RECLAMATION

Managing Water in the West

Windy Gap Firming Project

Draft Environmental Impact Statement

DES 08-30

U.S. Department of the Interior
Bureau of Reclamation
Great Plains Region
Eastern Colorado Area Office
Loveland, Colorado

Cooperating Agencies:

- U.S. Army Corps of Engineers
- U.S. Department of Energy, Western Area Power Administration DOE/EIS-0370
- Grand County

August 2008

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Eastern Area Office
Loveland, Colorado

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Great Plains Region

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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

Windy Gap Firming Project
Draft Environmental Impact Statement

Lead Agency:
- U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region, Eastern Colorado Area Office, Loveland, Colorado

Cooperating Agencies:
- U.S. Army Corps of Engineers
- U.S. Department of Energy, Western Area Power Administration
- Grand County, Colorado

Abstract: This Draft Environmental Impact Statement (DEIS) describes and analyzes the potential effects of the proposed Windy Gap Firming Project (WGFP) and four alternatives to the proposed project including the No Action alternative. The WGFP would construct a new water storage reservoir that would provide more reliable water deliveries to Front Range and West Slope communities and industry from the existing Windy Gap Project. Current Windy Gap facilities are unable to deliver the firm yield of water that was originally anticipated due to the limitations and constraints of the existing system. The desired condition is to add water storage and related facilities to existing Windy Gap operations capable of delivering a firm annual yield of about 30,000 AF to project participants.

The proposed project is a collaborative effort among 14 water providers and users (participants) facilitated by the Municipal Subdistrict, Northern Colorado Water Conservancy District. The improved yield from the proposed project would provide project participants with additional water supplies to meet a portion of their existing and future water demands.

The DEIS evaluates five alternatives: 1) No Action; 2) Proposed Action – Chimney Hollow Reservoir (90,000 AF); 3) Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF); 4) Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF); 5) Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF).

If you wish to make comments on the DEIS, you may send comments to Reclamation at the addresses below. Comments may also be submitted by email to wtully@gp.usbr.gov or by fax to 970-663-3212 to the attention of Will Tully. Comments on the Draft EIS must be received by Reclamation no later than **October 28, 2008**. Reclamation will conduct public hearings on the DEIS.

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Filing Number: DES 08-30
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EXECUTIVE SUMMARY

DRAFT ENVIRONMENTAL IMPACT STATEMENT

WINDY GAP FIRMING PROJECT

INTRODUCTION

The Windy Gap Firming Project (WGFP) is a proposed water supply project that would provide more reliable water deliveries to Front Range and West Slope communities and industries. The Municipal Subdistrict, Northern Colorado Water Conservancy District acting by and through the Windy Gap Firming Project Water Activity Enterprise (Subdistrict), on behalf of WGFP Participants, is seeking approval from the U.S. Bureau of Reclamation (Reclamation) for additional physical connections to Colorado-Big Thompson (C-BT) Project facilities in order to implement the proposed project. Reclamation's decision on the WGFP is a major federal action requiring preparation of an Environmental Impact Statement (EIS). This Executive Summary summarizes the alternatives analyzed in detail and their anticipated environmental effects. The reader is referred to the entire Draft EIS for a more complete description and analysis.

Existing Windy Gap Reservoir, Grand County, Colorado

Due to limitations and constraints with the existing system, the current Windy Gap facilities, which were completed in 1985, are unable to deliver the anticipated firm yield of water. Water deliveries from the West Slope currently are limited by storage capacity in Granby Reservoir and by the delivery capacity of the Adams Tunnel, which delivers water from Grand Lake to the East Slope. The WGFP would add water storage and related facilities to the existing Windy Gap operations capable of delivering a firm annual yield of about 30,000 AF to Project Participants. The intent of the WGFP is to improve the yield from an existing project and existing Windy Gap water rights.

Project Participants in the WGFP include municipalities, rural domestic water districts, and an industrial water user. Project Participants on the East Slope are the City and County of Broomfield, Central Weld County Water District, Town of Erie, City of Evans, City of Fort Lupton, City of Greeley, City of Lafayette, Little Thompson Water District, City of Longmont, City of Louisville, City of Loveland, Platte River Power Authority, and the Town of Superior. In addition, the project seeks to firm the water supply for the Middle Park Water Conservancy District (MPWCD), which is a wholesale water supplier that allocates Windy Gap water to about 67 water providers, including towns, water districts, agricultural water suppliers, consumers, and ski areas in Grand and Summit counties on the West Slope. WGFP Participants determined that a cooperative project was the most efficient means to firm Windy Gap water deliveries rather than each entity developing storage for its own share of Windy Gap water.

COOPERATING AGENCIES

In addition to Reclamation (the lead agency), the U.S. Army Corps of Engineers (Corps), Western Area Power Administration (Western), and Grand County are cooperating agencies. The Corps has regulatory authority under the Clean Water Act for actions that require the placement of dredge or fill material in a water of the United States. Western is participating as a cooperating agency because it has jurisdiction over the transmission line that would be relocated if Chimney Hollow Reservoir is constructed. Western would need to acquire a new easement for the relocated line as well as construct, operate, and maintain the line. Western also has responsibilities for marketing additional power that may be generated as a result of the WGFP. Grand County has an interest in the project because Colorado River diversions and several alternative reservoir sites are located in the county.

PROJECT NEED

Windy Gap Project water is currently diverted from the Colorado River just downstream of the confluence of the Colorado and Fraser rivers into the Windy Gap Reservoir (Figure ES-1). From the reservoir the water is pumped to Granby Reservoir for storage and conveyance through C-BT Project facilities and ultimate delivery to Windy Gap Project allottees on the East Slope. MPWCD's Windy Gap water is stored in Granby Reservoir and released to replace stream diversions or ground water use by contract holders at various locations in Grand and Summit counties.

