee now comprise over 80 percent of the recreational fishery harvest and around 68 percent of the total catch (Johnson and Koski 2005), with over 600,000 angler hours spent pursuing kokanee. Kokanee are released from the Roaring Judy Fish Hatchery on the East River each spring and the fish are carried by the East and Gunnison rivers downstream to Blue Mesa Reservoir. After three years in Blue Mesa, kokanee return to the hatchery where eggs are collected. Eggs taken from the kokanee are critical for other kokanee fisheries in Colorado. The kokanee fishery is limited by several factors including loss of fish to predation and to diversion into canals between the hatchery and reservoir; predation from lake trout in the reservoir; competition and predation with increasing populations of yellow perch and possibly northern pike in the reservoir; and loss through the Blue Mesa Dam outlets. Information indicates that kokanee numbers have declined in recent years as a result of these factors.

Rainbow trout make up about 25 percent of the catch and brown trout around 5 percent. Lake trout make up less than 3 percent of the catch; however trophy sized lake trout are not uncommon with the State record from Blue Mesa Reservoir in 2007, and lake trout fishing is becoming a more significant recreation activity. The state of Colorado record rainbow trout was recently caught in the upper end of Morrow Point Reservoir. Brown and lake trout are supported by natural reproduction. Other members of the Blue Mesa Reservoir fish community include longnose and white suckers, longnose dace, northern pike, and more recently yellow perch (Johnson and Koski 2005).

The fishery at Blue Mesa Reservoir is largely supported by zooplankton production which supports the kokanee, rainbows, and smaller lake trout. Terrestrial insects are important for rainbow trout in the reservoir while chironomid (midges) larvae and pupae are utilized by several species. Larger lake trout feed extensively on trout, kokanee, and crayfish in the reservoir.

Downstream Morrow Point and Crystal reservoirs are steep-sided oligotrophic (low primary production) reservoirs with limited access and fisheries. The scenery and low numbers of anglers do provide a unique, high quality, type of recreational angling. Survival of fish through the Blue Mesa powerplant provides "stocking" for Morrow Point and rainbow trout and kokanee are the most common species.

3.3.5.1D Gunnison River Downstream

The Gunnison River from Crystal Dam to North Fork Confluence has developed into a productive tailwater fishery due to relatively uniform and cold water releases and has been rated as a Gold Medal and Wild Trout (naturally reproducing) fishery by the CDOW. Through the mid-1990's the fishery was dominated by naturally reproducing rainbow trout; however, the rainbow fishery has been decimated by whirling disease beginning around 1995 (Nehring et al 2000); at the present time brown trout dominate the fishery. The CDOW has monitored populations in this reach of the Gunnison since 1981 and data can be used to track the fishery response to flows, management regulations, and the introduction of whirling disease. Bluehead suckers are common in this reach and flannelmouth are also present as are non-native longnose and white suckers and common carp.

Sampling in 2005 showed that both brown trout and total trout biomass was the highest ever observed up to that time in the river, showing that brown trout had largely replaced the rainbow populations. The total biomass of 391 pounds/acre in 2005 was the highest estimated in 22 years of sampling and was 70 percent greater than the 22 year average (Kowalski 2005). This report concluded that "The brown trout population in the Gunnison River has benefited from several years of favorable flow conditions and has increased to historic levels. There are more quality and trophy sized trout in the population than anytime in the last 24 years and brown trout have compensated for the numbers of large rainbows present before WD (whirling disease)." In 2007 the total biomass had increased to nearly 450 pounds/acre. The CDOW is conducting various management experiments in an attempt to restore rainbows to this reach, including attempting to develop WD resistant rainbow strains and experimental stocking. Initial results of this management appear positive with survival of rainbow trout increasing.

Reservoir operations provide a minimum flow of at least 300 cfs through the Gunnison Gorge NCA except in extreme droughts, emergencies, and extraordinary maintenance activities and this minimum has been adequate to support the fishery since the mid 1980's. Because the Gunnison River is managed as a wild trout fishery and is not dependent on hatchery stocking, instream habitat for trout reproduction, fry emergence and recruitment as a function of flow is perhaps the most important factor influencing trout population dynamics. Crystal's operation of stabilizing downstream releases is very important in preserving the wild trout fishery.

Brown trout spawn in the river between mid-October and mid-November (Nehring 1988). Incubation of the eggs requires approximately 100 to 120 days, with hatching occurring in late March. These sac fry spend several weeks within the river gravels before sac absorption, swim-up, and active food foraging. Conversely, rainbow trout begin actively spawning around April 1. The onset of spawning may vary by 2 to 3 weeks, depending upon the water temperature. Rainbow spawning generally ceases in May, followed by a 30- to 60-day incubation period and a 1- to 3-week period between the time of hatching and swim-up. Therefore, relatively stable or increasing flows sufficient to prevent redd (nest of fish eggs) desiccation or ice damage from mid-October through late February to late March seems best for natural reproduction and recruitment for brown trout. High flows (>3,500 cfs) or large fluctuations from April 15th to June 1st will negatively impact brown trout recruitment, however. Stable flows from April 1 to July 1 are also required to maximize spawning success for rainbow trout and high flows (>3,500 cfs) or large fluctuations from about June 1st to July 1st will negatively impact rainbow trout fry emergence and recruitment.

The relationship between habitat and Gunnison River flow has been studied by Nehring and Anderson (1985) and Nehring and Miller (1987) and generally show that adult rainbow and brown trout habitat is highest with flows in the 400 to 1,200 cfs range. Habitat declines with flows below or above this range. Spawning habitat plateaus around the 500-600 cfs range; spawning habitat is available at high flows, but chances of dewatering redds by later drops in flows increases. Periodic flows in the 2,000-4,000 cfs range are important for moving silt, maintaining spawning areas, and maintaining habitat for aquatic insects.

A moderate spring peak flow around the last week of May to the first week of June benefits both rainbow and brown trout as long as flow changes are ramped carefully. Ideally, down ramping rates for flows above 2,500 cfs should be no more than 500 cfs/day, done in 2 steps over the day. Below 2,500 cfs, down ramping rates should be no more than 250 cfs/day, in two 125 cfs increments. Ramping up can be done more quickly, for example 1,000 cfs in 2 increments above 2,500 cfs and 500 cfs in 2 increments below 2,500 cfs.

The CDOW (Kowalski 2008) has recommended flow regimes to support the fishery:

> "*The relationship between flows in the Gunnison River and their effect on trout populations has been studied extensively by the Division of Wildlife. The Gunnison River has ample habitat, food resources, and spawning areas to sustain a world class trout fishery under the current operating regime. The normal limiting factor of the trout population is survival of newly emerged fry. Trout fry are extremely vulnerable during the first month post emergence and require stable, low velocity habitat along the margins of the river. We have observed complete year class losses due to unfavorable flow patterns during this critical*

time. River flows during spawning can also have a large effect on the reproductive success of the fish. Female trout deposit eggs in gravel pockets (redds) and select locations by the velocity, depth, and substrate characteristics. Depending on flows, these locations can be near the margins of the river. Large flow decreases post spawning can strand the redds and severely reduce hatching success."

General

- Extended periods of minimum flows will negatively affect fish populations
- Whirling disease has damaged wild rainbow reproduction but research is ongoing to establish whirling disease resistant rainbow trout that will reproduce naturally in the Gunnison
- Rainbow trout potentially provide more angling opportunity than browns as they are easier to catch and have spawning behavior that is more in line with native fish Flow Recommendations
- A moderate peak flow in the spring will generally benefit the river by moving sediment, increasing insect diversity, performing channel maintenance, and keeping riffle habitat productive
- Large peaks (>3500 cfs) during critical fry emergence times in the Spring will damage recruitment

Brown Trout

- Spawn mid October to mid November
- Fry emergence Mid April through end of May
- High flows (>3,500 cfs) or large fluctuations from April 15th to June 1st will negatively impact brown trout recruitment
- Winter base flows should be set around October 15th without subsequent decreases, flow increases after this period are not a problem

Rainbow Trout

- Spawn April to mid May
- Fry emergence occurs from early June to early July
- High flows (>3,500 cfs) or large fluctuations from about June 10th to July 1st will negatively impact rainbow trout recruitment

Spring Peak Timing and Ramping Rates

- A Spring peak flow around the last week of May to the first week of June will benefit both rainbows and browns as long as flows are ramped down carefully
- Above 2500 cfs: ramping down no more than 500 cfs/day, done in two steps, 250 cfs in the morning and 250 cfs at night
- Below 2500 cfs: ramping down of no more than 250 cfs/day is recommended in two 125 cfs increments
- Ramping up can be done more quickly, above 2500 cfs: 1000 cfs in two increments and below 2500 cfs: 500 cfs in increments"

Between the Gunnison River's North Fork confluence and Austin, the river continues to support a quality trout fishery dominated by brown trout. Natural reproduction is probably limited due to higher sediment loads but fish from the Gunnison Gorge NCA disperse into this area and rainbow trout have been stocked in recent years. In this reach non-game species increase and native roundtail chub, bluehead sucker, flannelmouth sucker, and non-native white sucker become more common. Between Austin and Delta, the trout fishery gradually declines due to warming summer water temperatures and increased turbidity.

Warm water species dominate the fish community in the Gunnison River between Delta and Grand Junction. In this reach sediment loads increase and total dissolved solid and selenium loading increases. This reach of the Gunnison retains a healthy population of native fish and they comprised 79 percent of a total sample in 1993 surveys (Burdick, 1995). This is an unusually high percentage of native fish for a river in the Upper Colorado River Basin and may result from the Redlands Diversion Dam which served as a barrier to movement of non-native fish from the Colorado River for most of the 20th century. Numerically, bluehead sucker (36 percent), flannelmouth sucker (29 percent), roundtail chub (14 percent), common carp (7 percent), white sucker (6 percent), brown trout (3 percent), rainbow trout (2 percent) and sucker hybrids (1 percent) were the most common fish captured downstream from the North Fork confluence. Endangered fish in this section of river are discussed in the "Special Status Species" section of this chapter. Kowalski (Personal Communication on 08/28/08) reported on a more recent 2008 survey that continued to show a healthy population of native fish in the lower Gunnison River.

3.3.5.2 Impact Analysis

3.3.5.2A Upper Gunnison Area

Under the No Action and action alternatives, the Taylor Park exchange agreement is expected to continue and significant new water depletions are not projected; thus significant changes in river flows upstream from the Aspinall Unit are not anticipated. Therefore, significant changes in upstream aquatic resource habitat are not projected under action alternatives. Effects on the downstream Blue Mesa Reservoir fishery can affect numbers of kokanee salmon and brown and rainbow trout that move from the reservoir into upstream tributaries. As discussed below, significant effects on the Blue Mesa Reservoir fishery are generally not predicted; a possible exception could occur under Alternative C that has increased effects on Blue Mesa Reservoir productivity.

3.3.5.2B Reservoirs

Changes in water release patterns from Blue Mesa Reservoir can potentially affect reservoir thermal stratification, productivity, entrainment, and ultimately fish biomass, production, and yield. Colorado State University studied the ecological effects of Blue Mesa Reservoir operations between 1993 and 2002 (Johnson and Koski 2005). In general, these studies concluded that changes in water release patterns using the powerplant/bypass outlet features, located in the hypolimnion, would not significantly affect the reservoir productivity or thermal stratification. Johnson and Koski (2005) concluded that "Overall, while changes to withdrawal depth may affect the reservoir's food web and fishery, the reservoir appeared to be resistant to changes in the release regime from the hypolimnetic outlet. Thus water managers at Blue Mesa Reservoir have considerable latitude for changing hypolimnetic release patterns without affecting physicochemical conditions or productivity of the reservoir." However, changes in spillway usage, which releases warmer water from the reservoir than other outlets, could reduce reservoir productivity and increase lake trout predation on kokanee.

Table 3.3 18 includes a summary of Blue Mesa Dam spillway use under alternatives being considered. Additional information can be found in the Section 3.3.1. Based on spill data, action alternatives would be expected to reduce Blue Mesa Reservoir's productivity; however, changes due to Alternatives A, B, and D are relatively small. Alternative C would potentially have a greater adverse effect due to increased spillway usage.

Table 3.3 18—Blue Mesa Dam Spillway Use and Summer Surface Area.

	No Action	Alt A	Alt B	Alt C	Alt D
Percentage of years Blue Mesa Reservoir spills	17	19	29	26	23
Number of days Blue Mesa Reservoir spills during entire 31-year study period	54	57	68	133	63
Blue Mesa Reservoir Avg. End of August Surface Area (acres)	8225	8137 (-1%)	8011 (-3%)	7457 (-9%)	8069 (-2%)

Summer surface area at Blue Mesa Reservoir affects reservoir productivity with increasing surface area increasing total productivity. As can be seen from Table 3.3 18 above and Figures 3.3-6 and 3.3-7 in the Water Uses and Resources Section, surface area decreases under action alternatives, with the most significant effect under Alternative C with an average decrease of around 9 percent, and with decreases ranging to over 40 percent. Largest reductions in summer surface area result from extended dry periods.

Entrainment of fish, particularly kokanee salmon, through Blue Mesa Dam outlet structures has been well documented (Mueller and Hiebert 1997) and it appears that in some years, losses of kokanee can be high. Mueller and Hiebert found a positive correlation between release rate and entrainment in 1995 during the runoff; studies in the 1970's concluded that there was high entrainment in the late fall and winter. Overall it is not known if there is always a correlation between discharge rate and entrainment. Therefore it can not be projected whether alternative operations will affect entrainment. Significant effects on the fisheries at Morrow Point and Crystal reservoirs are not projected. Increased spillway use under action alternatives, particularly Alternative C, may increase loss of trout over the Crystal Dam spillway.

3.3.5.2C Gunnison River-Crystal Dam to North Fork Confluence

The trout fishery between Crystal Dam and the North Fork confluence has been extremely productive over the last 30 years which have included extended droughts, high flow years, flash floods, and other extremes. The introduction of whirling disease has been the primary factor adversely affecting the fishery. Alternatives being considered will change the flow regime in this reach of the river. Flow levels affect quantity and quality of trout habitat, spawning conditions, and fry and adult survival. The CDOW considers fry survival to be the most important factor in the Gunnison River (Nehring and Miller 1987).

Table 3.3 19 summarizes average monthly flows for the study period for each alternative and provides a general indication of shifts in monthly flows. Total annual flows will not change under the alternatives.

Table 3.3 19—Average Monthly Flows (cfs)-Black Canyon and Gunnison Gorge NCA for Period of Study.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action	773	851	909	1143	1578	2000	1633	839	787	756	861	995
Alt A	780	853	898	984	1658	2039	1666	869	776	759	853	987
Alt B	750	836	843	971	2026	2186	1513	829	717	713	808	932
Alt C	714	744	751	911	2090	2644	1758	950	592	581	642	747
Alt D	759	842	855	981	1865	2194	1533	845	737	732	825	956

Adult habitat for trout in this reach of the river in the summer is extensive when flows are in the 400 to 1,200 cfs range and at a lower range under winter conditions. Flows between 300 and 400 cfs are adequate, but summer water temperatures in the lower end of this reach become more of a concern at these lower levels. Under conditions of low flow, water temperatures can reach the 70 degree F range near the North Fork confluence.

Table 3.3 20 summarizes changes in various parameters from the alternatives. All action alternatives increase duration of low flows with Alternative C having the greatest increase and potentially the greatest impact. Overall adult habitat should remain adequate to support a Gold Medal fishery although reductions will occur, particularly with Alternative C.

Table 3.3 20—Average annual days flows in the 400 – 1,200 cfs range; in 300-400 cfs range and at 300 cfs May through September, Gunnison Gorge NCA.

	No Action	Alt A	Alt B	Alt C	Alt D
Avg. Days in 400-1,200 cfs range per year	86	84 (-2%)	83 (-3%)	80 (-7%)	85 (-1%)
Avg. Days in 300-400 cfs range (% change)	21.3	22.9 (+8%)	24.8 (+16%)	30.5 (+43%)	23.8 (+12%)
Avg. Days at 300 cfs minimum (% change)	16.3	16.2 (-1%)	18.0 (+10%)	23.3 (+43%)	18.0 (+10%)

Spawning habitat is available under a wide range of flows, estimated between 300 and 3,000 cfs and thus this habitat should be adequate under all alternatives being considered. Loss of eggs can occur, however, if flows drop significantly between the time eggs are deposited and fry emerge from the gravels. This can occur for brown trout if significant drops occur between October and May and for rainbows if significant drops occur between April and June. Significant drops in flows for brown trout (considered here as a 50 percent drop in flows) occurs most often under No Action, A and D (10 percent to 13 percent of years) and 3 percent under all other alternatives. Significant drops following rainbow spawning occurs less than 5 percent of the years under all alternatives including No Action. Overall spawning conditions should be adequate to maintain the trout fishery under all alternatives.

Survival of fry is critical to the Gunnison River fishery. When brown and rainbow fry emerge from gravels in the late April through June period they need habitat with low velocity flows. This type habitat is maximized at low, stable flows but is available in a 300 to 3,000 cfs range. At the higher end of this range, inundated shorelines provide the habitat; for example, the CDOW reports excellent fry habitat in the Ute Park area at flows around 2,000 cfs. At flows above 3,000 cfs, fry habitat declines significantly. Fry are very sensitive to flow fluctuations and can be stranded by rapidly dropping flows or entrained in the current by rapidly increasing flows. Overall high flows or large fluctuations in the first month after fry emerge from the gravels can adversely affect survival. According to CDOW, high flows in the 6,000 cfs range reduce fry survival. In addition, lower flows provide better water temperatures for fry growth.

Overall, action alternatives designed to increase peak flows will have detrimental effects on fry habitat and recruitment with Alternative A having the least impact and Alternative C the greatest. Table 3.3 21 summarizes the years that May peaks exceed 3,000 cfs (brown trout concern); that June-July peaks (rainbow trout concern) exceed 3,000 cfs; and that flows exceed 6,000 cfs.

Table 3.3 21—Various Parameters Affecting Gunnison Gorge NCA Fishery.

	No Action	Alt A	Alt B	Alt C	Alt D
Percentage of years May flows exceed 3,000 cfs	55	61	71	74	61
Percentage of years June-July flows exceed 3,000 cfs	42	39	55	65	52
Percentage of years flows exceed 6,000 cfs May-July	13	19	45	42	48
Percentage of years Crystal Reservoir spills	32	55	64	77	58

Past history on the river has shown that high spring flows can have significant adverse impacts on trout recruitment; however, careful ramping on the descending limb of the hydrograph can significantly reduce impacts. Ramping rate guidelines on the ascending limb of the hydrograph are steeper under action alternatives compared to No Action;

however, rates are the same as No Action for the more critical descending limb. During Crystal Reservoir spills that occur more frequently under action alternatives, control of ramping rates becomes more difficult. The increase is particularly significant for Alternative C as shown in Table 3.3 21.

Increased maintenance activities in the Crystal Dam stilling basin may be required under action alternatives, particularly Alternatives B and C. These activities can adversely affect trout due to needed flow reductions during the maintenance activity.

Higher spring flows under action alternatives will have the benefit of moving sediment through the river and maintaining/improving physical habitat conditions for aquatic insects and fish. These flows may provide an added benefit by reducing fine-grained sediment habitat for tubifex worms, the intermediate host of whirling disease. Alternatives B and C, that tend to shorten periods of consecutive low flow years, would have the most benefit.

3.3.5.2D Gunnison River-North Fork Confluence to Austin

Downstream from the North Fork, the river remains a trout fishery; however, habitat conditions are influenced by inflows from the North Fork that often carry a heavy sediment load. Trout reproduction is believed to be limited in this reach and fish from the upstream Gunnison Gorge help maintain populations. Any projected reductions in recruitment in Gunnison Gorge may adversely affect this section of river. Protecting adult habitat conditions is probably a key factor in this fishery. Alternatives being considered are not projected to have adverse effects on this habitat, and more frequent high flows may help maintain habitat. During summer low water periods, water temperature becomes a factor in this reach and comes into play when flows are in the 300 cfs range in the Gunnison Gorge. Also at lower flows, the dilution of the normally turbid North Fork flows is reduced. Modeling results (Table 3.3 20) show that all action alternatives increase the number of days of low summer flows (A-8 percent increase; B-16 percent increase; C-43 percent increase; and D-12 percent increase) and Alternatives B and C increase the frequency of years low summer flows occur. As with the upstream area, increased spring peaks under action alternatives will improve physical habitat conditions by moving sediment through the reach and helping maintain channel conditions. Native fish are more common in this reach as indicated previously and should benefit from physical habitat improvements and would be less likely to be adversely affected by an increase in days of low summer flows.

3.3.5.2E Gunnison River-Austin to Colorado River Confluence

In this reach of the river, endangered (discussed in more detail in the “Special Status Species” section of this EIS) and non-listed native fish are the management priority. Improvements in physical habitat due to increased spring flows under action alternatives should benefit native species such as the roundtail chub and flannelmouth sucker when compared to No Action. Overall action alternatives would improve conditions in this reach, with Alternative C providing the most benefit followed by Alternatives B, D, and A.

3.3.6. VEGETATION AND WILDLIFE RESOURCES

This section addresses the potential impacts to vegetation and wildlife resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect vegetation resources?

Overview

Scope

The scope includes wildlife habitat and vegetation associated with riparian areas and reservoir basins at Aspinall Unit reservoirs and along the Gunnison River.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by alternative Aspinall Unit operations:

- Significant changes in acreage or species composition of riparian areas.
- Significant changes in riparian habitat utilized by wildlife.

Summary of Impacts

Under the No Action Alternative, present trends of increasing vegetation encroachment into river channel will continue. For action alternatives, increased spring flows will promote more natural vegetation and wildlife habitat conditions downstream.

3.3.6.1 Affected Environment

The Gunnison Basin ranges from 4,550 feet in elevation at the mouth of the Gunnison River to over 14,000 feet in the headwaters, and annual precipitation varies from under 10 inches to over 40 inches. In response, native vegetation ranges from desert shrubs to sagebrush, pinyon-juniper woodlands, oak brush, ponderosa pine, lodgepole pine, Douglas fir, Engleman spruce, alpine fir, and aspen. Waterways support riparian vegetation of willow, box elder, cottonwood species, tamarisk, and other species in narrow strips in canyon areas but expanding in width in broad floodplains such as near Delta.

3.3.6.1A Vegetation

Reservoirs—Riparian areas upstream from Blue Mesa Reservoir have been affected by erosion control bank protection, grazing, and water control. Vegetation around Blue Mesa Reservoir is primarily sagebrush with scattered cottonwoods and willows around the shoreline and at tributary mouths and Gambel's oak, juniper, serviceberry, and wild rose in draws leading to the reservoir. Moister sites around the reservoir support Ponderosa pine, Douglas fir, and spruce. A large narrowleaf cottonwood bottomland occurs upstream from the upper end of the reservoir and contains oxbows, sloughs, and ponds. This area is one of the largest remaining cottonwood stands in the Gunnison Basin (Rocchio et al 2004) and supports an understory of willows, Woods' rose, alder, honeysuckle, and river hawthorn.

Steep terrain around Morrow Point and Crystal reservoirs supports aspen and a variety of conifers such as Douglas fir, pinyon, and juniper. The rare Black Canyon gilia (Gilia penstemonoides) is found in cliffs above Blue Mesa Reservoir (Lyon et al 1999).

Downstream from Aspinall Unit—Downstream from Crystal Reservoir a narrow strip of riparian vegetation occurs dominated by box elder, willow, and tamarisk with scattered Douglas fir and ponderosa pine in the Black Canyon NP. In this Park reach, the riparian zone and riparian vegetation are largely controlled by river flows as discussed in Auble et al (1991) and Elliott and Hammack (1999). Historically, riparian vegetation probably was limited due to the annual cycle of high spring flows (Lichvar 1987). Reduced spring flows following construction of Blue Mesa Dam have allowed alluvial soils and riparian vegetation to increase along the river channel and on alluvial fans. Vegetation encroaches toward the river in low flow periods and then is removed or reduced by high flow periods; however, high flow periods have less frequency of occurrence and less magnitude than prior to the Aspinall Unit. The NPS monitors vegetation in the Black Canyon NP to correlate vegetation conditions with river flows (see Appendix F).

Similar conditions of a very narrow riparian corridor with reed canary grass, willows, tamarisk, and scattered box elder occur downstream from the Black Canyon NP to the North Fork confluence. Pinyon and juniper trees occur above the historic high water marks and shrubs such as sagebrush, rabbitbrush, and serviceberry are found. In the Gunnison Gorge, regulation of flow by the Aspinall Unit has reduced overbank flooding and bank and floodplain scouring. As a result vegetation has encroached, including non-native species such as tamarisk, reed canarygrass, and redtop and native species such as box elder and willows (Elliot et al. 1994). The Bureau of Land Management has an active program of tamarisk control in the Gunnison Gorge NCA between the Black Canyon NP and the North Fork confluence.

The riparian corridor expands downstream from the North Fork confluence, particularly as the valley widens between the town of Austin and the Roubideau Creek confluence. Cottonwood bottomlands increase and willow and tamarisk are common. Scattered groves of Fremont cottonwood occur along the river; these areas are very limited yet very important from a wildlife and aesthetic standpoint. Skunkbush sumac, coyote willow, and tamarisk are often associated with the cottonwoods but also occur in independent stands. Reduced spring flows adversely affect regeneration of cottonwood areas as well as encourage development in bottomland areas. Irrigated agriculture borders the river between Austin and the Roubideau Creek confluence with scattered tracts upstream and downstream from these locations. Downstream from Roubideau Creek the river is restricted to canyon reaches in most areas. In places where the valley widens, the floodplain has been largely developed for irrigated agricultural or gravel pits. Riparian vegetation including tamarisk and willow occurs in a narrow strip that tends to stabilize banks during low flow periods. Cottonwood groves are scattered along the river and tamarisk expansion is a major problem.

3.3.6.1B Wildlife

The wide ranges in elevation and vegetation in the basin support a variety of wildlife species. As occurs in much of the west, riparian areas provide particularly important habitat and support a disproportionate number of species and individuals. Species associated with waterways and riparian corridors are potentially affected by reoperation alternatives.

Mid-elevation riparian areas, such as occur along the Gunnison River between Blue Mesa and Taylor Park reservoirs, are very productive for wildlife and supports the richest variety of bird species in western Colorado (Righter et al. 2004). Common species include warbling vireo, house wren, yellow warbler, song sparrow, downy and hairy woodpeckers, and goldfinches. Waterfowl, bald eagles, and great blue herons are common along the rivers. Bald eagles winter in this area and are seasonally concentrated in response to upstream kokanee salmon migrations.

Blue Mesa Reservoir provides limited wildlife habitat; however, waterfowl are common and mudflats created by reservoir drawdown attracts shorebirds, gulls, and terns. A heron rookery is located along the river upstream from Blue Mesa Reservoir within the Curecanti NRA. Lands around the reservoir provide habitat for the Gunnison sage grouse; wintering deer, elk, and bighorn sheep; and other species. The Gunnison sage grouse is a species of special concern; populations in the Curecanti NRA can vary between 100 individuals in a mild winter to substantially higher numbers in a severe winter (NPS 2001). Common raptors include red-tailed hawk, Swainson’s hawk, golden eagle, bald eagle, and kestrel (NPS 2005). Significant wildlife habitats include the big game winter range on south-facing slopes above the reservoir and the riparian area upstream from Blue Mesa Reservoir. The Curecanti NRA protects approximately 18,000 acres of severe winter range for elk and 16,000 acres for mule deer. Suitable habitat for bighorn sheep also occurs around the reservoirs (NPS 2007). Morrow Point and Crystal reservoirs provide little habitat although adjacent lands provide isolation for wildlife due to the steep terrain and poor access.

Downstream from Crystal Reservoir, the Black Canyon provides limited, but well protected, wildlife habitat due to the rugged cliff terrain and limited riparian area. Beaver and river otter occur along the river and raptors include bald and golden eagles and the peregrine falcon. White-throated swift, cliff swallows, violet-green swallows, canyon wrens, and dippers are associated with the river as a food source. While still consisting of rugged terrain, the Gunnison Gorge NCA downstream from the Black Canyon NP includes open areas such as Ute Park. Deer, elk, mountain sheep, mountain lion, beaver, and river otter can be found along the river. Bald and golden eagle are found along with wintering waterfowl and limited nesting waterfowl. Chukars water along the river, dippers feed on aquatic insects, and swallows and swifts are common and feed on prolific insect hatches from the river.

Downstream from the North Fork confluence, the valley widens and low-elevation riparian forests increase. This habitat is very limited in the region—covering less than one percent of western Colorado—however it supports at some time of the year more than half of the bird species in the region (Righter et al 2004). This habitat is also the most threatened due to reduced spring flows and due to encroachment of gravel mining, channelization, non-native species such as tamarisk, and other factors. Two blocks of this habitat are protected at the Escalante State Wildlife Area downstream from Delta and the Grand Junction Wildlife Area at the river's mouth. Western screech owls, western kingbirds, and Bullock's orioles are examples of nesting birds in this habitat. Separate stands or understories of skunkbush, willow, and tamarisk support species such as Gambel's quail, Bewick's wren, yellow-breasted chat, grosbeaks, and Lazuli bunting.

3.3.6.2 Impact Analysis

3.3.6.2A Vegetation

Vegetation at the Aspinall Unit reservoirs and upstream areas is not expected to change significantly under alternative operations. Riparian areas in the Curecanti NRA upstream from Blue Mesa Reservoir should improve under all alternatives due to weed control efforts and programs to benefit native riparian species.

Downstream riparian vegetation will be affected by increased spring flows under action alternatives and by continuing programs to control non-native species such as tamarisk. If tamarisk control is successful, many miles of tamarisk-lined shoreline along the lower Gunnison River may convert to willows and other native species.

Under the No Action Alternative, scouring of islands and stream banks would be limited and conditions to establish or renew cottonwood groves would be limited. Under these conditions more desert type conditions would continue to infringe on riparian areas in the historic floodplain. Higher spring flows under the action alternatives will reduce vegetation encroachment on the river channel in the Black Canyon NP and Gunnison Gorge NCA. This represents a return to more natural conditions, although peak flows will remain below pre-Aspinall Unit conditions. Alternatives B and C, with the highest peaks and longer duration (see Water Uses and Resources Section 3.3.1), will have the greatest effect on shoreline vegetation in the Black Canyon NP and Gunnison Gorge BCA. Appendix F contains additional information on Black Canyon NP vegetation.

Downstream from the North Fork, island areas, cobble bars, and backwater channels will be scoured of vegetation more often and recruitment of cottonwoods should increase under action alternatives, with alternatives with the more frequent peaks having the greatest effect. The scattered mature cottonwood areas downstream from the North Fork confluence should benefit from increased spring flows under the action alternatives.

3.3.6.2B Wildlife

Significant effects on wildlife are not projected under the alternatives considered. Species that utilize riparian areas are most likely to be affected. Under the No Action Alternative, the trend toward more desert conditions in the historic floodplain would continue to gradually degrade riparian conditions and adversely affect wildlife dependent on this riparian habitat. Increased scouring of riverbank vegetation under action alternatives would decrease nesting habitat for some bird species which may be partially or fully offset by habitat creation in backwater areas and at higher elevations of the stream bank. Benefits would occur if cottonwood regeneration increases. In addition, more frequent periods of higher spring flows under action alternatives may reduce development infringement into riparian areas.

3.3.7. SPECIAL STATUS SPECIES

This section addresses the potential impacts to special status species that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect special status species?

Overview

Scope

The scope includes ESA listed threatened or endangered fish in the basin and ESA listed threatened or endangered terrestrial species associated with the Gunnison and Colorado rivers' riparian zones. In addition species that are candidates for listing under the ESA are considered. The biological assessment is presented in Appendix B.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by changes in Aspinall Unit operations as a result of the alternatives:

- Significant changes in habitat maintenance/improvement river flows that impact critical habitat.
- Substantial changes in water quality in critical habitat.
- Substantial changes in habitat utilized by terrestrial threatened or endangered species.

Summary of Impacts

The four endangered fish species would be affected by alternatives considered. Each action alternative shows an overall improvement in habitat conditions for the fish with Alternative C having the most significant benefit followed by Alternative B. Alternatives A and D provide lesser benefits. Other threatened or endangered species would not be affected by alternatives.

