RECLAMATION
Managing Water in the West

Draft Environmental Assessment

City of Aurora
Proposed Excess Capacity Contracts

Pueblo Dam and Reservoir
Fryingpan-Arkansas Project
Pueblo, Colorado

U.S. Department of the Interior
Bureau of Reclamation
Great Plains Region

September 2006

Acronyms

ac-ft	acre-feet
AHRA	Arkansas Headwaters Recreation Area
APE	Area of Potential Effect
bgs	below ground surface
BWWP	Board of Water Works of Pueblo
CDNR	Colorado Department of Natural Resources
CDPOR	Colorado Division of Parks and Outdoor Recreation
CDPHE	Colorado Department of Public Health and Environment
CDOW	Colorado Department of Wildlife
CDWR	Colorado Division of Water Resources
cfs	cubic feet per second
CNHP	Colorado Natural Heritage Program
CWCB	Colorado Water Conservation Board
EA	Environmental Assessment
ESA	Endangered Species Act
EIS	Environmental Impact Statement
FONSI	Finding of No Significant Impact
Fry-Ark Project	Fryingpan -Arkansas Project
FWS	U.S. Fish and Wildlife Service
gpm	gallons per minute
IGA	Intergovernmental Agreement
IHA	Indicators of Hydrologic Alteration
M&I	Municipal and Industrial
MCL	Maximum contaminant level
mgd	million gallons per day
NEPA	National Environmental Policy Act
NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
NRHP	National Register of Historic Places
OAHP	Office of Archeology and Historic Preservation
PFMP	Pueblo Flow Management Program
Reclamation	U.S. Bureau of Reclamation
RICD	Recreational In-Channel Diversion
ROY	Restoration of Yield
SECWCD	Southeastern Colorado Water Conservancy District
SWA	State Wildlife Area
UAVFMP	Upper Arkansas Voluntary Flow Management Program
USGS	United States Geological Survey
WQS	Water Quality Standard
WWSP	Winter Water Storage Program

CONTENTS

TABLES

FIGURES

Chapter 1 Purpose and Need for Action

1.1 INTRODUCTION

The U.S. Bureau of Reclamation (Reclamation) is considering a request from the City of Aurora, Colorado, acting by and through its Utility Enterprise, for long-term municipal and industrial excess capacity contracts. The proposed excess capacity contracts include two components:

1) A contract that would allow Aurora to use up to 10,000 ac-ft of available excess storage space in Pueblo Reservoir, which would provide flexibility in efficiently managing Aurora's water supply and facilitate Aurora's exchange of its Arkansas River water rights to upstream points; and
2) A contract that would allow for the annual exchange of up to 10,000 ac-ft of Aurora's water stored in Pueblo Reservoir with Fryingpan-Arkansas (Fry-Ark) Project water in Twin Lakes Reservoir or Turquoise Reservoir.

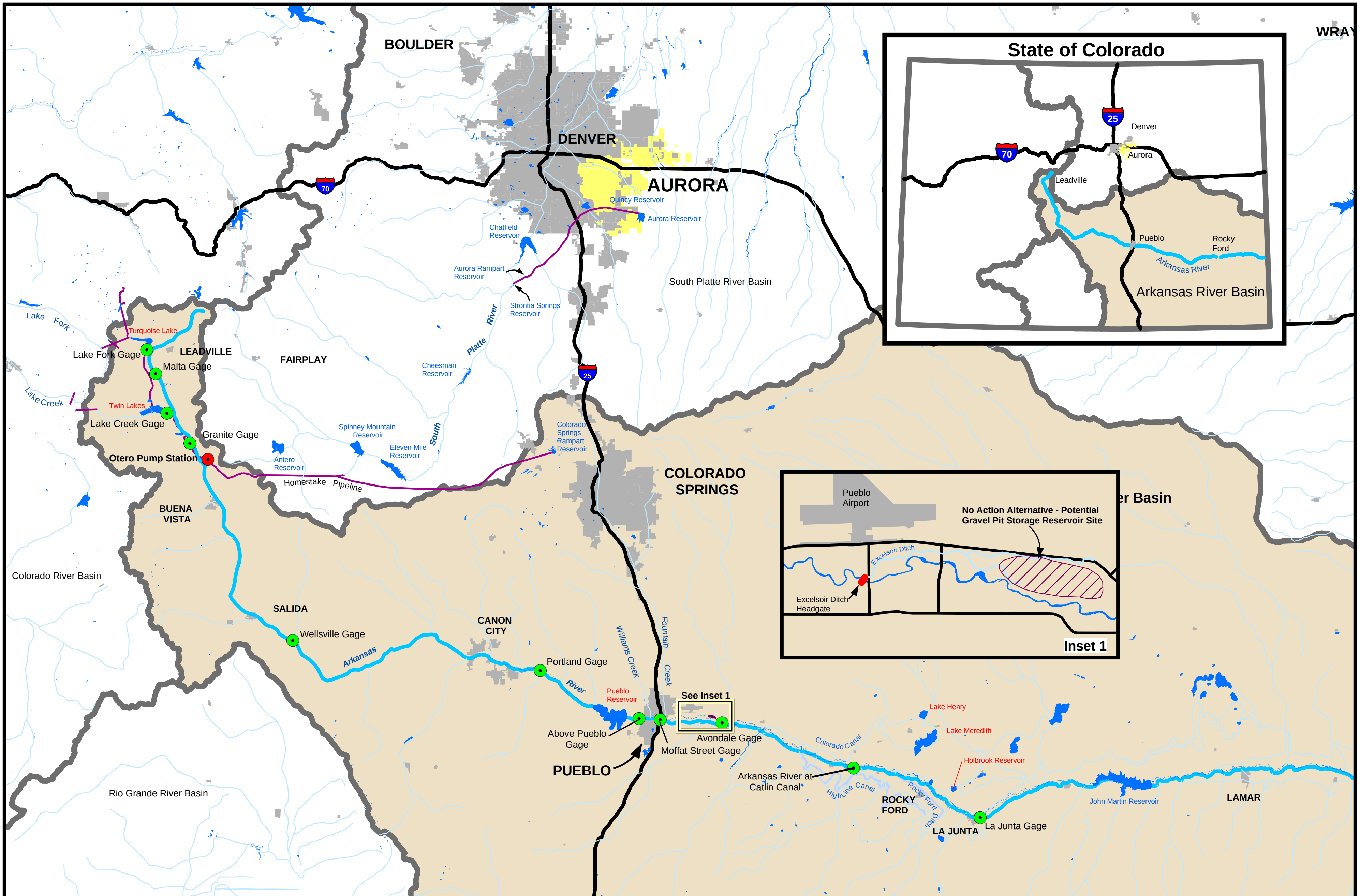
The proposed excess capacity contracts would use existing facilities to move Aurora's water from the Arkansas River basin to the South Platte River basin via pipelines and the Otero pump station north of Buena Vista.

An excess capacity contract is often referred to as an "if and when" contract — if and when space is available in Pueblo Reservoir, Aurora would be allowed to use this excess storage capacity for its Arkansas River water rights, subject to higher storage priorities by the Fry-Ark Project and other entities within the Arkansas River basin. An "if and when" exchange contract permits an entity to exchange non-Fry-Ark Project water stored in one reservoir for Fry-Ark Project water stored in another reservoir if and when Reclamation determines that conditions are appropriate for an exchange. Temporary (1-year) "if and when" storage contracts for a portion of Aurora's water have been executed on an annual basis with Reclamation since 1986. Temporary "if and when" exchange contracts have been executed annually since 1999. The proposed long-term storage and exchange contracts would allow similar storage and exchanges to occur for a term of 40 years.

The Fry-Ark Project is a Reclamation multipurpose transbasin project that delivers water from the West Slope of Colorado to the upper Arkansas River basin near Leadville for use in the Arkansas River basin. Water imported from the West Slope is conveyed to Turquoise Reservoir, and then typically conveyed through the Mt. Elbert conduit to Twin Lakes Reservoir. These facilities store Fry-Ark Project water in addition to other sources of water before it is released to the Arkansas River for delivery to Pueblo Reservoir where it is further distributed to Fry-Ark Project users (Figure 1-1). Since the Project first delivered water to the Arkansas River basin in 1975 it has delivered an average of about 55,000 ac-ft annually from the Colorado River basin to the Arkansas River basin for use by agricultural and municipal interests in the Arkansas River basin (CDSS 2004).

1.2 PROJECT PURPOSE AND NEED

The purpose of the proposed excess capacity contracts for use of storage space in Reclamation's Fry-Ark Project is to establish a long-term agreement that allows Aurora to more efficiently manage and use its decreed Arkansas River water rights and leased Arkansas River water. Currently, Aurora's water rights and lease water from the Arkansas River provide about 25 percent to 40 percent of its water supply (depending on hydrologic conditions in a particular year) and are needed to meet the City's existing and projected municipal and industrial water demands. Use of excess capacity in



Existing pipelines

Gaging stations

Otero pump station

River basin boundary

Arkansas River

0 12 24 Miles

N

ERO
ERO Resources Corp.
1842 Clarkson Street
Denver, CO 80218
(303) 830-1188
Fax: 830-1199

Figure 1-1
Project Area

Prepared for: US Bureau of Reclamation
File: 2538-gages_inset_change.mxd (ms)
September 13, 2005

the Fry-Ark Project does not require construction of a new reservoir or other physical facilities to accommodate storage, conveyance, and exchange of this water.

Aurora's water rights and leased water from the Arkansas River basin are expected to provide approximately 21,000 to 31,000 ac-ft of Aurora's water supply on an average annual basis depending on varying lease amounts as agreed to in the Intergovernmental Agreement (IGA) with Southeastern Water Conservancy District (SECWCD).[1] Aurora needs this water to meet existing demand, as well as to ensure a long-term reliable supply of water for drought years and projected future growth. Long-term excess capacity storage and exchange contracts with Reclamation would facilitate movement of the water from the Arkansas River basin to the South Platte River basin where it would be available for use by Aurora in the most efficient manner possible.

1.3 DECISION PROCESS

Aurora has requested up to 10,000 ac-ft of excess storage capacity in Pueblo Reservoir to temporarily store its Arkansas River water rights and leased water. Once water is stored in Pueblo Reservoir, it may be exchanged upstream to Twin Lakes Reservoir or Turquoise Reservoir. The water can then be released into the Otero Pipeline for delivery to the South Platte River basin. Aurora has also requested that Reclamation allow contract exchanges of up to 10,000 ac-ft annually of Aurora's water with Fry-Ark Project water in Twin Lakes Reservoir or Turquoise Reservoir.

Reclamation must decide whether to enter into a long-term (40-year) contract or contracts with Aurora to implement these storage and exchange agreements. Because this decision and the associated contracts require a federal action, the Project is subject to compliance with the National Environmental Policy Act (NEPA) of 1969, amendments, and other regulatory laws. This Environmental Assessment was prepared by Reclamation to analyze and disclose the potential effects associated with the Proposed Action, as well as No-Action if Reclamation denies Aurora's request for storage and exchange contracts.

Reclamation's decision on the request to grant storage and exchange contracts to allocate excess capacity for non-Fry-Ark Project water would be pursuant to the Act of June 17, 1902 (32 Stat. 388) and Acts amendatory and supplementary thereto.

This Draft Environmental Assessment (EA) was prepared in accordance with NEPA, the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508), and Reclamation's National Environmental Policy Act Handbook (U.S. Bureau of Reclamation 2000). The City of Aurora is the Project proponent and Reclamation is the lead agency for compliance with NEPA and preparation of the EA.

This EA describes the environmental consequences of the Proposed Action and No Action Alternative. The EA is used to identify the significance of impacts and to determine whether to prepare a Finding of No Significant Impact (FONSI) or an Environmental Impact Statement (EIS). This Draft EA is being submitted to the public for a 45-day review and public comment period. Reclamation also will hold a public open house during the public comment period to present results of the EA and take comments. Following receipt of comments on the Draft EA, Reclamation will determine whether to prepare a FONSI or, if significant impacts are identified and cannot be mitigated, Reclamation will prepare an EIS.

Regardless of whether an EA or EIS is prepared, Reclamation will enter into preliminary contract negotiations with the City of Aurora following release of the draft NEPA document. Contract negotiations are conducted during preparation of NEPA documents because there may be issues identified in either of these processes that affect the other. Contract negotiations do not commit Reclamation to completing a contract. The contract negotiation process involves discussion of specific provisions of the contract and is open to the public,

[1] The IGA allows Aurora to lease up to 12,500 ac-ft in 2004 and again in 2005. Beginning in 2006, Aurora may lease up to 10,000 ac-ft in any three years of the next ten. In 2017, a new ten-year cycle would begin.

with a period set aside at each negotiation session for public comment. NEPA compliance for the proposed Project must be finalized and documented in either a FONSI or a Record of Decision (ROD) before contract negotiations are finalized and the contract is executed. If the proposed Project receives a FONSI, Reclamation and Aurora would complete negotiations for a long-term contract implementing the proposed action.

1.4 BACKGROUND

In 1986 and 1987, Aurora purchased shares in the Colorado Canal Mutual Water Company operating the Colorado Canal, Lake Henry, and Lake Meredith (Colorado Canal System). In 1987, Aurora purchased approximately 58 percent of the shares of the Rocky Ford Ditch Company (Rocky Ford I). Aurora has also purchased an additional 36 percent of the Rocky Ford Ditch (Rocky Ford II). Water right applications providing for these 1986, 1987, and 2004 transfers and exchanges were decreed by Colorado Court Division 2 as noted in Table 1-1. Rocky Ford II water rights have been adjudicated and belong to Aurora. In 2004, the yield of the Rocky Ford II water rights was 1,812 ac-ft. The yield is expected to increase to about 2,500 ac-ft in 2005, and the full estimated yield of 5,100 ac-ft will be diverted when revegetation is certified complete.

The Rocky Ford II Exchange Decree has been entered in Case No. 99-CW-170 a) and b). It allows Aurora to exchange Rocky Ford II water from Pueblo Reservoir to other points within the basin.

By decree, Rocky Ford I water may be diverted only at Pueblo Reservoir. The Rocky Ford II decree includes diversion at Pueblo Reservoir, Twin Lakes Reservoir, Turquoise Reservoir, Clear Creek Reservoir, Otero Pump Station, and an unspecified gravel pit reservoir storage site below Pueblo Reservoir. Colorado Canal decrees allow for water diversion at the original Colorado Canal headgate.

Aurora currently has a lease agreement with shareholders of the High Line Canal Company. The water lease allows farmers to lease, loan, or exchange water without losing the water right or permanently selling it. Under the lease arrangement, Aurora can temporarily lease agricultural water rights up to 3 years out of every decade from willing lessors according to the terms and conditions of the lease, Colorado state water law, and an agreement between Aurora and the Southeastern Colorado Water Conservation District. When Aurora leases water in the Arkansas Valley, only the consumptively used portion of the water right can be transferred to prevent injury to other water right holders. High Line Canal lease water can be diverted at Pueblo Reservoir according to the Temporary Substitute Supply Plan approved by the Colorado State Engineer. In the future, Aurora may negotiate leases with other Arkansas Valley ditches in the reach between the confluence of Timpas Creek and the Arkansas River (approximately 5 miles downstream of Rocky Ford) and Pueblo Reservoir.

The proposed excess capacity contracts would facilitate the movement of Aurora's water rights from the Rocky Ford Ditch and Colorado Canal System, as well as water leased from the High Line Canal or other sources from the Arkansas River basin to the South Platte River basin (Table 1-1). The transfer and lease of water rights are regulated by Colorado water law and are not within the jurisdiction of Reclamation or within the scope of this EA. Water exchanges are also regulated under state law. The proposed contract with Reclamation is required for Aurora to use excess storage capacity in Pueblo Reservoir and facilitate exchanges. However, without an excess capacity contract from Reclamation Aurora would still attempt to move its water rights from the Arkansas River basin to the South Platte River basin pursuant to existing decrees and agreements.

The excess capacity contracts would allow storage and exchange of Rocky Ford I, Rocky Ford II, and Colorado Canal decreed water, and Highline Canal or other lease water for municipal, commercial, industrial, and other beneficial uses as provided by Aurora's water rights and the Temporary Substitute Supply Plan.

Table 1-1. Aurora Arkansas River Water Right Decrees.

Water Right	Transfer Decree	Exchange Decree
Rocky Ford I	83CW18	87CCW63
Rocky Ford II	99CW169	99CW170
Colorado Canal	84CW62, 84CW63, 84CW64	

1.4.1 Aurora's Water Demand

In 2005, the City of Aurora served a population of about 304,000 residents along with numerous businesses and commercial water users (City of Aurora Planning Department 2005). Gross water demand, including transit and evaporation losses, currently averages about 75,000 ac-ft per year. Water demand is expected to grow proportionally with population, which is projected (City of Aurora Planning Department 2005) to grow at a rate of about 2.2 percent per year (Table 1-2). Projections of population and City water demand at this growth rate indicate a population of about 644,000 and a gross water demand of 175,000 ac-ft by the year 2050 (Figure 1-2). Employment in Aurora is projected to grow at a faster rate than population, which also will increase the need for future water deliveries for business, commercial, and industrial demand.

To conserve water and reduce the demand for new sources of water, Aurora has established water conservation and demand management measures. These measures were recently updated in a Water Management Plan (Aurora Water Department 2006). The overall goal is to reduce water use per dwelling by about 10 to 20 percent, with a focus on more efficient use of outdoor irrigation. Water conservation measures include actions such as:

- Pricing incentives
- Metering of all uses
- Lawn size restriction
- Alternative sources of water for irrigation
- Promotion of xeriscaping
- Water education programs
- Residential water audits

These conservation measures are reflected in the demand projection (Figure 1-2).

In response to recent drought conditions, Aurora established a Drought Management Program to provide further restrictions on water use based on available water resources in any given year. The Drought Management Program defines five stages of drought with incremental increases in the severity of water use restriction. Some of the measures used to reduce water demand during drought conditions include:

Table 1-2. Aurora's Projected Population Growth and Water Demand.

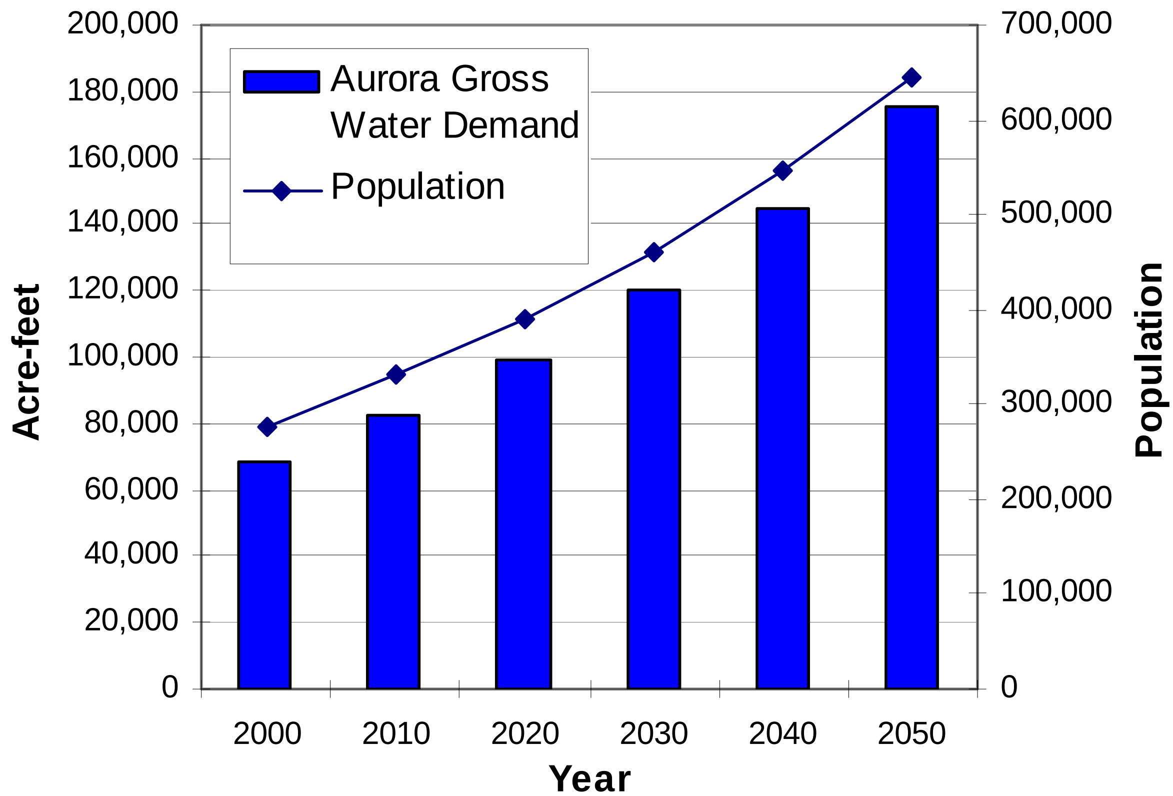
Year	Population	Gross Water Demand (ac-ft)
2000	276,393	68,310
2010	330,287	82,457
2020	390,304	99,533
2030	461,227	120,146
2040	545,038	145,028
2050	644,078	175,063

- Outdoor watering restrictions
- Planting restrictions
- A tap allocation system
- A tiered block rate structure that increases rates for higher water use
- Rebates and incentives for upgrading sprinkler systems and installing low flow toilets and efficient washing machines
- A car wash certification program

In 2002, improvements to the City's Lawn Permit Ordinance further restricted lawn size and increased requirements for the addition of soil amendments in new lawns. The City's landscape standards were revised to allow for an increased use of xeriscape and an ordinance was passed requiring all new car washes to install water reclamation systems. In addition, the City adopted a new irrigation standards ordinance regulating new systems to a higher efficiency standard. As the City's reservoirs recover from the recent drought, it is anticipated that programs such as the replacement of high water use appliances and the implementation of new City ordinances will continue and have a lasting effect on reducing water use. Aurora plans to continue its review and implementation of new City ordinances that conserve water resources.

The implementation of water conservation and drought management measures by the City of Aurora has resulted in a substantial reduction in water use. In 2003, the Drought Management Program reduced water use by about 30 percent over

Figure 1-2. Aurora's Projected Future Water Demand and Population.



pre-drought years (City of Aurora 2004a). Conservation savings reduced water demand by about 16,000 ac-ft in 2004. Conservation savings are likely to diminish as a percentage over time as water users reduce their demand permanently.

In addition to water conservation measures, the City is expanding its reclaimed and non-potable water system. Under Colorado water law, Aurora has the right to reuse all the water it imports from the Arkansas and Colorado River basins, its South Platte basin agricultural water rights that have been transferred to municipal use, and its South Platte basin non-tributary wells. Almost 90 percent of Aurora's water supply is reusable. Thus, all of Aurora's Arkansas River water rights subject to the proposed contract are reusable to extinction. Reusable water is used to satisfy augmentation requirements and a portion is treated and reclaimed for non-potable irrigation. In the future, such reusable water will also be reclaimed for potable use.

Reclaimed water is used for irrigation of parks, open space, golf courses, and greenbelts. Currently the Sand Creek Water Reuse facility provides about 5,000 ac-ft per year for reuse. The City estimates that by 2020, about 20,000 ac-ft a year of treated reclaimed wastewater will be available for potable reuse. Conservation and reuse of reclaimed treated wastewater serve to reduce the rate of projected demand increases and are reflected in demand projections in Table 1-2.

1.4.2 Aurora's Water Supply

To meet water demands, Aurora relies on several raw water sources from the South Platte, Colorado, and Arkansas River basins (Figure 1-3).

Water from these sources is diverted in a manner prescribed by City water right decrees as administered by the Colorado State Engineer's Office and varies with hydrologic conditions. Renewable surface water provides about 95 percent of the raw water supply for Aurora, with the remainder from ground water sources. Aurora's water supply program is designed to meet customer demands with an operating reserve under average year hydrologic conditions. Meeting current and future demands will require maximizing use of existing and future water rights through the use of additional renewable water sources, water conservation, reclamation and reuse, and ground water supplies.

In 2004, gross water supplies from all sources, including Arkansas River water rights and leases, totaled 83,183 ac-ft. The Arkansas River basin yields for 2004 are presented in Table 1-3. Gross water supplies are the estimated divertible flows prior to adjustment for transmission losses, evaporation, and delivery obligations. Under terms and conditions of several decrees, the City of Aurora is obligated to deliver a portion of some specific water rights to third parties. During dry years, water supplies may drop to less than 25,000 ac-ft; in wet years, as much as 111,000 ac-ft is available. Water storage is essential to carry over yield from wet years to provide reserve water supplies during dry years.

Figure 1-3. Aurora's Surface Water Supply Sources.

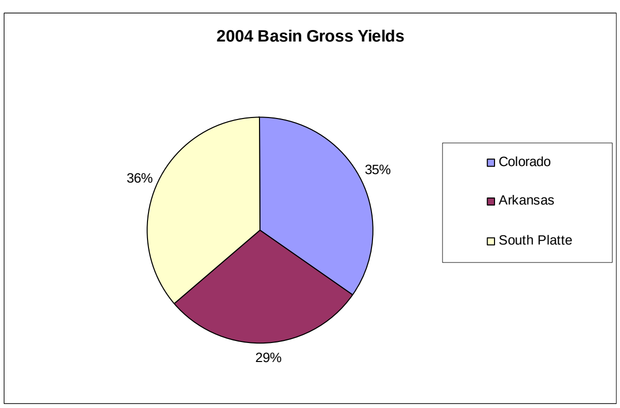


Table 1-3. City of Aurora 2004 Arkansas River Basin Water Supply.

Source	Amount (ac-ft)
Twin Lake Native	332
Upper Arkansas Ranches	554
Colorado Canal	1,924
Rocky Ford Ditch I	8,270
Rocky Ford II	1,812
Highline Lease	8,445
Lake County Temporary Substitute Supply Plan	1,753
Basin Total	23,090

Water rights and leased water from the Arkansas River meet a portion of Aurora's existing and future water demand. Currently the Arkansas River supplies about 25 to 40 percent of Aurora's water supply. For example, the Arkansas River basin water rights in 2004 contributed 28% of the City's raw water yield. The Rocky Ford I and Colorado Canal supply an annual net delivery of about 12,000 ac-ft of water on average to Aurora from an average gross yield of 16,000 ac-ft. To meet existing demands this water has been historically exchanged to Twin Lakes Reservoir, Turquoise Reservoir, and Otero Pump Station and transferred to the South Platte. This exchange has been facilitated in part by annual "if and when" contracts with Reclamation since 1999 to meet demands. Recent acquisition and decrees of additional Rocky Ford II Ditch shares will provide about 5,100 ac-ft of water on average by 2010 as retired agricultural lands are independently certified as successfully revegetated. In addition, water leased from the agricultural water users could provide up to 10,000 ac-ft of water in 3 years out of a 10-year cycle beginning in 2006.

1.5 PUBLIC INVOLVEMENT AND ISSUES

Scoping is the first phase of the public involvement process. It is designed to help determine the scope of issues and alternatives to be addressed in the EA. The intent of the scoping process is to gather comments, concerns, and ideas from those who have an interest in or may be affected by the Proposed Action and identify issues the public and government agencies believe are most important. During scoping (from October 2003 to February 2004), Reclamation sought and received input from the public, interested organizations, and agencies to help identify issues for evaluation in the EA.

Reclamation initiated the scoping process with release of a scoping announcement and other materials in October 2003. The scoping announcement, which describes the proposed Project and compliance requirements, was mailed to approximately 300 federal, state, and local governments, interested citizens, as well as water districts, environmental groups and other organizations that Reclamation determined may have an interest in the proposed Project. Legal notices describing the Project were placed in newspapers in Pueblo, Salida, Buena Vista, Leadville, Denver, Colorado Springs, Rocky Ford, and Cañon City in the fall of 2003. In addition, Reclamation sent a news release to print, radio, and television media in Denver, Pueblo, La Junta, Leadville, Salida, Buena Vista, Lamar, Colorado Springs, and Pueblo West. The scoping announcement was also placed on Reclamation's web site.

Reclamation also held two agency scoping meetings to provide federal, state, and local government representatives with more information about the proposed Project, and the opportunity to ask questions and provide comments. These meetings were held at Colorado State Park facilities at Pueblo Reservoir on January 13, 2004 from 1 p.m. to 3 p.m. and at the City of Aurora's Municipal Building on January 15, 2004 from 9:00 a.m. to 12:00 p.m. More than 50 local, state and federal agencies were invited.

The agency scoping meeting in Pueblo was attended by individuals representing the Colorado Division of Wildlife, U.S. Forest Service, Bureau of Land Management, Colorado State Parks, State of Kansas, Chaffee County, Pueblo County, Canon City, Town of Olney Springs, Town of Ordway, Town of Poncha Springs, Board of Water Works of Pueblo, the Southeastern Colorado Water Conservancy District, Lower Arkansas Valley Water Conservancy District, Arkansas Headwaters Recreation Association, and Colorado Mountain Club, among others. Following announcement of the meeting by the Pueblo Chieftain newspaper, members of the public also attended the meeting. In all, 49 people attended the Pueblo agency scoping meeting.

An agency scoping meeting held in Aurora on January 15, 2004 provided an additional opportunity for agencies to provide comments. Six people attended this meeting, including representatives from the Bureau of Land Management, U.S. Forest Service, Colorado Division of Wildlife, and the Colorado Department of Public Health and Environment—Water Quality Control Division.

Reclamation held a public scoping meeting on January 29, 2004, to provide the public with more information about the proposed Project and an opportunity to ask questions and provide comments. This scoping meeting included an open house for members of the public to discuss the proposed Project with Reclamation staff, a presentation by Reclamation and the Colorado State Engineer's Office, and a period for the public to ask questions and make comments. The meeting was well attended by about 250 people. While Reclamation staff and the environmental consultant did take informal notes on oral comments, the meeting was not a recorded event and the public was encouraged to submit written comments to Reclamation to assure an accurate record of their comments. The initial comment period deadline of November 24, 2003 was later extended to February 2, 2004 and then to February 12, 2004 to allow sufficient time for public comment.

Reclamation received about 2,000 form letters and 250 individual comments on the proposed Project, including about 2,100 from individuals, 16 from government or public agencies, and 19 from organizations. Approximately 90 percent of the comments from individuals were form letters that expressed the same comments. Issues of primary concern mentioned during the scoping process are summarized below by topic. A detailed scoping summary report was completed and released in March 2004. A copy of the scoping report was placed on Reclamation's website. The comments and issues of concern received are summarized below. Reclamation used the public comments to focus the analysis on important issues.

Alternatives

- Consider building a pipeline from the Arkansas River to Aurora
- Investigate other reservoir sites
- Consider water leases
- Reuse or recycle existing supplies
- Consider trading Rocky Ford water for Colorado Springs Homestake water
- Consider use of ground water in the Denver basin
- Use water conservation to meet demand
- Consider a shorter term for the contract

Hydrology

- Effect on Arkansas River flow from Lake County to Pueblo Reservoir and downstream to state line
- Effect on Arkansas River alluvium and surrounding aquifers in upper Arkansas basin
- Effect on Upper Arkansas Voluntary Flow Management Program (UAVFMP)
- Effect on minimum streamflow requirements
- Effect on existing transbasin diversions

Water Quality

- Effect on water quality in the reach of the Arkansas River through Pueblo
- Effect on water quality from the Arkansas River and Fountain Creek confluence downstream
- Effect on water quality at the Pueblo Waste Water Treatment plant and other waste water facility discharge locations
- Identify changes in water quality delivered to Kansas
- Effect on water quality for lower Arkansas municipal and industrial use

Biological Resources

- Effect of changes in flows and water quality on biological resources including: fishery and aquatic life; threatened and endangered species; wildlife; and wetlands and riparian corridor

Recreation

- Effect on boating, fishing, hunting on the upper Arkansas River
- Effect on recreation at Pueblo Reservoir
- Effect on recreational flows below Pueblo Reservoir and in the proposed recreational park
- Effect on recreation at Twin Lakes Reservoir and Turquoise Reservoir

Socioeconomics

- Effect on recreation economy in upper Arkansas and future growth in Chaffee County
- Effect on Fryingpan–Arkansas purpose
- Effect on agriculture in Chaffee County
- Effect of reduced water quality on agriculture in lower Arkansas basin and ability of cities to provide quality water to citizens

Cumulative Effects

- From all proposed storage and exchange contracts including Colorado Springs Southern Delivery System and other Reclamation storage contracts in Pueblo Reservoir
- Consider other potential projects including Preferred Storage Options Plan, Arkansas Valley Conduit, Eagle River basin diversions

- Consider Aurora's use of all of its Arkansas water rights

Regulatory Issues

- Define Reclamation's legal basis for entering into storage contracts outside of the Fryingpan-Arkansas Project participants
- Explain basis for determining excess capacity
- Conduct an Environmental Impact Statement instead of Environmental Assessment
- Consider programmatic EIS for all projects in the Arkansas basin

Chapter 2 Alternatives

2.1 INTRODUCTION

Chapter 2 describes the Proposed Action and No Action Alternative. Under the No Action Alternative, Reclamation would no longer contract with Aurora for the storage and exchange of Aurora's water rights. Under the Proposed Action, Reclamation would enter into a long-term contract with Aurora to allow the use of excess capacity in the Fry-Ark Project for storage and conveyance of Aurora's non-Fry-Ark Project water and exchange of Aurora's water with Fry-Ark Project water. Several other alternatives identified during scoping are discussed in Section 2.4, *Alternatives Eliminated from Detailed Study*. In addition, reasonable foreseeable future actions that were considered for the evaluation of cumulative effects are discussed in Section 2.5.

2.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Reclamation would not enter into an excess capacity contract with Aurora. Additionally, Reclamation would not enter into an agreement with Aurora for contract exchanges of up to 10,000 ac-ft of Aurora's Arkansas River water for Fry-Ark Project water in Twin Lakes Reservoir or Turquoise Reservoir. In the absence of these contracts with Reclamation, Aurora would look to other ways to use its decreed Arkansas River water rights, as discussed below.

2.2.1 Short-Term Actions

Aurora would pursue both short-term and long-term actions to secure and exchange existing Arkansas River water rights. In the short-term, this would include filings with Colorado Water Court to modify existing decrees to allow additional alternate points of diversion for use of those water rights to upstream locations. The adjudication process to change or modify Aurora's decrees is estimated to take about five years. During this time, Aurora would store its Colorado Canal System water rights in Lake Meredith and Lake Henry and, to the extent exchange capacity exists, exchange these rights upstream to Twin Lakes Reservoir and Turquoise Reservoir. Rocky Ford I water rights must be diverted at Pueblo Reservoir according to the existing decree. Therefore, in the short-term without a storage contract with Reclamation these rights would be unavailable for direct use and exchanges by Aurora until the decree could be modified through the Colorado water court system. The Rocky Ford II water decree allows diversions at Pueblo Reservoir and other alternative points of diversion, including a gravel pit reservoir storage site below Pueblo Reservoir.

In the interim period before Aurora's decrees could be modified, the associated water rights that cannot be used would likely be traded or sold to other water users. During this period, the consumptive use component of Aurora's water rights could be diverted by other water rights at various points of diversion above or below the original point of diversion. Aurora's Rocky Ford and Colorado Canal decrees require that historically irrigated land associated with its water rights are revegetated and no longer irrigated with these water rights.

2.2.2 Long-Term Actions

To provide for the long-term use of its water rights and to develop their full available yield, Aurora would use a 10,000 acre-foot storage facility. Aurora currently has an option on the purchase of a gravel mining site that could provide water storage following gravel excavation. The gravel pit reservoir storage site is located adjacent to the Arkansas River about six miles downstream of the

City of Pueblo (Figure 1-1). Depending on mining operations and final site development, it is anticipated that about 500 acres of land would be needed to provide sufficient storage for 10,000 ac-ft of water.

Water would be diverted to the gravel pit via the existing Excelsior Ditch located about two miles upstream of the storage location (Figure 2-1). The Excelsior Ditch headgate on the Arkansas River is expected to have adequate capacity, but some improvements to the Ditch may be necessary to convey Aurora's Arkansas River water rights. Water from the gravel pit reservoir storage site would be returned to the Arkansas River using a new outlet structure and pumping facilities as necessary.

Development of the gravel pit site, including mining operations and the associated improvements that would be needed to make this site suitable for water storage, is expected to take about 10 years. In the interim, Aurora would use its Arkansas River water as previously described under *Short-Term Actions*.

Operation of gravel pit storage would be similar to that for storage in Pueblo Reservoir. Aurora would divert its Colorado Canal and Rocky Ford water rights into the gravel pits when in priority, and exchange water upstream to Twin Lakes Reservoir and Turquoise Reservoir, into space already owned by Aurora for conveyance via the Otero Pump Plant into the South Platte basin. Aurora would lease water from the High Line Canal and other sources according to the IGA and exchange this water upstream to Twin Lakes Reservoir and Turquoise Reservoir space already owned by Aurora. Aurora would not conduct contract exchanges with Reclamation for Fry-Ark water, but would continue to use contract exchanges with the Board of Water Works of Pueblo or others as available.

Partially excavated gravel pit reservoir storage site

2.2.3 Estimated Cost

The estimated cost for development of gravel pit reservoir storage facilities is approximately $40 million plus annual operation and maintenance costs (McHugh, pers. comm. 2005).

2.3 PROPOSED ACTION

Under the Proposed Action, Reclamation would execute a long-term (40-year) excess capacity contract(s) with Aurora for the use of up to 10,000 ac-ft of available excess storage capacity in Pueblo Reservoir. The storage space could be filled and emptied multiple times each year to accommodate water exchanges to Twin Lakes Reservoir, Turquoise Reservoir, and the Otero Pump Station.

Physical exchanges, contract exchanges, and alternate points of diversion are legal mechanisms that enable water rights holders to divert and/or store water supplies at a location other than the location required in the original water right. These mechanisms enable the water right holders to divert the water at locations that enable more convenient use of the water supply. **Physical exchanges** consist of an out-of-priority diversion from an upstream location and a release of the same amount of water at a downstream location, with the requirement that no senior water rights are injured between the diversion and associated release. **Contract exchanges** are the transfer of stored water from one reservoir to another that are accomplished through accounting and do not involve the physical exchange of water. An **alternate point of diversion** water right allows users to divert water rights at locations that are different than the diversion locations allowed in the original water right. A change in use water right changes the type of use (typically from agricultural to municipal, industrial, or other urban uses) allowed by the original water right.

In addition, Reclamation would enter into a separate contract with Aurora that would allow annual contract exchanges of up to 10,000 ac-ft of Aurora's water rights stored in Pueblo Reservoir with Fry-Ark Project water stored in Twin Lakes Reservoir and Turquoise Reservoir. Contract exchanges could take place multiple times in one year, as long as the total amount exchanged in one year does not exceed 10,000 ac-ft.

The Proposed Action does not require construction of new facilities to accommodate storage, conveyance, and exchange of this water. Once native Arkansas River water is stored in Pueblo Reservoir, it may be exchanged upstream by one of three methods:

1) Water may be exchanged for native inflows to Twin Lakes Reservoir or Turquoise Reservoir;
2) Aurora's non-Project water stored in Pueblo Reservoir could be exchanged for stored water in upstream reservoirs including Twin Lake Reservoir or Turquoise Reservoir; or
3) Water may be directly exchanged to the Otero Pipeline and Pump Station.

Once water is exchanged upstream and delivered to the existing Otero Pump Station, it would be pumped to the South Platte basin by the existing Homestake Pipeline for use by Aurora.

Typically water rights are specifically defined by water right decrees established in Colorado Water Court and indicate the maximum amount of water that may be diverted, stored or exchanged. The amount of water actually diverted or available varies annually depending on hydrologic conditions. Average values typically indicate the amount of water that is available over a defined historical period or a projected average based on anticipated future conditions. Additional discussion on the hydrologic modeling and assumptions that were used to predict the consequences of the Proposed Action and No Action are included in Chapter 3.

Only water that Aurora is legally entitled to divert and store in Fry-Ark facilities, either through a decree by the Colorado water court, or by temporary approval of the Colorado State Engineer's Office, could be stored or exchanged under these contracts. A description of the storage and exchange contracts and their operation under the Proposed Action is included in the following sections.

2.3.1 Pueblo Reservoir Storage Contract

Under the Proposed Action, the City would use up to 10,000 ac-ft of excess storage capacity in Pueblo Reservoir when space is available. This space would be used for storage of native Arkansas River water decreed to Aurora under its Rocky Ford I, Rocky Ford II, and Colorado Canal water rights, as well as the lease water from the High Line Canal or other sources. Storage of Aurora's water in Pueblo Reservoir would typically begin on March 15 of each year and accumulate through the spring and summer. Once runoff begins in earnest, typically in late May or June, Aurora would begin to exchange water to upstream sites. As runoff tapers off, storage in the contracted space would typically begin to decline as Aurora continues exchanges to upstream sites. Contract exchanges between Aurora and Reclamation would occur when the exchange potential in the Arkansas River is insufficient to move water stored in Pueblo Reservoir upstream.

Typically, Aurora's excess capacity storage space at Pueblo Reservoir would be evacuated by November 15 of each year. However, Aurora could retain some water in storage for exchange and use in the following year if it cannot exchange it due to current year river conditions and/or system demands. A brief overview on the operations for each of Aurora's sources of water follows. This discussion is based on Aurora's past operation of Rocky Ford I and Colorado Canal water rights under previous temporary "if and when" contracts and estimated future operations under the Proposed Action. Additional details are included in Chapter 3.

2.3.2 Rocky Ford Ditch Operations

The Rocky Ford Ditch headgate is located near Rocky Ford, Colorado, approximately 70 miles downstream from the Pueblo Reservoir outlet works. Under Aurora's Rocky Ford water right decrees entered in cases 83-CW-18 and 99-CW-169, Rocky Ford Ditch water may be diverted at several alternate points of diversion including Pueblo Reservoir (Figure 1-1). Aurora's decreed annual Rocky Ford Ditch yield for both the Rocky Ford I and II purchase and transfers is estimated to average 14,957 ac-ft. From this total diversion, 1,619 ac-ft would be held at Pueblo Reservoir for winter return flow release as delayed return flow obligations. According to hydrologic modeling, of the total amount diverted at the alternate points of diversion, approximately 13,300 ac-ft would be available for municipal use by Aurora on an average annual basis. Rocky Ford water diverted and stored at Pueblo Reservoir under the Proposed Action would be exchanged to upstream locations for native flows or as part of a contract exchange. In either instance Aurora's water could be diverted to the South Platte River basin from Twin Lakes Reservoir, Turquoise Reservoir, or the Otero Pump Station.

Rocky Ford water can be diverted throughout the growing season (March 15 through October 31) at a rate commensurate with the historical irrigation consumptive use associated with Aurora's share of the Rocky Ford Ditch Company. Diversion rates range from a low of 18 cubic feet per second (cfs) in March to a high of 53 cfs in June and July. The Rocky Ford Ditch I and II maximum daily diversion rates at the alternate points (Pueblo Reservoir) are illustrated in Table 2-1. Presently, all of the Rocky Ford I water can be diverted to storage but only a portion of the RF II water can be diverted to storage. As more land associated with the Rocky Ford II water rights are revegetated, more water will be available for diversion. Aurora expects that they will be able to divert their full RF II water rights (5,100 ac-ft) by 2010.

2.3.2.1 *Rocky Ford Physical Exchanges*

Water diverted and stored at Pueblo Reservoir under Aurora's Rocky Ford Ditch rights and exchange decrees would be exchanged to upstream storage in Twin Lakes Reservoir or Turquoise Reservoir. Water also could be exchanged directly to the diversion at the Otero Pump Station. A physical exchange allows an entity to divert water out of priority at one location in the basin and replace the diversion with water at another point of diversion as long as senior appropriators are not injured. During a physical exchange, streamflow in the reach between the exchanging reservoirs is decreased by the amount of the exchange. In this case, it would be the reach between Twin Lakes Reservoir and Pueblo Reservoir. Aurora would divert water at one of the upstream storage sites, and would replace a like amount of water to the Arkansas River below Pueblo Reservoir to ensure that senior water right holders downstream of Pueblo Reservoir are not injured. Physical exchange of flowing water must be approved by the Colorado State Engineer's Office or Colorado's water court to ensure that no senior

Pueblo Reservoir

Table 2-1. Rocky Ford Ditch Maximum Diversion Rates (Rocky Ford I and II).

Period	Rocky Ford Ditch Diversions (cfs)
March 15-31	18
April	32
May	38
June	53
July	53
August	50
September 1 - 15	38
September 16 - 30	42
October	22

water rights in the intervening reach of the stream are harmed because of the exchange. The exchange decree for Rocky Ford I water (87-CW-63) was approved in Colorado water court in 1987. The exchange decree for Rocky Ford II water (99-CW-170) was approved in Colorado water court in 2005.

Rocky Ford I and II exchange decrees would be operated in a manner so as not to adversely affect the amount of water that Reclamation would use to support the Upper Arkansas Voluntary Flow Management Program (UAVFMP). The UAVFMP is designed to provide augmentation flows for the benefit of the Arkansas River fishery and recreational uses. Recommendations are provided to Reclamation annually from the Colorado Department of Natural Resources and include flow recommendations for fisheries and recreation. Colorado has provided these recommendations to Reclamation annually since 1990 and generally includes recommended minimum rafting flows of 700 cfs between July 1 and August 15 at the Wellsville gage. Aurora would not make exchanges against releases made for instream flow purposes, and it would not exchange against native flows when the exchange would cause the Arkansas River flow to be reduced below the amounts agreed to in the UAVFMP.

In addition, Aurora entered into a stipulation with the Arkansas River Outfitters Association that limits the rate at which Aurora may operate its Rocky Ford Ditch exchanges. In accordance with the stipulation, the rate of exchange shall not exceed a maximum exchange rate for a given flow in the mainstem of the Arkansas River at the Wellsville gage as indicated in Table 2-2. Aurora's typical exchange rates would range from 50 to 100 cfs, with a maximum decreed exchange rate of 500 cfs.

Table 2-2. Aurora's Maximum Exchange Rates for Rocky Ford Water Rights on the Arkansas River Based on Flows at the Wellsville Gage.

Gage Flow (cfs)	Maximum Exchange Rate (cfs)
0 - 249	0
250 – 499	50
500 – 999	75
1,000 – 1,499	125
1,500 – 1,999	175
2,000 – 2,999	250
3,000 and above	500

Rocky Ford exchange decrees include limitations that do not allow exchanges to operate at times when the native flow of the Arkansas River at the Wellsville gage is less than 240 or 260 cfs, depending on the time of the year. In addition, other stipulations provide that exchanges could not be operated when the native flow of the Arkansas River at the Portland gage is less than 190 cfs. By decree (84-CW-179), physical exchanges from Pueblo Reservoir to Twin Lakes Reservoir and Turquoise Reservoir are not allowed from November 15 through March 14 during the Winter Water Storage Program.

2.3.2.2 Rocky Ford Contract Exchanges

Under the Proposed Action, Aurora would continue to operate contract exchanges with the Board of Water Works of Pueblo (BWWP) and Reclamation. Aurora would provide stored water to Reclamation at Pueblo Reservoir and would receive a like amount of stored water from Reclamation at Twin Lakes Reservoir or Turquoise Reservoir. In addition, Aurora has a contract agreement with BWWP that includes a minimum exchange of 4,000 ac-ft and a maximum exchange of 10,000 ac-ft annually. Under this agreement, Aurora would provide stored water from its excess capacity storage space in Pueblo Reservoir to the BWWP in exchange for a like amount of stored water from the BWWP at Twin Lakes Reservoir or Turquoise Reservoir. Contract exchanges with BWWP typically would occur from September to December at an exchange rate of up to 1,000 ac-ft per month.

2.3.3 Colorado Canal Operations

The Colorado Canal System includes a 52-mile diversion canal that diverts water from the Arkansas River approximately 20 miles downstream of Pueblo Reservoir near Boone, Colorado, and two storage reservoirs—Lake Henry and Lake Meredith — located near Ordway, Colorado (Figure 1-1). Aurora owns Colorado Canal water rights, which include 13,857 ac-ft of storage in Lake Meredith and Lake Henry. Aurora's annual Colorado Canal System yield averages about 7,900 ac-ft, although the actual yield is highly variable. The Colorado Canal System water rights are diverted from the Arkansas River at the original point of diversion and transported through the canal to Lake Meredith and Lake Henry. During the irrigation season when the Colorado Canal System is in priority (typically during the spring run-off and some summer precipitation events), Aurora would accumulate additional storage amounts. System storage also includes water stored during the Winter Water Storage Program (November 15 through March 14).

Aurora's Colorado Canal transfer and exchange decrees (84-CW-62, 84-CW-63, and 84-CW-64) allow water to be exchanged directly from the Lake Meredith Outlet upstream to Pueblo Reservoir, Twin Lakes Reservoir, and/or Turquoise Reservoir. Aurora's storage space in the Colorado Canal System could be depleted and restored several times during the year. Typically, all water would be evacuated from storage by November 15 of each year. However, Aurora could retain some water in storage for exchange and use the following year if it cannot exchange water due to river conditions.

2.3.3.1 Colorado Canal Physical Exchanges

Pursuant to the Colorado Canal exchange decrees, Aurora can operate this exchange in two ways.

1) Aurora can divert water at Twin Lakes Reservoir or Turquoise Reservoir and replace it with a like amount of water to the Arkansas River at the Lake Meredith Outlet Canal. The exchange would be operated in a manner that would prevent injury to senior diverters in the intervening stream reach between the Lake Meredith Outlet Canal and the upstream exchange site.
2) Alternatively, water can be exchanged from the Lake Meredith Outlet structure to Pueblo Reservoir first and then exchanged upstream to Aurora's space in either Twin Lake Reservoir or Turquoise Reservoir.

Aurora's exchange decree includes a stipulation that requires that the Colorado Canal Company, of which Aurora owns 29 percent, to notify the Arkansas Valley Ditch Association when the upstream exchanges are operating and when the Arkansas River at the Avondale gage is less than 500 cfs. If Arkansas Valley Ditch operations were affected, the Colorado Canal Company would reduce exchanges.

2.3.3.2 Colorado Canal Contract Exchanges

Aurora would use contract exchanges to move Colorado Canal water stored in Pueblo Reservoir to Twin Lakes Reservoir and Turquoise Reservoir. Contract exchanges would occur with existing contracts with the BWWP and with Reclamation under the terms of the Proposed Action. Aurora would provide stored water to Reclamation and the BWWP at Pueblo Reservoir, and receive a like amount of stored water from these entities at Twin Lakes Reservoir or Turquoise Reservoir.

2.3.4 Leased Water

Aurora recently entered into a lease contract with shareholders of the High Line Canal Company for water that can be stored at Pueblo Reservoir under the proposed excess capacity contract in 2004 and 2005. The lease allows Aurora to divert up to a maximum of 12,500 ac-ft of High Line Canal water throughout the growing season (March 15 through November 14) at a rate commensurate with the historical irrigation consumptive use. The water was diverted at Pueblo Reservoir pursuant to annual approval of a Temporary Substitute Supply Plan by the Colorado State Engineer.

In the future, Aurora may negotiate leases with other Arkansas Valley ditches in the reach between the Rocky Ford Ditch and Pueblo Reservoir. The lease program is described in the IGA with Southeastern Water Conservancy District and limits the leases to no more than 3 years out of every ten-year period beginning in 2006, with a maximum annual lease of no more than 10,000 ac-ft.

Aurora proposes to use contract exchanges to move leased water stored in Pueblo Reservoir to upstream storage in Twin Lakes Reservoir or Turquoise Reservoir. Aurora would provide stored water to Reclamation at Pueblo Reservoir in exchange for a like amount of stored water from Reclamation at Twin Lakes Reservoir or Turquoise Reservoir.

2.3.5 Restoration of Yield and Holbrook Reservoir Operation

Restoration of Yield (ROY) was developed in principle as part of the Pueblo Flow Management Program (PFMP) Intergovernmental Agreement (IGA 2004). The intent of ROY is to develop operations and facilities that would allow the signatory parties to recover a portion of the yield lost as part of their participation in the PFMP. Recently, the City of Aurora has signed a temporary agreement with the Holbrook Irrigating Company to use excess capacity in the Holbrook system as part of the ROY program (Holbrook and Aurora 2005). The City of Aurora then signed agreements with other ROY participants to divide the available excess capacity between the participants (Aurora et al. 2005).

The agreement between Aurora and Holbrook allows use of the entire Holbrook system by Aurora, including both Holbrook Reservoir and Dye Reservoir. The Temporary Substitute Water Supply Plan obtained by Aurora to administer the program includes the ability to divert unexchanged reusable return flows in the Colorado Canal system as well (Wolfe 2005).

The active storage capacity for Holbrook Reservoir is approximately 6,200 ac-ft (Simpson, pers. comm. 2005). The agreements state the ROY participants may use "Excess Capacity" in the reservoirs. Thus, the ROY participants can only store water in Holbrook Reservoir when space is available beyond Holbrook's normal operations. Based on agreements signed between the ROY participants, Table 2-3 shows a breakdown of ROY storage in Holbrook Reservoir.

Table 2-3. Division of ROY Storage in Holbrook Reservoir

Entity	Percent of ROY Storage	Maximum Potential Holbrook Storage (ac-ft)
Aurora	46%	2,852
Colorado Springs Utilities	46%	2,852
Fountain	5%	310
BWWP	2%	124
SECWCD	1%	62
Total	100%	6,200

Note: Assumes 6,200 ac-ft of potential ROY storage in Holbrook Reservoir. Storage available as "Excess Capacity" only.

Water used to fill Holbrook Reservoir can be diverted by several means: the Holbrook Reservoir native flow storage rights (priority dates of 3/2/1892 and 9/15/1909), by exchange from lower portions of the system and through the Winter Water Storage Program (Division 2 diversion and water rights records). Because the native water rights' priority dates are relatively junior, the reservoirs are only able to divert water during times of high flow on the river and do not always fill under their native flow right. The reservoirs do often fill during the Winter Water season. However, as part of the agreements, Holbrook will operate so that Winter Water does not spill ROY participant water from the Holbrook system if storage space is available in Pueblo Reservoir (Holbrook and Aurora 2005).

2.3.6 Aurora's Other Water Operations in the Arkansas Valley (Not Part of the Proposed Action)

This section discusses the relationship of Aurora's other water rights and existing facilities associated with the use of water under the proposed storage and exchange contracts. There would be no change in the infrastructure of existing facilities with implementation of either the Proposed Action or No Action Alternative.

2.3.6.1 Twin Lakes Reservoir and Turquoise Reservoir Storage Operations

Aurora owns 2,722 ac-ft of storage space in Twin Lakes Reservoir and has a long-term contract with Reclamation for 5,000 ac-ft of storage space in Turquoise Reservoir.

The majority (95 percent) of Aurora's Arkansas River basin water rights would be exchanged upstream to storage in Twin Lakes Reservoir. On occasion, water would be exchanged to Turquoise Reservoir or Clear Creek Reservoir, but any water exchanged to other locations must eventually be delivered to Twin Lakes Reservoir by exchange or direct delivery to make it available to the Otero Pump Station.

2.3.6.2 Otero Pump Station Operations

Aurora would deliver all of its Arkansas River basin water from Twin Lakes Reservoir via the existing Otero Pipeline to the Otero Pump Station for delivery to the South Platte River basin in the existing Homestake Pipeline. Aurora's share of the capacity in the pump station is approximately 78 cfs. The Proposed Action would not change the capacity of existing pipelines or the Otero Pump Station.

2.3.6.3 South Platte River Delivery Operations

Water delivered to the South Platte basin is currently stored in Spinney Mountain Reservoir and released as needed downstream. Releases from Spinney Mountain Reservoir are diverted at Strontia Springs Dam and transported via an existing pipeline to Aurora's Rampart Reservoir and then to either of Aurora's water treatment facilities, or Quincy Reservoir or Aurora Reservoir for terminal storage. There would be no changes to the capacity or operation of these facilities. Releases from Spinney Mountain Reservoir would adhere to the proposed South Platte Protection Plan (Denver Water and Trout Unlimited 2003) and the associated Streamflow Management Plan.

2.3.7 Water Rights, Commitments, and Stipulations

The Proposed Action includes commitments associated with agreements and stipulations within the water right decrees that were developed to protect the Arkansas River and its users and avoid and/or minimize potential adverse environmental consequences. These commitments would be in effect throughout the 40-year contract between Reclamation and Aurora if the Proposed Action is implemented. A summary of those commitments is listed below.

2.3.7.1 General Commitments

- Aurora's storage and exchange decrees would be administered in accordance with the water rights decrees and laws of the State of Colorado.
- Reclamation would not permit or allow any operation of the exchanges that would adversely affect Reclamation's operation of the Fry-Ark Project.
- The existing Fry-Ark Project spill priorities would be maintained for existing Fry-Ark Project space.

2.3.7.2 Upper Basin Operation Commitments

In the upper reaches of the Arkansas River, from Pueblo Reservoir to upper basin storage in Twin Lakes Reservoir and Turquoise Reservoir, exchanges can only be exercised at times when they would not interfere with or reduce flows below the levels at the gages listed in Table 2-4. This includes:

- Colorado Water Conservation Board (CWCB) minimum streamflow requirements of 15 cfs in Lake Fork Creek below Turquoise Reservoir and Lake Creek below Twin Lakes Reservoir.
- Rocky Ford exchange decrees (87-CW-63 and 99-CW-170) include minimum flow commitments at the Wellsville gage (Table 2-4) and minimum streamflows at the Portland gage as shown in Table 2-4 and Table 2-5.
- Aurora has agreed it would not exchange against any releases made by Reclamation to augment streamflows and meet Colorado's recommended flows in the Arkansas River (Decrees 87-CW-63 and 99-CW-170).

Table 2-4. Summary of Upper Arkansas River Minimum Flow Commitments.

Location	Minimum Flow (cfs)
Lake Fork Creek below Turquoise	15
Lake Creek below Twin Lakes	15
Wellsville Gage	240/260
Portland Gage	190
UUAVFMP Rafting flows July 1-August 15 (Wellsville)	700

- Aurora has agreed to a stipulation in the Rocky Ford II decree (99-CW-170) with the Arkansas River Outfitters Association. This stipulation limits the rate at which Aurora may operate its Rocky Ford Ditch exchanges. In accordance with the stipulation, the rate of exchange shall not exceed the maximum exchange rate when the flows of the Arkansas River at the Wellsville gage are at the levels shown in Table 2-2. This stipulation was extended to the Rocky Ford I decree (87-CW-63).
- Per Rocky Ford exchange decrees (87-CW-63 and 99-CW-170), physical exchanges from Pueblo Reservoir to Turquoise Reservoir, Twin Lakes Reservoir and Clear Creek Reservoir would not be allowed during the Winter Water Storage Program (November 15 through March 14).

2.3.7.3 Lower Basin Operating Conditions

In the lower Arkansas River basin below Pueblo Reservoir, Aurora has agreed to the restrictions described below and shown in Table 2-5.

Table 2-5. Summary of Lower Arkansas Basin Flow for Aurora to Store Water in Pueblo Reservoir.

Location	Flow (cfs)
Arkansas at Portland	155 (native flows)
Arkansas above City of Pueblo	100
Moffat Street or Combined Flow Location	57 or 85
St Charles Mesa Water District (Moffat St. gage Nov. 15-March 15)	50
Arkansas at Avondale (only for exchanges from Meredith	500

- Pursuant to the decrees (83-CW-18, 99-CW-169, and the High Line lease), Aurora's diversions at Pueblo Reservoir are reduced when native inflows drop below 208 cfs. Diversions are completely curtailed when the native inflows are less than 155 cfs. Diversion and storage of leased water rights in Pueblo Reservoir can occur only when native inflows at the Portland gage are greater than 155 cfs.
- Aurora would operate to provide a minimum flow of 100 cfs at the Above Pueblo gage including the release from the fish hatchery, which is located approximately 0.4 miles downstream of Pueblo Dam (Decrees 83-CW-18, 99-CW-169, and the High Line lease).
- The combined flow location is located below the outlet from Runyon Lake (HARP return flows) and above Fountain Creek (The exact location is yet to be determined.) There must be at least 85 cfs at the combined location or 57 cfs at the Moffat Street gage before Aurora can divert at Pueblo Reservoir (Decree 99-CW-169 and extended to 83-CW-18).
- Aurora would curtail exchanges and diversions when winter flows are less than 50 cfs at the Moffat Street gage between November 15 and March 15 for the St. Charles Mesa Water District (Decree 99-CW-170 and extended to 87-CW-63).
- Aurora would curtail exchanges from the Colorado Canal system if the flows in the Arkansas River at the Avondale gage drop below 500 cfs, if requested by the Arkansas Valley Ditch Company (Decrees 84-CW-62, 83-CW-63, and 84-CW-64).
- Aurora would operate the High Line Canal lease water or future lease water pursuant to an annual Temporary Substitute Supply Plan approved by the State Engineer's Office or through future decrees obtained in Water Court.

In May of 2004, the City of Aurora signed the Pueblo Flow Management Program IGA to provide target recreational flows in the Arkansas River through the City of Pueblo. However, the IGA contains a clause (Section XIII.B.3) that allows

Aurora to terminate its participation in the program if the City does not receive a Long Term Excess Capacity Contract in Pueblo Reservoir from Reclamation. Therefore, it is assumed that the Aurora would not be bound by the target flows in the IGA if the No-Action Alternative is implemented.

2.3.8 Estimated Cost

The estimated cost for the Proposed Action includes payments to Reclamation for the storage and exchange of water. These payments would be determined during contract negotiations between Aurora and Reclamation. Storage and exchange payments to Reclamation would be applied to repayment of the Fry-Ark Project and to annual operation and maintenance costs for the project. In addition, Aurora would make payments totaling about $24 million to the Southeastern Water Conservancy District under an IGA. Existing reservoirs, rivers, and conveyance facilities would be used; therefore, no construction-related costs would be incurred under the Proposed Action. Operational costs for pumping exchanged water from the Otero Pump Station into the South Platte would be at the same rate as current costs, or about $35 per acre-foot.

2.4 ALTERNATIVES ELIMINATED FROM DETAILED STUDY

During the public scoping process, a variety of alternative actions were suggested (Reclamation 2004b). The following alternatives were considered, but eliminated from detailed study for various reasons as described below.

Construction of a pipeline from the Arkansas River to Aurora. The construction of a pipeline directly from the lower Arkansas River (e.g., from near La Junta) was suggested. Conveyance of water over 100 miles from the lower Arkansas River to Aurora with an elevation difference of over 1,500 feet would require substantial infrastructure development, long-term pumping, operation and maintenance costs, and would result in environmental disturbance from pipeline facility construction. This alternative was eliminated from further consideration because of the substantial environmental disturbance and cost associated with construction of a new pipeline.

Use other sources of water. The use of new water sources other than Aurora's Arkansas River basin water rights does not meet the purpose and need of the Proposed Action. Aurora's Arkansas River basin water rights provide over 25 percent of Aurora's municipal needs. The purpose of the Proposed Action is to store and deliver Aurora's leased and decreed water rights to Aurora for beneficial uses. Aurora owns other sources of water and will continue to use those sources, as well as develop new sources as needed. Aurora has determined that the yield from its current water rights in the Colorado, Arkansas, and South Platte river basins should be maximized before new sources of supply are pursued. This includes the proposed Excess Capacity Contracts, as well as methods to recover reusable return flows for potable and non-potable uses.

Construct a new reservoir. The construction of a new reservoir either above or below Pueblo Reservoir was suggested as an alternative. Aurora considered new on-channel and off-channel reservoir sites upstream of Pueblo Reservoir in the past as a means of developing new supplies and firming the yield from transbasin diversions and exchanges from the lower Arkansas River. A new reservoir upstream of Pueblo Reservoir was eliminated as an option for the following reasons:

- The anticipated environmental impacts associated with dam construction and conveyance facilities when compared to the Proposed Action, which requires no new infrastructure development or land disturbance are significant.
- The cost of the dam and associated infrastructure would be substantial, particularly compared to the Proposed Action that involves no new infrastructure.
- In order to make use of Aurora's existing lower Arkansas basin rights in an upstream reservoir, flows would have to be exchanged through the reach between Pueblo Reservoir and the reservoir site. Limitations on exchange potential would reduce the yield available to Aurora from those rights.

The No Action Alternative includes construction of a new reservoir below Pueblo Reservoir.

Enlarge Pueblo Reservoir. The enlargement of Pueblo Reservoir was eliminated as an alternative because sufficient excess capacity is presently available in Pueblo Reservoir to accommodate the Proposed Action in all but very wet years. The storage and yield benefits associated with an enlarged Pueblo Reservoir were not considered to justify the cost and impacts associated with enlargement of Pueblo Reservoir. Enlargement of Pueblo Reservoir is being considered by the Southeastern Colorado Water Conservancy District and other Arkansas River basin entities. It is possible that Aurora could participate in that project if supported by SECWCD. However, the magnitude of the design, permitting and construction process to accomplish the project would not allow it to be brought on line in time to meet Aurora's short-term water requirements.