The original Windy Gap Project was estimated to deliver about 48,000 acre-feet (AF) of firm annual deliveries to Windy Gap allottees and the MPWCD; however, Project Participants have not been able to rely on Windy Gap water for water deliveries for two primary reasons:

Purpose and Need

The purpose of the Windy Gap Firming Project is to deliver a firm annual yield of about 30,000 AF of water from the existing Windy Gap Project to meet a portion of the water deliveries anticipated from the original Windy Gap Project and to provide up to 3,000 AF of storage to firm water deliveries for the Middle Park Water Conservancy District. Firm water deliveries from the Windy Gap Project are needed to meet a portion of the existing and future demands of the Project Participants.

- In dry years, the Windy Gap Project has not been able to divert water because more senior water rights upstream and downstream have a higher priority to divert water and "call out" the more junior Windy Gap Project water right. In addition, the Windy Gap Project is required to bypass water to maintain certain minimum streamflows downstream of the Windy Gap diversion dam.
- Granby Reservoir, a component of the C-BT Project, is currently the only storage available for Windy Gap water prior to delivery to Participants. Water conveyed and stored for the C-BT Project has

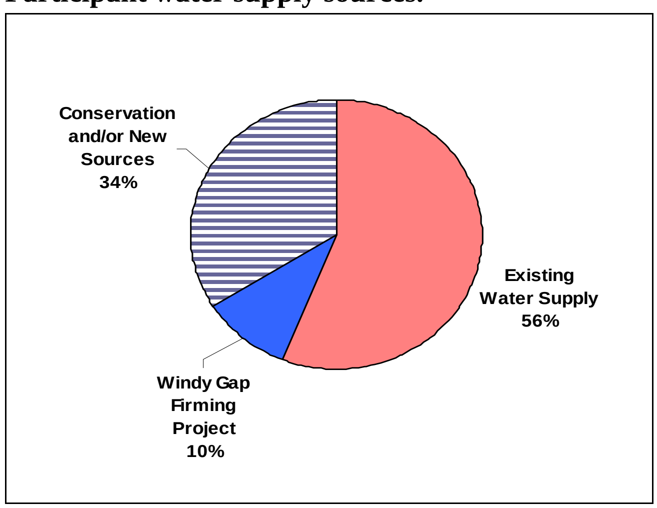
Figure ES-1. Windy Gap Reservoir facilities.

priority over water conveyed and stored for the Windy Gap Project. Thus in wet years, when the C-BT system is full, there is no conveyance or storage capacity for Windy Gap Project water. This prevents the Windy Gap Project from storing water in some wet years for use in subsequent dry years.

Because the Windy Gap Project is unable to provide reliable yields in both wet and dry years, the current firm yield is zero. Firm yield is typically defined as the amount of water that can be delivered on a reliable basis in all years and is typically determined by yield in dry years. For the Windy Gap Project, lack of available storage space in wet years also affects yield.

Participants in the proposed project have a need to firm Windy Gap water deliveries to meet existing and future water demands. In 2005, WGFP Participants had a firm water supply of about 141,000 AF and a demand of about 120,000 AF. Water demand for East Slope Participants is projected to increase to about 251,000 AF by 2050 and shortages in firm yield at that time would increase to more than 110,000 AF (Table ES-1). Water demand is projected to increase 17,000 AF by 2030 for Grand and Summit county water users partially served by the MPWCD. While water conservation is an important strategy used by the Participants to improve the efficiency of water use, extend supplies, and reduce overall demand, conservation measures will not be sufficient to meet projected water demands. The WGFP would collectively supply about 10 percent of the projected 2050 East Slope Participant water supply needs (Figure ES-2) and would contribute to meeting the future demands of Grand and Summit counties. The source for about 34 percent of future water supplies is still unknown. It is anticipated that some portion of this future supply will be realized by increased water conservation, but additional water supplies will still be needed.

Figure ES-2. Summary of projected 2050 Participant water supply sources.



PUBLIC AND AGENCY PARTICIPATION

Reclamation provided an early and open process to determine the scope of significant issues to be addressed in the Draft Environmental Impact Statement (DEIS). Prior to initiation of the EIS process and publication of the Notice of Intent in September 2003, the Subdistrict, with Reclamation participation, held two public

Table ES-1. WGFP Participant water supply, demand, and estimated shortage.

Participant	Firm Supply from All Sources (2005)	Projected 2050 Water Demand	Estimated 2050 Water Shortage	Estimated Firm Yield under the Proposed Action**
Broomfield	13,739	24,400	10,661	5,600
Central Weld County Water District	2,786	5,900	3,114	93
Erie	2,145	8,900	6,755	1,840
Evans	9,298	13,300	4,002	455
Fort Lupton	3,538	6,800	3,262	265
Greeley	43,850	78,500	34,650	2,230
Lafayette	4,534	8,600	4,066	610
Longmont	30,963	42,300	11,337	4,515
Louisville	5,063	6,900	1,837	825
Loveland	17,792	28,300	10,508	2,075
Little Thompson Water District	5,510	19,100	13,590	1,200
MPWCD	NA	*	NA	429
Platte River Power Authority	0	5,150	5,150	5,050
Superior	1,544	3,300	1,756	1,380
TOTAL	140,762	251,450	110,688	26,567

*Grand and Summit counties project an increase in water demand of 17,000 AF by 2030, with a total build-out demand of about 32,000 AF.
**Values rounded.

information meetings in July 2003 to describe the proposed project. Following publication of the Notice of Intent and during and after three public scoping meetings in September and October 2003, Reclamation received input from the public, interested organizations, and agencies. An agency scoping meeting also was held in September 2003 to gather input from federal, state, and local government agencies. Periodic communication and meetings were held with various agencies and entities over the course of preparation of the DEIS.

ALTERNATIVES

Following extensive screening of more than 170 different alternatives using National Environmental Policy Act (NEPA) criteria and Clean Water Act Section 404(b)(1) guidelines, in cooperation with the Corps, five alternatives were included for evaluation in the DEIS. The No Action alternative and four action alternatives are described below.