3.3.7.1 Affected Environment

3.3.7.1A General

Threatened or endangered species are formally listed under Section 7 of the ESA, while candidates are species for which the Service has sufficient information on their status and potential problems to propose them as endangered or threatened, but they have yet to be formally listed. Species of concern are species the Service believes to be vulnerable, but require further study to determine their status.

The Service has cited nine endangered, four threatened, and two candidate species potentially affected by the proposed action based on their potential presence in the affected area:

Clay-loving wild buckwheat	*Eriogonum pelinophilum*	endangered
Uinta Basin hookless cactus	*Sclerocactus glaucus*	threatened
Jones' cycladenia	*Cycladenia humilis var. jonesii*	threatened
Yellow-billed cuckoo	*Coccyzus americanus*	candidate
Mexican spotted owl	*Strix occidentalis lucida*	threatened
Southwestern willow flycatcher	*Empidonax traillii extimus*	endangered
California condor	*Gymnogyps californianus*	endangered
Colorado pikeminnow	*Ptychocheilus lucius*	endangered
Razorback sucker	*Xyrauchen texanus*	endangered
Humpback chub	*Gila lacypha*	endangered
Bonytail	*Gila elegans*	endangered
Black-footed ferret	*Mustela nigripes*	endangered
Canada lynx	*Lynx Canadensis*	threatened
Gunnison's prairie dog	*Cynomys gunnisoni*	candidate
Uncompahgre fritillary butterfly	*Boloria acrocnema*	endangered

3.3.7.1B Vegetation and Wildlife

The clay-loving wild buckwheat is a small shrub that is found in semi-desert shrub communities of adobe hills. It is normally located in specific microhabitats and can be associated with shadscale and mat saltbush. Its range is restricted to small acreages in Delta and Montrose Counties and primary threats include fragmentation or clearing of habitat for urban development and off-road vehicle use. In the early 20th century, habitat was probably more extensive and was probably cleared for agricultural lands. Soils supporting the species are derived from Mancos shale (Lyon and Williams 1998). The species is not associated with riparian lands along the Gunnison River and would not be affected by the alternatives.

The Uinta Basin hookless cactus is a small cactus normally found on gravelly alluvial soils or in clay between 4,500 and 6,000 feet and can be associated with shadscale, sagebrush, greasewood, saltbush, and other desert vegetation. In Colorado it is reported from Montrose, Delta, Gunnison, Garfield, and Mesa Counties; and is also found in Utah. Threats may include trampling from grazing, recreation use of lands, off-road vehicle use, and development on some lands. Past reports include populations on benches along the Gunnison River from Hotchkiss downstream (Lyon and Williams 1998). The species is not associated with riparian lands along the Gunnison River and would not be affected by the alternatives.

The Jones' cycladenia is a small herbaceous perennial listed as threatened and restricted to the canyonland area of the Colorado Plateau in eastern Utah and a small portion of Arizona. This plant is found in gypsiferous soils in mixed shrub-pinyon juniper communities. Threats include off-road activity and mineral development. The species is not associated with habitats that might be affected by the alternatives.

The western yellow-billed cuckoo is a candidate for listing under the ESA. The species breeds in large blocks of riparian habitats, in particular cottonwood woodlands, and dense understory foliage appears to be important. Based on historical accounts, the species was localized and uncommon along Colorado drainages while being locally common in other western areas (Fish and Wildlife Service 2005). The species was probably never common in western Colorado and is now extremely rare (Kingery 1998). In 1998, 242 miles of riparian habitat were surveyed along six rivers in west-central Colorado with one cuckoo detected (Dexter 1998). However, in 2008 breeding was confirmed along the North Fork (Beason 2008).

Cottonwood woodlands have been lost or fragmented in the study area due to clearing for towns and agriculture, filling and diking of lowlands, development of recreation sites in woodlands, fires, invasion of tamarisk and other non-native plants, and reduction of spring peaks that are important for regeneration of cottonwood stands.

Increased spring peaks with the alternatives may have some benefit to the regeneration of cottonwood stands which could provide habitat for the cuckoo; however, without long-term protection, cottonwood woodlands will continue to be degraded through other activities.

The Mexican spotted owl is a threatened species and occurs in rocky canyons and forested mountains generally below 9,500 feet. The Mexican spotted owl has the largest geographic distribution of any of the *S. occidentalis* subspecies. Historically, the owl ranged from the southern Rocky Mountains in Colorado; the Colorado Plateau in southern Utah; southward through Arizona, New Mexico, and far western Texas; in Mexico through the Sierra Madre Occidental and Oriental mountains and the southern end of the Mexican Plateau. Presently, the owl's range reflects the historic range, but owl numbers are much reduced and habitat is patchy. The primary threat Mexican Spotted Owls face is the loss of mature trees to timber harvesting and to stand-replacement fires, especially in steep canyons and in riparian zones. Several blocks of critical habitat have been designated in Colorado outside of the project area. Potential habitat for the species occurs in the project area; however, the alternatives would have no effect on this habitat.

The California condor is an extremely rare member of the vulture family. By 1982 only 22 condors existed and a captive breeding program began. The species was reintroduced to the Colorado Plateau in 1996 with the release of six birds in northern Arizona. Recovery goals include establishment of geographically separate populations in California and Arizona. Threats include lead poisoning, collisions with power lines, and shooting. Released birds have made intermittent travels into the project area; however, there is no long-term use. Potential habitat for the species would not be affected by the alternatives.

The Southwestern willow flycatcher nests in dense riparian vegetation and are thus vulnerable to impacts associated with modification of riparian habitats such as channelization, recreational development, grazing, and agricultural conversion (Kingery 1998). The subspecies does not occur in the Gunnison Basin but potential habitat occurs in the Dolores and Lower Colorado River basins. Critical habitat has not been proposed in the project area. Increased spring peaks with the alternatives in the Colorado River may have some minor benefit to the regeneration of cottonwood and willow riparian stands which could provide habitat for the willow flycatcher; however, overall no effect is projected on this subspecies.

The black-footed ferret is one of the most endangered mammals in North America. The ferret is associated with prairie dog towns and was once believed extinct. A reintroduction program is underway, including introductions in northwest Colorado. At the present time, there are no known populations in the Gunnison Basin. Potential habitat is fragmented in the basin, with prairie dog towns separated by cropland and other human developments. Historical presence in the basin is not known. The alternatives should have no effect on this species or its potential habitat.

Lynx may have disappeared from Colorado by about 1973. Sightings prior to that time were few, scattered throughout mountainous areas of the state. In 1999 a program of lynx restoration began in the San Juan Mountains, and by 2005 more than 200 animals had been released, a number of litters of kittens had been born, and lynx were expanding throughout the high country and occasionally beyond. Lynx reproduction has not been confirmed in 2007 and 2008, possibly related to snowshoe hare decline. The lynx is found in dense sub-alpine forest and willow corridors along mountain streams and avalanche chutes, the home of its favored prey species, the snowshoe hare.

Reintroduced lynx have entered the Gunnison Basin where potential habitat occurs at higher elevations. The potential exists that the species will become permanently established in the basin. The alternatives should have no effect on existing lynx populations or potential habitat.

The Gunnison's prairie dog lives along the Colorado Plateau in southeastern Utah, southwestern Colorado, and portions of New Mexico and Arizona. Certain populations, including some in the Gunnison Basin, are considered as a candidate for listing under the ESA. Populations are considered to occur in two range portions – montane populations at higher elevations and prairie populations at lower elevations. The montane populations are considered as candidates for listing. Habitat for the montane populations includes plateaus, benches, and intermountain valleys with grass-shrub-mountain meadow vegetation. There is an approximately 250 acre colony in the Curecanti NRA at Blue Mesa Reservoir. Many factors influence populations including urban and agricultural development, other land conversions, grazing, poisoning, and recreational shooting; however, sylvatic plague is the most significant factor. This plague is a non-native pathogen that arrived in North America around 1900 (Seglund et al. 2005, Fish and Wildlife Service 2008). The alternatives should have no effect on populations or habitat of this species.

The Uncompahgre fritillary butterfly is listed as endangered and has a very small known range in the mountainous areas of Gunnison, Hinsdale, and Chaffee counties of southwestern Colorado. All known colonies are associated with patches of snow willow above 12,500 foot elevation. The alternatives should have no effect on populations or habitat of this species.

3.3.7.1C Fish

This EIS addresses habitat and populations of endangered fish in the Gunnison River and to a lesser extent addresses these fish in the Colorado River downstream from the Gunnison confluence. It is recognized that improvement in flow regimes in the Gunnison can have positive cumulative impacts on habitat in the Colorado River downstream from the Gunnison confluence. Recovery Program activities for the Gunnison River are discussed; however, it should be noted that there are also many programs involving the Colorado mainstem and other tributaries including activities to improve flow conditions. The habitat of the four listed species has changed over the last 125 years. There have been significant changes in the hydrology; geomorphology; water quality, including water temperature; and species composition of the Gunnison River; further information is found in McAda (2003).

Four endangered fish species are believed to be native to the warm water reaches of the Gunnison River—the Colorado pikeminnow and razorback sucker, and possibly the bonytail and humpback chub. The pikeminnow and razorback likely had healthy populations before settlement of the basin while information on historic populations of bonytail and humpback chubs is not available. There are insufficient fishery surveys to determine when pikeminnow and razorback sucker populations declined but surveys completed in the late 1970's and early 1980's showed very low populations in the Gunnison River (Burdick 1995). Four razorback suckers were captured between Escalante Creek and Delta during this period while pikeminnow were relatively more common. The decline of populations is likely due to three primary factors: loss or degradation of habitat; blockage of migration; and introduction of non-native fish species. The two types of factors that appear to have had the greatest impact have been water development and introduction of non-native species.

The Colorado River Basin originally supported a fish fauna with 36 species from 20 genera and nine families. Of these 36 native species, 64 percent were endemic to the basin and only eight were found in both upper and lower portions of the basin. The native fish of the major rivers in the Basin are long-lived and have evolved to live in a system of high spring snowmelt flows, periodic high turbidity, and a wide range of flow and water quality conditions.

Development of the water resources of the Gunnison Basin began in the late 19th Century, primarily for irrigation. Storage reservoirs were generally small and spring peak flows, while reduced, remained high. The extensive irrigation diversions significantly reduced summer and fall base flows and probably increased summer water temperatures. Construction of storage reservoirs, including the Aspinall Unit, increased significantly in the second-half of the 20th century and greatly reduced spring peak flows while tending to increase base flows from early 20th century levels (Figure 3.3-29). Tyus and Saunders (2001) concluded that the Aspinall Unit resulted in extreme alteration of historic flows in the Gunnison River.

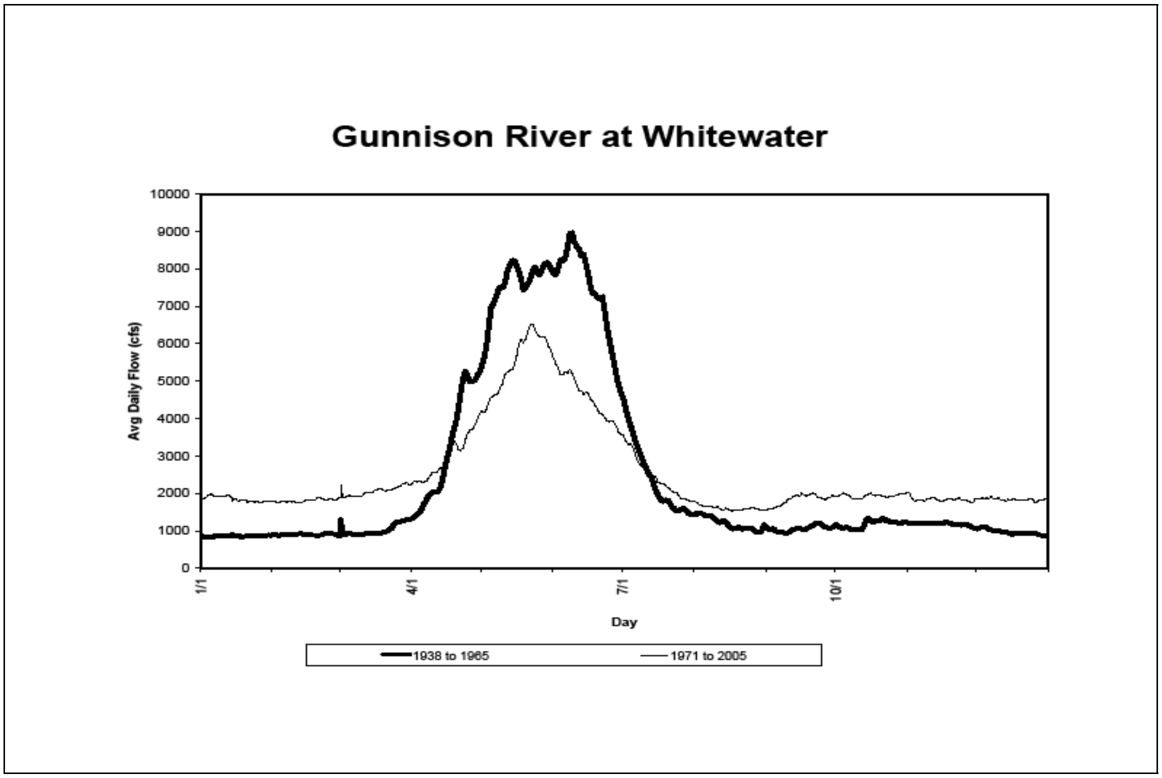

Figure 3.3- 29—General Representation of Flow Changes in the Lower Gunnison River.

Pitlick et al. (1999) reported that since 1950, annual peaks of the Colorado River near Cameo have decreased by 29 percent and annual peaks of the Gunnison near Grand Junction decreased by 38 percent. Mean annual flows of the Gunnison have not changed significantly since 1950, while annual flows of the Colorado River have decreased significantly due to transmountain diversions. As an indication of increased summer and winter flows following construction of the Aspinall Unit, the percentage of months that flows exceed 300 cfs downstream from the Redlands Diversion Dam have increased from 43 to 65 percent for August; 32 to 85 in September; 49 to 88 in October; 64 to 83 in December; 12 to 79 in January; 20 to 80 in February; 43 to 82 in March; and 85 to 90 in April.

Changes in flow regimes affected backwater habitats, channel maintenance, sediment movement, and other habitat factors. McAda (2003) summarized investigations into the influence of water development on channel morphology and river habitat:

> *"Pitlick et al. (1999) documented large-scale morphological changes that have occurred in parts of the Gunnison (lower 60 mi) and Colorado rivers (15-mi reach, 18-mi reach, and Ruby-Horsethief Canyon) by comparing aerial photographs taken in 1937, 1954, 1968, 1993, and 1995. The largest changes were in the 15- and 18-mi reaches where the Colorado River is largely unconstrained and still free to move about the floodplain (Pitlick et al. 1999). Although main channel and side channel area increased in some river segments, the overall trend was a decrease in*

> *surface area with main channel area decreasing by 15 percent, backwater area decreasing by 9 percent and side channel area decreasing by 26 percent (Pitlick et al. 1999). The reduction in side channel habitat may be especially important because side channels increase habitat diversity even though they comprise a small percentage of the river. Complex river reaches (i.e. multi-thread reaches) provide a variety of habitats in a small area and are preferred over single-thread reaches by adult Colorado pikeminnow. The 15- and 18-mi reaches provide most side-channel habitat in the Colorado River (Pitlick and Cress, 2000) and contain a much higher number of adult Colorado pikeminnow than other, much longer reaches of the river.*
>
> *Change in the channel area of the Gunnison River was less than observed for the Colorado River, but results were probably underestimated because of large differences in river flow when the two sets of aerial photographs were taken (Pitlick et al. 1999). Also the Gunnison River is more incised than the Colorado River and less change would be expected. Pitlick et al. (1999) documented little change in main channel and side channel area, but showed a 15 percent decrease in island area between 1937 and 1995."*

While spring peak flows have decreased in the rivers, sediment inflow to the rivers apparently has not (Pitlick et al. 1999, Pitlick and Cress 2000). These two interacting factors reduce channel complexity as side channels gradually fill with sediment. Overall the rivers can become narrower and more simplified. This tendency is magnified by construction of dikes and other channel control structures. According to Pitlick et al. (1999), the period from the late 1950's through the 1970's had lower peak flows and similar annual sediment loads than occurred before or after that period, and this may have resulted in substantial sediment deposition in fish habitat, thus affecting spawning areas and backwaters. Very high flows, such as occurred in 1983 and 1984 tend to reverse the process temporarily.

Sediment deposition may also adversely affect the carrying capacity of rivers for the endangered fishes by reducing periphyton and macro-invertebrates that are important parts of the riverine food web (Osmundson et al. 2002, and Lamarra 1999).

Prior to water development in the basin, it is assumed that fish freely moved between the Gunnison and Colorado rivers; however, early water projects cut off these movements. The Redlands Diversion Dam, located 3 miles upstream from the Colorado River confluence, was a barrier to upstream fish migration to the Gunnison River for nearly 100 years; and, during base flow periods, diverted a significant portion of the river and also presumably larval and adult fish. The Hartland Diversion, upstream from Delta, to a lesser extent, was also a barrier to migration. On the mainstem Colorado River migration was precluded by Boulder Dam in 1935 and by subsequent dams including Glen Canyon. Diversion dams on the Colorado River upstream from the Gunnison confluence in Mesa County Colorado also blocked migration.

Mining in the headwaters and uncontrolled grazing in early settlement years affected water quality and streamflows, while large-scale irrigation in valleys underlain by Mancos shale resulted in return flows with increased salinity and selenium levels. Hamilton (1999) hypothesized on the possible role of selenium in the decline of endangered fish species in the Colorado River Basin:

> "*In retrospect, the extremely elevated selenium concentrations in the Colorado, Gunnison, Uncompahgre, and San Juan rivers and their tributaries from the mid-1930's, which presumably started in the 1890s when irrigation activities began, would be expected to have had a devastating effect on native fish, based on adverse effects demonstrated in recent studies with endangered fish and numerous other species. This adverse effect was recognized indirectly as the disappearance around the 1910 to 1920 period of large-river fish such as Colorado pikeminnow and razorback sucker before large dams were constructed in the upper Colorado River basin. In the lower basin these fish were found until 1911 in abundance in irrigation ditches, but by 1925 to 1930 were considered scarce. The statement of Minckley et al. (1991) about the striking historical absence of young razorback sucker in collections suggests reproductive failure probably was occurring, i.e., no recruitment of young fish to the population, which is one of the well documented effects of selenium exposure. There is little doubt that the construction of mainstem reservoirs and introduction of exotic species have contributed to the decline of endangered fish in the Colorado River. There is now evidence that selenium, historically and currently, may be contributing to the endangerment of fish in the Colorado River basin.*"

Others concluded that most of the evidence implicating selenium is circumstantial and that "neither the historical record nor the technical literature consistently supports the emphasis given selenium toxicity" (Korte 2000).

Operation of the Aspinall Unit has tended to increase winter water temperatures and decrease summer water temperatures in the lower Gunnison River downstream to near Whitewater. Higher flows in the spring tend to be cooler than occur at low flows (Table 3.3 7 in Water Uses and Resources section). Cooler water temperatures can affect spawning in the spring and growth of fish later in the year.

Development of towns such as Delta, the railroad that parallels the river downstream from Delta, and individual orchards and farms along the river led to the construction of dikes and bank protection measures all along the Gunnison River and filling in or cutting off backwater areas that were likely important to razorback sucker. Irving and Burdick (1995) estimated that bottomland habitat availability was much more common prior to dike construction and flow regulation. The loss of backwaters may be of particular importance to the razorback sucker. The razorback spawns in the spring as flows increase and eggs hatch one-two weeks after spawning. Larvae are thought to drift into backwaters and floodplains that provide early critical habitat for the young fish.

Backwaters were once extensive in the Delta area and have been reduced; this habitat has also been reduced downstream from the Roubideau confluence area but was probably never common. Flows greater than 10,000 cfs increase inundation of remaining backwaters and flooded bottomland habitat. The frequency of years having flows greater than 10,000 cfs decreased from 57 percent to 33 percent following construction of the Aspinall Unit based on a study period between 1937 and 1997. Similar channel modification developments occurred along the Colorado River, particularly in valley reaches.

Nonnative fish have been introduced to the Gunnison and other basin rivers and now are common in endangered fish habitat. Fifty-two fish species occur in the Upper Basin, but only 13 of those are native species (Fish and Wildlife Service 2000). Competition with and predation from the non-natives, affect the endangered fish species. Tyus and Saunders (2001) discussed how competition and predation by introduced fishes has emerged as a major biotic factor limiting the survival and recovery of endangered fish populations. Overall, however, the Gunnison River appears to have a higher percentage of native fish (such as roundtail chubs and bluehead and flannelmouth suckers) than other upper basin rivers. The CDOW surveyed the Gunnison River in 2008 and reported a high percentage of native fish with bluehead sucker, roundtail chub, and flannelmouth sucker common (Kowalski 2008). There is some belief that the Redlands Diversion Dam may have impeded the spread of non-natives such as channel catfish and largemouth bass upstream into the Gunnison. However, some nonnative species such as carp, red shiner, sand shiner, and fathead minnow are abundant in the Gunnison River. Brown trout and to a lesser extent rainbow trout are common in the Gunnison River upstream from Austin and occasionally overlap critical habitat downstream from Delta. McAda (2003) reported that there is some evidence that high spring flows may reduce the abundance of some nonnative fish. Burdick (2005) found that young of native fish composed a much higher percentage of the fish population in Gunnison River backwaters in the high water year of 1993 than in the low water year of 1992. The introduced species may be less able to survive the high flows than native fish. Even if this reduction is temporary, it may increase the survival of young native fish.

Nonnative vegetation may also affect the fish. The nonnative shrub tamarisk has become established along most of the Gunnison and Colorado rivers, facilitating stabilization of river banks that reduces natural channel conditions.

Critical habitat for the Colorado pikeminnow and razorback sucker was designated in 1994. Overall 1,980 miles of rivers were designated. “Critical habitat," as defined in section 3(5)(A) of the ESA, means: ``(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 geographical 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."

Critical habitat for both species includes the Gunnison River and its 100-year floodplain from the Uncompahgre River confluence to the Colorado River confluence (Figure 3.3-30). In Colorado and Utah, critical habitat includes the Colorado River from the town of Rifle to Lake Powell; the Gunnison River from Delta to the Colorado River confluence; the Yampa River from Craig to the Green River; the White River from Rio Blanco Dam to the Green River; and the Green River from Dinosaur National Monument to the Colorado River confluence.

Critical habitat was also designated for the humpback chub and bonytail within portions of the Colorado and Green rivers in Colorado and Utah.

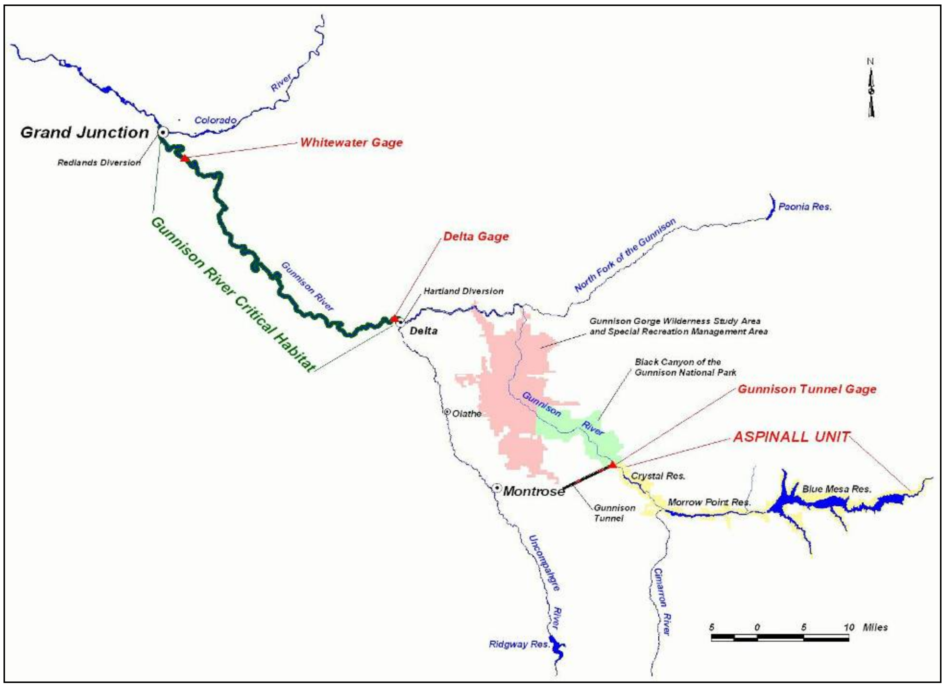

Figure 3.3- 30—Critical Habitat, Gunnison River.

Recovery goals, that define when species may be downlisted or delisted, have been established for the species; these goals essentially call for establishing self sustaining populations. Goals are defined as population numbers, recruitment, and trends in the Green and Upper Colorado River. There are no specific goals for the Gunnison River, and Gunnison River populations would be included in the Upper Colorado River numbers.

The Recovery Program has overseen research activities on the endangered fish of the Gunnison River, with field studies being initiated in 1992. One end product of these investigations was publication of Flow Recommendations (McAda 2003) for the Gunnison and Colorado (downstream from the Gunnison confluence) rivers to benefit the endangered species.

The Aspinall Unit provided research flows in the 1990's for the Recovery Program studies, and since that time has implemented management of "risk of spill" water to benefit the endangered fish. The extended drought of the early 2000's has limited the effectiveness of this approach.

The Recovery Program has established hatcheries and grow-out facilities along the Gunnison River, and stocking of Colorado pikeminnow and razorback began in the Gunnison River in the 1990's in efforts to establish reproducing populations. Habitat improvements have been completed on the Gunnison River. A fish ladder was constructed around the Redlands Diversion Dam and has been operated successfully since 1996; between 1996 and 2008 the ladder was used by 102 pikeminnow, 24 razorback suckers, 1 bonytail, and over 85,000 other native fish (Recovery Program 2008). Recaptures have shown that there is some movement both upstream and downstream past the Redlands Diversion Dam. A fish screen has been installed on the Redlands Canal to reduce losses of native and endangered species in the canal. Bottomland/floodplain habitat has been improved near Whitewater and Delta to increase nursery habitat for young fish. Fish passage, backwater protection, and improved flows have also been implemented on the Colorado River mainstem.

Historical information on the Gunnison River's fish populations is limited and was summarized by Burdick (1995):

> *"Jordan (1891) collected both Colorado squawfish and razorback sucker from the Gunnison and Uncompahgre Rivers near Delta. He also reported collecting one "bonytail"; however this specimen may have been confused with the more numerous roundtail chub, since they were considered subspecies until 1970 (Holden and Stalnaker 1975). Chamberlain (1946) reported razorback sucker as common in the Gunnison River downstream from Delta, and also reported Colorado squawfish from the lower Gunnison River. Kidd (1977) reported that a commercial fisherman frequently collected both Colorado squawfish and razorback sucker from 1930 until 1950 near Delta. Some razorback sucker were collected by CDOW during the 1950's, and one was collected near Delta in 1975 (Wiltzius 1978). Anecdotal accounts also suggest razorback sucker may have been abundant in the Delta area. Quartarone (1993) cites local Delta residents reporting both Colorado squawfish and razorback sucker as common in the Delta area and that razorback sucker used to enter the Hartland Diversion Ditch where they became stranded. Kenneth and Wendell Johnson (Personal communication, 1993), long-time residents of Delta, indicated that they commonly caught razorback sucker in homemade traps in a flooded oxbow that was connected to the Gunnison River during spring runoff. They also added that they noticed that razorback sucker numbers declined rapidly in the late 1950's. Wiltzius (1978) believed that the Redlands Diversion Dam reduced Colorado squawfish numbers in the Gunnison River by preventing upstream movement from the Colorado River."*

Colorado pikeminnow—The Colorado pikeminnow (formerly known as Colorado squawfish) is the largest member of the minnow family in North America and historically was the main predator fish in the Colorado River system. This long-lived fish was found throughout warm water reaches of the entire Colorado River Basin downstream to the Gulf of California. It is estimated that the pikeminnow no longer occurs in approximately 75 percent of its historic range and was listed as endangered in 1967. The Green River and its major tributaries support the largest population; the upper Colorado River population is more limited (Osmundson and Burnham 1998). The Green River is probably the key to recovery of the species. The species occurred in the Gunnison River and has probably not ever been totally expatriated from the river; its historical upstream limits on the Gunnison are not known, but fish probably occurred at least upstream to the North Fork confluence.

While data is scarce, it does appear that the Gunnison historically supported a population of pikeminnow that at some point in time declined markedly. Wiltzius (1978) summarized written and anecdotal reports on this species; information on the relative abundance of the species was not consistent within these reports. Surveys since 1980 revealed only a very small population in the Gunnison River (Valdez et al. 1982; and Wick et al., 1985).

More recently, Burdick (1995) captured 5 adult pikeminnow during the 1992-1994 period. All fish reported by Burdick (1995) and Valdez and Clemmer (1982) were captured between River Mile (RM) 17 and 48 (see Lands Section in this chapter for RM locations), with most occurring near RM 33. During 2006 sampling, 2 wild adult pikeminnow were captured (McAda and Burdick 2006), although none were collected during 2007 (McAda and Burdick 2007). Figure 3.3-31 presents recent distribution information. Larval pikeminnow were collected in very small numbers downstream from the Redlands Diversion Dam in 1992, 1995, and 1996 and larval fish were collected near RM 29 and RM 5.5 in the mid-1990's (Osmundson and Kaeding 1991; Anderson 1994; Burdick 1995; and Anderson 1999). A possible spawning area was located between RM 32 and 33 based on congregation of radio-tagged fish and collection of larvae.

The following habitat information is taken from McAda (2003).

Adult pikeminnow use a variety of riverine habitats. Winter habitat appears to be primarily slow-moving pools, eddies, and backwaters. In the spring, river flows and velocities increase and pikeminnow use available off-channel habitats such as backwaters. As spring runoff declines and backwater availability declines, the species uses the main channel habitats more frequently. Overall, complex river segments with combinations of islands, backwaters, and side channels are preferred. Colorado pikeminnow spawn as the spring runoff declines and water temperatures increase. Spawning begins generally in late June and in high water years can be delayed into August or early September. Based on limited larvae collection, spawning in the Gunnison River ranged from early June to mid-July.

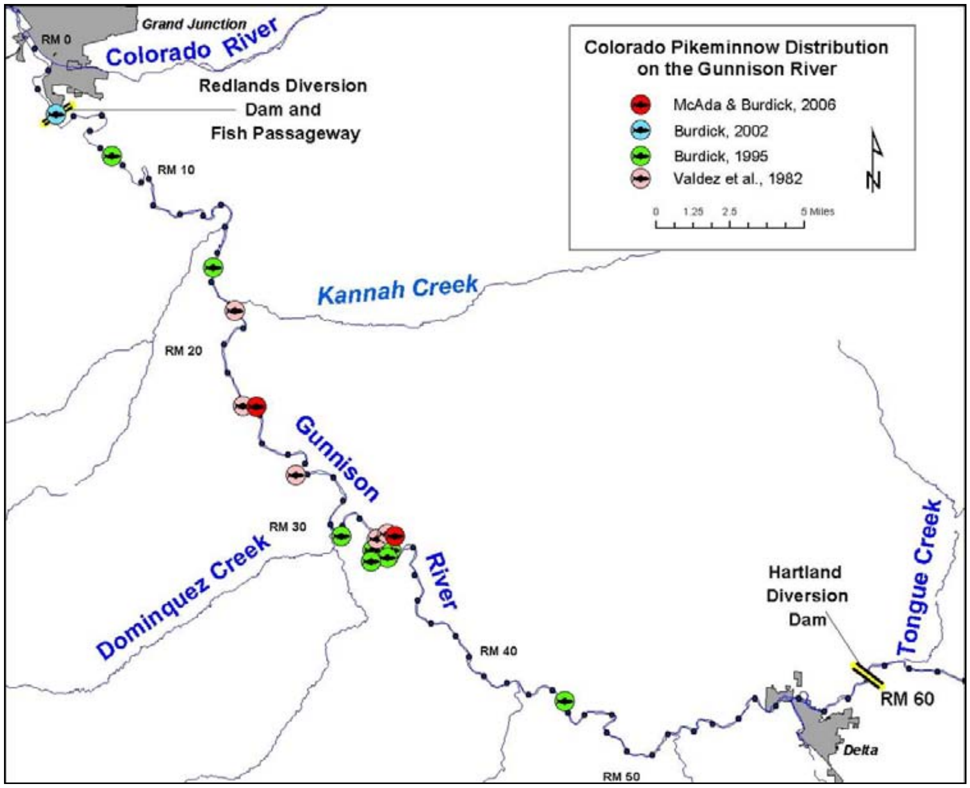

Figure 3.3- 31—Recent Distribution, Colorado Pikeminnow, Gunnison River.