Shorten the contract period with Reclamation. In order to provide a reliable mechanism for the transfer of Aurora's water rights, a long-term contract for storage is required. Reclamation policy for long-term contracts is a minimum of 10 years and a maximum of 40 years. The City of Aurora has requested a 40 year contract. Contract negotiations as part of the Proposed Action will negotiate the contract term. The contract term is a component of the Proposed Action, but does not constitute a separate alternative.

Implement sustainable water management or other measures to reduce demand. The City of Aurora has developed and implemented water conservation and drought management programs to conserve water use and reduce demand. Aurora's aggregate (residential and commercial/industrial) water demand rate of about 170 gallons per capita per day is currently less than the average demand rate for Front Range metropolitan communities. Aurora will continue to operate and expand this program to conserve water resources regardless of the decision on the Proposed Action. Projected water demands exceed existing supplies and foreseeable supplies from other sources even with conservation measures.

Trade Colorado Springs Homestake water for Aurora's Arkansas River water. This alternative involves the exchange of Colorado Springs Homestake water imported from the West Slope for Aurora's Arkansas River basin water, which could then be transported to Colorado Springs if the proposed Southern Delivery System (SDS) Project is built. Colorado Springs currently conveys its Homestake water via the Otero Pump Station to Rampart Reservoir northwest of the Springs, where the water is stored and delivered to water treatment facilities. Aurora also owns capacity in the Otero Pump Station and Pipeline, and could take additional Homestake water through this system to the South Platte basin.

This alternative is not acceptable to the City of Colorado Springs (Gracely 2005) and was eliminated for the following reasons:

- This alternative would require multiple infrastructure developments and substantial expense, including enlarging the proposed capacity for the SDS pipeline.
- Colorado Springs currently has limitations in the amount of water they can store in Pueblo Reservoir, so additional storage would need to be developed.
- The completion of the SDS Project is uncertain.
- Colorado Springs Homestake water is delivered to Rampart Reservoir where it can serve higher elevations in the City. Whereas, the SDS pipeline would deliver water to lower elevation portions of the system. This would adversely affect the efficiency and cost of distributing Colorado Springs water supplies to their customers.

2.5 REASONABLY FORESEEABLE ACTIONS FOR CUMULATIVE EFFECTS ASSESSMENT

Several reasonably foreseeable actions are anticipated to occur in the future regardless of the implementation of the Proposed Action or the No Action Alternative. Reasonably foreseeable future actions, when combined with past and present actions and the alternatives evaluated in this EA, may result in cumulative effects. This section describes reasonably foreseeable actions, as well as those actions that were not considered reasonably foreseeable. The cumulative effects of the reasonably foreseeable actions for affected resources are evaluated in Chapter 3.

2.5.1 Reasonably Foreseeable Actions

Because the Proposed Action would not result in any new infrastructure or ground disturbance, reasonably foreseeable actions were limited to those that would have overlapping effects with the proposed project on water resources. Reasonably foreseeable hydrologic conditions for the cumulative effects analysis were based on anticipated changes in water demand, use, and storage in 2045, the approximate end of Aurora's requested storage and exchange contracts. Anticipated reasonably foreseeable conditions include:

- Increased use of Fry-Ark and native water by municipal entities.
- Consistent with the Board of Water Works of Pueblo Excess Capacity Contract, storage in Pueblo Reservoir would increase from 3,000 ac-ft to 15,000 ac-ft over the period from 2001 to 2021.
- Colorado Springs Utilities' Excess Capacity Contract for storage in Pueblo Reservoir would be reduced from 10,000 ac-ft to 1,000 ac-ft.
- Colorado Springs Utilities would increase ground water pumping and potable reuse to meet future demands.
- Colorado Springs Utilities would construct a 25,000 acre-foot reservoir in the Fountain Creek basin as part of the reuse plan.
- All entities currently participating in ROY storage (Aurora, Colorado Springs, Fountain, SECWCD, and BWWP) would continue their participation.

Because the No Action Alternative includes the development of gravel pit reservoir storage, reasonably foreseeable actions in the vicinity of the gravel pit reservoir storage site were assessed; however, no reasonably foreseeable actions or activities were identified.

2.5.2 Actions Not Considered Reasonably Foreseeable

Several potential actions not considered reasonably foreseeable were identified. Although these actions are not currently reasonably foreseeable, they could occur at some point in the future; however, based on the best available information, these actions would not be considered reasonably foreseeable at this time.

Southern Water Delivery System. The Southern Delivery System (SDS) Project is a proposed regional water delivery project designed to provide a portion of the future water needs through 2046 for the City of Colorado Springs, City of Fountain, Security Water District, and perhaps the Pueblo West Metropolitan District. As proposed, SDS would deliver Fry-Ark Project water and non-Fry-Ark Project water from the Arkansas River near the City of Pueblo to the Participants' service areas. The SDS Project includes excess capacity storage in Pueblo Reservoir and potential conveyance connections with Fry-Ark facilities. Pueblo Reservoir and associated Fry-Ark facilities are owned by the United States and operated by Reclamation. SDS proponents would need to negotiate one or more contracts with Reclamation to implement the proposed project. Currently, Reclamation is evaluating potential alternatives in an Environmental Impact Statement.

The SDS Project was not considered reasonably foreseeable because the project is still being reviewed under NEPA compliance and there is no reasonable certainty that the project would be implemented and if implemented, under what conditions. Reclamation has not made a decision on the SDS Project and has no approved basis for negotiating a contract with project proponents.

Preferred Storage Options Plan (PSOP). This action potentially includes enlargement of Turquoise Reservoir or Lake Pueblo or re-operation of space in Pueblo Reservoir and other Frying Pan-Arkansas Project facilities. Preliminary feasibility studies have been conducted by the SECWCD and Colorado Springs Utilities, but no determination has been made on whether to pursue this project. Any assumptions on whether it would be constructed and how it would operate are speculative. This project would require federal authorization; however, no NEPA compliance or permitting requests have been initiated. Changes to Federal legislation and funding are required before implementation could commence. At this time, enlargement of Fry-Ark facilities is not reasonably foreseeable for the above reasons.

Arkansas Valley Conduit. The Arkansas Valley Conduit is an authorized feature of the Fry-Ark Project under the Act of August 16, 1962 (Public Law 87-590), but was never built. The Conduit would transport water from Pueblo Dam east to communities along the Arkansas River and would extend to Lamar Colorado. The SECWCD and potential participants are currently considering construction of the Conduit to serve the various municipal participants on the lower Arkansas River. Implementation of this project would require new Congressional authorization and Federal funding. In 2005, Senator Allard, with the co-sponsorship of Senator Salazar and Representative Musgrave introduced the Arkansas Valley Conduit legislation as S. 1106 and H.R. 2555. Legislation for the funding of this project and cost-share by project beneficiaries has not passed. NEPA compliance or permitting requests have not been initiated. Any assumptions on whether it would be constructed and how it would operate are speculative. For the above reasons, this project is not considered reasonably foreseeable.

Chapter 3 Affected Environment and Environmental Consequences

This chapter provides baseline information on the affected environment and the potential environmental consequences associated with implementing either the Proposed Action or No Action Alternative as described in Chapter 2. Resources evaluated in this chapter include water resources, geomorphology, ground water, water quality, aquatics, vegetation, wildlife, threatened and endangered species, recreation, land use, socioeconomics, and cultural resources. Each resource includes a discussion of the affected environment, and the direct, indirect, and cumulative environmental consequences. The potential effects associated with the Proposed Action or No Action Alternative are discussed including a comparison of the difference between alternatives. Appendix A includes hydrology model output tables referenced in the text.

The primary study area for this evaluation includes the upper Arkansas River upstream of Pueblo Reservoir and the lower Arkansas River from Pueblo Reservoir downstream to La Junta. Streams include the Lake Fork of the Arkansas River from Turquoise Reservoir to the Arkansas River, Lake Creek below Twin Lakes Reservoir, and the Arkansas River from Twin Lakes Reservoir downstream to La Junta. Six existing reservoirs, including Twin Lakes Reservoir, Turquoise Reservoir, Pueblo Reservoir, Lake Meredith, Lake Henry, and Holbrook Reservoir could potentially be affected by the proposed project. In addition, new gravel pit reservoir storage under the No Action Alternative would be located near the Arkansas River east of the City of Pueblo. These streams and reservoirs are collectively referred to as the study area and are shown in Figure 1-1. The study area includes portions of Lake, Chaffee, Fremont, Pueblo, Crowley, and Otero counties.

The Proposed Action would not involve construction of new structures and, therefore, would not involve physical disturbances to the Arkansas River or study area reservoirs. The No Action Alternative would use a gravel pit for water storage following mining operations. Mining operations are not part of the No Action Alternative and would be completed prior the use of the gravel pits for water storage under the No Action Alternative.

3.1 SURFACE WATER QUANTITY

This section describes the existing surface water conditions in the study area and the effects of the Proposed Action and No Action Alternative on streamflow quantity, streamflow hydraulics, reservoir quantity, reservoir surface area, and reservoir water surface elevation. The affected environment is described for several stream and reservoir locations throughout the study area. Monthly average historical streamflow graphs are provided for USGS streamflow gages that are representative of river reaches within the study area. Time series graphs showing monthly historical reservoir storage contents throughout the study period are also provided. Simulated direct and cumulative effects streamflow and reservoir contents are plotted, and environmental consequences associated with the Proposed Action and No Action Alternative are discussed. Additional information on water resources is included in the Water Resources Technical Report (MWH 2005b).

3.1.1 Affected Environment

3.1.1.1 Hydrologic Setting

The Arkansas River basin in Colorado encompasses approximately the southeastern quarter of Colorado. Native water supplies in the basin are supplemented by several transbasin diversion projects. In addition, several storage facilities in the basin store peak runoff for use throughout the year. Storage reservoirs in the study area include: Turquoise Reservoir, Twin Lakes Reservoir, Pueblo Reservoir, Lake Meredith, Lake Henry, and Holbrook Reservoir.

Natural streamflow in the Arkansas River occurs primarily as a result of snowmelt runoff. Mean annual precipitation ranges from less than 10 inches in the plains to more than 40 inches in the high mountains (Abbot 1985). Precipitation in the mountains occurs primarily as snowfall, which results in high intensity short duration runoff events in the late spring and early summer months. Precipitation in the plains occurs slightly more evenly throughout the year, with frequent isolated intense summer storms. Except for the high mountain areas within the drainage basin, most of the basin is considered a semi-arid environment (Abbot 1985).

Water Use

Water is used for many purposes within the Arkansas River basin, including, agricultural, municipal, industrial, recreation, fisheries, and augmentation (CWCB 2002). Irrigation, primarily downstream of the City of Pueblo, is the single largest use of water within the Arkansas River basin, followed by municipal and industrial (M&I) use. The Colorado Water Conservation Board (CWCB) estimates annual diversions for irrigation within the Arkansas River basin, which includes many counties outside of the study area, to be about 2 million ac-ft. The next highest diversion category, other than water diverted for storage, is municipal use, estimated to be about 173,000 ac-ft (CWCB 2002). The two largest M&I water users in the Arkansas River basin are Colorado Springs Utilities and the Board of Water Works of Pueblo.

The City of Aurora exports water from the basin for municipal use within its water service area in the South Platte River basin through purchases of agricultural ditch system shares and through leases with agricultural ditch systems.

Water Supplies

Water supplies for water users in the Arkansas River basin are primarily made up of native supplies from Arkansas River surface flows, ground water, and transbasin diversions. Major transbasin projects in the Arkansas River basin include the Fryingpan-Arkansas (Fry-Ark) Project, Homestake Project, Twin Lakes Project, Busk-Ivanhoe System, the Columbine, Ewing, and Wurtz ditches, and the Blue River Project. Multiple use diversion projects, including the Colorado Canal System and the Rocky Ford Ditch, have been converted from agricultural use to predominantly M&I use.

The most relevant transbasin project to the Proposed Action is the Fry-Ark Project, constructed by Reclamation to supplement municipal and agricultural demands within the Arkansas Valley of Colorado. Aurora's proposed excess capacity contracts would use Fry-Ark reservoirs to facilitate the transfer of water from the Arkansas River basin to the South Platte River basin.

The Fry-Ark Project consists of five reservoirs and one transbasin diversion tunnel. Fry-Ark reservoirs in the Arkansas River basin include Turquoise Reservoir, Twin Lakes Reservoir, Mount Elbert Forebay, and Pueblo Reservoir. Ruedi Reservoir is located on the West Slope and is not affected by the Proposed Action. The Boustead Tunnel diverts water from the Roaring Fork River basin on the West Slope of the Continental Divide into Turquoise Reservoir. Boustead Tunnel average annual imports were about 55,300 ac-ft for the 1982-2002 study period used in this evaluation (CDSS 2004). Water from Turquoise Reservoir is stored and released through the Mount Elbert Conduit to the Mount Elbert Forebay. Water from the forebay is then used to generate power at the Mount Elbert Pumped-Storage Powerplant. Twin Lakes is the receiving reservoir for water used at the power plant, and water is released from Twin Lakes to the Arkansas River via Lake Creek. Pueblo Reservoir is a direct-streamflow storage reservoir on the Front

Range that stores and delivers water to municipal and agricultural entities in the lower Arkansas Valley. The storage capacities for each of the Fry-Ark reservoirs are shown in Table 3-1.

The SECWCD was established in 1958 as the local sponsoring agency for the Fry-Ark Project. The SECWCD is responsible for repayment to the United States and allocation of Fry-Ark water to its constituents. Through their allocation principals, the SECWCD has categorized Fry-Ark Project municipal water users into four groupings: municipal entities west of Pueblo, the BWWP, municipal entities east of Pueblo, and Fountain Valley Authority entities. Each entity is allocated a certain percentage of Fry-Ark Project yield and storage. A total of 159,000 ac-ft of Fry-Ark Project storage is set aside for municipal storage and municipal carryover storage (Reclamation 1990). A summary of Fry-Ark Project yield and storage allocations for each of the entities is presented in Table 3-2.

In addition to storage of Project water, Reclamation has historically allowed storage of non-Fry-Ark Project water in Fry-Ark Project storage space through programs such as the Winter Water Storage Program (WWSP) and “if and when” (Temporary Excess Capacity or Short-Term Excess Capacity) contracts. Under these programs, non-Fry-Ark Project water may be stored when Fry-Ark Project storage space is not filled with Fry-Ark Project water. The largest municipal users of these contracts have historically been Colorado Springs Utilities and the City of Aurora; amounts have been up to 10,000 ac-ft and have typically been located in Pueblo Reservoir. These contracts are now referred to as “Short-Term Excess Capacity Contracts” (Short-term contracts). The historical volume of these contracts is presented in Table A-1.

Table 3-1. Fryingpan-Arkansas Project Reservoir Storage Volumes.

Reservoir	Reservoir Storage (ac-ft)					
	Dead	Inactive(1)	Active Conservation	Joint Use(2)	Flood Control	Total Capacity
Ruedi	63	1,095	101,278	0	0	102,373
Turquoise	2,810	8,920	120,478	0	0	129,398
Pueblo	2,329	28,121	228,828	66,000	26,991	349,940
Twin Lakes	63,324	72,938	67,917	0	0	140,855
Mount Elbert Forebay	561	3,825	7,318	0	0	11,143

(1) The volume shown for inactive includes the volume shown for dead storage. Dead storage is storage below the outlet works that physically cannot be drained. Inactive storage is storage that by operational principals is reserved for in-reservoir use and never evacuated from storage.

(2) The Joint Use pool is reserved for flood control space from April 15 through November 1. At other times, it can be used for conservation storage.

Source: Reclamation 1990.

Table 3-2. Summary of Fry-Ark Municipal Yield and Storage Allocations.

Entity	Allocation Percentage	Average Annual Yield Allocation(1)	Storage Space Allocation(2)
		(ac-ft)	
Municipal—West of Pueblo (not including p Pueblo West)	4%	3,216	12,400
Board of Water Works of Pueblo	10%	8,040	31,200
Municipal East of Pueblo	12%	9,648	37,400
Fountain Valley Pipeline	25%	20,100	78,000
Total	**51%**	**41,004**	**159,000**

(1) Based on average annual Fry-Ark Project yield of 80,400 ac-ft.

(2) From SECWCD Allocation Principles (SECWCD 1979). However, in the Allocation Policies (SECWCD 2004), the municipal carryover storage space was stated to be 163,100 ac-ft. Reclamation considers the additional 4,100 ac-ft to be used for non-Fry-Ark Project Purposes only (Musgrove, pers. comm. 2005).

Aurora's Proposed Action is for a long-term excess capacity contract for 10,000 ac-ft located in Pueblo Reservoir. Short-term contracts typically have a duration of 1 to 3 years, and require renewal at the end of the contracting term. The proposed long-term excess capacity contract would have a term of 40 years.

When storage space is unavailable to accommodate both Fry-Ark Project and non-Fry-Ark Project accounts, non-Fry-Ark Project water is "spilled" from the reservoirs. The current spill priorities shown in Table 3-3 were included in the contract between the United States and the Southeastern Colorado Water Conservancy District on January 23, 1986 (Musgrove, pers. comm. 2006). As shown, Aurora's proposed Long-Term Excess Capacity account would be in the first group of storage accounts to spill if inadequate storage space is available to meet all excess capacity contract requests.

The WWSP was developed to allow direct streamflow agricultural water rights to be stored in Pueblo Reservoir from November 15 to March 14, for use during the peak agricultural water demand season during the spring and summer. The principal entities that divert streamflow under the WWSP include the following agricultural entities: Bessemer, High Line, Oxford, Catlin, Colorado Canal System, Holbrook, Fort Lyon, and Amity. Municipal entities including Colorado Springs and Aurora utilize WWSP storage through shares in the Colorado Canal System.

Two flow management programs and a recreational in channel diversion (RICD) currently in operation affect Arkansas River streamflows: the UAVFMP and the Pueblo Flow Management Program (PFMP). The UAVFMP is based on target flow recommendations from the Colorado Department of Natural Resources (CDNR) at the Wellsville gage for fisheries and recreation. The

Table 3-3. Fryingpan-Arkansas Project Reservoir Spill Priorities.

Spill Order(1)	Storage Account(2)
1	Entities Outside of SECWCD (including Aurora)
2	"if and when" Storage
3	WWSP water in Excess of 70,000 ac-ft
4	Municipal non-Fry-Ark Project water
5	WWSP water less than 70,000 ac-ft
6	Native Arkansas River basin Fry-Ark Project water

(1) First to spill is the first account in the list.
(2) Refer to Appendix B for further detail on Fry-Ark Project spill priorities.

PFMP is based on an Intergovernmental Agreement among the Cities of Pueblo, Aurora, Colorado Springs, and Fountain, SECWCD, and the Board of Water Works of Pueblo. The IGA identifies flows in the Arkansas River from Pueblo Dam to Fountain Creek that the parties will cooperate to achieve. Flows are measured at the Above Pueblo gage (streamflow at the Above Pueblo location is the sum of streamflow at the Above Pueblo gage and return flows from the Pueblo Fish Hatchery) primarily for recreational purposes. Through IGAs, contracts with Reclamation, and its decrees, certain target flows must be met in the Arkansas River prior to Aurora diverting its Arkansas River water rights. The city of Pueblo obtained an RICD decree to maintain streamflows at the Arkansas River at Moffat Street streamflow gage. The appropriation date for the RICD is May 15, 2000, and the decree was signed April 5, 2006 (Colorado Water Court 2006). The RICD limits exchanges junior to the RICD appropriation date, with the intent of maintaining recreational flows in the Arkansas River reach near the Moffat Street gage for recreational purposes such as kayaking, canoeing, and rafting. The RICD water right flows are the same as the target flows for the PFMP. However, the RICD water right flows apply to streamflow at the Moffat Street gage, and the PFMP target flows apply to streamflow at the Above Pueblo gage.

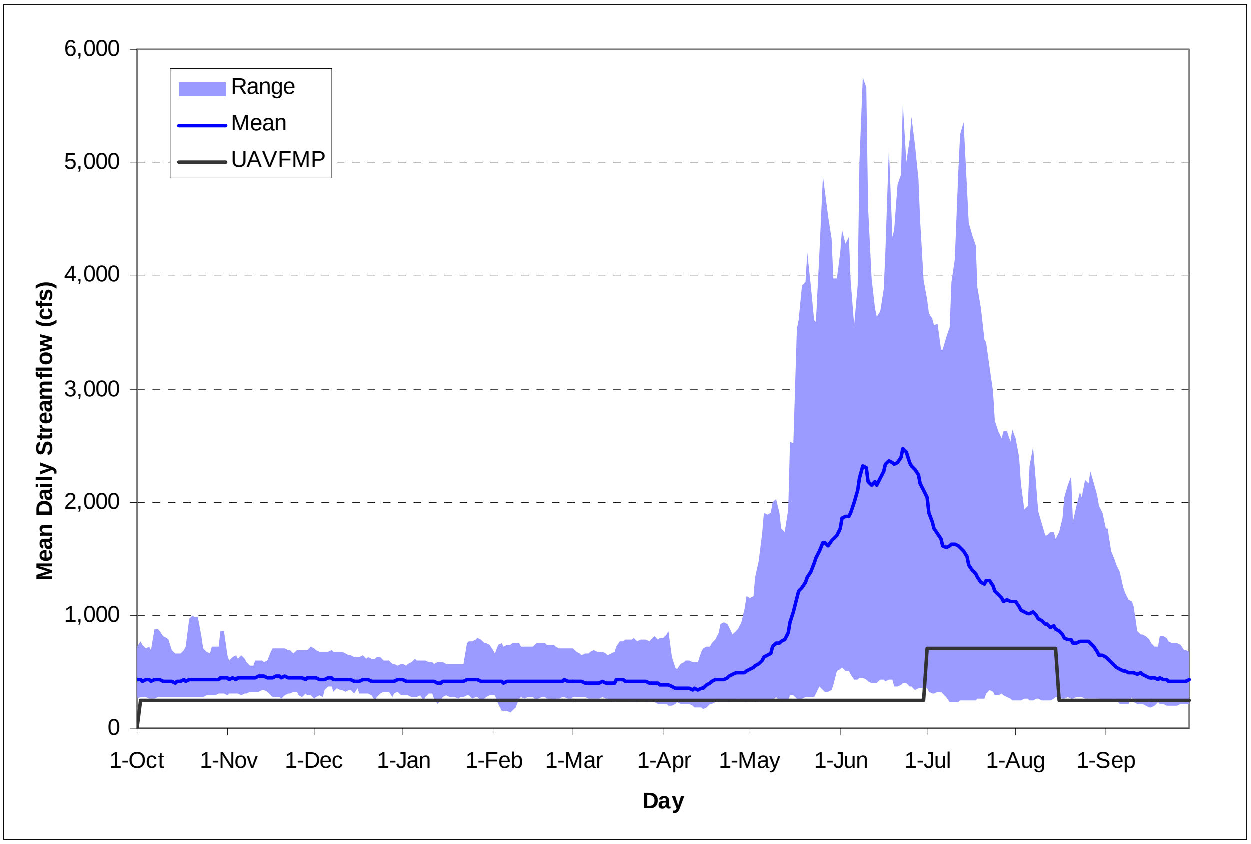
3.1.1.2 Historical Streamflow

The USGS and the Colorado Department of Natural Resources maintain streamflow gaging stations throughout the basin. A summary of historical daily streamflow records for the 1982-2002 study period is given for selected gages in the study area. Stream gage locations are shown in Figure 1-1.

Wellsville Gage

Mean daily historical streamflows, the range of historical daily streamflows, and the minimum streamflows associated with the UAVFMP are

Figure 3-1. Wellsville Daily Mean Historical Streamflow Summary for Study Period.



Source: CDSS 2004.

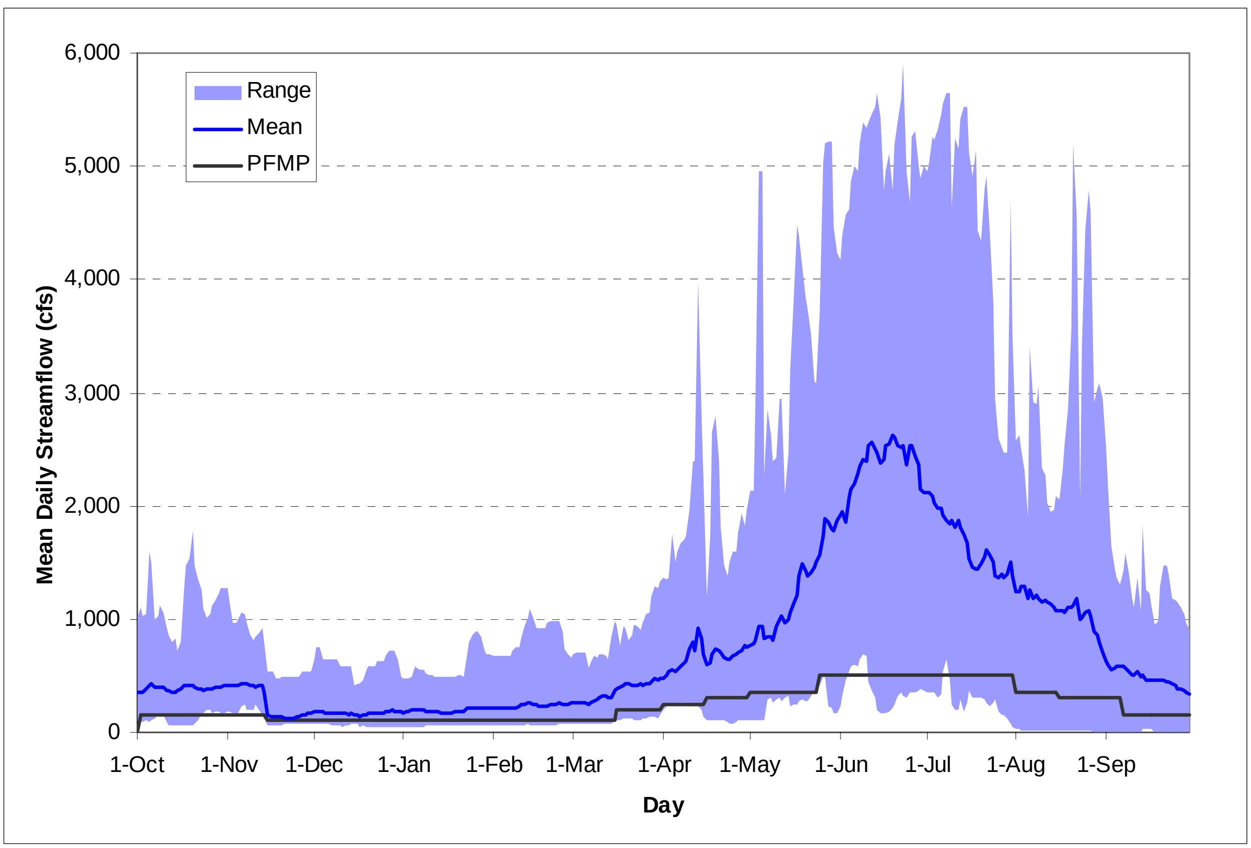
shown in Figure 3-1. The target flows are the minimum of the possible target flows in the UAVFMP (700 cfs from July 1 to August 15, and 250 cfs for the remainder of the year). Recommendations for the winter incubation period (November 16 to April 30) are based on streamflows during the previous spawning period (October 15 to November 15). The CDNR usually recommends that winter incubation flows be maintained at a level of not more than 5 inches below the river height during the previous spawning period. The mean historical streamflows show that the flow program targets are generally met. However, there have been years in the study period when the 700 cfs streamflow target was not met. This primarily occurred during drought conditions in 2002 and during years in the study period prior to the UAVFMP, which began in 1990.

Above Pueblo Gage

A summary of daily historical streamflow for the Above Pueblo gage is shown in Figure 3-2. Streamflow at the Above Pueblo gage is controlled by releases from Pueblo Reservoir. High mean streamflows in late summer are a result of Pueblo Reservoir releases made for irrigation.

The PFMP streamflow line shown in Figure 3-2 represents the “above average”[2] target flows, stipulated in the IGA (2004). Streamflows shown in Figure 3-2 are streamflows at the Above Pueblo gage. However, the target flows are administered as a combination of the Above Pueblo gage streamflow reading plus releases from the Pueblo Fish Hatchery, which releases water to the Arkansas River within one-half mile downstream

Figure 3-2. Above Pueblo Daily Mean Historical Streamflow Summary for Study Period.



Source: CDSS 2004.

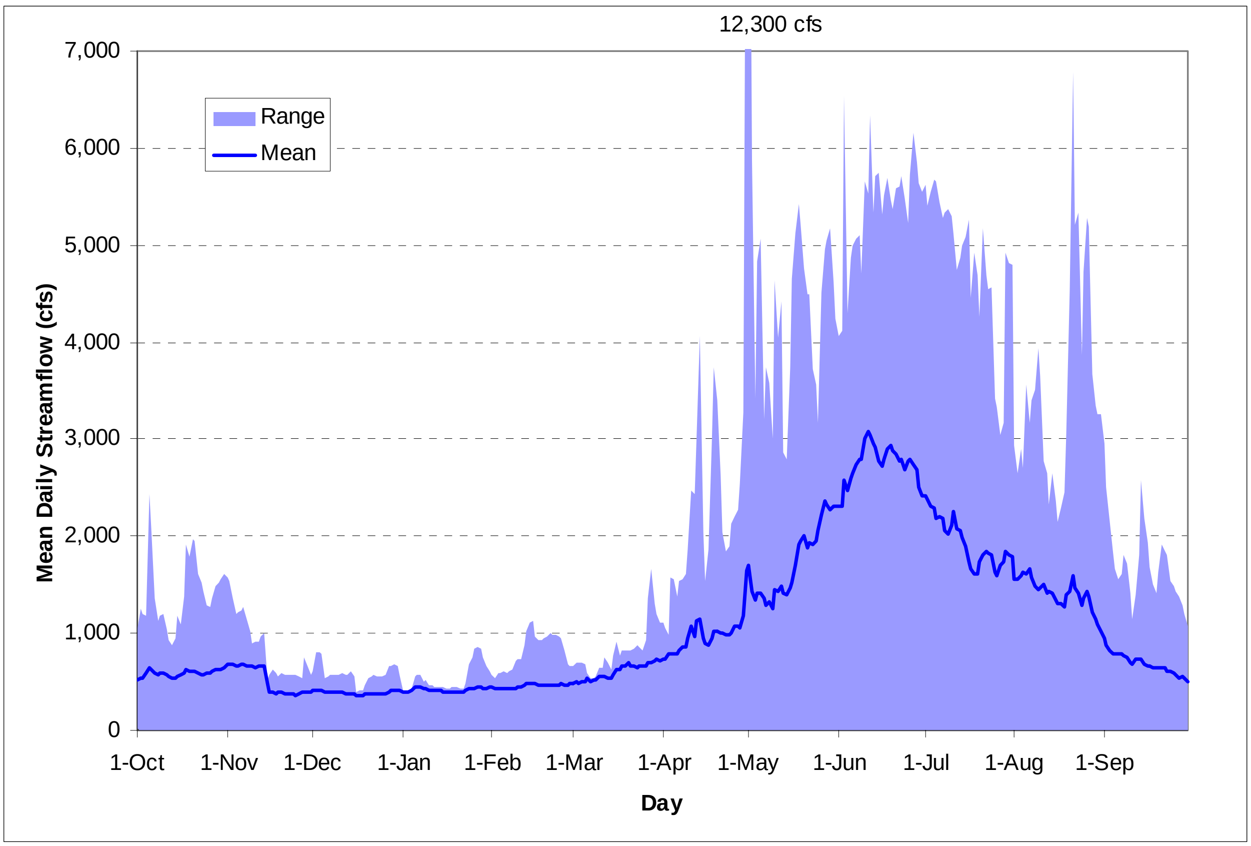
[2] The “above average” flow targets shown on the graph apply when the NRCS “most probable” forecast for the Arkansas River at Salida gage is 100 percent or more of the average Salida gage streamflow.

of the Above Pueblo gage. Releases from the hatchery have historically averaged 15 to 30 cfs. For purposes of presentation in the graph, only the "Above Average" hydrologic condition target flows are shown, because they are more restrictive lower target flows. Releases from storage are not made to meet IGA target flows. The target flows only curtail exchanges by entities that are party to the IGA.

Avondale Gage

The daily historical streamflow summary for the Avondale gage is shown in Figure 3-3. As with the Above Pueblo gage, streamflows at the Avondale gage are heavily influenced by releases from Pueblo Reservoir for irrigation purposes that can total several thousand cubic feet per second.

Figure 3-3. Avondale Daily Mean Historical Streamflow Summary for Study Period.

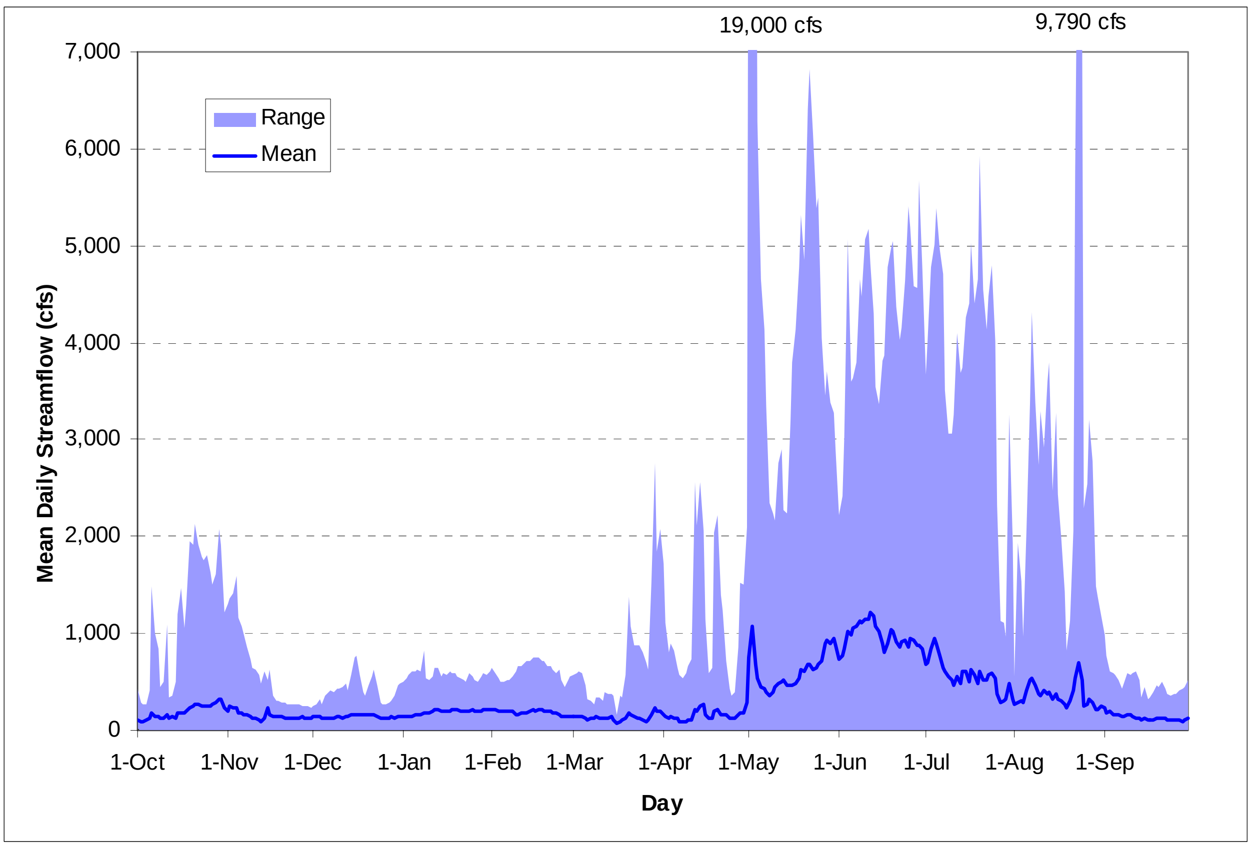


Source: CDSS 2004.

La Junta Gage

Daily summaries of streamflows at the La Junta gage are shown in Figure 3-4. As expected, streamflows at the La Junta gage are substantially less than streamflows at the Avondale gage. This is due to the amount of diversions that take place in the intervening reach. Wintertime streamflows are less due to the WWSP off-channel diversions.

Figure 3-4. La Junta Daily Mean Historical Streamflow Summary for the Study Period.



Source: CDSS 2004.

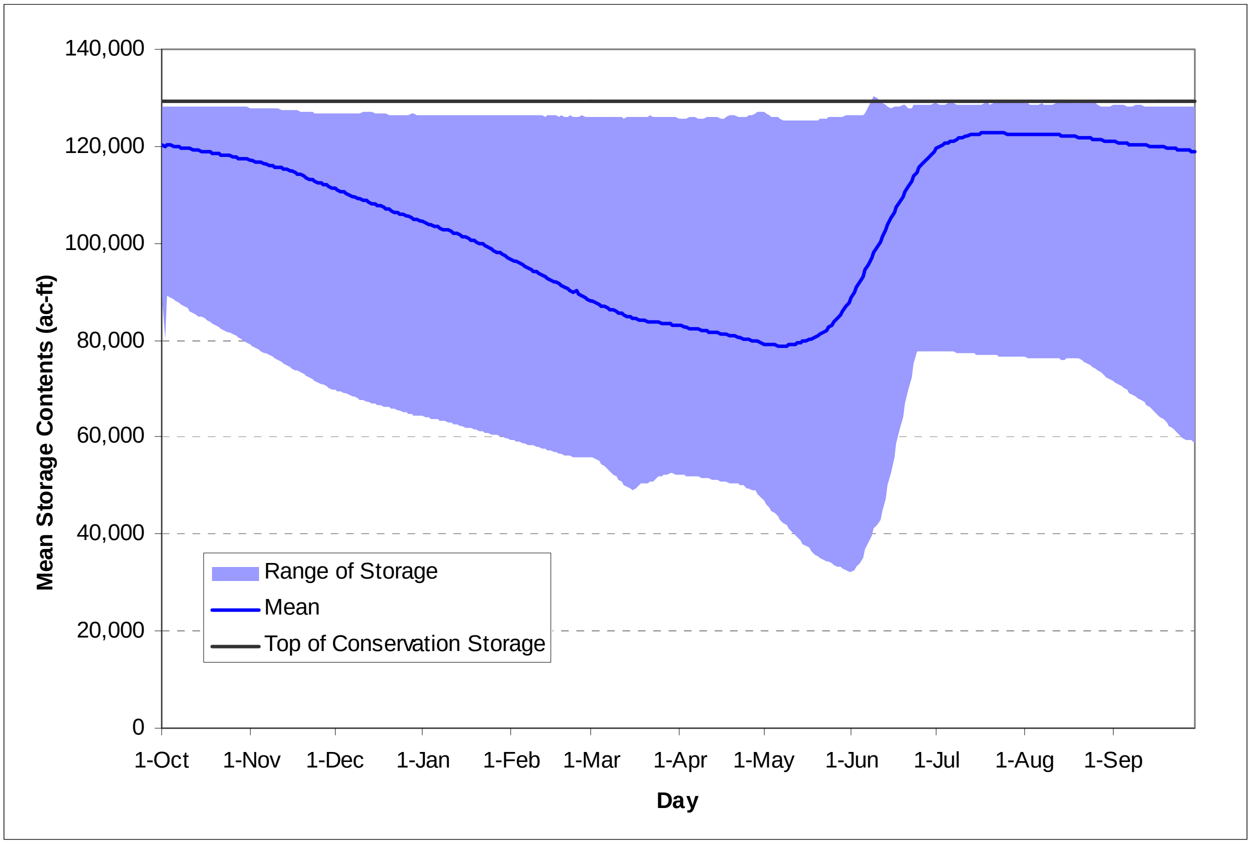
3.1.1.3 Historical Daily Reservoir Contents

Daily reservoir storage contents data were obtained from Reclamation's Hydromet Data System (Reclamation 2004a). A summary of historical daily storage records for the 1982-2002 study period is given for Turquoise Reservoir and Pueblo Reservoir. Reservoir locations are shown in Figure 1-1.

Turquoise Reservoir

Mean daily historical reservoir contents for Turquoise Reservoir are shown in Figure 3-5. Fry-Ark Project contents are generally drawn down through the winter months for two reasons: (1) to meet streamflow requirements at the Wellsville gage as part of the UAVFMP and (2) to make room for the following summer's transbasin imports through the Boustead Tunnel. In addition, water from non-Fry-Ark Project space, including Homestake space and CF&I space, is released for delivery through the Homestake pipeline and to Pueblo Reservoir. This is evident in the figure as storage space in Turquoise Reservoir is drawn down by about 40,000 ac-ft during the winter. Because the call on the Arkansas River is set to March 1, 1910, during the WWSP season, the CWCB in-stream streamflow rights are out of priority from November 15 through March 15 each year. However, past Reclamation operations have typically released 3 to 4 cfs in Lake Fork and 15 cfs in Lake Creek from Fry-Ark Project storage for fish habitat purposes. All native inflows during the WWSP season are stored in Turquoise and Twin Lakes reservoirs for the benefit of WWSP participants.

Figure 3-5. Turquoise Reservoir Daily Mean Historical Storage Summary for the Study Period.

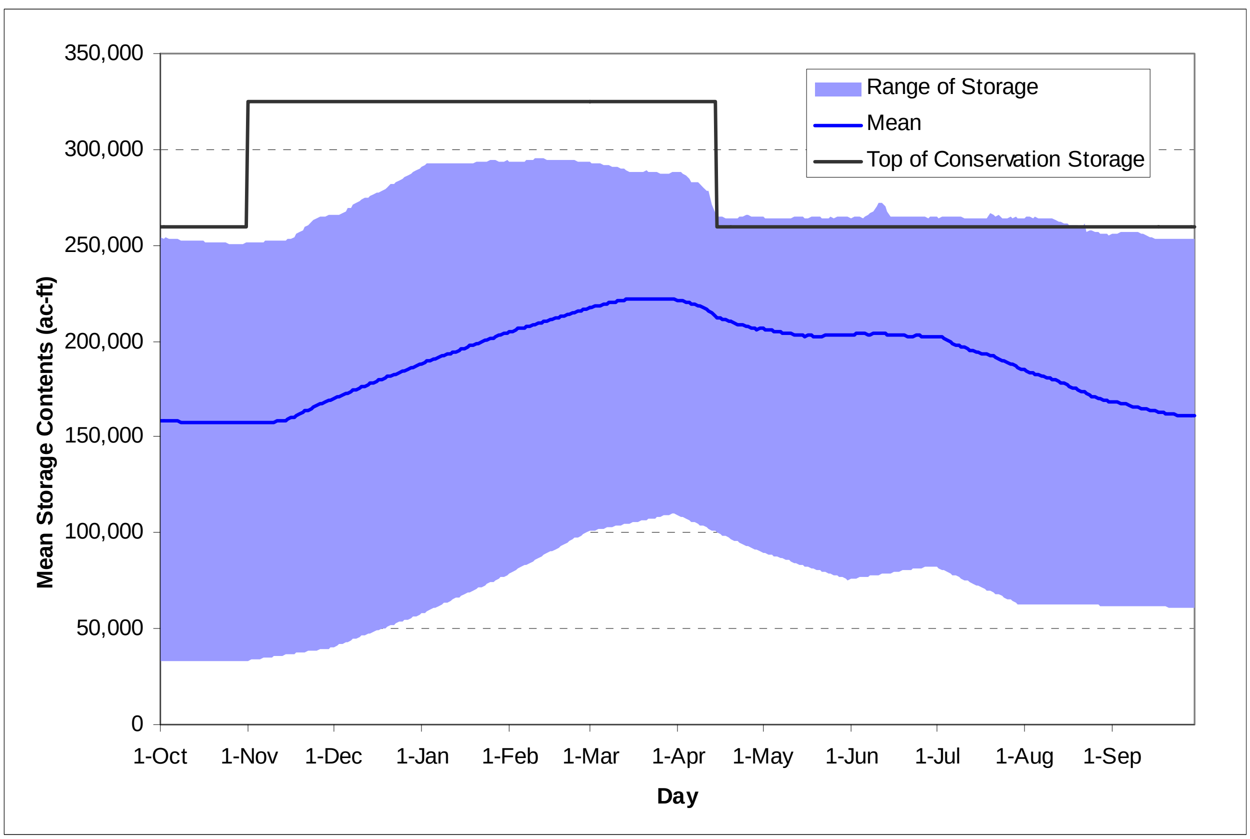


Source: CDSS 2004.

Pueblo Reservoir

Mean daily historical reservoir contents for Pueblo Reservoir are shown in Figure 3-6. Pueblo Reservoir stores water during the winter months as part of the WWSP. Typically, Pueblo Reservoir stores between 30,000 and 50,000 ac-ft per year of WWSP water, with a few years outside of this range (GEI 1998). The capacity of Pueblo Reservoir (top of conservation pool) is 256,949 ac-ft including the dead and inactive pool of 28,121 ac-ft. Additionally, the joint use pool contains 66,000 ac-ft of storage capacity, which is available for storage from November 1 to April 15. A decline in reservoir contents through the summer months reflects the delivery of both Fry-Ark Project water and WWSP water from the reservoir to meet late season agricultural and municipal demands.

Figure 3-6. Pueblo Reservoir Daily Mean Historical Storage Summary for Study Period.



Source: CDSS 2004.

3.1.1.4 Colorado Canal System Reservoirs

The other two major reservoirs within the study area, Lake Henry and Lake Meredith, are located within the Colorado Canal system. Both facilities are off-channel reservoirs. Water is diverted to the reservoirs from the Arkansas River through the Colorado Canal. The Colorado Canal can deliver water directly to either Lake Henry or Lake Meredith; however, because Lake Henry is upstream of Lake Meredith, water from Lake Henry can be delivered to Lake Meredith, but not vice-versa. Lake Henry is able to serve a portion of the irrigated lands under the system by gravity, but Lake Meredith cannot. Releases are made from the reservoirs to the Arkansas River and either exchanged to the Colorado Canal headgate for use by the agricultural shareholders, or exchanged to Pueblo Reservoir for use by the municipal shareholders. The active capacity of Lake Henry is 8,961 ac-ft, while the active capacity of Lake Meredith is 39,804 ac-ft. The accounts for Lake Meredith and Lake Henry are presented in Table 3-4 and Table 3-5.

Table 3-4. Lake Meredith Storage Accounts.

Account	Storage (ac-ft)
Dead/Inactive	**1,196**
Active	
Colorado Springs Utilities	20,661
City of Aurora	12,799
City of Fountain	502
Pueblo West	353
Woodland Park	329
Other M&I	927
Agricultural	4,233
Sub-Total	**39,804**
Total	**41,000**

Table 3-5. Lake Henry Storage Accounts.

Account	Storage (ac-ft)
Dead/Inactive	**1,039**
Active	
Colorado Springs Utilities	6,918
City of Aurora	1,163
City of Fountain	0
Pueblo West	0
Woodland Park	247
Other M&I	123
Agricultural	510
Sub-Total	**8,961**
Total	**10,000**

3.1.1.5 Holbrook Reservoir

Holbrook Reservoir is part of the Holbrook System, which is used for ROY storage previously discussed. Holbrook Reservoir is filled via the Holbrook Canal, which has a capacity of approximately 700 cfs. Recreational access to Holbrook Reservoir is leased by the Colorado Division of Wildlife as a State Wildlife Area (SWA). The active storage capacity of Holbrook Reservoir is about 6,200 ac-ft, and the surface area of the reservoir is slightly more than 600 acres.

3.1.2 Environmental Consequences

The effects on streamflow and reservoirs contents from the Proposed Action and No Action Alternative were determined using hydrologic modeling. Aurora's Quarter-Monthly Model (Hydrosphere 2005) was used to simulate streamflows and reservoir storage contents in the Arkansas River basin for Existing Conditions and future conditions with the Proposed Action and No Action Alternative. Simulated future demands were superimposed on historical hydrologic conditions for the 1982-2002 modeling period. Existing Conditions simulate 2004 water demands and operating conditions in the Arkansas River for the modeling period; whereas, historical conditions reflect varied river operations and demands on the river that occurred during the 1982 to 2002 study period. Because storage in the Arkansas River basin is dependent on carryover storage from previous years (i.e., reservoir contents will be low following dry years and high following wet years), the model was run for consecutive years from 1982 through 2002 in order to simulate the effects of carryover storage.

Pertinent assumptions and Quarter-Monthly Model variables for Existing Conditions, the Proposed Action, and No Action Alternative effects are shown in Table 3-6, and described more fully in the Quarter-Monthly Model Documentation Report (Hydrosphere 2005). As shown, most of the model assumptions are held constant in each of the simulations to isolate the effects of Aurora's Proposed Action. Direct and cumulative effects were determined based on the difference between simulated conditions under the Proposed Action and No Action Alternative.

Exchanges from the lower Arkansas River basin (from Rocky Ford Ditch, Colorado Canal, Highline Lease, and Holbrook Reservoir) to upper Arkansas River basin storage result in water that is located where it is accessible for Aurora's diversion through the Otero Pump Station. Greater exchanges result in increased yield to the City of Aurora. Simulated exchanges are summarized in Table 3-7 for Existing Conditions, Proposed Action, and the No Action Alternative for the direct and cumulative effects. Table 3-8 shows the projected delivery of Aurora's water to the Otero Pump Station for each of the alternatives and Existing Conditions. Yield is slightly less than exchange amounts because of losses between the upper Arkansas River basin storage and the Otero Pump Station (e.g., transit losses). The estimated yield of the Proposed Action is approximately 50,000 ac-ft per year or an estimated 14,300 ac-ft greater than the No Action Alternative. The cumulative effects analysis indicates that the yield of the Proposed Action would be approximately 11,500 ac-ft more than the No Action Alternative.

For the No Action Alternative, Aurora would only be able to divert an estimated 29,500 ac-ft per year between the time the No Action Alternative is implemented and the completion of the gravel lakes storage. After the gravel lakes storage is complete, storage under the No Action alternative increases to an estimated 35,700 ac-ft. The Proposed Action would allow diversion of the maximum available water, because there are no facilities associated with the Proposed Action that would cause a delay in implementation of the alternative during facilities construction.

Simulated streamflows and reservoir contents were converted to river stage and reservoir levels using rating curves. Streamflows and river stage are discussed for USGS stream gages that are representative of hydrologic conditions in the study area. Simulated storage contents and reservoir levels are discussed for the following reservoirs in the study area: Turquoise Reservoir, Pueblo Reservoir, Lake Meredith, and Holbrook Reservoir.

Effects on Twin Lakes Reservoir contents are minimal and are not discussed in detail. Twin Lakes Reservoir effects are minimal for two reasons: daily fluctuations occur in the top two feet of the reservoir due to power operations conducted by Reclamation as part of the Fry-Ark Project, and Aurora only owns 2 percent of the total storage capacity in Twin Lakes Reservoir. As a result, Aurora's operations associated with the Proposed Action and No Action Alternative would be insignificant relative to the existing fluctuations in Twin Lakes Reservoir storage contents. The daily fluctuations in the top two feet of the reservoir are for existing Reclamation operations of Twin Lakes Reservoir and are independent of the Proposed Action and the No Action Alternative.

Table 3-6. Summary of Simulation Model Variable Settings.

Model Variable	Existing Condition	Direct Effects		Cumulative Effects	
		No Action	Proposed Action	No Action	Proposed Action
General Settings					
Municipal Demand Year	2004	2004	2004	2045	2045
Additional Demand by Others	No	No	No	Yes	Yes
Agricultural Demands(1)	Historical	Historical	Historical	Historical	Historical
Otero Pump Station Capacity	118.5 mgd	118.5 mgd	118.5 mgd	118.5 mgd	118.5 mgd
Aurora Settings					
Excess Capacity in Pueblo Res.	10,000 ac-ft	0 ac-ft	10,000 ac-ft	0 ac-ft	10,000 ac-ft
Gravel Lakes Storage	0 ac-ft	10,000 ac-ft	0 ac-ft	10,000 ac-ft	0 ac-ft
USBR Contract Exchanges	0 ac-ft	0 ac-ft	10,000 ac-ft	0 ac-ft	10,000 ac-ft
Transbasin Diversions	Yes	Yes	Yes	Yes	Yes
Upper Arkansas Ranch water Rights	Yes	Yes	Yes	Yes	Yes
Rocky Ford I Transfer	Yes	Yes (junior to RICD)	Yes	Yes (junior to RICD)	Yes
Colorado Canal	Yes	Yes	Yes	Yes	Yes
Rocky Ford II Transfer(2) (3)	Yes (50%)	Yes (100%)	Yes (100%)	Yes (100%)	Yes (100%)
Highline Lease	Yes	Yes	Yes	Yes	Yes
Pueblo FMP/RICD - Aurora	None	None	Full	None	Full
ROY Storage – Aurora	No	No	Yes	No	Yes
Other Municipal Settings					
Board of Water Works of Pueblo Excess Capacity Storage in Pueblo Reservoir	3,000 ac-ft	3,000 ac-ft	3,000 ac-ft	15,000 ac-ft	15,000 ac-ft
Pueblo West Excess Capacity Storage in Pueblo Reservoir	1,000 ac-ft	1,000 ac-ft	1,000 ac-ft	1,000 ac-ft	1,000 ac-ft
Colorado Springs Utilities Excess Capacity in Pueblo Reservoir	10,000 ac-ft	10,000 ac-ft	10,000 ac-ft	1,000 ac-ft	1,000 ac-ft
Pueblo FMP/RICD – Others(4)	None	None	None	None	None
ROY Storage – Others	No	No	No	Yes	Yes
Colorado Springs' Future Operations(5)	No	No	No	Yes	Yes

(1) Agricultural demands are assumed to be the same as historical except for those systems that have been converted to municipal use, such as the Colorado Canal system, Rocky Ford Ditch and Highline Canal lease.

(2) The percentage value indicates the percent of the total decreed yield that is changed and diverted by Aurora. By decree, water cannot be changed from a tract of land until revegetation is complete.

(3) During actual 2004 operations, because Aurora's Upper basin exchange application (99CW170) was not finalized, Rocky Ford II water was diverted into the BWWP Excess Capacity account in Pueblo Reservoir, then moved to Twin Lakes by contract exchange with the BWWP (Simpson, pers. comm. 2005). The Upper basin exchange was decreed in 2005. Therefore, the Quarter-Monthly Model operates per the decree. The differences in storage and streamflow between actual and simulated operations during 2004 are negligible.

(4) Due to limitations in the Quarter-Monthly Model, all Colorado Canal exchanges (including those by Colorado Springs Utilities, Pueblo West and the City of Fountain) are subject to the same Pueblo FMP conditions as other Aurora exchanges

(5) Colorado Springs Utilities future operations assumed to consist of increased ground water pumping and increased non-potable and potable reuse.

Table 3-7. Simulated Annual Exchange into Upper Arkansas River Basin Storage.

	Existing Conditions			No Action Alternative			Proposed Action		
	River	Contract	Total	River	Contract	Total	River	Contract	Total
Direct Effects	13,004	8,952	21,957	10,266	0	10,266	12,269	12,333	24,602
Cumulative Effects	13,004	8,952	21,957	13,460	0	13,460	13,272	11,714	24,986

Note: Exchanges include river and contract exchanges from Pueblo Reservoir plus physical exchanges from the Colorado Canal system.

Table 3-8. Aurora's Existing and Projected Water Deliveries to the Otero Pump Station.

Hydrologic Condition	Existing Conditions	Direct Effects Yield (af/year)			Cumulative Effects Yield (af/year)		
		No Action Alt prior to Gravel Pit Development	No Action Alt after Gravel Pit Development	Proposed Action	No Action Alt prior to Gravel Pit Development	No Action Alt after Gravel Pit Development	Proposed Action
Overall Average	47,300	29,500	35,700	50,000	32,700	38,900	50,400
Mean Wet	49,600	31,500	37,700	51,000	35,900	42,100	51,400
Mean Dry	41,600	22,700	28,900	46,700	25,100	31,400	47,400

Estimated changes in streamflow and reservoir storage for representative locations in the study area are described below. The figures show the effects for overall mean years only. The following is a description of the hydrologic classification used to classify the years in the study period:

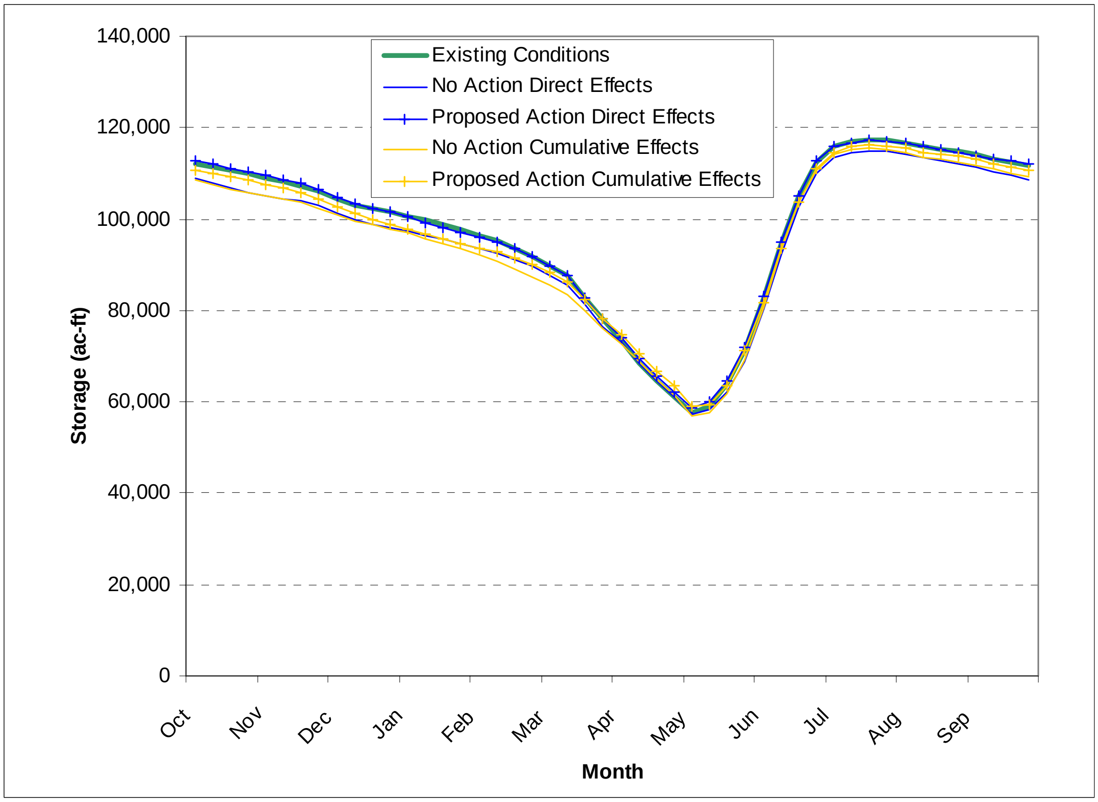
- **Overall Mean —** Mean of all years in the 1982-2002 study period.
- **Mean Dry —** Mean of the driest 30 percent of years in the study period (1988-1990, 1992, 2000, 2002).
- **Mean Wet —** Mean of the wettest 30 percent of years in the study period (1982, 1984, 1986, and 1995-1997).

3.1.2.1 Turquoise Reservoir

Simulated Turquoise Reservoir storage contents are shown in Table A-2 and Figure 3-7. For both the direct and cumulative effects, storage under the Proposed Action would be generally greater than the No Action Alternative, except for winter and spring months during mean dry years. The greatest difference between alternatives would occur during mean wet years. The increased storage under Proposed Action compared to No Action occurs because Aurora is able to contract exchange more water into Twin Lakes Reservoir and Turquoise Reservoir under the Proposed Action. Under the Proposed Action, Turquoise Reservoir monthly water levels would be about 3 percent higher on average than the No Action Alternative.

Changes in reservoir contents under cumulative effect operating conditions follow a pattern similar to direct effects, although the difference between alternatives is less. Under cumulative effects, increased water use from other users in the basin contributes to reduced reservoir contents for both alternatives when compared with Existing Conditions. This includes additional use from Colorado Springs Utilities, Board of Water Works of Pueblo and Fry-Ark Project accounts, which are anticipated to use more water from storage on an annual basis than they have in the past. The Proposed Action would have about 2 percent higher monthly water levels in Turquoise Reservoir on average than the No Action Alternative under cumulative effects.

Figure 3-7. Turquoise Reservoir Simulated Storage Contents Direct and Cumulative Effects for Overall Mean Years (Table A-2).



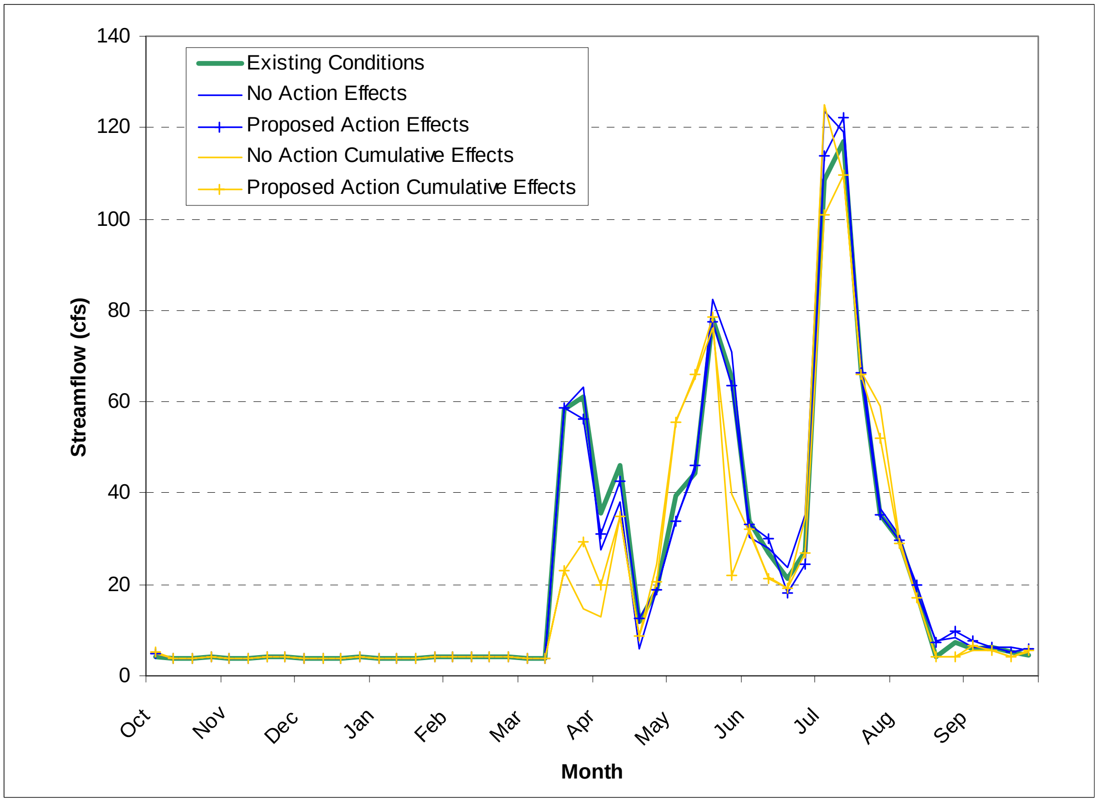
3.1.2.2 Lake Fork

Summaries of simulated streamflow for the Lake Fork gage are presented in Table A-3 and Figure 3-8. Lake Fork streamflow is mostly a result of releases from Turquoise Reservoir. Direct and cumulative effects associated with the No Action Alternative and the Proposed Action are minimal because releases from Turquoise Reservoir would maintain streamflow patterns in Lake Fork. Monthly average streamflow in Lake Fork under the Proposed Action would range from about 16 percent (4 cfs) higher to 9 percent (3 cfs) less than the No Action Alternative. Under cumulative effects, the Proposed Action would result in average monthly streamflows of up to 30 percent greater than the No Action Alternative to 9 percent less.

The Proposed Action would have less than a 0.08 feet (6 percent) decrease in average monthly June Lake Fork stream stage under direct effects compared to the No Action Alternative (Table A-14). Under cumulative effects, simulated Lake Fork streamflow result in a maximum increase of 0.03 feet (4 percent) in Lake Fork stage on average when comparing the Proposed Action to the No Action Alternative.

Specific operations of Turquoise Reservoir releases to Lake Fork are difficult to predict. Although releases to Lake Fork are possible releases from Turquoise Reservoir are typically through the Mt. Elbert Conduit to Twin Lakes. Releases are then made to Lake Creek and the Arkansas River for delivery to downstream users or to the Otero Pumping Station for delivery to Aurora and Colorado Springs. Releases from Turquoise to the Lake Fork are typically to maintain the decreed 15 cfs minimum instream flow year-around for Lake Fork. Therefore, although the analysis of model results shows some direct and cumulative effects on Lake Fork streamflows due to both the Proposed Action and No Action Alternative, it is unlikely that actual effects would be as great as those shown by the model on a monthly basis.