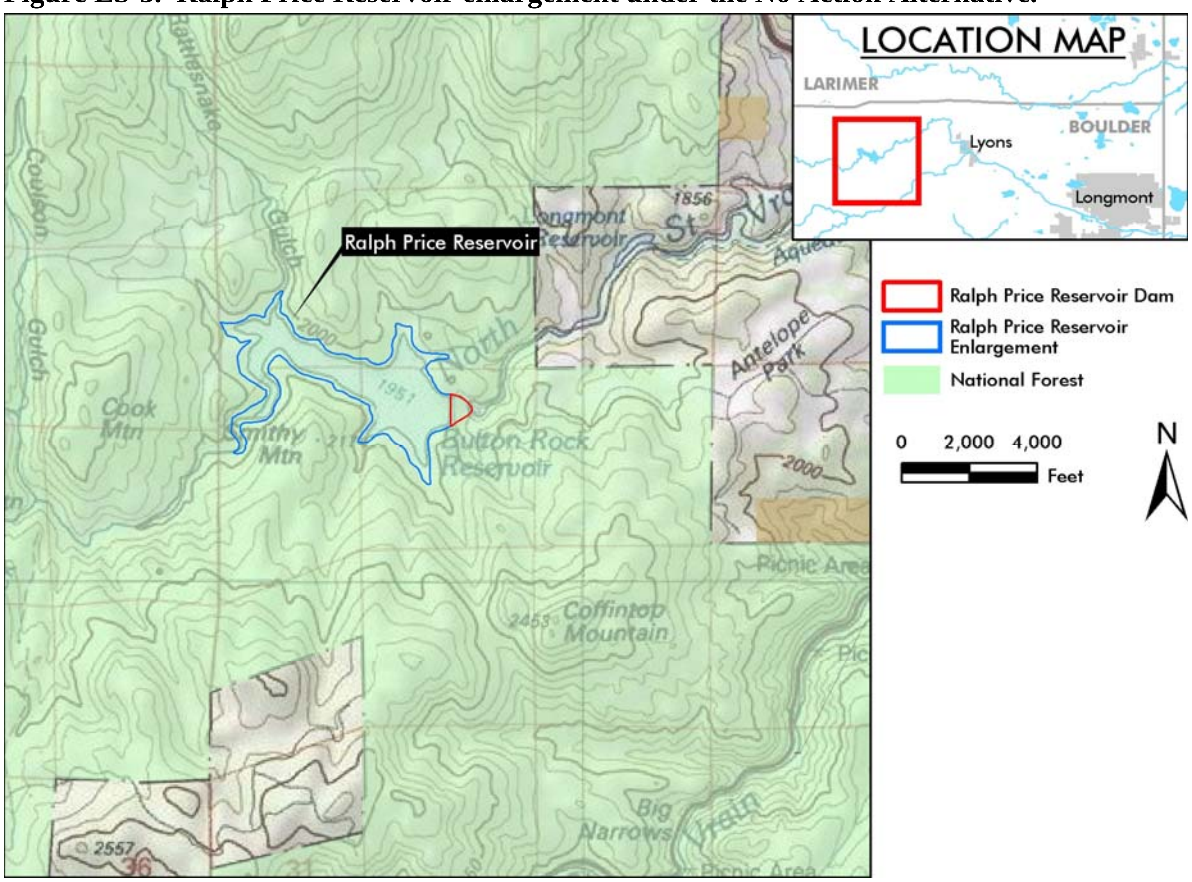
- **Alternative 1 (No Action):** Continuation of operations under existing agreements between Reclamation and the Subdistrict for conveyance of Windy Gap water through C-BT facilities and the enlargement of Ralph Price Reservoir by the City of Longmont.

- **Alternative 2 (Proposed Action):** Chimney Hollow Reservoir (90,000 AF) with prepositioning.
- **Alternative 3:** Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF).
- **Alternative 4:** Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF).
- **Alternative 5:** Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF).

Alternative 1 (No Action)

The No Action alternative defines what Participants would do if Reclamation does not approve a new connection of WGFP facilities to C-BT facilities as required for the action alternatives. Under this alternative, Participants would maximize delivery of Windy Gap water according to their demand, water rights, availability of storage in Granby Reservoir, and existing Adams Tunnel conveyance constraints. The City of Longmont would enlarge Ralph Price Reservoir by raising the dam and increasing storage capacity by 13,000 AF (Figure ES-3). Participants that do not have a currently defined storage option would take delivery of Windy Gap water whenever it is available within the capacity of their existing water systems and delivery points under the terms of the existing contract between Reclamation and the Subdistrict. Windy Gap diversions will increase in the future regardless of whether one of the action alternatives is implemented because of increased demand.

Figure ES-3. Ralph Price Reservoir enlargement under the No Action Alternative.



Alternative 2 (Proposed Action)

The Proposed Action includes construction of a 90,000 AF Chimney Hollow Reservoir, along with the ability to store, or preposition, C-BT water in the new reservoir (Figure ES-4). Water would be conveyed to Chimney Hollow Reservoir via a new pipeline connection to existing East Slope C-BT facilities. New connections between Chimney Hollow Reservoir and Carter Lake would allow delivery of water to Participants using existing infrastructure. No new West Slope infrastructure would be needed to divert or convey water to the East Slope.

Chimney Hollow Reservoir Site

Prepositioning would involve the use of available Adams Tunnel capacity to deliver C-BT water into Chimney Hollow Reservoir to occupy storage space that is not occupied by Windy Gap water. The delivery of C-BT water from Granby Reservoir into Chimney Hollow Reservoir would create space for Windy Gap water in Granby Reservoir. When Windy Gap water is diverted into Granby Reservoir, the C-BT water in Chimney Hollow Reservoir would be exchanged for a like amount of Windy Gap water in Granby Reservoir. Total allowable C-BT storage would not change and the existing C-BT diversions would not be expanded. If operated in this manner, Chimney Hollow Reservoir would be full most of the time.