Most spawning occurs when spring flow decreases and water temperatures are between 18 and 22 degrees C based on information from the Green and Colorado rivers. Spawning occurs in gravel-cobble substrates in riffles and runs, and adjacent pools or backwaters can be used for resting or staging. Spawning aggregations have been observed at specific sites in the Upper Basin including possibly one on the Gunnison River discussed previously.

Eggs are broadcast on cobble substrates in riffles and runs and incubate in the interstitial spaces for 4-7 days before hatching. The new larvae remain in the gravel/cobbles for about one week and then emerge and enter the river current. The larvae drift downstream and settle in quieter water of backwaters or other low-velocity habitats. The small pikeminnow are highly dependent upon backwaters or shallow embayments during their first year and reach 30-40 mm by their first winter. It appears that growth is maximized at water temperatures around 25 degrees C; and extended spring flows delay river warming which can reduce growth of young fish. Summer water temperatures at Whitewater only infrequently exceed 20 degrees C.

McAda (2003) reported that Gunnison River summer temperatures were about 3 degrees C cooler than river reaches in other parts of the Colorado River Basin that have relatively large populations of endangered fish. Osmundson (1999) considered the potential for extending the range of endangered fish in the Gunnison River, and stated that “Based on analysis of the temperature regime and the distribution of a remnant population of Colorado pikeminnow there, suitable habitat in the Gunnison River extends about 33 miles upstream of the Colorado River confluence" (to Dominquez Creek – Peeples Orchard). Cooler water upstream does not preclude fish from using upper reaches but the cooler temperatures can interfere with life processes such as reproduction and can lower growth rates. Osmundson (1999) reported good prey and habitat conditions upstream, but only sporadic use by Colorado pikeminnow and hypothesized that water temperature may reduce the upstream use.

The relationship between flow regimes and habitat maintenance was summarized in McAda (2003):

Spring

- Increasing flows cue fish to prepare for migration and spawning
- High flows inundate floodplain habitats to provide warm food-rich environments for growth and gonadal maturation
- High flows scour vegetation on banks and side channels to maintain habitat complexity

Habitat Complexity

- High flows scour sediment from the cobbles and gravels to provide suitable location for eggs and larvae
- High flows mobilize the bed in runs and riffles; fines are flushed from the substrate and interstitial spaces
- High flows transport sediment and build in channel bars for backwater habitat
- High flows reduce nonnative predators and competitors

Late Spring/Early Summer

- Declining flows and increasing water temperatures initiate migration and spawning
- Flows are sufficient to provide migration routes
- Flows are sufficient to prevent sedimentation of eggs and larvae

Summer

- Base flows maximize preferred habitat and sufficient depth for movement
- Base flows maximize backwater habitats available to young fish

Winter

- Base flows maximize preferred habitat and sufficient depth for movement and resting
- Base flows maximize backwater habitats available to young fish

Razorback Sucker—The razorback sucker is a large catostomid and is endemic to the Colorado River. It is a long-lived fish and historically was found throughout warm water reaches of the entire Colorado River Basin downstream to the Gulf of California. By the 1990's, the largest riverine population was found in the middle Green River. The species occurred in the Gunnison River and may have been totally expatriated from the river by the 1990's. Its historical upstream limits on the Gunnison are not known, but fish probably occurred at least upstream to the North Fork confluence. In the Colorado River in the vicinity of the Gunnison River mouth, the number of wild razorback suckers dropped precipitously between the early 1970's and the 1990's.

Historical information on the Gunnison River's fish populations is limited and was summarized by Burdick (1995) (previous discussion in this section). It appears the species was once abundant in the Gunnison River, yet significantly declined or disappeared in the second-half of the 20th century. The last wild adults were captured near Delta in 1981 (Holden et al. 1981). Extensive sampling after that failed to capture any more wild adults of the species in the Gunnison (McAda 2003). Recent surveys of stocked razorback sucker in the Gunnison indicated stocked fish have survived for 5-11 years (McAda and Burdick 2006 and 2007). Overall there is little evidence of successful recruitment of this species in the Upper Colorado River Basin, although recent surveys indicate that stocked razorback sucker are spawning successfully in the Gunnison and Colorado rivers (Osmundson and McAda 2006 and 2007). Figure 3.3-32 presents distribution information from recent years.

The following information is taken from McAda (2003). Adult razorbacks use a variety of low-velocity habitats. Pools and slow runs are used year-round with heavy use of backwaters and backwater-type habitats during spring runoff. Flooded gravel pits appear to provide backwater-type habitats. The greatest varieties of habitats, including runs, backwaters, and eddies, are used during summer months.

Razorback suckers are believed to spawn in spring as flows increase due to snowmelt in early to mid-May. In the Green River, spawning occurred earlier in low water years (Muth et al. 1998). Spawning in the Green River occurred at water temperatures ranging from 8 to 19.5 degrees C (Muth et al. 1998). The fish spawn in riffles or shallow runs over gravel or cobble bars and may migrate large distances to spawning sites. Eggs hatch in one-two weeks and larvae emerge from the gravel and enter the current about two weeks after hatching. The larvae are carried into floodplains, backwaters, flooded tributary mouths, or other areas of quiet water. Sufficient flows to reconnect floodplain habitats to the main channel are considered critical to the species survival. Modde et al. (1996) correlated successful razorback recruitment in the Green River with high spring flows and concluded "Without sufficient flows to reconnect floodplain habitats to the main channel, it is unlikely that razorback sucker recruitment will continue." Because there are so few fish in the wild, little is known of spawning aggregations; however, larval sampling has indicated spawning in the Delta area and downstream. Larvae were collected from shallow low-velocity habitats along the river's edge. McAda (2003) reported extensive spawning habitat between the Hartland Diversion and Escalante Wildlife Area on the Gunnison River; the Escalante area provides a relatively large amount of backwater habitats.

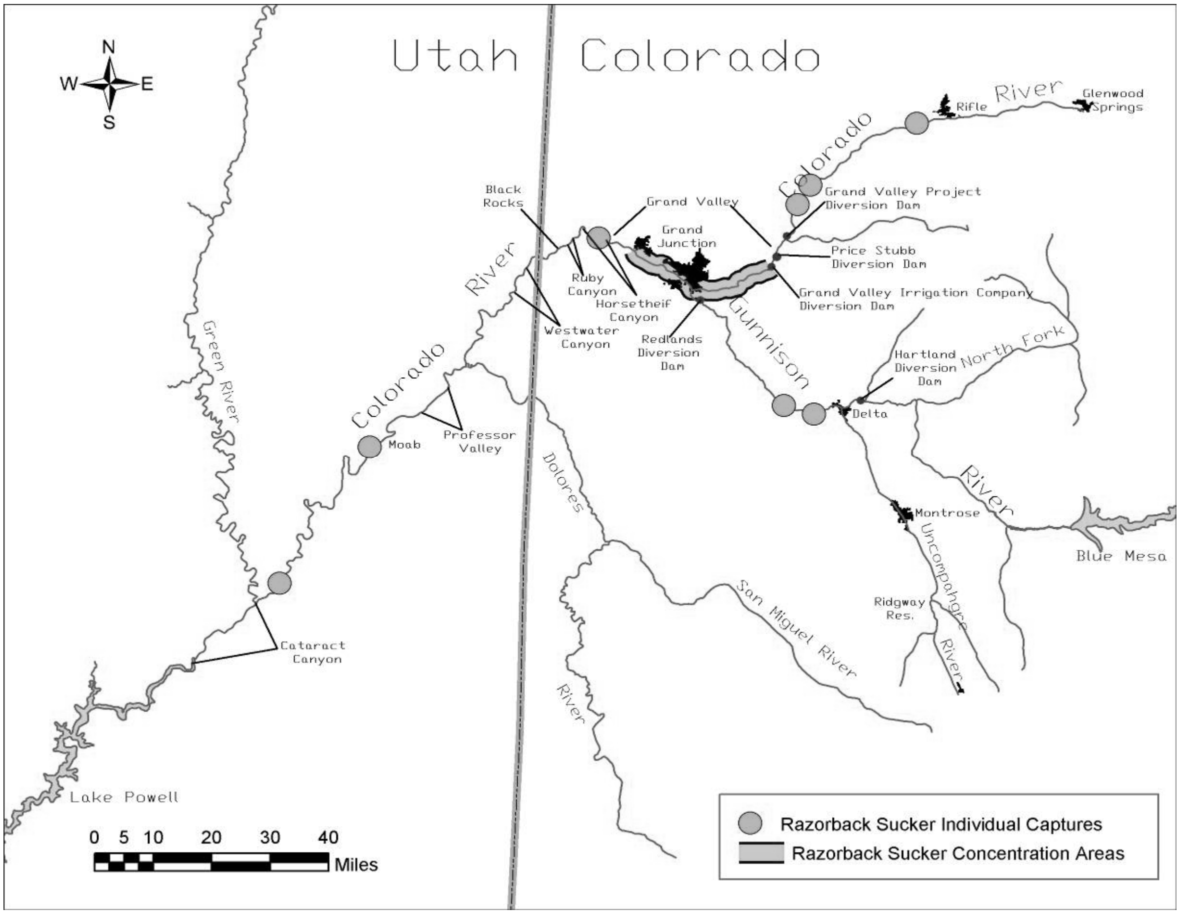

Figure 3.3- 32—Razorback Sucker Distribution, Colorado and Gunnison Rivers.

The relationship between flow regimes and habitat maintenance was summarized in McAda (2003):

Spring

- Increasing flows cue fish to migrate to spawning areas and trigger reproduction
- High flows inundate floodplain habitats to provide warm food-rich environments critical for larval fish and to provide river-floodplain connections
- High flows scour vegetation on banks and side channels to maintain habitat complexity
- High flows scour sediment from the cobbles and gravels to provide suitable location for eggs and larvae
- High flows mobilize the bed in runs and riffles; fines are flushed from the substrate and interstitial spaces
- High flows transport sediment and build in channel bars for backwater habitat
- High flows reduce nonnative predators and competitors

Late Spring/Early Summer

- Declining flows allow increasing water temperatures
- Flows are sufficient to provide migration routes for adults and larvae

Summer

- Base flows maximize preferred habitat and sufficient depth for movement
- Base flows maximize backwater habitats available to young fish

Winter

- Base flows maximize preferred habitat and sufficient depth for movement and resting
- Base flows maximize backwater habitats available to young fish

Humpback chub—The humpback chub is a mid-sized cyprinid endemic to the Colorado River, generally found in deep-water canyon-bound reaches of the Colorado, Yampa, and Green rivers.

The Gunnison River has never been confirmed as important habitat for this species; however, sampling was very limited in potential habitat areas in the early and mid-20th century period. Only one specimen has been confirmed and it was found in a canyon area about 4-miles downstream from Bridgeport in 1995.

Two of the key river reaches for this species are located at Black Rocks and Westwater Canyon on the Colorado River downstream from the Gunnison confluence near the Colorado-Utah Stateline.
Recovery Program activities in the Gunnison River are primary directed toward the Colorado pikeminnow and razorback sucker and no specific activities are designed for the humpback chub. It is possible that operation of the Redlands Fish Ladder may allow the humpback to occupy new habitat.

The following information is taken from McAda (2003). Adult humpback chubs use more limited habitats than the pikeminnow and razorback. Canyon-bound reaches of deep water are preferred such as at Black Rocks and Westwater Canyons on the Colorado River near the Colorado-Utah Stateline. They appear to prefer low-velocity habitats adjacent to the main channel, for example eddies.
Humpback chubs spawn in late spring or early summer at, or shortly after the spring peak, generally mid-June to late July. Little is know about spawning but limited data indicates that spawning occurs in gravel and cobble substrates. Larval drift does not appear to be as significant as with the pikeminnow and razorback.

Bonytail—The bonytail is a large cyprinid fish endemic to the Colorado River and is the rarest of the four big river endangered fishes in the Colorado River Basin; wild populations are considered nearly extinct.

The Gunnison River has never been confirmed as habitat for this species; however, early sampling and anecdotal information suggests the species was common in the Green and Colorado Rivers in the early 20th century (McAda, 2003). The Fish and Wildlife Service (2002) cited one capture in the Gunnison River near Delta by Jordan (1891), although identification of this specimen has been questioned. There were 5 captures in the mainstem Colorado River in the 1980's. Therefore it is possible that the species once utilized the Gunnison River.

Recovery Program activities in the Gunnison River are primary directed toward the Colorado pikeminnow and razorback sucker and no specific activities are designed for the bonytail. Stocking of the species under the Recovery Program in other river reaches began in 1996 (McAda 2003) using broodstock captured in Lake Mohave in the Lower Colorado Basin (Fish and Wildlife Service 2002). Bonytail have been stocked in Gunnison River gravel pit/backwaters and in 2008 CDOW captured 2 bonytail in the Gunnison River itself near the gravel pit (Kowalski 2008).

The following information is taken from McAda (2003). Because the bonytail is so rare in the wild, little is known about habitat preferences. Limited captures have occurred in canyon sections such as Cataract Canyon and Black Rocks on the Colorado and canyon sections of the Green River. Because the bonytail evolved in the same system as the pikeminnow and razorback, it is assumed that similar flow regimes would be beneficial to all species.

3.3.7.2 Impacts

3.3.7.2A General

The action alternatives would have varying degrees of beneficial effects on the four listed fish and their critical habitat within the action area when compared to No Action. Benefits result from the increased frequency, magnitude, and duration of spring peak flows and protection of base flows. The flow changes would assist in improving and maintaining habitat conditions for spawning and recruitment and for maintenance of adult pikeminnow and razorback suckers. For Colorado pikeminnow (and probably other endangered fish), Osmundson and Burnham (1998) reported that the success of recovery efforts will largely depend on providing environmental conditions that increase reproductive success and survival of early life stages. In general, the implementation of a flow regime that more closely resembles a natural flow regime of the river would provide benefits to the endangered fish and their habitat.

Figure 3.3-33 and Table 3.3 22 summarize a comparison of peak flows and Table 3.3 23 presents a comparison of the frequency of selected flows in critical habitat. As discussed, flows adequate to move sediment through the Gunnison River system are essential to maintaining and improving critical habitat for the listed fishes. Reaching flows that are half-bankfull or bankfull is considered key in the sediment movement. Goals of 8,070 and 14,350 cfs were established in the Flow Recommendations. At a flow of 8,070 cfs one-half (27) of the river cross sections identified by Pitlick et al. (1999) reach half-bankfull (initial motion) and at 14,350 cfs one-half of the river cross sections reach

Table 3.3 22—Summary of Peak Flow (mean daily) at Whitewater Gage for Study period, Percent Change from No Action shown in Parentheses.

	No Action	Alt A	Alt B	Alt C	Alt D
Mean May peak flow (cfs)	8,559	9,396 (+10%)	10,124 (+18%)	10,068 (+18%)	9,522 (+11%)
Mean June-July peak flow (cfs)	7,486	7,446 (-1%)	8,310 (+11%)	8,703 (+16%)	8,121 (+8%)

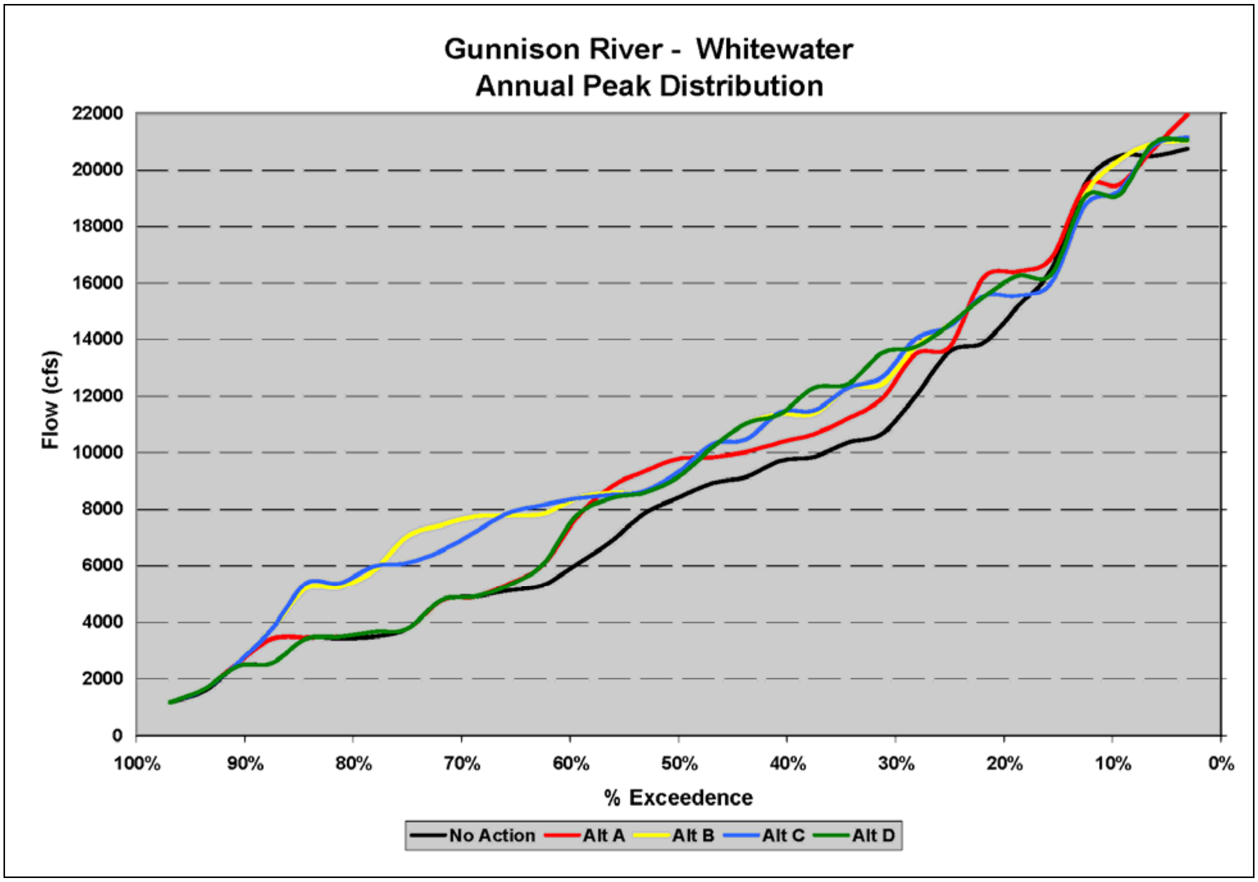

Figure 3.3- 33—Annual Peak Distribution at Whitewater.

bankfull (significant motion). As can be seen in Table 3.3 23, the number of days that flow reaches these thresholds increases as well as the frequency of the years they are reached.

Table 3.3 23— Percentage of Years in Study Period when Selected Flow Levels are exceeded at the Whitewater Gage during the Spring Runoff Period. Half-Bankfull (8,070 cfs) and Bankfull (14,350 cfs) are Highlighted.

Flow (cfs)	*Percentage of years selected flow exceeded*				
	No Action	**Alt A**	**Alt B**	**Alt C**	**Alt D**
6,000	*61*	*61*	*77*	*77*	*65*
7,000	*55*	*61*	*77*	*71*	*61*
8,070	*52*	*58*	*61*	*65*	*58*
9,000	*45*	*55*	*52*	*52*	*52*
10,000	*35*	*45*	*48*	*48*	*48*
11,000	*29*	*35*	*45*	*42*	*45*
12,000	*26*	*29*	*35*	*35*	*39*
13,000	*26*	*29*	*29*	*29*	*32*
14,350	*19*	*23*	*26*	*26*	*26*

Under the action alternatives, average peak flows would be greater and occur more frequently than No Action peak flows and are more approximate of natural conditions, indicating a return to less regulated flow conditions. Years with peak flows equal to or greater than initial motion threshold flows (8,070 cfs; Pitlick et al. 1999) should increase by at least 10 percent under the action alternatives, and flows equal to or greater than significant motion threshold flows (14,350 cfs) should increase at least 15 percent.

It should be noted that flows above and below target flows also provide benefits to habitat. Table 3.3 24 shows the percentage of transects (Pitlick et al. 1999) where half-bankfull and bankfull flow elevations were attained over a range of discharge and the relative gain in frequency of days at these flows alternatives. Flows in the range of 4,400 to 5,300 cfs also have the capacity to mobilize sand and finer sediments, which should function to keep spawning substrates relatively clean (Pitlick 2007).

Table 3.3 24— Percentage of Study Transects used by Pitlick et al. (1999) at Which Half-Bankfull and Bankfull Flows are Attained at a Given River Flow and the Average Number of Days (and Percent Difference) Each Flow is Met or Exceeded within a Given Year under No Action and Action Alternatives.

	Pitlick transects		**Duration of flow**				
	% at half-bankfull	**% at bankfull**	**Average days per year flow met or exceeded during study period**				
			No Action	**Alt A**	**Alt B**	**Alt C**	**Alt D**
6,000	19	0	28.0	26.4	29.6	34.7	28.7
7,000	33	0	21.6	20.6	24.2	29.5	23.7
8,070	46	2	16.0	16.2	17.2	18.7	17.4
10,000	81	6	8.6	9.4	10.9	12.0	10.9
12,000	94	26	5.6	6.2	7.1	8.2	7.3
14,350	100	46	2.8	3.3	3.0	3.1	3.0

The increase in frequency and duration of initial and significant motion (half- and bankfull flows) under the alternatives would help maintain the interstitial spaces in gravel and cobble bars that provide spawning habitat, habitat for larval fish immediately after hatching, and for macro-invertebrates which are important for the food web of the endangered fish. Increases in significant motion conditions shift cobble and gravel bars, scour vegetation, and help maintain side channels which overall helps maintain or improve channel complexity of benefit to the fish.

More fine sediment would be mobilized under action alternative flows than under No Action. Higher flows also have a disproportionate increase in sediment movement compared to lower flows. Thus, the net result of increased frequency of high flows would also include a greater active channel area under the action alternatives.

Due to operational limitations including flood control, extremely high flows (> 15,000 cfs) would not be significantly increased by the action alternatives and thus flows that significantly modify channel conditions and create new habitat would not increase. These flows would probably occur in the future due to extreme hydrologic conditions but would not differ significantly from No Action conditions.

Overall, inundation of floodplains tends to increase significantly between 5,000 cfs and 14,000 cfs, and frequency and duration of spring peak flows in this range are greater under the action alternatives than under No Action (Table 3.3 25). At 5,000-6,000 cfs small floodplain wetlands begin to appear in the area immediately downstream of Delta (Johnson Boys' Slough, others) and the Craig gravel pit pond near Whitewater connects to the main channel Gunnison River (Reclamation 2006a). Flooded acreage at the Escalante State Wildlife Area increases with Gunnison River flows such that 80, 140 and 200 acres become inundated at 8,000, 10,000 and 14,000 cfs, respectively (Valdez and Nelson 2006, Irving and Burdick 1995). Wetlands near Confluence Park at Delta flood at about 9,000 to 10,000 cfs.

Table 3.3 25— Floodplain Flows-No Action and Action Alternatives for Period of Study.

	Avg. days >5,000 cfs benefitting backwaters @Butch Craig, Johnson Slough					Avg. days >8,000 cfs benefitting backwaters at Escalante (80 acres)				
	No Action	Alt A	Alt B	Alt C	Alt D	No Action	Alt A	Alt B	Alt C	Alt D
Avg. days/yr	35.2	34.1	36.3	41.3	34.6	16.0	16.2	17.6	18.7	17.4
% of yrs	68	68	87	87	68	52	58	61	65	58
	Avg. days >10,000 cfs benefitting backwaters @ Escalante (100 acs), Confluence Park					Avg. days >14,000 cfs benefitting backwaters at Escalante (2000 acres)				
	No Action	Alt A	Alt B	Alt C	Alt D	No Action	Alt A	Alt B	Alt C	Alt D
Avg. days/yr	8.6	9.4	10.9	12.0	10.9	2.8	3.3	3.5	3.1	3.0
% of yrs	35	45	48	48	48	19	23	26	26	26

In most instances, the alternatives would assure flows to operate the Redlands Fish Ladder from April through September and the Redlands Fish Screen as needed. Migration flows of 300 cfs are recommended downstream from the Redlands Diversion Dam. On average, the action alternatives would result in 28-36 days annually below that flow level compared to 29 days at No Action flows during April-September. Flows less than 100 cfs would remain about the same during April-September under the action alternatives.

The action alternatives will meet the duration targets of the Flow Recommendations more frequently than No Action flows. Thus action alternatives more closely approximate recommendations for flow durations made by Pitlick et al. (1999; summarized in McAda 2003).

In years with increased spring flows, warming of the main channel of the Gunnison River would be delayed (Figures 3.3-34 and 3.3-35). If peak flows remain at or above 3,000 cfs during June, favorable spawning temperatures (≥18 °C) would occur in the Whitewater area but not likely in the Delta area. Favorable temperatures would occur in both areas during July at flows of about 2,000 to 3,000, however. The trade-off between high flows for channel maintenance and spawning temperature regime in the Gunnison River is thus an uncertainty that may need to be evaluated by the Recovery Program. The temperature of the Colorado River is not expected to change significantly in relation to the action alternatives (McAda 2003).

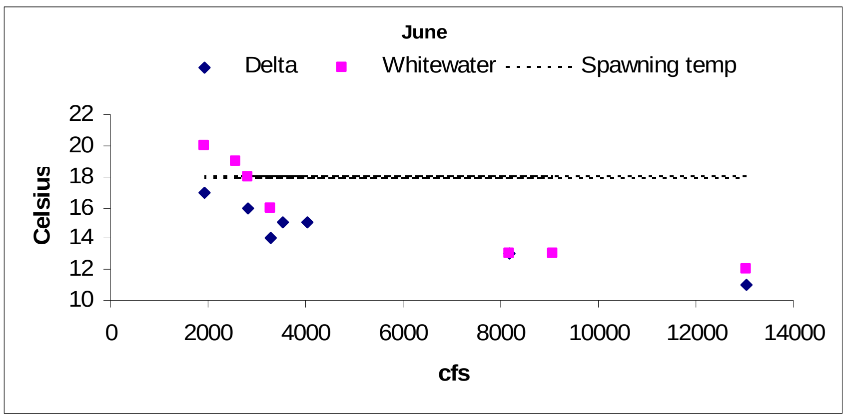

Figure 3.3- 34—Gunnison River Temperatures at Delta and Whitewater During June in Relation to Spawning Temperatures for Colorado Pikeminnow. [1]

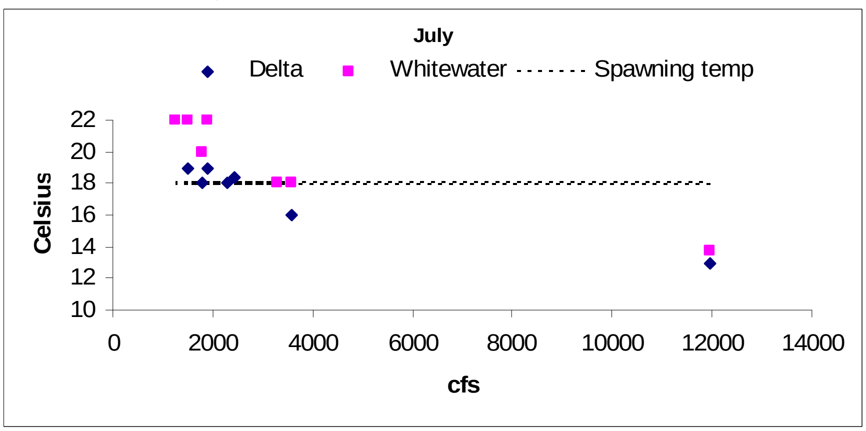

Figure 3.3- 35—Gunnison River temperatures at Delta and Whitewater During July in Relation to Spawning Temperature Threshold for Colorado Pikeminnow. [6]

[1] Data were collected during 1992-2000 (McAda 2003).

Figures 3.3-36 through Figures 3.3-39 show total number of days for each alternative flows would be below 3,000 cfs and consequently more likely at a desirable spawning temperature for Colorado pikeminnow at Delta and Whitewater for June and July.

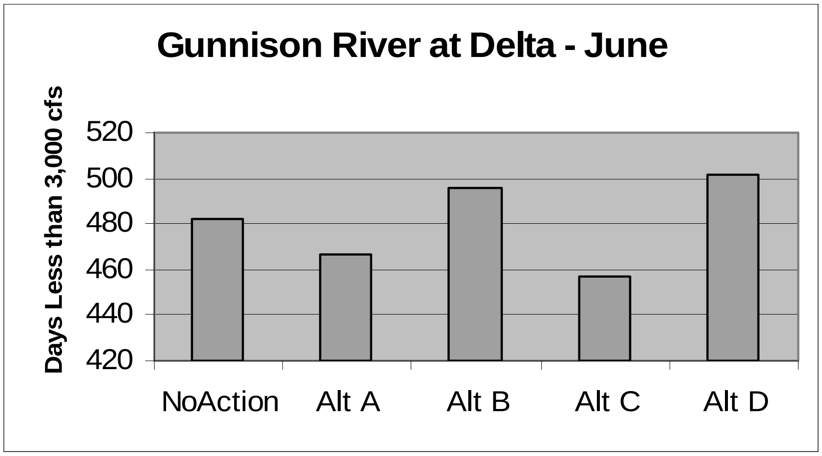

Figure 3.3- 36—Gunnison River at Delta, June.

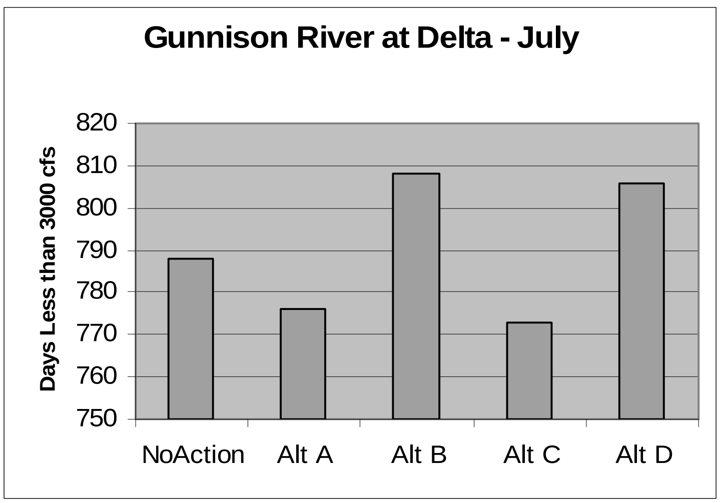

Figure 3.3- 37—Gunnison River at Delta, July.

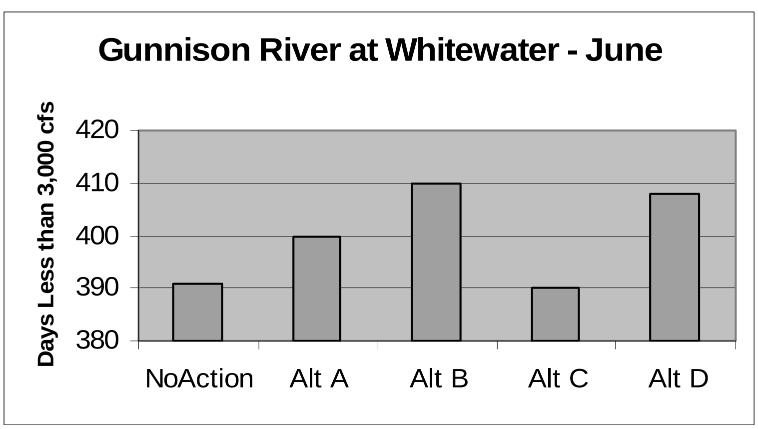

Figure 3.3- 38—Gunnison River at Whitewater, June.