Figure 3-8. Lake Fork Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-3).

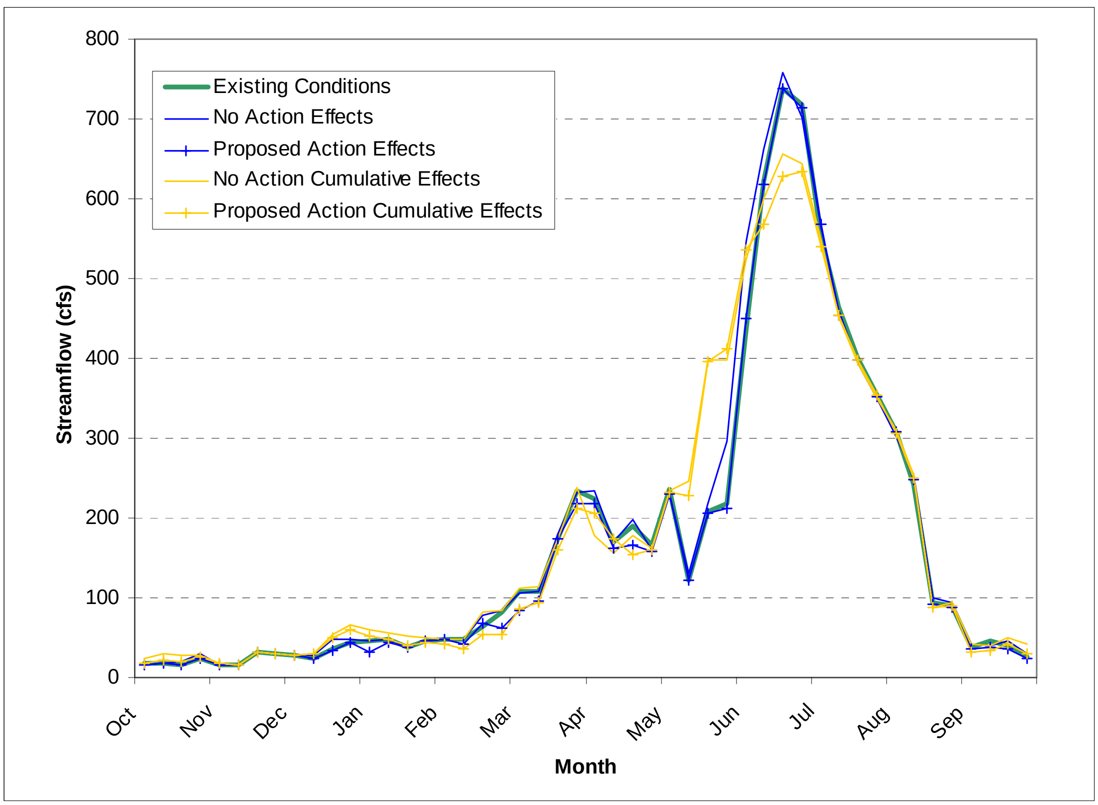


3.1.2.3 Lake Creek

Simulated streamflow summaries for the Lake Creek gage are shown in Table A-4 and Figure 3-9. As with the Lake Fork gage, streamflows are affected by reservoir releases, and Lake Creek streamflow is often a result of native and transbasin releases from Twin Lakes Reservoir. Releases from Twin Lakes Reservoir have historically been made to provide a streamflow of 15 cfs in Lake Creek (Reclamation 1975).

For both direct effects and cumulative effects, Proposed Action streamflows are less than Existing Conditions and the No Action Alternative streamflows, especially during the fall, winter, and early spring months. This is because Reclamation typically moves much of the Fry-Ark Project account in Turquoise Reservoir to Pueblo Reservoir during these months to make room for the Boustead Tunnel imports. Under the Proposed Action, the contract exchanges result in less water released to Lake Creek from the Fry-Ark account during the winter. Because contract exchanges are not part of Existing Conditions or the No Action Alternative, releases to Lake Creek are higher under Existing Conditions and the No Action Alternative than in the Proposed Action. The Proposed Action would have from about 1 percent (<1 cfs) to 15 percent (6 to 10 cfs) less monthly streamflow on average than the No Action Alternative under direct effects. The reduction in streamflow corresponds to increased average yields (river and contract exchanges to storage in the upper Arkansas River basin) when comparing the Proposed Action to the No Action Alternative, as shown in Table A-4. Under cumulative effects, average monthly streamflow for the Proposed Action ranges from about the same as the No Action Alternative to 28 percent less. Average monthly stream stage for the Proposed Action ranges from no difference to 0.12 feet lower than the No Action Alternative (Table A-15).

Figure 3-9. Lake Creek Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-4).



3.1.2.4 Wellsville Gage

Simulated streamflow at the Wellsville gage is shown in Table A-5 and Figure 3-10. Annual streamflow under the Proposed Action would be about 1 percent less than No Action on average for both the direct and cumulative effect analysis. This is because contract exchanges that are part of the Proposed Action result in less water released from the Fry-Ark account in Twin Lakes Reservoir to Lake Creek and the Arkansas River. The Proposed Action would have up to 7 percent less monthly streamflow than for the No Action Alternative during March in dry years and up to 10 percent less during mean wet years under cumulative effects. Stream stage for the Proposed Action and the No Action Alternative would be 0.01 feet less and 0.01 feet higher, respectively, on average when compared to Existing Conditions (Appendix A-16). Under cumulative effects, average monthly stream stage for overall mean, mean wet, and mean dry years for the Proposed Action is 0.02 feet (1 percent) lower when compared with the No Action Alternative.

Figure 3-10. Wellsville Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-5).

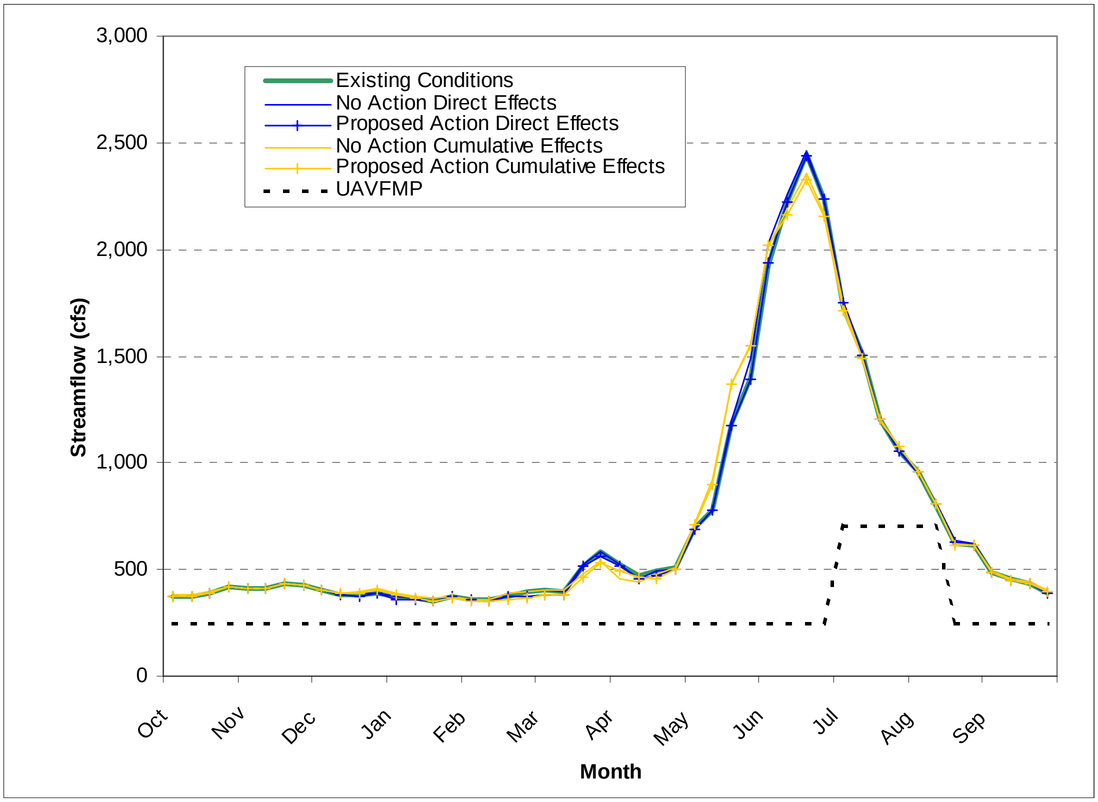


Table 3-9. UAVFMP –Target Flows vs. Simulated Streamflow.

	Existing Conditions	Direct Effects		Cumulative Effects	
		No Action	Proposed Action	No Action	Proposed Action
% Time Met or Exceeded	97.5%	97.4%	97.0%	97.2%	96.8%
Average Difference (cfs)(1)	91.0	86.1	76.2	82.7	75.1

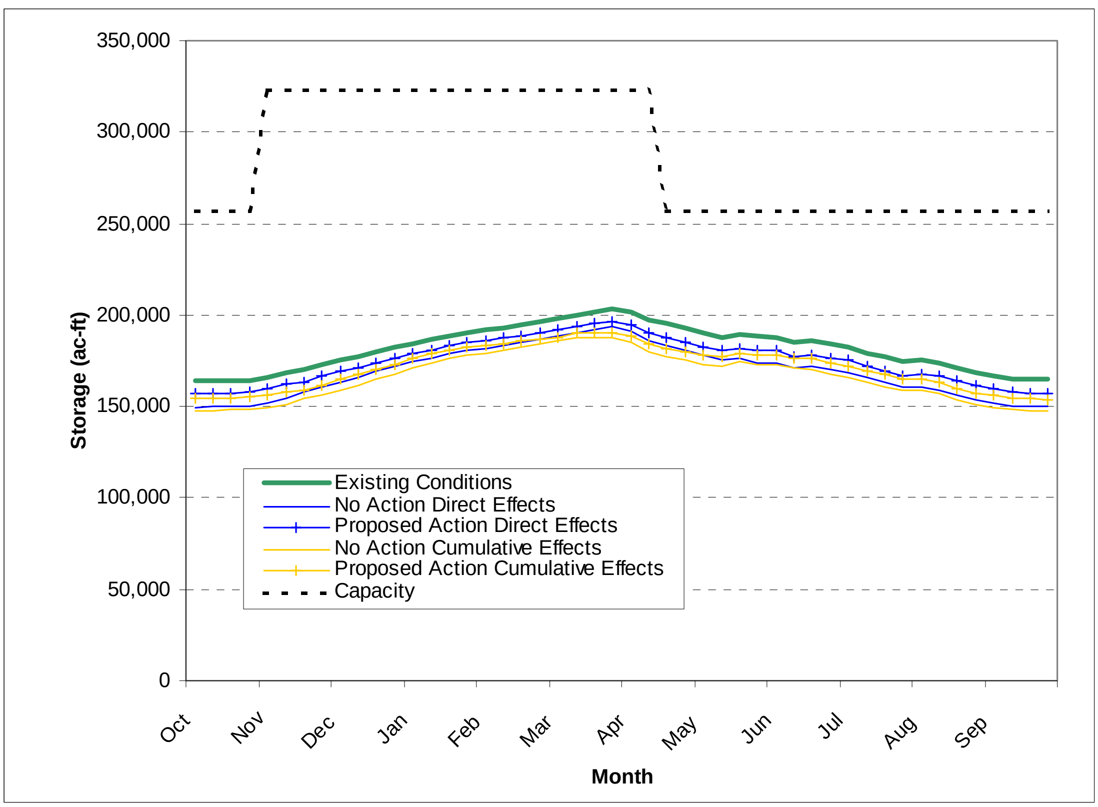
(1) Average difference is equal to the target streamflow minus simulated streamflow for quarter months when simulated streamflow is less than target streamflow.

The percent of time that UAVFMP target flows are met or exceeded is shown in Table 3-9. The ability of Reclamation to make releases to meet the flow program is about the same under each of the alternatives and varies less than 1 percent from Existing Conditions. The average reduction of 0.4 percent between the Proposed Action and No Action Alternative corresponds to less than 1 quarter-monthly period. Monthly mean streamflows shown in Figure 3-10 meet or exceed UAVFMP target streamflows throughout the year at the Wellsville gage, as well as in wet years. Based on the simulation model, reductions in the number of days that the target flows are met during the recreational streamflow period would occur during dry years as currently occurs under Existing Conditions.

3.1.2.5 Pueblo Reservoir

Simulated storage contents for Pueblo Reservoir are shown in Table A-6 and Figure 3-11. Pueblo Reservoir simulated storage contents under the Proposed Action are consistently higher than under the No Action Alternative. Greater storage volumes under the Proposed Action result from Aurora's water storage in Pueblo rather than in gravel pit reservoir storage under the No Action Alternative. The change in storage contents in Pueblo Reservoir for the Proposed Action would

Figure 3-11. Pueblo Reservoir Simulated Storage Contents Direct and Cumulative Effects for Overall Mean Years (Table A-6).



result in water surface elevations about 2.6 feet higher on average compared to the No Action Alternative under direct effects, with monthly differences up to about 4 feet. Differences in storage contents in Pueblo Reservoir under cumulative effects result in water surface elevations about 2.2 feet higher for the Proposed Action compared to the No Action Alternative.

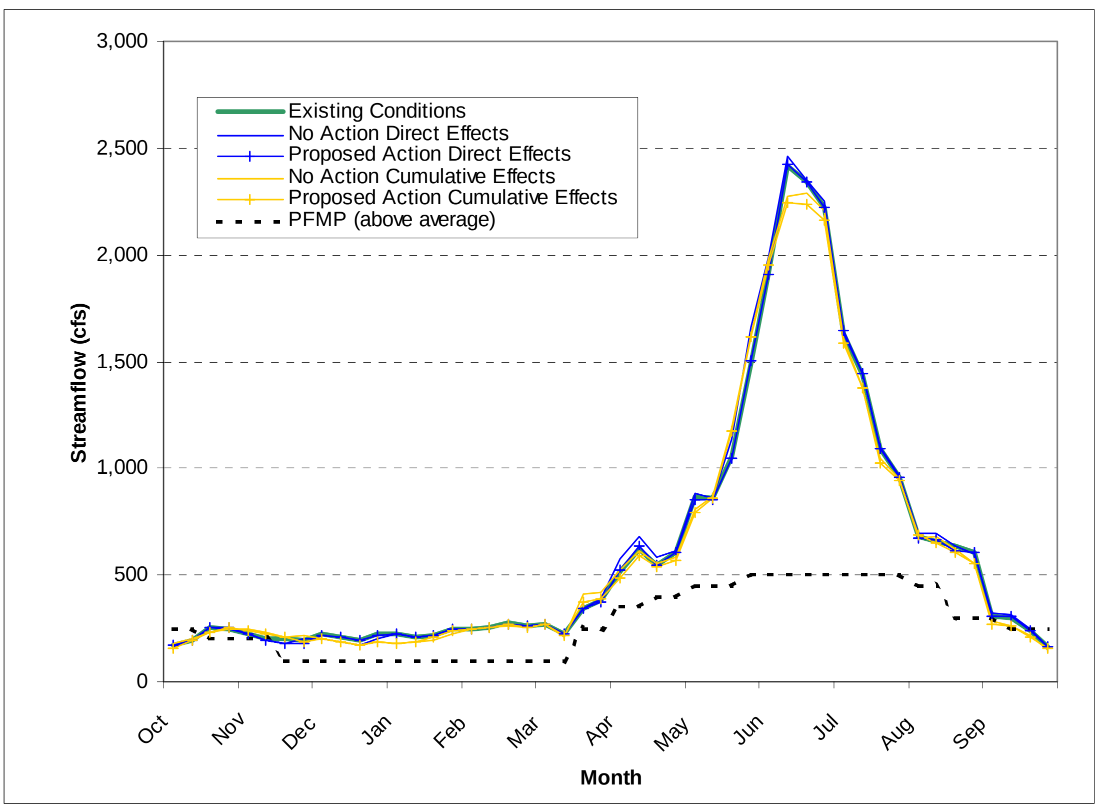
The Proposed Action would result in less storage in Pueblo Reservoir than under Existing Conditions primarily due to the effects of the PFMP and ROY storage in Holbrook Reservoir. Under the Proposed Action, Aurora's exchanges into Pueblo Reservoir would be limited due to the PFMP while they are not under Existing Conditions. The PFMP reduces the amount of streamflow that can be exchanged from the Arkansas River between Pueblo Reservoir and the Fountain Creek confluence. The effect of the PFMP is that there are fewer reductions in streamflow in this reach of the Arkansas River.

The greatest difference in simulated Pueblo Reservoir contents between the Proposed Action and No Action Alternative under direct and cumulative effects occurs in October and November during mean wet years. This occurs as a result of storage targets in the Quarter Monthly Model for Turquoise Reservoir and Twin Lakes Reservoir that trigger releases from the reservoirs during the fall and winter months. The targets are based on the historical tendency for Turquoise and Twin Lakes reservoirs to be drawn down to make room for the next year's spring runoff and West Slope imports. The increase in Pueblo Reservoir storage in October and November in the summary model output is primarily a result of releases from Turquoise and Twin Lakes reservoirs made during the fall of two wet years (1984 and 1996) to meet the storage targets.

3.1.2.6 Above Pueblo Gage

Streamflow at the Above Pueblo gage is shown in Table A-7 and Figure 3-12. Proposed Action and No Action Alternative streamflows are similar to Existing Conditions streamflows during the WWSP period (November 15 through March 15),

Figure 3-12. Above Pueblo Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-7).



because of restrictions on exchanges during this period that are part of Aurora's Arkansas River basin decrees. On average, the Proposed Action would result in monthly streamflows of 6 percent less to 10 percent more than the No Action Alternative for overall mean years. Between May and September streamflows as a result of the Proposed Action are an estimated 0 to 6 percent lower than estimated streamflows for the No Action Alternative (Table A-7). This is due to higher Rocky Ford yields under the Proposed Action. Additionally, the junior exchange status for moving water out of gravel lakes storage to upper Arkansas River basin storage under the No Action Alternative results in higher streamflows under the No Action Alternative. The direct effects for December during mean wet years show that Proposed Action streamflow would be 40 percent higher than streamflow under the No Action Alternative, which is a result of releases made to meet storage targets for Fry-Ark Project reservoirs as discussed in the preceding Pueblo Reservoir subsection. Increased streamflows for December during mean wet years for the Above Pueblo gage are unique to the Proposed Action because of contract exchanges from Pueblo Reservoir to Twin Lakes and Turquoise Reservoirs associated with the Proposed Action. Contract exchanges made under the Proposed Action result in higher storage in Twin Lakes and Turquoise Reservoirs, which result in storage releases from Pueblo Reservoir to meet the storage targets in the fall for the Fry-Ark Project Reservoirs (as discussed in the previous Pueblo Reservoir section). Pueblo Reservoir releases to meet the storage targets result in increased streamflow at the Above Pueblo gage. As a result of effects on streamflow, average annual stream stages vary by 0.03 feet (1 percent) or less between the Proposed Action and No Action Alternative (Table A-19).

For the cumulative effects simulations, Proposed Action and No Action Alternative streamflows would be less than Existing Conditions streamflows for most of the year, because Fry-Ark Project water is converted from predominantly agricultural use to predominantly municipal use and because of future exchanges by municipal entities. Annual average streamflow for the Proposed Action would be about 2 percent less than the No Action Alternative. Average annual stream stages vary by 0.03 feet (1 percent) or less between the Proposed Action and the No Action Alternative under cumulative effects (Table A-19).

The percent of time that PFMP target flows are met or exceeded is similar under each of the alternatives (Table 3-10). The 0.3 percent decrease from No Action to Proposed Action under direct effects, and 1.1 percent decrease from No Action to Proposed Action under cumulative effects, results in an average annual difference of 1 and 4 days, respectively.

Table 3-10. Pueblo Streamflow Management Program - Target Flows vs. Simulated Streamflow.

	Existing Conditions	Direct Effects		Cumulative Effects	
		No Action	Proposed Action	No Action	Proposed Action
% Time Met or Exceeded	63.4%	63.3%	63.0%	64.0%	62.9%
Average Difference (cfs)(1)	119.0	111.9	117.3	106.1	108.6

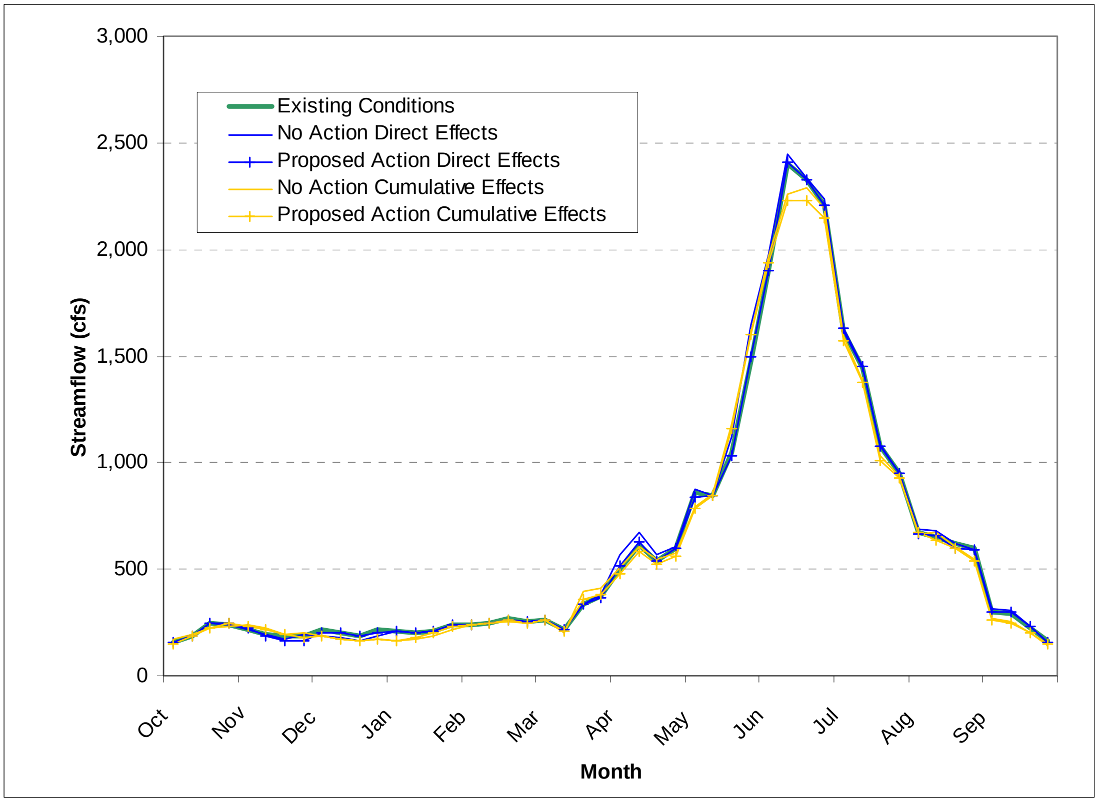
(1) Average difference is equal to target streamflow minus simulated streamflow for quarter months when simulated streamflow is less than target streamflow.

3.1.2.7 Moffat Street Gage

Streamflow at the Moffat Street gage on the Arkansas River is shown in Table A-8 and Figure 3-13. The direct effects of the No Action Alternative for overall mean year streamflows are up to 63 cfs higher than flows under Existing Conditions. Average monthly streamflows for overall mean years under the Proposed Action are 1 cfs less than under Existing Conditions. On average, the Proposed Action would result in streamflows about 2 percent less than No Action. The differences in streamflow between alternatives occur for the same reasons as those described for the Above Pueblo gage. Effects on streamflow result in an average annual stream stage for the Proposed Action of 0.01 feet (1 percent) less than stage for the No Action Alternative (Table A-20).

Cumulative effects to Arkansas River streamflow at the Moffat Street gage are similar to direct effects. Average annual streamflow under the Proposed Action would be about 2 percent less than streamflow under the No Action Alternative, with monthly streamflow variations of plus or minus 5 percent. Streamflow results in a difference in average annual stream stage between the Proposed Action and No Action Alternative of 0.03 feet (2 percent) or less under cumulative effects.

Figure 3-13. Moffat Street Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-8).

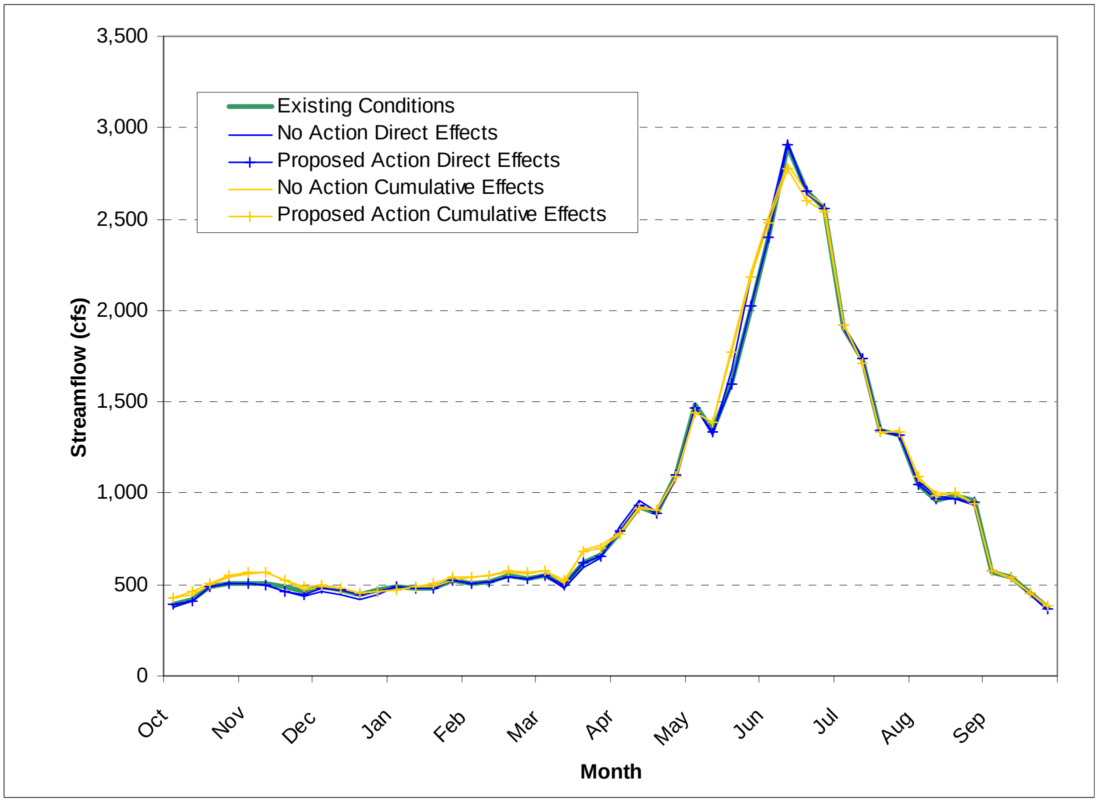


3.1.2.8 Avondale Gage

Avondale gage streamflows shown in Table A-9 and Figure 3-14 are similar for both alternatives and do not vary substantially from Existing Conditions. Monthly streamflow under the Proposed Action would range from about 3 percent lower to 5 percent greater than the No Action Alternative. The Avondale gage is downstream of the gravel lakes storage site included in the No Action Alternative. Under the direct and cumulative effects analyses, the greatest changes in streamflow between the Proposed Action and No Action Alternatives occur during May and June when Aurora's Rocky Ford yields are not divertible at gravel lakes storage because the storage capacity is full. As described for Pueblo Reservoir, pre-defined storage targets in the Quarter-Monthly Model increase effects during wet years. Releases made from Turquoise Reservoir during the wet years of 1984 and 1996, when Pueblo Reservoir was full, result in increased effects for the average monthly streamflows during the late fall months of November and December. Effects on streamflow result in differences of average annual stream stage between the Proposed Action and No Action Alternative of 0.02 feet (1 percent) or less (Table A-21).

Under the cumulative effects analysis, simulated streamflow at the Avondale gage is greater under both the Proposed Action and No Action Alternative than for Existing Conditions for most months. This is due to an increase in unused reusable return flows for Colorado Springs Utilities and BWWP. Average annual stream stage varies by 0.01 feet (1 percent) or less between alternatives under cumulative effects (Table A-21).

Figure 3-14. Avondale Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-9).



3.1.2.9 Lake Meredith

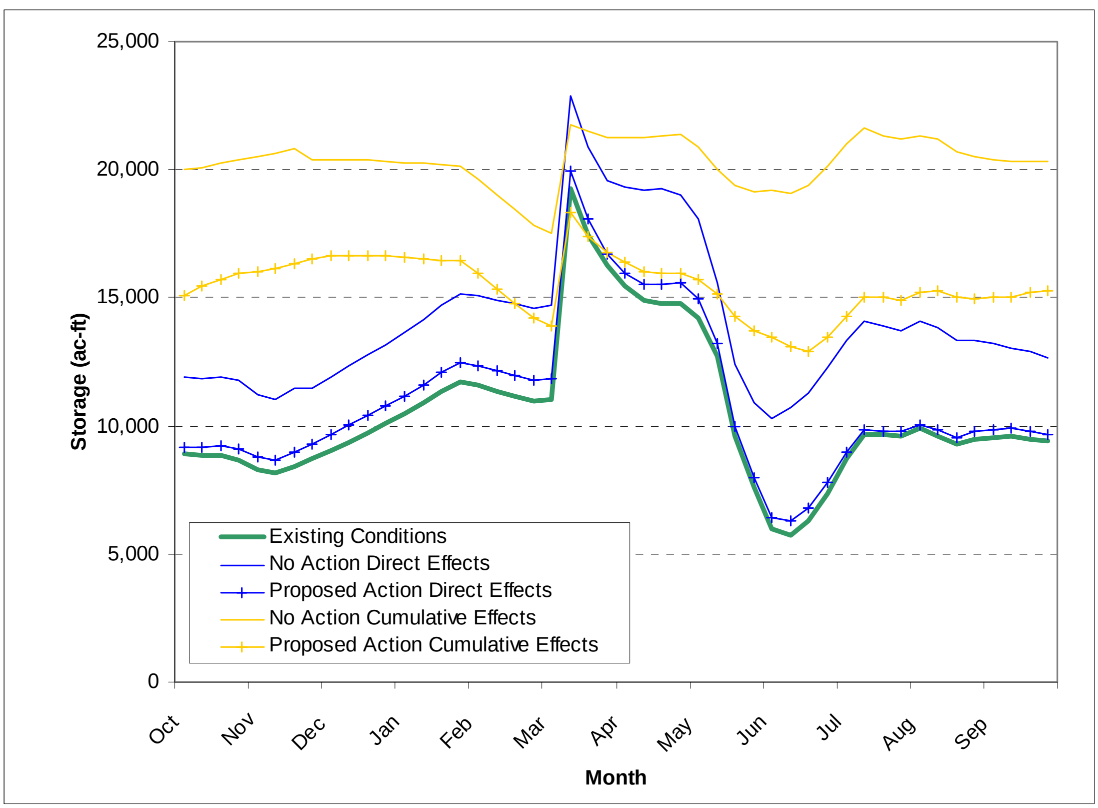
Simulated Lake Meredith reservoir contents are shown in Table A-10 and Figure 3-15. The Quarter-Monthly Model simulates the combined storage at Lake Henry and Lake Meredith. However, simulated Colorado Canal System reservoir contents are subsequently distributed to Lake Henry and Lake Meredith storage outside of the Quarter-Monthly Model using the following assumptions:

- Water available to the Colorado Canal system is first stored in Lake Meredith, up to the maximum storage available in Lake Meredith
- If more water is available than storage available in Lake Meredith, excess is stored in Lake Henry, up to capacity of Lake Henry
- Any additional available water is stored in Lake Meredith, which allows storage above the maximum Lake Meredith contents, similar to historical operations of the Colorado Canal system

Reservoir contents are slightly higher under the Proposed Action, and much higher under the No Action Alternative. Storage contents are higher for the No Action Alternative than for the Proposed Action and for Existing Conditions because Aurora would use Lake Meredith to store its water rights prior to exchanging upstream to Twin Lakes and the Otero Pump Station. No Action Alternative contents are highest because Aurora's storage in Pueblo Reservoir under the Proposed Action is greater than Aurora's storage in Gravel Lakes for the No Action Alternative. Aurora would make up the difference in storage capacity with storage in Lake Meredith under the No Action Alternative.

The surface area of Lake Meredith would be about 3 percent greater than Existing Conditions under the Proposed Action, while the No Action Alternative would result in about a 19 percent greater surface area. Under cumulative effects,

Figure 3-15. Lake Meredith Simulated Storage Contents Direct and Cumulative Effects for Overall Mean Years (Table A-10).

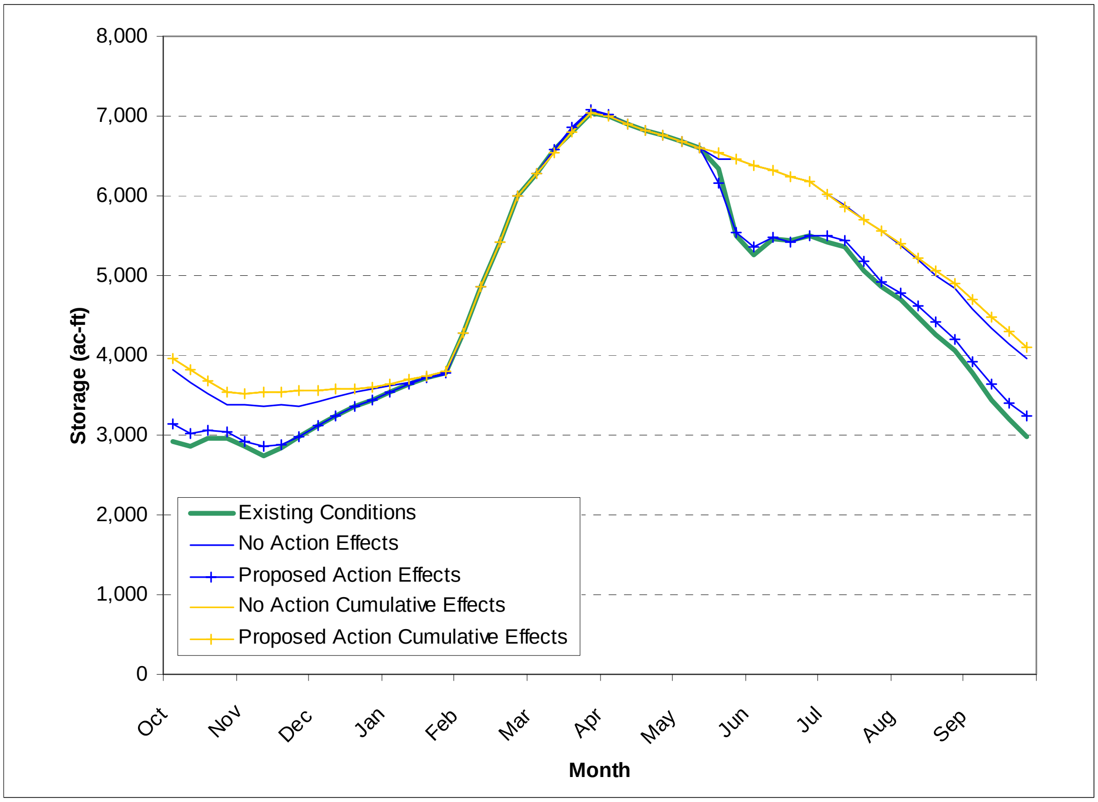


Lake Meredith water surface area would be about 31 percent higher on average than Existing Conditions compared to about 48 percent higher under No Action.

3.1.2.10 Lake Henry

Simulated reservoir contents at Lake Henry are shown in Table A-11 and Figure 3-16. Estimated storage contents under the No Action Alternative and the Proposed Action are 403 and 53 ac-ft greater, respectively than contents under Existing Conditions. Reservoir contents under the Proposed Action are about 7 percent less than contents under No Action. Cumulative effects are zero, because the modeling method assumes that all effects on reservoir contents in the Colorado Canal system occur at Lake Meredith before they occur at Lake Henry. As described in the previous section, the Quarter-Monthly Model reports the combined storage at Lake Henry and Lake Meredith. Effects on Lake Henry storage contents would only occur when Lake Meredith is full, due to the algorithm used to distribute the contents to Lake Henry and to Lake Meredith. Lake Meredith never fills for the Proposed Action under the cumulative effects, and as a result, there are no cumulative effects for Lake Henry.

Figure 3-16. Lake Henry Simulated Storage Contents Direct and Cumulative Effects for Overall Mean Years (Table A11).



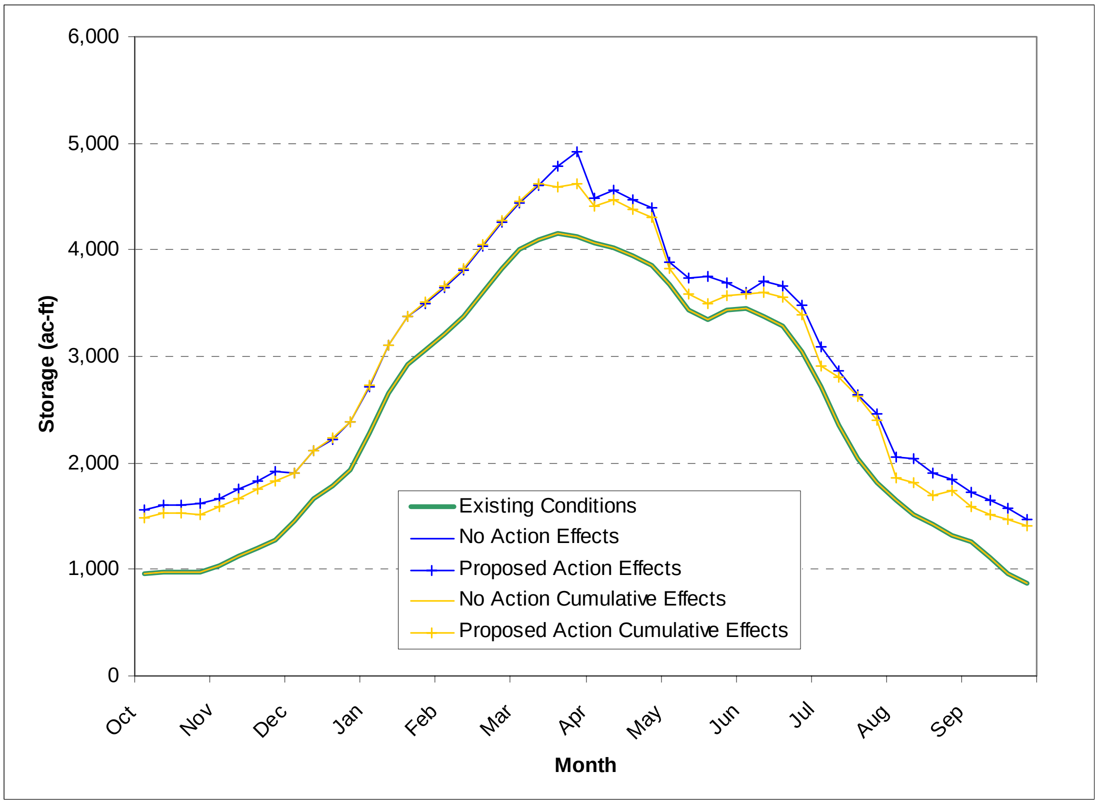
3.1.2.11 Holbrook Reservoir

Simulated Holbrook Reservoir storage contents are shown in Table A-12 and Figure 3-17. Holbrook Reservoir storage under the No Action Alternative would not change from Existing Conditions, reflecting the model assumption that Aurora does not utilize ROY storage under the Existing Conditions or the No Action Alternative. The approximate 20 percent increase in storage on average under the Proposed Action is the result of ROY storage in Holbrook Reservoir.

Direct and cumulative effects on reservoir levels and surface area, from changes in storage contents, likewise increase in all months for the Proposed Action. The simulated storage contents in Holbrook Reservoir correspond to average monthly water levels under the Proposed Action up to about 2 feet higher than under the No Action Alternative for overall mean years. During dry years monthly reservoir levels for the Proposed Action would range from 1 to 5 feet higher than No Action and Existing Conditions. Similar, but slightly lower reservoir surface elevations would occur under cumulative effects.

The reservoir contents given in Table A-12 and Figure 3-17 are equal to Aurora's simulated storage in Holbrook Reservoir in addition to the historical storage in the reservoir. The Quarter-Monthly model results show that occasionally more storage would be needed in the Holbrook system than is physically available. During these times, it is likely that the ROY participants would utilize other Holbrook system facilities, including Dye Reservoir, to meet the objectives of the ROY program. Because of the complexities associated with the Holbrook system, these additional storage opportunities were not simulated separately, but simulated in aggregate as storage in Holbrook Reservoir.

Figure 3-17. Holbrook Reservoir Simulated Storage Contents Direct and Cumulative Effects for Overall Mean Years (Table A-12).



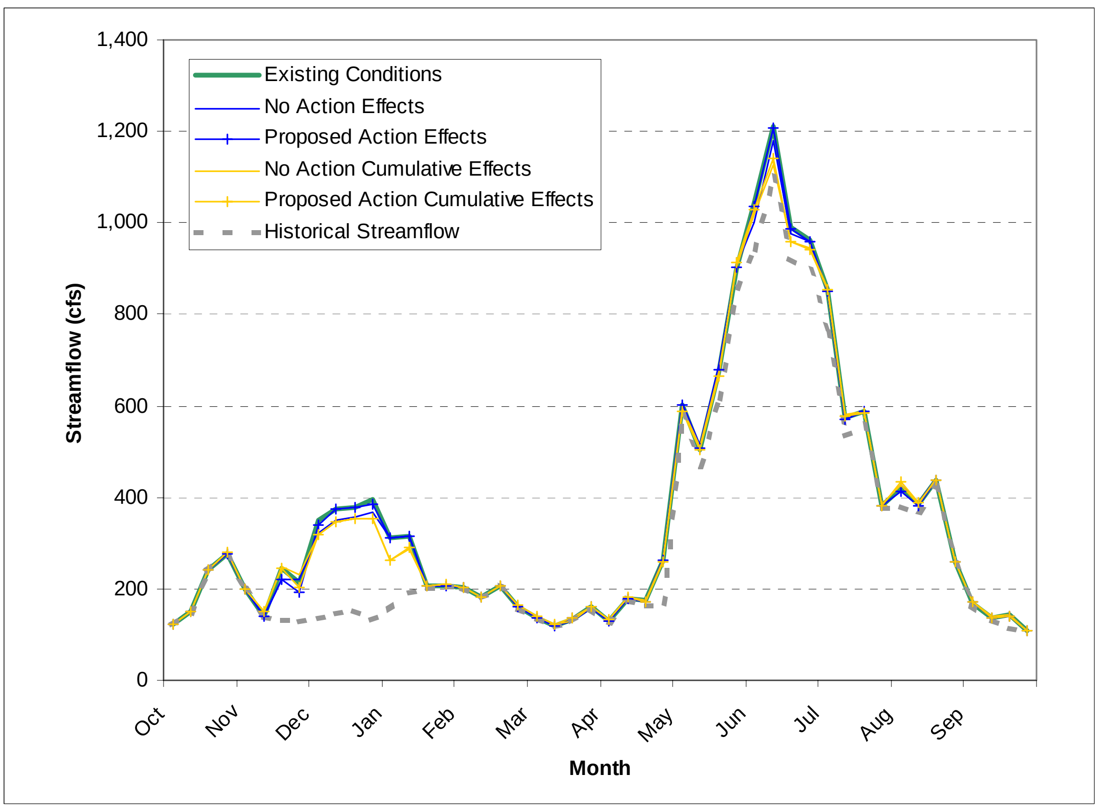
3.1.2.12 La Junta

Simulated streamflow at the La Junta gage is shown in Table A-13 and Figure 3-18. To ensure that water rights downstream of the study area are not injured, the highest priority in the Quarter-Monthly model is the historical gage flow at the La Junta gage. La Junta streamflows for all alternatives are equal to or greater than observed historical streamflows**,** indicating that all water rights and Arkansas River Compact deliveries downstream of the La Junta gage would be met as they were historically.

Because of flow management agreements between various entities in the Arkansas basin, the Quarter-Monthly Model predicts that the exchange potential on the Arkansas River below Pueblo Reservoir will be lower than what it has been historically. This reduced exchange potential limits the exchange of municipal return flows and transferred agricultural rights into Pueblo Reservoir. While Municipalities plan to implement recovery of yield measures, the model predicts that the proposed actions would be insufficient to capture all the flows to which the municipalities are entitled. Consequently, flows in the lower Arkansas River are predicted to increase over time. To determine where these additional flows would be diverted, the historical call on the Arkansas River was analyzed and the location of the most frequently calling water right determined on a monthly basis. Demand nodes were added to the model at the locations of the calling rights to divert water from the stream at various locations between Pueblo Reservoir and John Martin Reservoir.

Figure 3-18 shows that modeled streamflows at La Junta are higher than historical flows during the winter water storage season. Because of the call set by the WWSP, the method used to locate the call diverts these additional flows below La Junta. Because actual administration of the river is the responsibility of the Division 2 Engineer's staff, and because the WWSP operation of Pueblo, Twin Lakes, and Turquoise reservoirs effectively prohibits Aurora from making river exchanges during this period, the fate of additional winter

Figure 3-18. La Junta Gage Simulated Streamflow Direct and Cumulative Effects for Overall Mean Years (Table A-13).



flows below Pueblo Reservoir were not exhaustively simulated.

Historical conditions reflect river operations and demands on the river that occurred during the 1982 to 2002 study period, whereas both the No Action and Proposed Action are based on projected future conditions. Actual flows above La Junta would be regulated by the Division Engineer's Office, which would allow for diversions in accordance with State water law and the interstate compact with Kansas.

Hydrologic modeling indicates there would be minimal direct or cumulative effects at the La Junta gage because Aurora's water rights are located upstream of the La Junta gage. Under both alternatives there would be less than a 1 percent annual difference in average streamflow at the La Junta gage for both direct and cumulative effects compared to modeled Existing Conditions. The Proposed Action would have average monthly differences in streamflow from 3 percent less to 1 percent more than the No Action Alternative for overall mean years.

Differences in streamflow between the Proposed Action and No Action Alternative are due to increased diversions of Rocky Ford water under the Proposed Action because the increased ability to move water from Pueblo Reservoir to upper Arkansas River basin storage.

3.2 GEOMORPHOLOGY

Stream channel geomorphology addresses the physical conditions of a river including its depth, width, profile, and pattern. Changes in the amount and the frequency of streamflow can affect the geomorphology of the stream channel. Geomorphic and hydraulic conditions were assessed for segments of Lake Fork Creek, Lake Creek, and the Arkansas River within the study area. Stream classification and a comparison of historical versus recent aerial photographs provided a means for assessing and summarizing the river morphology in the study area. Environmental consequences were estimated for stream segments that were determined to be geomorphically sensitive to hydrologic changes.

3.2.1 Affected Environment

The affected environment for geomorphology was assessed through the determination of geomorphic stability using methods in Rosgen (1996). Geomorphic classification of stream segments was determined based on topographic maps, aerial photographs, and field observations. Stream stability was determined based on the geomorphic classification. Table 3-11 summarizes the existing geomorphic conditions for Lake Fork (Sections LF-1 and LF-2), Lake Creek (Section LC), and the Arkansas River (Sections 1-11). The locations of the stream segments are shown in Figure 3-19 and Figure 3-20.

The geomorphology of the section from Pueblo Dam to the Fountain Creek confluence (Section 7) was summarized based on an Arkansas River fisheries habitat restoration report (Corps 2001a). The Rosgen stream classification for natural streams was not used for this section as a result of man-made influences on the channel, which were constructed with the objective of converting the geomorphically altered river corridor into a more natural and stable corridor. This reach has some meanders but also channelized lengths with hardened banks and levees. Part of this reach has been constrained by a concrete levee for flood protection. The section of the reach closest to the Fountain Creek confluence has been influenced by backwater effects as a result of sediment deposition in the Arkansas River from Fountain Creek (Corps 2001a).

Historical (1960s) and current (1993 to 2001) aerial photographs were compared to determine changes in stream segments for the lower Arkansas River. Approximately three-quarters of the lower Arkansas River exhibited slight to major change in morphology over a 35-year period. Channel migration observed between 1964 and 1993 is likely a result of increased streamflow to the upper Arkansas River basin originating from transbasin diversions to the Arkansas River basin (e.g., the Fryingpan-Arkansas Project).

Table 3-11. Response of Lake Fork, Lake Creek, and Arkansas River to Hydrologic Disturbances.

Section* (see Figures 3-19 and 3-20)(1)	Stream Type	Sensitivity to Disturbance	Recovery Potential	Streambank Erosion Potential	Sediment Supply	Vegetation Controlling Influence
LF-1	E3	High	Good	Moderate	Low	Very High
LF-2	C3	Moderate	Good	Moderate	Moderate	Very High
LC	B3c	Low	Excellent	Low	Low	Moderate
1	DA4	Moderate	Good	Low	Very Low	Very High
2	B3c	Low	Excellent	Low	Low	Moderate
3	B2c	Very Low	Excellent	Very Low	Very Low	Negligible
4	B3c	Low	Excellent	Low	Low	Moderate
5	B1c	Very Low	Excellent	Very Low	Very Low	Negligible
6	B4c	Moderate	Excellent	Low	Moderate	Moderate
8	D5c-	Very High	Poor	Very High	Very High	Moderate
9	C5c-	Very High	Fair	Very High	Very High	Very High
10	D5c-	Very High	Poor	Very High	Very High	Moderate
11	C5c-	Very High	Fair	Very High	Very High	Very High

*LF = Lake Fork; LC = Lake Creek; and Sections 1-11 = Arkansas River.

(1) Rosgen stream classification for natural streams was not completed for Section 7 because the classification method is not appropriate for the reach due to man-made influences.

Peak discharge values were determined for select USGS gages to determine bankfull discharge (the 1.5-year peak discharge) and other return interval peak streamflows. Peak streamflow discharge values were determined by performing a frequency analysis for gage locations in stream sections that were determined to be geomorphically sensitive to hydrologic changes. Annual maximum instantaneous peak streamflows obtained from the USGS National Water Information System database were used in the frequency analyses. Peak discharges are summarized in Table 3-12.

Table 3-12. Summary of Historical Peak Discharges.

Gage (Gage Number)	Drainage Area (sq. mi.)	Period of Record(1)	Peak Streamflow Discharge (cfs)					
			1.5-Year	2-year	10-year	50-year	100-year	500-year
Arkansas River at Portland gage	4,024	1975 - 2004	4,500	5,400	8,700	11,600	12,900	15,800
Arkansas River Above Pueblo gage	4,670	1974 - 2004	3,000	3,800	6,700	9,500	10,700	13,700
Arkansas River at Moffat Street gage	4,778	1989 - 2004	3,100	4,000	8,300	12,800	14,900	20,300
Arkansas River near Avondale gage	6,327	1974 - 2004	4,400	5,700	11,700	18,000	20,900	28,500
Arkansas River at La Junta gage	12,210	1974 - 2004	2,700	4,200	14,200	29,600	38,300	64,800

(1) Period of record used in the frequency analysis. The entire period of record available was used for gage locations upstream of Pueblo Reservoir. The period of record after Pueblo Reservoir began operations (1974) was used for locations downstream of Pueblo Reservoir.

Figure 3-19. Rosgen Stream Classification for Upper Arkansas River.

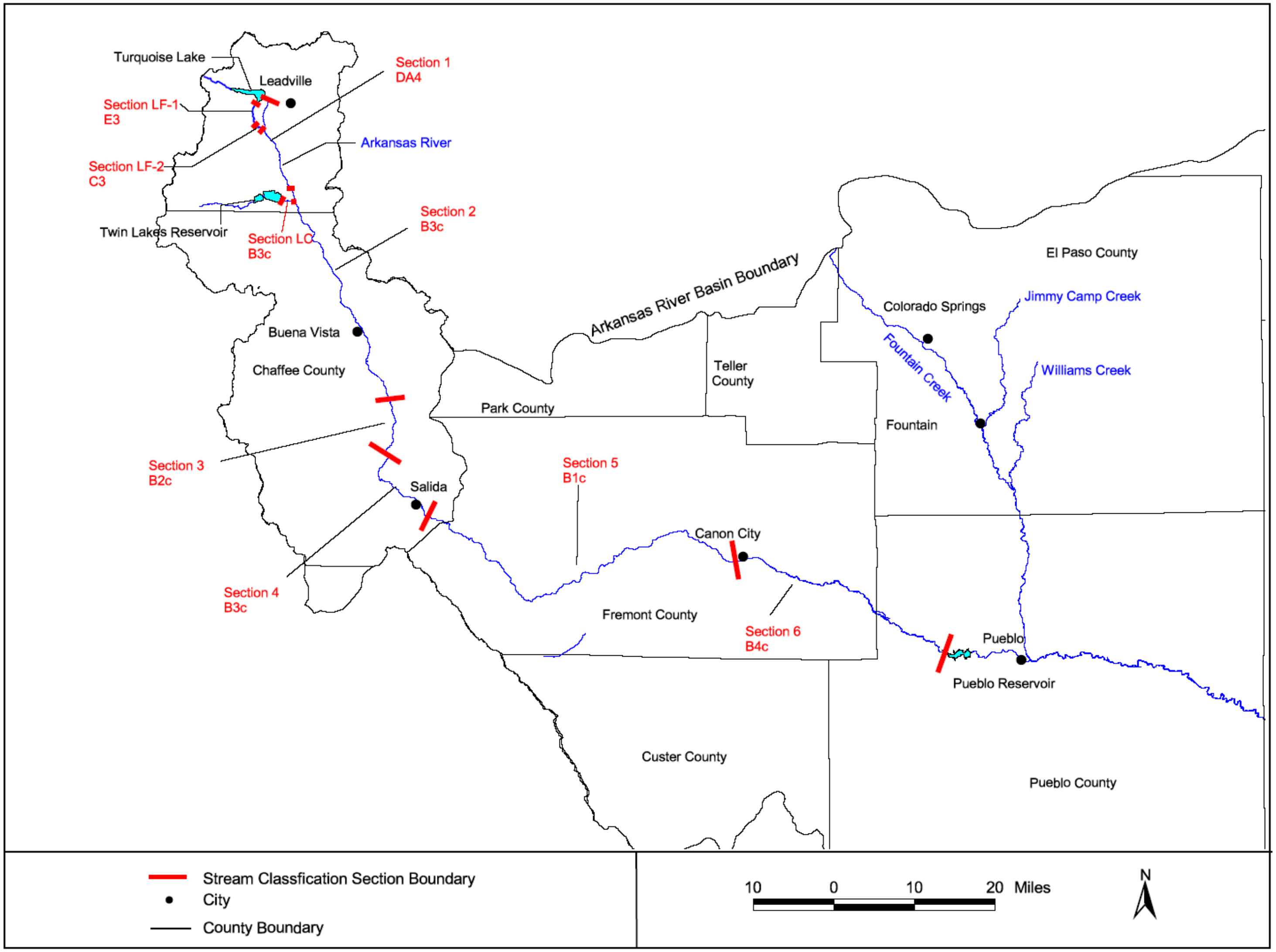
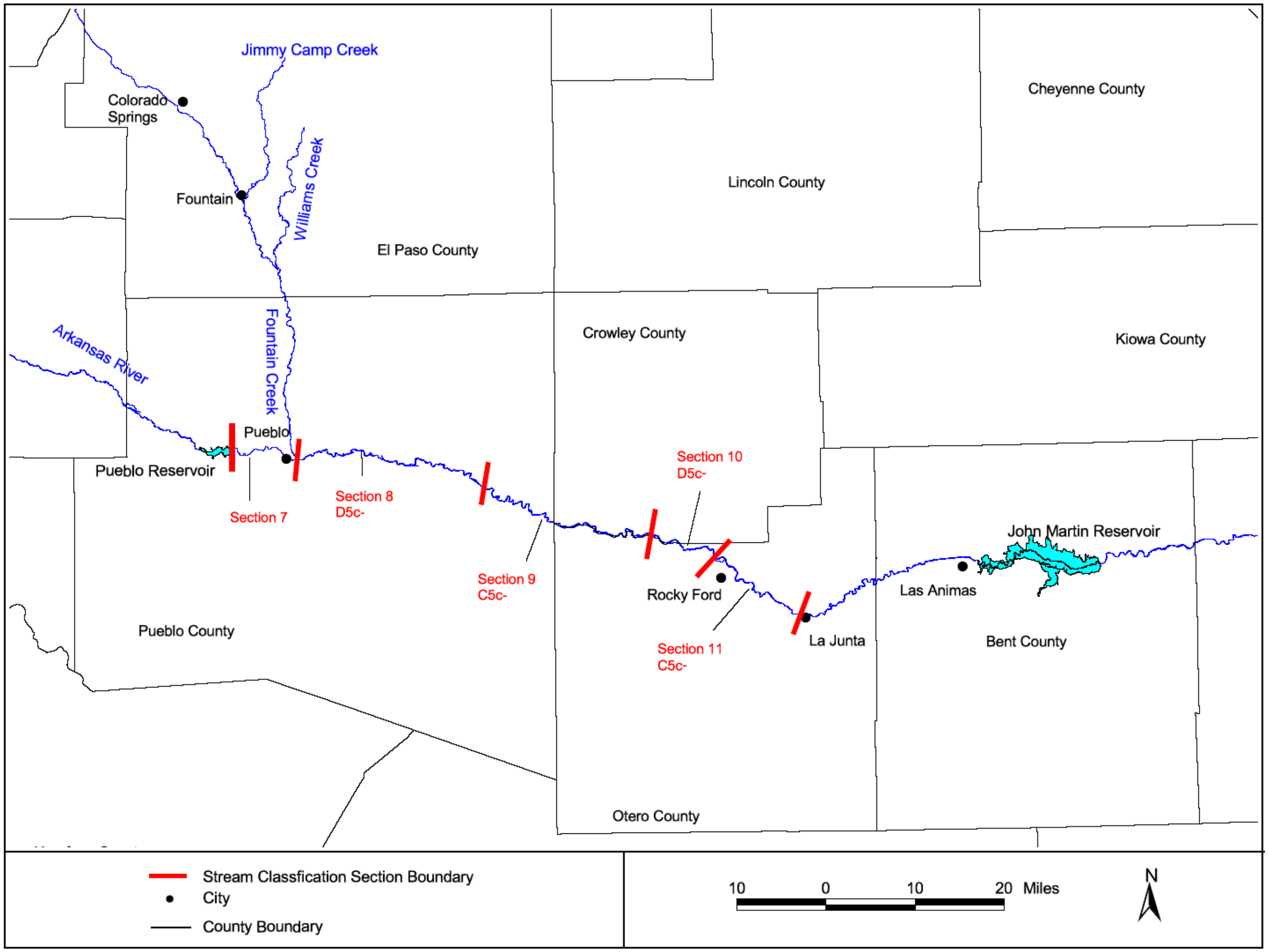


Figure 3-20. Rosgen Stream Classification for Lower Arkansas River.



3.2.2 Environmental Consequences

Potential changes to stream geomorphology due to the effects of the Proposed Action were evaluated by comparison of changes in streamflow duration curves to bankfull discharge. Flow duration curves indicate the percentage of streamflows that is above or below a given discharge rate. Through comparison of the streamflow duration curves, the maximum difference between the Proposed Action and No Action Alternative streamflow duration curves for a given non-exceedance percentage was determined. Non-exceedance percentage values represent the percent of streamflows that are less than or equal to a given percentage. Comparison of streamflow duration curves was completed for reaches that were determined to be moderately to very highly sensitive to hydrologic changes using the Rosgen classification technique. Gages that were determined to be in moderately to highly sensitive channel reaches were the Portland, Above Pueblo, Moffat Street, Avondale, and La Junta gages. Although the Above Pueblo and Moffat Street gages were not determined to be sensitive to hydrologic changes (i.e., Rosgen classification was not done for this reach of the Arkansas River, streamflow duration curves were compared for these gages because of the proximity to Pueblo Reservoir.

Geomorphic changes were analyzed in more detail if the difference in non-exceedance percentages between Proposed Action and No Action Alternative streamflows were greater than 10 percent and occurred at streamflow values that exceed the bankfull discharge, i.e., the 1.5-year recurrence interval streamflow (Rosgen 1996). Because the average morphologic characteristics of a channel are formed as a result of bankfull discharge (Rosgen 1996), differences between Proposed Action and No Action Alternative streamflow duration curves that are lower than the bankfull discharge would have minimal effects on channel geomorphology for the potentially affected stream channels.

Streamflow discharges were compared for the range of non-exceedance values for each stream segment that was determined to be moderately to highly sensitive to hydrologic changes using the Rosgen classification technique. The maximum difference between the Proposed Action and No Action Alternative, the corresponding non-exceedance percentage, and the 1.5-year return interval peak discharge values are summarized in Table 3-13.

As shown in Table 3-13, the La Junta gage direct effects analysis resulted in the only difference between Proposed Action and No Action Alternative streamflow duration curves greater than 10 percent for streamflow values greater than the 1.5-year return interval peak discharge. For the remainder of the gages, there are no streamflow changes greater than 10 percent above the 1.5-year return peak discharge rate, and effects on geomorphology are expected to be minimal for these locations.

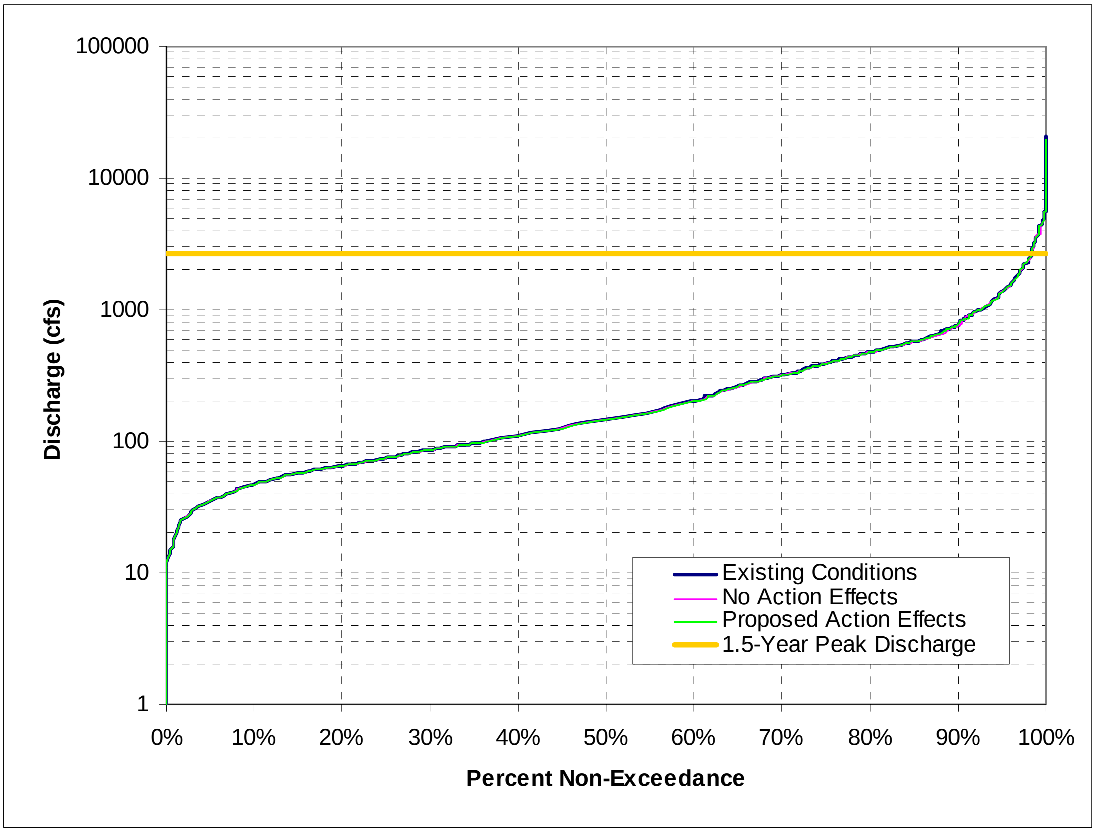
The streamflow duration curves for the direct effects at the La Junta gage are shown in Figure 3-21. Although Proposed Action streamflows at the 98 percent non-exceedance level are more than 10 percent higher than No Action Alternative streamflows, Proposed Action streamflows are closer to Existing Conditions streamflows than the No Action Alternative. At the 98 percent non-exceedance level, Proposed Action streamflow is 2,900 cfs, No Action streamflow is 2,600 cfs, and Existing Conditions streamflow is 2,900 cfs (Table 3-13). Proposed Action streamflows would result in less effect on stream geomorphology than the No Action Alternative, because Proposed Action streamflows would approximately equal Existing Conditions streamflows at the 98 percent non-exceedance level. There is a slight tendency toward more sedimentation near the La Junta gage under the No Action Alternative than under the Proposed Action because of fewer flows above the 1.5-year peak discharge rate.