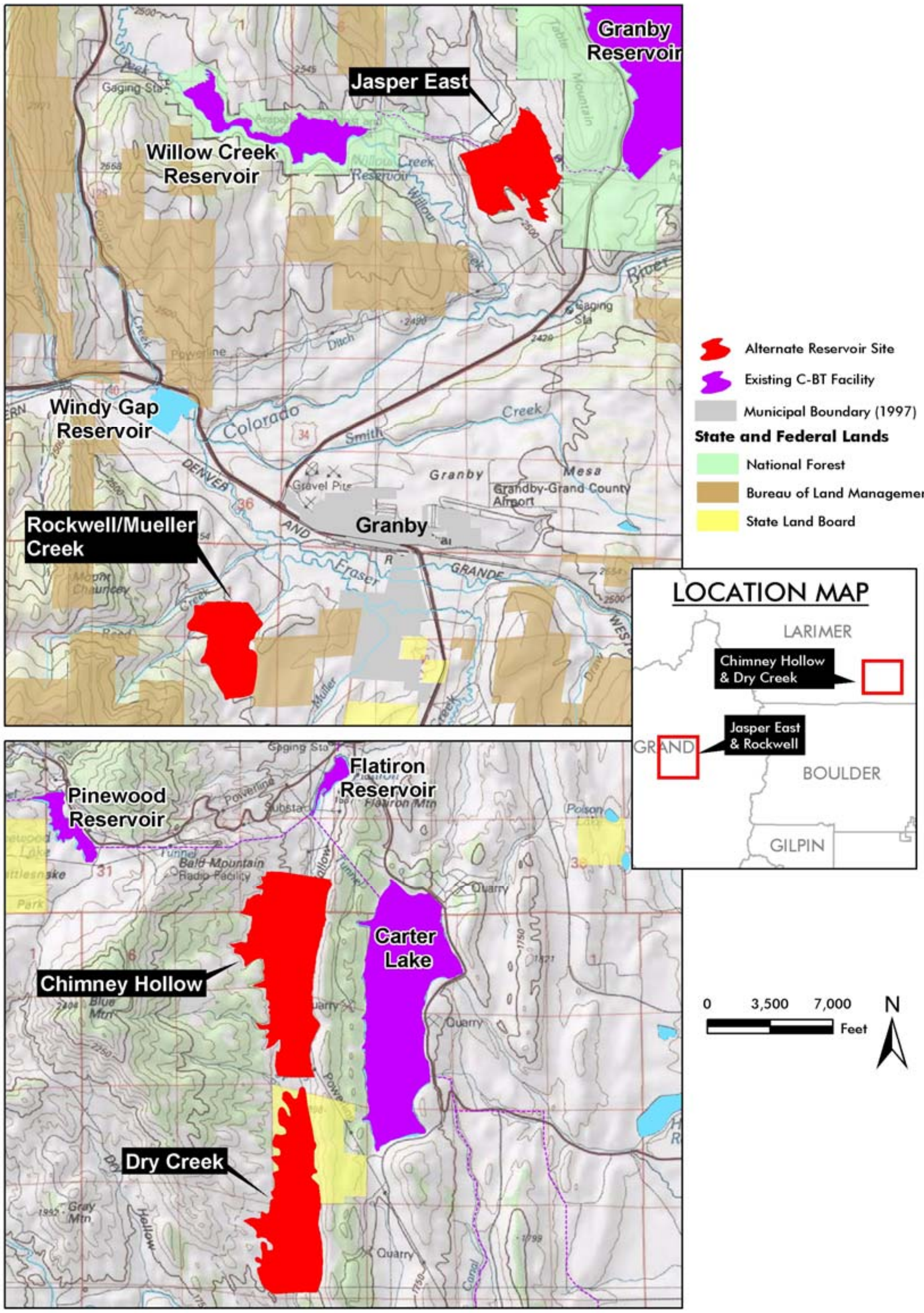
Alternative 3

Alternative 3 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Jasper East Reservoir on the West Slope (Figure ES-4). A new, 1-mile-long pipeline would connect Jasper East Reservoir to the existing Windy Gap pipeline that delivers water to Granby Reservoir. The Willow Creek Pump Station, forebay, and portions of the canal and pipeline would be relocated. The availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be delivered to either Jasper East Reservoir or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water would be diverted and stored in Jasper East Reservoir until there is sufficient capacity to transfer water to Chimney Hollow Reservoir.

Alternative 4

Alternative 4 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Rockwell/Mueller Creek Reservoir (Rockwell Reservoir) on the West Slope (Figure ES-4). Deliveries to and from Rockwell Reservoir would require a new connection to the existing Windy Gap pump station and a new 3.3-mile-long pipeline to Rockwell Reservoir. As with the Jasper East Reservoir site, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be delivered to either Rockwell Reservoir or Granby Reservoir. When Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water would be diverted and stored in Rockwell Reservoir until there is sufficient capacity to transfer water to Chimney Hollow Reservoir.

Figure ES-4. Alternative new reservoir sites.



Alternative 5

Alternative 5 is a combination of a 60,000 AF Dry Creek Reservoir on the East Slope and a 30,000 AF Rockwell Reservoir on the West Slope (Figure ES-4). Water deliveries to and from Rockwell Reservoir would require a new pipeline and connection to the existing Windy Gap pump station. A new 3.4-mile-long pipeline connection to C-BT facilities would convey Windy Gap water to Dry Creek Reservoir. A new 2.1-mile-long pipeline also would be needed to deliver water from Dry Creek Reservoir to Carter Lake. As with Alternatives 3 and 4, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be delivered to either Rockwell Reservoir or Granby Reservoir. When Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water would be diverted and stored in Rockwell Reservoir until there is sufficient capacity to transfer water to Chimney Hollow Reservoir.