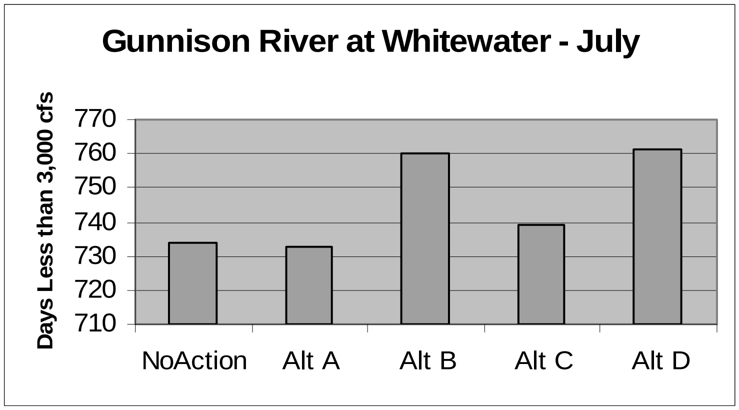

Figure 3.3- 39—Gunnison River at Whitewater, July.

There should not be significant effects on water quality (see Water Uses and Resource Section). The Aspinall Unit has tended to improve water quality conditions in critical habitat by reducing extremely low flow months when pollutants are concentrated. From August thru March, the Aspinall Unit generally more than doubled pre-Aspinall Unit flows. At lower flows, seen in some months under the action alternatives, the dilution effects of Aspinall releases would be reduced and pollutant concentrations such as for selenium would increase. However, base flows should be maintained adequately to provide dilution and base flows would reduce periods of extremely low flows. Table 3.3 26 shows modeled information on average monthly flows at the Whitewater gage under the action alternatives. See Section 3.3.1.2D for further information on water quality effects.

Table 3.3 26—River Flows (Average Monthly cfs), Gunnison River at Whitewater, for Alternatives.

	Alt	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Below Avg. years	**No Action**	1032	1006	1199	1932	2963	2246	1549	1239	1514	1525	1271	1173
	A	1039	1020	1202	1930	3149	2184	1561	1290	1493	1508	1251	1163
	B	1017	1006	1175	1924	3573	2176	1494	1244	1448	1463	1212	1112
	C	994	976	1130	1920	3762	2402	1439	1222	1420	1438	1177	1074
	D	1037	1018	1199	1929	3180	2212	1536	1280	1491	1504	1247	1162
Above Avg. years	**No Action**	1611	1734	2146	4379	8715	7981	4123	2013	2211	2258	2110	2120
	A	1618	1713	2122	4069	8673	8122	4184	2017	2213	2279	2114	2112
	B	1576	1690	2041	4045	8959	8501	3924	1979	2138	2226	2059	2051
	C	1532	1536	1900	3919	8877	9233	4498	2258	1912	1978	1755	1707
	D	1576	1690	2042	4060	9031	8468	3923	1977	2137	2226	2059	2051
All years	**No Action**	1310	1345	1647	3096	5700	4993	2777	1603	1841	1877	1671	1620
	A	1317	1348	1637	2945	5770	5033	2814	1630	1831	1880	1663	1611
	B	1286	1330	1584	2930	6114	5212	2655	1589	1773	1832	1618	1557
	C	1246	1241	1493	2867	6165	5676	2907	1714	1650	1700	1454	1372
	D	1296	1336	1595	2940	5958	5213	2676	1606	1793	1852	1635	1581

Changes in the mainstem of the Colorado River have not been analyzed in detail for this assessment. In general, spring flows would be increased in magnitude and/or duration downstream from the Gunnison confluence. The greatest increase would be seen in moderately wet and moderately dry years, during which over 1,500-2,000 cfs would be added to the flow of the Colorado River. About 2,000 cfs and 1,000 cfs would be added in average dry and average wet years. Dry and wet year additions would generally be negligible. In any case, benefits to the Colorado River due to increased flows from the Gunnison River would probably be maximized during years in which coordinated reservoir operations in the upper Colorado River basin are implemented. Since 2000, releases from upstream Colorado River reservoirs, averaging 48,000 af per year, have improved endangered fish habitat (Recovery Program, 2008). Table 3.3 27 summarizes average monthly flow changes for the study period below the Gunnison confluence.

Table 3.3 27—Approximate Average Contribution of Gunnison River (cfs) to Colorado River during May during Study Period.

	No Action	Alt A	Alt B	Alt C	Alt D
All Years	5700	5770	6114	6165	5958
Above Avg. Years	8715	8673	8959	8877	9031
Below Avg. Years	2963	3149	3573	3763	3180

The alternatives include continuation of existing water uses and implementation of the Recovery Program. The continuation of the Recovery Program will support habitat restoration, monitoring, fish passage and screening, stocking, and better control of non-native fish. All of these actions are anticipated to have a positive effect on endangered fish populations.

There are a number of factors affecting the recovery of the endangered fish in the Gunnison River including reductions in habitat, competition with non-native fish, channelization, potential water quality concerns, and others. The action alternatives do not resolve all of these factors but should improve conditions to increase recruitment and adult survival of the Colorado pikeminnow and razorback sucker in both the Gunnison and Colorado and possibly the humpback in the Colorado River in conjunction with other Recovery Program actions. Response of the bonytail is unknown although the more natural hydrograph may have future benefits if populations are established.

In general, benefits of the action alternatives include increased frequency and magnitude of relatively high spring flows to maintain channel conditions, spawning habitat, and channel complexity in critical habitat. The proposed flow regime should more closely resemble a natural flow regime when compared to No Action in that spring peaks would be greater in frequency, magnitude and duration, and that flows will vary among years in relation to snow pack and runoff. In addition to continuation of Recovery Program activities, the proposed action will provide benefits to the endangered fish and their habitat.

3.3.8 RECREATION

This section addresses the potential impacts to outdoor recreation from modified operations of the Aspinall Unit under the alternatives considered.

Issue: What are the effects on recreational uses and values at the Curecanti National Recreation Area and along that portion of the Gunnison River corridor that may be affected by Aspinall Unit operations?

Overview

Scope

The recreation analysis area includes the Gunnison River corridor from the eastern end of the Curecanti National Recreation Area (Curecanti NRA) downstream to the Colorado River confluence. While nearly the entire length of this portion of the river corridor has some recreational value and use, the primary focus of the section is on water-based recreational uses and associated support uses and elements at Blue Mesa Reservoir and within the Gunnison Gorge NCA.

Impact Indicators

The following indicators were used to determine the impacts to recreational use from changes in the operation of the Aspinall Unit:

- Visitation levels during the primary recreation season: May-September for the Curecanti NRA and May-October for the Gunnison Gorge NCA. A recreational visit is one person entering the Curecanti NRA for recreation purposes. The duration of a visit can be less than an hour or last for a number of days.
- Changes in recreational uses, particularly fishing, flat-water boating, whitewater rafting and kayaking, and associated camping.
- River flow levels or reservoir water surface elevations.
- Quality of visitor recreation experience.

Summary of Impacts

Action alternatives are expected to have minor to moderate impacts on recreation use. Alternative C with the largest effect on reservoir surface area and river flows would have the greatest adverse effect.

3.3.8.1 Affected Environment

3.3.8.1A General

The analysis area for recreation is a 170-mile portion of the Gunnison River corridor within Gunnison, Montrose, Delta, and Mesa Counties. The corridor includes portions of the Curecanti NRA, the Black Canyon of the Gunnison National Park (Black Canyon NP), and the Gunnison Gorge NCA.

Although the Gunnison River basin provides many varied recreational opportunities, the affected environment for recreation related to Aspinall Unit operations consists primarily of water-based recreational uses and/or opportunities (e.g., stream and reservoir boating, fishing, and sightseeing). Also affected may be certain terrestrial recreational uses, such as camping, which are associated with or support the water-based uses. The study area is analyzed in 4 segments. These segments are as follows:

- **Segment 1**: Curecanti NRA- This segment includes the Gunnison River and Aspinall Unit reservoirs from about 4 miles downstream of Gunnison, Colorado to the upstream boundary of the Black Canyon NP.
- **Segment 2**: Black Canyon NP.
- **Segment 3**: Gunnison Gorge NCA downstream of the Black Canyon NP to the confluence of the North Fork of the Gunnison and including the reach of the river to Austin, Colorado.
- **Segment 4**: Gunnison River downstream from the Gunnison Gorge NCA.

3.3.8.1B Curecanti National Recreation Area and Upper Gunnison River

Setting—The Gunnison River upstream from Blue Mesa Reservoir provides rafting and fishing recreation opportunities. Activities on this reach of the river and on the Taylor River tributary benefit from water exchanges between Taylor Reservoir and Blue Mesa Reservoir which provide improved flows for fisheries and recreation.

The Curecanti NRA was established in 1965 to enable the NPS to develop and manage the recreational, natural, and cultural resources surrounding Reclamation’s Aspinall Unit. Water is the central feature of this recreation area. Even so, there are wide varieties of recreational opportunities available. Fishing, boating, swimming, and camping are obvious but hiking, bird watching, horseback riding, cross country skiing and snowshoeing are also popular activities.

In 2007, there were a reported 964,640 recreation visits at Curecanti NRA (NPS 2008). This was slightly higher than the ten-year average of 945,000 recreation visits. The monthly pattern of visitation in 2007 displays the typical “head and shoulders” pattern of an outdoor recreation park (visitation increasing in spring, peaking in summer (July), decreasing in fall, and decreasing to a minimum in the winter).

As shown in Figure 3.3-40, a large proportion of the recreation use (approximately 75 percent) occurs in the summer season (May through September).

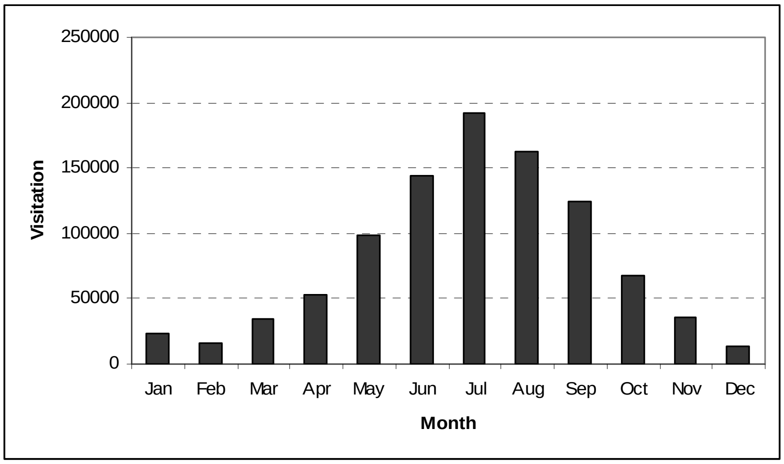

Figure 3.3- 40—Curecanti NRA Visitation in 2007 by Month.

A recreation economic evaluation study on Blue Mesa Reservoir conducted for Reclamation between May and September, 2004, indicated the following with regard to the respondents (Reclamation 2005b):

- The majority (76 percent) of visitors to Blue Mesa Reservoir were from Colorado.
- The majority (65.6 percent) of Colorado visitors were from outside of the study area (Delta, Montrose, and Gunnison counties).
- Blue Mesa Reservoir was the only destination for about 74 percent and the primary destination for 59 percent of the remainder.
- Primary activities identified for Blue Mesa Reservoir visitors included private boat fishing (29 percent), shore fishing (25 percent), camping (10 percent), sightseeing (10 percent), motorized boating (9 percent), swimming (3 percent), and non-motorized boating (2 percent).

Figure 3.3-41 displays summer season (May – September) recreational visitation and mean summer season reservoir contents at Blue Mesa Reservoir for the period 1979 through 2007.

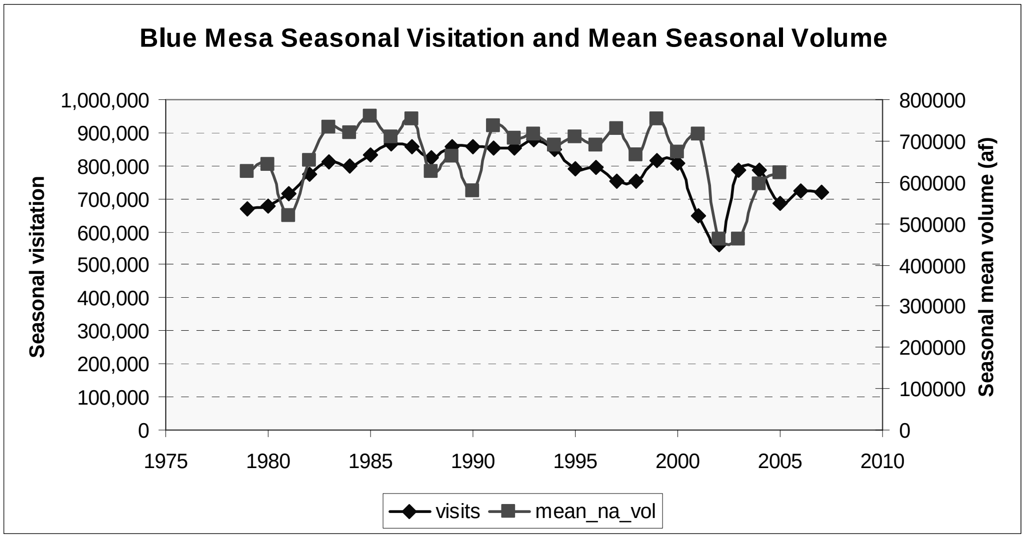

Figure 3.3- 41—Blue Mesa Seasonal Visitation and Seasonal Mean Volume.

The Curecanti NRA is a relatively narrow strip of land and water encompassing about 45 miles of the Gunnison River corridor between the town of Gunnison and the Black Canyon NP. The majority of the Curecanti NRA consists of lands acquired and withdrawn by Reclamation for the Aspinall Unit and for the Uncompahgre Project.

Blue Mesa Reservoir is the largest reservoir in Colorado; at full pool it is about 20 miles long with 96 miles of shoreline. At maximum water surface elevation the reservoir covers about 9,180 acres. Because of its accessibility and its nationally renowned sport fisheries, Blue Mesa Reservoir is a major recreational destination point. The new Colorado record lake trout (50 lbs 5 oz) was caught at Blue Mesa Reservoir on 23 May 2007. Morrow Point and Crystal Reservoirs are both long (12 miles and 6 miles, respectively) and narrow. Morrow Point Reservoir's surface area is 817 acres while Crystal's is 340 acres. Recreational use at these reservoirs is limited due to their topographic setting and limited accessibility. The Colorado record rainbow trout (19 lbs 10 oz) was caught in Morrow Point Reservoir in 2003.

The East Portal portion of the Curecanti NRA lies within the Gunnison River canyon between the upstream boundary of the Black Canyon NP and Crystal Dam. This segment is about 2.3 miles long.
Recreation Opportunities—Recreational opportunities and uses within the Curecanti NRA are varied and include the following:

Fishing: Fishing for cold-water species, including rainbow trout, brown trout, lake trout, and kokanee salmon occurs year round, from boats and from the shore when the reservoirs are ice free, and through the ice on Blue Mesa Reservoir during the winter. Stream fishing for trout includes float/boat and walk/wade opportunities on the Gunnison River, Cimarron Creek, Lake Fork and some of the smaller tributaries to the reservoirs.

Hiking: There are several hiking trails within the river corridor at Curecanti NRA. They include Neversink (1.5 miles) and Cooper Ranch (0.5 miles) along the Gunnison River above Blue Mesa Reservoir; Dillion Pinnacles (2.0 miles) and Ponderosa on Blue Mesa Reservoir; three trails at Morrow Point Reservoir – Pine Creek (1.0 mile), Curecanti Creek (2.0 miles, steep), and Hermit's Rest (3.0 miles, steep); and two trails at Crystal Reservoir – Mesa Creek (0.8 miles) and Crystal Creek (2.5 miles)[1].

Camping: Within the Curecanti NRA camping is available at several sites. Major facilities are located at Elk Creek, Lake Fork, Stevens Creek, and Cimarron. Limited facilities are located at Dry Gulch, Gateview, Ponderosa, East Portal, Red Creek, and East Elk Creek. Several backcountry and boat-in camping sites are located on the three Aspinall Unit reservoirs.

Boating: Motorized and non-motorized boating opportunities exist within the Curecanti NRA. Boating opportunities are the greatest on Blue Mesa Reservoir and its major tributaries; such opportunities include sailing, motor-boating, kayaking, canoeing, and rafting. Personal boating at Morrow Point Reservoir, Crystal Reservoir and East Portal is limited to hand-carried craft due to access conditions. There is a motorized boat tour of Morrow Point Reservoir run by the NPS during the summer months.

3.3.8.1C Black Canyon of the Gunnison National Park

Setting—This section of the Gunnison River is a very narrow, 14-mile long river corridor segment that lies at the bottom of the canyon within the Black Canyon NP. Aspinall Unit operations affect inner canyon recreation on or immediately adjacent to the river with high flows limiting use. The primary period of use is from May through September.

Access—Access to and within the inner canyon of the Black Canyon NP is very limited, difficult, and dangerous. The easiest access to the river is via the East Portal Road. Hiking access to the river within the Black Canyon is via several steep and difficult routes from either rim or along the river from the Chukar Put-In or from East Portal. Access via Red Rock Canyon is available through limited permits.

Recreational Opportunities/Uses—Recreational opportunities on this segment include the following:

Camping: Black Canyon NP camping is generally adjacent to the river and in support of multi-day inner canyon use. Primitive camping areas are limited and generally located near the base of the access routes.

[1] All distances are measured one way.

Hiking: Inner canyon hiking is difficult and dangerous. Distances identified in the NPS brochures for routes along the river are based on low flows (300-350 cfs). Wading is hazardous and not recommended. Flows above 450-500 cfs increase the danger.

Fishing: This segment is within the Gold Medal and Wild Trout waters designation; special regulations apply. Walk/wade trout fishing opportunities are available to anglers willing and able to walk in from the Chukar put-in (Gunnison Gorge NCA), from East Portal (Curecanti NRA), from Red Rock Canyon, or from the canyon rims within the Park. However, as previously stated access to and along the river is difficult and dangerous with the exception of the East Portal area which is accessible by vehicle and is a popular day use destination.

Kayaking (expert only): The Gunnison River through the Park is an arduous challenge for expert kayakers and is only runnable at relatively low flows. The rapids in the Park area are considered Class V to VI and some sections are unrunnable.

Visitation/Visitation Levels—The Black Canyon NP receives about 225,000 visitors per year; however, inner canyon visitation is a very small portion of that total due to the limited and difficult access. In 2007, there were 1,925 overnight stays in the backcountry along the Gunnison River; about 90 percent of these are estimated to be for fishing. An estimated 171 kayakers entered at East Portal; most of them spend one night on the river during their trip through the canyon. (Steve Winslow, Personal Communication on 1/09/2008).

3.3.8.1D Gunnison Gorge National Conservation Area

Setting—The Gunnison Gorge NCA straddles the Gunnison River immediately downstream of the Black Canyon NP. It encompasses about 20 miles of the Gunnison River and is managed by the Bureau of Land Management (BLM).

Permitted commercial operations in the Gunnison Gorge NCA include whitewater rafting, river float fishing trips, guided walk-wade fishing, horse pack-in services, and boat shuttle services (BLM 2003). The Gunnison Gorge NCA is an important source of recreation and tourism within Delta and Montrose counties. The primary period of use is May through October. It draws visitors from across the nation. In 2002, the estimated impact of Gunnison Gorge commercial rafting and float-fishing trips was estimated at $927,000 annually, with $362,000 in direct expenditures to the local economy (BLM 2003)

The upstream 14 miles is within the Gunnison Gorge Wilderness Area and the last six miles are within the Gunnison and North Fork Rivers Special Recreation Management Area (SRMA). These areas are managed for multiple uses including recreation in accordance with the 2004 Resource Management Plan. The river corridor is managed for primitive, unconfined types of recreation in a manner that provides for non-degradation and non-impairment of riparian and/or wilderness values. Motorized vehicles and craft are not allowed upstream of the North Fork confluence, except for the permitted jet boat shuttle service to the Smith Fork and CDOW fish management activities (BLM 2004). The river in this segment is mostly Class II- III rapids, with some class IV at certain flow levels (Lyons 2001).

Access to this segment is limited. There is no direct vehicle access to the river upstream of the Gunnison Forks day use area. Users must hike or pack into the Gorge via one of four trails or along the river. A jet-boat shuttle service from the Gunnison Forks currently provides access to Smith Fork about one mile into the wilderness.

Recreational Opportunities—Recreational opportunities include, but are not limited to the following:

Boating: There are numerous opportunities for private and commercial non-motorized boating, including rafting and kayaking. Within the wilderness, boat launches per day are currently limited to 2 commercial and a target of 4 private.

Fishing: This segment includes Gold Medal and Wild Trout waters designation; special regulations apply. Walk/wade and float/boat trout fishing opportunities, both private and guided, are available.

Camping: Dispersed camping is not allowed within the Gunnison Gorge NCA. Camping in the river corridor within the wilderness is limited to 25 designated sites; 10 for hikers, 13 for boaters, and 2 overflow sites. The maximum stay length for all wilderness users is 2 nights; boaters, only 1 night per campsite; hikers, 2 nights per campsite. Camping within the SRMA is limited to 7 days at designated campsites. No camping is allowed at the Gunnison Forks Day Use Area (BLM 2004).

Hiking: There are four trails that provide access to the wilderness portion of the Gunnison Gorge NCA: Chukar (1 mile); Bobcat (2 miles); Duncan (1.5 miles) and Ute (4 miles) (BLM 2003).

Visitation/Visitation Levels—BLM estimates that the Gunnison Gorge NCA has about 12,500-16,500 Gunnison River visitor days annually. Of these, about 7,500 days are within the Gunnison Gorge Wilderness; about 3,500-5,000 days are between Smith Fork and North Fork, and about 1,000-2,500 days between the North Fork and Austin. Total registered river visitation within the Gunnison Gorge Wilderness from 1988 through 2005 ranged from a high of 8,427 visitor days in 1994, to a low of 5,016 in 1995 with an average of 6882 (BLM 2003).

The BLM estimates types of recreation use as:

- 40 percent commercial rafting and float fishing in wilderness

- 8 percent commercial walk-in fishing and walk-wade/float fishing from Smith Fork to North Fork
- 26 percent private rafting and float fishing
- 26 percent private walk-in fishing and hiking

The BLM has presented general recreation flow preferences based on their experience on the river and with river recreationists:

- Whitewater boaters prefer 800 to 3,000 cfs, although users have adapted to lower flows during the recent drought years.
- Flows above 3,000 are not good for fishing and safety concerns increase.
- Flows of 500 to 1,000 cfs preferred for fishing.
- Overall, flows of 700 to 1,000 cfs are good for all users.
- Late summer flows are important on the Gunnison, because other rivers in the region often are too low during late summer.

Other observations on flow related recreation include:

- Montrose County Sheriff or the BLM could close the river to use during high water periods (around 9,000+ cfs) to protect public safety.
- Below 500 cfs, the river becomes more dangerous and technical; above 5,000-6,000 cfs the river becomes very dangerous (Reclamation 2001)
- At 500 cfs, the river becomes touchy for full-sized (14 x 5 ft.) rafts; scraping both sides at times (Kahler, Personal Communication on 11/15/05)
- At 300-400 cfs the jet boat outfitter has difficulty going upriver
- Flows around 4,000 cfs adversely affect BLM’s management in the gorge, through a loss of campsites and river corridor fishing access trails (Karen Tucker, personal communication, [2/4/2008].
- Flows above 2,000 cfs bring out more private kayakers for day trips.
- Some float-fishing outfitters may cancel trips at flows over 3,000 cfs due to safety concerns, loss of fishing opportunities, and loss of clients (clients cancel).

3.3.8.1E Lower Gunnison River

The lower Gunnison River between Delta and the confluence with the Colorado River offers a variety of recreation opportunities along its 60-mile length. Approximately one-half of the river corridor is public land managed by the BLM.

The primary period of use is early May into October with hiking and boating the primary activities. There are several access points and boat launch sites along this segment of the river including Confluence Park in Delta, Escalante Canyon, Dominquez Canyon, Whitewater, and near the Redlands Diversion Dam. The river offers much less technical floating conditions than the Gunnison Gorge, and canoeing and novice rafting are popular.

Recreational Opportunities—Recreational opportunities on this segment include the following:

Boating: There are numerous opportunities for private and commercial boating, including rafting, canoeing, and kayaking.

Fishing: Fishing opportunities for this segment of the Gunnison River are very limited.

Camping: Designated campsites are located along the river.

Hiking: The River flows through slick rock canyon country that offer numerous hiking opportunities including the Dominquez Canyon wilderness study area.

Visitation/Visitation Levels—The visitation levels within this segment are not well known but use appears to be increasing in recent years.

3.3.8.2 Impact Analysis

3.3.8.2A Aspinall Unit Reservoirs

Visitation at Blue Mesa Reservoir is related to many factors including regional economic conditions (including fuel prices), fishing success, weather conditions, and reservoir surface area. Previous studies by Duffield, Neher and Patterson (2006) and Piper (2007, 2008) have identified a statistically significant relationship between Blue Mesa Reservoir levels and visitation.

As described in previous sections of this EIS, the RiverWare model was used to simulate operations at the Aspinall Unit on a daily basis from January 1975 to December 2005. The daily data produced by the RiverWare model were extracted and the mean elevation of Blue Mesa reservoir was computed for the summer recreation season in each year. Using these mean seasonal elevations and the model described by Piper (2007) and further described in Appendix D, the number of visits was estimated for No Action and for each action alternative. A visit is defined as one person entering the Curecanti NRA for recreation purposes. The duration of a visit can vary from less than an hour to several days. This process resulted in 31 observations of estimated visitation for each of the alternatives. For the visitation estimates, the mean, median, 90 percent exceedance and the 10 percent exceedance were computed. These results are reported in the tables and narrative which follows.

Table 3.3 28 illustrates the estimated visitation at Blue Mesa Reservoir for the No Action Alternative. The mean, 90 percent exceedance and 10 percent exceedance visitation values are reported.

The mean values shown in Table 3.3 28 correspond to “average” hydrologic conditions during the summer recreation season. The 90 percent exceedance conditions shown in

Table 3.3 28—No Action Summer Visitation.

Measure	Summer Visitation
Mean	948,038
Dry year (90% exceedance)	521,569
Wet year (10% exceedance)	1,187,637

this table reflect reservoir elevations which are typical of “low” hydrologic conditions, such as would occur during a drought. The 10 percent exceedance values reflect reservoir elevations which might be expected under “high” hydrologic conditions, such as those which would occur following a winter with very high snowfall.

Table 3.3 29 contains estimates of changes in Blue Mesa Reservoir summer visitation relative to the No Action condition. As shown in this table, relative to No Action, Alternative C is estimated to have the greatest impact on summer-time recreation while Alternative A is estimated to have the least effect. All of the action alternatives have some adverse affect on estimated visitation at Blue Mesa Reservoir.

Table 3.3 29—Changes in Blue Mesa Reservoir Summer Visitation Relative to No Action.

Measure	Alternative A	Alternative B	Alternative C	Alternative D
Mean change in visitation	-12,900 (-1.36%)	-68,700 (-7.23%)	-184,200 (-19.43%)	-44,800 (-4.73)
Dry year change in visitation	-29,200 (-5.59%)	-33,500 (-6.42%)	-161,300 (-30.93%)	-39,700 (-7.62%)
Wet year change in visitation	-5,400 (-0.45%)	-25,700 (-2.16%)	-62,900 (-5.30%)	-34,000 (-2.86%)

Other adverse effects on water-based recreational use within the Curecanti NRA include:

- The “bathtub ring” resulting from reservoir drawdown is generally considered an aesthetic impact. The wider the ring, the less aesthetic the view.
- Low water levels may cause boat launch ramps to become unusable.
- Fluctuation of Blue Mesa Reservoir’s water surface elevation may affect recreational use of the reservoir [Curecanti NRA] by:
    - Causing a change in boating hazards.
    - Changing surface area and thus possibly the boating carrying capacity and the perception of solitude verses crowding.
    - Daily water surface elevation fluctuations on Morrow Point Reservoir, if beyond the capacity of the tour boat dock facilities, may adversely affect the tour boat operations and the subsequent revenues.

A beneficial effect is that low water levels allow for expanded use of the Blue Mesa Reservoir basin for motorized vehicles.

3.3.8.2B Downstream from Aspinall Unit

In the long-term, action alternatives would better protect natural conditions in the Black Canyon, Gunnison Gorge and lower river due to the more natural hydrograph. Visitor use patterns may change, however, due to changes in flow levels during the primary recreation season. Since visitor use is influenced by numerous factors, many unrelated to river flows, it is difficult to quantify any changes in recreation use. However, increased spring flows may reduce walk-in and rafting fishing while possibly favoring kayaking.

On the river downstream from Delta, some types of recreation, such as canoeing, may be reduced in spring months. Changes in duration of desirable recreation flows can be shown and this type information is presented in Table 3.3 30. More detailed information is presented in Appendix A, Aspinall EIS Hydrology Report.

Overall, higher spring flows in May and to a lesser extent June, will tend to reduce recreation use in the Black Canyon, Gunnison Gorge, and downstream.

Table 3.3 30—Changes in Flow Patterns Related to Recreation Use, Gunnison Gorge and Black Canyon.

Flow Pattern	No Action	Alt. A	Alt. B	Alt. C	Alt. D
Average days, May-September, flows in desirable recreation range of 500-1,000 cfs	34.1	40.2	42.5	45.0	42.4
Average days, May-September, flows less than 400 cfs impacting recreation, in particular boating; increases use in Black Canyon	21.3	22.9	24.8	30.5	23.8
Average days, May-September, flows over 3,000 cfs adversely affecting fishing related recreation	17.2	16.0	19.8	27.2	19.1
Average days, June, over 3,000 cfs affecting fishing during stonefly hatch	6.7	6.5	8.9	12.1	8.6
Average days, May-July, flows over 5,000 cfs with safety concerns	4.4	6.4	8.3	13.5	7.7

3.3.9 SOCIOECONOMICS

This section addresses the potential impacts to socio-economic resources from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect socio-economic resources?

Overview

Scope

Recreational Use and Net Economic Value—The recreation section of this EIS describes the types of recreational activities, their locations and intensities within the Gunnison Basin. Ideally, the impacts of the alternatives would be estimated for all of these activities and sites. Detailed data sufficient for economic analysis are available for only a relatively small sub-set of these recreational activities and locations. Due to these limitations, the focus of the recreational economic analysis is on the Aspinall Unit.

Regional Economic Impact—For this EIS the regional economic impact analysis is based on changes in recreation at the Aspinall Unit. The regional economic analysis described here encompasses Delta, Gunnison, and Montrose Counties of the State of Colorado. The EIS study area also includes Mesa County. However, this county was omitted from the regional analysis due to data constraints.

Nonuse Value—A number of studies have shown that nonuse economic value for affected resources extends not only to the immediate geographic area where the resource is found but to a much wider area. The scope of the nonuse economic value analysis is the Western United States and the United States as a whole.

Impact Indicators

For purposes of this EIS, the following socioeconomic impact indicators are employed: recreation use, Net Economic Value (NEV), regional economic impact and nonuse value.

Recreation Use— The focus of the recreational analysis is on visitation during the summer recreation season (May 1 through September 30) at the Aspinall Unit. Visitation is defined as one person entering the Curecanti NRA for recreation purposes. The duration of a visit can be less than an hour or several days.

Net Economic Value— NEV is a measure of the amount individuals are willing to pay, over and above the costs of participating in a recreation activity. The total NEV is related to the number of recreationists who participate in each activity, the time of year in which they participate, and the value of each trip taken.