Table 3-13. Streamflow Duration Curve Summary Table for Geomorphically Sensitive Locations.

Gage	Proposed Action Minus No Action Maximum Discharge (% Difference)[(1)]	Discharge at Non-Exceedance Value (cfs)	1.5-year Peak Discharge (cfs)
Portland			
Direct Effects	-11	160	4,500
Cumulative Effects	-11	160	4,500
Above Pueblo			
Direct Effects	-8	880	3,100
Cumulative Effects	-5	3,000	3,100
Moffat			
Direct Effects	-8	880	3,100
Cumulative Effects	-5	350	3,100
Avondale			
Direct Effects	8	6,700	4,400
Cumulative Effects	15	190	4,400
La Junta			
Direct Effects	12	2,900	2,700
Cumulative Effects	8	2,800	2,700

[(1)] Calculated as (Proposed Action streamflow – No Action streamflow) / No Action streamflow for each of the non-exceedance values.

Figure 3-21. La Junta Gage – Streamflow Duration Curve.



3.3 GROUND WATER QUANTITY

Characteristics of ground water aquifers were summarized for the affected environment for the Upper and lower Arkansas River basins. Environmental consequences are estimated based on changes in surface water conditions as a result of the Proposed Action and No Action Alternative.

3.3.1 Affected Environment

Two types of aquifers are present in the upper Arkansas River basin: unconsolidated sediment aquifers and consolidated rock aquifers. The unconsolidated aquifers, which are the most productive aquifers in the basin, are comprised of valley-fill alluvium, glacial deposits, and basin-fill deposits. Alluvial aquifer material is present along the upper Arkansas River and its major tributaries except in the area adjacent to the Arkansas River between Salida and Cañon City. Alluvium is up to 100 feet thick, and well yields are reported up to 500 gpm, with a median yield of 15 gpm. Seepage loss measurements indicate that within the upper Arkansas River basin, the Arkansas River is a gaining stream as a result of ground water inflow, except for a short reach between Salida and Wellsville (USGS 1984). The only consolidated rock aquifer in the upper Arkansas River basin that provides significant water resources is the Dakota-Purgatoire sandstone formation (USGS 1984), which outcrops in locations near Cañon City and is up to 4,500 feet deep in other locations. Water levels in the Upper basin alluvium ranged from 5 to 58 feet below ground surface (bgs) during the 1990s (USGS 1997). Strong seasonal fluctuations in ground water levels are common in the Upper basin, and are positively correlated with spring snowmelt runoff.

Alluvial aquifers in the lower Arkansas River basin are more reliable as a source of ground water, because they are more extensive and continuous than alluvium in the upper Arkansas basin. Quaternary age alluvium along the Arkansas River extends 150 miles from Pueblo Reservoir to the Kansas state line, is up to 250 feet thick, and is underlain by impermeable Cretaceous bedrock (Barkmann et al. 2003). Aquifer characteristics such as transmissivity, hydraulic conductivity, well yield, specific capacity, and specific yield vary widely for the lower Arkansas alluvium, depending on variations in soil type and saturated thickness, and are presented in Table 3-14.

Water levels in alluvium along the lower Arkansas River and its tributaries are generally 5 to 30 feet bgs, with a shallower water table closer to the Arkansas River and its tributaries. Recharge to the lower Arkansas River alluvium mostly occurs through river discharge to the aquifer, with localized recharge from irrigation canals and surface application of irrigation water downstream of the Pueblo and Crowley County line. Water development projects that import water to the basin (e.g., Fryingpan-Arkansas Project) and increase streamflow in the lower Arkansas basin have enhanced recharge to the alluvium.

For the counties adjacent to the Arkansas River within the study area, ground water use ranges from 0.55 percent of total water use for Fremont County to 4.31 percent of total water use (USGS 2000) for Pueblo County. Ground water use is summarized by county in Table 3-15.

Table 3-14. Alluvial Aquifer Characteristics for the Lower Arkansas River Basin from Pueblo to Kansas State Line.

Transmissivity (ft^2/d)	Hydraulic Conductivity (ft/d)	Well Yield (gpm)	Specific Capacity (gpm/foot of drawdown)	Specific Yield
2,000-60,000	70-1,200 (mean=530)	10-4,000	7-54	0.13-0.20

Source: Barkmann et al. 2003.

Table 3-15. Summary of Annual Ground Water Use for the Year 2000 for Counties Adjacent to the Arkansas River within the Study Area.

Upper Basin County	Total Ground Water Use (ac-ft)	M&I Ground Water Use (ac-ft)	Agricultural Ground Water Use (ac-ft)
Lake	718	718	0
Chaffee	1,032	1,032	0
Fremont	987	763	224
Pueblo	11,903	4,016	7,887
Crowley	1,088	516	572
Otero	11,409	2,782	8,627

Source: USGS 2000.

3.3.2 Environmental Consequences

The primary causes for changes in ground water levels in the study area would be changes in river stage or changes in irrigation and ground water pumping practices.

Changes in river stage can alter the hydraulic gradient between surface water and hydraulically connected ground water. Changes in surface water discharge to ground water (or vice versa) can result from effects on the hydraulic gradient between surface and ground water systems. River stages are expected to be different for the Existing Conditions, Proposed Action, and No Action Alternative, as described in Section 3.1.2. As a result, effects on ground water associated with changes in streamflow stage were considered.

Other factors that influence ground water levels are the withdrawal or addition of water to ground water aquifers. Ground water withdrawal is common from the aquifers in the study area. Ground water is pumped for multiple uses including municipal and industrial (M&I), agricultural irrigation, and domestic supply. Additions to ground water aquifers include aquifer recharge programs, which are accomplished by injecting water into ground water aquifers. Effects on ground water as a result of variations in ground water withdrawal and injection for the Proposed Action and No Action Alternative are discussed. As discussed in subsequent sections, there are no ground water withdrawal or injection components associated with the Proposed Action or the No Action Alternative.

Two threshold criteria were evaluated to determine effects on ground water in the study area:

- Differences between mean monthly streamflow depth for the Proposed Action and No Action Alternative in either the direct or cumulative effects analyses greater than 10 percent were studied in further detail (due to associated effects on the hydraulic gradient between surface and ground water systems)
- Differences between ground water withdrawal or injection practices greater than 5 percent would be studied in further detail (due to associated effects on the volume of ground water and average ground water levels)

Estimated stream stage on the Arkansas River under the Proposed Action would generally be no more than 5 percent higher and no more than 3 percent lower than under the No Action Alternative (MWH 2005).

The Proposed Action and No Action Alternative do not directly affect ground water withdrawal or injection practices. As previously shown in Table 3-6, the difference between the Proposed Action and No Action Alternative involve variations in surface water exchanges and storage locations, and the projected changes in stream stage would have a negligible affect on ground water. There are no reasonably foreseeable actions in the cumulative effects analysis that involve ground water withdrawal or injection within the Aurora EA study area.

Based on consideration of the two criteria for determining effects on ground water levels associated with the Proposed Action and No Action Alternative, it was determined that there would be no direct or cumulative effects on ground water hydrology as a result of Aurora's actions.

3.4 SURFACE WATER QUALITY

This section describes the affected environment and the direct and cumulative environmental consequences of the Proposed Action and No Action Alternative. Details of the water quality analysis can be found in the Aurora EA Water Quality Technical Report (MWH 2006).

3.4.1 Affected Environment

The Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD) is Colorado's lead agency for protecting the quality of the state's waters and the safety of drinking water systems. The WQCD implements federal and state laws including the Federal Clean Water Act and the Colorado Water Quality Control Act. CDPHE regulates several large permitted dischargers in the study area including wastewater treatment plants, mines, and other industrial facilities.

CDPHE divides the Arkansas River into upper (UA), middle (MA), and lower Arkansas River (LA) basins and splits the basins into numbered segments. Attainment of WQS is typically determined on a segment basis.

For many constituents CDPHE has established both chronic and acute WQS. Chronic WQS apply to long-term exposure and acute WQS apply to short-term exposure. For most constituents, CDPHE determines if chronic WQS are being attained by comparing the 85^{th} percentile of concentration data in a segment to the chronic WQS. For total recoverable metals, the median of concentration data for the segment is compared to the chronic WQS. Attainment of acute WQS is evaluated by comparing individual measurements to the acute WQS (CDPHE 2005).

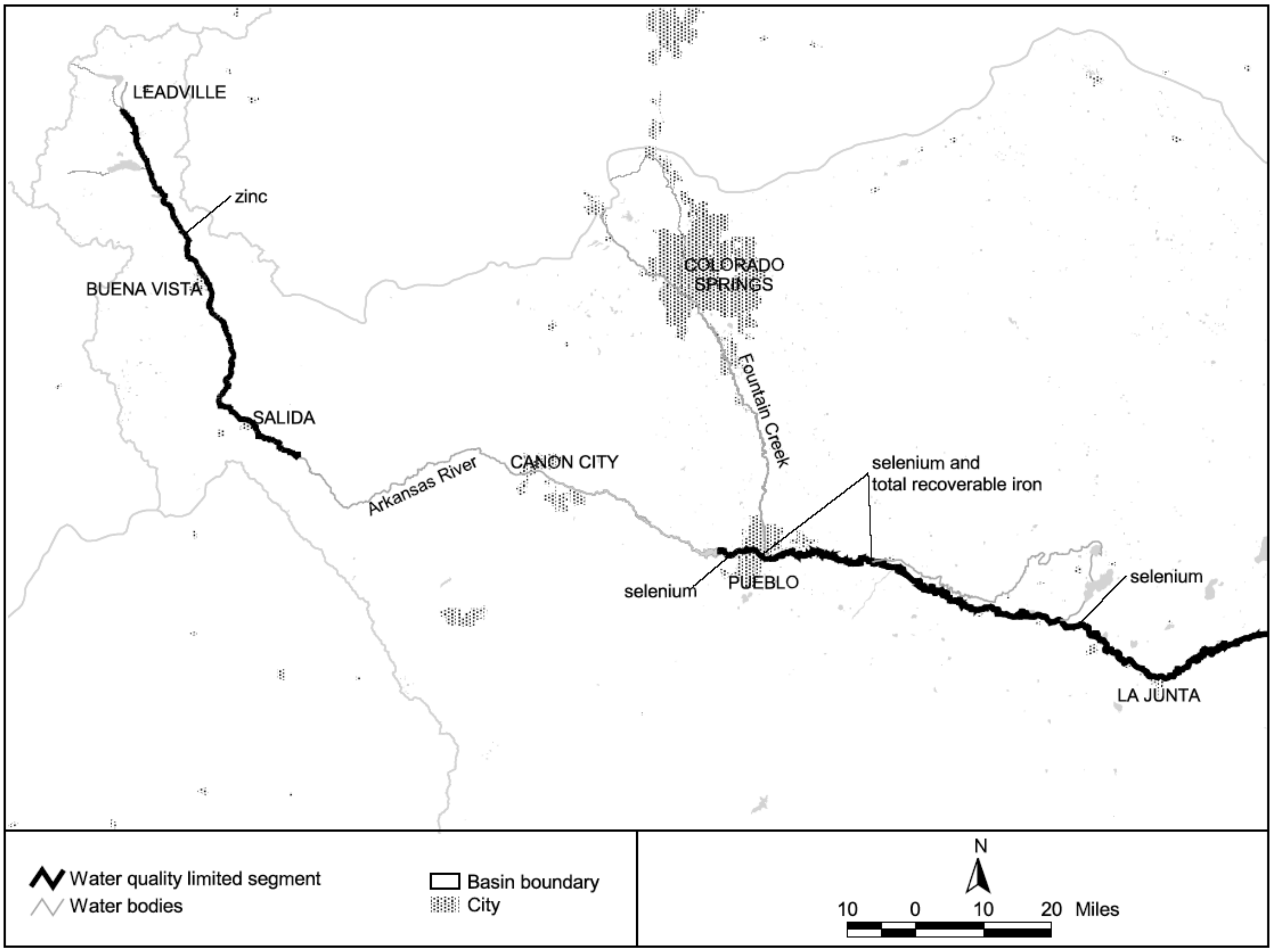
The Federal Clean Water Act requires that states submit to the Environmental Protection Agency (EPA) a list of those waters for which technology based effluent limitations and other required controls are not stringent enough to attain water quality standards (WQS). The list of water quality limited segments, known as the 303(d) list, includes the study area segments and parameters shown in Figure 3-22. Dissolved copper and cadmium were removed from the 303(d) list in the upper Arkansas River in 2006 (CDPHE 2006). Mine cleanup efforts may be responsible for reductions in copper and cadmium concentrations to levels that now attain WQS. Total recoverable iron was added as a new impairment to the Arkansas River between Fountain Creek and the Colorado Canal in 2006 (CDPHE 2006).

Water quality parameters of interest are either those where there is a known impairment in the study area (as shown in Figure 3-22) or those that were raised as a concern in the public scoping process. Parameters not known to cause impairment in the study area, but raised as a concern in the scoping process include (Reclamation 2004b):

- Salinity
- Sulfate
- Nutrients
- General reservoir water quality
- Arsenic
- Mercury
- Boron

The water quality constituents of interest are discussed below for streams and reservoirs in the study area.

Figure 3-22. Water Quality Limited Segments in the Study Area.



Source: CDPHE 2006.

3.4.1.1 Stream Water Quality

Metals in the Upper Arkansas River

Several metals have historically been on the 303(d) list in the upper Arkansas River. The evaluation of water quality data indicated that ambient concentrations of cadmium, copper, zinc, and potentially manganese in the upper Arkansas River exceed WQS (CDPHE 2005c). Potential exceedances of WQS were found in Lake Fork for cadmium, copper, lead, manganese, and zinc (USGS 2005a; CMC 2005). Dissolved copper data in Lake Creek was found to exceed the chronic WQS. However, the Lake Creek data evaluated was from 1990 to 1993 and may not represent current conditions in Lake Creek (USGS 2005b).

Total Recoverable Iron in the Lower Arkansas River

Elevated total recoverable iron concentrations in the lower Arkansas River are most likely attributable to Fountain Creek and other erosional tributaries. These streams contribute sediment and associated particulate iron to the lower Arkansas River, particularly during storm events (USGS 2002a). Table 3-16 summarizes median total recoverable iron concentrations in Arkansas River segments for comparison to the chronic WQS. In comparison to concentrations in the Arkansas River, median non-storm concentrations in Fountain Creek downstream of Monument Creek ranged from 1,160 ug/L to 2,800 µg/L. Stormflow concentrations in Fountain Creek ranged from 4,020 to 58,450 µg/L (USGS 2002a).

Table 3-16. Summary of Total Recoverable Iron Concentrations in the Study Area.

Arkansas River Segment	Median (µg/L)	Chronic WQS (µg/L)
UA2c. Lake Fork to Lake Creek	349	1,000
UA3. Lake Creek to Pueblo Reservoir	183	1,000
MA2. Pueblo Reservoir to Wildhorse Creek	180	1,000
MA3. Wildhorse Creek to Fountain Creek	100	1,000
LA1a. Fountain Creek to Colorado Canal	1,600	1,600
LA1b. Colorado Canal to John Martin Reservoir	2,000	2,000

Source: CDPHE 2005c; USGS 2005b.

Salinity

There are no WQS for salinity on the Arkansas River. However, salinity is a concern for both municipal and agricultural users of water in the lower Arkansas River. Measurements of specific conductance and total dissolved solids (TDS) are both reflective of salinity levels. The most common measure of salinity is specific conductance, which is a measure of the ability of water to conduct electrical current. Typically specific conductance (in microsiemens per centimeter [µS/cm]) is equal to about 150 percent of TDS (in milligrams per liter [mg/L]), although site-specific relationships can be more accurate because the types of ions in the water affect measurement of specific conductance.

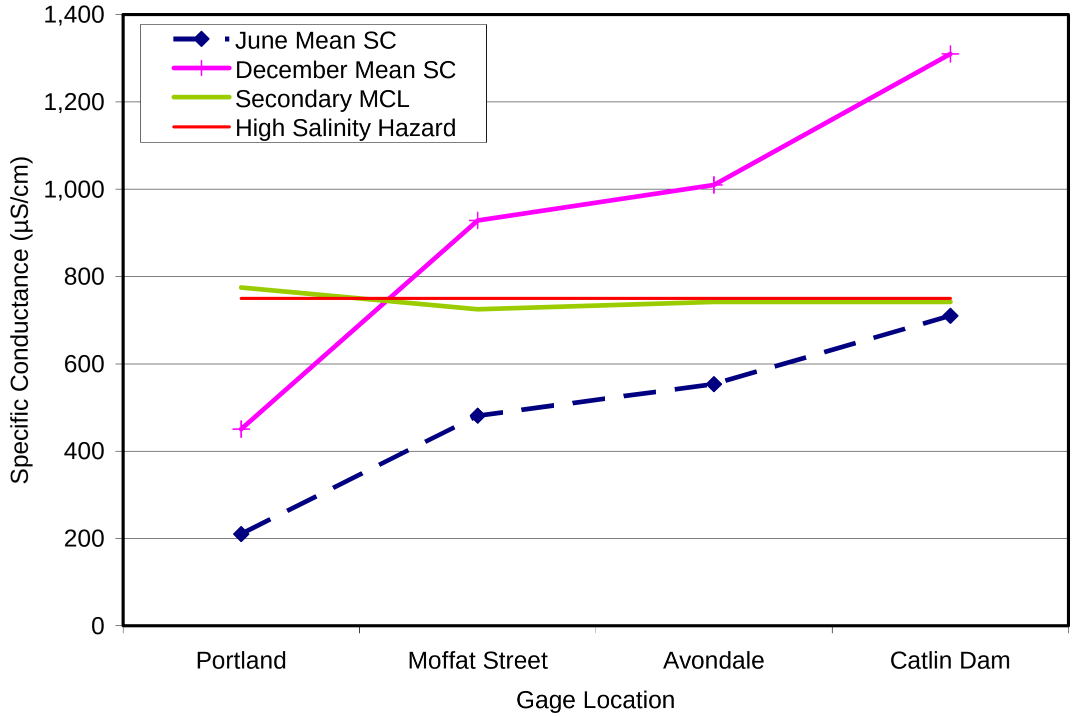
The lower Arkansas River and alluvial ground water are drinking water sources for several communities. Salinity in the lower Arkansas River, downstream of Fountain Creek, consistently exceeds the drinking water secondary maximum contaminant level (MCL) for TDS of 500 mg/L. The secondary MCL is not an enforceable standard, but it indicates a concentration above which taste and/or odor might be a problem. High TDS source water has caused some municipalities in the lower Arkansas River basin to implement advanced water treatment processes. Salinity in the lower Arkansas River also consistently exceeds the high salinity crop hazard of 750 µS/cm (Richards 1954), indicating that the productivity of some salt-sensitive crops could be reduced by the salt content of the water.

Salinity in the Arkansas River typically increases in the downstream direction, as shown in Figure 3-23. Salinity is inversely related to streamflow with lower concentrations observed during high streamflow months.

Sulfate

Concentrations of sulfate increase in the downstream direction in the study area but are less than the applicable WQS (USGS 2005b). At a particular location, concentrations of sulfate are directly related to concentrations of salinity (MWH 2006).

Figure 3-23. Mean Monthly Salinity at Arkansas River Stream Gage Locations.



Notes: SC = specific conductance.

Secondary MCL as specific conductance calculated using regression equations in USGS (2004). Catlin Dam is assumed to be equal to Avondale.

Stream Gages: Arkansas River at Portland (07097000), located upstream of Pueblo Reservoir; Arkansas River at Moffat Street at Pueblo (07099970), located downstream of Pueblo Reservoir and upstream of Fountain Creek; Arkansas River near Avondale (07109500), located downstream of Fountain Creek and upstream of the Colorado Canal headgate; Arkansas River at Catlin Dam near Fowler (07119700), located downstream of the Colorado Canal headgate and upstream of Lake Meredith return streamflow.

Source: USGS 2005b.

Dissolved Selenium in the Middle and Lower Arkansas River

Dissolved selenium concentrations exceed WQS downstream of Pueblo Reservoir in the Arkansas River mainstem. Selenium concentrations typically increase from Pueblo Reservoir downstream to the end of the study area. Table 3-17 summarizes the 85^{th} percentile and maximum concentrations for comparison to the chronic and acute WQS. Shale formations, either exposed to the surface or weathered into soil, are thought to be the primary source of selenium in the Arkansas River. Selenium dissolves out of rock and soil into ground water, and is then transported to the surface water. Although aquatic life-based WQS are exceeded in the lower Arkansas River, there have been no recorded adverse effects on terrestrial or aquatic life in the study area due to dissolved selenium (USGS 1991).

Arsenic, Mercury, and Boron

Concentrations of arsenic, mercury, and boron in the study area are currently below applicable WQS and human health criteria.

Nutrients

Regulated nutrients in the study area include the nitrogen-containing compounds ammonia, nitrate, and nitrite. Concentrations of these nutrients are generally well below WQS in the upper and middle Arkansas River, upstream of Fountain Creek. Concentrations tend to be higher in the lower Arkansas River, but still attain WQS. Current nutrient WQS are generally based on drinking water and aquatic life standards. Elevated nutrient concentrations, mainly nitrogen and phosphorus, can lead to excessive algae growth, which is generally considered a negative water quality effect. Even if numerical WQS for nitrate, nitrite, and ammonia are attained, excessive algae growth could still occur.

3.4.1.2 Reservoir Water Quality

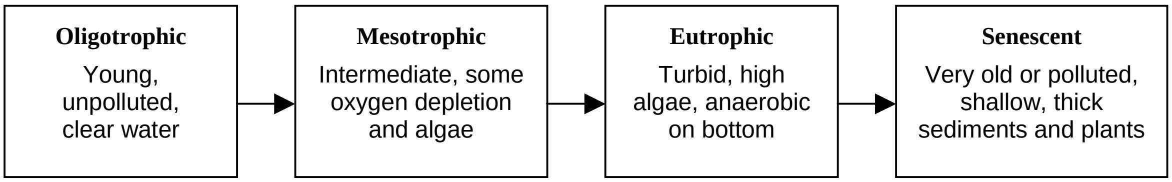
In addition to attainment of WQS, nutrients are important for general reservoir water quality. Elevated concentrations of phosphorus and nitrogen can increase algae growth in reservoirs and its unpleasant effects including reduced water clarity, reduced dissolved oxygen, and potential drinking water taste problems. Eutrophication is a natural lake and reservoir process in which levels of nutrients increase over time. Eutrophication can be accelerated by human activities that increase nutrient loading.

Table 3-17. Summary of Dissolved Selenium Concentrations.

Arkansas River Segment	85th Percentile (µg/L)	Max (µg/L)	WQS Chronic (µg/L)	WQS Acute (µg/L)
UA2c. Lake Fork to Lake Creek	0	2.9	4.6	18.4
UA3. Lake Creek to Pueblo Reservoir	0	2.1	4.6	18.4
MA2. Pueblo Reservoir to Wildhorse Creek	6.5	7.0	6.0(1)	18.4
MA3. Wildhorse Creek to Fountain Creek	11.4	36.0	11.7(1)	18.4
LA1a. Fountain Creek to Colorado Canal	14.5	17.0	Existing Quality(2)	Existing Quality(2)
LA1b. Colorado Canal to John Martin Reservoir	15.2	36.0	16.0(1)	18.4

(1) Temporary modification until 12/31/07.
(2) Temporary modification until 7/1/08.

The eutrophication process is summarized below:



Turquoise Reservoir

Turquoise Reservoir is located at high elevations with snowmelt runoff from the West Slope and tributary watersheds as the main water sources. Concentrations of most constituents, including nutrients, are low in Turquoise Reservoir and the reservoir is considered oligotrophic.

Pueblo Reservoir

Pueblo Reservoir is located at the interface of the foothills and the plains. Water quality of the inflow to Pueblo Reservoir from the Arkansas River is generally good with no impairments in the stream segment directly upstream of the inlet (CDPHE 2006). During the summer, horizontal layers with different temperatures naturally develop in Pueblo Reservoir with the warmest water on top and coldest water on the bottom, a phenomenon known as thermal stratification. Stratification prevents the mixing of water between the horizontal layers, resulting in potentially very different water quality characteristics in the different layers. Short periods of anoxia, in which dissolved oxygen is depleted, have been recorded very near the bottom during the late summer and early fall (USGS 1994). Suboxic periods (concentrations less than 3 mg/L) usually lasting less than four weeks occur at the bottom of Pueblo Reservoir resulting in releases of nutrients and trace elements from the bottom sediments, including iron, manganese, nitrogen, and phosphorus (USGS 1994). Manganese in particular, has been measured near the bottom of Pueblo Reservoir in concentrations exceeding drinking water standards. However, concentrations in water released from the reservoir generally meet drinking water standards (USGS 2002b). Phosphorus is the limiting nutrient for phytoplankton growth in Pueblo Reservoir. Pueblo Reservoir has a Trophic State Index (TSI) of about 53, on the boundary between mesotrophic and eutrophic (USGS 2005b; Carlson 1979).

Lake Henry, Lake Meredith, and Holbrook Reservoir

Lake Henry, Lake Meredith, and Holbrook Reservoir are shallow, plains reservoirs with water depths that change substantially as water is stored and used during the water year. Water quality data for Holbrook Reservoir is not available, but characteristics are likely to be similar to Lake Henry and Lake Meredith. Lake Henry and Lake Meredith do not strongly stratify. They both have median salinity concentrations that are in excess of the high salinity hazard and secondary MCL. Data collected by Colorado Springs Utilities (2005) suggest that the lakes may not be attaining dissolved selenium WQS. USGS (1993) found that both lakes could be considered eutrophic based on Secchi disk depth and elevated phosphorus concentrations, but that based on chlorophyll *a* the lakes have TSIs around 50, bordering between mesotrophic and eutrophic.

3.4.2 Environmental Consequences

Direct and cumulative effects to water quality were determined by comparing simulated Existing Conditions, Proposed Action, and No Action Alternative specific conductance and dissolved selenium concentrations, as well as qualitative and quantitative analyses of other parameters of concern. Simulated flows and reservoir storage levels from the Quarter-Monthly Model (Hydrosphere 2005) were used as inputs to the salinity model and for other types of water quality analyses.

Simulated concentrations of specific conductance and dissolved selenium are based on historical relationships between streamflow, specific conductance, and selenium. The simulations facilitate the comparison of differences in specific conductance and selenium between the alternatives and Existing Conditions. The simulations do not include any estimated effects of changes in land use or irrigation practices that might occur by the year 2045. These potential changes are not related to the alternatives and they are not considered reasonably foreseeable.

3.4.2.1 Metals in the Upper Arkansas River

Historically, elevated metals concentrations have occurred in the upper Arkansas River. A qualitative assessment of metals in the upper Arkansas River was made based on the potential for the Proposed Action and No Action Alternative to affect sources of metal contamination and streamflows in the upper Arkansas River watershed.

Primary sources of metals in the upper watershed are historical mining activities and natural runoff over and through geologic formations (USGS 1998). Proposed Action and No Action Alternative operations would not alter surface hydrology in areas with historical mines or high-metal geology, which are concentrated in the vicinity of Leadville. Therefore, it is concluded that neither alternative would have a direct nor cumulative effect on metals loads to the upper Arkansas River. Because average streamflows in the upper Arkansas River would change only slightly under Proposed Action or the No Action Alternative (see Water Quantity section), no substantial changes in metals concentrations would occur.

USGS (2005a) showed that releases from Turquoise Reservoir to Lake Fork dilute most metals concentrations in Lake Fork during low streamflow periods. Therefore, future changes to the volume of releases from Turquoise Reservoir could affect water quality in Lake Fork. However, as discussed in the Surface Water Quantity section, the Proposed Action and No Action Alternative would maintain the current streamflow pattern, timing and amount of streamflow in Lake Fork. Therefore, effects to metals concentrations in Lake Fork are unlikely for either the Proposed Action or No Action Alternative.

3.4.2.2 Total Recoverable Iron in the Lower Arkansas River

The lower Arkansas River has been identified as being impaired by total recoverable iron (CDPHE 2006). The alternatives would not affect Fountain Creek and the other tributaries that are the most likely sources of total recoverable iron to the lower Arkansas River. The alternatives result in minimal changes to streamflow in the impaired reach of the Arkansas River, as represented by the Avondale gage (see Water Quantity section Figure 3-14). Because sources of total recoverable iron and the dilution capacity of the Arkansas River are minimally affected by the alternatives, neither alternative is likely to affect total recoverable iron concentrations.

3.4.2.3 Salinity

Elevated salinity is a concern in the Arkansas River downstream of Pueblo Reservoir due to its potentially negative effects on crop yields and the cost of drinking water treatment. The salinity effects analysis used a stratified reservoir model for Pueblo Reservoir, regression equations relating salinity to streamflow, and mass balance calculations to simulate specific conductance at the Above Pueblo, Avondale, and Catlin Dam stream gages, in Lake Henry and Lake Meredith, and in the Arkansas River downstream of Lake Meredith releases (MWH 2006). Results of the specific conductance modeling are summarized in Table 3-18 and Figure 3-24. Although there is no WQS for salinity in the Arkansas River, the 85^{th} percentile of quarter-monthly simulated specific conductance is used as the descriptive statistic, according to CDPHE's method of characterizing of ambient water quality in comparison to chronic WQS (CDPHE 2005).

Table 3-18. Simulated 85th Percentile Specific Conductance for Direct and Cumulative Effects.

Location	High Salinity Hazard/ Secondary MCL[1]	85th Percentile of Quarter Monthly SC			Proposed Action – No Action	
		Existing Conditions	No Action	Proposed Action		
Direct Effects	(µS/cm)	(µS/cm)	(µS/cm)	(µS/cm)	(µS/cm)[2]	(%)[3]
Above Pueblo gage	750 / 740	517	522	526	5	1%
Avondale gage	750 / 742	1,116	1,126	1,118	-8	-1%
Catlin Dam gage	750 / 742	1,426	1,435	1,427	-7	-1%
Lake Henry/Meredith	750 / 772	1,247	1,260	1,249	-10	-1%
Ark River at Meredith return streamflow	750 / 742	1,399	1,410	1,400	-9	-1%
Cumulative Effects						
Above Pueblo gage	750 / 740	517	533	535	2	0%
Avondale gage	750 / 742	1,116	1,093	1,088	-5	0%
Catlin Dam gage	750 / 742	1,426	1,398	1,390	-8	-1%
Lake Henry/Meredith	750 / 772	1,247	1,238	1,241	3	0%
Ark River at Meredith return streamflow	750 / 742	1,399	1,382	1,377	-5	0%

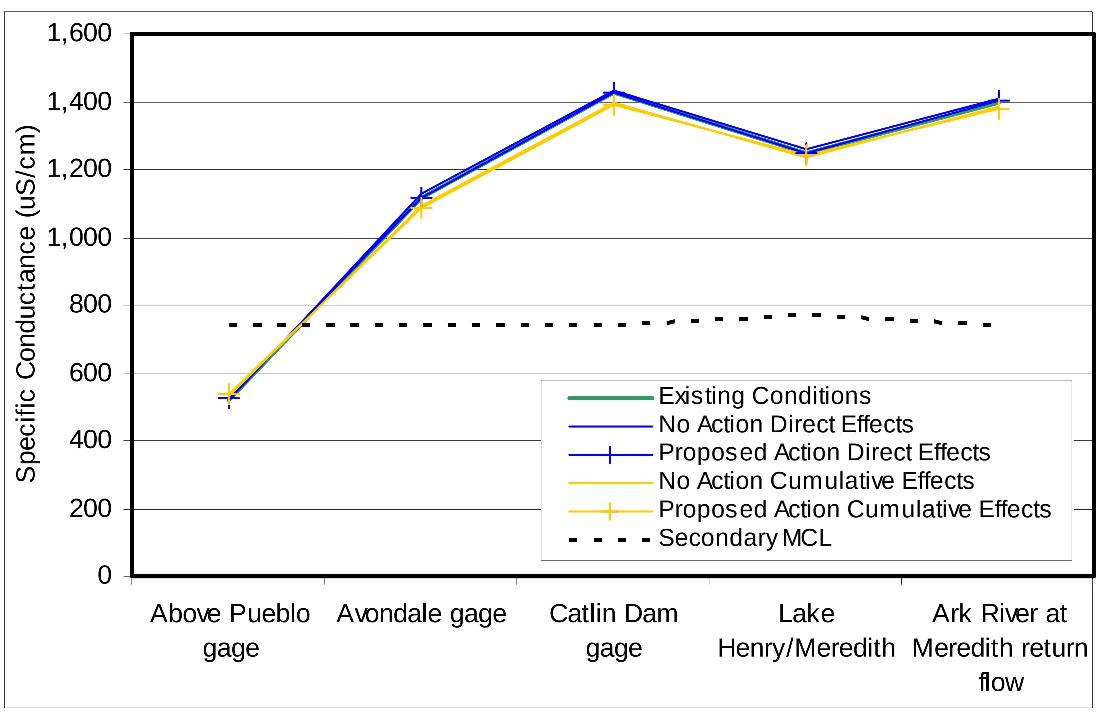
SC = specific conductance, Ark River = Arkansas River.

(1) Secondary MCL is equal to 500 mg/L (TDS) and is estimated as specific conductance in µS/cm at each location using site-specific regression equations between TDS and specific conductance (USGS 1993, 2004). The Catlin Dam gage and return streamflow locations are assumed to be equal to the Avondale gage.

(2) 85th percentile Proposed Action - 85th percentile No Action specific conductance (values calculated from model output may vary slightly from subtraction of rounded values shown in table).

(3) (85th percentile Proposed Action - 85th percentile No Action)/ 85th percentile No Action specific conductance.

Figure 3-24. Simulated 85th Percentile Specific Conductance for Direct and Cumulative Effects.



The model results of direct and cumulative effects indicate minimal differences in the 85th percentile of specific conductance between Existing Conditions, Proposed Action, and the No Action Alternative (MWH 2006). The estimated difference between the Proposed Action and No Action Alternative is 10 µS/cm or less and the percentage differences are 1 percent or less at each location. Salinity, as measured by specific conductance, downstream of the Above Pueblo gage would remain above the secondary MCL/ high salinity hazard for both alternatives under direct and cumulative effects conditions.

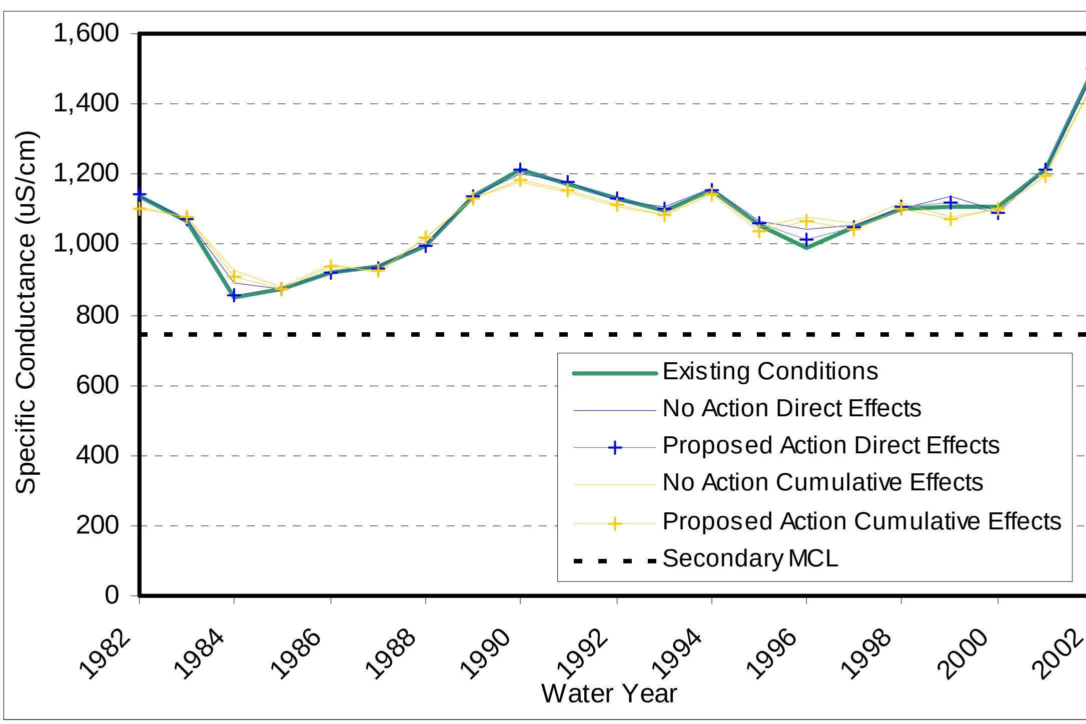
Figure 3-25 depicts annual mean simulated specific conductance at the Catlin Dam gage for the 1982-2002 study period. On a mean annual basis, there is little difference in simulated specific conductance between alternatives. This magnitude of mean annual variation is typical of what was simulated at each model location. Specific conductance decreases slightly for the cumulative effects because streamflows at the mouth of Fountain Creek are higher with lower specific conductance concentrations. Higher streamflows from Fountain Creek dilute specific conductance in the lower Arkansas River.

Both alternatives have a minor effect on salinity concentrations.

3.4.2.4 Sulfate

Sulfate concentrations are directly related to salinity concentrations in the Arkansas River because sulfate is one of the ions comprising total dissolved solids (MWH 2006). Because the effects of the alternatives are minimal for salinity concentrations, they would also be minimal for sulfate concentrations.

Figure 3-25. Simulated Mean Annual Specific Conductance at Catlin Dam Gage.



3.4.2.5 Dissolved Selenium in the Middle and Lower Arkansas River Basin

Elevated concentrations of dissolved selenium are a concern in the Arkansas River downstream of Pueblo Reservoir. Regression equations based on the historical relationship between salinity and dissolved selenium were used to estimate selenium concentrations at the Above Pueblo, Avondale, and Catlin Dam gages (MWH 2006). The 85th percentile of simulated quarter-monthly dissolved selenium concentrations is compared to the chronic WQS. Acute selenium effects are summarized by comparing the percentage of quarter-months in which concentrations exceed the acute WQS for each alternative.

Chronic effects on dissolved selenium concentrations for Existing Conditions and each alternative are summarized in Table 3-19. Similar to the salinity results, there was little difference in simulated dissolved selenium concentrations between Existing Conditions and the alternatives for both the direct effects and cumulative effects analyses. The differences in the 85th percentile of dissolved selenium concentrations were less than or equal to 0.6 µg/L (4 percent) at each location. Simulated dissolved selenium concentrations are equal at the Above Pueblo gage for each alternative. Dissolved selenium concentrations are similar at the Avondale gage for direct effects and would decrease for both alternatives at the Avondale gage for cumulative effects conditions because higher streamflows at the Fountain Creek mouth dilute selenium concentrations in the lower Arkansas River. At the Catlin Dam gage, the 85th percentiles of simulated selenium concentrations are at or near the chronic WQS for Existing Conditions and both alternatives.

The percentages of quarter-months in which simulated dissolved selenium concentrations exceed acute WQS are summarized in Table 3-20. At the Avondale gage, the comparison is made to the Table Value Standard of 18.4 µg/L because the current standard is a temporary modification equal to "Existing Conditions". There is little difference between Existing Conditions and the alternatives in the number of exceedances of acute WQS. The Proposed Action results in 1 percent fewer simulated exceedances of the acute Table Value Standard at the Avondale gage than the No Action Alternative for both direct and cumulative effects.

Dissolved selenium concentrations were not estimated for Lake Henry and Lake Meredith. Inflow concentrations to the lakes from the Arkansas River would be similar for the alternatives and Existing Conditions because estimates of selenium concentration at the Avondale gage were similar. Changes in dissolved selenium concentrations in Lake Henry and Lake Meredith due to evaporation are likely to be of a magnitude similar to changes in salinity within the reservoirs. For the salinity modeling, the 85th percentile of specific conductance for the two reservoirs is similar for the Proposed

Table 3-19. Summary of Simulated Dissolved Selenium Chronic Environmental Consequences.

Location	Chronic WQS	85th Percentile of Quarter Monthly Dissolved Se			Proposed Action – No Action	
		Existing Conditions	No Action	Proposed Action		
Direct Effects	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)[(1)]	(%)[(2)]
Above Pueblo gage	6.0	4.4	4.4	4.4	0.0	0%
Avondale gage	Existing Quality	17.0	17.2	17.0	-0.2	-1%
Catlin Dam gage	16.0	16.0	16.2	16.1	-0.1	-1%
Cumulative Effects						
Above Pueblo gage	6.0	4.4	4.4	4.4	0.0	0%
Avondale gage	Existing Quality	17.0	16.5	16.4	-0.1	-1%
Catlin Dam gage	16.0	16.0	15.9	15.7	-0.2	-1%

Se = selenium.

(1) 85th percentile Proposed Action - 85th percentile No Action dissolved selenium.

(2) (85th percentile Proposed Action - 85th percentile No Action)/ 85th percentile No Action dissolved selenium.

Table 3-20. Summary of Simulated Exceedances of Acute Dissolved Selenium WQS.

Location	Acute WQS	Percentage of Quarter Months Exceeding WQS			Proposed Action – No Action
		Existing Conditions	No Action	Proposed Action	
Direct Effects	(μg/L)	(%)[1]	(%)[1]	(%)[1]	(%)
Above Pueblo gage	18.4	0%	0%	0%	0%
Avondale gage	Existing Quality[2]	7.1%	8.1%	7.1%	-1%
Catlin Dam gage	18.4	0.5%	0.9%	0.5%	0%
Cumulative Effects					
Above Pueblo gage	18.4	0%	0%	0%	0%
Avondale gage	Existing Quality[2]	7.1%	5.1%	4.0%	-1%
Catlin Dam gage	18.4	0.5%	0.1%	0.1%	0%

(1) Number of simulated acute WQS exceedances / 1,008 quarter months.
4 quarter months x 12 months x 21 years = 1,008 quarter months in study period.

(2) Temporary modification until 7/1/08, comparison is made to the Table Value Standard of 18.4 μg/L.

Action and No Action Alternative. Other factors potentially affecting selenium concentrations in Lake Henry and Lake Meredith, such as biological uptake and chemical reactions, are difficult to evaluate because selenium mechanics are not well understood. However, according to the available information, it is likely that selenium concentrations would be similar for the Proposed Action and No Action Alternative in Lake Henry and Lake Meredith.

In summary, at all locations evaluated, there would be minimal effects to dissolved selenium concentrations for either alternative.

3.4.2.6 Arsenic, Mercury, and Boron

Arsenic, mercury, and boron were raised as constituents of concern through the EA public comment process. However, the analysis of available water quality data for the affected environment analysis showed that concentrations of these three constituents were low compared to the applicable WQS (MWH 2006). The alternatives, which differ only in terms of river operations, would not affect any surface or depositional sources of boron, arsenic, or mercury. The alternatives also would not result in any substantial changes to streamflow, indicating that the alternatives are not likely to affect concentrations of these constituents.

3.4.2.7 Percentage of Streamflow from Fountain Creek

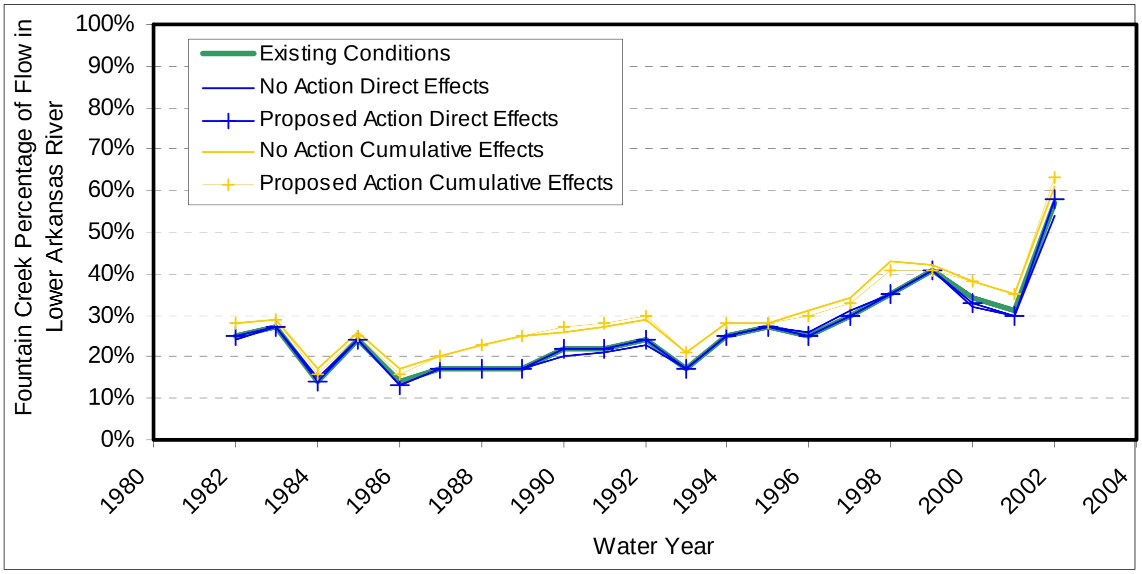
The percentage change in Fountain Creek's contribution to streamflow in the Arkansas River was evaluated because a large change in the percentage of streamflow from Fountain Creek could alter the water quality of the lower Arkansas River and lower Arkansas River reservoirs. Fountain Creek and the Arkansas River have different water quality characteristics for several constituents including sediment, total recoverable iron, and bacteria (USGS 1998, 2005b). Table 3-21 and Figure 3-26 summarize the Quarter-Monthly Model simulated percentage of water from Fountain Creek in the lower Arkansas River.

The annual mean percentage of streamflow from Fountain Creek is nearly equal in any given year for

Table 3-21. Study Period Mean Percentage of Streamflow from Fountain Creek.

	Existing Conditions	No Action	Proposed Action	Proposed Action – No Action
Direct Effects	25%	25%	25%	0%
Cumulative Effects	25%	29%	28%	-1%

Figure 3-26. Annual Mean Percentage of Arkansas River Streamflow from Fountain Creek.



Existing Conditions and the alternatives for direct effects. Under cumulative effects conditions, wastewater return flows in Fountain Creek from municipalities in the Fountain Creek basin increase, resulting in a greater percentage of Arkansas River streamflow from Fountain Creek. However, the annual mean percentage of streamflow from Fountain Creek is nearly equal over the study period for the Proposed Action and No Action Alternative cumulative effects. Therefore, the minor changes in Fountain Creek contributions to Arkansas River streamflow under direct and cumulative effects for both alternatives would have similar effects on Arkansas River quality.

3.4.2.8 Nutrients

Nutrient loading to the middle and lower Arkansas River is one of the factors that could contribute to algae growth in downstream reservoirs. Potential nutrient sources include wastewater treatment plant discharges, agricultural return flows, urban runoff, and other non-point sources (USGS 1998). These sources are equal for the Proposed Action and No Action Alternative analyses. Under cumulative effects there may be additional nutrient loading because in 2045 more wastewater effluent would be discharged to surface waters. However, the additional discharges are the same for the Proposed Action and No Action Alternative. The nutrients effects analysis focuses on the differences in streamflow at critical stream gages because although sources may be the same, concentrations can be affected by streamflow.

The Avondale and Portland gages were evaluated as critical stream gages for nutrients because they are located directly upstream of study area reservoirs. As shown in the summary of Avondale gage flows (see Table A-9) and Portland gage flows (see Table 3-22), there is little difference between the flows at these gages between the alternatives or from Existing Conditions. Therefore, minimal differences in nutrient concentrations in the middle and lower Arkansas River would be expected between the Proposed Action and No Action Alternative.

3.4.2.9 Reservoir Water Quality

Nutrient loading is an important part of general reservoir water quality due to its potential effects on algae growth and rate of eutrophication or lake productivity. As discussed above, nutrient loading from external sources to study area reservoirs would not change as a result of the Proposed Action or No Action Alternative. Salinity and selenium concentrations in lower Arkansas River basin reservoirs are similar for Existing Conditions and the

Table 3-22. Portland Gage Simulated Average Streamflow for Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow(1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	412	414	412	-2	-1%	419	413	-5	-1%
Nov	449	449	449	0	0%	447	447	0	0%
Dec	407	411	406	-6	-1%	415	413	-2	0%
Jan	384	384	379	-5	-1%	392	383	-9	-2%
Feb	389	393	383	-10	-3%	391	372	-19	-5%
Mar	507	508	493	-15	-3%	487	469	-18	-4%
Apr	576	572	562	-10	-2%	543	549	6	1%
May	1,199	1,220	1,194	-26	-2%	1,317	1,312	-6	0%
Jun	2,488	2,531	2,490	-41	-2%	2,461	2,445	-16	-1%
Jul	1,538	1,543	1,542	-1	0%	1,535	1,527	-7	0%
Aug	856	861	858	-3	0%	853	850	-4	0%
Sep	460	462	456	-6	-1%	461	452	-9	-2%
Average	805	812	802	-10	-1%	810	803	-7	-1%

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

alternatives, as discussed previously. The following discussion evaluates characteristics of reservoirs affected by hydrology, such as residence time and depth, which could potentially affect water quality.

Turquoise Reservoir

The source of water to Turquoise Reservoir is snowmelt runoff from high elevations of either the eastern or western slope of the Rocky Mountains. However, as shown in Table 3-23 and Figure 3-27, the percentage of source water from the West Slope is nearly equal for direct and cumulative effects for both alternatives.

Changes in Turquoise Reservoir depth were evaluated because substantial decreases in depth could potentially change the typical stratification and mixing patterns of the reservoir. The Surface Water Quantity Section 3.1.3.1 describes how the Proposed Action results in slightly greater storage in Turquoise Reservoir than the No Action Alternative—3 percent greater for direct effects and 2 percent greater for cumulative effects. The differences in storage result in small differences in reservoir depth as shown in Figure 3-28. Reservoir depths for direct and cumulative effects for both alternatives are so similar to Existing Conditions that a change to the typical stratification and mixing patterns of Turquoise Reservoir should not occur.

Theoretical water residence times in Turquoise Reservoir vary from year to year as shown in Figure 3-29. On average, the residence times are very similar for Existing Conditions and each alternative. For both direct and cumulative effects conditions, the Proposed Action results in a residence time 2 days shorter, or 1 percent different, than the No Action Alternative. The small changes noted in residence time between the alternatives and Existing Conditions should not result in changes to water quality in Turquoise Reservoir.

Because the inflow sources, depth, and residence time are very similar among the Existing Conditions, Proposed Action, and No Action Alternative, Turquoise Reservoir water quality should not be affected by either alternative.

Table 3-23. Average Percentage of Turquoise Reservoir Water From the West Slope During the Study Period.

	Existing Conditions	No Action	Proposed Action	Proposed Action – No Action
Direct Effects	87%	86%	87%	1%
Cumulative Effects	87%	87%	87%	0%

Figure 3-27. Annual Mean Percentage of Turquoise Reservoir Water From West Slope.

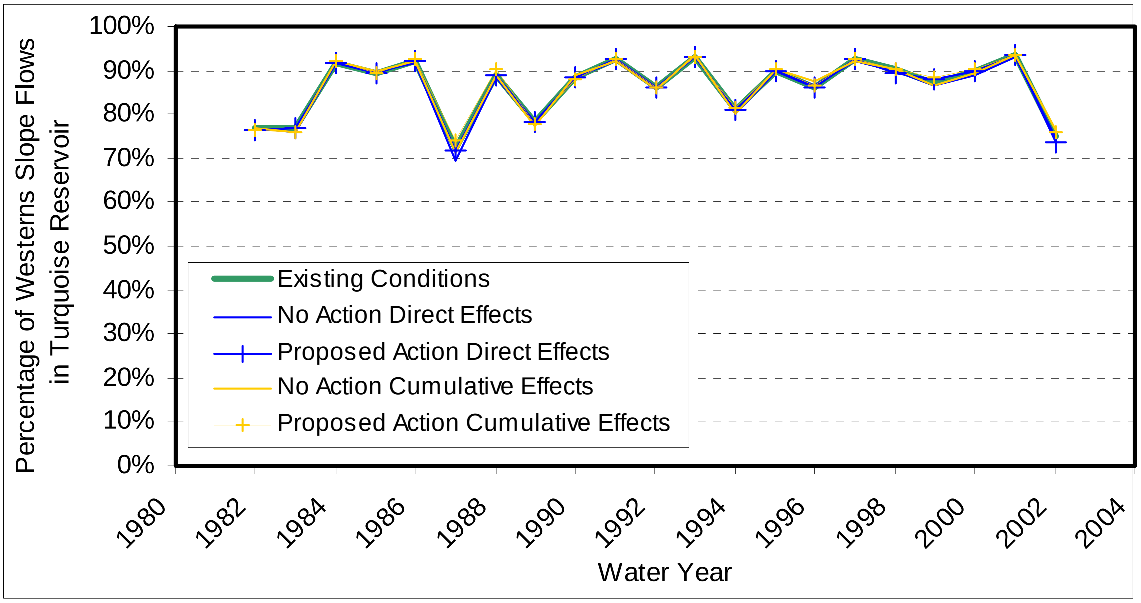


Figure 3-28. Quarter-Monthly Simulated Depth – Turquoise Reservoir.

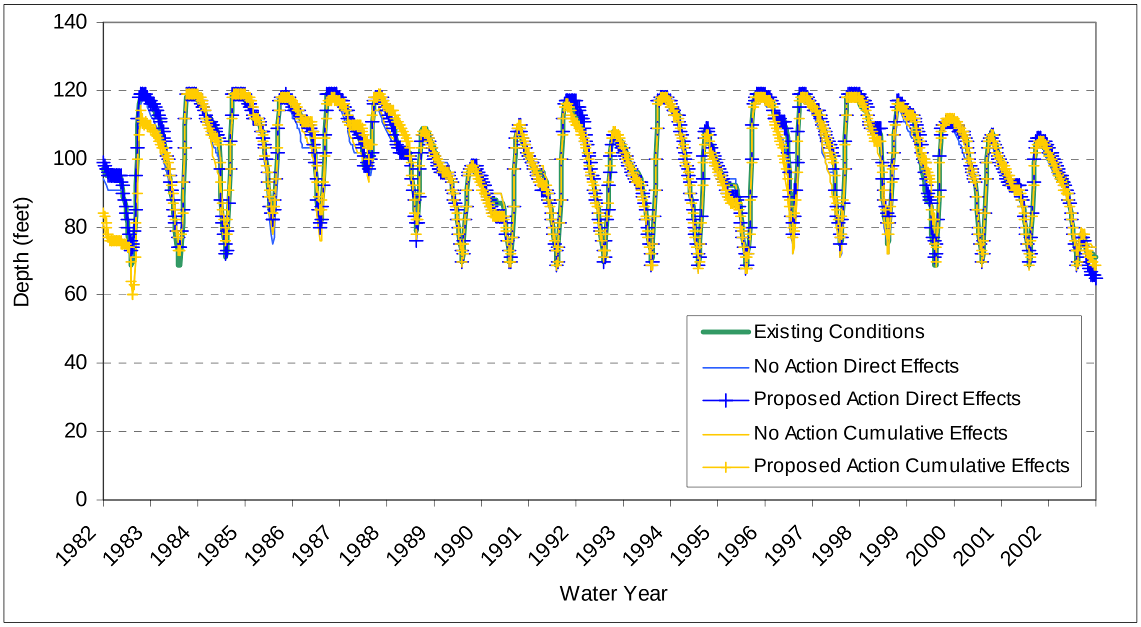
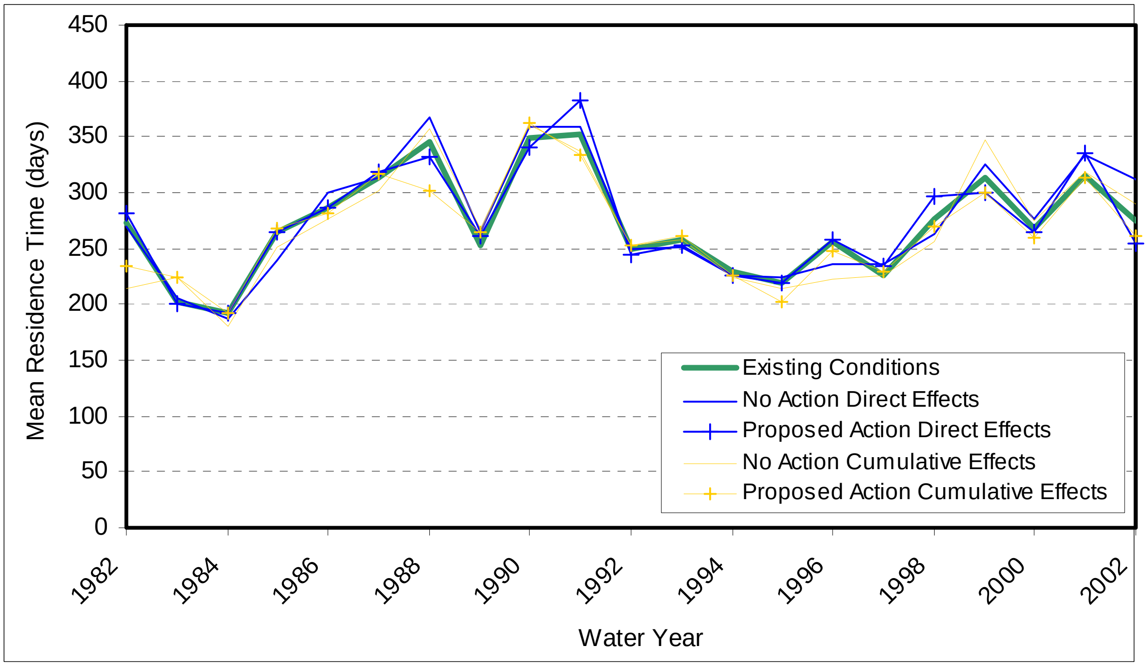


Figure 3-29. Mean Annual Residence Time – Turquoise Reservoir.



Pueblo Reservoir

Reductions in depth could potentially upset summer stratification in Pueblo Reservoir resulting in mixing of the reservoir water. There are many potential effects of an upset to the stratification pattern in Pueblo Reservoir, depending on the time of year and particular conditions when the reservoir turns over. Some of the effects could be positive, such as higher dissolved oxygen in the hypolimnion, and some could be negative, such a mixing of high nutrient water from the hypolimnion throughout the reservoir if there is enough high nutrient water in the hypolimnion to affect reservoir water quality. Figure 3-30 depicts quarter-monthly simulated depths in Pueblo Reservoir. Table 3-24 summarizes simulated monthly mean depths in Pueblo Reservoir.

The direct effects of the Proposed Action and No Action Alternatives are less water in Pueblo Reservoir and therefore shallower depths than Existing Conditions. As discussed in Water Quantity Section 3.1.3.5, Proposed Action and No Action Alternative storage in Pueblo Reservoir is limited by the PFMP. Under cumulative effects conditions, both alternatives are slightly shallower than under direct effects. The No Action Alternative results in greater effects than the Proposed Action. There is no numerical threshold for the depth when stratification is disrupted because there are many factors in addition to depth affecting stratification. However, the minimal differences in monthly mean depth (3 percent or less between the alternatives and 10 percent or less between the alternatives and Existing Conditions for both direct and cumulative effects) are unlikely to result in a change in stratification.

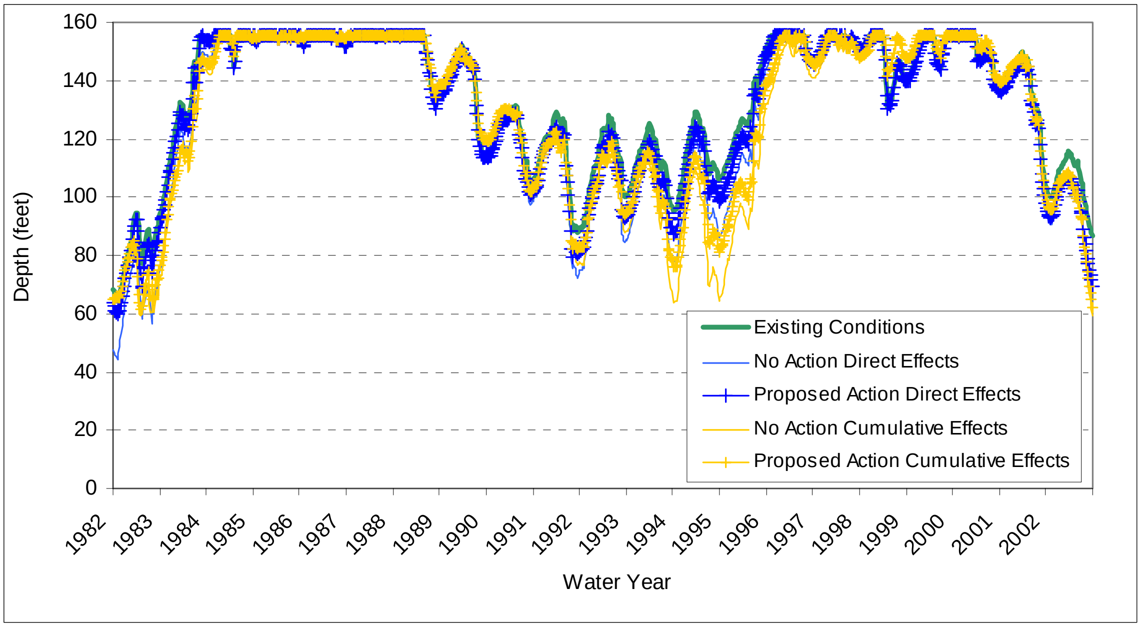
Stratification is most likely to be disrupted in study period years when reservoir depths are unusually shallow, such as 1991 to 1995. The annual minimums shown in those years were simulated to occur in the fall, rather than summer. During the fall the reservoir normally changes from stratified temperature zones to a mixing of water in the hypolimnion and epilimnion. In those unusual years, water quality effects of reduced depth are more likely for the No Action Alternative. The most likely effect of a shallower reservoir would be that if it stratifies, it would likely mix earlier in the fall and the length of the period of stratification would be shorter.

Table 3-24. Monthly Mean Simulated Depth in Pueblo Reservoir

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		No Action	Proposed Action	Proposed Action – No Action		No Action	Proposed Action	Proposed Action – No Action	
	(ft)	(ft)	(ft)	(ft) (1)	(%)(2)	(ft)	(ft)	(ft) (1)	(%)(2)
Oct	127	121	124	3	2%	120	123	3	3%
Nov	129	123	126	3	2%	122	125	3	2%
Dec	132	128	130	2	2%	126	129	3	2%
Jan	136	132	133	1	1%	131	132	1	1%
Feb	138	134	136	2	1%	133	134	1	1%
Mar	140	137	138	1	1%	135	136	1	1%
Apr	139	135	137	2	1%	132	134	2	2%
May	137	132	134	2	2%	130	132	2	2%
Jun	136	131	133	2	2%	129	132	3	2%
Jul	133	128	130	2	2%	126	129	3	2%
Aug	131	124	128	4	3%	123	126	3	2%
Sep	128	121	125	4	3%	120	123	3	3%
Average	**134**	**129**	**131**	**2**	**2%**	**127**	**130**	**3**	**2%**

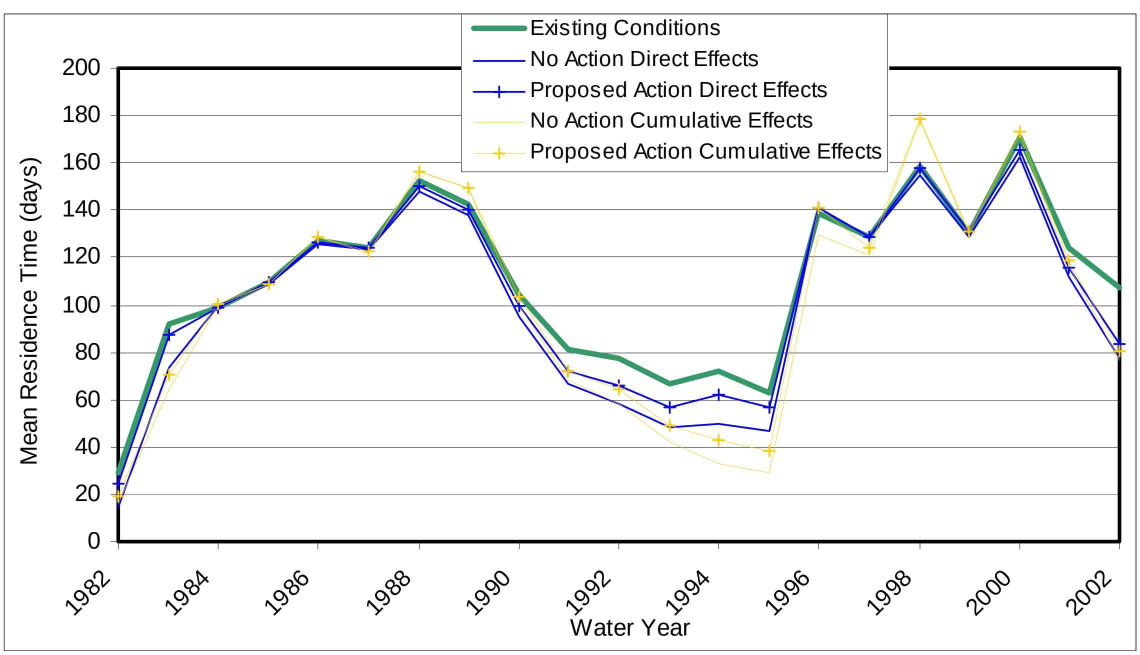
(1) Proposed Action depth – No Action depth.
(2) (Proposed Action depth – No Action depth)/No Action depth.