ENVIRONMENTAL EFFECTS

The WGFP would result in environmental effects to a number of resources. The effects of all of the action alternatives related to increased water diversions would be similar because similar amounts of water would be diverted from the Colorado River. The No Action alternative would result in similar, but smaller, effects because Windy Gap diversions would increase in the future with a higher water demand even though the enlargement of Ralph Price Reservoir would only increase storage for Windy Gap water by 13,000 AF. This summary focuses on those resources with the greatest potential impacts. Effects on ground water, geology, soils, air quality, noise, cultural resources, and visual quality are expected to be minimal and are not discussed in this summary. Impacts to these resources are discussed in detail in the DEIS. The following sections summarize the effects to other resources. Proposed mitigation is discussed at the end of this summary.

Surface Water Hydrology

The WGFP would result in increased diversions and reduced flows in the Colorado River below Windy Gap Reservoir. In many years, the flows would be unchanged, but in wetter years, diversions would increase, with a corresponding decrease in Colorado River flows. Estimated average annual flow changes from hydrologic modeling are described below.

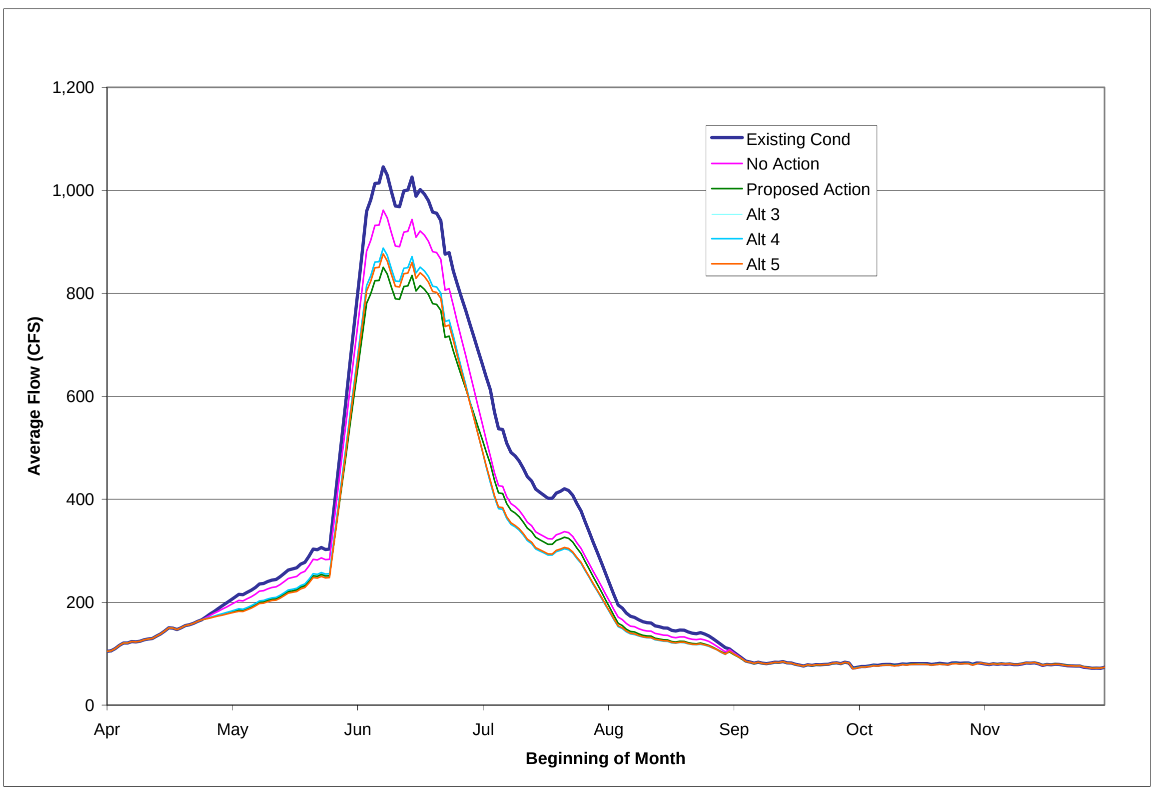
- Windy Gap diversions would increase about 7,000 AF per year on average from existing conditions under the No Action alternative compared to an increase of about 9,500 AF for the Proposed Action, and an increase of 12,000 AF for the other alternatives (Table ES-2).
- Colorado River average annual flow below Granby Reservoir would decrease about 7 percent (4,000 AF) under the No Action alternative, 15 percent (9,000 AF) under the Proposed Action, and 12 to 13 percent for the other alternatives as a result of the availability of additional Windy Gap storage and fewer reservoir spills (Table ES-2).
- Colorado River average annual flow below the Windy Gap diversion would decrease by 8 percent (12,000 AF) under the No Action alternative compared to a 14 percent (21,000 AF) decrease for the action alternatives (Table ES-2). The majority of the reductions in flow would occur between May and August (Figure ES-5) with average monthly flow reductions up to 20 percent for the No Action alternative, 23 percent for the Proposed Action, and 28 percent for Alternatives 3 to 5. The average monthly percent flow reduction would be greater in wet years. In dry years, there would be no change in flow from existing conditions.

Table ES-2. Average annual changes in Colorado River flow and diversions by alternative.

Alternative	Colorado River below Granby Reservoir		Windy Gap Diversions		Colorado River below Windy Gap		Colorado River below Kremmling	
	AF	%	AF	%	AF	%	AF	%
Existing Conditions	59,385	—	36,532	—	151,358	—	701,801	—
Alt 1 – No Action	55,345	-7	43,573	+19	138,914	-8	689,357	-2
Alt 2 – Proposed Action	50,220	-15	46,084	+26	130,075	-14	680,512	-3
Alt 3	52,071	-12	48,052	+32	130,370	-14	680,807	-3
Alt 4	52,091	-12	47,997	+31	130,453	-14	680,890	-3
Alt 5	51,903	-13	48,483	+33	129,681	-14	680,118	-3