Regional Economic Impact—Regional economic impact describes the effects of visitor expenditures on the local economy and their contribution to local economic output, employment and labor income.

Nonuse Value—Nonuse value is the economic value that people hold for ecosystems, the species which inhabit them, scenic wonders and historically significant resources that are not associated with the physical use of these resources.

Summary of Impacts

Recreational Use—Table 3.3 31 compares the visitation impacts of all of the action alternatives, relative to the No Action Alternative. As shown in this table, Alternative C is predicted to have the greatest impact on summer recreational visits over the entire range of hydrologic conditions.

Table 3.3 31—Summary—Change in Summer Visitation (Trips)[1]

	Mean	Drought (90% Exceedance)	Wet (10% Exceedance)
Alternative A	-12,897.9 (-1.36%)	-29,181.4 (-5.59%)	-5,368.9 (-0.45%)
Alternative B	-68,553.7 (-7.23%)	-33,485.4 (-6.42%)	-25,685.0 (-2.16%)
Alternative C	-184,160.4 (-19.43%)	-161,307.4 (-30.93%)	-62,904.9 (-5.30%)
Alternative D	-44,807.9 (-4.73%)	-39,731.5 (-7.62%)	-33,953.5 (-2.86%)

Net Economic Value—Table 3.3 32 compares the predicted impacts on the NEV of recreation, relative to No Action, for all of the action alternatives. As shown in this table, Alternative C is predicted to have the greatest impact on NEV of any of the action alternatives.

Table 3.3 32—Summary—Change in NEV (2008$).

	Mean	Drought (90% Exceedance)	Wet (10% Exceedance)
Alternative A	-625,206.70 (-1.18%)	-6,588,757.00 (-21.70%)	-767,368.40 (-1.05%)
Alternative B	-3,868,797.60 (-7.27%)	-9,138,734.50 (-30.09%)	-4,418,988.40 (-6.02%)
Alternative C	-11,058,278.90 (-20.79%)	-13,795,692.60 (-45.43%)	-9,046,324.50 (-12.33%)
Alternative D	-2,774,258.20 (-5.22%)	-6,221,702.70 (-20.49%)	-4,493,358.40 (-6.13%)

Regional Economic Impact—Table 3.3 33 compares the regional economic impacts of all of the action alternatives, relative to the No Action Alternative. These regional impacts are driven by the changes in predicted visitation described earlier. As shown in this table, Alternative C is predicted to have the greatest impact on the regional economy. Relative to No Action, Alternative C reduces the employment, output and income by about 19.43 percent.

[1] Visitation is one person visiting the Aspinall Unit for any length of time for the purpose of recreation.

Table 3.3 33— Comparison of Each Alternative to the No Action Alternative.

Alternative	Employment (number of jobs)[1]			Output ($ million)[2]			Income ($ million)[3]		
	Total	Difference from No Action	Percent of Difference from No Action	Total	Difference from No Action	Percent of Difference from No Action	Total	Difference from No Action	Percent of Difference from No Action
No Action	3,501			$252			$101		
Alternative A	3,454	-47	-1.34%	$248	($4)[4]	-1.59%	$99	($2)[4]	-1.98%
Alternative B	3,264	-237	-6.77%	$235	($17)	-6.75%	$94	($7)	-6.93%
Alternative C	2,821	-680	-19.42%	$203	($49)	-19.44%	$81	($20)	-19.80%
Alternative D	3,335	-166	-4.74%	$240	($12)	-4.76%	$96	($5)	-4.95%

[1] Employment is measured in number of jobs.

[2] Output represents the dollar value of industry production.

[3] Income is the dollar value of total payroll (including benefits) for each industry in the region plus income received by self-employed individuals located within the region.

[4]Parentheses indicate negative numbers.

Source: IMPLAN modeling results.

Nonuse Value—NEV studies of either the Black Canyon or of the native fish populations living downstream have not been identified. However, a study by Ekstrand and Loomis (1998) does provide estimates of nonuse economic value for protecting critical native fish habitat in the region.

Due to differences in geographic scope and data limitations, we are unable to employ these estimates directly for quantitative impact analysis. Nonetheless, we can provide an informed qualitative assessment. Based on the evidence available to us, we conclude that, relative to No Action, all the action alternatives will result in an increase in nonuse economic value.

3.3.9.1 Affected Environment

3.3.9.1A Recreation Use

As described in further detail in the Recreation section of this EIS, recreation use in the Gunnison River Basin is extensive and varied. Due to data and modeling limitations, the focus of the recreational use analysis is on visitation at the Curecanti NRA.

3.3.9.1B Net Economic Value

NEV is a measure of the amount individuals are willing to pay, over and above the costs of participating in a recreation activity. The total NEV is related to the number of recreationists who participate in each activity, the time of year in which they participate, and the value of each trip taken. An approachable and readily available overview of

NEV is provided by King and Mazzotta (2007). A much more comprehensive treatment can be found in National Research Council (2004).

Kaval and Loomis (2003), Loomis (2005) and Kaval (2007) summarize existing economic studies which estimate the value of reservoir, river and other types of recreation. Duffield, Neher and Patterson (2007) review the subset of recreation economic studies which have been carried out in the Colorado River Basin.

As related in High Country Citizen's Alliance (2003) and Land and Water Fund of the Rockies (2003), the public discourse over water management in the Gunnison River Basin has been long and rancorous. Not surprisingly, a number of site specific studies of NEV have been carried out in the Basin. The first documented recreation economic study in the basin was undertaken by Johnson (1989). He estimated the NEV of fishing at Blue Mesa Reservoir using two different approaches. The results of the Johnson (1989) study along with additional findings are reported in Walsh and Johnson (1987). This initial research formed the basis for later publications by McKean, Walsh and Johnson (1991) and McKean, Johnson and Walsh (1987). As part of a more comprehensive Ford Foundation supported study, Harpman et al. (1993) estimated the value of water used for recreation in the Taylor River and identified a significant relationship between river flows, fish populations and angling value. Building on their previous research, Johnston et al. (1995) compared the costs and benefits of fish stocking at Blue Mesa with other sites in Colorado.

Using unpublished data collected by Harpman (1990), Pennington (2005) estimated the value of whitewater boating on the Taylor and Upper Gunnison Rivers. She identified a significant relationship between the NEV of whitewater boating use and river flow. A subsequent investigation by Piper (2007), found that visitation to the Aspinall Unit (Blue Mesa, Morrow Point and Crystal Reservoirs) and the NEV of recreation varied systematically with the elevation of Blue Mesa Reservoir. Most recently, Duffield et al. (2007) estimated a statistical relationship between recreation at the Aspinall Unit and monthly water storage at Blue Mesa Reservoir.

3.3.9.1C Regional Economic Impact

Visitors to the Gunnison River Basin spend large sums of money in the region. These recreators purchase gas, food and drink, lodging, guide services, and outdoor equipment while visiting the region. Expenditures represent participation costs and thus do not represent a benefit measure from the national viewpoint. Direct expenditures are nonetheless important since they support local businesses and provide employment for local residents. In this sense, such expenditures provide some measure of the local impacts of recreational users.

However, direct expenditures alone do not fully measure the impacts of spending by visitors to the region. Local businesses and residents spend part of the money they receive from anglers and whitewater boaters to purchase goods and services from other individuals and local businesses. These individuals and businesses, in turn, spend a portion of their revenue in the region, and so on. A portion of each dollar spent by nonresident recreators is re-spent over and over in the region and thus the impact of each dollar of direct expenditure by visitors is greater than the original $1.00.

The study area encompasses Delta, Gunnison, Mesa, and Montrose Counties. The common measures of regional economic impacts are output, employment, and labor income. Table 3.3 34 presents these measures for the four-county area for the year 2006 based on the Impact Analysis for Planning (IMPLAN) model database (Minnesota IMPLAN Group 2006) The IMPLAN model and its application are discussed below.

Table 3.3 34—Regional Employment, Output and Labor Income.

Sector category	Output		Employment		Labor income	
	$ million	% Total	Number of jobs	% Total	$ million	% Total
Agriculture, forestry, fish and hunting	440.1	3.3%	5,271	4.4%	87.7	1.9%
Mining	1,058.5	7.8%	3,425	2.9%	310.7	6.9%
Utilities	187.7	1.4%	558	0.5%	43.4	1.0%
Construction	1,703.2	12.6%	13,479	11.3%	648.2	14.3%
Manufacturing	1,980.2	14.6%	5,670	4.8%	260.8	5.8%
Wholesale trade	415.2	3.1%	3,191	2.7%	156.1	3.4%
Transportation and warehousing	532.1	3.9%	4,395	3.7%	209.5	4.6%
Retail trade	977.2	7.2%	14,751	12.4%	403.0	8.9%
Information	241.3	1.8%	1,293	1.1%	64.3	1.4%
Finance and insurance	761.9	5.6%	4,264	3.6%	178.1	3.9%
Real estate and rental	797.0	5.9%	4,302	3.6%	137.8	3.0%
Professional: scientific and technical services	507.9	3.8%	4,982	4.2%	222.7	4.9%
Management of companies	30.3	0.2%	135	0.1%	14.7	0.3%
Administrative and waste services	275.7	2.0%	4,569	3.8%	123.7	2.7%
Educational services	35.8	0.3%	975	0.8%	12.8	0.3%
Health and social services	921.6	6.8%	12,450	10.4%	490.6	10.8%
Arts- entertainment and recreation	106.1	0.8%	2,096	1.8%	37.7	0.8%
Accommodation and food services	496.4	3.7%	9,969	8.4%	157.5	3.5%
Other services	405.2	3.0%	7,821	6.6%	173.9	3.8%
Government	1,652.3	12.2%	15,736	13.2%	800.5	17.7%
Total	13,525.5	100.0%	119,335	100.0%	4,533.6	100.0%
Source: 2006 IMPLAN data file for Colorado.						

Output**—**Output, or industry output, represents the value of production of goods and services produced by business within a sector of the economy. Total output in the study area equals $13,525 million. The manufacturing sectors produce the highest level of output in the study area (14.6 percent of the total regional output). The construction sectors generate the second highest level of output within the study area (12.6 percent of total regional output). The government sectors rank third in level output (12.2 percent of the total regional output).

Employment**—**Employment measures the number of jobs related to each sector of the economy. According to the 2006 IMPLAN data there are approximately 119,000 jobs in the study area. In the study area, the government sector (local, state and federal) makes up the largest number of jobs (13.2 percent of total regional employment) in the study area. Retail trade related jobs rank second in terms of overall number of jobs in the study area (12.4 percent of total regional employment). The construction sector ranks third in regional employment (11.3 percent of the total regional employment).

Labor Income**—**Labor income is the sum of employee compensation and proprietor income. The government sectors generate the largest portion of labor income in the region (17.7 percent of the total regional labor income). Labor income equals approximately $4,533 million in the study area. The sectors related to construction rank second (14.3 percent of the total regional labor income). Ranking third are the sectors related to health and social services (10.8 percent of the total labor income).

The regional economic activity that results from expenditures made by nonresident anglers, whitewater boaters, and other recreators who visit the Gunnison River Basin has been estimated in several contexts. The earliest and perhaps most widely cited study of recreation expenditures and their impacts was published by McKean et al. (1988). This research was based on the field work undertaken by Johnson (1989) and focused primarily on the contribution of Blue Mesa anglers to the economy of Gunnison County. The most contemporary and comprehensive collections of recreation expenditure data were undertaken by Booz Allen Hamilton (2004) and Munger and Vinton (2005).

3.3.9.1D Nonuse Value

Preceding sections of this document have focused on the human uses of water in the Gunnison River Basin. These uses include: fishing, whitewater boating, other water based recreational activities and the production of electric power. Analyses of the impacts on all of these uses are presented subsequently. Until relatively recently, most socioeconomic descriptions of resource impact probably would have ended there.

Social scientists have long acknowledged the possibility that humans could be affected by changes in the status of the natural environment even if they never visit or otherwise use these resources. These individuals may be classified as non-users, and economic expressions of their preferences regarding the status of the natural environment are termed “nonuse” or “passive use” value. Nonuse values refer to all values that people hold for ecosystems, the species which inhabit them, scenic wonders and historically significant resources that are not associated with the physical use of these sites. A straightforward and readily available overview of this topic is provided by King and Mazzotta (2007). A more comprehensive and academic treatment of nonuse value can be found in National Research Council (2004).

The literature on nonuse value emphasizes the uniqueness of the resource in question and the irreversibility of the loss or injury. Frequently mentioned factors that might give rise to nonuse value include:

- Desire to preserve the functioning of specific ecosystems.
- Feelings of environmental responsibility toward plants and animals.
- Iconic examples of nature and natural features

Members of the general public may hold nonuse value for at least two of the resources described in this EIS: the Black Canyon NP and populations of threatened and endangered native fish.

With respect to the Black Canyon NP, a number of studies have identified large and significant public values for river restoration and preservation efforts. Examples include high visibility studies of the Grand Canyon (Welsh et al 1995), the Elwha River (Loomis 1996) and the Rio Grande River (Berrens et al. 1996, Ward and Booker 2003). A more general study by Sanders et al. (1990) documented the economic value associated with preserving river flows in Colorado.

Large segments of the general public support the preservation and restoration of threatened species of native fish. Native Americans and early settlers exploited the native fish populations of the Upper Colorado River Basin both for food and sport (Quartarone 1995, Holden 1991). Historically, some species were even harvested commercially (Holden 1991). In the 1950’s, native fish were thought of as “trash fish” by some. Organized and extensive efforts were made to extirpate them from some locations, including the Green River (Holden 1991). Times have changed considerably since then and the public’s knowledge, beliefs and attitudes towards endangered native fish have become much more positive. In a 1995 survey, 81 percent of respondents believed that recovering endangered fish was as important as recovering the populations of endangered birds and mammals (Vaske et al. 1995).

3.3.9.2 Methodology

3.3.9.2A Recreation Use and Net Economic Value

The number of visitors to the Aspinall Unit and the NEV of their visits were estimated using the approach described in Piper (2007, 2008). As detailed in these sources and further described in Appendix D, visitation and the NEV of recreation are statistically related to the reservoir elevation at Blue Mesa Reservoir during the summer recreation season (May through September).

As described in previous sections of this EIS, the RiverWare model was used to simulate operations at the Aspinall Unit on a daily basis from January 1975 to December 2005. The daily data produced by the RiverWare model were extracted and the mean elevation of Blue Mesa reservoir was computed for the summer recreation season in each year. Using these mean seasonal elevations and the model described by Piper (2007), the number of visitors and the NEV of their recreational experience were estimated for each alternative. This process resulted in 31 observations of estimated visitation and NEV for each of the alternatives. For the visitation estimates, the mean, median, 90 percent exceedance and the 10 percent exceedance were computed. These results are reported in the tables and narrative which follow.

The Piper (2007) model estimates the NEV of recreation in nominal 2004 dollars. As further explained in Appendix D, some additional calculations are required to reflect the time value of money. The base year used for economic analysis purposes in this EIS is 2008. The 2004 NEV estimated by the model were inflated to 2007 dollar values using the consumer price index (CPI). These values were then escalated to 2008 dollars using an escalation rate of 2.2 percent. Observations occurring after 2008 were escalated by 2.2 percent per year and then discounted by 4.875 percent, the current Federal discount rate. This process places these estimated values, which occur in different years, on a commensurate 2008 present value basis. The mean, median, 90 percent exceedance and 10 percent exceedance values of the resultant data series were then calculated. The NEV results, measured in 2008 dollar terms, are reported in the narrative and results tables.

3.3.9.2B Regional Economic Impact

This section describes the methodology used for the regional economic impact analysis conducted for the purposes of this EIS. The regional economic impacts stem from expenditures made by non-resident visitors at the Aspinall Unit for each alternative. The regional economic impact analysis measures how the alternatives impact the region's local economy as measured by changes in employment, output, and income as compared to the No Action Alternative.

The regional economic analysis includes not only the initial or direct impact on the primary affected industries, but also the secondary impacts resulting from those industries providing inputs to the directly affected industries as well. This also includes the changes in economic activity stemming from household spending of income earned by those employed in the sectors of the economy impacted either directly or indirectly. These secondary impacts are often referred to as "multiplier effects."

The common measures of regional economic impacts are output, employment, and labor income. Output is the dollar value of production (sales revenues and gross receipts) from all industries in the region. Labor income is a measure of employee compensation (wages and benefits) plus income for self-employed individuals. Employment is the number of jobs, both full-time and part-time, in a particular sector.

Regional economic impacts stemming from recreation activity derive from in-region recreational expenditures for such items as hotels and motels, restaurants, groceries, gasoline, etc. Changes in regional recreation expenditures can result in gains or losses in regional output, income, and employment.

The regional economic impact analysis characterizes the effects of in-region expenditures using a model of the regional economy developed for the study area. The IMPLAN (Minnesota IMPLAN Group Inc 2007) regional analysis model was employed for this analysis. IMPLAN is an input-output modeling system that estimates the regional effects of exogenous changes in final demand (expenditures). The IMPLAN database for 2006, the most recent dataset available, was used for the analysis described in this EIS.
In regional economic impact analyses of recreation, the assumption is typically made that the majority of impacts are generated by expenditures from recreationists residing outside the region. Within region recreationists are generally assumed to spend the majority of their recreation expenditures within the region regardless of the alternatives under consideration implying they would generate little by way of additional regional economic activity. As a result, this analysis focuses on in-region expenditures by nonlocal recreationists.

This analysis uses data obtained from the 2004 Blue Mesa Reservoir survey (Munger and Vinton 2005) to separate local and nonlocal visitation and estimate nonlocal expenditures. The survey questionnaire included questions about the origin of recreational trips and asked respondents to indicate if Blue Mesa was their primary destination. This information is used in the regional analysis to separate local and non-local visitation. The survey also asked recreationists to estimate their total expenditures for the current visit, the portion of those expenditures incurred within the local region, and the breakdown of expenditures into various expenditure categories (e.g., lodging, food, gas, etc.). This information is used to allocate these expenditures across the 500+ economic sectors included in the IMPLAN model.

The recreation visitation estimates are used in the regional economics analysis. Since these changes in visitation include both local and nonlocal recreationists, estimates of the nonlocal portion of the visitation change had to be developed. The survey data used in the model described in Section 3.3.8 used a sub-set of the data that was collected in the 2004 Blue Mesa survey. In this subset, nearly 75 percent of the visitors were from outside the study area of Gunnison, Montrose and Delta counties. Applying this nonlocal visitation percentage to the estimates of the total change in visitation provides an estimate of the nonlocal change in visitation by alternative.

Table 3.3 35 presents the average in-region expenditures for all recreational activities per trip for nonlocal recreationists which were used in this analysis. These expenditures per trip by expenditure category were then multiplied by the estimate of nonlocal visitation by alternative to measure the total nonlocal recreation in-region expenditures by expenditure category and alternative. This alternative specific expenditure information was used with the IMPLAN model to estimate the regional impacts of recreation for each alternative.

Table 3.3 35— Average In-Region Expenditures per Household per Trip for Nonlocal Recreationists.

Expense Category	Expense Amount
Groceries	$54.06
Restaurant	$33.22
Boat and Auto Fuel	$68.93
Bait and Tackle	$10.66
Equipment Rental	$7.27
Outfitters	$2.04
Souvenirs and Other	$23.67

Source: Munger and Vinton (2005).

3.3.9.2C Nonuse Value

Given the limited time and resources available, we were unable to commission a nonuse value study of native fish populations or the Black Canyon specifically for this EIS. Nonetheless we can draw some general inferences about nonuse economic value from the available literature.

As summarized in Loomis and White (1996a, 1996b) and Kroeger and Manalo (2006), a great number of economic studies have demonstrated large public values for the preservation of rare and endangered species, including native fishes. In terms of geographic scope and species focus, a study by Ekstrand and Loomis (1998) is particularly relevant to this EIS.

Ekstrand and Loomis estimated the economic benefits of protecting critical habitat for nine threatened and endangered fish in the Colorado, Green and Rio Grande River Basins. This study estimated nonuse economic value for the same species and encompasses the geographic region examined in this EIS. For these reasons, the Ekstrand and Loomis (1998) study is employed to make some inferences about the potential effects of the action alternatives on nonuse economic value.

3.3.9.3 Impact Analysis

3.3.9.3A Recreation Use and Net Economic Value

No Action—Using the approach described and further documented in Appendix D, the visitation and NEV of recreation at the Aspinall Unit were estimated for the No Action Alternative. The mean, 90 percent exceedance and 10 percent exceedance values are illustrated in Table 3.3 36.

The mean values shown in Table 3.3 36 correspond to "average" hydrologic conditions during the summer recreation season. The 90 percent exceedance conditions shown in this table reflect reservoir elevations which are typical of "low" hydrologic conditions, such as would occur during a drought. The 10 percent exceedance values reflect reservoir elevations which might be expected under "high" hydrologic conditions, such as those which would occur following a winter with very high snowfall.

Table 3.3 36—No Action Summer Visitation and NEV.

Measure	Summer Visitation	Net Economic Value (2008$)
Mean	948,038.0	53,197,142.60
Drought (90% exceedance)	521,569.2	30,369,267.80
Wet (10% exceedance)	1,187,637.3	73,351,536.10

As shown in Table 3.3 36, the mean summer visitation for the No Action Alternative is approximately 948,000 trips. Visitation is predicted to be about 522,000 trips under the 90 percent exceedance hydrology. This reflects the reduced visitation levels predicted at lower reservoir elevation levels. For the 10 percent exceedance hydrologic conditions, reservoir elevations during the summer recreation season are considerably higher and the predicted No Action visitation is approximately 1,188,000 trips.

For the No Action case, the estimated NEV of recreation at the Aspinall Unit for the mean, 90 percent exceedance and 10 percent exceedance level hydrologies is $53,197,000, $30,369,000 and $73,352,000 respectively (all measured in 2008$).

The No Action visitation and NEV shown in Table 3.3 36 are used as the basis for comparing the recreation economic impacts of the action alternatives discussed subsequently in this EIS.

Alternative A—Under Alternative A, reservoir elevations during the summer recreation season are somewhat lower than they are under the No Action Alternative. This is particularly evident during periods of low inflows, characterized by the 90 percent exceedance hydrology.

Relative to the No Action Alternative, the change in summer visitation and the NEV of recreation expected for Alternative A are shown in Table 3.3 37. As

Table 3.3 37—Alternative A—Change in Summer Visitation and NEV.

Measure	Summer Visitation	Net Economic Value (2008$)
Mean	-12,897.9 (-1.36%)	-625,206.70 (-1.18%)
Drought (90% exceedance)	-29,181.4 (-5.59%)	-6,588,757.00 (-21.70%)
Wet (10% exceedance)	-5,368.9 (-0.45%)	-767,368.40 (-1.05%)

shown in this table, the lower reservoir elevations associated with this alternative result in lower visitation and a lower NEV of recreation.

Alternative B—Under Alternative B, reservoir elevations during the summer recreation season are lower than they are under the No Action Alternative. This is particularly evident during periods of low inflows, characterized by the 90 percent exceedance hydrology.

Relative to the No Action Alternative, the change in summer visitation and the NEV of recreation anticipated for Alternative B are shown in Table 3.3 38. As shown in this table, the lower reservoir elevations associated with this alternative result in lower visitation during the summer recreation season. In addition, the NEV of recreation during the season is reduced.

Table 3.3 38—Alternative B—Change in Summer Visitation and NEV.

Measure	Summer Visitation	Net Economic Value (2008$)
Mean	-68,554 (-7.23%)	-3,868,797.60 (-7.27%)
Drought (90% exceedance)	-33,485.4 (-6.42%)	-9,138,734.50 (-30.09%)
Wet (10% exceedance)	-25,685.0 (-2.16%)	-4,418,988.40 (-6.02%)

Alternative C— Under Alternative C, reservoir elevations during the summer recreation season are lower than they are under the No Action Alternative. This is evident for the range of hydrologic conditions including the mean, 90 percent exceedance and 10 percent exceedance.

Relative to the No Action Alternative, the change in summer visitation and the NEV of recreation for Alternative C are shown in Table 3.3 39. As shown in this table, the lower reservoir elevations associated with this alternative result in lower visitation during the summer recreation season. In addition, the NEV of recreation during the season is considerably reduced.

Table 3.3 39—Alternative C—Change in Summer Visitation and NEV.

Measure	Summer Visitation	Net Economic Value (2008$)
Mean	-184,160.4 (-19.43%)	-11,058,278.90 (-20.79%)
Drought (90% exceedance)	-161,307.4 (-30.93%)	-13,795,692.60 (-45.43%)
Wet (10% exceedance)	-62,904.9 (-5.30%)	-9,046,324.50 (-12.33%)

Alternative D— Under Alternative D, reservoir elevations during the summer recreation season are lower than they are under the No Action Alternative. This is particularly evident during periods of low inflows, characterized by the 90 percent exceedance hydrology.

Relative to the No Action Alternative, the change in summer visitation and the NEV of recreation predicted for Alternative D are shown in Table 3.3 40. As shown in this table, the lower reservoir elevations associated with Alternative D result in lower visitation during the summer recreation season. In addition, the NEV of recreation during the season is reduced.

Table 3.3 40—Alternative D—Change in Summer Visitation and NEV.

Measure	Summer Visitation	Net Economic Value (2008$)
Mean	-44,807.9 (-4.73%)	-2,774,258.20 (-5.22%)
Drought (90% exceedance)	-39,731.5 (-7.62%)	-6,221,702.70 (-20.49%)
Wet (10% exceedance)	-33,953.5 (-2.86%)	-4,493,358.40 (-6.13%)

3.3.9.3B Regional Economic Impact

No Action—The No Action alternative provides the basis of comparison for changes in employment, output, and income for each alternative studied in this EIS. Two measures of the No Action Alternative are provided in Table 3.3 41.

Table 3.3 41—Comparison of Each Alternative to the No Action Alternative.

Alternative	Employment (number of jobs)[1]			Output ($ million)[2]			Income ($ million)[3]		
	Total	Difference from No Action	Percent of Difference from No Action	Total	Difference from No Action	Percent of Difference from No Action	Total	Difference from No Action	Percent of Difference from No Action
No Action	3,501			$252			$101		
Alternative A	3,454	-47	-1.34%	$248	($4)[4]	-1.59%	$99	($2)[4]	-1.98%
Alternative B	3,264	-237	-6.77%	$235	($17)	-6.75%	$94	($7)	-6.93%
Alternative C	2,821	-680	-19.42%	$203	($49)	-19.44%	$81	($20)	-19.80%
Alternative D	3,335	-166	-4.74%	$240	($12)	-4.76%	$96	($5)	-4.95%
[1] Employment is measured in number of jobs.									
[2] Output represents the dollar value of industry production.									
[3] Income is the dollar value of total payroll (including benefits) for each industry in the region plus income received by self-employed individuals located within the region.									
[4]Parentheses indicate negative numbers.									

Source: IMPLAN modeling results

As shown in Table 3.3 41 the No Action Alternative stimulates approximately 3,500 recreationally oriented jobs (7.7 percent of the total jobs in the three county area). The No Action Alternative also generates $252 million in recreationally oriented output which represents 5.2 percent of the total economy.

Approximately $101 million (6.3 percent of the total economy) in recreationally oriented income is generated by the No Action Alternative. The majority of the regional impacts stemming from recreational expenditures occur in the accommodation and food service sector and the retail trade sector.

Alternative A—Alternative A, as shown in Table 3.3 41, generates approximately 3,450 jobs (7.6 percent of the regional economy). This reflects a difference of -47 jobs, 1.3 percent fewer jobs than the No Action Alternative, as shown in Table 3.3 41. Approximately $248 million in output and $99 million in income is generated by Alternative A, also representing $4 million (-1.6 percent) less output impact and $2 million less income (-2 percent) as compared to the No Action Alternative. Although all of the action alternatives cause adverse impacts – Alternative A has the least adverse impact on jobs, output, and income.

Alternative B— Alternative B, as shown in Table 3.3 41 generates approximately 3,260 jobs (7.2 percent of the regional economy). Approximately $235 million of output is generated by Alternative B. Alternative B also generates $94 million in income. Alternative B generates -6.8 percent fewer jobs, and -6.8 percent less output and -6.9 percent less income as compared to the No Action Alternative, as shown in Table 3.3 41.

Alternative C—Alternative C, (Table 3.3 41) generates approximately 2,820 jobs (6.2 percent of the regional economy). Approximately $203 million of output and $81 million in income is generated by Alternative C. Alternative C generates -19.4 percent fewer jobs and -19.4 percent less output and -19.8 percent less income as compared to the No Action Alternative, as shown in Table 3.3 41. Alternative C has the greatest adverse impact on jobs, output, and income.

Alternative D— Alternative D, as shown in Table 3.3 41, generates approximately 3,335 jobs (7.3 percent of the regional economy). Approximately $240 million of output and $96 million in income is generated by Alternative D. Alternative D generates -4.7 percent fewer jobs and -4.7 percent less output and -5 percent less income as compared to the No Action Alternative, as shown in Table 3.3 41.

3.3.9.3C Nonuse value

The concept of nonuse economic value was introduced previously and a number of studies pertinent to this EIS were described. As explained there, it is probable the public has strong preferences about at least some of the resources affected by the action alternatives described in this EIS. Judging from the available literature — nonuse economic value for these resources is likely to be quite high.

A study by Ekstrand and Loomis (1998) is especially pertinent to this EIS. This study provides estimates for the nonuse economic value of protecting critical habitat for nine threatened and endangered fish species in the Colorado, Green and Rio Grande River Basins. The geographic scope of the Ekstrand and Loomis study encompasses the impact area delineated in this EIS and their study focused on the same species. Ekstrand and

Loomis reported the estimated benefits of preserving critical habitat, in the geographic region they studied, range from $50 to $330 per household (one-time payment, in 1998 dollars). Conservatively aggregating over the 1998 number of households in Arizona, Colorado, New Mexico and Utah, the estimated nonuse economic value ranges from $299 Million to $1.971 Billion (in 2008 dollars).

We cannot directly apply the estimates of nonuse economic value reported by Ekstrand and Loomis (1998) to a quantitative analysis of the alternatives considered in this EIS. There are two primary reasons for this. First, the Ekstrand and Loomis study is based on a larger geographic area than the impact area under consideration here. Second, the incremental effects of the action alternatives on critical habitat remain unquantified.

Because of these limitations, we cannot use the Ekstrand and Loomis (1998) study to provide quantitative estimates of the effects of the alternatives on nonuse economic value. However, based on the evidence available to us, we can offer a qualitative assessment: Since the action alternatives will enhance the habitat available for threatened and endangered native fish (albeit by an unknown amount), we conclude they will result in an increase in nonuse economic value.

3.3.10 LANDS (INCLUDING SPECIAL DESIGNATIONS)

This section addresses the potential impacts to lands and land uses from actions associated with the modified operations of the Aspinall Unit under the alternatives considered. In particular, potential impacts to the Black Canyon NP and Gunnison Gorge NCA are considered.

Issue: How would the No Action and action alternatives affect land resources?

Overview

Scope

The scope includes land uses and special land designations at Aspinall Unit reservoirs and along the Gunnison River and its major tributaries.

Summary of Impacts

Under the No Action Alternative, lands with special designation such as the Curecanti NRA, Black Canyon NP, and downstream Bureau of Land Management lands with special designations would continue to be managed for their special purposes and river flows/reservoir operations would remain compatible with these uses. While action alternatives would have both positive and negative effects on reservoir and downstream resources, changes would not prevent specially designated lands from meeting their purposes or significantly affect public use.

Impact Indicators

Indicators of impacts include changes in reservoir operations or downstream river flows that would result in substantial changes in resources or public uses.

3.3.10.1 Affected Environment

The affected environment includes approximately 147.4 miles of the Gunnison River from the eastern boundary of the Curecanti NRA to the confluence of the Gunnison and Colorado rivers near Grand Junction, Colorado. Lands within and adjacent to Blue Mesa, Morrow Point, and Crystal reservoirs are federally owned and consists of primarily Reclamation project lands acquired for the Aspinall Unit of the CRSP. These lands fall under the jurisdiction of either Reclamation or the NPS. The Sapinero, Centennial, and Gunnison State Wildlife Areas are also located adjacent to the northeastern portion of the Curecanti NRA as well as BLM and the National Forest.