Figure 3-30. Quarter-Monthly Simulated Depth – Pueblo Reservoir.



Shorter residence times are generally beneficial to water quality in Pueblo Reservoir because contaminants are flushed out of the reservoir faster (USGS 1994). Figure 3-31 depicts the annual mean residence time in Pueblo Reservoir for Existing Conditions and both alternatives. In almost every year, residence time in Pueblo Reservoir is decreased under the Proposed Action and No Action Alternative compared to Existing Conditions. The No Action Alternative generally results in shorter residence times than the Proposed Action for both direct and cumulative effects. This is primarily due to reduced storage in Pueblo Reservoir under the No Action Alternative. The overall decrease in residence time due to the Proposed Action and No Action Alternative could potentially improve water quality in Pueblo Reservoir compared to Existing Conditions.

Figure 3-31. Annual Mean Residence Time – Pueblo Reservoir.



Lake Henry and Lake Meredith

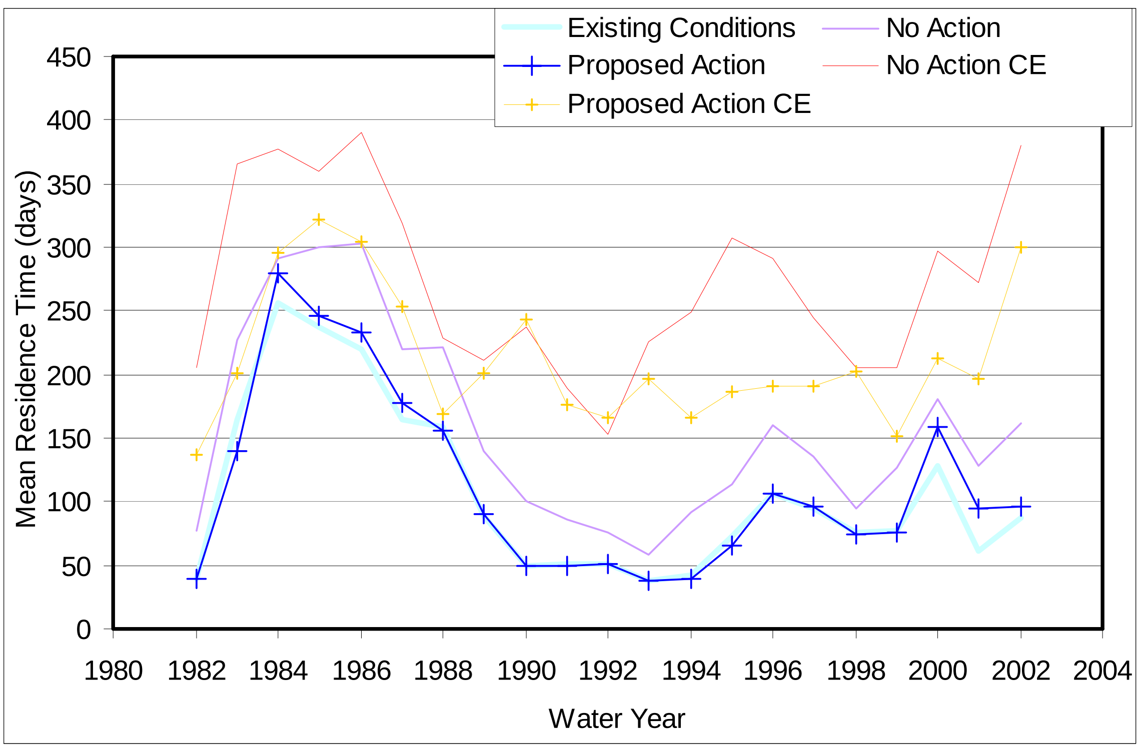
Residence time was calculated for Lake Henry and Lake Meredith combined. In reservoirs that do not strongly stratify, the potential adverse effects of increasing residence time are increased algae growth and concentration of contaminants due to increased evaporation. Figure 3-32 depicts the mean annual residence times for Lake Henry and Lake Meredith combined. Under direct effects, the No Action Alternative results in slightly longer residence times than the Proposed Action and Existing Conditions. Under cumulative effects, both alternatives result in longer residence times than Existing Conditions, although the No Action Alternative results in the longest residence times.

The salinity mass balance for Lake Henry and Lake Meredith indicated that the change in residence time did not greatly increase the 85^{th} percentile of concentrations. Under cumulative effects, the Proposed Action and No Action Alternative result in generally longer residence times than under direct effects. However, the salinity model indicated that the increased residence time would not substantially increase the 85^{th} percentile of concentrations of dissolved constituents. Algae growth could be greater for the alternatives with longer residence times, but wind and wave action are likely to keep these shallow reservoirs aerated to counteract the depletion of dissolved oxygen caused by algal respiration and decomposition.

Holbrook Reservoir

Residence time calculations and mass balance calculations could not be performed for Holbrook Reservoir with the available Quarter-Monthly Model results. Therefore, the water quality effects of changes in Holbrook Reservoir storage are discussed qualitatively. As discussed in the Surface Water Quantity section, the No Action Alternative and Existing Conditions result in equal depths for Holbrook Reservoir because of the assumption that Aurora does not utilize ROY storage. The Proposed Action results in greater storage in Holbrook Reservoir on average. The additional storage in Holbrook Reservoir is generally temporary as water is stored on a seasonal basis and released to the Arkansas River to facilitate exchanges. Water

Figure 3-32. Mean Annual Residence Time - Lake Henry and Lake Meredith.



Note: CE = cumulative effects.

would be stored and then quickly moved out of the reservoir, rather than remain in the reservoir for extended periods. Because the water would not be left in the reservoir to evapoconcentrate, no adverse effects to water quality are expected due to the Proposed Action.

3.5 AQUATIC RESOURCES

This section addresses aquatic resources in the upper and lower Arkansas River basin and the potential effects of the Proposed Action and No Action Alternative. The alternatives could potentially affect aquatic resources through changes in flow regimes, habitat, and/or water quality.

Information on aquatic biological resources, which was available from numerous sources, is summarized in the Aquatic Resources Technical Report (CEC 2006). Much of the information was available from data collected by the Colorado Division of Wildlife (CDOW), Colorado State University, and Chadwick Ecological Consultants. Data were compiled primarily for the years 1999 through 2004, although one fish collection project completed in early 2005 was also included.

3.5.1 Affected Environment

The study area for aquatic resources includes Turquoise Reservoir, the Lake Fork of the Arkansas River, Lake Creek, and the Arkansas River from the Lake Fork downstream to Pueblo Reservoir in the upper Arkansas River basin (Figure 1-1). In the lower Arkansas River basin, the study area includes Pueblo Reservoir, the Arkansas River from Pueblo Dam downstream to La Junta, Lake Henry, Lake Meredith, and Holbrook Reservoir. The following sections describe the fish, benthic invertebrate, and habitat characteristics in the study area.

3.5.1.1 Turquoise Reservoir

Turquoise Reservoir is oligotrophic to ultraoligotrophic (low biological productivity), but is considered suitable to sustain trout species despite limited food resources (Bridges et al. 2000). This lake is managed as a coldwater fishery primarily for lake trout. Brown and rainbow trout are sustained through stocking. Lake trout have self-sustaining populations with spawning along shoreline habitat during the fall.

CDOW samples the fish of Turquoise Reservoir every other year with gill nets. Longnose suckers are the most common species collected from 1999 through 2003, with lake trout and rainbow trout the most prevalent game fish. Stocking of brown and rainbow trout occurs in most years. Cutthroat trout and a few lake trout have also been stocked once or twice since 1999.

3.5.1.2 Upper Arkansas River

Lake Fork

Fish populations were sampled by CDOW and Chadwick Ecological at one site on the Lake Fork of the Arkansas River nearly each year between 1999 and 2004. Brown trout are the dominant fish species and the presence of all year classes indicates a self-sustaining population. Brook trout, cutthroat trout, and rainbow trout also are present in low numbers. Limited numbers of longnose and white suckers also have been collected since 1999. No fish stocking occurs in the Lake Fork of the Arkansas River; however, fish stocked in Turquoise Reservoir occasionally are collected in Lake Fork.

Benthic macroinvertebrates are sampled each spring and fall at one site on the Lake Fork of the Arkansas River. Data indicate that population levels fluctuate from year to year. In all years, the population comprises a wide variety of species, including sensitive species of mayflies, stoneflies, and caddisflies. Overall, the data indicate healthy benthic invertebrate populations in the Lake Fork.

Lake Creek

Lake Creek downstream of Twin Lakes is a 1.5-mile reach of stream not routinely sampled for fish or invertebrates. This reach probably contains a resident population of brown trout. Other trout and sucker species, including brook, cutthroat, lake, and rainbow trout as well as longnose and white suckers, are probably also present in the stream as they move out of Twin Lakes. Lake Creek is not stocked.

Arkansas River

The upper Arkansas River from the confluence of the Lake Fork of the Arkansas River downstream to Pueblo Reservoir is managed by CDOW as a coldwater brown trout and rainbow trout fishery. The management objectives are to optimize the production of self-sustaining brown trout populations and encourage the development of a self-sustaining rainbow trout fishery (Bridges et al. 2000).

At all sampling sites in the upper Arkansas River study area, brown trout are the dominant species. Brook, cutthroat, and rainbow trout, along with longnose and white suckers also are present in lower numbers. Longnose dace are present at sites downstream of Buena Vista. Rainbow trout are stocked annually in this portion of the upper Arkansas River.

From Cañon City downstream to Pueblo Reservoir, the Arkansas River contains both coldwater and warmwater fish species. Periodic sampling indicates the presence of coldwater species, such as brown trout, and warmwater species, such as flathead chub (a species of special concern in Colorado), green sunfish, and sand shiner. Eleven different species have been collected in the reach of the Arkansas River between Cañon City and Pueblo Reservoir.

Benthic macroinvertebrates have been collected in spring and fall at two sites just downstream of the Lake Fork of the Arkansas River. The data indicate the presence of healthy, balanced communities of invertebrates, including the presence of numerous species of sensitive mayflies, stoneflies, and caddisflies.

3.5.1.3 Pueblo Reservoir

CDOW manages Pueblo Reservoir is as a cold, cool, and warmwater fishery (Bridges et al. 2000). Annual sampling by CDOW since 1999 indicates that gizzard shad, walleye, bluegill, and wiper are the most common fish collected. CDOW has collected a total of 16 species of fish and three different hybrid varieties since 1999. Most of the species are game fish providing recreational fishing opportunities.

CDOW stocks many types of game fish in Pueblo Reservoir. Rainbow trout, channel catfish, walleye, and wiper are the most common types of fish stocked since 1999.

3.5.1.4 Lower Arkansas River

Pueblo Reservoir to Wildhorse Creek

As a result of releases from Pueblo Reservoir, the Arkansas River from Pueblo Reservoir downstream to Wildhorse Creek is classified as coldwater habitat suitable for supporting trout. CDOW and Chadwick Ecological jointly sampled this reach of the river in 2004 and collected 15 different species and three hybrid varieties of fish. White sucker was the most common species collected. The species composition included brown trout, rainbow trout, cutbow (cutthroat x rainbow) hybrids, as well as warmwater species such a wiper (white bass x striped bass hybrids), largemouth bass, saugeye (sauger x walleye hybrids), and yellow perch that probably moved downstream from Pueblo Reservoir. The species composition also included native warmwater species such as central stoneroller, green sunfish, and white sucker. The three types of trout collected are routinely stocked by CDOW in this reach of the Arkansas River.

Wildhorse Creek to La Junta

Downstream of Wildhorse Creek, the Arkansas River is classified as warmwater fish habitat. Data collection for fish has been sporadic. Sampling from 2005 and earlier documented a total of 25 species in this reach of the Arkansas River (Krieger 2005). Fathead minnow, red shiner, sand shiner, longnose dace, and white sucker have been collected most often since 1979. These five species are native to the Arkansas River. Most of the species collected since 1979 are warmwater species. Flathead chubs (species of concern) were common and a few Arkansas darters (State threatened), and suckermouth minnows (State endangered) were also collected in this reach. A few brown and rainbow trout were collected in late winter of 2005 near Pueblo and probably drifted downstream from the coldwater reach of the river upstream of Wildhorse Creek.

Sampling of benthic invertebrates by Chadwick Ecological in the mid 1990s near Pueblo indicates that populations vary substantially from year to year. The benthic population contained a few pollution-intolerant species, but there were more pollution-tolerant species.

3.5.1.5 Lake Henry, Lake Meredith, Holbrook Reservoir

CDOW manages Lake Henry, Lake Meredith, and Holbrook Reservoir as warmwater fisheries. During the drought period from 2001 through 2003, all three reservoirs were drained, which disrupted normal fish sampling and management. Lake Henry and Lake Meredith are recovering; however, Holbrook Reservoir continued to have low water levels in fall 2005.

Based on sampling results prior to the drought, Lake Henry and Lake Meredith supported a variety of warmwater fish species. Gizzard shad was one of the most common species in both reservoirs, and served as a forage base for many of the game fish species. Sampling from both reservoirs indicates that channel catfish, saugeye, and wipers were common game fish. Holbrook Reservoir has not been sampled since 1998 because of low or no water in the reservoir and currently has very few fish surviving.

Lake Henry and Lake Meredith are typically stocked with several warmwater fish species including black crappie, channel catfish, saugeye, and wipers. As water levels improve in these reservoirs, CDOW will likely continue this fish stocking schedule. Holbrook Reservoir will not be actively managed until water levels return. Future management of this reservoir will probably include the stocking of warmwater game fish.

3.5.2 Environmental Consequences

The assessment of environmental consequences evaluates the potential for changes in aquatic resources due to the Proposed Action and the No Action Alternative. Evaluation of output from the Indicators of Hydraulic Alteration (IHA) model (Richter et al. 1996, 1997) was the primary tool used for assessing potential environmental consequences to fish and invertebrate populations in streams and reservoirs in the study area. The IHA model summarizes hydrologic data and is used to compare the flow regimes of the different alternatives. The statistical modeling of hydrologic data under IHA uses median rather than mean values because they are more appropriate in identifying flow conditions that could affect aquatic resources. The IHA model and its use is described in greater detail in the Aquatic Resources Technical Report (CEC 2006).

Aquatic biota are generally influenced by extremes in flow and habitat conditions that limit population size. Average conditions have less effect on population size. The focus of the effects analysis was on the key IHA parameters most likely to influence fish and benthic invertebrate populations in the study area. In streams, these parameters describe high and low flow events. Decreasing low flows (making them more severe), increasing high flows (more severe) or increasing fluctuations in flow conditions could have adverse effects to aquatic resources. In reservoirs, an increase in volume is beneficial to aquatic species. A change in key IHA parameters of 10 percent or more was used to indicate that aquatic resources may be potentially affected either positively or negatively.

Aquatic resources could potentially be affected by changes in water quality or changes in riparian vegetation. Based on the results of the water quality analysis (MWH 2006) the Proposed Action would not result in water quality changes in the study area that would affect aquatic resources. Results of the analysis of vegetation and wetlands (ERO 2006a) indicate that neither the Proposed Action nor No Action Alternatives would have a measurable effect on aquatic resources as a result of changes in riparian vegetation.

3.5.2.1 Turquoise Reservoir

The No Action, Proposed Action, and Existing Conditions flow regimes are very similar and have only minor differences in how water is stored in Turquoise Reservoir. The No Action Alternative results in an estimated 31-day later filling of the reservoir and it stays full for a shorter period (Figure 3-7 and Table A-2). This may reduce the productivity of the reservoir during the summer growing season. The No Action Alternative would have a minor effect on aquatic resources compared to the Proposed Action and to Existing Conditions. The Proposed Action and Existing Conditions reservoir levels are very similar and there would be no effect from the Proposed Action compared to Existing Conditions in Turquoise Reservoir.

3.5.2.2 Upper Arkansas River

Lake Fork

As shown on Figure 3-8, the No Action, Proposed Action, and Existing Conditions flow regimes are very similar for the Lake Fork of the Arkansas River. However, IHA results indicate 52 percent higher 1-day and 38 percent higher 7-day peak flows than the No Action Alternative. The higher peak flows make the spring runoff period more severe on fish and invertebrate populations by making them expend more energy in higher water velocities or by flushing them out of their preferred habitat. Thus, the No Action Alternative would be more beneficial to aquatic resources than the Proposed Action and possibly Existing Conditions.

Lake Creek

As shown in Figure 3-9, the Proposed Action and No Action Alternatives have minor differences in flows during the late winter low flow period. However, these differences are 6 cfs or less (Table A-4) and there is unlikely to be a difference in the effect to aquatic resources between the Proposed Action and the No Action Alternative in Lake Creek. Both flow regimes are also similar to Existing Conditions and would have no effect on aquatic resources compared to Existing Conditions.

Arkansas River Mainstem

Flows in the Arkansas River from the Lake Fork downstream to Pueblo Reservoir are very similar for the Proposed Action, the No Action Alternative, and Existing Conditions (Figure 3-10). Changes in mean flows are generally less than 3 percent at the Wellsville gage (Table A-5) and changes in IHA parameters are generally 5 percent or less. The similarity in the three flow regimes indicates that there would be no effects to aquatic resources for either the Proposed Action or No Action Alternative in the Arkansas River upstream of Pueblo Reservoir.

3.5.2.3 Pueblo Reservoir

As shown in Figure 3-11 and Table A-6, the Proposed Action and the No Action Alternative would result in similar storage patterns in Pueblo Reservoir. There are only a few differences in IHA parameters between the flow regimes. The overall similarity between the flow regimes indicates that there would be no effect on aquatic resources in Pueblo Reservoir with the No Action and Proposed Action compared to Existing Conditions.

3.5.2.4 Lower Arkansas River

Arkansas River Above Pueblo

The Above Pueblo gage on the Arkansas River is just downstream of Pueblo Dam and representative of flows on the coldwater reach of the river upstream of Wildhorse Creek. As shown on Figure 3-12, in this reach of the river, the Proposed Action and the No Action Alternative would result in a minimal change in streamflow from Existing Conditions and it is not anticipated that the change will affect aquatic resources.

Arkansas River Downstream of Pueblo Reservoir

The Avondale gage on the Arkansas River represents flows on the river downstream of Pueblo and downstream of Fountain Creek. The Proposed Action and the No Action Alternatives would result in similar flows in this reach of the river (Figure 3-14 and Table A-9). It is unlikely that the minor changes in flows would affect aquatic resources in this reach of the lower Arkansas River.

Arkansas River Near La Junta

The La Junta gage represents the Arkansas River to the downstream boundary of the study area. The alternative flow regimes result in similar flows (Figure 3-18). However, IHA analysis of the daily flow data indicates that short-term low flow conditions (1-day and 7-day minimum flows) would be 26 percent and 13 percent lower, respectively, (more severe) with the No Action Alternative compared to the Proposed Action. Low flows can adversely affect fish and invertebrates by reducing the available habitat and by disrupting their normal activity patterns. The Proposed Action flow regime would be more favorable to aquatic resources than the No Action Alternative by resulting in less severe low flows.

IHA analysis indicates that the No Action Alternative would also result in low flow conditions that are 13 percent to 15 percent (8 to 12 cfs) lower than Existing Conditions. The lower flows may result in a minor effect to aquatic resources for the No Action Alternative compared to Existing Conditions in this reach of the lower Arkansas River.

3.5.2.5 Lake Henry

The quarter monthly hydrology for Lake Henry indicates that the No Action Alternative results in approximately 9 percent to 17 percent more water in the reservoir than the Proposed Action or Existing Conditions (Figure 3-16, Table A-11) during summer and fall of an average year. Furthermore, IHA analysis indicates that the short-term daily low storage volumes (1-day and 7-day minimum storage) would be 35 percent and 34 percent higher with the No Action Alternative. The larger storage volume would provide more habitat for aquatic organisms. The No Action Alternative would have a beneficial effect on aquatic resources in Lake Henry compared to the Proposed Action and Existing Conditions.

3.5.2.6 Lake Meredith

As shown in Figure 3-15, the No Action Alternative would result in approximately 2,000 to 4,000 ac-ft more water being stored in Lake Meredith than the Proposed Action and Existing Conditions. IHA analysis indicates that the No Action Alternative also would have a shorter duration of low water conditions. Both of these conditions would provide more habitat for fish and invertebrates and this indicates that the No Action Alternative would have a beneficial effect on aquatic resources in Lake Meredith compared to the Proposed Action or Existing Conditions.

3.5.2.7 Holbrook Reservoir

The Proposed Action results in approximately 300 to 600 ac-ft more water being stored in Holbrook Reservoir (Table A-12). IHA analysis of the daily data indicates that the Proposed Action would result in a 1-day minimum water level that is 243 percent (557 ac-ft) higher than for the No Action Alternative. The reservoir also would fill a little earlier in the growing season, and there would be less fluctuations. These changes could provide more and better habitat for fish and invertebrates. The No Action Alternative would result in the same conditions in the reservoir as Existing Conditions. Therefore, the Proposed Action would result in more beneficial conditions in Holbrook Reservoir than the No Action Alternative and Existing Conditions.

3.5.3 Cumulative Effects

The cumulative effects analysis evaluates the potential for changes in aquatic resources due to the Proposed Action and the No Action Alternative when combined with other reasonably foreseeable actions described in Section 2.5. This cumulative effects evaluation uses IHA model output in the same way as for the direct environmental consequences.

Aquatic resources could potentially be affected by changes in water quality or changes in riparian vegetation. Based on the results of the water quality analysis (MWH 2006), there would be no substantial cumulative effect to water quality parameters in the study area that would affect aquatic resources. Results of the analysis of vegetation and wetlands (ERO 2006a) indicate that there would be no measurable cumulative effect with the Proposed Action and the No Action Alternative. Therefore, there would be no effects to aquatic resources from changes in riparian vegetation.

3.5.3.1 Turquoise Reservoir

The cumulative effects hydrology indicates very similar storage patterns in Turquoise Reservoir for all alternatives (Figure 3-7). The IHA analysis of the daily storage data indicate the reservoir could fill approximately one month later in the growing season and have an 11 percent shorter duration at full volume for the No Action Alternative than for the Proposed Action. The later filling and shorter duration at full volume would tend to limit the overall biological productivity in the reservoir. Therefore, the No Action Alternative would result in a minor cumulative effect on aquatic resources in Turquoise Reservoir. The Proposed Action is very similar to Existing Conditions and would have no cumulative effect on aquatic resources.

3.5.3.2 Upper Arkansas River

Lake Fork

Both the No Action and Proposed Action flow regimes are similar for the Lake Fork of the Arkansas River (Figure 3-8). There would be no difference to aquatic resources between the two flow regimes. However, based on the IHA analysis of the daily data, both the No Action and Proposed Action have 7-day maximum flows that are approximately 33 percent (60 cfs) higher (more severe) than Existing Conditions. The flow regimes for both alternatives and Existing Conditions are similar in most other parameters. The higher maximum flows under the two alternatives would be less beneficial to fish and invertebrates and may result in a minor cumulative effect to aquatic resources compared to Existing Conditions.

Lake Creek

In Lake Creek, there are differences between the No Action, Proposed Action, and Existing Conditions throughout the year (Figure 3-9). Most of these differences are minor, and there is unlikely to be a difference in the effect to aquatic resources of one flow regime over another.

Arkansas River Mainstem

In the upper Arkansas River upstream of Pueblo Reservoir, the Proposed Action, No Action Alternative, and Existing Conditions result in very similar cumulative flow regimes (Figure 3-10). The similarities in the flow regimes indicate that there would be no cumulative effects to aquatic resources compared to Existing Conditions.

3.5.3.3 Pueblo Reservoir

Both the No Action and Proposed Action cumulative flow regimes result in similar storage patterns in Pueblo Reservoir (Figure 3-11). The differences in storage volumes with the two flow regimes are generally less than 5 percent (Table A-6). The overall similarity in the flow regimes indicates that there would be no cumulative effect of the Proposed Action compared to the No Action Alternative.

3.5.3.4 Lower Arkansas River

Arkansas River Above Pueblo

At the Above Pueblo gage on the lower Arkansas River downstream of Pueblo Reservoir, the quarter-monthly hydrology indicates that the Proposed Action, No Action Alternative, and Existing Conditions result in similar cumulative flow regimes (Figure 3-12). The Proposed Action would be more favorable to aquatic resources than the No Action Alternative in this reach of the lower Arkansas River; however, both the No Action and Proposed Action would result in lower flows in January (more severe) than Existing Conditions. This could be unfavorable to both fish and invertebrates. The No Action and Proposed Action would probably result in a minor cumulative effect to aquatic resources in the Arkansas River near Pueblo.

Arkansas River Downstream of Pueblo Reservoir

In the reach of the Arkansas River downstream of Fountain Creek represented by the Avondale gage, the Proposed Action and No Action Alternatives result in similar flow regimes (Figure 3-14). There would be no difference in their effect on fish and benthic invertebrates. However, the daily data analyzed with IHA indicate that both the Proposed Action and No Action Alternative would result in slightly higher winter flows (13 percent to 19 percent) than Existing Conditions. More beneficial, higher winter flows indicate that both alternative flow regimes may have a beneficial cumulative effect in the reach of the lower Arkansas River.

Arkansas River Near La Junta

The La Junta gage represents the Arkansas River to the lower boundary of the study area. Data indicate that the Proposed Action, No Action, and Existing Conditions cumulative flow regimes are similar at this gage (Figure 3-18). Both alternative flow regimes would have no cumulative effect on aquatic resources compared to Existing Conditions.

3.5.3.5 Lake Henry

The No Action and Proposed Action reservoir levels at Lake Henry would result in an average of approximately 500 ac-ft more water being stored in the reservoir than during Existing Conditions, which would be favorable to fish and invertebrates. Both the No Action and Proposed Action would result in a beneficial effect on aquatic resources in Lake Henry.

3.5.3.6 Lake Meredith

The cumulative effects of No Action and Proposed Action at Lake Meredith would result in more water being stored in the reservoir and would result in a beneficial effect to aquatic resources compared to Existing Conditions. The No Action Alternative would result in an average of approximately 5,000 ac-ft more water being stored in the reservoir than the Proposed Action (Table A-10). Therefore, the No Action Alternative would be more beneficial than the Proposed Action.

3.5.3.7 Holbrook Reservoir

The cumulative effects of the Proposed Action would result in 400 ac-ft more water being stored on average in Holbrook Reservoir than the No Action Alternative and than Existing Conditions (Table A-12). Also, the Proposed Action would result in the reservoir being at low volume for a shorter period and the reservoir being fuller, longer. These differences indicate that the Proposed Action would have a beneficial effect on aquatic resources in Holbrook Reservoir compared to the No Action Alternative and Existing Conditions.

3.6 VEGETATION

This section addresses vegetation types in the study area along the Arkansas River, Lake Fork, Lake Creek, and affected lakes and reservoirs. The evaluation focuses on riparian and wetland vegetation potentially affected by changes in hydrologic conditions.

Information on vegetation was collected using published studies, reports, aerial photography, and existing mapping (CNHP 2003; ERO 2000; Smith and Hill 2000; Corps 2001b), and U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps. Reconnaissance-level field review was conducted for portions of the Arkansas River, Pueblo Reservoir, Lake Meredith, and Lake Henry, and the gravel pit reservoir storage site. The Vegetation and Wetland Resources Technical Report (ERO 2006a) provides additional information used in preparation of this section.

3.6.1 Affected Environment

The study area covers a broad range of ecological zones, from Turquoise Reservoir at an elevation 9,870 feet to about 4,100 feet near La Junta. Turquoise Reservoir and the upper Arkansas River near Leadville are located in the subalpine zone. The Arkansas River flows through the montane zone from Twin Lakes Reservoir through Buena Vista and Salida. From Salida to upstream of Pueblo Reservoir, the Arkansas River flows through canyons and meadows of the foothills zone. Below Pueblo Reservoir, the Arkansas River flows east through the shortgrass prairie zone on the plains.

Riparian and wetland areas generally occur along streams, reservoir perimeters, and other locations where surface or ground water is sufficient to support these vegetation types. The Arkansas River and reservoirs in the study area provide conditions suitable for riparian and wetland vegetation in some locations.

The following sections describe the principal riparian and wetland vegetation characteristics associated with the upper and lower Arkansas River and reservoir sites.

3.6.1.1 Upper Arkansas River

Above Pueblo Reservoir, the study area is located in three ecological zones: subalpine, montane, and foothills. The subalpine zone includes the Arkansas River above the Town of Granite, Lake Fork, Lake Creek, and Turquoise Reservoir. Riparian and wetland areas in the subalpine zone are typically dominated by willows, sedges, and grasses, and areas where blue spruce and Engelmann spruce are present. Below Leadville, the Arkansas River flows through sedimentary/alluvial outwash materials that allow floodplain development (Smith and Hill 2000). Riparian and wetland areas are present in the floodplains.

Lodgepole pines and Engelmann spruce-subalpine fir forest dominate the steep shorelines around Turquoise Reservoir. At the west end of the reservoir, a few small areas of subalpine meadow and shrub-dominated riparian communities are present. Small wetland areas are scattered along the reservoir shoreline. Wetland and riparian development around the shoreline of Turquoise Reservoir is minimal due to the steep slopes around the lake. Narrow riparian areas are present along Lake Fork below Turquoise Reservoir and Lake Creek below Twin Lakes.

The Arkansas River between Granite and Salida is located within the montane ecological zone. Riparian areas and wetlands are confined to floodplains or terraces adjacent to the Arkansas River as it flows through a narrow valleys and canyons with steep banks. Riparian areas are dominated by conifers such as Engelmann spruce or blue spruce, narrowleaf cottonwood, aspen, and several species of willow. The Arkansas River in this reach is entrenched; therefore, wetlands only occur in small isolated pockets where the upper bank has sloughed into the edge of the stream or where sandbars have formed protected areas in which wetland vegetation has established. Wetland vegetation in these areas includes various species of willows, sedge, and grass.

The foothills zone generally occurs between Salida and Pueblo Reservoir and encompasses the transition from montane ecosystems to lower-elevation plains systems. Foothill riparian forests typically are dominated by narrowleaf cottonwood at higher elevations and plains cottonwood at lower elevations. Throughout most of the reach from Salida to above Pueblo Reservoir, the Arkansas River flows through narrow canyons. Riparian areas and wetlands generally are confined to narrow corridors or patches along the Arkansas River. Between Cañon City and Portland, where the Arkansas River flows into a broader valley, cottonwood galleries are present within the stream corridor.

3.6.1.2 Pueblo Reservoir

Pueblo Reservoir is located in the transition area between the foothills and the shortgrass prairie to the east. Prairie vegetation occurs in valley bottoms and areas with gentle slopes. Pueblo Reservoir is surrounded by shale and limestone cliffs, alluvial washes and, at the west end, the broad floodplain of the Arkansas River.

Mixed grass prairie is the most abundant community type in the uplands surrounding Pueblo Reservoir. Wetlands and riparian areas occur along small tributaries to Pueblo Reservoir and in the broad floodplain of the Arkansas River at the reservoir inlet. A large cottonwood gallery dominated by plains cottonwood and other species such as sandbar willow, Siberian elm, and peachleaf willow are present at the upstream end of the reservoir. Pasture grasses are common in the understory. The Colorado Division of Wildlife (CDOW) has created several small ponds and wetlands in this area for waterfowl and wildlife habitat. Riparian areas at the western end of Pueblo Reservoir are supported by ground and surface water associated with the Arkansas River. Fluctuating water levels and steep shorelines along Pueblo Reservoir do not provide the reliable hydrology needed to support substantial perennial wetlands.

3.6.1.3 Lower Arkansas River

Downstream of Pueblo Reservoir, the Arkansas River enters the plains ecological zone, where the river flows through agricultural areas and rangeland. The lower Arkansas River basin is characterized by open meadows, rolling shortgrass prairie, and shrublands. Riparian woodlands include plains cottonwood, with crack willow, peachleaf willow, Russian olive, tamarisk, and Siberian elm. Shrub riparian areas are dominated by tamarisk and sandbar willow. Riparian areas and wetlands along the lower Arkansas River are supported by ground and surface water and irrigation return flow.

Wetland vegetation in the Arkansas River floodplain is infrequent between Pueblo and Avondale because the stream channel is entrenched (Smith and Hill 2000). Downstream of Avondale, wetlands occur on sand bars in the active stream channel and along the banks of the river. Dominant wetland species include giant reedgrass, reed canarygrass, tamarisk, and sandbar willow.

3.6.1.4 Gravel Pit Reservoir Storage Site

The gravel pit reservoir storage site in the No Action Alternative is located in the plains ecological zone. The site is located in an upland setting and currently supports a gravel mine, irrigated agriculture, and undeveloped lands. Annual weeds are common on the property. Cottonwood stands are present in the Arkansas River floodplain and along irrigation ditches. The site is permitted for gravel extraction and all of the vegetation will have been removed and the site mined before the City of Aurora obtains use of the gravel pit for water storage.

3.6.1.5 Lake Meredith, Lake Henry, and Holbrook Reservoir

Lake Meredith, Lake Henry, and Holbrook Reservoir are located on the eastern plains north of Rocky Ford. The lakes are surrounded by grassland prairie and active and abandoned agricultural lands. Abandoned agricultural lands around Lakes Meredith and Henry contain weedy stands of kochia. Grasslands include both native and non-native species. Riparian areas are confined to narrow bands of sparse plains cottonwood, sandbar willow, tamarisk, and Siberian elm along the inlets to the reservoirs. Fluctuations in lake water levels create seasonal wetlands and mudflats below the lake high water line.

Wetlands at Lake Meredith are present in the flat terrain along the lakeshore margin, including several large wetland complexes on the northwest and western shorelines. The extent of exposed wetland area varies seasonally and annually with the wide fluctuation in water levels. Tamarisk, a weedy invasive species, is present in wetland areas along the shoreline in several locations.

Shrub riparian areas and wetlands dominated by tamarisk have formed at the inlet to Lake Henry. These riparian areas and wetlands are less extensive than those at Lake Meredith, and are composed of similar species.

Vegetation at Holbrook Reservoir is similar to the vegetation at Lakes Meredith and Henry, although irrigated agriculture dominates lands surrounding the reservoir.

3.6.2 Environmental Consequences

The evaluation of effects to vegetation focused on riparian and wetlands vegetation because these types of vegetation are most likely to be influenced by changes in hydrologic conditions associated with the alternatives. Monthly and quarter monthly (7- to 8-day averages) average, wet, and dry year stream stage data was reviewed to evaluate potential effects on riparian and wetland vegetation along the Arkansas River. Examination of hydrologic modeling focused on the difference in stream stage between the Proposed Action and the No Action Alternative during the growing season (April through September). Projected changes in reservoir elevation and surface area during the growing season were used to evaluate the effects on riparian and wetland vegetation bordering reservoirs. The following thresholds were used to identify potential adverse effects on riparian and wetland resources:

- Average stream stage varies from Existing Condition water levels by more than 12 inches over a period of 4 consecutive weeks during the growing season.
- Average reservoir water levels increase the elevation or area of the reservoir beyond the existing operational pool or fluctuations exceed historical levels.

The stream stage threshold was established based on the characteristics and tolerances of wetland and riparian vegetation to hydrologic changes. Riparian and wetland vegetation is typically supported by surface and/or ground water. Although hydrologic conditions are important in the maintenance of wetlands, simple cause-and-effect relationships are difficult to establish (Mitsch and Gosselink 1993). In stream systems, wetlands and riparian areas may occur in floodplains where the alluvial ground water table is near the surface or along the streambank. In gaining streams (streams that gain water from surrounding lands), the water table may be higher in the floodplain than in the stream. In losing streams (streams that lose water to surrounding lands), the water table may be lower in the floodplain than in the stream.

Water surface elevations in streams vary seasonally and daily. Such factors as soil texture, stream slope, entrenchment/incision, impermeable soil substrates, and other topographic features also influence development of riparian and wetland vegetation and the relationship between stream water surface elevations and vegetation. Based on available information from other studies, a shift in the composition of riparian and wetland vegetation to more upland plant communities is unlikely unless sustained changes in stream stage of more than 12 inches (Scott et al. 2000; Scott et al. 1999; Corps 1987) up or down over a continuous period of greater than 4 weeks during the growing season. Stream stage changes of less magnitude, or for a shorter duration, are unlikely to result in a measurable change in riparian and wetland vegetation.

Stream channel morphology also influences the maintenance, distribution, and composition of riparian vegetation. Results of the geomorphology evaluation described in Section 3.2 also were used to assess potential effects to riparian and wetland vegetation adjacent to the Arkansas River.

The potential effect to riparian and wetland vegetation from changes in hydrologic conditions was evaluated for representative stream locations and reservoirs in the upper and lower Arkansas River basin as discussed below.

3.6.2.1 Upper Arkansas River

Lake Fork and Lake Creek

Lake Fork is the short-stream segment between Turquoise Reservoir and the Arkansas River, and Lake Creek is located downstream of Twin Lakes. Under the No Action Alternative, monthly changes in stream stage during the growing season under average, wet, and dry year conditions for both streams would vary between an increase in stream stage of less than 0.18 feet and a decrease of 0.16 feet compared to Existing Conditions. Changes in stream stage for the Proposed Action would range from an increase of less than 0.07 feet to a decrease of 0.11 feet. The difference in average monthly stream stage between alternatives for both creeks would be less than 0.14 feet. The change in Lake Fork average monthly stream stage would range from a maximum decrease of 3 percent to an increase of 6 percent under No Action. Lake Fork average monthly stream stage would decrease by less than 1 percent and increase by less than 5 percent under No Action. The change in Lake Creek average monthly stream stage would range from a maximum decrease or increase of 7 percent for both alternatives (Tables A-14 and A-15).

The projected changes in stream stage for either alternative would not measurably affect riparian and wetland vegetation adjacent to Lake Fork or Lake Creek. The projected changes in stream stage during the growing season would be well within the range of historical monthly variation in stream stage and are generally within the range of error of the stream gage. Minimum streamflow releases of 15 cfs on both streams would help maintain riparian vegetation.

Arkansas River at Wellsville

The Wellsville gage is representative of the projected changes in hydrology for the upper Arkansas River from Buena Vista to Cañon City. Under average, wet, and dry year conditions, monthly stream stage during the growing season varies from Existing Conditions from a decrease of 0.04 feet to an increase of 0.06 feet for the No Action Alternative and from a decrease of 0.05 feet to an increase of 0.03 feet for the Proposed Action. During the growing season, the difference in average monthly stream stage between the Proposed Action and the No Action Alternative would be less than 0.04 feet. The change in average monthly stream stage would range from a maximum decrease or increase of 2 percent for both alternatives (Table A-16).

The projected changes in Arkansas River stream stage during the growing season would be within the range of historical monthly variation in stream stage and are within the range of error of the gage. The amount and duration of changes in stream stage would not measurably affect montane forested, scrub/shrub, and herbaceous riparian or wetland vegetation communities adjacent to the stream. Minimum flow requirements on the Arkansas River at Wellsville (700 cfs July 1 to August 15 and 250 cfs otherwise) also help support riparian vegetation under both alternatives.

The Arkansas River at Wellsville is not considered sensitive to geomorphological changes in the stream channel and, the projected differences in streamflow between both alternatives and Existing Conditions would be less than a monthly increase of 4 percent and a decrease of 3 percent under all conditions. Projected changes in streamflow under either alternative are unlikely to affect channel characteristics that influence riparian and wetland vegetation composition or distribution.

Turquoise Reservoir

Under both the Proposed Action and No Action Alternative, fluctuation in reservoir elevation would fall within the range of historical reservoir operations. During the growing season, monthly reservoir water surface elevations vary little between alternatives. Under the Proposed Action, Turquoise Reservoir average monthly elevation during the growing season would range from about 0.1 feet lower to 0.7 feet higher than Existing Conditions compared to about 0.8 feet to 1.8 feet lower under No Action. Water levels under the Proposed Action would average about 1.5 feet higher than No Action (Table A-17).

Vegetation outside of the existing reservoir pool would not be inundated or directly affected by either alternative. As part of normal reservoir operations, the elevation of Turquoise Reservoir has varied considerably since it was constructed, and the reservoir is often drawn down 40 feet or lower (Reclamation 1984). This drawdown generally occurs in the winter in preparation for spring runoff. The vegetation communities adjacent to Turquoise Reservoir have developed in response to the fluctuating hydrologic conditions and include upland and riparian species not dependent on lake levels. Small changes in water levels under either alternative are unlikely to substantially affect riparian vegetation because reservoir fluctuations would fall within the range of historical operations and shoreline vegetation is supported by multiple water sources.

3.6.2.2 Pueblo Reservoir

Under both the Proposed Action and No Action Alternative, fluctuation in Pueblo Reservoir elevation would fall within the range of historical operations. Riparian and wetland vegetation outside of the existing operating range would not be inundated or adversely affected. Under the Proposed Action, Pueblo Reservoir average monthly elevation during the growing season would range from about 2.6 feet to 3.4 feet lower than Existing Conditions compared to about 4.2 to 7.0 feet lower under No Action. During the growing season, average monthly reservoir elevations would be about 1.6 to 3.6 feet higher under the Proposed Action compared to No Action (Table A-18). As part of normal reservoir operations, the elevation of Pueblo Reservoir has varied considerably since it was constructed. Vegetation present adjacent to the reservoir developed in response to the historical drawdowns and fluctuating hydrologic conditions at the reservoir; thus, the minor changes in water surface elevations under either alternatives would not adversely affect riparian or wetland vegetation.

3.6.2.3 Lower Arkansas River

Although hydrologic modeling indicates minor differences in streamflow for the Proposed Action and No Action Alternatives compared to Existing Conditions, Arkansas River streamflow under both alternatives would be equal to or greater than historical flows at La Junta to satisfy downstream water rights (see Section 3.1.3.12). Thus, there would be no effect to riparian and wetland vegetation for either alternative downstream from La Junta. The following discussion addresses the modeled changes in streamflow at the La Junta gage.

Changes in stream stage data were evaluated for four gages on the lower Arkansas River: the Above Pueblo gage located below Pueblo Reservoir; the Moffat Street gage near the City of Pueblo; the Avondale gage below Fountain Creek; and the La Junta gage (Tables A-19 to A-22). For all locations the projected change in monthly stream stage during the growing season for average, wet, and dry years from Existing Conditions ranged from a maximum decrease of 0.06 feet to a maximum increase of 0.14 feet for the No Action Alternative. For the Proposed Action, the change in stream stage for these four sites ranged from a maximum decrease of 0.02 feet and an increase of 0.04 feet. The difference in average monthly stream stage between alternatives would be less than 0.1 feet at the Above Pueblo Gage and decreases to less than 0.02 feet at the La Junta gage.

The minor modeled changes in stream stage would not adversely affect riparian and wetland vegetation adjacent to the Arkansas River in the lower Arkansas River. The projected changes in Arkansas River stream stage during the growing season would be within the range of historical monthly variation in stream stage and are within the range of error of the gage. The amount and duration of changes in stream stage would not measurably affect foothills and shortgrass prairie, shrub, forested, and herbaceous riparian or wetland vegetation communities adjacent to the stream.

Minor changes in the duration of streamflows above the 1.5-year recurrence interval at the La Junta gage, under the No Action Alternative, could slightly increase the potential for sedimentation, which could increase the potential for encroachment by riparian vegetation. There would be no change in the duration of streamflow amounts between the Proposed Action and Existing Conditions that would affect stream morphology or the conditions supporting existing riparian and wetland vegetation (see Section 3.2 Geomorphology).

3.6.2.4 Gravel Pit Reservoir Storage Site

Under the No Action Alternative, water would be stored at a gravel pit along the lower Arkansas River downstream of the City of Pueblo. Riparian and wetland vegetation would not be affected at the gravel pit reservoir storage site because all vegetation will have been removed over the course of mining before the City of Aurora obtains use of the site for water storage.

3.6.2.5 Lake Meredith

The fluctuation in Lake Meredith water surface elevation under the Proposed Action and the No Action Alternative would fall within the range of historical reservoir operations, which included periodic filling and draining. During the growing season, under the No Action Alternative, average monthly reservoir elevation would be up to about 2 feet higher than under Existing Conditions, and up to 1.7 feet higher than the Proposed Action (Table A-23).

The riparian and wetland vegetation surrounding Lake Meredith may benefit from higher average water levels under the No Action Alternative and to a lesser degree under the Proposed Action.

3.6.2.6 Lake Henry

Lake Henry is commonly drained and filled. Fluctuation in reservoir elevations under the Proposed Action and the No Action Alternative would occur within the existing maximum pool and would fall within the range of historical reservoir operations.

During the growing season, monthly reservoir elevations vary little between the Proposed Action and the No Action Alternative. Under the Proposed Action, average monthly reservoir elevation would be less than 0.8 feet lower than No Action during the growing season (Table A-24). The vegetation communities adjacent to Lake Henry that have developed in response to the fluctuating hydrologic conditions are unlikely to be affected by small changes in reservoir elevation for either alternative.

3.6.2.7 Holbrook Reservoir

As part of existing reservoir operations, the elevation of Holbrook Reservoir has varied considerably since it was constructed, and the reservoir is often filled and drained (CDOW 2005). Under the Proposed Action and the No Action Alternative, reservoir elevation would continue to fluctuate within the historical range of operations.

During the growing season, monthly reservoir elevation for the Proposed Action would average about 0.5 to 2 feet higher than No Action and Existing Conditions (Table A-25). During dry years, water surface elevations under the Proposed Action could be as much as 4.4 feet higher than the No Action Alternative. Riparian and wetland vegetation surround Holbrook Reservoir may benefit from higher average water levels under the Proposed Action and would not change under No Action.

3.6.3 Cumulative Effects

The evaluation of cumulative effects was conducted in the same manner as direct and indirect effects based on modeled changes in hydrologic conditions with other reasonably foreseeable actions implemented in the future. Changes in stream stage and reservoir elevation under cumulative effects are found in Appendix A, Tables A-14 to A-25).

In general, under cumulative effect hydrologic conditions, the range of change from Existing Conditions in Lake Creek, Lake Fork, and Arkansas River streamflow would be greater than under direct effect hydrologic conditions. However, none of the projected changes in streamflow during the growing season for either the Proposed Action or No Action Alternative would result in changes in stream stage of greater than 12 inches for more than four consecutive weeks. Changes in stream stage during the growing season for all Arkansas River gage sites and both alternatives under average, wet, and dry years range from a maximum monthly decrease of 0.23 feet to an increase of 0.16 feet. Differences in stream stage between the Proposed Action and the No Action Alternative are less than +/-0.1 feet at all Arkansas River stream gage sites; therefore, there is no substantial difference between alternatives. There would be no substantial changes in Arkansas River streamflow that would affect channel morphology or the conditions for supporting existing riparian and wetland vegetation

Under No Action, Lake Fork monthly changes in stream stage during the growing season under average, wet, and dry year conditions would vary between a decrease of 0.3 feet and an increase of 0.11 feet compared to Existing Conditions. Changes in stream stage for the Proposed Action would range from a decrease of 0.29 to an increase of 0.06 feet. The difference in stream change between alternatives would be less than 0.04 feet. The change in average monthly stream stage would range from a maximum decrease of 8 percent to an increase of 1 percent for both alternatives.

Lake Creek has the widest range of change in stream stage varying from a decrease of 0.16 feet to an increase of 0.56 feet in wet years under No Action. The Proposed Action would result in similar stream changes of a maximum decrease of 0.21 feet and an increase of 0.52 feet. The change in average monthly stream stage would range from a maximum decrease of 7 percent to an increase of 39 percent for both alternatives.

Projected minor changes in stream stage would not adversely affect riparian and wetland vegetation adjacent to Lake Fork, Lake Creek, or the upper or lower Arkansas River. Flow changes during the growing season would be within the range of historical monthly variation in stream stage. The amount and duration of changes in stream stage under cumulative effects hydrology would not measurably affect riparian or wetland vegetation communities. Existing minimum streamflow releases of 15 cfs on Lake Fork and Lake Creek would help maintain riparian vegetation.

Projected changes in water surface elevations during the growing season at reservoir sites under cumulative effects hydrology would be greater than the direct effects analysis. Turquoise Reservoir average monthly elevations for the Proposed Action would range from about 0.7 feet lower to 1.3 feet higher than Existing Conditions and from about 0.2 to 1.3 feet higher than No Action. Average monthly Pueblo Reservoir elevations under the Proposed Action would decrease on average about 4.9 feet from Existing Conditions compared to a decrease of about 7.2 feet under No Action. Reservoir elevations would continue to be within the historical operating range for both reservoirs and thus would not adversely affect riparian and wetland vegetation bordering the reservoirs.

Reservoir levels at Lake Meredith under both alternatives would be substantially higher during the growing season compared to Existing Conditions, which may benefit riparian and wetland vegetation. Lake Henry water surface elevations would average about 1 foot higher than Existing Conditions under both alternatives, slightly benefiting riparian vegetation. Higher average water levels at Holbrook Reservoir under the Proposed Action (1.7 feet) compared to No Action and Existing Conditions may benefit riparian vegetation.

3.7 WILDLIFE

This section describes terrestrial wildlife species that could potentially be affected by the alternative actions. The Aquatic Resources section addresses fish and the Threatened and Endangered Species section addresses federal and species of state concern. Information on wildlife in the study area was obtained from published reports, available studies, and knowledge of the habitat types present documented in the Wildlife Resources Technical Report (ERO 2006b).

3.7.1 Affected Environment

Wildlife habitat types match the ecological zones described in the Vegetation section. Higher elevations (9,200-11,500 feet) in the upper Arkansas River basin near Turquoise Reservoir fall within the subalpine zone. The montane zone includes habitat between about 7,500 feet and 9,200 feet. The foothills zone includes the Arkansas River near Pueblo Reservoir and the prairie zone includes the lower Arkansas River downstream of the City of Pueblo.

Wildlife habitat of primary interest for this evaluation includes riparian and wetland areas potentially affected by changes in hydrologic conditions associated with the two alternatives. The following sections provide an overview of wildlife of the ecological zones in the upper Arkansas River, Pueblo Reservoir, and the lower Arkansas River.

3.7.1.1 Upper Arkansas River

The upper Arkansas River study area traverses three ecological zones—subalpine, montane, and foothills above Pueblo Reservoir. Riparian habitat along the upper Arkansas River in the subalpine zone includes shrublands with relatively low plant diversity and a short growing season. Bird species diversity is somewhat low in these areas, but common species likely include broad-tailed hummingbird, dusky flycatcher, yellow warbler, MacGillivray's warbler, Wilson's warbler, Lincoln's sparrow, song sparrow, white-crowned sparrow, and fox sparrow (Benedict 1991). Beavers are residents, as well as maintainers, of these riparian areas. Forested areas around Turquoise Reservoir provide overall and summer range for mule deer and elk (ERO 2000). An elk migration corridor is present west of Turquoise Reservoir. Other mammals found in the spruce-fir forest include black bear, red fox, porcupine, ermine, and pine marten.

Common animals of lodgepole pine forest in the montane zone include black bear, bobcat, elk, mule deer, and porcupine. Along the Arkansas River, conifers such as subalpine fir, Engelmann spruce, blue spruce, and quaking aspen are present. Characteristic bird species found in the riparian areas include American dipper, hairy woodpecker, and black swift.

The foothills zone includes a wide diversity of terrestrial ecological systems. These include Douglas-fir and ponderosa pine forests, piñon-juniper woodland, Gambel oak shrubland, intermontane-foothills grassland, shrublands, cottonwood woodlands, and ephemeral wetlands. In deciduous systems, yellow warbler is the most common bird species found, followed by American robin, northern flicker, house wren, warbling vireo, song sparrow, western wood-pewee, and broad-tailed hummingbird (Kingery 1998). In coniferous systems, Cordilleran flycatcher is the most frequently recorded bird species, followed by broad-tailed hummingbird, ruby-crowned kinglet, American robin, golden-crowned kinglet, Swainson's thrush, mountain chickadee, yellowrumped warbler, and western tanager (Kingery 1998).

3.7.1.2 Pueblo Reservoir

Lands surrounding Pueblo Reservoir provide potential habitat for a variety of game and non-game species. Habitats that support wildlife at Pueblo Reservoir include mixed grass prairie, piñon-juniper woodland, greasewood shrubland, and shoreline areas.

Mule deer summer and winter range is present throughout the majority of lands surrounding the reservoir (CDOW 2004). Mule deer winter concentrations, as well as a deer migration corridor, are located upstream of the Swallows area. Pronghorn winter range and overall range is present throughout the Pueblo Reservoir and Arkansas River corridor above and below the reservoir. Bighorn sheep overall range is present at the west end of the reservoir, although most sheep activity is located farther up the canyon (ERO 2000). Game birds found in the area include turkey and pheasant. Turkey overall range and winter concentration areas and pheasant overall range are located on the western end of the reservoir.

Mixed grass prairie is the most abundant community type at Pueblo Reservoir and is dominated by native bunchgrasses, sod-forming grasses, small shrubs, forbs, and succulents. Several skippers and butterflies need this grassland system to survive, including the Ottoe skipper, cross-line skipper, Arogos skipper, dusted skipper, and regal fritillary. Other, more common and characteristic species of the foothills grasslands include swift fox, plains pocket mouse, prairie vole, black-tailed prairie dog, plains spadefoot, plains garter snake, plains gray skipper, and Riding’s satyr (Benedict 1991).

Pueblo Reservoir lies in the Central Flyway and provides habitat for migratory and resident birds including white pelican, great blue heron, osprey, marsh hawk, piñon jay, western meadowlark, and several other species of raptors, waterfowl, and shorebirds. Great blue herons maintain a rookery (nest colony) at the reservoir inlet in a grove of large cottonwood trees and forage along the reservoir shore. Bald eagles often winter at Pueblo Reservoir, and American peregrine falcons are occasional visitors.

Shoreline habitat bordering Pueblo Reservoir supports some vegetation, but it is most notable for its lack of vegetation. The actions of inundation, waves, and wind greatly inhibit vegetative growth. The shore provides habitat for shorebirds, a diverse group of birds, including plovers, sandpipers, phalaropes, oystercatchers, and avocets that migrate, breed, and winter throughout the world. A number of species have been observed and identified along the shoreline of Pueblo Reservoir during migration. These migratory shorebirds are often found along the reservoir’s edge in search of crayfish and other invertebrates. The most common species seen near Pueblo Reservoir include American avocet, common snipe, willets, Wilson’s phalaropes, various sandpipers, semipalmated plovers, and long-billed dowitchers .

3.7.1.3 Lower Arkansas River

The Arkansas River below Pueblo Reservoir is characterized by a lowland riparian system. Throughout the shortgrass prairie, lowland riparian habitats occur along the few stream and river courses. Riparian vegetation includes plains cottonwood, willows, herbaceous vegetation, and introduced species such as tamarisk. Mammal species of eastern deciduous forests such as white-tailed deer, fox squirrel, and eastern cottontail have capitalized on the recent development of wooded corridors, and many of the species now found in this habitat in the shortgrass region are actually eastern natives (Knopf 1986).

Birds use riparian habitat along the lower Arkansas River for nesting, cover, resting, migration stopover areas, and migration corridors. Potential species found in this habitat include American kestrel, western screech-owl, great horned owl, mourning dove, northern flicker, western wood-pewee, western kingbird, eastern kingbird, black-billed magpie, American robin, yellow warbler, and Bullock’s oriole (Andrews and Righter 1992; Kingery 1998). Common waterfowl and shorebirds found along the lower Arkansas River include mallard, common merganser, gadwall, northern pintail, great blue heron, American coot, and American avocet.

3.7.1.4 Gravel Pit Reservoir Storage Site

The general location of the gravel pit reservoir storage site being considered under the No Action Alternative currently supports irrigated and dryland agriculture and an existing gravel mine. Cottonwood stands are present in the Arkansas River floodplain and along irrigation ditches near the site. Wildlife species associated with this site are similar to those described above for the lower Arkansas River.

3.7.1.5 Lake Meredith, Lake Henry, and Holbrook Reservoir

Lake Meredith, Lake Henry, and Holbrook Reservoir fall within the shortgrass prairie environment of eastern Colorado. The Colorado Division of Wildlife manages these reservoirs as State Wildlife Areas. Habitat surrounding the reservoirs includes grasslands and active and abandoned agricultural lands. All three reservoirs attract a variety of waterfowl and seasonal migrants. Fluctuations in lake levels provide mudflat habitat used by a number of shorebirds. Lakes Henry and Meredith provide foraging areas for great blue heron and white pelican (CDOW 2004). The area around Lake Meredith also provides overall range for white-tailed deer and is a concentration area for mule deer.

3.7.2 Environmental Consequences

Effects to terrestrial wildlife were based primarily on the potential indirect effects to wildlife habitat as the result of hydrologic changes that could affect vegetation communities used by wildlife. Because neither the Proposed Action nor the No Action Alternative involve construction of new facilities, there would be no direct effects on wildlife resources. The No Action Alternative would use a gravel pit for water storage after the completion of mining operations.

The context and intensity of effects of alternative actions are described as having either no effect, a minor effect, or an adverse effect. No effect indicates that wildlife would not be affected or the changes would be so slight that it would not be of any measurable or perceptible consequence to the species population. A minor effect is likely to have limited effect on wildlife and the effect would be localized, small, and of little consequence to the species population. Effects would be considered adverse if:

- Anticipated hydrologic changes to streamflow and reservoir water levels substantially affect the composition and quality of habitat used by wildlife species.
- Wildlife population numbers, viability, distribution, travel, or reproduction is likely to measurably decline.

Wildlife species that primarily use riparian and wetland habitat, or that occupy uplands and occasionally use streamside and shoreline habitat, could be indirectly affected by changes in hydrologic conditions that result in changes to the composition and quality of wetland or riparian vegetation communities. Based on analysis of changes in stream stage in the Arkansas River, Lake Fork, and Lake Creek, and projected changes in reservoir elevations for Turquoise Reservoir, Lake Pueblo, Lake Meredith, Lake Henry, and Holbrook Reservoir as discussed in the Vegetation section, there would be no effect to wetland and riparian habitats from either alternative.

The amount and duration of changes in stream stage for both alternatives would not measurably affect riparian or wetland vegetation adjacent to the Arkansas River upstream of Pueblo Reservoir, in the lower basin downstream to La Junta, or in Lake Fork and Lake Creek. Because there would be no affect on riparian or wetland vegetation from hydrologic changes, there would be no effect to wildlife species such as migratory birds, mammals, reptiles, or amphibians that use streamside habitat.

Water surface elevation for both alternatives at the reservoirs in the study area would stay within the historical range of operations to which species that may use habitat near the reservoir have adapted. The average monthly surface area for Turquoise Reservoir would be within 1 percent of Existing Conditions for both alternatives. Pueblo Reservoir's average monthly water surface area would be up to 8 percent less than Existing Condition under the No Action alternative and up to 4 percent less under the Proposed Action. These changes would not substantially affect available habitat for shorebirds or waterfowl at these large reservoirs. Reservoir surface area would be higher on average than Existing Conditions at Lake Meredith for both alternatives and higher at Holbrook Reservoir under the Proposed Action, which may improve habitat for waterfowl at these small, shallow reservoirs. Lake Henry water elevations would remain similar to Existing Conditions under both alternatives and no change in existing wildlife habitat is anticipated.

The No Action Alternative would not result in any direct effect to existing wildlife species or habitat at the proposed gravel pit reservoir storage site because this area would not be used for water storage until mining is complete. Use of a gravel pit for water storage could create potential habitat primarily for waterfowl and aquatic life.

3.7.3 Cumulative Effects

The projected changes in stream stage and reservoir elevations with reasonably foreseeable actions in place would generally result in a slightly greater range of surface water elevations than under direct effects for both alternatives. The differences in stream stage and reservoir elevations between the Proposed Action and No Action Alternative would remain minor. As discussed in the Vegetation section, the hydrologic changes under cumulative effects would have no affect on riparian or wetland vegetation along the Arkansas River, Lake Fork, Lake Creek, or reservoirs in the study area. As a result there would be there would be no effect to wildlife habitat or wildlife species from implementation of either the Proposed Action or No Action Alternative.

3.8 THREATENED AND ENDANGERED SPECIES AND OTHER SPECIES OF CONCERN

This section addresses plants, wildlife, and aquatic species that are protected under the Endangered Species Act (ESA) as threatened, endangered, or candidate species. In addition, Colorado Division of Wildlife (CDOW) state-listed threatened and endangered species and other species of concern identified by the Colorado Natural Heritage Program (CNHP) were evaluated. Some species are also classified as sensitive by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). Because the effects of both alternatives are related to changes in streamflow and reservoir storage, this evaluation focuses on fish and wildlife species that are dependent on open water, riparian, and wetland areas for reproduction or breeding, and on plant species that occur in wetland and riparian areas.

Species information was collected using published studies, reports, and agency information from the CDOW and U.S. Fish and Wildlife Service (FWS). The CNHP, which maintains a database on species of concern by county, provided information on the distribution and historical occurrence of species. Information on changes in stream flow, stream stage, and reservoir elevation was taken from the Water Resources Technical Report (MWH 2005b). The Threatened and Endangered Species and Species of State Concern Technical Report (ERO 2006c) and the Aquatic Resource Technical Report (CEC 2006) provided additional information used in preparation of this section.

3.8.1 Affected Environment

3.8.1.1 Threatened and Endangered Species

Seven terrestrial threatened or endangered wildlife species and two candidate species for federal listing potentially occur in Lake, Chaffee, Fremont, Pueblo, Crowley, and Otero counties (FWS 2005) (Table 3-25). Three of these wildlife species potentially use wetland or riparian habitat, including the bald eagle, interior least tern, and piping plover. The greenback cutthroat trout is the only fish species federally listed as threatened in the upper Arkansas River basin. The Arkansas darter is a candidate species for federal listing potentially occurring in the lower Arkansas River basin. One threatened and one candidate plant potentially occurs in study area counties, but there is no suitable habitat for these species in riparian or wetland habitats in the study area. The following sections discuss those species with potential for occurrence in the various portions of the study area.

Upper Arkansas River

No active bald eagle nests are known to occur in the Arkansas River basin upstream of Pueblo Reservoir, although an active bald eagle nest site is located north of Cañon City on Four-mile Creek, a tributary to the Arkansas River (Audubon 2005; NDIS 2005). Bald eagles are common winter inhabitants of the upper Arkansas River basin, with the most extensive areas of winter use along the Arkansas River from Cañon City to Salida and near Buena Vista, along Grape and Texas creeks, and near several smaller Arkansas River tributaries northwest of Cañon City (NDIS 2005).

Turquoise Reservoir

Historically, native greenback cutthroat trout were present in the upper Arkansas River basin. They have been replaced in most of the coldwater streams in the study area by other trout species. One strain of greenback cutthroats was stocked in Turquoise Reservoir in 2003 by CDOW. However, these fish were not genetically pure greenback cutthroat and the stocking was not part of a greenback recovery or reintroduction (Policky, pers. comm. 2005). No native greenback cutthroat populations exist in the study area.

Pueblo Reservoir

Bald eagle winter habitat is present at Pueblo Reservoir, including winter roost sites, winter range, and winter concentration areas (NDIS 2005). Although potential habitat for the piping plover is present at Pueblo Reservoir, no piping plovers have been recorded (Yost, pers. comm. 2005). Pueblo Reservoir also contains possible habitat for the interior least tern, but occurrences of this species have not been recorded (CNHP 2004).

Lower Arkansas River and Gravel Pit Reservoir Storage Site

The CDOW has identified an active bald eagle nest along the Arkansas River east of Pueblo Reservoir near Avondale (NDIS 2005). Bald eagles could use portions of the lower Arkansas River and the cottonwoods near the potential gravel pit reservoir storage site during the winter.

Piping plover and interior least tern have the potential to occur on sandy beaches and shorelines in the lower Arkansas River basin. From 1987 to 1995, piping plovers nested at the Great Plains, Adobe Creek, and John Martin reservoirs, all of which are in the vicinity of the project area (Nelson 1998). Interior least terns are known to breed at Adobe Creek, Neenoshe, and John Martin reservoirs, and prefer to nest on beaches, especially on islands where they are more protected from predators and thus enjoy greater nesting success (Nelson 1998). Interior least terns and piping plover have not been reported along the lower Arkansas River.