- Below Kremmling and the confluence with the Blue River, Colorado River average annual streamflow reductions would be about 2 percent (12,000 AF) under the No Action Alternative and 3 percent (21,000 AF) for the action alternatives (Table ES-2).
- Average annual Willow Creek streamflow below Willow Creek Reservoir would decrease by 7 percent (1,400 AF) under the No Action alternative, 14 percent (2,600 AF) for the Proposed Action, and 12 percent (2,200 AF) for the other alternatives due to changes in Willow Creek Feeder Canal deliveries to Granby Reservoir.
- Big Thompson River flows below Lake Estes would increase about 1 percent (450 AF) on average under the No Action alternative compared to a 5 percent increase (3,200 AF) for the Proposed Action,

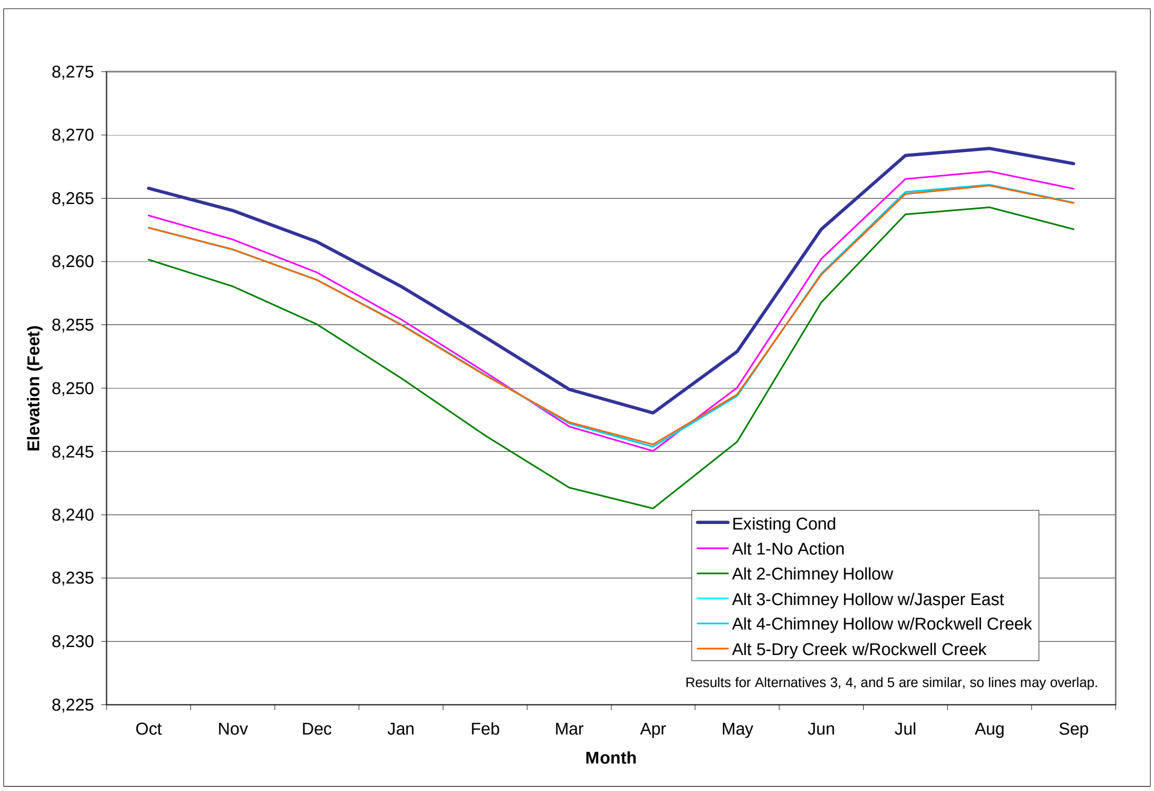
Figure ES-5. Average daily flow in the Colorado River below Windy Gap Reservoir by alternative.



and less than a 2 percent increase (1,000 AF) for the other alternatives as a result of the additional Windy Gap water imports and lower diversions for power generation in the C-BT system.

- Streamflow below Participant wastewater treatment plants (WWTPs) would increase from the discharge of Windy Gap return flows to the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek.
- Water levels in Grand Lake or Shadow Mountain Reservoir would not change under any of the alternatives.
- Granby Reservoir average monthly water levels would decrease from 2 to 3 feet under the No Action alternative, 5 to 8 feet under the Proposed Action, and 3 to 4 feet under the other alternatives (Figure ES-6). A series of dry years could lower water levels up to 23 feet under the Proposed Action.
- Water levels in Carter Lake would decrease less than 1 foot under all of the alternatives.
- Average monthly water levels in Horsetooth Reservoir would not change under the No Action alternative, would decrease 2 to 6 feet under the Proposed Action, and would decrease 0 to 2 feet under the other alternatives.
- Windy Gap firm yield would increase from zero under existing conditions to about 26,000 AF under the Proposed Action and alternatives (Table ES-3). Firm yield under the No Action alternative would be about 1,200 AF and would not meet the project purpose and need.

Figure ES-6. Granby Reservoir estimated average monthly surface elevation by alternative.



Stream Morphology and Floodplains

Stream morphology refers to the form and structure of a stream, including its channel, banks, floodplain and drainage area, which could be altered as a result of changes in flow. The upper Colorado River is a morphologically stable stream. The changes in flow expected from the WGFP are not expected to cause measurable changes to stream morphology or to sediment transport and deposition in the Colorado River below Windy Gap Reservoir.

Table ES-3. Windy Gap Firming Project firm yield.

Condition/Alternative	Firm Yield (AF)
Existing Conditions	0
Alt. 1 – No Action	1,229
Alt. 2 – Proposed Action	26,559
Alt. 3	25,849
Alt. 4	25,849
Alt. 5	26,629

- Under all alternatives, the 2-year peak discharge on the Colorado River at the Hot Sulphur Springs gage below the Windy Gap diversion would be exceeded about 3 percent of the time, or about 1 percent less frequently than under existing conditions. High volume channel maintenance flows would also experience a slight decrease in frequency. The projected reduction in the frequency of peak discharges and channel maintenance flows is unlikely to significantly affect stream morphology or change sediment transport or deposition.
- Flushing flows in the Colorado River equal to or greater than 450 cfs, which occur about 45 days per year on average under existing conditions, would decrease to 38 days per year under the No Action alternative, 36 days under the Proposed Action, and 35 days under the other alternatives. The reduction in the frequency of flushing flows would remain adequate to transport sediment and prevent deposition.
- Increased flows in East Slope streams below the Participants WWTPs would have minimal effect on stream morphology.
- The potential for flooding along the Colorado River and Willow Creek would decrease and the potential for flooding along East Slope streams below the Participants WWTPs would increase slightly.