Lands along the Gunnison River downstream of the Aspinall Unit are a mixture of Federal, State, county, city, and private ownership.

3.3.10.1A Aspinall Unit and Curecanti National Recreation Area

This reach of the Gunnison River begins at the Curecanti NRA's eastern boundary approximately 1 mile upstream of Neversink at River Mile (RM) 147.4. Lands within the Curecanti NRA are under the jurisdiction of Reclamation and/or the NPS. These federally owned lands have been withdrawn or acquired by fee or easement for water storage, public outdoor recreation, and other purposes of the CRSP and encompass approximately 45 miles of the Gunnison River. The Curecanti NRA Elk Creek Visitor Center and headquarters is located adjacent to Blue Mesa Reservoir near RM 135.8. In addition to providing public recreation, the lands are very important for protecting wildlife, vegetation, cultural resources, and aesthetics of the area. Additional information is found in the Recreation Section of this chapter.

3.3.10.1B Gunnison River Downstream of Crystal Dam

Lands along the Gunnison River downstream from Crystal Dam have a variety of ownership and uses as outlined below. The river is divided into three main reaches: 1) Crystal Dam to the North Fork confluence (28.8 miles), 2) North Fork confluence to the Uncompahgre River confluence (18.3 miles), and 3) Uncompahgre River to the Colorado River (56.5 miles). The river reaches are described below and summarized in Table 3.3 42.

Reach 1 is all federal land and begins just below Crystal Dam in the Curecanti NRA, runs through the Black Canyon and Gunnison Gorge NCA and ends at the confluence of the Gunnison River and the North Fork of the Gunnison. This reach is approximately 29.8 miles in length. The first 2.1 miles of this reach are located in the Curecanti NRA and managed by Reclamation and the NPS. The Gunnison Diversion Dam and East Portal of the Gunnison Tunnel operated by the UVWUA are located in this reach. The NPS's East Portal Ranger Station, Gunnison River fishing access and a small campground are seasonally open to the public via the East Portal Road. The next 14 miles of Reach 1 are designated as wilderness within the Black Canyon NP and primarily used for limited river-based recreation and resource protection. The USGS Gunnison River below Gunnison Tunnel Gage is located at River Mile 102.5. The remaining 13.7 miles of this reach of the Gunnison River are located within the Gunnison Gorge NCA managed by the Bureau of Land Management. Approximately 11.3 miles of the Gunnison River downstream to about 1 mile downstream from the confluence with the Smith Fork is also designated as wilderness.

The Gunnison Gorge NCA consists of 62,844 acres of BLM managed lands along the Gunnison River between the Black Canyon NP and near the town of Austin. Included is the Gunnison Gorge Wilderness of 17,784 acres along 14 miles of the Gunnison River between the Black Canyon NP and a point approximately two miles downstream from the Smith Fork confluence. The Gunnison Gorge NCA was established by Congress to permanently protect nationally significant resources and provide public recreation. The area is managed under a Resource Management Plan prepared by the Bureau of Land Management (BLM 2004).

Table 3.3 42—Gunnison River Miles.

Feature	River Mile	River Reach
Curecanti National Recreation Area	147.4-102.5	Aspinall
NPS Elk Creek Visitor Center	135.8	Aspinall
Blue Mesa Dam and Powerplant	123.2	Aspinall
Morrow Point Dam and Powerplant	111.4	Aspinall
Crystal Dam and Powerplant	104.6	Aspinall
Gunnison Tunnel and Diversion Dam	102.7	Reach 1
Gunnison River below Gunnison Tunnel Gage	102.5	Reach 1
Black Canyon of the Gunnison National Park	102.5-88.5	Reach 1
Smith Fork Confluence	78.2	Reach 1
North Fork Confluence	74.8	Reach 1
Gunnison Gorge National Conservation Area	66.8-88.5	Reaches 1&2
Relief Ditch Diversion	70.7	Reach 2
North Delta Diversion	69.5	Reach 2
Bona Fide Ditch Diversion	65.5	Reach 2
Austin Highway 92 Bridge	65.2	Reach 2
Hartland Diversion	60.1	Reach 2
Delta Highway 50 Bridge	57.9	Reach 2
Gunnison River at Delta Stream Gage	57.3	Reach 2
Uncompahgre River Confluence	56.5	Reach 3
Escalante State Wildlife Area	52.6-43.2	Reach 3
Roubideau Creek Confluence	51	Reach 3
Escalante Creek Confluence	42.4	Reach 3
Dominquez Creek Confluence	30.3	Reach 3
Bridgeport	29.9	Reach 3
Kannah Creek Confluence	18.2	Reach 3
Gunnison River near Grand Junction (Whitewater) Gage	14.6	Reach 3
Butch Craig Bottomland Site	12.5	Reach 3
Redlands Diversion Dam	3.1	Reach 3
Redlands Fish Ladder	3.1	Reach 3
Redlands Fish Screen Return	2.8	Reach 3
Colorado River Confluence	0	Reach 3

As quoted in a recent USGS Report (2004) regarding geology in the Gunnison Gorge , the Gorge:

> *"…is one of the most beautiful and accessible wild areas to be found in the United States…Towering cliffs, quiet riverside glens, cascading rapids, winding trails with spectacular canyon views—these are just a few of the features enjoyed by visitors"*.

Access to upstream river reaches in the Gunnison Gorge NCA is limited by topography; whitewater rafting, fishing, and sightseeing are major uses. The Gunnison Gorge NCA is nationally known for its scenery, geologic formations, fishing, and whitewater boating opportunities. River flows, controlled by operations of the Aspinall Unit, are important to the Gunnison Gorge NCA for recreation use and maintenance of the river channel and aquatic resources. Elliot and Parker (1997) reported that controlled releases from the upstream Aspinall Unit have facilitated fine sediment deposition and vegetation encroachment on the river bank. Cobbles and boulders and debris flows from intermittent side tributaries are infrequently moved and can constrict the channel and increase pool areas until reworked by large floods.

The majority of Reach 2 is privately owned or within the Gunnison Gorge NCA and includes four irrigation diversions which provide water to local farms in and around Delta, Colorado. This reach is approximately 18.3 miles in length and begins in the Gunnison Gorge NCA at the confluence of the North Fork (commonly known as Pleasure Park), and continues through the City of Delta to the confluence with the Uncompahgre River. The USGS Gunnison River at Delta stream gage is located upstream of the Uncompahgre River confluence at River Mile 57.3.

Reach 3 consists of a combination of public lands and large private ranches and orchards along the lower Gunnison River. Reach 3 is approximately 56.5 miles in length and is designated critical habitat for the endangered Colorado pikeminnow and razorback sucker. Escalante State Wildlife Area (RM 52.6 to 43.2) and BLM's Dominquez Wilderness Study Area (RM 42 to 26.2) occur within this reach. As discussed in the Special Status Species Section of this chapter, the area includes backwater areas believed to be of value to the endangered fish. The USGS Gunnison River near Grand Junction stream gage (commonly referred to as the Whitewater Gage) is located at RM 14.6. The Service operates a fish ladder at the Redlands Diversion Dam. The RWPC operates a fish screen in the Redlands Canal which returns fish that enter the canal to the Gunnison River at RM 2.8. RM 0 is the confluence of the Gunnison and Colorado Rivers near downtown Grand Junction, Colorado.

3.3.10.2 Impact Analysis

3.3.10.2A Aspinall Unit Reservoirs

There should be no change in land use or land status around the Aspinall Unit reservoirs and in the Curecanti NRA. Reservoir lands would continue to be managed by the NPS under all alternatives to meet multiple resource goals including recreation and protection of natural resources. These goals would continue to be met under all action alternatives. Minor to moderate reductions in recreation use could occur due to changes in reservoir surface area as discussed in the Recreation Section of this chapter.

3.3.10.2B Black Canyon of the Gunnison National Park

Appendix F contains a write-up prepared by the National Park Service on the effects of alternatives on the Black Canyon Resources. The write-up includes the following summaries:

> *"Action-alternatives B and C are the most effective for channel maintenance of the four action alternatives. Each has a moderate intensity scour, resulting primarily from the effect of the 6,000 cfs class of peak flows. This is beneficial for channel maintenance and sediment mobilization and partly explains the beneficial*

rating. Over time, however, owing to the lack of the 10,000 cfs class flows it will become ever more difficult to move the larger sediment size, the D84, and operations governed by Alternatives B and C will become ineffective. Failure to move the D84 impacts the entrainment of the smaller sediment within the interstices of the cobbles. The net result is continued storage of sediment within the alluvial channel. Operations governing the No Action and Alternatives A utilize under-forecasted runoff values to produce peak outflows.

The proposed action alternatives lack sufficient flows at or above 10,000 cfs to prevent colonization of woody vegetation. The 10,000 cfs flows are the flows with sufficient shear force to accomplish removal of woody plants by mechanical action.

Operation governed by the No Action Alternative and Alternatives A and D lack sufficient flows at 6,000 cfs to prevent continued drying of the alluvial bottomland. This is expected to happen owing to encroachment of xeric community onto the mesic community and the mesic onto the hydric community.

Operations governed by Alternatives B or C can be expected to slow the encroachment of the xeric onto the mesic community and to slow the encroachment of the mesic onto the hydric community. This results from the greater frequency of inundation of the alluvial bottomland. As stated previously, these alternatives lack the 10,000 cfs flows necessary to prevent colonization of the alluvial bottomland by woody vegetation.

The shearing flows and sediment remobilization flows are essentially the same and the results of the work (done by the 10,000 cfs flows) interrelated. When the cobble-size sediment is mobilized the woody and herbaceous vegetation is also sheared away. Without the shearing flows the practical result of the inundation flows is to irrigate the bottomland facilitating growth of invasive riparian plants, for example reed canary grass. A negative impact to Alternatives B and C is the possible loss of native plants communities that were in balance with the frequent shearing flows."

3.3.10.2C Gunnison Gorge National Conservation Area

Under the No Action Alternative, recreation uses would be expected to continue to increase in the Gunnison Gorge NCA. Ongoing resource protection projects should improve riparian vegetation conditions and watershed conditions. Action alternatives may facilitate channel maintenance with an increase in spring peak magnitude and frequency. Sediment deposition and vegetation encroachment would be reduced with the greatest changes occurring under Alternatives B and C. Extremely high flow events that are needed periodically to accomplish significant channel maintenance including movement of debris flow material would not be expected to increase under action alternatives. Effects on vegetation, recreation, and fish and wildlife resources are discussed elsewhere in this chapter. Overall, action alternatives would have beneficial effects on the Gunnison Gorge NCA, and purposes of the Gunnison Gorge NCA would continue to be met under any of the action alternatives.

3.3.10.2D Lower Gunnison

Changes in operations of the Aspinall Unit under action alternatives would not result in significant changes in downstream land uses. Spring flows with higher magnitude and duration under action alternatives would be expected to improve conditions at the Escalante State Wildlife Area for wildlife including the endangered fish species. Need for erosion control along the railroad and maintenance of irrigation diversion may increase, with the greatest potential under Alternative C.

More natural flows under the action alternatives would generally benefit the lower Gunnison River that borders the downstream Dominquez wilderness study area.

3.3.11 ENVIRONMENTAL JUSTICE AND INDIAN TRUST ASSETS

This section addresses the potential impacts to environmental justice and Indian trust assets that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect environmental justice and Indian trust assets?

Overview

Scope

The area of potential effects is defined as the Gunnison River Basin.

Summary of Impacts

Adverse impacts of Indian Trust Assets (ITA) or Environmental Justice populations are not projected under the No Action and action alternatives.

Impact Indicators

- Adverse effect on the value, use, or enjoyment of an ITA.
- Disproportionally high and adverse human health and environmental effects or other negative operational-related impacts to minority and low-income populations.

3.3.11.1 Affected Environment

There have been no ITA's identified related to the Aspinall Unit operations; however, the Ute Mountain Ute Indian Tribe has acquired lands and water rights in the Gunnison Basin.

Executive Order 12898 established the requirement to address Environmental Justice concerns within the context of agency operations. Disproportionately high and adverse human health and environmental effects of programs, policies, and activities on minority and low-income populations are to be identified and addressed. Table 3.3 43 summarizes demographics for the counties in the Study area, and indicates the percentages of minority populations in the general area.

The Reclamation Project Act of 1939 provides that electricity from federal hydropower will first be offered for sale to public, municipal and rural electric customers, also known as preference customers, and then to profit making utilities, like investor-owned utilities, if available. All of the CRSP power has been allocated among preference customers.

Table 3.3 43—2006 Demographics of Counties in the Gunnison Basin.

	Delta	Gunnison	Hinsdale	Mesa	Montrose	Saguache	San Juan	Seven Counties	Total State
Population, 2006 Estimate	30,401	14,331	819	134,189	38,559	7,006	578	225,883	4,753,377
White persons	96.6%	96.4%	97.8	96.1	96.1%	95.9	97.9%	96.2%	90.1%
Black persons	0.5%	0.6%	0.0%	0.7%	0.5%	0.2%	0.0%	0.6%	4.1%
American Indian and Alaska Native persons	0.9%	1.0%	1.5%	1.0%	1.4%	2.0%	1.2%	1.1%	1.1%
Asian persons	0.4%	0.7%	0.4%	0.7%	0.6%	0.5%	0.0%	0.6%	2.6%
Native Hawaiian and Other Pacific Islander	0.0*	0.0*	0.0%	0.1%	0.1%	0.1%	0.7%	0.1%	0.1%
Persons reporting two or more races	1.6%	1.3%	0.4%	1.4%	1.4%	1.3%	0.2%	1.4%	1.8%
Persons of Hispanic or Latino Origin	12.7%	5.7%	1.5%	10.9%	16.8%	45.4%	11.4%	12.9%	19.7%
Median household income (2004)	$35,280	$38,979	$38,891	$40,045	$40,234	$23,638	$32,057	$38,815	$50,105
2006 Average Annual Unemployment Rate	4.0%	3.2%	3.0%	3.9%	3.9%	6.3%	5.8%	3.9%	4.3%

* Value greater than zero but less than half unit of measure shown
Hinsdale, Mesa, Montrose, and Saguache Counties include figures outside the Gunnison Basin.

Data from http://quickfacts.census.gov/qfd/states/

Areas serviced by rural electric cooperatives, associations, Indian tribes and municipalities who purchase CRSP Power are shown in Figure 3.3-42.

3.3.11.2 Impact Analysis

Under the No Action Alternative, impacts related to ITA's or Environmental Justice are not projected to occur. Action alternatives are not expected to affect ITA's or Environmental Justice concerns. As indicated in the Water Resources Section, operations under action alternatives are not expected to increase "calls" by downstream senior water rights that might adversely affect junior water rights, including rights held by the Ute Mountain Ute Tribe and other minority populations.

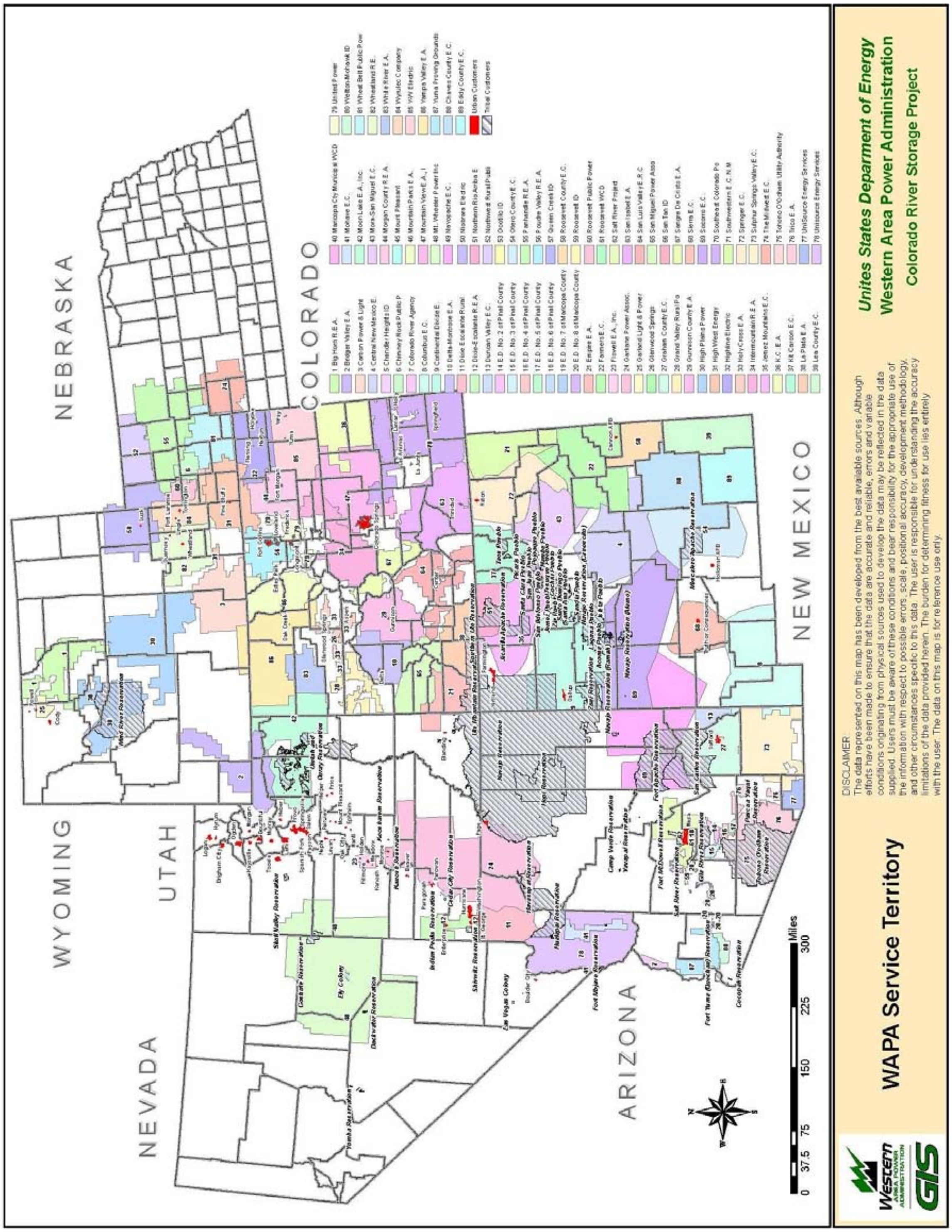

Figure 3.3- 42—CRSP Preference Customers.

Table 3.3 44 summarizes general demographics of CRSP Power Customer service areas within the seven state service area based on 2000 U.S. Census Data. The data was developed by identifying the counties included in each electric cooperative or associations' service area and subtracting villages, towns and cities that do not receive CRSP power. Indian reservations that purchase CRSP power were also included either at the county or reservation level. For example, Grand Valley Power purchases CRSP power and distributes it to rural Mesa, Delta and Garfield Counties in Colorado. To estimate the population serviced by Grand Valley Power in Mesa County, municipalities of Grand Junction, Fruita, Palisade, Clifton, and DeBeque (serviced by Xcel Energy) were subtracted from the total Mesa County population to estimate a rural Mesa County population serviced by Grand Valley Power.

Table 3.3 44—CRSP Power Customer Demographics.

Place	Total Population	White Percent	Other Races Percent	Per Capita Income	Hispanic Percent
ARIZONA CRSP	1,825,783	74.63%	25.12%	20,373.28	19.56%
UTAH CRSP	558,833	91.06%	8.94%	15,532.18	6.30%
NEW MEXICO CRSP	478,769	56.84%	43.16%	15,107.97	36.09%
WYOMING CRSP	153,597	90.85%	9.12%	17,398.36	5.67%
NEVADA CRSP	364,827	66.51%	33.49%	23,798.31	20.03%
NEBRASKA CRSP	33,406	94.25%	5.76%	17,252.74	6.35%
COLORADO CRSP	1,578,334	88.76%	11.20%	25,388.90	13.60%
Total CRSP Customers	**4,993,549**	**79.27%**	**20.63%**	**21,049.84**	**17.30%**

Table 3.3 45— Seven State Demographics.

Place	Total Population	White Percent	Other Races Percent	Per Capita Income	Hispanic Percent
ARIZONA	5,130,632	75.50%	24.50%	20,275.00	25.25%
UTAH	2,233,169	89.24%	10.76%	$18,185.00	9.03%
NEW MEXICO	1,819,046	66.75%	33.25%	17,261.00	42.08%
WYOMING TOTAL	493,782	92.08%	7.92%	19,134.00	6.41%
NEVADA	1,998,257	75.16%	24.84%	$21,989.00	19.72%
NEBRASKA	1,711,263	89.60%	10.40%	19,613.00	5.52%
COLORADO	4,301,261	82.77%	17.23%	24,409.00	17.10%
Seven State Total	**17,687,410**	**79.89%**	**20.11%**	**20,804.20**	**19.89%**

The population demographics shown in Table 3.3 44 for CRSP Power Customer service areas are very similar to the demographics for the combined states (Table 3.3 45) in which the service area are located. Therefore, no disproportionally high and adverse human health and environmental effects or other negative operational-related impacts to minority and low-income populations are projected for changes in CRSP power production under any alternative.

3.3.12 CULTURAL AND PALEONTOLOGICAL RESOURCES

This section addresses the potential impacts to cultural resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect cultural resources?

Overview

Scope

The scope includes prehistoric and historic cultural resources and paleontological resources that may occur around Aspinall Unit Reservoirs and downstream along the Gunnison River.

Summary of Impacts

Under the No Action and action alternatives continued cultural resource research and protection by the NPS would be expected to expand knowledge of resources around the Aspinall Unit Reservoirs. Reservoir fluctuations would continue to affect sites in a similar manner under all alternatives, including No Action. Downstream effects on cultural resources would not be anticipated due to implementation of any action alternative.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by changes in dam releases as a result of the alternatives:

- Significant changes in peak river flows that could impact downstream resources,
- Substantial changes in Blue Mesa Reservoir drawdown compared to historic operations.

3.3.12.1 Affected Environment

The "Area of Potential Effect" (APE) for this DEIS is considered the Aspinall Unit Reservoirs, Curecanti NRA, and the Gunnison River and its 100-year floodplain downstream from Crystal Dam.

For over 10,000 years, humans have been living in the Gunnison Basin. Artifacts and radiocarbon dating from the Curecanti NRA show occupation of the area beginning around 8,000 B.C.

The major prehistoric cultural periods defined include Paleo-Indian, Archaic, and the Formative. Data indicating Paleo-Indian components of big game hunting in west-central Colorado include surface finds of projectile points diagnostic of each of the 3 Paleo-Indian traditions: Clovis, Folsom, and Plano. The transition from big game hunting to intensified plant use and hunting of smaller game is characteristic of the Archaic Period.

The Formative Stage or Late Prehistoric period began around 500 A.D. The first evidence of an Indian group in the upper Gunnison Basin, which was recognized and named by Euro-Americans, is that of the Utes who entered the area around 1200 A.D. Spanish exploration into the study area began in the 1700's and extensive fur trading occurred in the 1800's (Moeller et al, 1993). The Utes were removed to reservations in the 1880's and ranching, farming, logging, and development of transportation routes quickly began.

Limited archeological research was conducted in the Curecanti area in the early 20th century. Detailed cultural surveys in the Blue Mesa area began in the 1970's under the direction of the NPS. Excavations conducted by the NPS, Western State College, and others at the Curecanti NRA since the late 1970's have provided important information about the cultural chronology of the region (Reed and Metcalf 1999). It soon became apparent that the Blue Mesa area contained nationally significant cultural material. The Curecanti NRA includes a 6,750 acre Archeological District established in 1984 and is included on the National Register of Historic Places. More than 500 prehistoric sites have been recorded within the recreation area (NPS, personal communication 2008; 2007; Brunswig, 2006).

Paleo-Indian cultural complexes (ca. 9,000 B.C.-5,000 B.C.) are represented along with later Archaic and late prehistoric periods. Concentrations of Paleo-Indian sites occur along the Gunnison River east of Blue Mesa Dam possibly indicating the river as a travel corridor (Reed 1984 cited in Moeller et al. 1993). Projectile points and radiocarbon dating of charcoal show Paleo-Indian use of what is now the Curecanti NRA (NPS 1994). One hearth excavated in the Elk Creek area had a radiocarbon date of approximately 8,000 B.C.

The Archaic era dates from approximately 7000 to 400 B.C. or later and Archaic sites predominate in the area (Moeller et al. 1993). Archaic hearths have been excavated near the old Gunnison River channel. Near Elk Creek, a habitation structure dated between 2,400 and 3,700 B.C. was studied and represents very early habitation in the area (NPS 1994). The area of Blue Mesa Reservoir was a high use camp area with many sites near mouths of tributaries and near lithic sources (Moeller et al, 1993).

There are sites at Curecanti dating to later periods up to 1600 A.D. and later. These sites represent Archaic-type hunting and gathering live styles with improved technologies such as the use of bow and arrow. The Utes utilized the area from around 1200-1300 A.D. until the late 1800's.

Steep canyon areas, such as occur in Morrow Point and Crystal Reservoir basins and in the Black Canyon, do not show significant prehistoric use along the river channel, although survey work in these areas has been limited. Sites do occur on higher benches and mesas.

The Ute, Chukar, and Red Canyon trails are believed to have been used in prehistoric times to enter the Gunnison Gorge and cultural sites have been recorded in association with these trails. Prehistoric sites are located above the historic waterline of the Gunnison River, particularly along the rim of the Gorge.

Gunnison Basin cultural sites downstream from the North Fork confluence represent Ute, Fremont, Archaic, and Paleo-Indian groups. The majority of the sites are in the Roubideau Creek confluence to Grand Junction reach of the river, although sites are also recorded upstream from this reach. Site types such as rock shelters, campsites, lithic areas, and petroglyphs are relatively common. Sites occur on the Uncompahgre Plateau and along tributaries and mesas along the Gunnison River. Periodic high water events and modern settlement patterns have probably erased evidence of occupation within the immediate floodplain of the river.

Recorded historic sites in the project area are related to early railroad development, mining, ranching, irrigation, and transportation. The northern route of the Old Spanish Trail may have passed through the Blue Mesa Reservoir Area although a location has not been confirmed (NPS 2007). The discovery of gold in the San Juan Mountains resulted in an influx of settlement in the 1860's and 1870's. Early ranches were established in the 1870's. Around the Blue Mesa area there is evidence of early ranching, mining, and logging.

A series of treaties diminished lands occupied by the Utes and by 1881 Utes were removed from the area. The Denver and Rio Grande narrow gauge route from Gunnison to Montrose was operated from 1881 to 1940 and followed the river in what are now Blue Mesa and Morrow Point Reservoirs. The railroad exited the canyon at Cimarron where the NPS maintains exhibits, including a National Register trestle and train exhibit. There are also historic sites associated with the Gunnison to Lake City branch of the railroad. Downstream from Crystal Dam is the Gunnison Tunnel, listed on the National Register, which was completed in 1909 and delivers water to the Uncompahgre Valley. The tunnel is also listed as a National Historic Civil Engineering Landmark (NPS 2007).

The Gunnison Gorge contains cabin sites, historically used trails, and remnants of mining including placer mining along the river. Sites are located above the historic waterline of the river.

Downstream from the Gunnison Gorge, evidence of early irrigation structures exist such as abandoned water wheels and functional diversion dams. The Roubidoux or Fort Uncompahgre trading post was established in the 1830's somewhere near the confluence of Roubideau Creek and the Gunnison River downstream from Delta but efforts to locate the site have yielded no results. Downstream from Roubideau Creek, evidence of abandoned railroad routes and bridges exist in the vicinity of the present railroad along with abandoned and operating ranches from the 19th century. Evidence of an abandoned ferry is found in the Dominguez Creek confluence area.

The Redlands Dam Complex, including the diversion dam, canal system, and powerplant, has been recorded as a historic site (5ME764) and is considered eligible for the National Register of Historic Places by the Colorado Historical Society.

The Redlands Diversion Dam itself has an interesting history. Construction on the Redlands project began in 1905 and Benjamin and Frank Kieffer incorporated the Redlands Irrigation Company in 1906. The original diversion dam was about 1,000 feet upstream from the present location; the existing dam was built in 1918. Operators of the Redlands project originally sold electric power and water, and irrigated substantial acres of company land. Later, the company's agricultural lands were sold to private farmers and the company operated primarily as a water distributor and power producer. Today, the Company still operates in this manner, although most customers are now homeowners rather than farmers.

Paleontological resources are found throughout the study area. Around Blue Mesa Reservoir the Jurassic Age Morrison formation has yielded dinosaur fossils, some below the waterline. More recent Dakota sandstone and Mancos shale also contain fossils. The lower Gunnison River is bordered in some areas by the same formations that contain paleontological resources.

3.3.12.2 Impact Analysis

Cultural sites from the various prehistoric periods occur above and below the Blue Mesa water elevation. Erosion from wave action has exposed many sites. The following graph (Figure 3.3-43) shows fluctuations of water surface area over the last 40 years; this fluctuation has exposed many of the recorded sites.

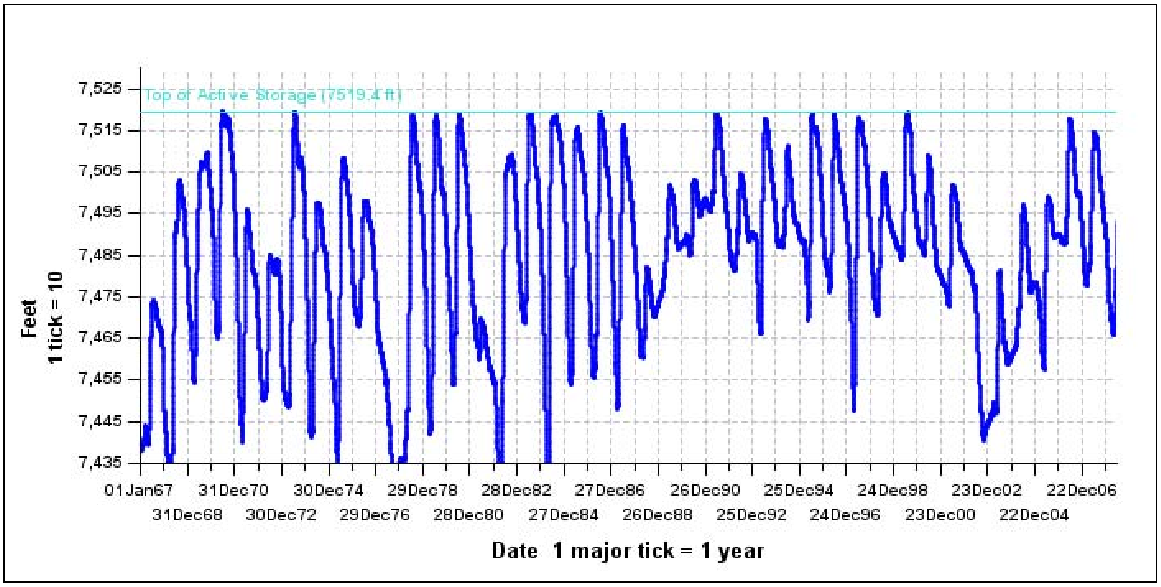

Figure 3.3- 43—Historic Reservoir Fluctuations at Blue Mesa Reservoir.

Under the No Action Alternative, fluctuations and wave action of Blue Mesa Reservoir would be expected to continue exposing prehistoric sites and possibly paleontological resources along steeper shorelines. Monitoring, site protection, and surveys by the NPS would be expected to continue. Under action alternatives these fluctuations and wave action would continue with similar impacts on sites. Significant new impacts are not projected due to the action alternatives because reservoir fluctuations would remain within the range expected for the No Action Alternative and well within the range that has occurred since Blue Mesa was first filled (see Figures 3.3-6 and 3.3-7 in the Water Uses and Resources Section). As seen in Table 3.3-46 minimum elevations and minimum Blue Mesa surface area would be very similar under No Action and Alternatives A, B, and D. Alternative C does have lower minimums but is still well with historic drawdowns.

Table 3.3 46—Blue Mesa Reservoir Elevation and Surface Area: Actual Historic and Projected under Alternatives Considered.