In 2005, Arkansas darters were found in the Arkansas River in eastern Pueblo County (Krieger 2005). Previous sampling in the 1970s through 1990s did not discover any Arkansas darters in the Arkansas River in the study area, although they have been collected in other smaller streams in the basin. The Arkansas River does not provide optimum habitat for this species. Arkansas darters are "normally found in small, shallow, clear, usually spring-fed streams" (Krieger et al. 2001). They are only occasionally found in larger, more turbid streams such as the Arkansas River. The Arkansas River may not support self-sustaining populations of darters, but many serve as a route for migration between populations in tributary streams.

Lake Henry, Lake Meredith, and Holbrook Reservoir

A bald eagle nest was recorded at Lake Henry in 1996 (CNHP 2004); however, more recent records have indicated that the nest may no longer be active (Cooley and Gooseman, pers. comm. 2004; Leukering, pers. comm. 2004). It is possible that eagles constructed the nest, and then abandoned it. Bald eagles are known to congregate at all three locations, which are classified as winter concentration areas (NDIS 2005). Potential habitat for both the interior least tern and the piping plover is present at Lakes Henry and Meredith, and Holbrook Reservoir, although there are no breeding records for either species at these locations (CNHP 2004 and 2005).

Table 3-25. Federally Listed Threatened, Endangered, and Candidate Species with Potential to Occur in Lake, Chaffee, Fremont, Pueblo, Crowley, and Otero Counties.

Scientific Name	Common Name	Status[1]	Habitat	Species dependent on riparian, wetland or aquatic habitat[2]	Possible Location[3]
WILDLIFE					
Haliaeetus leucocephalus	Bald eagle	T	Trees and cliffs, rivers, large lakes; forages in rivers and lakes	Y	UA, LA, TuL, TwL, PR
Mustela nigripes	Black-footed ferret	E	Rangeland	N	NA
Lynx canadensis	Canada lynx	T	Spruce/fir	N	NA
Centrocercus minimus	Gunnison sage grouse	C	Sagebrush	N	NA
Sterna antillarum athalassos	Interior least tern	E	Open, flat beaches, river and lake margins	Y	LA, PR, M/H/HO
Tympanuchus pallidicinctus	Lesser prairie chicken	C	Sandy grasslands or shrublands	N	NA
Strix occidentalis lucida	Mexican spotted owl	T	Cliffs in forests	N	NA
Charadrius melodus	Piping plover	T	Sand and occasionally. gravel or pebble beaches, especially among grass tufts	Y	LA, PR, M/H/HO
Boloria acrocnema	Uncompahgre fritillary butterfly	E	Alpine	N	NA
FISH					
Etheostoma cragini	Arkansas darter	C	Brooks and streams	Y	LA
Oncorhynchus clarki stomias	Greenback cutthroat trout	T	Historically in rivers throughout Colorado's East Slope mountains	Y	UA
PLANTS					
Eutrema penlandii	Penland alpine fen mustard	T	Alpine	N	NA
Botrychium lineare	Slender moonwort	C	Grassy slopes, edges of streamside forest	N	NA

[1]E = Endangered; T = Threatened; C = Candidate for federal listing.

[2]For breeding or nesting.

[3]Portion of study area in which species has potential to occur. UA = Upper Arkansas River, LA = Lower Arkansas River, TuL = Turquoise Reservoir, TL = Twin Lakes, PR = Pueblo Reservoir, M/H/HO = Lake Meredith/Lake Henry/Holbrook Reservoir, NA = Not Applicable-no suitable habitat.

3.8.1.2 Species of State Concern

This section describes wildlife, fish, and plant species known to occur, or with the potential to occur, in the study area and, although not federally protected, they have been designated as state threatened, endangered, or as a species of concern by the CDOW, or have been described as imperiled or vulnerable in the state by the CNHP. Collectively, CDOW- and CNHP-designated species are referred to as species of state concern.

A total of 19 species of state concern have documented occurrences or potential habitat in riparian, wetland, and open water habitat in the study area (Table 3-26). This includes four wildlife species, four fish species, and 11 plant species. Species occurrence or suitable habitats for the different sections of the study area are discussed below.

Upper Arkansas River

The boreal toad is known to occur in the upper reaches of numerous tributaries to the Arkansas River (Boreal Toad Recovery Team 2002-2005). Although there are two historical records of the boreal toad in the Leadville area (CNHP 2004), it is unlikely they occurred on the Arkansas River, because the boreal toad relies on areas with little or no wave action or moving water (Hammerson 1999). The Arkansas River does not provide boreal toad breeding habitat.

The triploid checkered whiptail occurs only in southeastern Colorado and primarily occupies hillsides arroyos and canyons (Hammerson 1999). It may occasionally be found in riparian or wetland habitats and could potentially occur along the Arkansas River at elevations below 6,900 feet.

The golden columbine and the Brandegee milkvetch were recorded in 1873 at sites in what is now the town of Cañon City (CNHP 2004). The golden columbine occurs in the mountains along streams or rocky ravines (Spackman et al. 1997). The Brandegee milkvetch typically occupies uplands, but it can occur on gravel bars or rock outcrops along streams (Spackman et al. 1997). Because of development, it is likely that both of these plants no longer occur at the sites where they were historically recorded, but portions of the Arkansas River may provide suitable habitat.

There are historical records for gayfeather near Florence (CNHP 2004) and it has been observed in wet meadows in the foothills and in the Wet Mountain Valley of Colorado (Weber and Wittman 1996). Gayfeather could be present in wet meadows adjacent to the upper Arkansas River.

The Arkansas canyon stickleaf occupies washes, naturally disturbed sites, steep rocky slopes, and other upland habitat (Spackman et al. 1997); however, it is possible that individuals could occur in washes or floodplains that are occasionally scoured by the Arkansas River. The Arkansas canyon stickleaf has been reported numerous times from downstream of Buena Vista to downstream of Salida (CNHP 2004).

Flathead chubs are fairly common in the Arkansas River reach between Cañon City and Pueblo Reservoir (Nessler et al. 1999). Southern redbelly dace have been collected from Arkansas River tributaries between Cañon City and Pueblo, but have not been found in the Arkansas River (Nessler et al. 1999). This species prefers small stream habitat not found in the Arkansas River.

Twin Lakes Reservoir and Turquoise Reservoir

Potential habitat for the boreal toad is present in wetlands on the west side of Twin Lakes Reservoir and, to a lesser extent, at the inlet to Turquoise Reservoir. Historical observations of boreal toads in this area are limited to one breeding record in 1983, one unconfirmed observation in 2004 at Turquoise Reservoir, and two specimens collected in 1914 from Twin Lakes (Lambert 2005). No boreal toads were found at the inlets of Twin Lakes Reservoir or Turquoise Reservoir during extensive surveys conducted in the Sawatch and Mosquito ranges by the CDOW, CNHP, USFS, U.S. Geologic Survey, and other members of the Boreal Toad Recovery Team. No occurrences of this species have been recorded in Lake Creek or Fork Creek below the reservoirs.

Table 3-26. Species of State Concern that Occur in Riparian, Wetland, or Aquatic Habitat[4] in Lake, Chaffee, Fremont, Pueblo, Crowley, and Otero Counties.

Scientific Name	Common Name	County(ies) Listed	CNHP Rank[1]	State Rank[2]	USFS/BLM Rating[3]	Habitat	Potential Location[5]
Wildlife							
Bufo boreas	Boreal toad	Lake, Chaffee	G4, S1	E	FS	Wetlands with shallow standing water, ponds	UA, TwL, TuL
Rana blairi	Plains leopard frog	NA	G5, S3	SC	FS/BLM	Margins of lakes, ponds; areas of standing water	LA, PR
Aspidoscelis neosselatus	Triploid checkered whiptail	Fremont, Pueblo, Crowley, Otero	G2, S2	SC	—	Hillsides, arroyos, and canyons associated with the Arkansas River and tributaries	LA, PR
Charadrius alexandrinus nivosus	Western snowy plover	Crowley, Otero	G4, S1	SC	BLM	Playas, reservoir edges on eastern plains, foothills, mountain parks	LA
Fish							
Platygobio gracilis	Flathead chub	NA	—	SC	—	Streams and large rivers	UA, LA
Hybognathus placitus	Plains minnow	NA	—	E	—	Large rivers	LA
Phoxinus erythrogaster	Southern redbelly dace	NA	G5, S1	E	—	Small streams	UA, LA
Phenacobius mirabilis	Suckermouth minnow	NA	—	E	—	Large rivers	LA
Plants							
Nuttallia densa	Arkansas canyon stickleaf	Fremont	G2, S2	—	BLM	Washes, naturally disturbed sites, and other upland sites	UA
Carex concinna	Beautiful sedge	Chaffee	G4/G5, S1	—	BLM	Cool moist forests, peat moss	UA
Astragalus brandegeei	Brandegee milkvetch	Fremont	G5, S2	—	BLM	Sand or gravelly banks, stony meadows, other upland habitat	UA
Asplenium platyneuron	Ebony spleenwort	Fremont, Otero	G5, S1	—	—	Shaded seeps at base of cliffs	UA, LA
Epipactis gigantea	Epipactis	Chaffee	G3, S2	—	FS/BLM	Poncha Hot Springs, steep sandstone cliffs and springs	UA
Liatris ligulistylis	Gayfeather	Lake	G5, S1/S2	—	—	Wet meadows in the piedmont and Wet Mountain Valley	UA
Aquilegia chrysantha var. *rydbergii*	Golden columbine	Lake, Fremont	G4, S1	—	BLM	Mountains, along streams or rocky ravines	UA

Scientific Name	Common Name	County(ies) Listed	CNHP Rank[1]	State Rank[2]	USFS/BLM Rating[3]	Habitat	Potential Location[5]
Listera borealis	Northern twayblade	Lake, Chaffee	G4, S2	—	BLM	Moist springs	UA
Sisyrinchium pallidum	Pale blue-eyed grass	Chaffee	G2/G3, S2	—	—	Meadow wetlands and fens	UA
Ptilagrostis porteri	Porter feathergrass	Lake	G3/G5, S2	—	FS/BLM	Fens and willow carrs	TwL
Eustoma grandiflorum	Prairie gentian	Pueblo, Crowley	G5/S3	—	FS/BLM	Wet, often alkaline meadows	PR, LA

[1] G1 = Critically imperiled globally; G2 = Imperiled globally; G3 = Vulnerable throughout its range or found locally in a restricted range; G4 = Apparently secure globally, though it might be quite rare in parts of its range; G5 = Demonstrably secure globally, though it may be quite rare in parts of its range; S1 Critically imperiled in Colorado; S2 = Imperiled in Colorado; S3 = Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals); S4 = Apparently secure statewide, though it may be quite rare in parts of its range, especially at the periphery (usually more than 100 occurrences and 10,000 individuals).

[2]ST = State of Colorado listed threatened; SE = State of Colorado listed endangered; SC = State of Colorado listed species of concern.

[3] FS = Listed by the USFS or BLM as sensitive.

[4]For breeding, nesting, and/or survival.

[5] Portion of study area in which species has potential to occur. UA = Upper Arkansas River, LA = Lower Arkansas River, TuL = Turquoise Reservoir, TL = Twin Lakes, PR = Pueblo Reservoir, M/H/HO = Lake Meredith/Lake Henry/Holbrook Reservoir, NA = Not Applicable-no suitable habitat.

Porter feathergrass is known to occur in Lake County (Spackman et al. 1997). Potential habitat for Porter feathergrass is present at Twin Lakes Reservoir and Turquoise Reservoir, and there are historical records on the west side of Twin Lakes Reservoir (CNHP 2004), but no recent observations (Olson, pers. comm. 2006). Wetland and fen habitat outside of the reservoir conservation pool at Twin Lakes may provide potential habitat.

Pueblo Reservoir

Pueblo Reservoir provides potential habitat for the triploid checkered whiptail and the plains leopard frog. The triploid checkered whiptail has been observed at Pueblo Reservoir and just below the dam (Henke 2004). Lake margins provide possible habitat for the plains leopard frog (Hammerson 1999). The sandy shoreline of Pueblo Reservoir provides potential habitat for the snowy plover, but there are no records of occurrence (CNHP 2004).

Lower Arkansas River and Proposed Gravel Pit Reservoir Storage Site

The CNHP has not recorded any occurrences of wildlife species of state concern on the lower Arkansas River below Pueblo Reservoir. However, two amphibians of concern—the triploid checkered whiptail and the plains leopard frog—potentially occur in riparian areas of the lower Arkansas River and possibly near the potential gravel pit reservoir storage site.

The flathead chub has been collected at many sites over the years in the Arkansas River in the study area from Cañon City downstream (Krieger 2005). They are one of the more common species in the Arkansas River downstream of Fountain Creek. The suckermouth minnow has only recently been found in the lower Arkansas River from a 2005 collection near Rocky Ford (Krieger 2005). Past collections demonstrate that this species is more common in the Arkansas River downstream of John Martin Reservoir, which is downstream of the study area (Bestgen et al. 2003). Plains minnow has not been found in the Arkansas River for several decades and does not occur in the study area (Nessler et al. 1999).

Prairie gentian, a plant that occurs in wet, generally alkaline meadow, has been documented along the Arkansas River below the dam at Pueblo Reservoir (Audubon 2005), and suitable riparian areas along the lower Arkansas River contain potential habitat. There are no records for ebony spleenwort, which occurs in shaded seeps at the base of cliffs and suitable habitat is limited in the study area.

Lake Meredith, Lake Henry, and Holbrook Reservoir

The plains leopard frog has been observed at Lake Henry (CNHP 2004) and potential habitat for this species occurs at Lake Meredith and Holbrook Reservoir. All three locations provide potential habitat for the western snowy plover, which has been recorded about 2 miles north of Lake Henry (CNHP 2004).

3.8.2 Environmental Consequences

This section discusses the potential direct and indirect effects on federally listed threatened, endangered, or candidate species and species of state concern for the Proposed Action and No Action Alternative. Included is Reclamation's determination under Section 7 of the ESA on the potential effect to federally listed species. For other species of state concern, the context and intensity of the effects of the alternative actions are characterized as beneficial, no effect, minor effect, or an adverse effect. Effects would be considered adverse if the action resulted in long-term effects to a species population or habitat.

3.8.2.1 Threatened and Endangered Species

The piping plover, interior least tern, and bald eagle would not be affected by the Proposed Action or No Action Alternative. The bald eagle could benefit slightly from a new gravel pit reservoir storage under the No Action Alternative. The greenback cutthroat trout would not be affected by either alternative. The Arkansas darter, a candidate species for federal listing, would not be affected by either alternative. Potential effects for these species are discussed below.

Piping Plover and Interior Least Tern

The projected average decrease in the water surface area of Pueblo Reservoir of less than 3 percent during the breeding season under the Proposed Action and less than 7 percent for the No Action Alternative would have minimal effect on potential habitat for the piping plover or interior least tern. Reduced water surface area could potentially increase the exposure of shoreline for these species, although because much of the shoreline surrounding Pueblo Reservoir is steep, minor reductions in water levels are unlikely to significantly affect the availability of habitat for these species. Reservoir water levels would continue to fluctuate within the historical range of operations. The projected changes in Pueblo Reservoir water levels for either alternative would not significantly affect the availability of suitable habitat and is not likely to adversely affect these species.

Potential habitat for the piping plover and interior least tern at Lake Meredith, Lake Henry, and Holbrook Reservoir is present along the shoreline of each location. Water elevations would continue to fluctuate annually in these reservoirs; although on average Lake Meredith under the No Action Alternative would have a greater surface area in the breeding season than Existing Conditions and the Proposed Action would slightly increase the surface area of Lake Meredith. Higher lake elevations would reduce the amount of mudflats around Lake Meredith that could provide suitable habitat for the piping plover or interior least tern. Lake Henry water surface area would not change substantially from Existing Conditions for either alternative. Under the Proposed Action, Holbrook Reservoir would have a surface area about 3 percent higher during the breeding season than the No Action Alternative and Existing Conditions.

There is no record of piping plover or interior least tern nesting activity at Lake Meredith, Lake Henry, or Holbrook Reservoir and suitable habitat for these species would remain available on the reservoir margins for both alternatives. Projected changes in elevations at Lake Meredith and the minor changes in reservoir operation at Lake Henry and Holbrook Reservoir would not affect the availability of suitable habitat and is not likely to adversely affect the piping plover or interior least tern for either alternative.

Bald Eagle

The projected hydrologic changes in Arkansas River flow and affected reservoir elevations in the study area from either the Proposed Action or No Action Alternative would not affect bald eagle habitat or foraging opportunities and is not likely to adversely affect the bald eagle. Changes in streamflow and lake levels would not affect riparian vegetation including roosting or nesting trees potentially used by the bald eagle along the Arkansas River or winter roosting trees at Pueblo Reservoir. There would be no effect to fish populations or waterfowl in the Arkansas River or Pueblo Reservoir that would affect foraging opportunities for the bald eagle. The development of a gravel pit reservoir storage under the No Action Alternative could provide foraging habitat beneficial to the bald eagle.

Greenback Cutthroat Trout

The greenback cutthroat trout occurs only in the headwaters of the South Platte and Arkansas River and Front Range streams drainages. There are no genetically pure greenback cutthroat trout populations in the Arkansas River, Turquoise Reservoir, or Twin Lakes Reservoir; thus, the alternatives would have no effect on this species.

Arkansas Darter

The Arkansas darter was recently found below Avondale in the Arkansas River, although its principal habitat is in smaller tributaries. The minor change in aquatic resource parameters associated with changes in streamflow in the Arkansas River for both alternatives would not affect the movement of the Arkansas darter between preferred habitats in tributaries to the Arkansas River. As a result, the Proposed Action and No Action Alternative are not likely to adversely affect the Arkansas River darter.

South Platte River Federally Listed Species

Both the Proposed Action and No Action Alternative would deliver water from the Arkansas River basin into the South Platte River. Reclamation discussed the effects of the Proposed Action on federally listed species in the South Platte River basin with the FWS to determine if the Proposed Action would result in any stream depletions that would affect threatened and endangered species located on the Platte River in Nebraska. The Proposed Action would result in additional water in the Platte River system so, Reclamation has concluded that the Proposed Action will not affect listed species in the South Platte River basin.

3.8.2.2 Potential Effects to Species of State Concern

Wildlife

Four terrestrial wildlife species of state concern have been recorded in the study area including the boreal toad, plains leopard frog, triploid checkered whiptail, and snowy plover. There would be no effect to these species from projected changes in hydrologic conditions for the streams and reservoirs in the study area for the Proposed Action or No Action Alternative as described below.

Boreal Toad. The boreal toad has been recorded in upper Arkansas River tributaries, but is not typically present in fast-moving streams or large reservoirs. The projected changes in streamflow in the Arkansas River, Lake Creek, and Lake Fork as well as minor changes in Turquoise Reservoir and Twin Lakes Reservoir operations for either alternative would not affect habitat used by the boreal toad.

Plains Leopard Frog. The only record for the plains leopard frog in the study area is at Lake Henry. The plains leopard frog is supported by habitat at Lake Henry despite fluctuations that have historically filled and completely drained the reservoir. Under the Proposed Action and No Action Alternative, fluctuations in water surface elevations would be within the historical range of reservoir operations and water levels would be within 2 percent of current operations. These minor changes in reservoir operation at Lake Henry would have no effect on the plains leopard frog. The projected changes in water surface elevations at Pueblo Reservoir and in the lower Arkansas River would likewise not affect riparian habitat potentially used by the plains leopard frog.

Triploid Checkered Whiptail. The Under the Proposed Action and No Action Alternative, fluctuations in water surface elevations in Pueblo Reservoir would be within the historical range of reservoir operations. There would be no effect to arroyo and hillside habitat potentially used by triploid checkered whiptail and thus this species would not be affected by either of the alternatives.

Western Snowy Plover. As shown in Figure 3-15, Figure 3-16, and Figure 3-17, increased storage at Lake Meredith, Lake Henry and Holbrook Reservoir, would result in a slight reduction in western snowy plover habitat under both alternatives. However, existing shoreline habitat would be unchanged and reservoir elevations would continue to fluctuate annually within the historical range.

Aquatic Species

Flathead Chub. Projected streamflow changes in the Arkansas River under the Proposed Action from Pueblo Reservoir to La Junta would have no affect on aquatic resource habitat supporting flathead chub. Under the No Action Alternative, the projected change in Arkansas River flows upstream of Pueblo Reservoir as reflected in the Wellsville gage, would not affect flathead chub. Below Pueblo Reservoir, as reflected in the Avondale gage, there would be a minor effect on flathead chub compared to Existing Conditions from reduced flow (see Tables A-5 and A-9).

Suckermouth Minnow. The Proposed Action would have no effect on aquatic resources in the Arkansas River to La Junta or suckermouth minnow habitat. The No Action Alternative may have a minor effect on suckermouth minnow compared to Existing Conditions in this section of the river from reduced flows.

Plant Species

The study area includes potential habitat for 10 plant species of state concern, including 6 species that have recorded occurrences in the study area. As discussed in the *Vegetation* section, the minor changes in stream stage that would occur in the Arkansas River, Lake Fork, and Lake Creek would not affect riparian or wetland habitat potentially supporting plant species of state concern and thus there would be no effect to these species by either the Proposed Action or No Action Alternative.

Under the Proposed Action and No Action Alternative, fluctuations in water surface elevations in all study area reservoirs and lakes would be within the historical range of reservoir operations and would remain within the existing operation pool. Thus, for all the reservoirs and lakes in the study area, habitat for plant species of concern outside of the existing operation pools would not be inundated or directly impacted by either alternative.

3.8.3 Cumulative Effects

3.8.3.1 Wildlife and Plant Species

The potential effect to threatened, endangered, candidate species, and species of state concern with reasonably foreseeable actions implemented would be similar to that described for direct and indirect effects for both alternatives.

The hydrologic regimes under cumulative effects as described in the *Water Resource* and *Vegetation* sections would not adversely affect riparian and wetland vegetation along the Arkansas river, Lake Fork, Lake Creek and thus there would be no effect to habitat for federally listed threatened or endangered wildlife or state wildlife and plant species of state concern. The Proposed Action and No Action Alternative are not likely to adversely affect the interior least tern, piping plover, and bald eagle, or species of state concern.

3.8.3.2 Aquatic Species

As with direct effects there would be no effect to greenback cutthroat trout because they are not present in the study area. Arkansas darters potentially occurring in the Arkansas River near Avondale may be beneficially affected by the higher minimum flows in this reach under both alternatives.

Projected streamflow changes in the Arkansas River from Cañon City to Pueblo Reservoir and the lower Arkansas River to La Junta would have no effect on aquatic resource habitat supporting flathead chub under the Proposed Action or No Action Alternative. In the Arkansas River reach below Pueblo Reservoir, a minor cumulative effect to flathead chub habitat is possible from reduced winter flows under both alternatives. Flathead chub may benefit from improved flows near Avondale for both alternatives.

Streamflows in the lower Arkansas River near La Junta would have no affect on suckermouth minnow populations under either alternative.

3.9 RECREATION

This section addresses recreation use in the lower and upper Arkansas River basin and the potential effects to recreation from each alternative. Information on recreational resources was gathered from Reclamation data, Arkansas Headwaters Recreation Area (AHRA), the Colorado River Outfitters Association (CROA), Bureau of Land Management (BLM), Colorado Division of Wildlife (CDOW), Colorado Division of Parks and Outdoor Recreation (CDPOR), and local city and county agencies. The Recreation Technical Report (ERO 2006d) provides additional information used in preparing this section.

3.9.1 Affected Environment

The study area for the recreation analysis includes the upper Arkansas River upstream of Pueblo Reservoir, Pueblo Reservoir, and the lower Arkansas.

3.9.1.1 Upper Arkansas River

The entire upper Arkansas River portion of the study area lies within the AHRA, which starts northwest of Leadville downstream to Pueblo Reservoir. The AHRA is managed jointly by Colorado State Parks and the Bureau of Land Management to meet recreational needs.

Turquoise Reservoir

Turquoise Reservoir provides shoreline and boat angling opportunities in a scenic, high-altitude mountain setting. The primary water-based recreation activities are fishing and boating (both motorized and non-motorized). Recreation activity is greatest during the peak recreation season from June to August (Smith and Hill 2000). The U.S. Forest Service manages recreation use.

Boating on Turquoise Reservoir is mainly for angling, sailing, and pleasure power boating. There are two boat ramps. At full capacity, Turquoise Reservoir offers 1,780 surface acres of water for boating (Reclamation 2004a, 2004c).

The most recent angling use estimates for Turquoise Reservoir indicate about 9,200 anglers in 1997 (Smith and Hill 2000). Since 1997, angling success at Turquoise Reservoir has decreased due to a decline in stocking of catchable trout (8 inches or greater). The lake is free of whirling disease, and only whirling disease-free fish can be stocked according to CDOW policy. Catchable-size rainbow trout that are whirling disease-free have not been available for stocking in Turquoise Reservoir in recent years; therefore, smaller trout have been stocked by CDOW since 1997 (Policky 2003).

Lake Fork and Lake Creek

Lake Fork (below Turquoise Reservoir) and Lake Creek (below Twin Lakes Reservoir) offer limited public angling opportunities because much of the land is private. Several outfitters permit angling on private lands for brown, brook, and cutthroat trout.

Upper Arkansas River Boating

Recent use estimates developed by the CDPOR and CDOW indicate that approximately 50 percent of Arkansas River use is for boating (i.e., rafting and kayaking), 30 percent is for sightseeing, between 5 and 16 percent is for angling, 5 percent is for picnicking, and 3 percent is for camping (Smith and Hill 2000). Of these uses, the two primary activities most directly affected by changes in river flow are boating and angling.

The upper Arkansas River includes several nationally recognized whitewater boating sections including the Numbers, Browns Canyon, and Royal Gorge. Approximately 90 percent of the total boating use is rafting, including both commercial and private trips. The remaining 10 percent of boaters are kayakers and canoers (Smith and Hill 2000). The river offers a broad variety of skill levels, and boating experiences range from easy Class I (beginner) to challenging Class V (experts only). Boating activity on the Arkansas River varies from year to year and generally spans from mid-May to Labor Day, with peak boating use between mid-June to mid-August (Greiner, pers. comm. 2004b). In 2003, about 334,000 commercial boaters and 38,000 private boaters used the Arkansas River (Hearn, pers. comm. 2004).

In general, most rafters and kayakers using the upper Arkansas River prefer the upper range of flows (Smith and Hill 2000). Recommended flows for kayaking ranges from a low flow preference of 650 cfs to a high flow preference of 2,500 cfs (Table 3-27). Rafters have a recommended low flow preference of 750 cfs and a high flow preference of 2,500 cfs (Table 3-27). Optimum conditions vary for boaters depending on the type of boating and individual skills and experience. Study results indicate that kayakers have an optimum flow preference range between 1,300 and 1,500 cfs. Rafters have an optimum flow preference range between 1,500 and 2,000 cfs (Smith and Hill 2000).

Table 3-27. Recommended Flows for Boating on the Upper Arkansas River.

Activity	Recom-mended Low Flow	Optimum Low Flow	Optimum High Flow	Recom-mended High Flow
	cfs			
Rafting	750	1,500	2,000	2,500
Kayaking	650	1,300	1,500	2,500

Source: Smith and Hill 2000.

Upper Arkansas River Angling

Most angling on the upper Arkansas River occurs during the summer. The river is well known as an outstanding, self-sustaining brown trout fishery. Rainbow trout are also present due to supplemental stocking; however, their populations are much more limited (Policky 2004). In 2004, about 81,000 anglers used the upper Arkansas River, of which about 90 percent were from the shore and the remainder from boats (Hearn, pers. comm. 2004).

The majority of anglers prefer flows below 1,000 cfs when the water is clear (Colorado Sportsman's Guide 2004). May through early July typically provides less desirable angling conditions due to higher stream flows created by snowmelt runoff (Id.).

Optimum fishing conditions vary considerably depending on the type of angling and individual skills and experience (Smith and Hill 2000). Fly anglers prefer flows between 250 and 800 cfs, with an optimum flow preference between 400 and 500 cfs (Table 3-28). Spin bait anglers appear to be more tolerant of higher flows than fly anglers and prefer flows of 500 to 2,000 cfs, with an optimum flow range of 700 to 1,200 cfs. Flow preferences for float fishing are also higher, ranging from a minimum of 550 cfs to a high of 2,500 cfs, with optimum conditions ranging from 900 to 1,200 cfs.

Table 3-28. Recommended Flows for Angling on the Upper Arkansas River.

Activity	Recom-mended Low Flow	Optimum Low Flow	Optimum High Flow	Recom-mended High Flow
	(cfs)			
Fly Fishing	250	400	500	800
Spin Fishing	500	700	1,200	2,000
Float Fishing	550	900	1,200	2,500

Source: Smith and Hill 2000.

In 1990, Reclamation and the Colorado Department of Natural Resources (CDNR) signed the UAVFMP under which Reclamation would attempt to manage Fry-Ark water deliveries to provide flows to support natural resources, specifically rafting and the fishery, on the upper Arkansas River upstream of Pueblo Reservoir. Each spring the CDNR submits a letter recommending flow targets for the year to Reclamation to provide an annual flow regime that helps maintain a brown trout fishery, meet the demands for boating recreation, and allows the managers of the AHRA to meet their recreation and natural resources management objectives within the area's boundaries. There is no legal obligation on Reclamation to provide flows, and implementation of CDNR's recommendations is subject to a number of conditions, including the rights of water users and Reclamation's existing contractual obligations; however, Reclamation has been able to operate the project to meet water delivery and storage requirements while benefiting many of these resource needs.

Through stipulations with various parties, and as decreed in their exchange water rights, Aurora has agreed to limitations on the exercise of its water rights that provide protection of stream flows. These existing limitations protect water quality, environmental, and recreational concerns. The typical recommendation from CDNR for streamflow necessary to sustain recreation activities such as boating is 700 cfs at the Wellsville gage. The UAVFMP is used to help extend the boating season, typically in dry years, by providing at least 700 cfs as measured at the Wellsville gage until August 15. These and other minimum flow requirements are shown in Table 2-4.

3.9.1.2 Pueblo Reservoir

Pueblo Reservoir is the centerpiece of Lake Pueblo State Park and provides year-round access to up to about 4,600 surface acres of water and 60 miles of shoreline. Much of the recreational use at Pueblo Reservoir is centered on activities such as boating, fishing, personal watercraft, sailboarding, and water skiing (French, pers. comm. 2004). Annual visitation at Pueblo Reservoir ranges from about 1.3 to 1.6 million (French, pers. comm. 2004). Peak months for recreational use at Lake Pueblo State Park are June, July, and August, which account for over 50 percent of annual visitation (Smith and Hill 2000).

Pueblo Reservoir has two marinas, two boat ramps, and a sailboard launch area. The high diversity of game fish species makes Pueblo Reservoir a popular destination for anglers. Popular game fish species include walleye, rainbow trout, wiper, channel catfish, smallmouth and largemouth bass, and crappie. Because Pueblo Reservoir seldom freezes, shoreline and boat fishing are popular throughout the year (Smith and Hill 2000). About 500,000 anglers fish at Pueblo Reservoir each year (French, pers. comm. 2004).

3.9.1.3 Lower Arkansas River

Lake Meredith, Lake Henry, and Holbrook Reservoir

Lake Meredith, Lake Henry, and Holbrook Reservoirs are State Wildlife Areas managed by the CDOW that provide fishing, boating, hunting, and other recreation uses. Historically these reservoirs have provided habitat for a number of warmwater game fish species such as saugeye, crappie, channel catfish, yellow perch, and wiper, although drought conditions in 2002 substantially reduced the fishery in Lake Henry and killed all the fish in Lake Meredith. On a busy summer weekend, as many as 2,500 people may visit Lake Meredith and Lake Henry (Crowley County 2004).

Sail boarding, jet skiing, and water skiing are also popular summer recreation activities at each of the reservoirs. Waterfowl hunting is available at the reservoirs from November through March.

Lower Arkansas River

Water-based recreation activities on the lower Arkansas River include boating, angling, swimming, and other water sports.

Boating (particularly kayaking) on the lower Arkansas River below Pueblo Dam is likely to increase due to recent improvements designed to accommodate kayakers. As part of the U.S. Army Corps of Engineers Fisheries Habitat Restoration Project, a 1,900-foot segment of the Arkansas River through the City of Pueblo was designed as a Whitewater Park and was completed in spring 2005. The City of Pueblo estimates that the kayak course will attract as many as 25,000 users per year (ERO 2005).

An IGA among the cities of Pueblo, Aurora, Colorado Springs, and the Board of Water Works of Pueblo, and the Southeastern Colorado Water Conservancy District established the Pueblo Flow Management Committee, which meets regularly to make recommendations on flows in the Arkansas River downstream of Pueblo Dam. In addition, the Pueblo Flow Management Committee may consider alternatives to maintain recreation flows for a specified number of days per week, or a reduced schedule of recreational flows (City of Pueblo 2004). Aurora would not participate in the Pueblo Flow Management Program (PFMP) under the No Action Alternative.

The lower Arkansas River is currently managed as a sport fishery. CDOW annually stocks the Arkansas River below the Pueblo Dam with rainbow and brown trout. However, other game fish species, including walleye and perch have been recorded in the area (Corps 2003). Most angling in this portion of the study area occurs between Pueblo Dam and Wildhorse Creek. The City of Pueblo estimates that 50,000 to 75,000 fishing days occur on the lower Arkansas River between Pueblo Dam and Fountain Creek each year.

Angling on the Arkansas River between Fountain Creek and La Junta is limited due to lack of public access and low quality fish habitat. Angling opportunities toward the eastern end of the study area include Rocky Ford State Wildlife Area, where marginal warmwater fishing is available in the Arkansas River (CDOW 2004).

Other recreation on the lower Arkansas River includes swimming at an abandoned gravel pit in the Rock Canyon Swim Area, the Historic Arkansas Riverwalk of Pueblo (an urban waterfront park), the Runyon/Fountain Lakes State Wildlife Area, a private water ski club on Lake Colorado, and the Rocky Ford West State Wildlife Area. Each of these areas are at least partially supported by Arkansas River flows.

3.9.2 Environmental Consequences

Potential direct and indirect effects were based on potential changes in recreation use, opportunity, and quality. Because the alternatives only involve water movement and storage within existing streams and reservoirs, and no new construction is proposed, it is assumed that only water-related recreational uses would be affected by the proposed project. Direct effects to recreation were determined from evaluation of changes in streamflow and reservoir surface water elevation and area from hydrologic modeling. For the No Action Alternative, the effects on recreation also include a 10,000-acre-foot gravel pit reservoir storage east of the City of Pueblo.

Effects are considered adverse if any of the following occurs:

- Changes in streamflow in the upper Arkansas River would cause the UAVFMP recommendations to not be met for portions of the season
- Changes in streamflow would shorten the boating season in the upper Arkansas River by more than 10 percent
- Changes in streamflow or water quality would substantially reduce fish productivity and the quality or amount of recreational fishing opportunities

Recreation effects were evaluated for the upper Arkansas River upstream of Pueblo Reservoir, Pueblo Reservoir, and lower Arkansas River as discussed below.

3.9.2.1 Upper Arkansas River

Turquoise Reservoir

The Proposed Action and No Action Alternative would have a minor effect on boating and other water-based recreation at Turquoise Reservoir from small changes in surface water elevation and surface area for average, wet, and dry years. Under the No Action Alternative, during the primary recreation season (June through August), average surface water elevation would decrease less than 1.5 feet relative to Existing Conditions (Table A-17). For the Proposed Action, average surface water elevation would range from a decrease or increase of 0.2 feet compared to Existing Conditions. Thus, the Proposed Action would result in water surface elevations about 1 to 2 feet higher, and a surface area about 9 to 14 acres greater than No Action during the primary recreation season. The less than 1 percent change in lake surface area for either alternative would not measurably affect the quality of the recreation experience and visitor numbers. In addition, user surveys at Turquoise Reservoir have indicated little sensitivity to water levels in their use of the reservoirs and the quality of the experience (Smith and Hill 2000).

Because neither alternative would affect fishery productivity, as discussed in the Aquatic Resources section, angling success would not be affected.

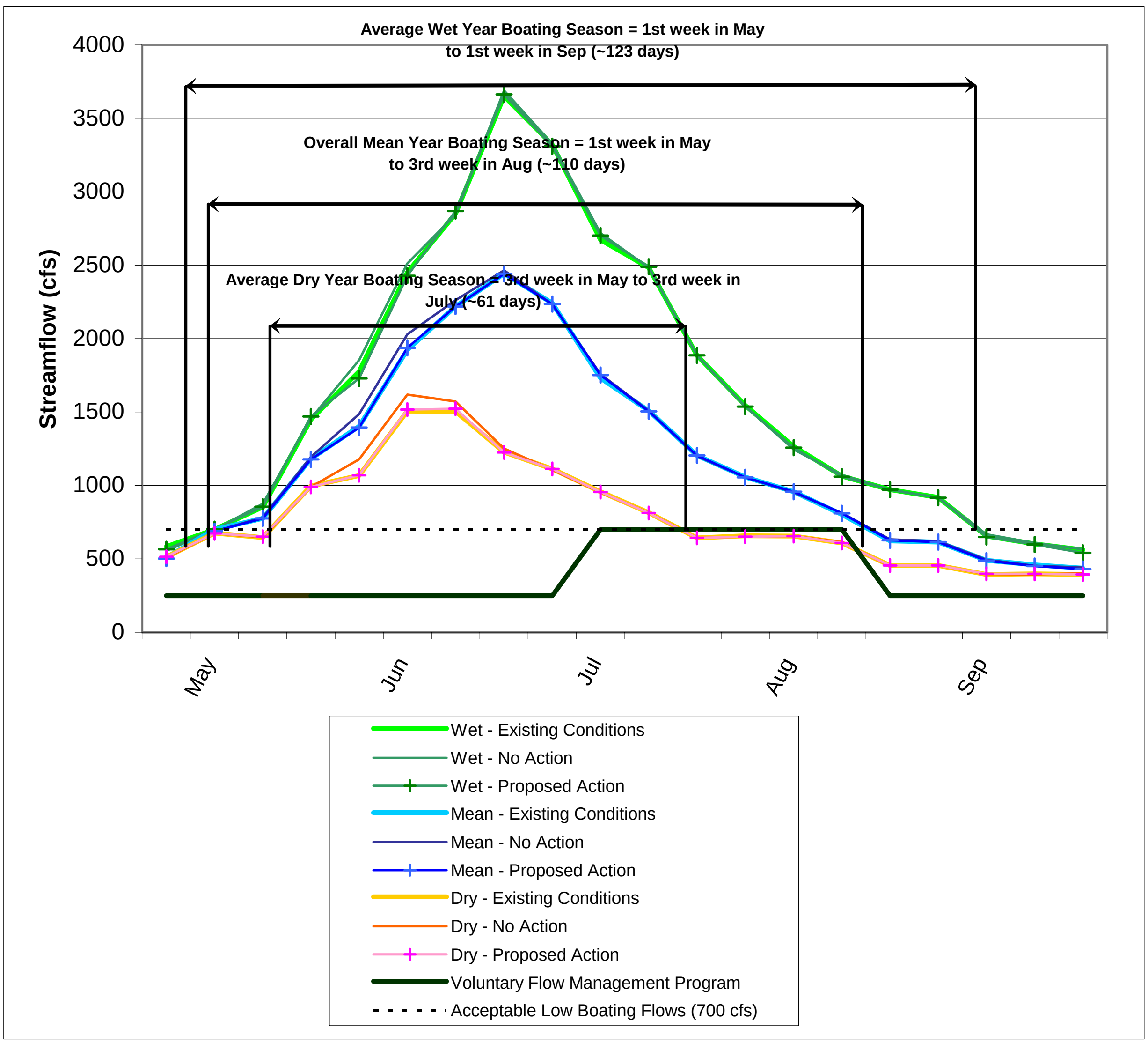
Upper Arkansas River Boating

The Wellsville gage on the Arkansas River downstream of Salida was used to evaluate potential effects to boating and angling in the upper Arkansas River. This gage is the measuring point for the Arkansas River UAVFMP and is representative of streamflow conditions in one of the most popular recreation segments of the upper Arkansas River. Other gages located on the upper Arkansas River upstream or downstream of the Wellsville gage would have proportionally similar changes in flow to those measured at the Wellsville gage.

Projected Arkansas River streamflows at Wellsville during the boating season would be similar for both alternatives and would remain within about 2 percent of Existing Conditions during average, wet, and dry years (Figure 3-33). The alternatives would not interfere with meeting the UAVFMP recommendations. The UAVFMP recommendations for the upper Arkansas River of 700 cfs from July 1 through August 15 would be met during average and wet years for both alternatives (Figure 3-33). During dry years, flows at the Wellsville gage are less than the UAVFMP recommendation of 700 cfs for about a month of the summer boating season under Existing Conditions, as well as the Proposed Action and No Action Alternative (Figure 3-33). Dry year streamflow typically drops below UAVFMP recommendations about the third week in July. Dry year flows for the Proposed Action and No Action Alternative would be similar to Existing Conditions and would not benefit or diminish flows during the late July and August portion of the boating season.

The typical length of the boating season on the Arkansas River varies annually and generally spans from mid-May to Labor Day depending on the amount of precipitation and runoff (Greiner, pers. comm. 2004a). For the purposes of the effects analysis, 700 cfs was used to define the length of the boating season in average, wet, and dry conditions because this streamflow is the lowest recommended flow for protecting recreation concerns in the UAVFMP and is the recommended low flow for rafting (Smith and Hill 2000). Boating season length varies from 61 days in dry years to 123 days in wet years based on the length of time flows exceed 700 cfs (Figure 3-33). Any changes in boating season length for either alternative would be less than a week, thus projected changes in streamflows under the Proposed Action or No Action Alternative would have less than a 10 percent effect on the length of the boating season. Boating season length would be about the same under both alternatives.

Figure 3-33. Arkansas River Wellsville Gage - Boating Season, Direct Effects.



The relatively minor changes in flows under either alternative indicate that the frequency of flows occurring between optimum low and high flow recommendations for boating (1,500 and 2,000 cfs for rafting, and 1,300 and 1,500 cfs for kayaking) would not vary appreciably from Existing Conditions.

Upper Arkansas River Angling

Projected changes in streamflow under the Proposed Action and No Action Alternative indicate that there would be no effect on flow conditions for angling on the upper Arkansas River. Recommended low flows, according to the *Arkansas River Water Needs Assessment* (Smith and Hill 2000) for fly fishing (250 cfs), spin fishing (500 cfs), and float fishing (550 cfs) would continue to be met through the peak summer recreation season (Memorial Day through Labor Day) under average, wet, and much of dry years similar to Existing Conditions. The minor changes in flow under either alternative indicate that the frequency of flows occurring between optimum low and high flow recommendations for all types of angling (400 and 500 cfs for fly fishing, 700 and 1,200 cfs for spin fishing, and 900 and 1,200 cfs for float fishing) would not vary appreciably from Existing Conditions. Aquatic resource parameters would not be adversely affected by either alternative; thus, fishery productivity and angling success would not be affected.

Lake Fork and Lake Creek Angling

Angling quality on Lake Fork and Lake Creek is not expected to change under the Proposed Action and No Action Alternative. Higher maximum flows on Lake Fork under the Proposed Action could have a minor effect on aquatic resources, but a shortening of the peak flow duration would be a slight benefit. The Lake Fork and Lake Creek fishery and angling success would not be measurably affected by either alternative and there would be no substantial difference between alternatives.

3.9.2.2 Pueblo Reservoir

The Proposed Action and No Action Alternative would have a minor effect on boating and other water-based recreation at Pueblo Reservoir due to a small decrease in surface water elevation and boatable surface area in average, wet, and dry years. During the peak recreation season from June to August in average years, the surface water elevation would decrease less than 6.4 feet (Table 3-29) and surface area would decrease by less than 242 acres (7 percent) under the No Action Alternative relative to Existing Conditions. For the Proposed Action, average surface water elevation would decrease less than 3.1 feet and average surface area would decrease by less than 119 acres (3 percent) compared to Existing Conditions.

Projected changes in surface water elevation are unlikely to measurably affect the quality of the recreation experience and visitor numbers. This is supported by surveys conducted at Pueblo Reservoir that indicated little sensitivity to minor fluctuations in water levels and the quality of the recreation experience, perhaps because Pueblo Reservoir water levels have historically fluctuated widely (Smith and Hill 2000). However, visitors believed the quality of their experience was affected by lake elevations as low as 4,839 feet. Only in dry years during the months of August and September would the reservoir surface elevation potentially fall below 4,839 feet, and this would occur under Existing Conditions, as well as the Proposed Action and No Action Alternative. Thus, the effects from the Proposed Action and No Action Alternative on visitor experience would not vary substantially from Existing Conditions. The changes in water surface elevation under both alternatives would not affect the accessibility of boat ramps.

Table 3-29. Average Pueblo Reservoir Water Surface Elevation Under Direct Effects

Month	Existing Conditions	No Action	Proposed Action
	feet		
June	4,861	4,856	4,858
July	4,858	4,853	4,855
August	4,856	4,849	4,853

3.9.2.3 Lower Arkansas River

Lake Meredith

Increases in surface water elevation and surface area associated with the Proposed Action and No Action Alternative would provide a beneficial effect on water-based recreation at Lake Meredith given the shallow reservoir conditions and historically large drawdowns that occur during the summer. During the peak recreation season (June through August), average surface water area under No Action would increase up to 730 acres (33 percent) above Existing Conditions. For the Proposed Action, average surface area would increase up to 80 acres (4 percent) above Existing Conditions. The increase in reservoir levels would improve the overall quality of the recreation experience and may increase the visitor numbers under both alternatives.

Lake Henry

Minor increases in surface water elevation and surface area throughout the year associated with the both alternatives would benefit water-based recreation at Lake Henry given the shallow reservoir conditions and historically large drawdowns that occur during the summer. Compared to Existing Conditions, No Action water surface area would increase up to 42 acres during the peak recreation season on average and the Proposed Action would increase surface water area up to 12 acres. These small increases would slightly improve the quality of the recreation experience, but are not likely to alter visitor numbers.

Holbrook Reservoir

Holbrook Reservoir would not be used under the No Action Alternative; therefore, no change in current operating conditions or suitability for recreation would occur. Holbrook Reservoir water surface area would increase up to 55 acres (24 percent) under the Proposed Action compared to Existing Conditions and the No Action Alternative during the summer recreation season. Increases in surface water area in the summer and throughout the year under the Proposed Action would provide a minor benefit to water-based recreation at Holbrook Reservoir for this shallow reservoir. Such increases would likely improve the overall quality of the recreation experience, but are not likely to substantially alter visitor numbers.

Holbrook Reservoir also would provide secondary recreation benefits under the Proposed Action because its use allows improved Arkansas River recreation flow releases below Pueblo Reservoir.

Gravel Pit Reservoir Storage

The No Action Alternative would use a gravel pit for water storage following mining operations. A gravel pit reservoir could potentially provide fishing and wildlife viewing opportunities.

Lower Arkansas River Recreation

Arkansas River at Moffat Street Gage. Projected Arkansas River streamflow at the Moffat Street gage below Pueblo Reservoir indicates that the Proposed Action and No Action Alternative would not affect kayaking in average and wet years. Streamflow would exceed the PFMP 500 cfs flow target during the peak summer boating months (Memorial Day through Labor Day) and would vary on average annually by no more than 2 percent from Existing Conditions. During late May and the middle of August during dry years, streamflows under the No Action and Proposed Action would drop below 500 cfs similar to Existing Conditions. Although average streamflow would be slightly greater under No Action during the peak recreation season, there would be negligible difference in the effect on recreation between alternatives.

Under No Action, Aurora would not be required to meet target recreational flows identified in the 2004 IGA to provide recreational flows in the Arkansas River through the City of Pueblo. This could affect whether target recreation flows for kayak competitions or special events are attained.

Projected changes in flow regime under both alternatives would not affect fishery productivity or angling opportunities.

Other Recreation Areas on Lower Arkansas River. Projected changes in streamflow in the lower Arkansas River would be less than 2 percent on average during the summer under both alternatives. Those minor fluctuations would not affect water-based recreation at Rock Canyon Swim Area, the Historic Arkansas Riverwalk, Runyon and Fountain Lakes SWA, or the Lake Colorado water ski club. Game fishing on the lower Arkansas at the Rocky Ford SWA would not be affected by the minor changes in flow.

3.9.3 Cumulative Effects

3.9.3.1 Upper Arkansas River

Turquoise Reservoir

The Proposed Action and No Action Alternative would result in up to a 1 percent decrease (12 acres) in Turquoise Reservoir surface area during the peak summer recreation season (June through August) on average. These changes are unlikely to have a measurable effect on the overall quality of the recreation experience or visitor numbers for either alternative.

Because neither alternative would affect fishery productivity, as discussed in the Aquatic Resources section, angling success would not be affected.

Upper Arkansas River Boating

Projected streamflows during the boating season would be similar for both alternatives at the Wellsville gage. The alternatives would not interfere with the UAVFMP recommendations being met. Streamflows would remain within 2 percent of Existing Conditions during average and wet years from the June to August peak boating season (Table A-5). Streamflow in May for both alternatives would increase about 12 percent in average and wet years and about 9 percent in dry years. During dry years, there would be a reduction in June flows for the No Action Alternative of up to 3 percent and up to 5 percent for the Proposed Action. Dry year flows for both alternatives would not substantially benefit or diminish flows during the late July and August portion of the boating season.

Projected flows under the Proposed Action and No Action Alternative indicate that any changes in boating season length for either alternative would be less than a week. Thus, projected changes in streamflows under the Proposed Action and No Action Alternative would have less than a 10 percent effect on boating season length. The boating season length would remain about the same under both alternatives.

The relatively minor changes in flows under either alternative indicate that the frequency of flows occurring between optimum low and high flow recommendations for boating (1,500 and 2,000 cfs for rafting, and 1,300 and 1,500 cfs for kayaking) would not vary appreciably from Existing Conditions.

Upper Arkansas River Angling

Projected changes in streamflow under the Proposed Action and No Action Alternative indicate that there would be no effect on angling on the upper Arkansas River. Recommended low flows (Smith and Hill 2000) for fly fishing (250 cfs), spin fishing (500 cfs), and float fishing (550 cfs), would continue to be met through the peak summer recreation season (Memorial Day through Labor Day) under average, wet, and much of dry years similar to Existing Conditions. The minor changes in flow associated with either alternative indicate that the frequency of flows occurring between optimum low and high flow thresholds for all types of angling (400 and 500 cfs for fly fishing, 700 and 1,200 cfs for spin fishing, and 900 and 1,200 cfs for float fishing) would not vary appreciably from Existing Conditions. Aquatic resource parameters would not be adversely affected by either alternative, thus fishery productivity angling success would not be affected.

Lake Fork and Lake Creek Angling

Angling quality on Lake Fork and Lake Creek is not expected to substantially change under the Proposed Action and No Action Alternative. Lower February flows for the Proposed Action in Lake Creek may have a minor effect on fish and invertebrates. Measurable effects to angling on Lake Creek or Lake Fork are unlikely for either alternative.

3.9.3.2 Pueblo Reservoir

The Proposed Action and No Action Alternative would have a minor effect on boating and other water-based recreation at Pueblo Reservoir due to a decrease in surface water elevation and boatable surface area in average, wet, and dry years. During the peak recreation season from June to August, the No Action average surface water elevation would decrease less than 7.8 feet (Table 3-30) and average surface area would decrease by less than 291 acres (8 percent) relative to Existing Conditions. For the Proposed Action, average surface water elevation would decrease less than 5.1 feet and average surface area would decrease by less than 188 acres (5 percent) compared to Existing Conditions.

Table 3-30. Average Pueblo Reservoir Water Surface Elevation Under Cumulative Effects.

Month	Existing Conditions	No Action	Proposed Action
	feet		
June	4,861	4,854	4,857
July	4,858	4,851	4,854
August	4,856	4,848	4,851

Projected changes in surface water elevation are slightly greater than direct effects, but are unlikely to measurably affect the quality of the recreation experience or visitor numbers. The changes in water surface elevation under both alternatives would not affect the accessibility of boat ramps.

3.9.3.3 Lower Arkansas River

Lake Meredith

Increases in surface water elevation and surface area associated with the Proposed Action and No Action Alternative would provide a beneficial effect on water-based recreation at Lake Meredith given the shallow reservoir conditions and historically large drawdowns that occur during the summer. During the peak recreation season (June through August), average surface water area under No Action would increase up to 1,718 acres (78 percent) above Existing Conditions. For the Proposed Action, average surface area would increase up to 1,093 acres (50 percent) above Existing Conditions. The increase in reservoir levels would substantially improve the overall quality of the recreation experience and is likely to increase visitor numbers under both alternatives.

Lake Henry

Minor increases in surface water elevation and surface area throughout the year associated with the both alternatives would benefit water-based recreation at Lake Henry given the shallow reservoir conditions and historically large drawdowns that occur during the summer. Compared to Existing Conditions, both alternatives would increase lake surface area up to 44 acres (4 percent) during the summer recreation season on average. This small increase would slightly improve the quality of the recreation experience, but is not likely to alter visitor numbers.

Holbrook Reservoir

Holbrook Reservoir would not be used under the No Action Alternative; thus, no change would occur in current operating conditions or suitability for recreation. Holbrook Reservoir water surface area would increase up to 38 acres (13 percent) under the Proposed Action compared to Existing Conditions and the No Action Alternative during the summer recreation season in average years. Increases in water surface area of up to 90 acres (47 percent) would occur during the summer months of dry years under the Proposed Action. Increases in reservoir levels in the summer and throughout the year under the Proposed Action would provide a minor benefit to the quality of water-based recreation at Holbrook Reservoir, but is unlikely to substantially alter visitor numbers.

As with direct effects, the use of Holbrook Reservoir would allow releases below Pueblo Reservoir to help maintain recreation flows in the Arkansas River.

Gravel Pit Reservoir Storage

The No Action Alternative would use a gravel pit for water storage following mining operations. A gravel pit reservoir could potentially provide fishing and wildlife viewing opportunities.

Lower Arkansas River Recreation

Arkansas River at Moffat Street Gage. Projected Arkansas River streamflow at the Moffat Street gage below Pueblo Reservoir indicates that the Proposed Action and No Action Alternative would not affect kayaking in average and wet years. Streamflow would exceed the 500 cfs flow PFMP target level during the peak summer boating months (Memorial Day through Labor Day) and would vary on average annually by no more than 2 to 4 percent from Existing Conditions. During late May and the middle of August during dry years, streamflows under the No Action and Proposed Action would drop below 500 cfs, similar to Existing Conditions. Average streamflows would be similar for both alternatives during the peak recreation season; therefore, there would be negligible difference in the effect on recreation between alternatives.

Under No Action, Aurora would not be required to curtail diversions and/or exchanges to comply with the PFMP target recreational flows identified in the 2004 IGA to provide recreational flows in the Arkansas River through the City of Pueblo. This could affect whether target recreation flows for kayak competitions or special events are attained.

Projected changes in flow regime under both alternatives would not affect fishery productivity or angling opportunities.

Other Recreation Areas on Lower Arkansas River. Projected changes in streamflow in the lower Arkansas River would be less than 4 percent on average during the summer under either alternative. Those minor fluctuations would not affect water-based recreation at Rock Canyon Swim Area, the Historic Arkansas Riverwalk, Runyon and Fountain Lakes SWA, or the Lake Colorado water ski club. Game fishing on the lower Arkansas at the Rocky Ford SWA would not be affected by the minor changes in flow.

3.10 LAND USE

This section addresses potential changes in land use and ownership associated with implementation of the Proposed Action and No Action Alternative. Because the Proposed Action does not require any new surface disturbances for implementation, the focus of the evaluation was on the development of a water storage reservoir at a future gravel pit site under the No Action Alternative.

3.10.1 Affected Environment

Development of a water storage facility under the No Action Alternative is dependent on the future mining of aggregate materials from an area located about 10 miles east of the City of Pueblo near the Arkansas River (Figure 1-1). The approximate 2,400-acre potential gravel pit site is privately owned and mineral extraction is in compliance with State and local permits. Currently the site includes a small area of aggregate production and areas of irrigated and dryland agriculture. Under the No Action Alternative, Aurora would not take possession of the property until aggregate mining is complete and the City would then add the necessary infrastructure to make the gravel pits suitable for water storage. The existing Excelsior Ditch off the Arkansas River would be used to convey water to the water storage reservoirs.

3.10.2 Environmental Consequences

The Proposed Action and No Action Alternative would result in changes in streamflow in the upper and lower Arkansas River, Lake Fork, Lake Creek and changes in water storage for Turquoise Reservoir, Pueblo Reservoir, Lake Meredith, Lake Henry, and Holbrook Reservoir as described in the Water Resources section. None of the projected changes in streamflow or storage would directly affect existing land uses or land ownership for either alternative. The Proposed Action does not require any new infrastructure that results in land disturbance or acquisition of new lands. As a result, the Proposed Action would have no effect on existing land use or ownership within the study area.

Under the No Action Alternative, the owners of the gravel pit reservoir site and Aurora would complete an agreement that allows transfer of surface ownership to Aurora following mining. Aurora would then convert the gravel pit to a water storage reservoir and operate the reservoir to meet its water storage and exchange requirements. Approximately 500 acres of land would be needed to create 10,000 ac-ft of reservoir storage. Any effects to existing land use would occur during the mining operation prior to acquisition by Aurora. Water storage would be the long-term land use of the property.

Conversion of the gravel pit to water storage would be subject to applicable County permitting requirements. Aurora likely would have to enter into agreements or obtain easements for use of the Excelsior Ditch.

3.10.3 Cumulative Effects

Identified reasonably foreseeable actions include future changes in water use, storage, and operations that could affect streamflow and reservoir operations in the Arkansas River and reservoirs in the basin. None of these actions would directly affect land use or ownership; thus, there would be no cumulative effect to land use or ownership associated with the No Action or Proposed Action from future water use.

No reasonably foreseeable actions were identified in the vicinity of the gravel pit reservoir storage site in the No Action Alternative. Thus, there would be no cumulative effects to land use or ownership under No Action.

3.11 SOCIOECONOMICS

This section describes potential socioeconomic effects of the Proposed Action and No Action Alternative. The focus is upon the potential socioeconomic effects associate with changes in the flow and water quality of the Arkansas River that affect recreation, agriculture, and municipal water supplies.

The socioeconomic resource study area was defined to include areas that could experience socioeconomic effects from the Proposed Action or the No Action Alternative. This definition was based on comments received during the public scoping process related to potential socioeconomic concerns, as well as areas that may be affected by changes in river basin operations.

The socioeconomic study area encompasses seven counties in Colorado. The study area was further broken down into three sub-areas: The upper Arkansas Valley includes Lake County, Chaffee County and Fremont County — areas that benefit from flows in the Arkansas River for both water supplies and river-based recreational tourism; Pueblo County includes Pueblo Reservoir, the City of Pueblo and other communities that use the Arkansas River for multiple purposes; the lower Arkansas Valley, including Bent County, Crowley County and Otero County, is composed of communities that rely on the Arkansas River (or hydrologically connected wells) for water supplies and that are closely tied to the river in terms of their history, culture, and economies.

Information to characterize overall baseline economic and demographic conditions in the study area was assembled from local, state and federal data sources and previous reports and publications. Secondary data was used to describe current conditions and historical trends in measures such as total population, ethnic/minority population, employment, earnings by sector, labor force, unemployment rate, household income, and other general economic and demographic measures.

Additional data was collected and analyzed for economic sectors and activities that might be particularly affected by the alternatives. These areas included agriculture, recreation/tourism, water rates, and future water demands. The study team conducted interviews with local information sources where additional information was required to characterize the affected environment and/or to develop analytical relationships between the effects of the proposed project and socioeconomic conditions. The Socioeconomic Resources Technical Report (BBC 2006) provides additional information used in preparing this section.

3.11.1 Affected Environment

3.11.1.1 Upper Arkansas Valley

The upper Arkansas Valley portion of the study area includes the counties from the headwaters of the Arkansas River to the foothills west of Pueblo. Lake, Chaffee, and Fremont counties are within this region. The State of Colorado estimated the 2004 population of the upper Arkansas Valley to total over 72,000 residents, of which, nearly two-thirds live in Fremont County (DOLA 2005). The Colorado State Demographer projects population in the three-county region to grow by over 70 percent between 2000 and 2030 to reach a total population of almost 120,000.

The upper Arkansas Valley has a relatively high concentration of employment in the public sector. More than one-quarter of upper Arkansas Valley jobs are in government, compared with 13 percent for Colorado as a whole (IMPLAN 2005). This is attributable to the large number of jobs at correctional facilities near Buena Vista and Cañon City, plus a large amount of employment by local governments.

Winter and summer tourism has grown into one of the largest industries in the upper Arkansas Valley. Activities include rafting, skiing, hiking and camping, touring historic sites and districts, and special events. In 2004, there were 204,000 user days of commercial rafting on the Arkansas River, producing an estimated total economic impact of $53 million (CROA 2005). Jobs in the arts/entertainment/recreation, retail trade and accommodation/food services sectors – which include economic activities tied to river rafting, guided fishing, hotel, and food and drink establishments – account for 14 percent of total upper Arkansas Valley employment.

Economic activity in the upper Arkansas Valley also depends on income from employment outside the region. A substantial number of residents, especially Lake County residents, commute to jobs outside the region.

Demographic data for the upper Arkansas Valley show relatively low incomes and educational attainment, and a relatively large population of older citizens. The nearly 11,000 people in group quarters in these counties in 2000, mostly in correctional facilities, comprised 15 percent of the total regional population. Estimated median household income in the upper Arkansas Valley was about $34,600 in 1999, roughly three-quarters of the median income for all households in Colorado (U.S. Census Bureau 2000). Of upper Arkansas Valley residents, 12 percent were living below the poverty level in 1999, higher than average in Colorado and about the same as the United States average. From 2001 through 2004, unemployment rates in the upper Arkansas Valley were typically about 1 percent higher than the statewide unemployment rate.

3.11.1.2 Pueblo County

The Pueblo County portion of the study area includes Pueblo Reservoir, the City of Pueblo, the southern portion of the Fountain Creek Valley, suburban communities including Pueblo West and Colorado City, rural communities such as Avondale, and areas of irrigated farming to the south and east of Pueblo.

Pueblo County population was about 150,000 people in 2004, an increase of nearly 9,000 people since the 2000 Census (DOLA 2005). The State Demographer's population forecasts for Pueblo County reflect growth rates for the county that are very similar to the growth rate projected statewide. Pueblo County population is projected to increase by about 50 percent to about 226,000 residents by 2030. The population of the City of Pueblo is projected to increase by almost 40,000 residents by 2030, to nearly 138,000. The most rapid growth rate is for Pueblo West, with the population projected to grow from about 16,900 residents in 2000 to about 43,400 residents before 2030.

From the mid-1980s to the present, Pueblo's economy has benefited from the addition of a variety of new employers, though periodic layoffs, closures and downsizing continue to present economic development challenges for the city. Pueblo wages remain lower than other Colorado urban centers and unemployment rates still exceed state averages. Relatively high-wage manufacturing employment has been replaced by lower-wage trade and services jobs.

Pueblo County has a relatively large population of older adults, and educational attainment and incomes are lower than averages for the state and the nation. In 2000, 15 percent of local residents lived below the poverty line in 2000 compared with 9 percent of residents statewide (U.S. Census Bureau 2000). Additionally, a large proportion of the county population is Hispanic.

Pueblo County produced $42 million of agricultural products in 2002, about twice as much as the upper Arkansas Valley and about 1/6th as much as the lower Arkansas Valley (U.S. Census Bureau 2002). The county had a total of about 25,000 acres of irrigated cropland and 6,000 acres of irrigated pasture.

Pueblo Reservoir is an important recreation resource. As one of the top five statewide recreational attractions (based on visitation), the area receives as many as 1.6 million visitors per year. The City of Pueblo opened a whitewater recreation amenity on the Arkansas River in downtown Pueblo in spring 2005.

The largest public water systems in Pueblo County are the Board of Water Works of Pueblo, which provides water to the City of Pueblo, the St. Charles Mesa Water District, and the Pueblo West Metropolitan District.

3.11.1.3 Lower Arkansas Valley

The lower Arkansas Valley study region includes Crowley, Otero, and Bent counties. There were about 32,000 residents in the region in 2004, an increase of about 3,000 people since 1980 (DOLA 2005). Much of this growth is attributable to the development of correctional facilities in Crowley and Bent counties. The modest population growth this region has experienced over the past 25 years runs counter to the long-term trend of gradual population decline. Each of the counties and most of the major communities within them peaked in population prior to 1950. The State Demographer, however, projects the more recent trend of slow growth to continue into the future with the region reaching a total population of 36,000 by 2030.