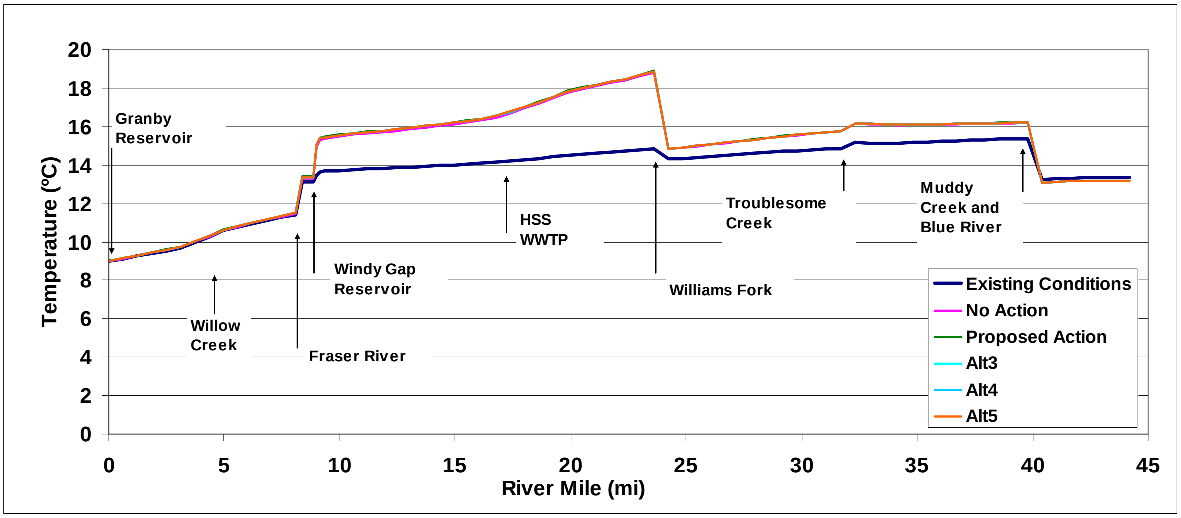
Surface Water Quality

Water quality impacts from WGFP include changes in the Colorado River below Granby Reservoir, in Willow Creek below Willow Creek Reservoir, and in several East Slope streams, including the Big Thompson River, St. Vrain Creek, North St. Vrain Creek, Coal Creek, Big Dry Creek, and the Cache la Poudre River. Potential effects to water quality were also evaluated in the Three Lakes system (Granby Reservoir, Shadow Mountain Reservoir, and Grand Lake), Carter Lake, and Horsetooth Reservoir, as well as the predicted water quality for new reservoirs. Stream and reservoir water quality models were used to estimate the following water quality effects.

- Under average flow conditions for a typical late July day below Windy Gap Reservoir, temperatures in the Colorado River are predicted to increase 0.5°C under the No Action alternative, 0.6°C for the Proposed Action, and 0.7°C to 0.8°C for the other alternatives. This would increase the potential for exceedance of the maximum weekly average temperature standard (18.2°C) for all alternatives.
- When Windy Gap diversions reduce Colorado River flow to the 90 cfs minimum flow in late July (which occurs infrequently), temperatures are predicted to increase about 4°C for all alternatives

(Figure ES-7). This would increase the potential for exceedance of the maximum weekly average temperature standard under all alternatives.

Figure ES-7. Colorado River predicted average daily stream temperatures for July 25 assuming diversion to the 90 cfs minimum instream flow below Windy Gap Reservoir.



- Ammonia and inorganic phosphorus concentrations in the Colorado River are predicted to increase and dissolved oxygen (DO) concentrations decrease under all alternatives. Water quality standards would not be exceeded under average flow conditions, but when Windy Gap diversions reduce flow to the 90 cfs minimum flow, the DO concentrations is predicted to be less than the spawning standard for a few miles upstream of the Williams Fork.
- Ammonia and some metal concentrations in Willow Creek would increase slightly for all alternatives, but water quality standards are not expected to be exceeded.
- Total phosphorus concentrations in Granby Reservoir are predicted to increase under all alternatives and total nitrogen concentrations would increase under the No Action and Proposed Action alternatives (Table ES-4). Alternatives 3 to 5 would have lower nitrogen levels due to the effects of storage in a West Slope Reservoir prior to delivery to Granby Reservoir. Chlorophyll *a* concentrations (algae) are predicted to increase under the Proposed Action, but there would be no

Table ES-4. Granby Reservoir predicted water quality changes by alternative compared to existing conditions.

Parameter	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+6.3%	+12.7%	+4.0%	+3.2%	+1.6%
Total nitrogen (µg/L)	+0.3%	+0.7%	-2.1%	-2.8%	-3.5%
Chlorophyll *a* (µg/L)	No Change	+2.4%	No Change	No Change	No Change
Peak chlorophyll *a* (µg/L)	No Change	-1.5%	No Change	No Change	No Change
Secchi-disk depth (m)	No Change	No Change	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	-2.2%	-4.4%	No Change	No Change	No Change
TSS (mg/L)	No Change	+4.3%	+4.3%	+4.3%	+4.3%

change in water clarity as measured by the Secchi-disk depth for any of the alternatives.