	1967-2007	No Action	Alt A	Alt B	Alt C	Alt D
Minimum Blue Mesa Reservoir Elevation	7427	7433.53	7433.48	7433.52	7410.58	7433.49
Minimum Blue Mesa Reservoir Surface Area (ac)	----	4648	4645	4647	3458	4645

Downstream from the Aspinall Unit, peak flow frequencies would increase with action alternatives when compared to No Action; however, the largest peaks which result from very high snowpack conditions would be similar under No Action and action alternatives. Regulation by the Aspinall Unit would still maintain lower peaks than occurred prior to the Aspinall Unit. Therefore no significant impacts on downstream cultural resources are projected due to flow changes.

3.3.13 GEOLOGY

This section addresses the potential impacts to geologic resources that could result from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect geologic resources?

Overview

Scope

The scope includes geology, soils and erosion characteristics of the Aspinall Unit and along the Gunnison River and its major tributaries downstream of the Aspinall Unit.

Summary of Impacts

No impacts to geologic or soil resources are projected to occur under the No Action Alternative or any of the action alternatives.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by changes in dam releases as a result of the alternatives:

- Significant changes in drawdown rates or reservoir elevations at Morrow Point or Crystal reservoirs.
- Substantial changes in bank erosion downstream from the Aspinall Unit.

3.3.13.1 Affected Environment

3.3.13.1A Geology

The Black Canyon of the Gunnison lies in a transition zone between two physiographic provinces, the Colorado Plateau on the west, and the Southern Rocky Mountains on the east. Volcanism in the middle to late Tertiary Period diverted surface drainage southward around the newly formed West Elk Mountains and across the buried Precambrian rocks of the Gunnison Uplift. Once entrenched into these hard, highly fractured and faulted metamorphic and granitic rocks the river had to pursue its established course. Down cutting probably began about two million years ago, before the start of Pleistocene glaciation, as indicated by the presence of terrace gravels from glacial melt water at elevations below the rims of the Black Canyon.
The northeast side of the uplift is gently up-warped and the southwest side is bounded by the Cimarron-Red Rocks fault system trending N 50° to 70° W approximately 2.25 miles upstream of Morrow Point Dam. Because of their close proximity to Morrow Point Dam,

the Cimarron and Red Rocks faults control the seismic risk at this site. These faults are oblique-slip or tear faults along the southwestern margin of the Gunnison Uplift.

Alluvium and colluvium in the river channel consists of sand, gravel, cobbles, and many large blocks of crystalline rocks. These blocks are a result of rock falls from the steep canyon walls, and are up to 10 feet in diameter.

Morrow Point Dam—Several thousand feet of Precambrian metamorphic rocks are exposed in the Gunnison Canyon. Uplift faulting and folding have created an intensely jointed structural environment. Morrow Point Dam is founded on competent, resistant metamorphic rocks composed of gneiss, quartzite, pegmatite, and schist with weak foliation planes composed of biotite and mica schist. Intrusions of igneous pegmatite are present throughout the dam site and occur as thin stringers to large masses.

There are five main landslide areas identified in the reservoir area upstream of the dam. The landslides can generally be classified as debris slides or flows. These slides have the potential for movement of a large volume of landslide debris into the reservoir, which is a major operational concern. Of the five landslides, the one closest to the dam, Landslide A, has the greatest potential to generate waves in the reservoir that could overtop the dam. Landslide A is monitored closely during operational changes and annually for movement.

Blue Mesa Dam—The abutment and foundation rocks consist of predominantly granite gneiss with granite pegmatite intrusions. These rocks form the inner gorge of the Black Canyon and crop out in increasing thickness in a downstream direction. The overlying Jurassic sandstones and shales begin just above the crest elevation on the right abutment, and at a slightly higher elevation on the left abutment.

Five landslides exist in the vicinity of Blue Mesa Dam and are monitored annually. They do not threaten the safety of the dam, but two active slides pose a threat to public safety along Highway 50. Potential rockfall in the canyon pose a risk to the public and operations around the powerplant and spillway areas.

Crystal Dam—Crystal Dam is located in a narrow section of the Black Canyon of the Gunnison River, where the river has cut into Precambrian rocks of the Black Canyon Uplift. The rocks are primarily metamorphic, with igneous intrusions. The Red Rocks Fault, located north of the dam site approximately 3,400 feet, trends east-southeastward for 20 miles or more.
The primary metamorphic rock types at the dam site are metaquartzite and mica schist. Irregularly shaped pegmatite intrusions are common in the metamorphic rocks. Foliation (layering) is well developed in the schist, but less prominent in the other rock types.

Rockfall and local rock slides are common in the canyon. While not affecting the safety of the dam directly, access to the site can be blocked. A large landslide is present along the reservoir rim, approximately 4.5 miles upstream of the dam along the northeast side of the reservoir. The slide appears to be a pervious debris slide, which moves slowly and commonly during wet periods. The landslide is monitored during unusual reservoir operations and annually.

3.3.13.1B Soils

Soils of the Gunnison River Basin have developed on gently to strong sloping floodplains and terraces, moderately to strongly sloping mesas and low rolling hills, and steep to very steep rough mountainous uplands. They have developed in alluvium, residuum, and colluvium from shale, sandstone, rhyolite, breccia, and tuff, under low to high effective precipitation, at elevations ranging from 5,000 to 14,000 feet (SCS 1962).

On the basis of climatic influence on soil characteristics, five major groupings of great soil groups have been recognized. These groupings are:

- Desert-Sierozem—Soils in this grouping have developed under low effective precipitation, on gentle to moderate undulating floodplains and strongly to steeply sloping, severely eroded low rolling shale hills, in alluvium and residuum from sandstone and saline shale, at elevations ranging from 5,000 to 6,000 feet. They are deep, generally slowly permeable, moderately coarse to fine textured soils. This grouping also includes about 3 percent Solonetz (high sodium) soils, 6 percent of deep, moderately fine textured Regosols; 15 percent of deep, medium to fine textured Alluvial soils; 22 percent miscellaneous land types; and 17 percent moderately coarse to moderately fine textured Lithosols. Salinity is a major problem and is reflected in the spotty crop growth observed in these soils.

- Brown-Chestnut—Soils of this grouping have developed under slightly higher effective precipitation than the Desert-Sierozem soils, on gently sloping stream terraces, outwash fans and valley fills, and moderately to steeply sloping uplands, in glacial till, alluvium and residuum from sandstone and shale, at elevations ranging from 6,000 to 8,000 feet. They are deep, moderately coarse to moderately fine textured soils. This grouping also includes about 19 percent miscellaneous land types; 8 percent deep, moderately coarse to fine textured Alluvial soils; 14 percent moderate coarse to medium textured Lithosols; and 4 percent Humic Gley soils.

- Mountain Prairie-Chestnut—Soils of this grouping have developed under a higher effective precipitation that the Brown-Chesnut grouping. They have developed on gently to moderately sloping Alluvial fans and valley fills, and steep to very steep mountainous uplands, in glacial till of mixed parent rock and alluvium and residuum from a variety of parent rocks at elevations ranging from 7,000 to 9,000 feet. They are moderately deep to deep, moderately coarse to moderately fine textured soils. This grouping also includes about 17 percent miscellaneous land types; 7 percent moderately coarse to medium textured Lithosols; and 5 percent deep, moderately coarse to moderately fine textured Alluvial soils with inclusions of deep, moderately coarse to moderately fine textured Humic Gley soils.

- Gray Wooded-Brown Podzolic-Mountain Prairie—Soils of this grouping have developed high effective precipitation on moderate to strongly sloping valley fills, alluvial fans and mesa tops, and steep to very steep mountainous uplands, in alluvial, residuum and colluvium, from sandstone, shale, tuff, and rhyolite, at elevation from 9,000 to 11,500 feet. They are moderately deep to deep, moderately coarse to moderately fine textured soils, generally with a high percentage of large angular pieces of parent rock throughout the profile. Common inclusions include small, wet depressional areas of peat, muck and mineral soil. This grouping also includes about 21 percent miscellaneous land types; 18 percent deep, moderately coarse to moderately fine textured Alluvial soils; and 5 percent moderately coarse to medium textured Lithosols.

- Alpine Meadow-Alpine Bog—Soils of this grouping have developed under high precipitation in moderately sloping depressions of alluvium and colluvium and on strongly sloping ridge-tops and steep side slopes in residuum from tuff, breccia, rhyolite, andesite, basalt and granite, at elevations above timberline and above 11,500 feet. They are shallow to moderately deep, moderately coarse to medium textured, high organic soils. Most of this group consists of miscellaneous land types.

Soil Erosion—Bank erosion commonly occurs on the outside edge of meander bends along the river or streams, where banks are exposed to the force of the river during high flows. Banks between the meander bends are generally less steep and more vegetated. Vegetation can play a key role in preventing erosion, with dense root masses holding soil together and preventing bank erosion.

Some bank erosion occurs along the Gunnison River and its tributaries, but the river/stream channels are generally entrenched or have dense vegetation along the banks to protect them.

Side tributaries can add fine sediment to the river during storms which cause increased bank erosion, but, in general, the river/stream banks are stable. The river/stream beds generally consist of gravel and cobbles with some fine sand.

3.3.13.2 Impact Analysis

3.3.13.2A No Action Alternative

Any geologic resource impacts from the operation of the reservoir would fall within historic parameters or anticipated changes in the future Aspinall Unit operations. As a result, there would be no anticipated increase in erosion, sedimentation, landslide activity or potential restriction of mineral resource recovery. In addition, reservoir-induced seismicity has not been a problem in the past and is not expected to change.

Few, if any, impacts to soil resources would occur. Historical operations of the reservoirs have resulted in relatively stable reservoir levels with little soil erosion around the reservoirs' edges. Downstream releases have been controlled to the extent that bank erosion has been low, vegetation has encroached on the river, and the river has become relatively stable.

3.3.13.2B Action Alternatives

Short-term impacts would include, but would not be limited to, bank erosion along the Gunnison River and its major tributaries, increased shoreline erosion along the reservoir edge, small landslides along the edges of the different reservoirs from local saturated conditions, and increased dust concentrations in exposed areas around the reservoirs. Operational criteria to reduce the potential for landslides would continue. Long term impacts would not be substantial due to bank stabilization over time.

3.3.14. OTHER RESOURCES

This section addresses the potential impacts to various resources that could be affected from actions associated with the modified operations of the Aspinall Unit under the alternatives considered.

Issue: How would the No Action and action alternatives affect resources such as air quality, noise, and hazardous materials?

Overview

Scope

The scope includes the Gunnison River and its tributaries, Aspinall Unit reservoirs, and uses of the river, reservoirs and adjacent lands.

Summary of Impacts

The No Action Alternative and action alternatives are predicted to have no measureable impact to air quality, noise and hazardous materials.

Impact Indicators

The indicators used to determine impacts centered on whether the following effects would be caused by changes in dam releases as a result of the alternatives:

- Short- or long-term violation of any National or State ambient air quality standards.
- Interference with any local air quality management planning efforts to attain or maintain air quality standards.
- Noise generated that exceeded established ordinances or criteria.
- Substantial increases in noise levels over existing noise levels in noise-sensitive areas.
- Noise that would be disturbing or injurious to wildlife.
- Implementation of the No Action or action alternatives disturbs hazardous materials that would result in a health risk to the public or environment.

3.3.14.1 Affected Environment

3.3.14.1A Air Quality

For air quality planning, the Colorado Air Quality Control Commission includes the Gunnison Basin within the larger Western Slope Region. The Western Slope Region includes all counties lying west of the Continental Divide. Table 3.3 47 includes the current National and State Ambient Air Quality Standards.

Table 3.3 47—Ambient Air Quality Standards.

Pollutant	Period	National[1]	Colorado[2]
PM_{10}	24-hr average[3]	150 µg/m^3	150 µg/m^3
	Average Annual	--	50 µg/m^3
$PM_{2.5}$	24-hr average[4]	15.0 µg/m^3	--
	annual[5]	35 µg/m^3	--
Sulfur dioxide	3-hr average[6]	0.5 ppm (1300 µg/m$^{3)}$	700 µg/m^3
	24-hr average[6]	0.14 ppm	100 µg/m^3
	annual	0.03 ppm	15 µg/m^3
Carbon monoxide	1-hr average[6]	9 ppm (10 mg/m$^{3)}$)	40 mg/m^3
	8-hr average[6]	35 ppm (40 mg/m^3)	10 mg/m^3
Nitrogen dioxide	annual	0.053 ppm (100 µg/m$^{3)}$	100 mg/m^3
Ozone	1-hr average[7]	0.12 ppm	235 µg/m^3
	8-hr average[8]	0.075 ppm (2008 Standard)	--
	8-hr average[9]	0.08 ppm (1997 Standard)	--
Lead	Quarterly Average	1.5 µg/m^3	--

[1]Source: National Ambient Air Quality Standards (40 CFR part 50)
[2]Source: Colorado Ambient Air Quality Standards, Colorado Control Commission (5CC 1001-14). All measurement of air quality are corrected to a reference temperature of 25NC and to a reference pressure of 760 millimeters of mercury (1,013.2 Millibars). Standards other than annual average are not to be exceeded more than once per year.
[3]Not to be exceeded more than one per year on average over 3 years.
[4]To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15 µg/m^3.
[5]To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3.
[6]Not to exceed more than once per year.
[7]To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (Effective May 27, 2008).
[8](a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone cocentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b)The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
[9](a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is , 1.
(b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

Air quality within the Gunnison Basin is considered good with concerns in the Western Slope Region focusing primarily around impacts from a recent surge in energy development. In the 1990's, air quality concerns focused primarily around woodstoves, unpaved roads, and street sanding. Many of the Western slope communities addressed these air pollution sources and are no longer as significant as the impacts from energy development, including direct emissions, support service impacts and associated growth (CDPHE 2007). Many Western Slope Communities have taken aggressive action to control residential burning emissions.

In the Gunnison Basin, the Town of Crested Butte, and Mesa and Delta Counties have adopted either mandatory or voluntary control measures to reduce residential burning pollution during the winter months. Air quality data is collected at monitoring stations in

Crested Butte, Mt. Crested Butte, and Delta. Air quality monitoring was discontinued in Gunnison in 2006. Table 3.3 48 summarizes air quality data from CDPHE (2007) Air Quality Date Report.

Table 3.3 48—PM_{10} & $PM_{2.5}$ Concentrations for the Gunnison Basin.

		PM_{10} (µg/m^3)		PM2.5 (µg/m^3)	
Site Name	**Location**	**Annual Average**	**24-Hr Maximum**	**Annual Average**	**24-Hr Maximum**
Crested Butte	603 6th St	27.1	100	--	--
Mt. Crested Butte	19 Emmons Loop	29.1	120	6.42	21.7
Gunnison	211 Wisconsin Ave	17.4	55	--	--
Delta	560 Dodge St	24.3	53	7.10	18.0
State Standard		**50**	**150**	**15.0**	**35.0**

The air quality monitoring stations measure particulate matter (PM) which are tiny particles of solid of semi-solid material found in the atmosphere, often referred to as dust. It is classified according to size. PM_{10} are particles smaller than 10 microns and $PM_{2.5}$ are particles smaller than 2.5 microns. Particulate matter can reduce lung function, aggravate respiratory conditions and may increase the long-term risk of cancer or development of respiratory problems.

State and Federal Air Pollutant Standards for particulate matter are as follows:

> **PM_{10}**-24-hour standard of 150 micrograms per cubic meter cannot be exceeded more than once per year and the average annual standard of 50 micrograms per cubic meter.
>
> **$PM_{2.5}$**-Annual mean standard must not exceed 15 micrograms per cubic meter averaged over three years. 24-hour standard is 35 micrograms per cubic meter applied to the 3-year average of the 98th percentile value.

3.3.14.1B Noise

The Colorado General Assembly established day and night-time standards (CRS 25-12-101) for noise limits for residential, commercial, light industrial, and industry. These standards range from 50 dbA for night-time residential to 80 dbA for day-time industry at a distance of 25 feet. If the sound levels exceed the given limit then the noise is a public nuisance.

Within the area of analysis, the dominant sounds in the project area originate from natural sources—water, wind, and wildlife. Though human-made sounds can be heard within the Curecanti NRA from sources such as traffic from surrounding highways, overhead aircraft, and motorized watercraft use within the reservoirs, overall, the soundscape of much of the Curecanti NRA appears to be well preserved, as certain portions of the Curecanti NRA offers a sense of serene solitude. Curecanti NRA backcountry trails give visitors opportunities to hear natural sounds. NPS concluded in a Draft Resource Protection Study/EIS that a significant resource available to Curecanti NRA visitors is the soundscape and that it is a resource worthy of attention and conversation, and offers opportunities for visitors to enjoy a reprieve from the often bustling sounds of their everyday lives (NPS 2007).

The Gunnison River below Crystal Dam enters the Black Canyon NP and travels approximately 14 miles through the park. The soundscape is protected by the inner canyon's wilderness designation and remoteness. Wilderness protection continues downstream another 11.3 miles through the Gunnison Gorge NCA managed by the Bureau of Land Management.

3.3.14.1C Hazardous Materials

The hazardous materials of most concern are coal products transported by train along the Gunnison River from Delta to Grand Junction. Petroleum pipeline river crossings also pose a significant hazard if pipeline exposure/erosion occurs and the line was damaged; compressed natural gas would be an airborne hazard, while liquefied petroleum gas would become a waterborne petroleum contamination hazard. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration database (PHMSA 2008) identified two major natural gas pipelines crossing the Gunnison River within the project area. The pipelines are the TransColorado Main Pipeline west of Delta, Colorado and the Sourcegas LLC Interstate Collbran to Read Junction Pipeline east of Delta.

Another area of concern includes the City of Delta municipal wastewater treatment facility which may present a biohazard contamination to the river. Recent improvements to the facility were made to provide 100 year flood plain protection.

3.3.14.2 Impact Analysis

3.3.14.2A Air Quality

Predicted air quality impacts are limited to increases in particulate matter as a result of wind erosion on exposed reservoir sediments. Table 3.3 49 Shows average annual reservoir sediment exposure (in surface acres) from maximum fill to the end of August.

Table 3.3 49—Average Area Exposed from Reservoir Drawdown.

	No Action	Alt. A	Alt. B	Alt. C	Alt. D
Average Area Exposed from Reservoir Drawdown (acres)	457	496	469	654	480
Difference from No Action (acres)	--	+39	+12	+197	+23

No Action Alternative—Under the No Action Alternative, it is predicted that National and State Ambient Air Quality Standards would continue to be met. Air quality monitoring data in Table 3.3 48 shows that the air quality data collected at the four monitoring stations are well within the standards for particulate matter.

Action Alternatives—National and State ambient air quality standards are predicted to be met under all of the action alternatives. When compared to the No Action Alternative, modeled hydrology predicts Alternatives A, B and D would result in a less than 0.5 percent increase in average surface area exposure for wind erosion from average maximum reservoir elevation to the average end of August reservoir elevation. Alternative C was predicted to result in an additional 2.9 percent exposed surface area when compared to the No Action Alternative. The potential for increases in wind erosion from additional surface area exposure from reservoir drawdowns are not predicted to increase particulate matter concentrations by a measurable level.

3.3.14.2B Noise

No substantial increase in noise levels is predicted to occur as a result of implementation of the No Action or any of the action alternatives. Changes in noise level would be limited to natural sounds associated with increased flows. Wilderness designations within the Black Canyon NP and Gunnison Gorge NCA would continue to provide protections to the natural soundscape.

3.3.14.2C Hazardous Materials

Implementation of the No Action or any of the action alternatives is predicted to have no measureable effect on transportation of hazardous materials within the project area. Aspinall Unit operations under all alternatives would be within the historic range. Natural gas pipelines and the City of Delta municipal wastewater treatment plant have protection up to the 100-year flood event.

3.4 Summary and Other Considerations

Impacts of alternatives are summarized in the table at the end of Chapter 2 of this EIS. Overall, action alternatives would benefit downstream endangered fish and their habitat. In addition, more natural flows would help maintain the river channel and associated riparian areas in the Black Canyon, Gunnison Gorge, and areas downstream. Minor to moderate adverse effects would be expected to occur to recreation, sport fisheries, and hydropower. Aspinall Unit purposes would be maintained. Alternative B has been selected as the preferred alternative.

The Council on Environmental Quality regulations for implementing NEPA requires the determination of short- and long-term impacts, direct and indirect impacts, irreversible and irretrievable commitments of resources, and unavoidable adverse impacts. The regulations also call for the consideration of the relationship of the proposed action and its impacts to other projects and activities in the area. The relationship can be direct, indirect, or cumulative in nature. Connected actions are those actions which are interrelated with the proposed action; cumulative actions are those actions, which, when viewed with other proposed actions, have cumulatively significant impacts; and related actions are those actions which, when viewed with other proposed actions, have similarities to the proposed action that provide a basis for evaluation together, such as common timing or geography.

Short-term impacts of the action alternatives would not be considered adverse; there is no construction associated with the alternatives and short-term impacts are most often related to construction activities.

The action alternatives result in significant long-term changes in release patterns from the Aspinall Unit and associated impacts would be long-term. Thus, changes to resources such as hydropower and recreation, discussed previously in this chapter, are considered long-term impacts. These changes are not necessarily irreversible or irretrievable and future efforts or changes in the status of the endangered fish may refine them.

Connected or related closely to new operations of the Aspinall Unit are other water developments. Subject to completion of ESA consultation, the reoperation of the Aspinall Unit is expected of offset endangered species impacts of the Dallas Creek and Dolores projects. The operation of the Aspinall Unit to better mimic natural flow conditions is a key element in the strategy to facilitate recovery of endangered fish species while providing the primary mechanism that allows ESA compliance for continued water development. Other elements of the Recovery Program, such as fish passage and stocking, are related to reoperation of the Aspinall Unit and together are designed to assist in the recovery of the endangered fish.

The cumulative effect of identified future water uses are built into the analysis of impacts in the EIS. Thus, impacts to resources are based on foreseeable cumulative impacts.

Biological diversity, or biodiversity, is a general term applied to the fundamental ecological concept that all living things are connected in some way. The general premise of life on earth is that species of fish, wildlife and plants have evolved, or otherwise adjusted, to the environmental conditions particular to the areas of the planet where they exist. Changes to those conditions, either natural or man-caused, often result in a decline in the numbers and variety of species and a disruption of the established interactions among remaining species. It is generally accepted that the more natural an environment remains, the healthier, or better able, it is to withstand all but major catastrophic events.

A change in biodiversity associated with the historical Gunnison River occurred when the Aspinall Unit was constructed and placed into operation. The dams and reservoirs physically altered the river and the surrounding terrain and modified the pattern of flows downstream. As is typical with dams constructed in the southwest United States, the Gunnison River downstream of the dam became clearer, due to sediment retained in the reservoir, and the water became colder, because it is released from a deep pool of water. Species of fish and other aquatic organisms, and those forms of life that existed along the river channel, were all affected to varying degrees. The conditions of the river immediately downstream of the dam became less favorable to the fish species that evolved and survived in warmer and muddier waters. The disruption of natural patterns of flows caused changes to the vegetation along the river banks, by altering the previously established conditions under which the plants reproduced and were sustained.

In addition to the changes caused to the river by the dams, there were changes to how the lands in the area were used. Reduced flooding downstream of the Aspinall Unit, encouraged more development along the river. Also, over the last century, the river has experienced diversions for human consumption and use at towns and cities, resulting in a variety of return flows to the river, including industrial, stormwater runoff and discharges from sewage treatment plants.

Compounding these changes has been the appearance of non-native species of fish and plants, creating competition with native species.

The preferred alternative is expected to contribute to stabilizing native biodiversity in the Gunnison River downstream of the dam. The Flow Recommendations are intended to reverse some of the hydrologic effects of the dam and its operations to allow recovery of the native razorback sucker and Colorado pikeminnow. They also allow water development to proceed. It is expected that other species that are part of native biodiversity will also benefit.

The growing body of scientific evidence suggests that global warming is not speculative. There is some general consensus among the scientific community that the West will experience warmer temperatures, longer growing seasons, earlier runoff of snowmelt, and more precipitation occurring as rain rather than snow (see Section 2.3.6.5). Specific predictions for the Gunnison Basin are highly speculative; however, predictions for the overall Colorado River Basin natural flows have ranged between reductions of 6 to 45 percent over the next 50 years (Reclamation 2007). In the long-term, the timing and quantity of runoff into the Aspinall Unit may be affected and may affect expected results from implementation of the proposed action either in a positive or negative manner. It is possible that the frequency of dry and moderately dry type years will increase, thus reducing the ability of the rivers to move sediment and maintain or improve habitat conditions. Conversely the magnitude of runoff events could become more variable and extreme and still provide conditions for sediment movement.

The hydrology modeling for this EIS does not project future inflows, but rather relies on the historic record to analyze a range of inflows. As discussed elsewhere in this assessment, the inflow to the Aspinall Unit has historically been highly variable and operations under the proposed alternative are planned to address this variability. The study period used in this analysis includes drought periods and both extremely dry and extremely wet years. Because the action being considered does not involve new construction of storage facilities or outlet features, sizing of facilities in relation to future climate is not a consideration. The preferred alternative also includes an adaptive management process, supported by Recovery Program monitoring, to address new information about the subject endangered fish, their habitat, reservoir operations, and river flows. Reclamation will also continue to support multi-faceted research on climate change (Reclamation 2007).

CHAPTER 4. ENVIRONMENTAL COMMITMENTS AND MITIGATION

4.1 Introduction

This chapter discusses environmental commitments associated with modifying the operations of the Aspinall Unit to implement the preferred alternative. It also includes a discussion of mitigation measures that have been developed or discussed in consultation with cooperating agencies.

4.2 Measures

4.2.1. Reservoir Operations

The Aspinall Unit will continue to be operated to meet authorized purposes, and existing water and power contracts will be honored. Consistent with authorized purposes, the Aspinall Unit will be operated in accordance with water laws and water rights as decreed under the State of Colorado and the Law of the River. Provisions are included to address severe drought conditions and emergency situations. Blue Mesa and Morrow Point powerplants will continue to provide peaking power operations and Crystal Dam and Reservoir will continue to reregulate upstream releases and to provide uniform downstream flows. Operation meetings open to the public will continue to be held three times per year.

4.2.2. Fish and Wildlife

Ramping rate guidelines will be used in planning reservoir operations, including ramping rates of 25 percent on ascending limb and at 15 percent or 400 cfs per day whichever is greater on descending limb. The downstream of Crystal Dam minimum flow of 300 cfs will continue to be followed with the exception of emergencies and extended droughts when it may be reduced to 200 cfs as in the past.

4.2.3. Endangered Species

The preferred alternative will be followed to provide flows for downstream endangered fish. An adaptive management program will be developed with the Fish and Wildlife Service and the Recovery Program to address new information and existing uncertainties.

4.2.4. Flood Control

The Aspinall Unit will continue to follow Corps of Engineers flood control criteria coordinating with the City and County of Delta in an effort to maintain flows below levels which may cause damage. Blue Mesa Reservoir will be drawn down to 7490 feet by the end of December to reduce chances of upstream ice jams and associated flooding.

Chapter 5. CONSULTATION AND COORDINATION

5.1 Introduction

This chapter documents the Bureau of Reclamations' consultation and coordination activities during the preparation of the Environmental Impact Statement (EIS) for Aspinall Unit operations. The public involvement activities are described, including the public scoping process, along with information on the activities that were implemented to solicit input from those agencies with jurisdictional authority, interest, or expertise in the activities or issues addressed in this EIS.

5.2 Public Involvement Activities

Reclamation used several methods to obtain public input in developing the EIS, including scoping and operation meetings and dissemination of public information through news releases and a project website. These public involvement activities are described in more detail in the following sections.

5.2.1 Public Scoping Process

One of the steps in preparing an EIS is called "scoping", which is designed to help determine the scope of issues and alternatives to be analyzed in the document from the interest and perspective of the public. Scoping occurs as early as possible after a lead agency decides to prepare an EIS under a process governed by the Council on Environmental Quality (oversight agency for the National Environmental Policy Act (NEPA) process. The scoping process provides the general public, local agencies, affected Federal and State agencies, and others the opportunity to provide input on key issues and concerns they believe should be evaluated in the environmental document.

Reclamation announced its intent to prepare an EIS in a Notice of Intent (NOI) published in the *Federal Register* on January 21, 2004. The Notice described Reclamation's intent to prepare an EIS, announced public meeting dates, and solicited public comments.

Public scoping meetings were held in February 2004 in Gunnison, Delta, and Grand Junction, Colorado. Representatives from federal, state, and local agencies attended the meetings, as well as members of the public. At the meetings, Reclamation presented background information and listened to public comments and questions. Forms were also provided for written comments. At the meetings, Reclamation also offered to meet individually with groups or organizations to discuss the EIS process. Reclamation published the results of the scoping process in 2004 (Reclamation 2004).

There were two primary, and not fully compatible, concerns expressed during the scoping process: 1) the existing and future traditional benefits and uses of the Aspinall Unit should be protected in the EIS process, and 2) the EIS process should be used to restore river conditions to a more natural condition and assist in endangered species recovery. Major concerns expressed included:

- Effects of alternatives on water rights and supplies
- Effects of alternatives on water quality
- Effects of alternatives on recreation
- Effects of alternatives on fish and wildlife resources
- Effects of alternative on hydropower and flood control
- Need for completion of ESA compliance on Dallas Creek and Dolores Projects and other existing water uses
- Effect of alternatives on the Black Canyon NP and coordination of alternatives with the reserved water right for the Black Canyon NP

Appendix E contains a report on scoping activities including concerns and suggestions provided by the public and agencies.

5.3 Cooperating Agencies

Several agencies and governmental organizations served as cooperating agencies during the EIS development:

State of Colorado
- Colorado Department of Natural Resources
- Colorado Water Conservation Board
- Colorado Division of Water Resources
- Colorado Division of Wildlife

Colorado River Water Conservation District
Southwestern Water Conservation District
Platte River Power Authority
Fish and Wildlife Service
National Park Service
Western Area Power Administration

Cooperating agencies are agencies with special expertise or authorities that can assist Reclamation in the EIS process. Cooperating agencies met to discuss methodology, scoping concerns, and development of alternatives. Informal consultation under the Endangered Species Act was conducted between Reclamation and the Fish and Wildlife Service. Alternative flow regimes were reviewed with the Service to develop operation plans to provide peak and base flows.

5.4 Distribution List

This EIS has been made available on the internet. In addition, copies have been provided to the following agencies, groups, and individuals.