Irrigation ditches supplying Arkansas River water were dug in the late 1800s and irrigated agriculture flourished by the early 1900s. The region has seen rapid expansion and decline of several agricultural industries based on weather, market conditions, and soil quality. Today, crop-growing agriculture in the lower Arkansas Valley includes farmers growing grains and hay, and perhaps also raising cattle, as well as vegetable farmers. Nine major feedlots are in the Valley, ranging from 3,000 head to about 35,000 head of cattle. Overall, the lower Arkansas Valley is one of Colorado's major centers for irrigated agriculture and livestock, producing nearly $242 million in agricultural products in 2002 (U.S. Census Bureau 2002).

Agriculture, government jobs, manufacturing, highway-related tourist facilities, and correctional facilities are the important components of the lower Arkansas Valley economic base. Government employment accounted for 25 percent of local jobs in 2003 compared to 13 percent of statewide jobs (IMPLAN 2005). Agriculture accounted for 14 percent of lower Arkansas Valley jobs versus a statewide average of only 2 percent. La Junta, in Otero County, is the primary manufacturing center in the region accounting for most of the 600 regional manufacturing jobs in 2003.

Demographic indicators for the lower Arkansas Valley show relatively depressed incomes, low educational attainment, and a relatively large population of older and Hispanics citizens. Estimated median household income in the lower Arkansas Valley was about $29,100 in 1999, almost 40 percent lower than the median income for all households in Colorado (U.S. Census Bureau 2000). Average unemployment rates from 2001 through 2004 for the lower Arkansas Valley were typically 1 to 2 percent higher than statewide unemployment rates.

Water supplies for agricultural and municipal use in the lower Arkansas Valley have relatively high levels of salinity that may affect crop yield. Larger communities from La Junta downstream to the Kansas border have installed expensive, advanced treatment systems to improve water quality for their residents and businesses.

3.11.2 Environmental Consequences

The evaluation of potential socioeconomic impacts was based in part, on the effects identified in the Water Resource and Water Quality Technical Reports (MWH 2005a, 2006) and Recreation Resources Technical Report (ERO 2006c) as previously discussed in the this EA. The Socioeconomic Resources Technical Report (BBC 2006) provides additional details on socioeconomic effects.

Potential socioeconomic effects were evaluated in relative terms based projected changes in revenue, costs, income or other variables associated with each of the alternatives. Socioeconomic effects are described according to the criteria below:

- Beneficial effect — Socioeconomic changes for affected parties are positive.

- No effect — Socioeconomic changes for affected parties are zero or so close to zero that the direction and magnitude of effects cannot be reliably estimated.
- Minor effect — Changes in revenues, costs, income, employment or other socioeconomic variables are negative, but unlikely to be noticeable relative to overall socioeconomic activity levels for affected groups or areas and typical year to year fluctuations.
- Adverse effect — Changes in revenues, costs, income, employment or other socioeconomic variables are negative and likely to be noticeable relative to overall socioeconomic activity levels for affected groups or areas and typical year to year fluctuations.

3.11.2.1 Upper Arkansas Valley

The primary socioeconomic concerns for the upper Arkansas Valley, as identified during the scoping process, included potential impacts on the recreation-based portions of the economy, and effects on upper Arkansas Valley agriculture.

Recreation/Tourism-related Effects

The potential effects to recreation from changes in Arkansas River flows and reservoir levels on upper Arkansas rafting, kayaking, and fishing are described in the Recreation section. The hydrologic analysis indicates that the 700 cubic feet per second threshold established by the UAVFMP would be met throughout the entire summer recreation season during mean and mean wet years under both the Proposed Action and the No Action Alternative. Streamflows under both alternatives would be similar to Existing Conditions (less than 2 percent change) under all hydrologic conditions. The length of the boating season would not vary appreciably from Existing Conditions under either alternative.

Based on the results of the water quality and flow data, the aquatic resource and recreation analysis also concluded that there would be no adverse effects on the quality of fishing in the upper Arkansas or the Lake Fork and Lake Creek tributaries. The Proposed Action is projected to result in slightly higher lake levels at Turquoise Reservoir than the No Action Alternative, though these levels would be slightly lower than under Existing Conditions. The magnitude of these less than 1 percent changes would not affect visitation levels.

In sum, the recreation analysis concluded there would be no appreciable changes in the quality of the boating or fishing experience in the upper Arkansas Valley. Because the Proposed Action and No Action Alternative would not result in changes in recreation activity levels, there would be no effect on the recreation-related economy in the upper Arkansas Valley.

Agriculture-related Effects

The principal water quality issue in the upper Arkansas Valley is the concentration of metals from runoff of historical mines in the area. While metal concentrations are primarily more of a concern for aquatic life than agricultural water use, as discussed in the Water Quality section, neither of the alternatives would adversely affect metal concentrations in the upper Arkansas River. As a result, there would be no effect from either alternative on the upper Arkansas Valley agricultural economy.

3.11.2.2 Pueblo County

Current and future socioeconomic conditions in the Pueblo County portion of the study area include water for municipal and industrial use, agricultural production in eastern portions of Pueblo County, and recreational activity related to the Arkansas River and Lake Pueblo.

Potential socioeconomic concerns in Pueblo County include effects on recreation activity at Lake Pueblo and at the whitewater course on the Arkansas River in downtown Pueblo. The potential for effects on eastern Pueblo County agricultural activity are also examined in this section.

Recreation/Tourism-related Effects

The recreation analysis concluded that the changes in operation of Pueblo Reservoir under both alternatives are unlikely to have a measurable effect on the quality of the recreation experience or visitor numbers. The Proposed Action and No Action Alternative would not adversely affect kayaking in the whitewater course near downtown Pueblo. Flows would exceed the PFMP 500 cfs target level under both alternatives during the peak summer boating months and flows would vary, on an annual average basis, by less than 2 percent from Existing Conditions. However, under the No Action Alternative, Aurora is not obligated to meet target recreational flows identified in the 2004 IGA. This could result in a loss in revenue generated by the whitewater course.

Fishery productivity and swimming would not be affected by either the Proposed Action or No Action Alternative. The recreation analysis examined potential effects at other water-related amenities in the Pueblo area, including the Historic Arkansas Riverwalk, Runyon and Fountain Lakes SWA, and the private water ski club and determined there would be no adverse impact on these facilities from either alternative.

In sum, there are unlikely to be any discernable socioeconomic effects on Pueblo County recreation-related activity and spending resulting from either the Proposed Action or No Action Alternative, with the exception that revenue generated by use of the whitewater park could be reduced under the No Action Alternative.

Agriculture-related Effects

Existing agricultural water rights for irrigation and stock watering are all senior to Aurora's proposed exchanges. Consequently, neither the Proposed Action nor No Action Alternative would affect the quantity of water available to Pueblo County irrigators.

Downstream of Pueblo Reservoir, salinity levels in the Arkansas River become an increasing concern for both crop production and domestic water consumption. In the agricultural areas of eastern Pueblo County, salinity during the summer irrigation season can pose a moderate salinity hazard for crops. Salinity modeling indicates that the differences in salinity concentrations at the Avondale Gage between the two alternatives and Existing Conditions would be less than 1 percent higher under the Proposed Action than under Existing Conditions. Annual average salinity levels under the Proposed Action would be about 1 percent lower than under the No Action Alternative. Based on these analyses, differences in salinity under either the Proposed Action or the No Action Alternative are too small to have a discernable effect on the Pueblo County agricultural economy.

3.11.2.3 Lower Arkansas Valley

The lower Arkansas Valley is an area that remains reliant on traditional agricultural activities for much of its economic base, and also experiences some recreation-related economic activity from visits to Lake Henry, Lake Meredith, and Holbrook Reservoir. The following discussion examines potential socioeconomic effects to agriculture, municipal, and recreation related water use.

Agriculture-related Effects

In the lower Arkansas Valley, salinity levels in the Arkansas River affect both crop production and domestic water consumption. At the Catlin Dam, near Fowler, salinity levels exceed the minimum level for the high hazard classification from September through April. During the irrigation season, salinity levels are generally in the moderate salinity hazard range. Salinity modeling indicates that the differences in salinity concentrations at the Catlin Dam Gage between the two alternatives and Existing Conditions would be small. Annual average salinity levels would be slightly higher under the Proposed Action than under Existing Conditions, but the differences are less than 1 percent. Annual average salinity levels under the Proposed Action would be slightly lower than under No Action, but these differences are also one percent or less.

Given the small magnitude of these estimated differences in salinity, there would be no discernable change in water quality-related affects on agriculture in the lower Arkansas Valley as a result of the Proposed Action or the No Action Alternative.

Neither the Proposed Action nor No Action Alternative involve additional permanent transfers of agricultural water out of the lower Arkansas Valley other than those water rights currently owned by the City of Aurora. Water transfers from the lower Arkansas Valley began in the mid-1950s and have continued up to the present. The social and economic effect of water transfers have varying benefits on the farmers who sell their water rights and affects the local economy and local government revenues (Weber 1989; Howe 2003). However, past water transfers from the lower Arkansas Valley are not affected by either alternative. Ownership of these water rights has already changed hands and the type of use has been converted from irrigation to municipal/industrial in Colorado water court. Regardless of whether the Proposed Action occurs or the No Action Alternative takes place, these previously transferred water rights will not revert to lower Arkansas Valley agricultural irrigation..

There is, however, an important distinction between the Proposed Action and No Action Alternative. As part of the Proposed Action, Aurora has signed an agreement with the SECWCD that would preclude Aurora from undertaking further permanent transfers of water from the lower Arkansas Valley during the term of the agreement (IGA 2003). During this agreement, Aurora would be limited to short-term leases. Aurora has executed temporary leasing arrangements with lower Arkansas Valley irrigators for the use of agricultural water.

There are no direct effects on the lower Arkansas Valley agricultural economy from changes in water quality or water quantity under either the Proposed Action or the No Action Alternative.

Public Water Providers and Customers

Water quality, particularly salinity levels, is an important issue for public water providers in the lower Arkansas Valley as well as for agriculture. Lower Arkansas River salinity exceeds the secondary drinking water standard established by EPA every month of the year, on average. Public water providers in the eastern portion of the lower Arkansas Valley, such as the cities of La Junta and Las Animas, have installed advanced treatment systems to contend with salinity issues.

Further increases in salinity would increase the costs of operating these treatment systems. There may be a direct, proportionate relationship between water salinity and power costs for reverse osmosis, and the higher the salinity, the greater the water losses and brine disposal requirements (Kelley 2004).

As discussed for agricultural water use, annual average salinity levels would be nearly identical under the Proposed Action, No Action, and Existing Conditions. Projected differences under wet and dry conditions are also minimal, between 0 percent and 2 percent. Consequently, there would be no effect from the either alternative on the costs of water treatment in the lower Arkansas.

Recreation/Tourism-related Effects

The recreation analysis concluded that substantially higher lake levels and surface area at Lake Meredith under the No Action Alternative would improve the boating recreation experience there and may increase visitation. The Proposed Action also increases lake levels compared to Existing Conditions, but by a smaller amount that is unlikely to generate additional visitors. Changes to Lake Henry water storage under both alternatives would be small. The increased water levels at Holbrook Reservoir under the Proposed Action would improve the quality of the recreation experience.

The increased water levels at Lake Meredith, particularly for the No Action Alternative, would benefit aquatic resources and the quality of fishing and corresponding angling activity. Increased recreation use is possible for both alternatives. Overall, there may be a small benefit to the boating and fishing recreation-related economy in the lower Arkansas Valley at Lake Meredith under the No Action Alternative, with a smaller potential benefit under the Proposed Action. Neither alternative is expected to have any negative effects on lower Arkansas Valley recreation-related economic activity compared to Existing Conditions.

3.11.2.4 Other Economic Effects

Water Supply Effects

Aurora's water rights and leased water from the Arkansas River currently provide 25 to 40 percent of the City's water supply. Because of the difficulty of exchanging water out of the potential gravel pit reservoir under the No Action Alternative, Aurora can convey more water to its service area under the

Proposed Action than under No Action. The amount of water Aurora can convey from the Arkansas River under the Proposed Action is comparable to the yield Aurora has historically realized under one year storage contracts with Reclamation. On average, the additional water supplies available to Aurora under the Proposed Action (relative to No Action) would total about 14,300 ac-ft per year. This difference in average annual yield between the two alternatives is equal to about 17 percent of Aurora's projected water demands in 2010. In addition, a portion of Aurora's water supply would not be available under the No Action Alternative until completion of the gravel storage reservoir, which is estimated to require about 10 years. Thus, the yield available to the City's system under the Proposed Action would be about 20,500 ac-ft per year greater than No Action until the gravel pit is operational (Table 3-8). This difference in yield prior to completing the gravel pit represents about 30 percent of the water used by Aurora's customers in 2000 and over 25 percent of total projected water use by Aurora's customers in year 2010.

The Proposed Action would provide more water to Aurora and better meet existing and projected water demand, provide resistance to drought, and the City may be less likely to impose emergency water restrictions. The Proposed Action would provide greater economic benefit to Aurora residents and businesses than the No Action Alternative.

The economic value of the difference in yield to Aurora between the alternatives is at least as great as the costs of alternative supplies Aurora currently obtains. Most recently, Aurora has entered into temporary leases of supplies from farmers in the lower Arkansas Valley. The average cost of the water obtained through these leases is about $440 per acre-foot, based on costs per acre of about $638 and historical yields of about 1.44 acre feet per acre (City of Aurora 2004b). Based upon this cost, the annual economic value of the 20,500 ac-ft difference in yield between the alternatives prior to gravel pit completion is about $9 million. The annual economic value of the 14,300 acre-foot difference in yield between the Proposed Action and the No Action Alternative after gravel pit completion is about $6.3 million per year.

Financial Effects

If the Proposed Action is implemented, Aurora and the SECWCD have agreed through a separate intergovernmental agreement, that Aurora will pay a total of over $24 million to SECWCD over the next 40 years. The SECWCD may use these funds at their discretion, but the IGA identifies several potential uses. Aurora also would make payments to Reclamation based on the volume of Aurora's water stored in Reclamation facilities each year and the volume of Aurora's water exchanged for Fry-Ark supplies. The rate that Reclamation would charge Aurora under the proposed long-term contract has yet to be negotiated, but would most likely include both a capital cost and an operations and maintenance component. Under Aurora's previous 2004 "If and When" storage and exchange contracts with the Reclamation, Aurora's payments to the Reclamation for 10,000 ac-ft of storage and exchange were about $900,000 per year. (Knapp, pers. comm. 2004).

The funds that Aurora would pay SECWCD if the Proposed Action is implemented would represent about 10 percent of SECWCD's current revenues. Potential uses of these funds identified in the IGA between Aurora an SECWCD include expedited repayment of the reimbursable portions of Fry-Ark construction cost, mitigation for impacts in the Arkansas River basin, development of water conveyance facilities downstream of Pueblo Reservoir, or funding a reserve fund for operation of the Fryingpan-Arkansas Project. . If the No Action Alternative is implemented, SECWCD would not receive the financial benefits of the $24 million Aurora is scheduled to pay if the Proposed Action is implemented. SECWCD's overall financial position would be essentially unchanged from current conditions.

The estimated cost of the 10,000 acre-foot gravel pit reservoir downstream of the City of Pueblo under the No Action Alternative is expected to be about $40 million (Knapp, pers. comm. 2004, 2005). Aurora also would incur ongoing costs for pumping and operating the gravel pit reservoir. These costs have not been estimated, but are not expected to be large given the minimal pump lift required to return water from the reservoir to the river.

3.11.3 Cumulative Effects

3.11.3.1 Upper Arkansas Valley

Recreation/Tourism-related Effects

The recreation analysis of the cumulative effects of potential changes in Arkansas River flows on upper Arkansas rafting, kayaking and fishing concluded that UAVFMP recommendations would be met in 2045 for the entire peak summer recreation season under overall mean and mean wet hydrologic conditions under either alternative. Relatively minor changes in flows associated with either alternative would not lead to an appreciable change from Existing Conditions in terms of the frequency of flows occurring between the optimum low and high flow thresholds for boating. Streamflows in mean dry years would also be similar to Existing Conditions.

The water quality, aquatic resource, and recreation analysis also determined that there would be no adverse effects on fishery quality or angling activity levels in the upper Arkansas or the Lake Fork and Lake Creek tributaries in 2045. Small changes in Turquoise Reservoir water levels are unlikely to affect visitation levels.

In sum, there would be no appreciable cumulative effects on the quality of the boating or fishing experience in the upper Arkansas Valley and neither the Proposed Action nor the No Action Alternative would result in changes in recreation activity levels. Consequently, there would be no cumulative impact on the recreation-related economy in the upper Arkansas Valley.

Agriculture-related Effects

Neither the Proposed Action nor No Action Alternative would have a cumulative effect on the quality of water available for Arkansas Valley irrigators. As a result, there would be no cumulative effect from either the Proposed Action or the No Action Alternative on the upper Arkansas Valley agricultural economy.

3.11.3.2 Pueblo County

Recreation/Tourism-related Effects

The recreation analysis concluded that both the Proposed Action and the No Action Alternative would have a minor cumulative effect on boating and recreational experiences at Pueblo Reservoir due to minor decreases in surface elevation and area. The Proposed Action is projected to result in higher 2045 surface water levels than the No Action Alternative. The recreation analysis concluded that all of these changes are too small to measurably affect recreation quality or visitation levels.

The Proposed Action and No Action Alternative would not have a cumulative effect on kayaking in the whitewater course near downtown Pueblo. Flows would exceed the PMFP 500 cfs target level under both alternatives during the peak summer boating months and flows would vary, on an annual average basis, by no more than 1 to 3 percent from Existing Conditions in 2045. However, under the No Action Alternative, Aurora is not obligated to meet target recreational flows identified in the 2004 IGA. This could result in a loss in revenue generated by the whitewater course in Pueblo if target flows are not met.

The Proposed Action and the No Action Alternative would not have a cumulative effect on fishery productivity and swimming in Pueblo County. The recreation analysis examined potential effects at other water-related amenities in the Pueblo area, including the Historic Arkansas Riverwalk, Runyon and Fountain Lakes SWA, and the private water ski club and determined there would be no adverse cumulative effect on these facilities from either alternative.

In sum, there are unlikely to be any discernable cumulative socioeconomic effects on Pueblo County recreation-related activity and spending resulting from either the Proposed Action or No Action Alternative, with the exception that revenue generated by use of the whitewater park could be affected under the No Action Alternative.

Agriculture-related Effects

Salinity modeling indicates that the cumulative effects of the two alternatives, along with other reasonably foreseeable activities, on 2045 salinity concentrations at the Avondale Gage would be minor. Based on these analyses, there would be no cumulative impact from either the Proposed Action or the No Action Alternative on the Pueblo County agricultural economy.

3.11.3.3 Lower Arkansas Valley

Agriculture-related Effects

As noted in the direct effects analysis, past water transfers from the lower Arkansas Valley are not affected by the Proposed Action. Existing irrigation rights in the lower Arkansas Valley are senior to Aurora's exchanges. None of the reasonably foreseeable activities identified for the cumulative effects analysis would result in a reduction in the quantity of water available to lower Arkansas Valley irrigators. Consequently, there are no cumulative effects on the quantity of water available for lower Arkansas Valley agriculture.

Salinity modeling indicates that the cumulative effects of the two alternatives, along with other reasonably foreseeable activities, on 2045 salinity concentrations at the Catlin Dam Gage would be minor. Given the small magnitude of these estimated differences in salinity, there would be no clear water quality-related cumulative effect on agriculture in the lower Arkansas Valley as a result of the Proposed Action or the No Action Alternative.

Public Water Providers and Customers

Based on the predicted minor changes in salinity, there would be no cumulative effect from the Proposed Action or the No Action Alternative on the cost of water treatment in the lower Arkansas Valley.

Recreation/Tourism-related Effects

The recreation analysis concluded that substantially higher 2045 lake levels and surface area at Lake Meredith under both the Proposed Action and the No Action Alternative would improve the boating and fishing recreation experience there and may increase visitation. Changes under both alternatives at Lake Henry are very small. The increased water levels at Holbrook Reservoir under the Proposed Action would improve the quality of the recreation experience. Overall, there may be a small positive cumulative effect to the boating recreation-related economy at Lake Meredith and Holbrook Reservoir under both alternatives relative to Existing Conditions. Given the small size of recreation-related economic activity compared to the overall economy, there is unlikely to be a noticeable effect on overall economic conditions.

3.11.3.4 Other Economic Effects

Water Supply Effects

Cumulative water supply related effects of the Proposed Action and the No Action Alternative are similar to the direct effects described in Section 3.11.2.4. On average, the Proposed Action would yield about 11,500 ac-ft more water for Aurora's system than the No Action Alternative. This additional yield is equivalent to about 7 percent of Aurora's projected total water demand in 2045. This greater yield means that Aurora's water supplies would be better able to meet water demand, respond to drought, and the City may be less likely to impose emergency water restrictions.

Financial Cumulative Effects

Section 3.11.2.4 described the direct financial effects of the Proposed Action on the City of Aurora, SECWCD and Reclamation. Cumulative financial effects on all three parties in 2045 would be less than or equal to the direct financial effect in the nearer term because inflation reduces the value of future payments that Aurora would make to SECWCD and because Aurora is able to spread the cost of payments to both entities over a larger water rate base.

3.11.4 Environmental Justice

Executive Order 12898, dated February 11, 1994, established the requirement to address Environmental Justice concerns within the context of federal agency operations. Evaluation of environmental justice impacts requires identification of minority and low-income populations (including Native American tribes) within the area affected by the proposed project and evaluation of the potential for the alternatives to have disproportionate impacts on such populations.

Median household incomes in the upper Arkansas Valley, Pueblo County and the lower Arkansas Valley are substantially below the state average. Pueblo County and the lower Arkansas Valley also have a substantially higher proportion of Hispanic residents than the state as a whole.

No adverse socioeconomic effects for the Proposed Action were identified in the direct or cumulative effects evaluation. Consequently, there are no environmental justice issues related to the direct or cumulative effects of the Proposed Action.

3.12 CULTURAL RESOURCES

This section addresses potential effects to cultural resources associated with implementation of the Proposed Action or No Action Alternative. Information on cultural resources was collected from Reclamation records and through a file and literature review conducted at the Colorado Historical Society's Office of Archaeology and Historic Preservation (OAHP). Hydrologic information from the Water Resource Technical Report (MWH 2005b) was used to evaluate changes in stream and reservoir elevations. The Cultural Resource Technical Report (ERO 2006e) provides additional information on cultural resources in the study area.

3.12.1 Affected Environment

Neither of the alternative actions would result in any new ground disturbances that would directly affect cultural resources. Thus, the discussion of affected area was limited to locations were hydrologic changes to streams or reservoirs could indirectly affect cultural resources from changing water levels.

The National Historic Preservation Act and 36 CFR Part 800 requires Reclamation to consider effects to cultural resources within the Area of Potential Effect (APE). The APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist." Because changes in reservoir storage have the potential to increase shoreline erosion, including erosion of any archaeological sites that may exist along the shoreline, the APE for the Proposed Action includes the minimum and maximum water surface elevations of Turquoise Reservoir, Pueblo Reservoir, Lake Meredith, Lake Henry, and Holbrook Reservoir.

No information on cultural resources occurring along the Arkansas River, Lake Fork, and Lake Creek was collected because streamflow changes would fall well within the historical range of flows for both the Proposed Action and No Action Alternative and would not adversely affect any cultural resources that may be present. The following sections discuss cultural resources identified near each of the five existing reservoirs where hydrologic changes would occur and the gravel pit reservoir storage site considered under the No Action Alternative.

Because there are no known cultural resources within the APE of Lake Henry, Lake Meredith, and Holbrook Reservoir, information from an intensive cultural resource survey at the Pueblo Chemical Depot (PCD) was used as proxy data to indicate the possible density of cultural resources at the reservoir sites. The PCD site is located in similar topographic setting as the reservoirs, although because of its proximity to the mountains, it may have a greater density of cultural sites than the reservoirs located farther east. Based on the results of the PCD survey, a cultural resource site density of about one site per 208 acres is possible at the reservoirs.

General site types found in the PCD survey include both limited activity open lithic scatters and habitation sites that exhibit the full range of artifact types, such as ground stone and features. Testing conducted at the PCD found that about 20 percent of the sites were recommended eligible for the NRHP (Larmore and Hoefer 2004). These sites were primarily located along terraces adjacent to Chico and Haynes Creeks, intermittent drainages that flow into the Arkansas River. Because Lake Holbrook and Lake Henry are artificial reservoirs, the potential for significant cultural resources is limited. Conversely, Lake Meredith is a natural closed basin that is presumed to have contained varying levels of water and natural resources attractive to past inhabitants of the area and therefore could be expected to contain cultural resources. However, because all three of these reservoir locations have been in operation for over 100 years, the actual percentage of significant cultural resources eligible for the NRHP is probably less than the 20 percent found at the PCD.

3.12.1.1 Turquoise Reservoir

Nine cultural resource sites are located within the APE associated with Turquoise Reservoir (Pioneer Archaeological Consultants 2000; Withers 1965). These sites are located below the expected maximum pool elevation of 9,869 feet and above the expected minimum pool elevation of 9,812 feet identified from hydrologic modeling. No precise elevation data are available to assess impacts from hydrologic fluctuations. Seven of the nine sites are prehistoric open camps, two of which include hearths susceptible to hydrologic erosion. All nine sites remain unevaluated for the NRHP and records indicate minimal information.

3.12.1.2 Pueblo Reservoir

A total of 13 cultural resource sites were officially documented within the APE associated with Pueblo Reservoir (Withers 1965; Withers and Huffman 1966; Pioneer Archaeological Consultants 2000). The APE for Pueblo Reservoir is defined as the expected maximum pool elevation of 4,880 feet and the expected minimum elevation of 4,769 feet from hydrologic modeling. Of these 13 sites, only the Bessemer Ditch has been evaluated for eligibility. The Bessemer Ditch originated upstream of the present location of Pueblo Dam (Gambrill 1980) and is designated as “officially needs data” prior to a NRHP recommendation. Several known, but undocumented sites exist within the pool area, including the community of Swallows and the historic Teller Ranch (Reclamation 2000). It is unknown whether these two sites are located within the anticipated reservoir fluctuation range.

3.12.1.3 Lake Meredith

No cultural resource inventories have been conducted within the APE for Lake Meredith, which has an active pool level of 4,254 feet and a dead pool elevation of 4,242 feet. The Lake Meredith outlet ditch and related features were documented by CDOT and are officially not eligible for the NRHP. Proxy data from a similar area indicate that about 17 unknown cultural resources could be expected within the maximum pool area of 3,700 acres. Of the estimated 17 cultural resources expected within the APE of Lake Meredith, an estimated 3 to 4 cultural resource sites could be eligible for the NRHP.

3.12.1.4 Lake Henry

Two cultural sites — a prehistoric lithic scatter and a prehistoric open camp — were recorded along the southern edge of Lake Henry (Buckles 1978). Neither site has been evaluated for eligibility to the NRHP, but each is located outside the APE for Lake Henry, which ranges from the maximum active pool level of 4,375 feet to the dead pool elevation of 4,367 feet. Proxy data from a similar area indicate that about six unknown cultural resources could be expected within the maximum pool area of 1,350 acres. Of the estimated six cultural resources expected within the APE of Lake Henry, only one is estimated to be eligible for the NRHP.

3.12.1.5 Holbrook Reservoir

No cultural resource inventories have been conducted within or surrounding the APE for Holbrook Reservoir. The APE for Holbrook Reservoir is between 4,139 feet, minimum reservoir elevation, and 4,150 feet, the maximum reservoir elevation. Proxy data from a similar area indicate that about three unknown cultural resources could be expected within the maximum pool area of 675 acres. Based on a 20 percent average that a cultural resource is eligible for the NRHP, it is unlikely that any of the cultural resources that might be identified at Holbrook Reservoir would be eligible for the NRHP.

3.12.1.6 Gravel Pit Reservoir Storage Site

No cultural resource inventories have been completed in the vicinity of the proposed gravel pit reservoir storage site included as part of the No Action Alternative. The No Action Alternative includes use of the existing Excelsior Ditch to divert water from the Arkansas River to fill gravel pit reservoir storage sites.

3.12.2 Environmental Consequences

The Proposed Action and No Action Alternative would not directly impact cultural resources because no ground disturbance would be required to implement the project. Indirect impacts to cultural resources are possible from changes in reservoir elevations that lead to the increased potential for shoreline erosion. The effect on cultural resources due to fluctuations in reservoir elevation is related to frequencies of inundation, exposure, and duration of exposure during periods of drawdown. All of the sites within the APE of each reservoir have likely undergone repeated episodes of exposure, inundation, and concentrated wave action. Prolonged inundation of archaeological sites most often is a beneficial effect due to the preservation afforded by sedimentation.

Potential effects to cultural resources were assessed by identifying archeological sites within the reservoir inundation pool and reviewing estimated changes in reservoir elevations and fluctuations. To determine the significance of the effect on cultural resources, the context and intensity of an effect is described as beneficial, no effect, minor effect, or adverse. Effects were considered adverse if disturbance of the site(s) would result in substantial loss of important information.

3.12.2.1 Turquoise Reservoir

The average annual surface elevation of Turquoise Reservoir is projected to decrease about 1 foot under the No Action Alternative and would remain the same under the Proposed Action. The maximum fluctuation in Turquoise Reservoir elevations currently ranges about 50 feet between an elevation of 9,819 feet and 9,869 feet (Table 3-31). Under No Action, the range in reservoir operations would decrease 1 foot and under the Proposed Action the reservoir would fluctuate 4 feet more than Existing Conditions.

Nine cultural resource sites are known to exist below the 9,869 feet maximum elevation for Turquoise Reservoir. Their locations as depicted on OAHP base maps provide imprecise elevation data and it is unknown whether the projected fluctuation range would affect these sites. However, preliminary elevations data suggest that four of these sites may be located below the minimum reservoir elevation under Existing Conditions and the alternatives. Fluctuations in reservoir elevations are expected to be similar to Existing Conditions for both alternatives with a maximum difference between the Proposed Action and No Action Alternative of 5 feet. For recorded sites and unknown or undocumented sites, the minor changes in the range of reservoir elevations is unlikely to increase the potential for adversely affecting cultural resources for either alternative. Historic properties would be subject to continued reservoir fluctuation regardless of the action taken and it would be difficult to distinguish potential effects from the alternatives and existing operations. Because the nine cultural resources located below the maximum elevation have not been evaluated for the NRHP, it is not possible to determine potential adverse effects to potential NRHP eligible sites..

3.12.2.2 Pueblo Reservoir

Existing reservoir fluctuations are between an elevation of 4,790 feet and 4,880 feet (Table 3-31). Under No Action the minimum lake elevation would decrease to 4,769 feet and there would be no change in the maximum elevation. Reservoir elevations would range from 4,785 feet to 4,880 feet under the Proposed Action, an increase in fluctuation range of 5 feet.

Under Existing Conditions, eight of the 13 archaeological sites identified in the APE are located between the minimum and maximum elevation range. Under the No Action alternative, all 13 identified sites are within the fluctuation range. The same 8 archaeological sites affected under Existing Conditions are located within the fluctuation range under the Proposed Action.

Historic properties at Pueblo Reservoir under the Proposed Action are unlikely to be affected because reservoir operations would be similar to Existing Conditions; thus, any affect to cultural resources—either beneficial or adverse—would also be similar to Existing Conditions. The lower range of reservoir elevations under the No Action alternative would potentially affect at least three sites not exposed under Existing Conditions or No Action. Because none of the sites within the APE have been evaluated for the NRHP, it is not possible to determine whether a NRHP eligible site would be affected. For cultural sites with unknown locations or undocumented sites, the minor changes in the range of reservoir elevations under the Proposed Action would not increase the potential for adversely affecting cultural resources given the on-going fluctuation that has occurred at the reservoir. Under No Action, unknown cultural resources potentially exposed at elevations below the minimum elevations under Existing Conditions and the Proposed Action could be affected.

Reclamation has recently undertaken the resurvey of Pueblo Reservoir. Initial survey will concentrate in areas below the maximum pool elevation to re-locate and conduct condition assessments of those sites inundated by the reservoir. This work will provide the data necessary to determine if NRHP sites are present within the APE.

3.12.2.3 Lake Meredith

Minimum and maximum Lake Meredith elevations would change less than 1 foot from Existing Conditions for both alternatives (Table 3-31). There are no known cultural resources within the APE at Lake Meredith and proxy data indicate 17 cultural resources could be found in the reservoir pool and possibly 3 to 4 of which could be eligible to the NRHP. Adverse effects to unknown cultural resources given the minimal change in water surface elevations under either alternative at Lake Meredith are unlikely, particularly for a reservoir that has been in operation for over 100 years.

Table 3-31. Fluctuation in Reservoir Elevations.

Reservoir	Elevation	Existing Conditions	No Action Effects	Proposed Action Effects	No Action Cumulative Effects	Proposed Action Cumulative Effects
Turquoise	Min	9,819	9,820	9,815	9,812	9,810
	Max	9,869	9,869	9,869	9,869	9,869
	Range	50	49	54	57	59
Pueblo	Min	4,790	4,769	4,785	4,784	4,787
	Max	4,880	4,880	4,880	4,880	4,880
	Range	90	111	96	96	94
Meredith	Min	4,243	4,243	4,243	4,243	4,243
	Max	4,254	4,254	4,254	4,253	4,253
	Range	11	11	11	10	10
Henry	Min	4,367	4,367	4,367	4,367	4,367
	Max	4,375	4,375	4,375	4,375	4,375
	Range	8	8	8	8	8
Holbrook	Min	2	2	2	2	2
	Max	20	20	22	20	22
	Range	18	18	20	18	20

3.12.2.4 Lake Henry

There is no change in the range of reservoir elevations from Existing Conditions for either alternative (Table 3-31). No known cultural resources are within the APE at Lake Meredith and proxy data indicate that about six cultural resources could be found in the reservoir pool, with perhaps one that would be eligible for the NRHP. Because there would be no change from Existing Conditions for either alternative, adverse effects to unknown cultural resources at Lake Henry are unlikely.

3.12.2.5 Holbrook Reservoir

There would be no change in the range of reservoir elevations between Existing Conditions and the No Action Alternative (Table 3-31). The maximum reservoir elevation would increase 2 feet under the Proposed Action. There are no known cultural resources within the APE at Holbrook Reservoir and proxy data indicate that about three cultural resources could be found in the reservoir pool. Adverse effects to unknown cultural resources are unlikely under either alternative, given the minimal change on a reservoir that has been in operation for over 100 years.

3.12.2.6 Gravel Pit Reservoir Storage Site

The City of Aurora would not take possession of the gravel pit and begin water storage until completion of mining operations by the operator. The mine operator would be responsible for addressing any regulatory requirements associated with potential cultural resources. The Excelsior Ditch has not been documented; any proposed change in the physical integrity of the ditch would require documentation and evaluation as required under Section 106 of the National Historic Preservation Act. The No Action Alternative would have no effect on any other cultural resources because any disturbance to the site would occur prior to development of the gravel pit for water storage.

3.12.3 Cumulative Effects

3.12.3.1 Turquoise Reservoir

The maximum elevation for Turquoise Reservoir would remain the same and the minimum elevation would decrease to 9,812 under the No Action Alternative and 9,810 feet under the Proposed Action (Table 3-31). The fluctuation range would increase 7 feet under No Action and increase 9 feet under the Proposed Action. Although it is unknown if the nine cultural resources are located within the projected fluctuation range because of imprecise elevation data, these sites would not be further affected by the Proposed Action or No Action Alternative. For recorded sites and unknown or undocumented sites, the minor changes in the range of reservoir elevations are unlikely to increase the potential for adversely affecting cultural resources for either alternative. Historic properties would be subject to continued reservoir fluctuation regardless of the action taken and it would be difficult to distinguish potential effects from the alternatives and existing operations. Because the nine cultural resources located below the maximum elevation have not been evaluated for the NRHP, it is not possible to determine potential adverse effects to potential NRHP eligible sites.

3.12.3.2 Pueblo Reservoir

Under the Proposed Action, Pueblo Reservoir elevations would be about 3 feet lower on average, would not exceed the current maximum elevation, and would fluctuate 4 feet more than under Existing Conditions (Table 3-31). Under the No Action Alternative, the minimum elevation would be about 6 feet lower and like the Proposed Action, would not exceed the current maximum elevation when compared to Existing Conditions. The difference between minimum elevations under the Proposed Action and No Action Alternative would be less than 2 feet.

Under both the No Action and Proposed Action Alternative, eight or nine of the cultural resources identified within the APE could potentially be affected. Minimum elevations are only expected to occur infrequently in very dry conditions. Even if conditions that expose these sites occur, they would be of short duration, and are unlikely to adversely affect the sites' integrity given the likely degree of sedimentation that has occurred since inundation.

3.12.3.3 Lake Meredith, Lake Henry, and Holbrook Reservoir

Lake elevations at Lake Meredith, Lake Meredith, and Holbrook Reservoir would continue to fluctuate within a narrow range for each of the alternatives. No cultural resources are known within the APE at any of the reservoirs and although some sites may be present as described for direct effects, adverse effects are unlikely under either alternative given the minimal change in water levels for reservoirs that have been in operation for over 100 years.

3.12.3.4 Gravel Pit Reservoir Storage Site

Effects to cultural resources at the gravel pit reservoir storage site would be the same as discussed under direct effects.

Chapter 4 Consultation and Coordination

This chapter identifies the agencies, organizations, and persons contacted during the preparation of the EA. A complete discussion of the public involvement process and the issues identified during scoping is included in Chapter 1, *Public Involvement and Scoping*. The following provides a summary of pubic involvement and agency consultation and coordination.

4.1 PUBLIC INVOLVEMENT

Methods used to inform the public of the proposed project and solicit comments included publication of a scoping announcement, news releases, legal notices, a public scoping meeting, and agency meetings.

In October 2003, Reclamation initiated the scoping process with release of a scoping announcement and other materials. The scoping announcement, which describes the proposed project and compliance requirements, was mailed to approximately 300 federal, state, and local governments, as well as water districts, environmental groups and other organizations and individuals that Reclamation determined may have an interest in the proposed project. At the same time, legal notices describing the project were placed in newspapers in Pueblo, Salida, Buena Vista, Leadville, Denver, Colorado Springs, Rocky Ford, and Cañon City. In addition, Reclamation sent a news release in October 2004 to print, radio, and television media in Denver, Pueblo, La Junta, Leadville, Salida, Buena Vista, Lamar, Colorado Springs, and Pueblo West.

Reclamation held a public scoping meeting on January 29, 2004 in Pueblo to provide the public with more information about the proposed project and an opportunity to ask questions and provide comments. The scoping meeting included an open house for members of the public to discuss the proposed project with Reclamation staff, a presentation by Reclamation and the Colorado State Engineer's Office, and time for the public to ask questions and make comments. The meeting was well attended by about 250 people. Reclamation requested written scoping comments by February 12, 2004. Approximately 2,150 comments were received.

A *Public Scoping Report* was released in March 2004. A notification on the availability of the report was sent to the mailing list and a copy of the scoping report was posted on Reclamation's website: (www.usbr.gov/gp/pubinv1.cfm). A summary of the scoping comments is included in Chapter 1, *Public Involvement and Scoping.*

Reclamation held a modeling workshop for the public on November 29, 2005 at the Colorado State University Pueblo Campus to present the results of the Draft Water Resource Technical Report and answer questions about the approach being used to evaluate the hydrologic changes associated with the proposed project. Notice of the meeting included postcards and e-mail to persons on the mailing list, and a press release. Attendance included about six people from the public and interested agencies, in addition to Reclamation staff. CDs of the draft Water Resource Technical Report were available at the meeting and on Reclamation's website.

4.2 AGENCY CONSULTATION

4.2.1 Agency Scoping

Reclamation held two agency scoping meetings to provide federal, state, and local government representatives with more information about the proposed project, and the opportunity to ask questions and provide comments on the proposed project. Agency meetings were held at Colorado State Park facilities at Lake Pueblo on January 13, 2004 and at the City of Aurora's Municipal Building on January 15, 2004. Agency scoping meetings were attended by representatives from:

- Arkansas Headwaters Recreation Association
- Bureau of Land Management
- Cañon City
- Chaffee County
- Colorado Department of Public Health and Environment-Water Quality Control Division
- Colorado Division of Wildlife
- Colorado Mountain Club
- Colorado State Parks
- Lower Arkansas Valley Water Conservancy District
- Board of Water Works of Pueblo
- Pueblo County
- Southeastern Colorado Water Conservancy District
- State of Kansas
- Town of Olney Springs
- Town of Ordway
- Town of Poncha Springs
- U.S. Forest Service

4.2.2 Other Agency Consultation

Reclamation met with members of the Lower Arkansas Valley Water Conservancy District on February 11, 2004 in Rocky Ford, Colorado. The purpose of this meeting was to answer questions on the NEPA process and the proposed project.

Reclamation initiated informal consultation with the U.S. Fish and Wildlife Service in March and April of 2004 to discuss potential impacts to threatened and endangered species from the proposed project.

Periodic consultation and data collection was also held with the Colorado Division of Wildlife during preparation of the EA to gather data and input on aquatic resources in Arkansas River.

4.3 DISTRIBUTION OF THE DRAFT ENVIRONMENTAL ASSESSMENT

The Draft EA was made available to agencies, organizations, and individuals that expressed an interest in the project. Postcard notices on how to receive a copy of the Draft EA were sent to all individuals or entities that provided a mailing address at scoping meetings, the modeling workshop, or in their scoping comments. In addition, local, state, and federal agencies in the project area were sent notifications. The Draft EA was posted on Reclamation's web site (www.usbr.gov/gp/pubinv1.cfm) and hard copies are available from:

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Attn: Kara Lamb
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Loveland, CO 80537-9711
Phone (970) 962-4326

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RECLAMATION

Managing Water in the West

Appendices to Draft Environmental Assessment

City of Aurora Proposed Excess Capacity Contracts

Pueblo Dam and Reservoir
Fryingpan-Arkansas Project
Pueblo, Colorado

U.S. Department of the Interior
Bureau of Reclamation
Great Plains Region

September 2006

Contents

Appendix A: Hydrologic Modeling Output

Appendix B: Fryingpan-Arkansas Project Spill Priorities

Appendix A

Hydrologic Modeling Results

Table A- 1. Historical Pueblo Reservoir Excess Capacity Contracts.

Entity	Year																		
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Aurora	1,000	1,000	1,000	10,000	10,000	10,000	1,000		1,700	3,500	3,000	3,000	1,000	3,000	3,000	3,000	5,000	5,000	10,000
Beaver Park									1,000	1,000									
Bessemer Ditch								1,250		10,000									
Brewer, Robert							283		400	400									
Carter, Alvin							281	220	335										
Catlin Canal Co			250	250	250	300	300	300	1,000	1,000	1,000	1,000						200	100
Cesar Dairy									150	250									
Colorado Springs	500		1,000		2,500	6,000	6,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	2,500	5,000	5,000	10,000	10,000
Colorado Department of Corrections									75	220									
CWPDA									1,000	2,100								1,000	750
Dept. of Parks and Outdoor Rec.									7,200	3,500									2,000
City of Fountain																		1,300	1,300
Holbrook Mutual Company										3,403									
Jordan, Gerald									500	500									
LAWMA										165									
LAVWCD																			500
Orville Tomky							58		250										
Public Service Company											1,000								
Pueblo Board of Water Works		250	2,000	2,000	2,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	5,000	5,000	5,000	5,000	5,000
Pueblo West Metropolitan District														1,000	1,000	1,000	2,000	2,000	3,000
Salida																		350	350
Security Water District																		400	400
SEWAE																		100	
Southwest Ready Mix									50										
Stratmoor Hills																			100
St. Charles Mesa Water District																		150	260
Upper Arkansas Water Cons. District									120	150			50	50					
Widefield Water and Sanitation District																		400	400
TOTALS	1,500	1,250	4,250	12,250	14,750	19,300	10,922	14,770	26,780	39,188	18,000	17,000	14,050	17,050	11,500	14,000	17,000	25,900	34,160

Notes:
(1) Source: 1986-2003 – Reclamation (Moberg 2004); 2004 – Reclamation (Hopkins 2005).
(2) 1986-1988 volumes for Aurora are estimated.
(3) Pueblo Board of Water Works was issued a 25-year long-term contract in 2001.

Table A- 2. Turquoise Reservoir Simulated Storage Contents Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Storage		Changes in Storage (1)		Storage		Changes in Storage (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	%	(ac-ft)	(ac-ft)	(ac-ft)	(%)
Overall Mean									
Oct	111,058	107,317	111,552	4,234	4%	107,217	109,620	2,403	2%
Nov	107,661	104,046	108,095	4,049	4%	103,831	106,124	2,293	2%
Dec	102,788	99,567	103,015	3,449	3%	99,232	100,647	1,415	1%
Jan	99,172	96,051	98,788	2,737	3%	95,178	96,217	1,038	1%
Feb	94,259	91,709	94,127	2,418	3%	89,762	92,007	2,245	3%
Mar	84,543	82,799	84,672	1,873	2%	81,136	83,736	2,600	3%
Apr	66,915	66,758	67,803	1,046	2%	66,886	68,828	1,943	3%
May	62,867	61,626	63,734	2,108	3%	61,382	63,300	1,919	3%
Jun	98,629	96,162	99,000	2,838	3%	97,022	97,575	553	1%
Jul	116,825	114,377	116,743	2,366	2%	115,074	115,665	591	1%
Aug	115,669	113,072	115,562	2,491	2%	113,432	114,524	1,092	1%
Sep	112,949	109,928	112,994	3,066	3%	110,528	111,882	1,354	1%
Average	97,778	95,284	98,007	2,723	3%	95,057	96,677	1,620	2%
Mean Wet									
Oct	112,921	108,850	113,220	4,369	4%	106,960	109,356	2,395	2%
Nov	110,753	106,094	110,575	4,481	4%	103,947	105,490	1,543	1%
Dec	106,821	100,416	106,041	5,625	6%	98,536	99,764	1,227	1%
Jan	104,940	96,780	103,891	7,111	7%	92,949	95,958	3,010	3%
Feb	101,921	94,479	101,185	6,706	7%	87,267	93,316	6,049	7%
Mar	91,786	85,758	91,473	5,714	7%	78,384	85,999	7,615	10%
Apr	67,639	65,389	68,439	3,050	5%	63,637	68,657	5,020	8%
May	63,861	60,992	65,053	4,061	7%	57,821	62,868	5,047	9%
Jun	105,552	101,581	106,067	4,486	4%	99,794	100,822	1,028	1%
Jul	128,658	126,048	128,919	2,872	2%	124,671	125,389	717	1%
Aug	129,032	126,752	129,192	2,439	2%	124,639	125,796	1,157	1%
Sep	127,596	125,027	128,062	3,036	2%	123,811	125,036	1,225	1%
Average	104,290	99,847	104,343	4,496	5%	96,868	99,871	3,003	3%
Mean Dry									
Oct	104,638	100,249	105,580	5,331	5%	101,555	104,402	2,847	3%
Nov	100,147	97,267	101,318	4,051	4%	98,225	100,861	2,636	3%
Dec	95,463	94,392	96,321	1,929	2%	95,014	96,574	1,560	2%
Jan	91,555	92,065	90,978	-1,087	-1%	92,348	91,892	-456	0%
Feb	86,791	88,009	85,581	-2,429	-3%	87,887	86,332	-1,554	-2%
Mar	79,405	81,034	78,610	-2,424	-3%	80,905	78,913	-1,992	-2%
Apr	65,304	67,418	65,264	-2,154	-3%	67,085	65,435	-1,650	-2%
May	59,397	60,344	58,848	-1,495	-2%	60,919	59,511	-1,408	-2%
Jun	87,204	86,506	86,127	-379	0%	88,335	87,346	-989	-1%
Jul	98,742	97,108	97,472	364	0%	99,022	98,813	-209	0%
Aug	95,388	93,288	93,842	555	1%	94,913	95,411	498	1%
Sep	91,446	89,586	89,528	-58	0%	90,493	90,645	152	0%
Average	87,957	87,272	87,456	184	0%	88,058	88,011	-47	0%

Note:
(1) Effects (ac-ft) = Proposed Action - No Action simulated storage. Effects (%) = (Proposed Action - No Action simulated storage)/No Action simulated storage.

Table A- 3. Lake Fork Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	4	4	4	0	-1%	4	4	0	2%
Nov	4	4	4	0	0%	4	4	0	0%
Dec	4	4	4	0	0%	4	4	0	0%
Jan	4	4	4	0	0%	4	4	0	0%
Feb	4	4	4	0	0%	4	4	0	0%
Mar	31	31	30	-2	-5%	11	15	3	30%
Apr	29	23	27	4	16%	21	22	1	5%
May	57	58	55	-3	-5%	60	57	-3	-5%
Jun	27	29	27	-3	-9%	27	25	-2	-7%
Jul	83	89	86	-3	-3%	91	83	-8	-9%
Aug	15	16	17	0	3%	14	14	0	-2%
Sep	6	6	6	0	4%	5	5	0	5%
Average	22	23	22	0	-2%	21	20	-1	-3%
Mean Wet									
Oct	4	4	4	0	0%	5	4	-1	-13%
Nov	4	4	4	0	0%	4	4	0	0%
Dec	4	4	4	0	0%	4	4	0	0%
Jan	4	4	4	0	0%	4	4	0	0%
Feb	4	4	4	0	0%	4	4	0	0%
Mar	56	56	56	0	0%	18	30	12	66%
Apr	60	46	55	8	18%	30	30	-1	-3%
May	69	75	69	-6	-8%	90	83	-8	-9%
Jun	32	37	30	-7	-19%	28	23	-5	-19%
Jul	158	163	165	2	1%	172	157	-15	-9%
Aug	14	13	14	1	7%	11	11	0	-1%
Sep	7	9	9	0	0%	5	6	1	19%
Average	35	35	35	0	-1%	31	30	-1	-5%
Mean Dry									
Oct	4	4	4	0	-2%	4	4	0	-2%
Nov	4	4	4	0	0%	4	4	0	0%
Dec	4	4	4	0	0%	4	4	0	0%
Jan	4	4	4	0	0%	4	4	0	0%
Feb	4	4	4	0	0%	4	4	0	0%
Mar	4	4	4	0	0%	4	4	0	0%
Apr	14	16	16	0	2%	15	15	0	1%
May	56	52	55	4	7%	49	51	2	4%
Jun	15	19	17	-2	-10%	19	15	-4	-20%
Jul	15	17	15	-2	-12%	18	17	-1	-3%
Aug	10	10	10	0	-2%	10	10	0	0%
Sep	4	4	4	0	0%	4	4	0	0%
Average	11	12	12	0	0%	12	11	0	-2%

Note:
(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 4. Lake Creek Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	19	21	18	-2	-11%	27	22	-6	-20%
Nov	23	23	23	0	-1%	23	23	0	-1%
Dec	33	38	32	-6	-15%	44	42	-2	-5%
Jan	45	45	40	-5	-11%	55	46	-9	-16%
Feb	60	65	55	-10	-15%	65	46	-19	-28%
Mar	154	154	141	-13	-9%	157	135	-21	-14%
Apr	189	191	177	-14	-7%	169	174	6	3%
May	195	215	192	-23	-11%	316	314	-3	-1%
Jun	621	662	624	-39	-6%	603	589	-14	-2%
Jul	445	445	446	2	0%	439	439	0	0%
Aug	187	190	187	-3	-2%	190	186	-4	-2%
Sep	38	40	33	-6	-15%	43	34	-9	-21%
Average	167	174	164	-10	-6%	178	171	-7	-4%
Mean Wet									
Oct	22	30	23	-7	-24%	39	30	-9	-24%
Nov	27	27	27	0	-1%	28	28	0	0%
Dec	33	49	33	-16	-33%	62	62	0	0%
Jan	23	23	23	0	0%	80	64	-16	-20%
Feb	19	17	17	1	4%	64	30	-34	-54%
Mar	165	162	159	-2	-1%	163	130	-33	-20%
Apr	256	249	241	-8	-3%	172	225	53	31%
May	204	222	199	-23	-10%	340	329	-11	-3%
Jun	817	837	818	-19	-2%	809	797	-11	-1%
Jul	649	654	649	-5	-1%	651	652	1	0%
Aug	297	294	294	-1	0%	295	289	-6	-2%
Sep	74	79	63	-15	-19%	90	71	-19	-21%
Average	216	220	212	-8	-4%	233	226	-7	-3%
Mean Dry									
Oct	15	18	15	-2	-12%	18	15	-3	-15%
Nov	20	20	20	-1	-3%	20	20	-1	-3%
Dec	21	24	19	-5	-21%	24	19	-4	-19%
Jan	35	35	25	-11	-30%	35	27	-8	-22%
Feb	66	67	56	-11	-16%	65	58	-8	-12%
Mar	140	146	115	-31	-21%	147	120	-27	-18%
Apr	175	174	163	-10	-6%	177	154	-23	-13%
May	187	214	187	-27	-12%	264	267	3	1%
Jun	450	498	455	-43	-9%	399	385	-14	-3%
Jul	267	262	264	2	1%	254	249	-5	-2%
Aug	133	134	134	-1	0%	133	130	-3	-2%
Sep	22	24	24	0	1%	18	18	0	-1%
Average	128	135	123	-12	-9%	130	122	-8	-6%

Note:
(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 5. Wellsville Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	386	389	386	-2	-1%	395	390	-5	-1%
Nov	420	420	420	0	0%	420	420	0	0%
Dec	388	393	388	-6	-1%	399	397	-2	0%
Jan	367	367	362	-5	-1%	377	368	-9	-2%
Feb	372	376	366	-10	-3%	376	358	-19	-5%
Mar	470	471	456	-15	-3%	454	436	-18	-4%
Apr	499	496	486	-10	-2%	471	477	6	1%
May	1,002	1,023	997	-26	-3%	1,125	1,119	-6	-1%
Jun	2,197	2,240	2,199	-41	-2%	2,175	2,159	-16	-1%
Jul	1,386	1,391	1,389	-1	0%	1,387	1,379	-7	-1%
Aug	754	759	756	-3	0%	756	752	-4	-1%
Sep	446	448	442	-6	-1%	451	442	-9	-2%
Average	724	731	721	-10	-1%	732	725	-7	-1%
Mean Wet									
Oct	399	407	400	-7	-2%	416	406	-10	-2%
Nov	411	411	411	0	0%	411	411	0	0%
Dec	393	410	393	-16	-4%	421	421	0	0%
Jan	350	350	350	0	0%	407	391	-16	-4%
Feb	319	316	317	1	0%	363	328	-34	-10%
Mar	497	494	491	-2	0%	457	436	-21	-5%
Apr	597	576	577	1	0%	482	534	52	11%
May	1,176	1,200	1,171	-29	-2%	1,332	1,314	-19	-1%
Jun	3,040	3,066	3,040	-26	-1%	3,027	3,011	-16	-1%
Jul	2,166	2,177	2,173	-3	0%	2,182	2,167	-15	-1%
Aug	1,059	1,055	1,055	0	0%	1,053	1,047	-6	-1%
Sep	578	585	570	-15	-3%	592	574	-18	-3%
Average	915	921	912	-8	-1%	929	920	-9	-1%
Mean Dry									
Oct	330	332	330	-2	-1%	333	330	-3	-1%
Nov	383	384	383	-1	0%	384	383	-1	0%
Dec	369	372	367	-5	-1%	372	367	-4	-1%
Jan	347	347	337	-11	-3%	347	340	-8	-2%
Feb	371	372	361	-11	-3%	370	362	-8	-2%
Mar	428	434	403	-31	-7%	435	407	-27	-6%
Apr	457	458	448	-10	-2%	460	437	-23	-5%
May	839	861	839	-23	-3%	909	914	5	1%
Jun	1,349	1,401	1,356	-45	-3%	1,302	1,284	-18	-1%
Jul	772	769	769	0	0%	762	757	-5	-1%
Aug	546	547	546	-1	0%	546	543	-3	-1%
Sep	390	392	393	0	0%	387	387	0	0%
Average	548	556	544	-12	-2%	550	543	-8	-1%

Note:

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 6. Pueblo Reservoir Simulated Storage Content Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Storage		Changes in Storage (1)		Storage		Changes in Storage (1)	
		No Action	Proposed Action	Proposed Action – No Action		No Action	Proposed Action	Proposed Action - No Action	
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	%	(ac-ft)	(ac-ft)	(ac-ft)	(%)
Overall Mean									
Oct	164,006	149,977	157,408	7,431	5%	148,130	154,640	6,510	4%
Nov	169,249	156,277	162,896	6,619	4%	152,929	158,783	5,854	4%
Dec	178,549	167,616	172,798	5,182	3%	163,399	168,711	5,313	3%
Jan	187,764	177,529	181,813	4,284	2%	174,830	179,536	4,706	3%
Feb	194,024	183,999	188,007	4,008	2%	181,465	185,056	3,591	2%
Mar	200,903	191,157	194,233	3,076	2%	187,120	189,579	2,458	1%
Apr	197,039	185,382	189,411	4,029	2%	179,188	183,482	4,293	2%
May	189,120	175,810	181,388	5,578	3%	173,201	177,839	4,638	3%
Jun	185,729	171,740	178,152	6,412	4%	170,365	176,017	5,652	3%
Jul	178,473	164,587	170,830	6,243	4%	162,169	168,190	6,021	4%
Aug	172,148	157,608	164,726	7,118	5%	154,985	161,318	6,333	4%
Sep	165,275	150,589	157,895	7,306	5%	148,418	154,788	6,369	4%
Average	181,857	169,356	174,963	5,607	3%	166,350	171,495	5,145	3%
Mean Wet									
Oct	179,314	160,274	173,183	12,909	8%	143,502	156,340	12,838	9%
Nov	184,275	167,135	179,008	11,873	7%	149,492	161,351	11,859	8%
Dec	190,591	179,318	187,182	7,864	4%	160,068	171,365	11,298	7%
Jan	197,059	188,184	193,601	5,417	3%	174,801	185,108	10,307	6%
Feb	200,866	191,999	197,339	5,340	3%	183,959	191,489	7,530	4%
Mar	204,933	195,783	201,126	5,343	3%	187,794	193,006	5,212	3%
Apr	201,858	190,729	196,971	6,242	3%	175,948	185,105	9,157	5%
May	196,754	184,704	191,632	6,928	4%	173,647	182,769	9,122	5%
Jun	205,178	194,125	201,007	6,883	4%	181,445	190,310	8,865	5%
Jul	207,776	197,987	203,942	5,955	3%	182,719	192,330	9,611	5%
Aug	207,276	197,424	203,678	6,254	3%	182,803	192,607	9,804	5%
Sep	206,995	196,415	202,896	6,482	3%	184,402	192,946	8,544	5%
Average	198,573	187,006	194,297	7,291	4%	173,382	182,894	9,512	5%
Mean Dry									
Oct	156,718	147,799	151,028	3,229	2%	154,175	156,611	2,436	2%
Nov	158,732	150,391	153,035	2,644	2%	155,833	157,683	1,850	1%
Dec	167,391	159,494	161,672	2,178	1%	164,455	165,851	1,396	1%
Jan	176,748	169,001	170,356	1,355	1%	173,539	174,277	738	0%
Feb	182,245	174,551	175,501	950	1%	178,615	179,139	525	0%
Mar	189,954	182,461	182,052	-409	0%	184,546	184,249	-297	0%
Apr	186,522	177,376	177,232	-144	0%	178,575	178,548	-27	0%
May	185,549	173,851	175,747	1,896	1%	176,083	175,945	-139	0%
Jun	177,873	164,445	167,880	3,435	2%	170,491	171,496	1,005	1%
Jul	151,474	137,119	141,309	4,190	3%	144,487	146,026	1,539	1%
Aug	127,084	110,937	116,395	5,458	5%	118,778	121,514	2,736	2%
Sep	116,296	99,573	105,244	5,671	6%	107,784	111,571	3,787	4%
Average	164,716	153,917	156,454	2,538	2%	158,947	160,242	1,296	1%

Note:

(1) Effects (ac-ft) = Proposed Action - No Action simulated storage. Effects (%) = (Proposed Action - No Action simulated storage)/No Action simulated storage.

Table A- 7. Above Pueblo Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	216	216	217	1	0%	213	207	-6	-3%
Nov	207	203	195	-8	-4%	227	216	-11	-5%
Dec	215	191	210	19	10%	186	186	0	0%
Jan	225	225	226	1	0%	195	203	7	4%
Feb	260	257	257	0	0%	254	258	4	2%
Mar	304	304	302	-2	-1%	324	310	-14	-4%
Apr	573	614	579	-35	-6%	569	545	-23	-4%
May	1,056	1,118	1,051	-67	-6%	1,107	1,096	-11	-1%
Jun	2,221	2,259	2,221	-38	-2%	2,182	2,145	-37	-2%
Jul	1,289	1,296	1,296	0	0%	1,254	1,244	-10	-1%
Aug	645	657	640	-18	-3%	634	626	-8	-1%
Sep	257	264	258	-6	-2%	230	226	-5	-2%
Average	622	634	621	-13	-2%	615	605	-10	-2%
Mean Wet									
Oct	242	248	245	-3	-1%	213	211	-2	-1%
Nov	171	140	135	-5	-3%	180	170	-11	-6%
Dec	277	191	267	77	40%	190	190	0	0%
Jan	233	231	234	3	1%	138	156	18	13%
Feb	244	244	244	0	0%	215	230	15	7%
Mar	363	361	360	-1	0%	365	362	-3	-1%
Apr	548	576	556	-20	-3%	544	520	-24	-4%
May	1,059	1,109	1,049	-61	-5%	1,137	1,138	1	0%
Jun	3,034	3,027	3,022	-5	0%	2,991	2,963	-29	-1%
Jul	2,064	2,049	2,066	17	1%	2,029	2,007	-21	-1%
Aug	900	909	897	-13	-1%	890	884	-6	-1%
Sep	395	413	397	-16	-4%	326	339	13	4%
Average	794	792	789	-2	0%	768	764	-4	-1%
Mean Dry									
Oct	131	128	128	0	0%	128	124	-3	-3%
Nov	181	194	182	-12	-6%	195	185	-11	-6%
Dec	181	181	181	0	0%	178	178	0	0%
Jan	222	222	222	0	0%	219	219	0	0%
Feb	268	268	268	0	0%	265	265	0	0%
Mar	251	251	251	0	0%	303	286	-17	-6%
Apr	428	474	440	-35	-7%	435	413	-22	-5%
May	481	554	482	-71	-13%	516	510	-6	-1%
Jun	1,204	1,268	1,215	-53	-4%	1,118	1,085	-33	-3%
Jul	939	961	943	-18	-2%	882	864	-18	-2%
Aug	574	607	587	-20	-3%	564	543	-21	-4%
Sep	188	187	190	4	2%	176	158	-17	-10%
Average	421	441	424	-17	-4%	415	403	-12	-3%

Note:

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 8. Moffat Street Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	207	208	209	1	0%	205	199	-6	-3%
Nov	198	194	186	-8	-4%	218	207	-11	-5%
Dec	203	178	198	19	11%	174	174	0	0%
Jan	214	215	216	1	0%	185	193	7	4%
Feb	252	250	250	0	0%	246	251	4	2%
Mar	294	296	293	-3	-1%	316	302	-14	-5%
Apr	564	606	571	-35	-6%	561	537	-24	-4%
May	1,043	1,106	1,038	-68	-6%	1,093	1,083	-11	-1%
Jun	2,207	2,244	2,206	-38	-2%	2,171	2,132	-38	-2%
Jul	1,281	1,287	1,287	0	0%	1,246	1,234	-12	-1%
Aug	636	647	630	-18	-3%	623	615	-8	-1%
Sep	248	256	250	-6	-2%	221	216	-5	-2%
Average	612	624	611	-13	-2%	605	595	-10	-2%
Mean Wet									
Oct	231	238	235	-3	-1%	203	201	-2	-1%
Nov	160	129	124	-5	-4%	170	159	-11	-6%
Dec	264	177	254	77	43%	177	177	0	0%
Jan	222	220	223	3	1%	127	145	18	14%
Feb	235	235	235	0	0%	207	222	15	7%
Mar	354	352	351	-1	0%	356	352	-3	-1%
Apr	540	569	549	-20	-4%	537	513	-24	-4%
May	1,048	1,099	1,037	-62	-6%	1,126	1,127	1	0%
Jun	3,020	3,013	3,008	-5	0%	2,987	2,955	-32	-1%
Jul	2,070	2,053	2,071	18	1%	2,035	2,009	-26	-1%
Aug	889	899	886	-13	-1%	878	871	-6	-1%
Sep	384	401	385	-16	-4%	313	326	13	4%
Average	785	782	780	-2	0%	760	755	-5	-1%
Mean Dry									
Oct	126	123	123	0	0%	123	119	-3	-3%
Nov	172	185	174	-12	-6%	186	175	-11	-6%
Dec	168	168	168	0	0%	165	165	0	0%
Jan	211	211	211	0	0%	208	208	0	0%
Feb	259	259	259	0	0%	255	255	0	0%
Mar	242	242	243	0	0%	295	278	-17	-6%
Apr	419	466	431	-35	-8%	427	405	-22	-5%
May	467	540	468	-71	-13%	502	496	-6	-1%
Jun	1,190	1,255	1,201	-54	-4%	1,105	1,071	-34	-3%
Jul	927	948	929	-19	-2%	869	850	-19	-2%
Aug	566	599	580	-20	-3%	555	534	-21	-4%
Sep	183	182	185	4	2%	171	153	-17	-10%
Average	411	432	414	-17	-4%	405	392	-13	-3%

Note:

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 9. Avondale Gage Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	450	442	450	7	2%	476	482	7	1%
Nov	491	477	480	4	1%	535	539	4	1%
Dec	468	442	463	21	5%	472	474	2	0%
Jan	491	490	491	1	0%	493	501	8	2%
Feb	527	523	525	2	0%	554	560	6	1%
Mar	579	566	578	12	2%	620	618	-2	0%
Apr	920	936	927	-9	-1%	919	918	-1	0%
May	1,599	1,645	1,593	-52	-3%	1,693	1,680	-13	-1%
Jun	2,632	2,661	2,633	-28	-1%	2,637	2,602	-35	-1%
Jul	1,583	1,578	1,589	11	1%	1,585	1,583	-2	0%
Aug	991	989	987	-2	0%	1,006	1,007	2	0%
Sep	487	486	490	4	1%	491	493	2	0%
Average	935	936	934	-3	0%	957	955	-2	0%
Mean Wet									
Oct	488	483	489	7	1%	490	498	8	2%
Nov	445	403	410	7	2%	474	482	8	2%
Dec	538	450	528	79	17%	483	487	4	1%
Jan	506	504	507	3	1%	443	461	18	4%
Feb	500	498	500	1	0%	504	520	17	3%
Mar	592	580	590	10	2%	615	622	6	1%
Apr	821	831	831	0	0%	825	824	-1	0%
May	1,553	1,591	1,542	-49	-3%	1,671	1,669	-3	0%
Jun	3,647	3,627	3,638	11	0%	3,650	3,616	-34	-1%
Jul	2,469	2,449	2,472	23	1%	2,452	2,437	-15	-1%
Aug	1,369	1,367	1,365	-2	0%	1,372	1,366	-7	-1%
Sep	715	724	717	-7	-1%	672	681	9	1%
Average	1,137	1,125	1,132	7	1%	1,138	1,138	1	0%
Mean Dry									
Oct	312	301	309	8	3%	344	358	13	4%
Nov	423	430	424	-6	-1%	470	468	-2	0%
Dec	410	409	410	1	0%	440	441	1	0%
Jan	456	456	456	0	0%	485	485	0	0%
Feb	529	528	529	1	0%	559	560	1	0%
Mar	518	502	519	17	3%	586	586	0	0%
Apr	689	702	701	-1	0%	695	694	-1	0%
May	711	766	710	-56	-7%	791	790	-1	0%
Jun	1,392	1,444	1,405	-39	-3%	1,346	1,322	-24	-2%
Jul	1,095	1,094	1,097	3	0%	1,091	1,094	2	0%
Aug	769	789	780	-9	-1%	801	793	-8	-1%
Sep	338	332	341	9	3%	364	360	-4	-1%
Average	637	646	640	-6	-1%	664	663	-2	0%

Note:

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 10. Lake Meredith Simulated Storage Contents Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Storage		Changes in Storage (1)		Storage		Changes in Storage (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	%	(ac-ft)	(ac-ft)	(ac-ft)	(%)
Overall Mean									
Oct	8,817	11,868	9,167	-2,701	-23%	20,185	15,558	-4,627	-23%
Nov	8,413	11,307	8,921	-2,386	-21%	20,578	16,260	-4,318	-21%
Dec	9,568	12,540	10,210	-2,329	-19%	20,380	16,645	-3,735	-18%
Jan	11,110	14,423	11,833	-2,590	-18%	20,209	16,504	-3,705	-18%
Feb	11,275	14,836	12,051	-2,785	-19%	18,747	15,072	-3,674	-20%
Mar	16,021	19,506	16,636	-2,870	-15%	20,512	16,604	-3,909	-19%
Apr	14,990	19,195	15,637	-3,558	-19%	21,320	16,083	-5,237	-25%
May	11,039	14,241	11,535	-2,706	-19%	19,866	14,722	-5,144	-26%
Jun	6,347	11,127	6,828	-4,298	-39%	19,445	13,219	-6,226	-32%
Jul	9,416	13,773	9,593	-4,180	-30%	21,275	14,813	-6,462	-30%
Aug	9,561	13,661	9,803	-3,858	-28%	20,947	15,127	-5,820	-28%
Sep	9,496	12,953	9,806	-3,147	-24%	20,339	15,140	-5,199	-26%
Average	10,504	14,119	11,002	-3,117	-22%	20,317	15,479	-4,838	-24%
Mean Wet									
Oct	12,982	16,225	12,940	-3,285	-20%	22,567	16,676	-5,891	-26%
Nov	12,920	15,853	12,965	-2,888	-18%	22,218	16,715	-5,503	-25%
Dec	14,404	17,143	14,415	-2,728	-16%	21,710	17,325	-4,385	-20%
Jan	16,161	19,025	16,160	-2,865	-15%	21,639	17,308	-4,331	-20%
Feb	16,183	19,313	16,227	-3,086	-16%	20,328	16,030	-4,297	-21%
Mar	18,854	22,526	18,834	-3,692	-16%	22,226	17,581	-4,645	-21%
Apr	17,206	21,699	17,267	-4,432	-20%	23,121	16,981	-6,140	-27%
May	12,648	15,994	12,949	-3,044	-19%	22,020	15,823	-6,197	-28%
Jun	9,008	13,724	9,072	-4,651	-34%	24,261	17,205	-7,055	-29%
Jul	14,736	19,119	14,928	-4,192	-22%	27,735	20,467	-7,268	-26%
Aug	16,062	19,940	16,522	-3,417	-17%	26,947	19,821	-7,126	-26%
Sep	18,088	21,069	18,817	-2,252	-11%	25,560	19,101	-6,459	-25%
Average	14,938	18,469	15,091	-3,378	-18%	23,361	17,586	-5,775	-25%
Mean Dry									
Oct	4,900	9,063	4,783	-4,280	-47%	19,082	13,753	-5,329	-28%
Nov	4,815	8,796	4,709	-4,087	-46%	20,761	15,741	-5,020	-24%
Dec	6,170	10,312	6,351	-3,960	-38%	20,898	16,100	-4,798	-23%
Jan	7,552	12,118	8,027	-4,091	-34%	20,549	15,804	-4,746	-23%
Feb	7,472	12,493	8,093	-4,400	-35%	18,715	14,004	-4,711	-25%
Mar	13,989	18,262	14,468	-3,794	-21%	20,359	15,930	-4,429	-22%
Apr	13,619	17,606	14,362	-3,243	-18%	21,359	16,114	-5,245	-25%
May	8,460	11,468	9,357	-2,112	-18%	18,261	13,975	-4,286	-23%
Jun	2,842	7,956	3,913	-4,043	-51%	13,124	8,459	-4,665	-36%
Jul	3,096	7,590	3,810	-3,780	-50%	12,936	8,061	-4,876	-38%
Aug	2,426	6,599	2,998	-3,601	-55%	13,944	9,683	-4,261	-31%
Sep	1,983	5,617	2,452	-3,165	-56%	14,523	10,830	-3,693	-25%
Average	6,444	10,657	6,944	-3,713	-35%	17,876	13,204	-4,671	-26%

Note:

(1) Effects (ac-ft) = Proposed Action - No Action simulated storage. Effects (%) = (Proposed Action - No Action simulated storage)/No Action simulated storage.

Table A- 11. Lake Henry Simulated Storage Contents Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Storage		Changes in Storage (1)		Storage		Changes in Storage (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	%	(ac-ft)	(ac-ft)	(ac-ft)	(%)
Overall Mean									
Oct	2,925	3,599	3,066	-533	-15%	3,750	3,750	0	0%
Nov	2,855	3,370	2,910	-460	-14%	3,540	3,540	0	0%
Dec	3,293	3,502	3,293	-209	-6%	3,581	3,581	0	0%
Jan	3,672	3,691	3,672	-19	-1%	3,716	3,716	0	0%
Feb	5,139	5,137	5,139	1	0%	5,139	5,139	0	0%
Mar	6,674	6,693	6,699	5	0%	6,663	6,663	0	0%
Apr	6,870	6,874	6,876	2	0%	6,870	6,870	0	0%
May	6,278	6,550	6,248	-302	-5%	6,570	6,570	0	0%
Jun	5,412	6,280	5,439	-841	-13%	6,280	6,280	0	0%
Jul	5,177	5,794	5,261	-534	-9%	5,789	5,789	0	0%
Aug	4,372	5,103	4,507	-596	-12%	5,146	5,146	0	0%
Sep	3,353	4,258	3,550	-708	-17%	4,393	4,393	0	0%
Average	4,668	5,071	4,721	-350	-7%	5,120	5,120	0	0%
Mean Wet									
Oct	3,676	3,942	3,676	-266	-7%	3,942	3,942	0	0%
Nov	3,507	3,678	3,499	-178	-5%	3,678	3,678	0	0%
Dec	3,663	3,670	3,658	-12	0%	3,670	3,670	0	0%
Jan	3,741	3,741	3,741	0	0%	3,741	3,741	0	0%
Feb	5,015	5,015	5,015	0	0%	5,015	5,015	0	0%
Mar	6,622	6,622	6,622	0	0%	6,622	6,622	0	0%
Apr	6,907	6,907	6,907	0	0%	6,907	6,907	0	0%
May	6,671	6,934	6,749	-186	-3%	6,934	6,934	0	0%
Jun	6,562	7,196	6,425	-771	-11%	7,196	7,196	0	0%
Jul	6,997	7,137	7,049	-88	-1%	7,116	7,116	0	0%
Aug	6,662	6,662	6,662	0	0%	6,662	6,662	0	0%
Sep	5,622	5,969	5,649	-319	-5%	5,969	5,969	0	0%
Average	5,470	5,623	5,471	-152	-3%	5,621	5,621	0	0%
Mean Dry									
Oct	2,125	2,529	2,396	-134	-5%	2,529	2,529	0	0%
Nov	1,889	2,341	2,046	-294	-13%	2,456	2,456	0	0%
Dec	2,186	2,452	2,186	-266	-11%	2,501	2,501	0	0%
Jan	2,710	2,729	2,710	-18	-1%	2,729	2,729	0	0%
Feb	4,508	4,508	4,508	0	0%	4,508	4,508	0	0%
Mar	6,097	6,097	6,097	0	0%	6,097	6,097	0	0%
Apr	5,920	5,920	5,920	0	0%	5,920	5,920	0	0%
May	4,801	5,101	4,801	-299	-6%	5,101	5,101	0	0%
Jun	3,432	4,507	3,426	-1,080	-24%	4,507	4,507	0	0%
Jul	2,734	3,736	2,730	-1,005	-27%	3,736	3,736	0	0%
Aug	1,928	2,836	1,925	-911	-32%	2,966	2,966	0	0%
Sep	1,410	2,211	1,638	-574	-26%	2,578	2,578	0	0%
Average	3,312	3,747	3,365	-382	-10%	3,802	3,802	0	0%

Note:

(1) Effects (ac-ft) = Proposed Action - No Action simulated storage. Effects (%) = (Proposed Action - No Action simulated storage)/No Action simulated storage.

Table A- 12. Holbrook Reservoir Simulated Storage Contents Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Storage		Changes in Storage (1)		Storage		Changes in Storage (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	%	(ac-ft)	(ac-ft)	(ac-ft)	(%)
Overall Mean									
Oct	974	974	1,594	620	64%	974	1,517	543	56%
Nov	1,160	1,160	1,789	628	54%	1,160	1,708	548	47%
Dec	1,713	1,713	2,155	442	26%	1,713	2,164	451	26%
Jan	2,730	2,730	3,169	439	16%	2,730	3,181	451	17%
Feb	3,502	3,502	3,939	437	12%	3,502	3,953	451	13%
Mar	4,096	4,096	4,691	596	15%	4,096	4,571	476	12%
Apr	3,969	3,969	4,482	513	13%	3,969	4,396	427	11%
May	3,473	3,473	3,765	292	8%	3,473	3,619	146	4%
Jun	3,287	3,287	3,614	327	10%	3,287	3,532	245	7%
Jul	2,230	2,230	2,766	536	24%	2,230	2,688	458	21%
Aug	1,481	1,481	1,964	483	33%	1,481	1,773	292	20%
Sep	1,052	1,052	1,599	546	52%	1,052	1,491	439	42%
Average	2,472	2,472	2,960	488	20%	2,472	2,883	411	17%
Mean Wet									
Oct	1,719	1,719	1,774	54	3%	1,719	1,719	0	0%
Nov	1,690	1,690	1,690	0	0%	1,690	1,690	0	0%
Dec	1,672	1,672	1,672	0	0%	1,672	1,672	0	0%
Jan	2,242	2,242	2,242	0	0%	2,242	2,242	0	0%
Feb	2,577	2,577	2,577	0	0%	2,577	2,577	0	0%
Mar	2,820	2,820	2,905	85	3%	2,820	2,896	75	3%
Apr	2,927	2,927	3,099	172	6%	2,927	3,099	172	6%
May	2,833	2,833	2,833	0	0%	2,833	2,833	0	0%
Jun	3,144	3,144	3,144	0	0%	3,144	3,144	0	0%
Jul	3,048	3,048	3,099	51	2%	3,048	3,099	51	2%
Aug	2,353	2,353	2,464	110	5%	2,353	2,469	116	5%
Sep	2,082	2,082	2,194	112	5%	2,082	2,184	102	5%
Average	2,426	2,426	2,475	49	2%	2,426	2,469	43	2%
Mean Dry									
Oct	580	580	2,200	1,620	279%	580	1,985	1,405	242%
Nov	910	910	2,615	1,705	187%	910	2,348	1,438	158%
Dec	1,411	1,411	2,469	1,058	75%	1,411	2,511	1,099	78%
Jan	2,680	2,680	3,729	1,049	39%	2,680	3,780	1,099	41%
Feb	4,597	4,597	5,642	1,045	23%	4,597	5,697	1,099	24%
Mar	5,731	5,731	7,040	1,310	23%	5,731	6,878	1,147	20%
Apr	5,369	5,369	6,525	1,156	22%	5,369	6,137	768	14%
May	4,187	4,187	4,822	635	15%	4,187	4,350	163	4%
Jun	3,327	3,327	3,940	613	18%	3,327	3,527	200	6%
Jul	1,496	1,496	2,430	934	62%	1,496	2,257	761	51%
Aug	614	614	1,649	1,036	169%	614	1,392	778	127%
Sep	299	299	1,442	1,143	382%	299	1,368	1,069	358%
Average	2,600	2,600	3,709	1,109	43%	2,600	3,519	919	35%

Note:

(1) Effects (ac-ft) = Proposed Action - No Action simulated storage. Effects (%) = (Proposed Action - No Action simulated storage)/No Action simulated storage.

Table A- 13. La Junta Simulated Streamflow Direct and Cumulative Effects.

Month	Existing Conditions	Direct Effects				Cumulative Effects			
		Streamflow		Changes in Streamflow (1)		Streamflow		Changes in Streamflow (1)	
		No Action	Proposed Action	Proposed Action - No Action		No Action	Proposed Action	Proposed Action - No Action	
	(cfs)	(cfs)	(cfs)	(cfs)	%	(cfs)	(cfs)	(cfs)	(%)
Overall Mean									
Oct	195	195	196	1	0%	196	196	0	0%
Nov	197	194	187	-7	-4%	205	198	-6	-3%
Dec	374	349	368	19	6%	342	342	0	0%
Jan	262	262	262	0	0%	242	243	1	0%
Feb	188	188	188	0	0%	189	189	0	0%
Mar	138	136	138	2	1%	137	139	1	1%
Apr	184	186	183	-2	-1%	185	184	-2	-1%
May	664	672	665	-7	-1%	663	659	-4	-1%
Jun	1,057	1,033	1,051	18	2%	1,017	1,022	5	1%
Jul	606	606	604	-1	0%	610	607	-3	-1%
Aug	379	383	377	-6	-1%	382	384	2	0%
Sep	140	141	139	-2	-1%	143	140	-3	-2%
Average	365	362	363	1	0%	359	359	-1	0%
Mean Wet									
Oct	141	141	141	0	0%	142	142	0	0%
Nov	146	117	113	-4	-4%	143	139	-5	-3%
Dec	485	398	475	77	19%	393	393	0	0%
Jan	275	275	275	0	0%	220	221	1	1%
Feb	210	210	210	0	0%	212	212	0	0%
Mar	112	112	112	0	0%	115	115	0	0%
Apr	86	86	86	-1	-1%	89	89	-1	-1%
May	419	426	419	-7	-2%	423	426	4	1%
Jun	1,784	1,709	1,769	60	4%	1,677	1,693	17	1%
Jul	1,078	1,069	1,070	1	0%	1,081	1,083	2	0%
Aug	594	594	595	1	0%	594	597	3	1%
Sep	208	209	209	0	0%	211	211	0	0%
Average	461	446	456	11	2%	442	443	2	0%
Mean Dry									
Oct	80	80	80	0	0%	81	80	0	0%
Nov	137	146	136	-9	-6%	144	134	-9	-7%
Dec	268	268	268	0	0%	265	265	0	0%
Jan	176	176	176	0	0%	174	174	0	0%
Feb	155	155	155	0	0%	155	155	0	0%
Mar	81	81	81	0	0%	81	81	0	0%
Apr	83	88	83	-5	-6%	85	83	-3	-3%
May	161	168	160	-8	-5%	164	158	-6	-4%
Jun	273	272	275	3	1%	272	272	0	0%
Jul	297	302	298	-5	-2%	303	296	-7	-2%
Aug	201	209	200	-9	-4%	209	200	-9	-4%
Sep	98	98	96	-2	-2%	100	96	-4	-4%
Average	167	170	167	-3	-2%	169	166	-3	-2%

Note:

(1) Effects (cfs) = Proposed Action - No Action simulated streamflow. Effects (%) = (Proposed Action - No Action simulated streamflow)/No Action simulated streamflow.

Table A- 14. Lake Fork Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	1.61	1.58	1.62	-0.03	-3%	0.01	1%	0.05	4%
May	2.09	2.09	2.08	0.00	0%	-0.01	-1%	-0.01	-1%
Jun	1.82	1.90	1.82	0.08	6%	0.00	0%	-0.08	-6%
Jul	2.17	2.22	2.18	0.05	3%	0.00	0%	-0.04	-3%
Aug	1.53	1.59	1.58	0.06	5%	0.05	5%	-0.01	-1%
Sep	1.28	1.29	1.30	0.01	1%	0.02	2%	0.01	1%
Mean Wet									
Apr	1.99	1.83	1.98	-0.16	-11%	-0.01	-1%	0.15	11%
May	2.24	2.29	2.23	0.06	3%	-0.01	0%	-0.06	-3%
Jun	1.89	2.00	1.85	0.11	8%	-0.05	-3%	-0.15	-10%
Jul	2.66	2.69	2.70	0.03	1%	0.04	2%	0.01	0%
Aug	1.56	1.56	1.56	0.00	0%	0.00	0%	0.01	1%
Sep	1.32	1.39	1.39	0.06	8%	0.07	8%	0.00	0%
Mean Dry									
Apr	1.49	1.55	1.55	0.06	6%	0.06	6%	0.00	0%
May	2.12	2.06	2.10	-0.06	-4%	-0.02	-1%	0.04	3%
Jun	1.70	1.81	1.74	0.11	9%	0.03	3%	-0.08	-6%
Jul	1.71	1.77	1.71	0.06	5%	-0.01	0%	-0.06	-5%
Aug	1.47	1.47	1.47	0.01	1%	0.00	0%	-0.01	-1%
Sep	1.23	1.23	1.23	0.00	0%	0.00	0%	0.00	0%

Lake Fork Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	1.61	1.52	1.55	-0.09	-8%	-0.07	-6%	0.02	2%
May	2.09	2.10	2.07	0.01	1%	-0.02	-1%	-0.02	-2%
Jun	1.82	1.84	1.80	0.02	1%	-0.02	-2%	-0.04	-3%
Jul	2.17	2.19	2.16	0.02	1%	-0.01	-1%	-0.03	-2%
Aug	1.53	1.52	1.51	-0.01	-1%	-0.02	-2%	-0.01	-1%
Sep	1.28	1.27	1.27	-0.01	-2%	-0.01	-1%	0.01	1%
Mean Wet									
Apr	1.99	1.69	1.69	-0.30	-20%	-0.29	-20%	0.01	1%
May	2.24	2.33	2.28	0.09	5%	0.04	2%	-0.05	-3%
Jun	1.89	1.84	1.78	-0.05	-4%	-0.11	-8%	-0.06	-4%
Jul	2.66	2.65	2.59	-0.01	0%	-0.07	-3%	-0.06	-3%
Aug	1.56	1.50	1.49	-0.07	-6%	-0.07	-7%	0.00	0%
Sep	1.32	1.27	1.30	-0.05	-6%	-0.03	-3%	0.03	3%
Mean Dry									
Apr	1.49	1.52	1.53	0.03	3%	0.04	4%	0.01	1%
May	2.12	2.02	2.03	-0.09	-6%	-0.08	-5%	0.01	1%
Jun	1.70	1.82	1.71	0.11	9%	0.01	1%	-0.10	-8%
Jul	1.71	1.79	1.77	0.07	6%	0.06	5%	-0.01	-1%
Aug	1.47	1.47	1.47	0.01	1%	0.01	1%	0.00	0%
Sep	1.23	1.23	1.23	0.00	0%	0.00	0%	0.00	0%

Table A- 15. Lake Creek Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	1.29	1.30	1.21	0.01	0%	-0.08	-6%	-0.09	-7%
May	1.30	1.39	1.29	0.10	7%	-0.01	-1%	-0.10	-8%
Jun	2.75	2.91	2.78	0.16	6%	0.02	1%	-0.13	-5%
Jul	2.26	2.25	2.26	0.00	0%	0.00	0%	0.00	0%
Aug	1.19	1.21	1.19	0.02	1%	0.00	0%	-0.02	-2%
Sep	0.45	0.46	0.42	0.01	2%	-0.03	-7%	-0.04	-8%
Mean Wet									
Apr	1.59	1.56	1.49	-0.03	-2%	-0.11	-7%	-0.07	-5%
May	1.29	1.40	1.28	0.10	8%	-0.01	-1%	-0.11	-8%
Jun	3.35	3.41	3.35	0.06	2%	0.00	0%	-0.06	-2%
Jul	2.93	2.94	2.93	0.01	0%	0.00	0%	-0.02	-1%
Aug	1.66	1.65	1.65	-0.01	0%	-0.01	-1%	-0.01	0%
Sep	0.69	0.70	0.63	0.01	1%	-0.07	-10%	-0.08	-11%
Mean Dry									
Apr	1.24	1.24	1.17	0.00	0%	-0.07	-6%	-0.07	-6%
May	1.29	1.42	1.29	0.12	10%	0.00	0%	-0.12	-9%
Jun	2.26	2.44	2.30	0.18	8%	0.04	2%	-0.14	-6%
Jul	1.64	1.62	1.63	-0.02	-1%	-0.01	-1%	0.01	0%
Aug	0.94	0.94	0.94	0.00	0%	0.00	0%	0.00	0%
Sep	0.35	0.36	0.36	0.02	5%	0.02	5%	0.00	0%

Lake Creek Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	1.29	1.22	1.20	-0.08	-6%	-0.09	-7%	-0.01	-1%
May	1.30	1.80	1.78	0.50	39%	0.49	38%	-0.01	-1%
Jun	2.75	2.76	2.72	0.01	0%	-0.03	-1%	-0.04	-2%
Jul	2.26	2.23	2.23	-0.02	-1%	-0.03	-1%	-0.01	0%
Aug	1.19	1.20	1.18	0.01	1%	-0.01	-1%	-0.02	-2%
Sep	0.45	0.48	0.42	0.03	7%	-0.03	-7%	-0.06	-13%
Mean Wet									
Apr	1.59	1.24	1.43	-0.36	-23%	-0.17	-11%	0.19	15%
May	1.29	1.86	1.81	0.56	44%	0.52	40%	-0.04	-2%
Jun	3.35	3.40	3.37	0.05	2%	0.02	1%	-0.03	-1%
Jul	2.93	2.94	2.93	0.01	0%	0.00	0%	-0.01	0%
Aug	1.66	1.66	1.63	0.00	0%	-0.03	-2%	-0.03	-2%
Sep	0.69	0.77	0.66	0.08	11%	-0.03	-4%	-0.11	-14%
Mean Dry									
Apr	1.24	1.26	1.10	0.01	1%	-0.14	-11%	-0.15	-12%
May	1.29	1.65	1.66	0.36	28%	0.37	28%	0.01	1%
Jun	2.26	2.10	2.05	-0.16	-7%	-0.21	-9%	-0.04	-2%
Jul	1.64	1.59	1.56	-0.05	-3%	-0.08	-5%	-0.03	-2%
Aug	0.94	0.92	0.91	-0.01	-1%	-0.03	-3%	-0.02	-2%
Sep	0.35	0.31	0.31	-0.03	-9%	-0.03	-10%	0.00	-1%

Table A- 16. Wellsville Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	3.64	3.64	3.60	-0.01	0%	-0.04	-2%	-0.03	-2%
May	4.48	4.51	4.47	0.03	1%	-0.01	0%	-0.03	-1%
Jun	5.78	5.82	5.78	0.04	1%	0.00	0%	-0.04	-1%
Jul	4.91	4.91	4.91	0.00	0%	0.00	0%	0.00	0%
Aug	4.08	4.09	4.09	0.01	0%	0.00	0%	-0.01	0%
Sep	3.53	3.53	3.52	0.00	0%	-0.01	0%	-0.01	-1%
Mean Wet									
Apr	3.85	3.81	3.80	-0.04	-2%	-0.05	-2%	-0.02	-1%
May	4.69	4.72	4.68	0.03	1%	0.00	0%	-0.03	-1%
Jun	6.55	6.56	6.54	0.02	0%	0.00	0%	-0.02	0%
Jul	5.73	5.74	5.74	0.01	0%	0.01	0%	-0.01	0%
Aug	4.57	4.56	4.56	-0.01	0%	0.00	0%	0.00	0%
Sep	3.82	3.83	3.80	0.01	0%	-0.02	-1%	-0.03	-1%
Mean Dry									
Apr	3.55	3.55	3.52	0.00	0%	-0.03	-1%	-0.03	-2%
May	4.27	4.30	4.27	0.03	1%	0.00	0%	-0.03	-1%
Jun	4.94	5.00	4.95	0.06	2%	0.01	0%	-0.05	-1%
Jul	4.18	4.18	4.18	0.00	0%	-0.01	0%	0.00	0%
Aug	3.74	3.74	3.74	0.00	0%	0.00	0%	0.00	0%
Sep	3.39	3.39	3.39	0.01	0%	0.00	0%	0.00	0%

Wellsville Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	3.64	3.59	3.59	-0.05	-3%	-0.05	-3%	0.00	0%
May	4.48	4.63	4.62	0.15	5%	0.14	5%	-0.01	0%
Jun	5.78	5.76	5.74	-0.02	0%	-0.03	-1%	-0.02	0%
Jul	4.91	4.91	4.90	0.00	0%	-0.01	0%	-0.01	0%
Aug	4.08	4.09	4.08	0.00	0%	-0.01	0%	-0.01	0%
Sep	3.53	3.54	3.52	0.01	1%	-0.01	0%	-0.02	-1%
Mean Wet									
Apr	3.85	3.62	3.72	-0.23	-10%	-0.13	-6%	0.10	5%
May	4.69	4.85	4.83	0.16	5%	0.15	5%	-0.02	-1%
Jun	6.55	6.55	6.54	0.00	0%	-0.01	0%	-0.01	0%
Jul	5.73	5.75	5.74	0.02	1%	0.00	0%	-0.02	0%
Aug	4.57	4.56	4.55	-0.01	0%	-0.02	-1%	-0.01	0%
Sep	3.82	3.84	3.81	0.02	1%	-0.01	0%	-0.03	-1%
Mean Dry									
Apr	3.55	3.56	3.49	0.01	0%	-0.06	-3%	-0.07	-3%
May	4.27	4.37	4.37	0.10	4%	0.10	4%	0.00	0%
Jun	4.94	4.89	4.86	-0.06	-2%	-0.08	-2%	-0.02	-1%
Jul	4.18	4.17	4.16	-0.01	-1%	-0.02	-1%	-0.01	0%
Aug	3.74	3.74	3.73	0.00	0%	-0.01	0%	-0.01	0%
Sep	3.39	3.38	3.38	-0.01	0%	-0.01	0%	0.00	0%

Table A- 17. Turquoise Lake Elevation--Direct Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	9,830.48	9,830.42	9,831.08	-0.06	0%	0.61	1%	0.67	1%
May	9,827.51	9,826.70	9,828.18	-0.81	-1%	0.67	1%	1.48	2%
Jun	9,850.77	9,849.26	9,851.00	-1.51	-2%	0.23	0%	1.74	2%
Jul	9,861.51	9,860.15	9,861.44	-1.36	-1%	-0.07	0%	1.29	1%
Aug	9,860.80	9,859.31	9,860.65	-1.49	-1%	-0.14	0%	1.35	1%
Sep	9,859.25	9,857.50	9,859.19	-1.75	-2%	-0.06	0%	1.69	2%
Mean Wet									
Apr	9,831.04	9,829.54	9,831.63	-1.50	-2%	0.58	1%	2.08	3%
May	9,828.29	9,826.29	9,829.17	-2.00	-3%	0.88	1%	2.88	4%
Jun	9,855.00	9,852.50	9,855.17	-2.50	-2%	0.17	0%	2.67	3%
Jul	9,868.54	9,867.04	9,868.71	-1.50	-1%	0.17	0%	1.67	1%
Aug	9,868.75	9,867.42	9,868.88	-1.33	-1%	0.13	0%	1.46	1%
Sep	9,868.00	9,866.54	9,868.25	-1.46	-1%	0.25	0%	1.71	1%
Mean Dry									
Apr	9,829.38	9,830.83	9,829.33	1.46	2%	-0.04	0%	-1.50	-2%
May	9,825.25	9,825.88	9,824.83	0.63	1%	-0.42	-1%	-1.04	-1%
Jun	9,843.83	9,843.38	9,843.13	-0.46	0%	-0.71	-1%	-0.25	0%
Jul	9,850.58	9,849.75	9,849.83	-0.83	-1%	-0.75	-1%	0.08	0%
Aug	9,848.54	9,847.33	9,847.54	-1.21	-1%	-1.00	-1%	0.21	0%
Sep	9,846.17	9,845.13	9,844.88	-1.04	-1%	-1.29	-1%	-0.25	0%

Turquoise Lake Elevation--Cumulative Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	9,830.48	9,830.51	9,831.76	0.04	0%	1.29	2%	1.25	2%
May	9,827.51	9,826.52	9,827.75	-0.99	-1%	0.24	0%	1.23	2%
Jun	9,850.77	9,849.82	9,850.04	-0.95	-1%	-0.74	-1%	0.21	0%
Jul	9,861.51	9,860.58	9,860.86	-0.93	-1%	-0.65	-1%	0.27	0%
Aug	9,860.80	9,859.56	9,860.20	-1.24	-1%	-0.60	-1%	0.64	1%
Sep	9,859.25	9,857.85	9,858.57	-1.40	-1%	-0.68	-1%	0.73	1%
Mean Wet									
Apr	9,831.04	9,828.33	9,831.79	-2.71	-3%	0.75	1%	3.46	4%
May	9,828.29	9,823.83	9,827.42	-4.46	-6%	-0.88	-1%	3.58	5%
Jun	9,855.00	9,851.33	9,851.83	-3.67	-3%	-3.17	-3%	0.50	0%
Jul	9,868.54	9,866.33	9,866.63	-2.21	-2%	-1.92	-2%	0.29	0%
Aug	9,868.75	9,866.29	9,866.92	-2.46	-2%	-1.83	-2%	0.63	1%
Sep	9,868.00	9,865.83	9,866.33	-2.17	-2%	-1.67	-1%	0.50	0%
Mean Dry									
Apr	9,829.38	9,830.63	9,829.46	1.25	2%	0.08	0%	-1.17	-1%
May	9,825.25	9,826.42	9,825.33	1.17	2%	0.08	0%	-1.08	-1%
Jun	9,843.83	9,844.54	9,843.79	0.71	1%	-0.04	0%	-0.75	-1%
Jul	9,850.58	9,850.83	9,850.71	0.25	0%	0.13	0%	-0.13	0%
Aug	9,848.54	9,848.46	9,848.63	-0.08	0%	0.08	0%	0.17	0%
Sep	9,846.17	9,845.67	9,845.63	-0.50	-1%	-0.54	-1%	-0.04	0%

Table A- 18. Pueblo Reservoir Elevation--Direct Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,864.31	4,860.14	4,861.73	-4.18	-4%	-2.58	-2%	1.59	1%
May	4,861.88	4,856.92	4,859.11	-4.96	-5%	-2.77	-3%	2.18	2%
Jun	4,860.86	4,855.53	4,858.14	-5.33	-5%	-2.73	-3%	2.61	3%
Jul	4,858.26	4,852.59	4,855.33	-5.67	-5%	-2.93	-3%	2.74	3%
Aug	4,855.67	4,849.25	4,852.51	-6.42	-6%	-3.16	-3%	3.26	3%
Sep	4,853.30	4,846.28	4,849.92	-7.01	-7%	-3.38	-3%	3.63	4%
Mean Wet									
Apr	4,864.12	4,859.33	4,862.21	-4.79	-4%	-1.91	-2%	2.88	3%
May	4,861.77	4,856.05	4,859.39	-5.73	-5%	-2.38	-2%	3.35	3%
Jun	4,864.62	4,859.24	4,862.86	-5.38	-5%	-1.76	-2%	3.62	3%
Jul	4,865.34	4,860.29	4,863.86	-5.04	-4%	-1.48	-1%	3.57	3%
Aug	4,865.20	4,860.16	4,863.76	-5.04	-4%	-1.45	-1%	3.59	3%
Sep	4,865.91	4,861.12	4,864.44	-4.78	-4%	-1.47	-1%	3.31	3%
Mean Dry									
Apr	4,861.90	4,858.77	4,858.74	-3.13	-3%	-3.16	-3%	-0.03	0%
May	4,861.62	4,857.64	4,858.21	-3.98	-4%	-3.41	-3%	0.57	1%
Jun	4,859.39	4,854.70	4,855.84	-4.69	-4%	-3.55	-3%	1.14	1%
Jul	4,851.40	4,845.75	4,847.39	-5.65	-6%	-4.01	-4%	1.64	2%
Aug	4,843.42	4,836.06	4,838.63	-7.36	-8%	-4.78	-5%	2.57	3%
Sep	4,839.16	4,830.54	4,833.71	-8.61	-10%	-5.44	-6%	3.17	4%

Pueblo Reservoir Elevation--Cumulative Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,864.31	4,857.41	4,859.02	-6.91	-6%	-5.29	-5%	1.61	2%
May	4,861.88	4,855.37	4,857.10	-6.51	-6%	-4.78	-4%	1.73	2%
Jun	4,860.86	4,854.43	4,856.61	-6.43	-6%	-4.26	-4%	2.17	2%
Jul	4,858.26	4,851.03	4,853.58	-7.23	-7%	-4.68	-4%	2.55	3%
Aug	4,855.67	4,847.86	4,850.62	-7.81	-8%	-5.05	-5%	2.76	3%
Sep	4,853.30	4,844.90	4,848.08	-8.40	-8%	-5.21	-5%	3.18	3%
Mean Wet									
Apr	4,864.12	4,853.11	4,856.53	-11.01	-10%	-7.60	-7%	3.42	3%
May	4,861.77	4,851.87	4,855.11	-9.90	-9%	-6.67	-6%	3.23	3%
Jun	4,864.62	4,855.23	4,858.36	-9.39	-8%	-6.26	-6%	3.13	3%
Jul	4,865.34	4,855.80	4,859.21	-9.54	-8%	-6.13	-5%	3.41	3%
Aug	4,865.20	4,855.97	4,859.40	-9.24	-8%	-5.80	-5%	3.44	3%
Sep	4,865.91	4,857.51	4,860.49	-8.39	-7%	-5.42	-5%	2.97	3%
Mean Dry									
Apr	4,861.90	4,858.82	4,858.86	-3.09	-3%	-3.04	-3%	0.05	0%
May	4,861.62	4,857.99	4,857.98	-3.62	-3%	-3.64	-3%	-0.02	0%
Jun	4,859.39	4,856.13	4,856.50	-3.26	-3%	-2.89	-3%	0.38	0%
Jul	4,851.40	4,847.66	4,848.44	-3.75	-4%	-2.96	-3%	0.79	1%
Aug	4,843.42	4,838.33	4,839.67	-5.09	-6%	-3.75	-4%	1.34	2%
Sep	4,839.16	4,833.01	4,835.06	-6.14	-7%	-4.09	-5%	2.05	3%

Table A- 19. Above Pueblo Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	3.05	3.15	3.07	0.10	3%	0.02	1%	-0.08	-3%
May	3.77	3.86	3.77	0.09	2%	-0.01	0%	-0.10	-3%
Jun	5.15	5.20	5.15	0.05	1%	0.00	0%	-0.05	-1%
Jul	4.03	4.05	4.05	0.01	0%	0.02	0%	0.00	0%
Aug	3.15	3.17	3.14	0.01	0%	-0.02	-1%	-0.03	-1%
Sep	2.32	2.34	2.33	0.02	1%	0.01	0%	-0.01	-1%
Mean Wet									
Apr	3.08	3.15	3.10	0.07	2%	0.02	1%	-0.05	-2%
May	3.87	3.92	3.85	0.05	1%	-0.02	0%	-0.07	-2%
Jun	6.10	6.10	6.09	0.00	0%	-0.01	0%	-0.01	0%
Jul	4.97	4.95	4.98	-0.02	0%	0.01	0%	0.03	1%
Aug	3.54	3.56	3.53	0.02	1%	-0.02	0%	-0.04	-1%
Sep	2.67	2.70	2.67	0.04	1%	0.00	0%	-0.04	-1%
Mean Dry									
Apr	2.68	2.81	2.71	0.13	5%	0.03	1%	-0.10	-4%
May	2.90	3.04	2.91	0.14	5%	0.01	1%	-0.13	-4%
Jun	4.00	4.10	4.00	0.11	3%	0.00	0%	-0.10	-2%
Jul	3.67	3.72	3.69	0.05	1%	0.01	0%	-0.03	-1%
Aug	3.01	3.08	3.05	0.07	2%	0.04	1%	-0.03	-1%
Sep	2.12	2.12	2.13	0.00	0%	0.01	1%	0.01	0%

Above Pueblo Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	3.05	3.11	3.06	0.06	2%	0.00	0%	-0.06	-2%
May	3.77	3.85	3.84	0.08	2%	0.07	2%	-0.01	0%
Jun	5.15	5.11	5.07	-0.05	-1%	-0.09	-2%	-0.04	-1%
Jul	4.03	3.99	3.98	-0.05	-1%	-0.05	-1%	0.00	0%
Aug	3.15	3.13	3.11	-0.03	-1%	-0.05	-1%	-0.02	-1%
Sep	2.32	2.26	2.24	-0.06	-3%	-0.08	-3%	-0.02	-1%
Mean Wet									
Apr	3.08	3.12	3.06	0.04	1%	-0.02	-1%	-0.06	-2%
May	3.87	3.96	3.96	0.09	2%	0.08	2%	0.00	0%
Jun	6.10	6.06	6.03	-0.04	-1%	-0.06	-1%	-0.02	0%
Jul	4.97	4.92	4.90	-0.05	-1%	-0.07	-1%	-0.02	0%
Aug	3.54	3.50	3.49	-0.04	-1%	-0.05	-1%	-0.01	0%
Sep	2.67	2.51	2.55	-0.16	-6%	-0.12	-4%	0.04	1%
Mean Dry									
Apr	2.68	2.81	2.74	0.13	5%	0.06	2%	-0.07	-2%
May	2.90	2.99	2.99	0.10	3%	0.09	3%	-0.01	0%
Jun	4.00	3.89	3.83	-0.11	-3%	-0.17	-4%	-0.06	-2%
Jul	3.67	3.62	3.59	-0.06	-2%	-0.09	-2%	-0.03	-1%
Aug	3.01	3.02	2.97	0.01	0%	-0.04	-1%	-0.05	-2%
Sep	2.12	2.09	2.03	-0.03	-2%	-0.09	-4%	-0.06	-3%

Table A- 20. Moffat Street Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	9.04	9.14	9.06	0.10	4%	0.02	1%	-0.08	-3%
May	9.59	9.66	9.58	0.07	2%	0.00	0%	-0.08	-3%
Jun	10.56	10.60	10.56	0.04	1%	0.00	0%	-0.04	-1%
Jul	9.79	9.80	9.80	0.01	0%	0.01	0%	0.00	0%
Aug	9.12	9.13	9.10	0.01	0%	-0.02	-1%	-0.03	-1%
Sep	8.36	8.38	8.36	0.02	1%	0.01	0%	-0.01	-1%
Mean Wet									
Apr	9.10	9.16	9.12	0.07	3%	0.02	1%	-0.05	-2%
May	9.71	9.74	9.69	0.03	1%	-0.02	-1%	-0.05	-2%
Jun	11.20	11.20	11.19	0.00	0%	-0.01	0%	-0.01	0%
Jul	10.47	10.45	10.48	-0.02	-1%	0.01	0%	0.03	1%
Aug	9.42	9.44	9.41	0.02	1%	-0.02	-1%	-0.04	-1%
Sep	8.67	8.71	8.67	0.03	2%	0.00	0%	-0.03	-2%
Mean Dry									
Apr	8.68	8.81	8.70	0.13	7%	0.02	1%	-0.11	-5%
May	8.88	9.01	8.90	0.12	6%	0.02	1%	-0.11	-5%
Jun	9.79	9.88	9.78	0.09	3%	0.00	0%	-0.09	-3%
Jul	9.56	9.61	9.57	0.05	2%	0.01	0%	-0.03	-1%
Aug	9.00	9.06	9.04	0.06	3%	0.04	2%	-0.03	-1%
Sep	8.17	8.17	8.18	0.00	0%	0.01	1%	0.01	1%

Moffat Street Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	9.04	9.12	9.06	0.08	3%	0.02	1%	-0.06	-2%
May	9.59	9.65	9.64	0.06	2%	0.05	2%	-0.01	0%
Jun	10.56	10.53	10.50	-0.03	-1%	-0.06	-2%	-0.03	-1%
Jul	9.79	9.75	9.75	-0.04	-1%	-0.04	-1%	0.00	0%
Aug	9.12	9.09	9.07	-0.03	-1%	-0.05	-2%	-0.02	-1%
Sep	8.36	8.29	8.28	-0.06	-4%	-0.08	-5%	-0.02	-1%
Mean Wet									
Apr	9.10	9.14	9.08	0.04	2%	-0.02	-1%	-0.06	-2%
May	9.71	9.76	9.76	0.05	2%	0.05	2%	0.00	0%
Jun	11.20	11.18	11.16	-0.02	0%	-0.03	-1%	-0.02	0%
Jul	10.47	10.42	10.41	-0.05	-1%	-0.06	-2%	-0.01	0%
Aug	9.42	9.38	9.37	-0.04	-2%	-0.05	-2%	-0.01	0%
Sep	8.67	8.52	8.56	-0.15	-8%	-0.11	-6%	0.04	2%
Mean Dry									
Apr	8.68	8.84	8.77	0.16	8%	0.09	5%	-0.07	-3%
May	8.88	8.98	8.98	0.10	4%	0.09	4%	0.00	0%
Jun	9.79	9.72	9.66	-0.07	-2%	-0.13	-4%	-0.06	-2%
Jul	9.56	9.53	9.50	-0.03	-1%	-0.06	-2%	-0.03	-1%
Aug	9.00	9.02	8.97	0.02	1%	-0.03	-1%	-0.05	-2%
Sep	8.17	8.14	8.08	-0.03	-2%	-0.09	-6%	-0.06	-4%

Table A- 21. Avondale Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	2.10	2.13	2.12	0.02	1%	0.01	1%	-0.01	-1%
May	2.73	2.76	2.72	0.03	1%	-0.01	0%	-0.03	-1%
Jun	3.45	3.47	3.45	0.02	1%	0.00	0%	-0.02	-1%
Jul	2.67	2.67	2.68	0.00	0%	0.01	0%	0.01	0%
Aug	2.17	2.17	2.17	-0.01	0%	-0.01	0%	0.00	0%
Sep	1.47	1.46	1.47	-0.01	-1%	0.00	0%	0.01	1%
Mean Wet									
Apr	2.03	2.04	2.04	0.02	1%	0.02	1%	0.00	0%
May	2.80	2.81	2.79	0.01	0%	-0.01	0%	-0.02	-1%
Jun	4.08	4.09	4.08	0.01	0%	0.00	0%	-0.01	0%
Jul	3.37	3.36	3.38	-0.01	0%	0.01	0%	0.02	1%
Aug	2.61	2.61	2.60	-0.01	0%	-0.01	0%	0.00	0%
Sep	1.84	1.85	1.84	0.01	0%	0.00	0%	-0.01	0%
Mean Dry									
Apr	1.77	1.79	1.78	0.02	1%	0.02	1%	0.00	0%
May	1.84	1.91	1.84	0.07	5%	0.00	0%	-0.07	-4%
Jun	2.59	2.65	2.59	0.05	2%	0.00	0%	-0.06	-2%
Jul	2.34	2.34	2.35	0.00	0%	0.01	0%	0.00	0%
Aug	1.87	1.89	1.89	0.03	2%	0.02	1%	-0.01	0%
Sep	1.19	1.18	1.20	-0.01	-1%	0.01	1%	0.02	2%

Avondale Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	2.10	2.13	2.13	0.03	2%	0.03	1%	0.00	0%
May	2.73	2.81	2.80	0.08	3%	0.08	3%	-0.01	0%
Jun	3.45	3.44	3.42	-0.01	0%	-0.03	-1%	-0.02	0%
Jul	2.67	2.69	2.70	0.02	1%	0.03	1%	0.01	0%
Aug	2.17	2.20	2.20	0.03	1%	0.03	1%	0.00	0%
Sep	1.47	1.48	1.49	0.01	1%	0.02	2%	0.01	1%
Mean Wet									
Apr	2.03	2.05	2.04	0.03	1%	0.02	1%	-0.01	0%
May	2.80	2.89	2.89	0.09	4%	0.09	4%	0.00	0%
Jun	4.08	4.07	4.06	-0.02	0%	-0.03	-1%	-0.01	0%
Jul	3.37	3.36	3.37	-0.01	0%	0.00	0%	0.01	0%
Aug	2.61	2.61	2.60	0.00	0%	-0.01	0%	-0.01	0%
Sep	1.84	1.77	1.79	-0.07	-4%	-0.05	-3%	0.02	2%
Mean Dry									
Apr	1.77	1.82	1.82	0.05	3%	0.05	3%	0.00	0%
May	1.84	1.97	1.98	0.13	8%	0.14	8%	0.00	0%
Jun	2.59	2.56	2.53	-0.03	-1%	-0.07	-3%	-0.03	-1%
Jul	2.34	2.36	2.37	0.03	1%	0.03	1%	0.00	0%
Aug	1.87	1.95	1.94	0.08	5%	0.07	4%	-0.01	-1%
Sep	1.19	1.25	1.25	0.06	6%	0.05	6%	-0.01	-1%

Table A- 22. La Junta Gage Stream Stage--Direct Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	6.09	6.10	6.09	0.01	1%	0.00	0%	-0.01	-1%
May	6.84	6.86	6.84	0.02	1%	0.00	0%	-0.02	-1%
Jun	7.46	7.44	7.46	-0.02	-1%	0.00	0%	0.02	1%
Jul	6.85	6.86	6.85	0.01	0%	0.00	0%	-0.01	0%
Aug	6.57	6.58	6.56	0.01	1%	0.00	0%	-0.01	-1%
Sep	6.10	6.11	6.10	0.00	0%	0.00	0%	0.00	-1%
Mean Wet									
Apr	5.89	5.89	5.89	0.00	0%	0.00	0%	0.00	0%
May	6.63	6.64	6.63	0.01	1%	0.00	0%	-0.01	-1%
Jun	8.24	8.18	8.23	-0.06	-2%	-0.01	0%	0.05	2%
Jul	7.33	7.33	7.33	-0.01	0%	-0.01	0%	0.00	0%
Aug	6.83	6.83	6.83	0.00	0%	0.00	0%	0.00	0%
Sep	6.30	6.30	6.30	0.00	0%	0.00	0%	0.00	0%
Mean Dry									
Apr	5.88	5.90	5.88	0.02	3%	0.00	0%	-0.02	-3%
May	6.13	6.15	6.13	0.02	2%	0.00	0%	-0.02	-2%
Jun	6.39	6.39	6.40	0.00	0%	0.01	1%	0.02	1%
Jul	6.46	6.49	6.46	0.03	2%	0.00	0%	-0.03	-2%
Aug	6.30	6.32	6.29	0.02	2%	0.00	0%	-0.02	-2%
Sep	5.96	5.96	5.96	0.00	0%	-0.01	-1%	-0.01	-1%

La Junta Gage Stream Stage--Cumulative Effects.

Month	Simulated Stage			Changes in Stage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	6.09	6.10	6.10	0.01	1%	0.00	0%	-0.01	-1%
May	6.84	6.85	6.83	0.01	0%	-0.01	0%	-0.01	-1%
Jun	7.46	7.42	7.42	-0.04	-2%	-0.04	-2%	0.00	0%
Jul	6.85	6.87	6.85	0.02	1%	0.00	0%	-0.01	-1%
Aug	6.57	6.58	6.57	0.01	1%	0.00	0%	-0.01	-1%
Sep	6.10	6.11	6.11	0.01	1%	0.00	0%	-0.01	-1%
Mean Wet									
Apr	5.89	5.91	5.91	0.02	3%	0.02	3%	0.00	0%
May	6.63	6.65	6.64	0.01	1%	0.01	1%	0.00	0%
Jun	8.24	8.13	8.14	-0.11	-4%	-0.09	-3%	0.02	1%
Jul	7.33	7.34	7.34	0.01	0%	0.01	0%	0.00	0%
Aug	6.83	6.84	6.84	0.01	1%	0.01	1%	0.00	0%
Sep	6.30	6.31	6.31	0.01	1%	0.01	1%	0.00	0%
Mean Dry									
Apr	5.88	5.89	5.88	0.01	1%	0.00	0%	-0.01	-2%
May	6.13	6.13	6.12	0.01	1%	-0.01	-1%	-0.02	-2%
Jun	6.39	6.39	6.39	0.00	0%	0.00	0%	0.00	0%
Jul	6.46	6.49	6.46	0.03	3%	0.00	0%	-0.03	-3%
Aug	6.30	6.32	6.29	0.02	2%	0.00	0%	-0.02	-2%
Sep	5.96	5.97	5.95	0.00	1%	-0.01	-1%	-0.01	-2%

Table A- 23. Lake Meredith Elevation--Direct Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,248.26	4,249.61	4,248.40	1.35	22%	0.15	2%	-1.20	-16%
May	4,246.93	4,248.16	4,247.10	1.22	26%	0.17	3%	-1.06	-18%
Jun	4,245.24	4,247.22	4,245.46	1.99	65%	0.22	7%	-1.77	-35%
Jul	4,246.16	4,247.86	4,246.24	1.70	42%	0.08	2%	-1.62	-28%
Aug	4,246.17	4,247.72	4,246.29	1.55	38%	0.11	3%	-1.43	-26%
Sep	4,246.06	4,247.41	4,246.21	1.35	34%	0.14	4%	-1.20	-23%
Mean Wet									
Apr	4,248.84	4,250.27	4,248.83	1.43	21%	-0.01	0%	-1.44	-18%
May	4,247.40	4,248.72	4,247.47	1.32	25%	0.08	1%	-1.24	-19%
Jun	4,246.03	4,248.03	4,245.99	2.00	51%	-0.04	-1%	-2.04	-35%
Jul	4,247.75	4,249.40	4,247.78	1.65	30%	0.04	1%	-1.61	-22%
Aug	4,248.35	4,249.65	4,248.54	1.30	21%	0.19	3%	-1.11	-15%
Sep	4,248.82	4,249.73	4,249.07	0.92	14%	0.25	4%	-0.67	-9%
Mean Dry									
Apr	4,248.12	4,249.32	4,248.29	1.20	20%	0.17	3%	-1.03	-14%
May	4,246.13	4,247.40	4,246.48	1.27	32%	0.35	9%	-0.91	-17%
Jun	4,243.98	4,246.25	4,244.48	2.28	125%	0.50	27%	-1.78	-43%
Jul	4,244.14	4,246.05	4,244.46	1.91	96%	0.32	16%	-1.59	-41%
Aug	4,243.78	4,245.69	4,244.07	1.92	118%	0.29	18%	-1.62	-46%
Sep	4,243.56	4,245.36	4,243.83	1.81	129%	0.28	20%	-1.53	-48%

Lake Meredith Elevation--Cumulative Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,248.26	4,250.36	4,249.00	2.10	35%	0.74	12%	-1.37	-17%
May	4,246.93	4,250.00	4,248.62	3.06	64%	1.69	35%	-1.38	-18%
Jun	4,245.24	4,249.78	4,248.08	4.54	148%	2.85	92%	-1.70	-22%
Jul	4,246.16	4,250.13	4,248.39	3.97	99%	2.23	56%	-1.74	-22%
Aug	4,246.17	4,250.10	4,248.54	3.92	98%	2.37	59%	-1.56	-20%
Sep	4,246.06	4,249.96	4,248.60	3.89	100%	2.54	65%	-1.35	-17%
Mean Wet									
Apr	4,248.84	4,250.81	4,249.26	1.98	30%	0.42	6%	-1.56	-18%
May	4,247.40	4,250.55	4,248.93	3.15	60%	1.53	29%	-1.62	-19%
Jun	4,246.03	4,251.05	4,249.26	5.01	129%	3.23	83%	-1.79	-20%
Jul	4,247.75	4,251.83	4,250.09	4.08	73%	2.35	42%	-1.74	-18%
Aug	4,248.35	4,251.66	4,249.93	3.31	54%	1.58	26%	-1.73	-18%
Sep	4,248.82	4,251.34	4,249.72	2.52	38%	0.91	14%	-1.62	-18%
Mean Dry									
Apr	4,248.12	4,250.41	4,249.06	2.29	38%	0.94	16%	-1.35	-16%
May	4,246.13	4,249.62	4,248.44	3.49	88%	2.31	58%	-1.18	-16%
Jun	4,243.98	4,248.05	4,246.58	4.07	224%	2.60	143%	-1.47	-25%
Jul	4,244.14	4,247.90	4,246.24	3.76	190%	2.11	106%	-1.66	-29%
Aug	4,243.78	4,248.21	4,246.81	4.44	274%	3.03	187%	-1.41	-23%
Sep	4,243.56	4,248.31	4,247.27	4.76	340%	3.72	265%	-1.04	-17%

Table A- 24. Lake Henry Elevation--Direct Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,373.31	4,373.32	4,373.32	0.00	0%	0.01	0%	0.00	0%
May	4,372.75	4,373.02	4,372.72	0.26	4%	-0.03	0%	-0.29	-4%
Jun	4,371.92	4,372.76	4,371.95	0.83	14%	0.03	0%	-0.81	-12%
Jul	4,371.68	4,372.30	4,371.76	0.62	11%	0.08	1%	-0.54	-9%
Aug	4,370.87	4,371.64	4,371.01	0.77	16%	0.14	3%	-0.63	-11%
Sep	4,369.86	4,370.83	4,370.08	0.97	26%	0.21	6%	-0.75	-16%
Mean Wet									
Apr	4,373.36	4,373.36	4,373.36	0.00	0%	0.00	0%	0.00	0%
May	4,373.14	4,373.37	4,373.21	0.23	3%	0.07	1%	-0.16	-2%
Jun	4,373.05	4,373.61	4,372.93	0.56	8%	-0.12	-2%	-0.68	-9%
Jul	4,373.44	4,373.57	4,373.49	0.13	2%	0.05	1%	-0.08	-1%
Aug	4,373.13	4,373.13	4,373.13	0.00	0%	0.00	0%	0.00	0%
Sep	4,372.19	4,372.52	4,372.22	0.33	5%	0.03	0%	-0.30	-5%
Mean Dry									
Apr	4,372.47	4,372.47	4,372.47	0.00	0%	0.00	0%	0.00	0%
May	4,371.39	4,371.70	4,371.39	0.31	6%	0.00	0%	-0.31	-6%
Jun	4,369.98	4,371.09	4,369.97	1.11	29%	-0.01	0%	-1.12	-22%
Jul	4,369.27	4,370.33	4,369.27	1.06	33%	0.00	0%	-1.06	-25%
Aug	4,368.42	4,369.43	4,368.42	1.01	43%	0.00	0%	-1.01	-30%
Sep	4,367.86	4,368.76	4,368.11	0.90	51%	0.25	14%	-0.65	-25%

Lake Henry Elevation--Cumulative Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)	No Action (ft)	Proposed Action (ft)	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	4,373.31	4,373.31	4,373.31	0.00	0%	0.00	0%	0.00	0%
May	4,372.75	4,373.03	4,373.03	0.28	4%	0.28	4%	0.00	0%
Jun	4,371.92	4,372.76	4,372.76	0.83	14%	0.83	14%	0.00	0%
Jul	4,371.68	4,372.30	4,372.30	0.61	11%	0.61	11%	0.00	0%
Aug	4,370.87	4,371.68	4,371.68	0.81	17%	0.81	17%	0.00	0%
Sep	4,369.86	4,370.96	4,370.96	1.10	29%	1.10	29%	0.00	0%
Mean Wet									
Apr	4,373.36	4,373.36	4,373.36	0.00	0%	0.00	0%	0.00	0%
May	4,373.14	4,373.37	4,373.37	0.23	3%	0.23	3%	0.00	0%
Jun	4,373.05	4,373.61	4,373.61	0.56	8%	0.56	8%	0.00	0%
Jul	4,373.44	4,373.55	4,373.55	0.11	1%	0.11	1%	0.00	0%
Aug	4,373.13	4,373.13	4,373.13	0.00	0%	0.00	0%	0.00	0%
Sep	4,372.19	4,372.52	4,372.52	0.33	5%	0.33	5%	0.00	0%
Mean Dry									
Apr	4,372.47	4,372.47	4,372.47	0.00	0%	0.00	0%	0.00	0%
May	4,371.39	4,371.70	4,371.70	0.31	6%	0.31	6%	0.00	0%
Jun	4,369.98	4,371.09	4,371.09	1.11	29%	1.11	29%	0.00	0%
Jul	4,369.27	4,370.33	4,370.33	1.06	33%	1.06	33%	0.00	0%
Aug	4,368.42	4,369.56	4,369.56	1.14	49%	1.14	49%	0.00	0%
Sep	4,367.86	4,369.14	4,369.14	1.28	73%	1.28	73%	0.00	0%

Table A- 25. Holbrook Reservoir Elevation--Direct Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)*	No Action (ft)*	Proposed Action (ft)*	No Action - Existing Conditions		Proposed Action - Existing Conditions		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	13.75	13.75	14.51	0.00	0%	0.75	6%	0.75	6%
May	12.88	12.88	13.34	0.00	0%	0.46	4%	0.46	4%
Jun	12.41	12.41	12.96	0.00	0%	0.55	5%	0.55	5%
Jul	9.78	9.78	11.03	0.00	0%	1.24	16%	1.24	16%
Aug	7.42	7.42	9.05	0.00	0%	1.62	30%	1.62	30%
Sep	6.36	6.36	8.33	0.00	0%	1.98	46%	1.98	46%
Mean Wet									
Apr	10.48	10.48	10.75	0.00	0%	0.27	3%	0.27	3%
May	10.33	10.33	10.33	0.00	0%	0.00	0%	0.00	0%
Jun	10.82	10.82	10.82	0.00	0%	0.00	0%	0.00	0%
Jul	10.67	10.67	10.75	0.00	0%	0.08	1%	0.08	1%
Aug	9.26	9.26	9.48	0.00	0%	0.22	3%	0.22	3%
Sep	8.91	8.91	9.10	0.00	0%	0.19	3%	0.19	3%
Mean Dry									
Apr	18.11	18.11	19.73	0.00	0%	1.61	10%	1.61	10%
May	16.01	16.01	16.99	0.00	0%	0.99	7%	0.99	7%
Jun	14.27	14.27	15.33	0.00	0%	1.06	9%	1.06	9%
Jul	9.33	9.33	11.56	0.00	0%	2.23	30%	2.23	30%
Aug	5.88	5.88	9.36	0.00	0%	3.48	90%	3.48	90%
Sep	4.32	4.32	8.68	0.00	0%	4.36	191%	4.36	191%

Holbrook Reservoir Elevation--Cumulative Effects.

Month	Simulated Storage			Changes in Storage					
	Existing Conditions (ft)*	No Action (ft)*	Proposed Action (ft)*	No Action - Existing Condition		Proposed Action - Existing Condition		Proposed Action - No Action	
				(ft)	(%)	(ft)	(%)	(ft)	(%)
Overall Mean									
Apr	13.75	13.75	14.43	0.00	0%	0.67	6%	0.67	6%
May	12.88	12.88	13.11	0.00	0%	0.23	2%	0.23	2%
Jun	12.41	12.41	12.79	0.00	0%	0.38	4%	0.38	4%
Jul	9.78	9.78	10.89	0.00	0%	1.11	14%	1.11	14%
Aug	7.42	7.42	8.46	0.00	0%	1.04	19%	1.04	19%
Sep	6.36	6.36	8.03	0.00	0%	1.67	39%	1.67	39%
Mean Wet									
Apr	10.48	10.48	10.76	0.00	0%	0.27	3%	0.27	3%
May	10.33	10.33	10.33	0.00	0%	0.00	0%	0.00	0%
Jun	10.82	10.82	10.82	0.00	0%	0.00	0%	0.00	0%
Jul	10.67	10.67	10.75	0.00	0%	0.08	1%	0.08	1%
Aug	9.26	9.26	9.49	0.00	0%	0.23	3%	0.23	3%
Sep	8.91	8.91	9.08	0.00	0%	0.17	2%	0.17	2%
Mean Dry									
Apr	18.11	18.11	19.30	0.00	0%	1.19	7%	1.19	7%
May	16.01	16.01	16.28	0.00	0%	0.27	2%	0.27	2%
Jun	14.27	14.27	14.64	0.00	0%	0.37	3%	0.37	3%
Jul	9.33	9.33	11.26	0.00	0%	1.93	26%	1.93	26%
Aug	5.88	5.88	8.64	0.00	0%	2.76	71%	2.76	71%
Sep	4.32	4.32	8.35	0.00	0%	4.02	176%	4.02	176%

* Relative elevation, not mean sea level elevation.

Appendix B

Fryingpan-Arkansas Project Spill Priorities

When storage space is unavailable to accommodate both Fry-Ark Project and non-Fry-Ark Project accounts, non-Fry-Ark Project water is “spilled” from the reservoirs. The current spill priorities shown in Table B-1 have been established by Reclamation (Reclamation 1990).

Spill priorities are established to maximize the usable storage space in Pueblo Reservoir. Because Pueblo Reservoir was built as part of the Fryingpan-Arkansas Project, water associated with Fryingpan-Arkansas water rights has the first priority for storage in Pueblo Reservoir. However, Reclamation allows storage of non Fryingpan-Arkansas Project water as described in the previous paragraphs (e.g., WWSP and Excess Capacity Contract water) when Fryingpan-Arkansas water does not maximize Pueblo Reservoir storage. Reclamation reserves the right to spill this non Fryingpan-Arkansas water when the storage is necessary for Fryingpan-Arkansas Project water. As shown in Table B-1, there is a pre-defined order that determines the order of non Fryingpan-Arkansas Project water accounts that will be spilled when the storage space is necessary for Fryingpan-Arkansas Project water. As shown in Table B-1, water stored under Aurora’s current Temporary Excess Capacity contracts and proposed Long-Term Excess Capacity account is part of the first group that would be spilled in order to make room for Fryingpan-Arkansas Project water.

Table B- 2. Fryingpan-Arkansas Project Reservoir Spill Priorities.

Spill Order †	Storage Account
1	Entities outside of District (including Aurora)
2	If-and-when storage
3	WWSP water in excess of 70,000 ac-ft
4	Municipal non-Fry-Ark Project water
5	WWSP water less than 70,000 ac-ft
6	Native Arkansas River Basin Fry-Ark Project water

† First to spill is the first account in the list.