Federal Agencies
Advisory Council on Historic Preservation
Department of Agriculture
Forest Service
Natural Resources Conservation Service
Department of Army
Corps of Engineers
Department of Energy
Western Area Power Administration
Department of the Interior
Bureau of Indian Affairs
Bureau of Land Management
National Park Service
Fish and Wildlife Service
U.S. Geological Survey
Department of Commerce
National Oceanic and Atmospheric Agency
National Weather Service
Environmental Protection Agency
Department of Justice

U.S. Congressional Delegation
Representative John Salazar, 3rd District
Senator Wayne Allard
Senator Ken Salazar

American Indian Tribal/National Governments
Ute Mountain Ute Tribe
Southern Ute Tribe

State Legislators
Joshua Penry, Colorado State Senator, District 7
Gail Schwartz, Colorado State Senator, District 5
Jim Isgar, Colorado State Senator, District 6
Steve King, Colorado State Representative, District 54
Laura Bradford, Colorado State Representative, District 55
Raymond Rose, Colorado State Representative, District 58
Kathleen E. Curry, Colorado State Representative, District 61

State Agencies
Governor
Colorado Department of Natural Resources, Denver
Colorado Water Conservation Board, Denver
Colorado Division of Wildlife, Denver, Montrose, Gunnison, Grand Junction
Colorado State Engineer, Denver, Montrose
Colorado State Parks
Colorado State Historic Preservation Officer

Local Agencies
County Commissioners-Gunnison, Montrose, Delta, Mesa
City of Gunnison
City of Montrose
City of Delta
City of Ridgway
City of Olathe
City of Ouray
City of Grand Junction

Irrigation Districts and Water Users and Power Organizations
Colorado River Water Conservation District, Glenwood Springs
Upper Gunnison Water Conservancy District, Gunnison
Uncompahgre Valley Water Users, Montrose
Tri-County Water Users, Montrose
North Fork Water Conservancy District
Redlands Water and Power Company, Grand Junction
Dolores Water Conservancy District
Southwestern Water Conservation District
Upper Colorado River Commission
Palmer Divide Water Group
Colorado River Energy Distributors Association, AZ
Platte River Power Authority
Excel Energy

Libraries
Gunnison County
Western State
Montrose County
Delta County
Mesa County

Media
Gunnison Country Times
Montrose Daily Press
Crested Butte
Delta County Independent

Grand Junction Daily Sentinel
Grand Junction Free Press
Denver Post
Rocky Mountain News

Interested Organizations
Western Resource Advocates
Nature Conservancy
High Country Citizens Alliance/Sierra Club
Living Rivers
Colorado Trout Unlimited
Trout Unlimited, Grand Junction, Montrose, Gunnison
Black Canyon Audubon
Center for Native Ecosystems
Interested Individuals
Club 20
Environmental Defense Fund
Gunnison Basin Power
Western Colorado Congress
Ridgway Guide Service
Black Canyon Anglers
Gunnison River Expeditions
Colorado River Recovery Program

Interested Individuals
Curt Treichel
Lynn Johnson,
George Sheldon
Bo Gates
Marlene Zanatell
Jim Cochran
Jim Hokit

5.5 List of Preparers

Jane Blair
Hydropower Economics, Operation and Maintenance
28 years experience

Dan Crabtree
Water Management Engineering, Water Resources
30 years experience

David Harpman
Socioeconomics
30 years experience

Erik Knight
Hydrology
10 years experience

Paul Davidson
Hydrology
20 years experience

S. Clayton Palmer
Economics, Power System Models, Statistical Analysis
23 years experience

Alan Schroeder,
Recreation
35 years experience

Tom Strain
Geology and Soils
27 years experience

Coll Stanton
Hydrology
34 years experience

Terry Stroh
Document Format, Environmental Justice, ITA, Other Resources
20 years experience

Ed Warner
Water Operations, Facilities, and Resources
28 years experience

Steve McCall
NEPA, Aquatics, Wildlife, Special Status Species
35 years experience

Bibliography

Anderson, R.M. 1994. Endangered fishes progress report. Federal Aid Project SE-319. Colorado Division of Wildlife, Ft. Collins, Colorado.

Anderson, R.M. 1999. Aspinall studies: annual assessment of Colorado pikeminnow larval production in the Gunnison and Colorado rivers, Colorado 1992-1996. Final Report to the Recovery Program for the Endangered Fishes of the Upper Colorado River, Project Number 43-B. Colorado Division of Wildlife, Grand Junction, Colorado.

Army Corps of Engineers. 1988. Blue Mesa Dam and Reservoir Water Control Manual.

Auble, G.T., J. Friedman, and M. Scott. 1991. Riparian vegetation of the Black Canyon of the Gunnison River, Colorado: composition and response to selected hydrologic regimes based on a direct gradient assessment model. Prepared by U.S. Fish and Wildlife Service for NPS. Ft. Collins, Colorado.

Beason, J. 2008. RMBO finds yellow-billed cuckoos in Western Colorado. Rocky Mountain Bird Observatory Newsletter. Oct. 2008. Brighton, Colorado.

Berrens, R. F., P. Ganderton and C.l L. Silva. 1996. Valuing the Protection of Minimum Instream Flows in New Mexico. *Journal of Agricultural and Resource Economics* 21 No. 2 (1996):294-309.

Booz Allen Hamilton. 2004. Lower Gunnison River Economic Evaluation Study—Final Report. Booze Allen Hamilton, Greenwood Village, Colorado. Product for the U.S. Bureau of Reclamation, Economics Group 86-68270, Denver, Colorado.

Boyer, J.M., and A. Cutler, Reclamation. 2004. Gunnison River / Aspinall Unit Temperature Study – Phase II. Final Report. Bureau of Reclamation, Salt Lake City, Utah.

Brunswig, R.H. 2006. Final report on the 2006 Ponderosa Campground prescribed burn survey, Curecanti National Recreation Area, Gunnison County, Colorado. University of Northern Colorado, Greeley.

Buckhorn Geotech. 1999. Needs Assessment for Floodplain Map Revision, Delta County Colorado.

Burdick, B.D. 1995. Ichthyofaunal studies of the Gunnison River, Colorado, 1992-1994. Recovery Implementation Program Endangered Fishes in the Upper Colorado River Basin. Grand Junction, Colorado.

_____. 2001. Five-year evaluation of fish passage at the Redlands Diversion Dam on the Gunnison River near Grand Junction, Colorado: 1996-2000. Final Report prepared for the Recovery Implementation Program, Project CAP-4b. U.S. Fish and Wildlife Service, Grand Junction, Colorado.

Burdick, B.D. 2005. Evaluation of the Effectiveness of the Fish Passage Structure at Redlands Dam. Annual Report prepared for the Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River Basin, Recovery Project Number C-4b. U.S. Fish and Wildlife Service, Colorado River Fishery Project, Grand Junction, Colorado.

Bureau of Land Management. 2003. Draft Resource Management Plan and Environmental Impact Statement: Gunnison Gorge National Conservation Area. Bureau of Land Management, Montrose, Colorado.

_____. 2004. Approved Resource Management Plan and Record of Decision: Gunnison Gorge National Conservation Area, Bureau of Land Management, Montrose, Colorado.

Bureau of Reclamation. 2001. Preliminary Analysis: Wayne N. Aspinall Unit Operations and the Draft Endangered Fish Flow Recommendations for the Gunnison and Colorado Rivers. Bureau of Reclamation, Western Colorado Area Office, Grand Junction, Colorado.

_____. 2003. Navajo Reservoir Operations: Final Environmental Impact Statement, Bureau of Reclamation, Grand Junction, Colorado.

_____. 2004. Scoping Report-Aspinall Unit Operations EIS. Western Colorado Area Office, Grand Junction, Colorado.

_____. 2005. Blue Mesa Reservoir Economic and Recreation Study, Data Collection and Survey Analysis: Final Report, Bureau of Reclamation, Technical Service Center, Economics Group, Denver, Colorado.

_____. 2006a. Physical evaluation of floodplain habitats restored/enhanced to benefit endangered fishes of the upper Colorado River basin. Annual Project Report C-6HYD. Colorado River Recovery Program.

_____. 2006b. Evaluation of Selenium Remediation Concepts for the Lower Gunnison and Lower Uncompahgre Rivers, Colorado. Prepared by the NIWQP and Reclamation's Technical Assistance to States Program in Conjunction with the Gunnison Basin Task Force, Grand Junction, Colorado.

Butler, David L. 2000. Evaluation of Water-Quality Data, Lower Gunnison River Basin and Colorado River Downstream from the Aspinall Unit, Colorado. U.S. Geological Survey Administrative Report prepared for the Bureau of Reclamation. Denver, Colorado

_____. 2007. Final Environmental Impact Statement-Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead. Volume III pp.R-45-R-48. Salt Lake City, Utah.

Chamberlain, T.K. 1946. Fishes, particularly the suckers, Catostomidae, of the Colorado River drainage and of the Arkansas River drainage, in relation to the Gunnison-Arkansas transmountain diversion. U.S. Fish and Wildlife Service, College Station, Texas.

Colorado Department of Public Health and Environment. 2007. Colorado Air Quality Control Commission Report to the Public, 2006-2007. Prepared by the Air Pollution Division of the Colorado Department of Public Health and Environment. Denver, Colorado.

Duffield, J. C. Neher, and D. Patterson. 2007. Economic Values of National Park System Resources Within the Colorado River Watershed: Phase II. Final Report to the National Park Service. Cooperative Agreement H1200010001 Task J2380050112. Department of Mathematical Sciences, University of Montana, Missoula, Montana.

Dexter, C. 1998. River survey of west-central Colorado, for yellow-billed cuckoo and riparian weeds. Report prepared for the Bureau of Land Management. Cited in Fish and Wildlife Service (2005).

Duffield, J., C. Neher and D. Patterson. 2006. Economic Values of National Park System Resources Within the Colorado River Watershed: Phase II. Draft Report to the National Park Service. Cooperative agreement H1200040001 task J2380050112. Department of Mathematical Sciences, University of Montana. Missoula, Montana.

Ekstrand, E.R. and J.B. Loomis. 1998 Incorporating Respondent Uncertainty When Estimating Willingness to Pay for Protecting Critical Habitat for Threatened and Endangered Fish. Water Resources Research. 34 No. 11 (November 1998):3149-3155.

Elliott, J.G. and R.S. Parker. 1997. Altered streamflow and sediment entrainment in the Gunnison Gorge. Journal of the American Water Resource Association. Volume 33, Issue 5, pp 1041-1054. U.S. Geological Survey, Denver, Colorado.

Elliott, J.G. and L. Hammack. 1999. Geomorphic and sedimentologic characteristics of alluvial reaches in the Black Canyon of the Gunnison National Monument, Colorado. Prepared by U.S. Geological Survey in cooperation with the NPS. Denver, Colorado.

Elliot, J.G., D. Murphy, and K. Tucker. 1994. Resource management considerations in a changing physical environment: the Gunnison Gorge, Colorado.

Fish and Wildlife Service. 1979. Dallas Creek Project Biological Opinion. Salt Lake City, Utah.

_____. 1980. Dolores Project Biological Opinion. Salt Lake City, Utah.

_____. 1999. Upper Gunnison Subordination Biological Opinion. Grand Junction, Colorado.

_____. 2000. Section 7 Consultation, sufficient progress, and historic projects agreement and Recovery Action Plan, Recovery Implementation Program for the endangered fish species in the Upper Colorado River Basin (revised from 1993). Denver, Colorado.

_____. 2002. Bonytail (*Gila elegans*) Recovery Goals: amendment and supplement to the Bonytail Chub Recovery Plan. Mountain-Prairie Region (6), Denver, Colorado.

_____. 2004. Final biological opinion for the Redlands Water and Power Company's Canal Fish Screen, Mesa County, Colorado. Region 6, Denver, Colorado.

_____. 2005. Species assessment and listing priority assignment for Yellow-billed cuckoo. Region 1, Sacramento, California.

_____. 2008. News Release: Gunnison's prairie dog populations in portions of Colorado and New Mexico warranted for listing under the Endangered Species Act. February 1, 2008. Lakewood, Colorado.

Hamilton, S.J. 1999. Hypothesis of historical effects from selenium on endangered fish in the Colorado River Basin. In: Human and Ecological Risk Assessment: Vol. 5, No.6, pp. 1153-1180. U.S. Geological Survey, Yankton, South Dakota.

Harpman, D.A., E.W. Sparling, and T. J. Waddle. 1993. A Methodology for Quantifying and Valuing the Effects of Flow Changes on a Fishery, Water Resources Research 29 No. 3 (March 1993):575-582.

Harpman, D.A. 1990. The Value of Instream Flow Used to Produce a Recreational Fishery. Department of Agricultural and Resource Economics, Colorado State University. Ft. Collins, Colorado. Unpublished Dissertation.

High Country Citizen's Alliance. 2003. Gunnison Basin Water Blueprint. Crested Butte, Colorado.

Holden, P.B. 1991. Ghosts of the Green River: Impacts of Green River Poisoning on Management of Native Fishes. Chapter 3 in, Battle Against Extinction: Native Fish Management in the American West. Edited by William L. Minkley and James E. Deacon. University of Arizona Press, Tucson, Arizona.

Holden, P.B. and C.L. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the middle and upper Colorado River Basins, 1967-1973. Transactions of the American Fisheries Society 104:217-231.

Holden, P.B., C. Richard, L. Crist, and J. Campbell. 1981. Aquatic biology studies for proposed Colorado-Ute Electrical Association powerplant near Grand Junction, Colorado. BIOWEST, Inc., Logan, Utah. PR56-1. 66pp.

Irving, D. and B. D. Burdick. 1995. Reconnaissance inventory and prioritization of existing and potential bottomlands in the upper Colorado River basin, 1993-1994. Final Report to the Recovery Program for the Endangered Fishes of the Upper Colorado River. U.S. Fish and Wildlife Service, Vernal, Utah and Grand Junction, Colorado.

Johnson, D.M. 1989. The Economic Benefits of Alternative Fishing Management Programs. Department of Agricultural and Resource Economics, Colorado State University. Ft. Collins, Colorado. Unpublished Dissertation.

Johnson, D.M., R.J. Behnke, D.A. Harpman, and R.G. Walsh. 1995. The Economic Benefits and Costs of Stocking Catchable Rainbow Trout: A Synthesis of Three Studies. North American Journal of Fisheries Management, 15(1): 26-32.

Johnson, D.M. and R.G. Walsh. 1987. Economic benefits and costs of the fish stocking program at Blue Mesa Reservoir, Colorado. Colorado Water Resources Research Institute, Colorado State University, Ft. Collins, Colorado.

Johnson, B.M. and M.L. Koski. 2005. Reservoir and food web dynamics at Blue Mesa Reservoir, Colorado, 1993-2002. Colorado State University Fisheries Ecology Laboratory, prepared for Bureau of Reclamation. Denver, Colorado.

Jordan, D.S. 1891. Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. U.S. Fish Comm. Bull. 9(1889):1-40.

Kaval, P. 2007. Recreation Benefits of U.S. Parks. Working Paper in Economics 12/07. Economics Department. University of Waikato. Hamilton, New Zealand. June 2007. Available from http://ideas.repec.org/p/wai/econwp/07-12.html. Accessed on 7 August 2008.

Kaval, P. and J.B. Loomis. 2003. Updated Outdoor Recreation Use Values with Emphasis on National Park Recreation. Final Report to the National Park Service. Project number IMDE-02-0070. Department of Agricultural and Natural Resource Economics, Colorado State University.

Kidd, G. 1977. An investigation of endangered and threatened fish species in the upper Colorado River as related to Bureau of Reclamation projects. Final Report. Northwest Fisheries Research, Clifton, Colorado.

King, D.M. and M. Mazzotta. 2007. Ecosystem Valuation. An online resource funded by several federal government agencies and maintained by the University of Maryland. http://www.ecosystemvaluation.org . Accessed on October 17, 2007.

Kingery, H.E. (ed). 1998. Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado.

Korte, N.E. 2000. Selenium poisoning of wildlife and western agriculture: cause and effect. Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, Tennessee.

Kowalski, D. 2005. Fish Sampling report-Gunnison River #3. Unpublished data. Colorado Division of Wildlife, Montrose, Colorado.

Kowalski, D. 2008. The effects of stream flow on the trout populations of the Gunnison River. Powerpoint presentation. Colorado Division of Wildlife, Montrose, Colorado.

Kroeger, T. and P. Manalo. 2006. A Review of the Economic Benefits of Species and Habitat Conservation. Conservation Economics Working Paper No. 4. Report prepared for the Doris Duke Charitable Foundation. Conservation Economics Program, Defenders of Wildlife.

Lamarra, V. 1999. Longitudinal variation in the trophic structure of the Upper Colorado River. Final Report to the Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River, Project Number 48-Report B. Ecosystems Research Institute, Inc. Logan, Utah.

Land and Water Fund of the Rockies. 2003. Gunnison Basin Water: No Panacea for the Front Range. Boulder, Colorado: The Land and Water Fund of the Rockies. 74 pages.

Loomis, J.B. 1996. Measuring the Economic Benefit of Removing Dams and Restoring the Elwha River: Results of a Contingent Valuation Survey. Water Resources Research, Vol. 32 No. 2 (February 1996):441-447.

Loomis, J.B. 2005. Updated Outdoor Recreation Use Values on National Forests and Other Public lands. General Technical Report PNW-GTR-658. Portland, OR: USDA, Forest Service, Pacific Northwest Research Station. http://www.fs.fed.us/pnw/pubs/pnw_gtr658.pdf

Loomis, J.B. and D.S. White. 1996a. Economic Benefits of Rare and Endangered Species: Summary and Meta-Analysis." *Ecological Economics* Vol 18 No. 3 (September 1996a):197-206.

_____. 1996b Economic Values of Increasingly Rare and Endangered Fish. Fisheries Vol. 21 No. 11 (November 1996b):6-10.

Lichvar, R. 1987. Riparian vegetation reconnaissance of the Black Canyon of the Gunnison. Mariah Associates. Laramie, Wyoming.

Lyons, S. 2001. Black Canyon of the Gunnison Explorer's Guide. Freewheel Publications, Paonia, Colorado.

Lyon, P., T. Stephens, J. Siemers, D.Culver, P. Pineda, and J. Zoerner. 1999. The Uncompahgre River Basin-a natural heritage assessment. Prepared for Valley Land Conservancy by Colorado Natural Heritage Program. Ft. Collins, Colorado.

Lyon, P. and E. Williams. 1998. Natural Heritage biological survey of Delta County, Colorado. Colorado Natural Heritage Program, Ft. Collins, Colorado.

McAda, C.W. 2003. Flow Recommendations to Benefit Endangered Fishes in the Colorado and Gunnison Rivers. Fish and Wildlife Service, Grand Junction, Colorado.
McAda, C.W. and B.D. Burdick. 2006. Evaluation of stocked razorback sucker and Colorado pikeminnow in the Gunnison River. Annual report to the Colorado Endangered Fish Recovery Program.

_____. 2007. Evaluation of stocked razorback sucker and Colorado pikeminnow in the Gunnison River. Annual report to the Colorado Endangered Fish Recovery Program.

McAda, C.W. and K. Fenton. 1998. Relationship of Fish Habitat to River Flow in the Gunnison River. Final Report to Upper Colorado River Endangered Fish Recovery Program. U.S. Fish and Wildlife Service, Grand Junction, Colorado.

McKean, J. R., D.M. Johnson and R.G. Walsh. 1988. Gunnison County Interindustry Spending and Employment Attributed to Fishing Visits at Blue Mesa Reservoir. Colorado Water Resources Research Institute, General Technical Report No. 53, 1988.

McKean, J.R., D.M. Johnson and R.G. Walsh. 1995. Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation, Land Economics, 7(1): 96-105.

McKean, J. R., R.G. Walsh and D. M. Johnson. 1991. Valuing Time in Travel Cost Demand Analysis By Visitors to Blue Mesa Reservoir. Colorado Water Resources Research Institute, General Technical Report No. 58.

Minckley. 1991. Native fishes of the Grand Canyon region: an obituary? In: Colorado River Ecology and Dam Management, pp. 124-177. National Academy Press, Washington D.C.

Minnesota IMPLAN Group, Inc. 2007. IMPLAN System (data and software), 1725 Tower Drive West, Suite 140, Stillwater, MN 55082. www.implan.com . Last accessed on 11 January 2007.

Modde, T., K.P. Burnham and E.J. Wick. 1996. Population status of the razorback sucker in the middle Green River. Conservation Biology 10:119-119.

Moeller, K.L., L.M. Malinowski, J.F. Hoffecker, D.A. Walitxchek, L. Shogren, J.E. Mathews, and B.T. Verhaaren. 1993. Class I overview of cultural resources for the Western Area Power Administration Salt Lake City area integrated projects electric power marketing environmental impact statement. Argonne National Laboratory, Argonne, Illinois.

Mueller, G. and S. Hiebert. 1997. Assessment of kokanee salmon transport through Blue Mesa Powerplant, Colorado during the spring and summer of 1994-1996. Technical Memorandum No. 8220-97-2. Bureau of Reclamation, Technical Services Center, Denver, Colorado.

Munger, D. M. and R. Vinton. 2005Blue Mesa Reservoir Economic and Recreation Study: Data Collection and Survey Analysis. Final Report. Economics Group, U.S. Bureau of Reclamation, Denver, Colorado.

Muth, R. T., G. B. Haines, S. M. Meismer, E. J. Wick, T. E. Chart, D. E. Snyder, and J. M. Bundy. 1998. Reproduction and early life history of razorback sucker in the Green River Utah and Colorado, 1992-1996. Final Report to the Recovery Program for the Endangered Fishes of the Upper Colorado River, Project Number 34, Larval Fish Laboratory, Colorado State University, Ft. Collins, Colorado.

Muth, R.T., L.W. Crist, K.E. LaGory, J.W. Hayse, K.R. Bestgen, T.P. Ryan, J.K. Lyons, and R.A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Upper Colorado River Endangered Fish Recovery Program Project FG-53, Denver, Colorado.

National Research Council. 2004. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. National Research Council, Committee on Assessing and Valuing the Services of Aquatic and Related Terrestrial Ecosystems. Washington, D.C: National Academy Press, 290 pages. ISBN: 0-309-54586-2, http://www.nap.edu/catalog/11139.html

National Park Service. 1979. Assessment of Alternatives for General Management Plan: Curecanti National Recreation Area. NPS, Montrose, Colorado.

_____. 2001. Environmental assessment for snowmobile rulemaking in Curecanti National Recreation Area. Gunnison, Colorado.

_____. 2005. Draft resource protection study environmetal impact statement. Multi-agency review version. Curecanti National Recreation Area. Gunnison, Colorado.

_____. 2007. Draft Resource Protection Study / Environmental Impact Statement-Curecanti National Recreational Area, Gunnison and Montrose Counties, Colorado. Montrose, Colorado.

_____. 2008. Curecanti National Recreation Area. Park Visitation Report. http://www2.nature.nps.gov/NPstats/dspPark.cfm . Accessed on 25 February 2008.

Nehring, R.B. 1988. Fish Flow Investigations. Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration, F-51-R, Progress Report, Ft. Collins, Colorado.

Nehring, R. B and R. Anderson. 1985. Fish Flow Investigations. Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration, F-51-R, Job No. 1, Progress Report, Ft. Collins, Colorado.

Nehring, R. B. and D. D. Miller. 1987. The influence of spring discharge levels on rainbow trout and brown trout recruitment and survival, Black Canyon of the Gunnison River, Colorado, as determined by IFIM/PHABSIM models. Proceedings of the Western association of Fish and Wildlife Agencies and the Western Division of the American Fisheries Society.

Nehring, R. B., K.G. Thompson, J. Padia and B. Neuschwanger. 2000. Whirling disease investigations. Colorado Division of Wildlife Job Progress Report. Federal Aid Project F237-R7. Fort Collins, Colorado.

Natural Resource Conservation Service. 1979. 1979 Important Farmland Map of Delta, County, CO. US Department of Agriculture, Natural Resource Conservation Service.

Osmundson, D.B. 1999. Longitudinal variation in fish community structure and water temperature in the Upper Colorado River: implications for Colorado Pikeminnow habitat suitability. Final Report to the Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River, Project Number 48. Fish and Wildlife Service, Grand Junction, Colorado.

Osmundson, D.B. and K.P. Burnham. 1998. Status and trends of the endangered Colorado squawfish in the Upper Colorado River. Transactions of the American Fisheries Society 127:957-970.

Osmundson, D.B. and L.R. Kaeding. 1989. Studies of Colorado squawfish and razorback sucker use of the “15-mile reach” of the upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir water sales. Final Report. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, Colorado. 85 pp

Osmundson, D.B. and L.R. Kaeding. 1991. Recommendations for flows in the 15-mile reach during October-June for maintenance and enhancement of endangered fish populations in the Upper Colorado River. Final report to the Final report to the Upper Colorado Endangered Fish Recovery Program. U.S. Fish and Wildlife Service, Grand Junction, Colorado.

Osmundson, D.B. and C. McAda. 2006. Verification of stocked razorback sucker reproduction in the Gunnison and Upper Colorado rivers via annual collection of larvae. Annual report to the Final report to the Upper Colorado Endangered Fish Recovery Program. U.S. Fish and Wildlife Service, Grand Junction, Colorado.

_____. 2007. Verification of stocked razorback sucker reproduction in the Gunnison and Upper Colorado rivers via annual collection of larvae. Annual report to the Final report to the Upper Colorado Endangered Fish Recovery Program. U.S. Fish and Wildlife Service, Grand Junction, Colorado.

Osmundson, D.B., R.J. Ryel, V.L. Lamarra, and J. Pitlick. 2002. Flow-sediment-biota relations: implications for river regulation effects on native fish abundance. Ecological Applications 12(6), pp. 1719-1739.

Pennington, M. 2005. A Contingent Valuation Study of White Water Boater's Willingness to Pay for Varying Levels of Instream Flow. Department of Applied and Resource Economics, University of Nevada. Reno, Nevada. Unpublished Thesis. 2005.

Pipeline and Hazardous Materials Safety Administration. 2008. Website: Http://www.npms.phsa.dot/gov, accessed on July 22, 2008. National Pipeline Mapping System, Pipeline Integrity Management Mapping Application, United States Department of Transportation.

Piper, S. 2007. The Economic Benefits of Recreation at Blue Mesa Reservoir—An Application of the Travel Cost Model. Draft Report. Economics Group, U.S. Bureau of Reclamation, Denver, Colorado.

_____. 2008. The Economic Benefits of Recreation at Blue Mesa Reservoir. Invited Paper. The 47th Annual Meeting of the Western Regional Science Association. February 17-20, 2008. Hilo, Hawaii.

Pitlick, J. 2007. Channel monitoring to evaluate geomorphic changes on the main stem of the Colorado River. Final report to the Final report to the Upper Colorado Endangered Fish Recovery Program. University of Colorado, Boulder.

Pitlick, J. and R. Cress. 2000. Longitudinal trends in channel characteristics of the upper Colorado River and implications for food-web dynamics. Final Report to the Recovery Program for the Endangered Fishes of the Upper Colorado River, Project Number 48. Department of Geography, University of Colorado, Boulder, Colorado.

Pitlick, J., M. Van Steeter, B. Barkett, R. Cress, and M. Franseen. 1999. Geomorphology and hydrology of the Colorado and Gunnison Rivers and implications for habitats used by endangered fishes. Final Report to the Recovery Program for the Endangered Fishes of the Upper Colorado River, Project Number 44. Department of Geography, University of Colorado, Boulder, Colorado.

Quartarone, F. 1993. Historical accounts of upper basin endangered fish. Colorado Division of Wildlife. Denver, Colorado. 66pp.

Quartarone, F. 1995. Historical Accounts of Upper Colorado River Basin Endangered Fish. Report produced for the Information and Education Committee of the Recovery Program for Endangered Fish of the Upper Colorado River Basin. S60 pages.

Ray, A.J., J. Barsugli, and K Avery. 2008.Climate Change in Colorado. Prepared for Colorado Water Conservation Board by Western Water Assessment. Boulder, Colorado.

Recovery Program. 2008. Upper Colorado River Endangered Fish Recovery Program/San Juan River Basin Recovery Implementation Program-program highlights. Denver Colorado.

Reed, A.D. and M.D. Metcalf. 1999. Colorado Prehistory; A Context for the Northern Colorado River Basin. Colorado Council of Professional Archaeologists, Denver, Colorado.

RHN Water Resources Consultants. 2005. Uncompahgre Project Water Management Plan. Montrose, Colorado.

Righter, R., R. Levad, C. Dexter, and K. Potter. 2004. Birds of western Colorado Plateau and Mesa Country. Grand Valley Audubon Society. Grand Junction, Colorado.

Rocchio, J., G. Doyle, and R. Rondeau. 2004. Survey of critical wetlands and riparian areas in Gunnison County. Colorado Natural Heritage Program. Ft. Collins, Colorado.

Sanders, L.D., R.G. Walsh and J.B. Loomis. 1990. Toward Empirical Estimation of the Total Value of Protecting Rivers. *Water Resources Research* 26 No. 7. (July 1990):1345-1357.

Seglund, Amy, E.A. Ernst, and C.O. O'Neill. 2005. Gunnison's prairie dog conservation assessment. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming.

Soil Conservation Service. 1962. Water and Related Land Resources, Gunnison River Basin-Colorado. A Report Based on a Cooperative Study by Colorado Water Conservation Board and United States Department of Agriculture. Economic Research Service-Forest Service-Soil Conservation Service.

Spahr, N.E. 2003. Comparison of 2002 Water Year and Historical Water-Quality Data, Upper Gunnison River Basin, Colorado. U.S. Geological Survey

Stanford, J. and J. Ward. 1983. The effects of mainstream dams on physicochemistry of the Gunnison River, Colorado. Proceedings of the 1981 symposium on the aquatic resources management of the Colorado River ecosystem. Edited by V. Adams and V. Lamarra. Ann Arbor Science Publishers, Ann Arbor, Michigan.

Tyus, H.M. and J.F. Saunders III. 2001. An evaluation of the role of tributary streams for recovery of endangered fishes in the Upper Colorado River Basin, with recommendations for future recovery actions. Upper Colorado Endangered Fish Recovery Program, Project no. 101. University of Colorado, Boulder, Colorado.

United States Department of Agriculture, National Agricultural Statistics Service. 2008. Http://www.nass.usda.gov/Statistics_by_State/Colorado/index.asp. Last accessed August 1, 2008.

Upper Gunnison River Water Conservancy District. 2006. Water Management Plan. Gunnison, Colorado.

U.S. Census Bureau. 2008. Website: Http://www.census.gov/

USGS 2002. Limnology of Blue Mesa, Morrow Point, and Crystal Reservoirs, Curecanti National Recreation Area, during 1999, and a 25-Year Retrospective of Nutrient Conditions in Blue Mesa Reservoir, Colorado. USGS Water Investigations Report 02-4199.

USGS 2004. Geology of Gunnison Gorge National Conservation Area, Delta and Montrose Counties, Colorado. USGS Fact Sheet 2004-3050, prepared in cooperation with Bureau of Land Management.

Valdez, R.A. and G.C. Clemmer. 1982. Life history and prospects for recovery of the humpback and bonytail chub. Pages 109-119 *in* W.H. Miller, H.M. Tyus, and C.A. Carlson, eds. Fishes of the upper Colorado River system: Present and future. Western Division, American Fisheries Society, Bethesda, Maryland.

Valdez, R.A., P. Mangan, R. Smith, and B. Nelson. 1982. Upper Colorado River investigations (Rifle, Colorado to Lake Powell, Utah). Pages 101-279 *in* W.H. Miller et al., editors. Colorado River Fishery Project Final Report; Part Two, Field Studies. U.S. Fish and Wildlife Service and Bureau of Reclamation, Salt Lake City, Utah.

Valdez, R.A. and P. Nelson. 2006. Upper Colorado River Subbasin Floodplain Management Plan. Upper Colorado Endangered Fish Recovery Program, Lakewood.

Vaske, Jerry J., Maureen P. Donnelly and Michelle Lyon. 1995. Knowledge, Beliefs and Attitudes Toward Endangered Fish of the Upper Colorado River Basin. Project Report to the U.S. Fish and Wildlife Service. HDNRU Report No 20. Human Dimensions in Natural Resources Unit. College of Natural Resources. Colorado State University, Colorado.

Walsh, R.G. and D.M. Johnson. 1987. Economic Benefits and Costs of the Fish Stocking Program at Blue Mesa Reservoir, Colorado. Colorado Water Resources Research Institute, General Technical Report No. 49.

Ward, F.A. and J.F. Booker. Economic Costs and Benefits of Instream Flow Protection for Endangered Species in an International Basin. Journal of the American Water Resources Association 39 No. 2 (April 2003):427-440.

Water and Power Resources Service. 1981. Project Data, Water and Power Resources Service, Engineering and Resource Center, Denver, CO. (WPRS, 1981)

Welsh, M.P., R.C. Bishop, M.L. Phillips, and R.M. Baumgartner. 1995. Glen Canyon Dam, Colorado River Storage Project, Arizona—Nonuse Value Study Final Report. Madison, Wisconsin: Hagler Bailly Consulting, Inc., pp. 400. Springfield, Virginia: National Technical Information Service, NTIS No. PB98-105406.

Wick, E.J., J.A. Hawkins, and C.A. Carlson. 1985. Colorado squawfish and humpback chub population and habitat monitoring, 1981-1982. Final Report. Endangered Wildlife Investigations SE-3-6. Colorado Division of Wildlife, Denver, Colorado.

Wiltzius. 1978. Some Factors Historically Affecting the Distribution and Abundance of Fishes in the Gunnison River: Final Report for Fishery Investigations of the Lower Gunnison River Drainage. Colorado Division of Wildlife, Fort Collins, Colorado.