- All alternatives would increase phosphorus concentrations in Shadow Mountain Reservoir; total nitrogen would increase in Alternatives 1 to 3 and decrease in Alternatives 4 and 5 (Table ES-5). Chlorophyll *a* concentrations would increase in Alternatives 1 to 3. Water clarity would not change in any alternative. Dissolved oxygen would decrease under the Proposed Action and not change in other alternatives.

Table ES-5. Shadow Mountain Reservoir predicted water quality changes by alternative compared to existing conditions.

Parameter	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+5.6%	+11.3%	+8.1%	+4.8%	+3.2%
Total nitrogen (µg/L)	+1.1%	+1.8%	+0.4%	-0.7%	-1.1%
Chlorophyll *a* (µg/L)	+1.8%	+1.8%	+1.8%	No Change	No Change
Peak chlorophyll *a* (µg/L)	+3.4%	+6.8%	+1.1%	No Change	-1.1%
Secchi-disk depth (m)	No Change	No Change	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	No Change	-1.4%	No Change	No Change	No Change
TSS (mg/L)	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%

- In Grand Lake, total phosphorus concentrations are expected to increase under all alternatives (Table ES-6). Total nitrogen is expected to increase under the No Action and Proposed Action alternatives. Chlorophyll *a* concentrations would increase under all alternatives and Secchi-disk depth would decrease under all alternatives, except Alternative 5. Dissolved oxygen concentrations would decrease under all alternatives.

Table ES-6. Grand Lake predicted water quality changes by alternative compared to existing conditions.

Parameter	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+6.0%	+12.0%	+6.0%	+6.0%	+4.8%
Total nitrogen (µg/L)	+0.4%	+1.6%	-0.4%	-0.4%	-0.8%
Chlorophyll *a* (µg/L)	+4.2%	+6.1%	+4.2%	+2.0%	+2.0%
Peak chlorophyll *a* (µg/L)	+4.1%	+5.4%	+1.4%	+1.4%	No Change
Secchi-disk depth (m)	-3.8%	-3.8%	-3.8%	-3.8%	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	-11.1%	-7.4%	-5.6%	-5.6%	-5.6%
TSS (mg/L)	No Change	+5.6%	+5.6%	+5.6%	No Change

- No additional water quality standards would be exceeded at the Three Lakes, but temperature and DO concentrations would continue to exceed state standards in Granby Reservoir. Lower DO levels would contribute to continued exceedance of the manganese standard in the Three Lakes.

- Ammonia concentrations in St. Vrain Creek, Big Dry Creek, and Coal Creek would increase under all of the alternatives. The potential for exceedance of the water quality standard is possible for some locations.
- In Carter Lake and Horsetooth Reservoir, total phosphorus, total nitrogen, and chlorophyll *a* concentrations would increase, and DO concentrations would decrease. Lower DO concentrations in Horsetooth Reservoir would contribute to continued exceedance of the manganese standard.

Aquatic Resources

The assessment of effects to fish habitat along the Colorado River was modeled following the concepts of the Instream Flow Incremental Methodology (IFIM). This approach combines stream hydraulics, habitat use criteria, and hydrology to predict fish habitat as a function of streamflow. Fish community and fish populations were assessed based on changes in physical habitat, as well as projected water quality changes within those systems in rivers and reservoirs. The changes were compared to the existing conditions to determine if there would be factors that affect fish populations at the acute or chronic level. Major effects are summarized below:

- The amount and frequency of available fish habitat in the Colorado River would decrease under all alternatives from reductions in streamflow. The greatest change would occur under the action alternatives, where up to a 24 percent decrease in adult rainbow trout habitat just upstream of the Williams Fork confluence would occur in 4 out of 10 years. Under the No Action alternative, the maximum decrease in habitat at this location would be 9 percent in 3 out of 10 years. Effects to juvenile rainbow trout and juvenile and adult brown trout would be less under all alternatives. The greatest reductions in fish habitat would occur during high runoff for a few months in the early spring and summer when Windy Gap diversions occur. A decrease in habitat at this time would have less impact than changes in flow during other times of the year when Windy Gap does not affect flows and less habitat is available.
- No adverse impacts to spring spawning rainbow trout or fall spawning brown trout are predicted for any of the alternatives.
- The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the summer, but measurable impacts to fish populations are not expected because flow reductions in July and August would be infrequent.
- The amount and frequency of available fish habitat in Willow Creek would decrease from reduced summer flows.
- Lower water levels and changes in water quality in Granby Reservoir, Carter Lake, and Horsetooth Reservoir are unlikely to impact fish.
- Increased East Slope streamflows would slightly enhance fish habitat in the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek.
- Flow changes in North St. Vrain Creek under the No Action alternative would affect fish habitat both positively and negatively depending on storage and release from Ralph Price Reservoir.

Vegetation and Wetlands

Permanent effects to vegetation and wetland resources would occur in areas that would be inundated by a reservoir or located within the footprint of dams, roads, relocated transmission line, or other facilities.

Temporary effects to vegetation and wetlands from construction of pipelines, staging areas, and other short-term disturbances would be revegetated following construction.

- The enlargement of Ralph Price Reservoir under the No Action alternative would result in a loss of about 77 acres of forest vegetation. Construction of Chimney Hollow Reservoir would permanently impact about 790 acres of shrublands, grasslands, and forest vegetation. The other alternatives would impact about 1,000 to 1,100 acres of mixed vegetation types.
- All of the alternatives would result in permanent and temporary impacts to wetlands and other waters (Table ES-7). Of the action alternatives, the Proposed Action would have the least impact to wetlands and waters.

Table ES-7. Summary of effects to wetlands and other waters by alternative.

Wetlands and Other Waters	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4*	Alternative 5*
	Acres				
Permanent	0.4	2.9	30.3	9.4 – 20.0	15.7 – 28.3
Temporary	—	0.2	5.2	3.9 – 6.9	4.3 – 7.3
TOTAL	0.4	3.1	35.5	13.3 – 26.9	20.0 – 35.6

*The range in wetland impacts is due to uncertainty about the wetlands present at the Rockwell/Mueller Creek Reservoir site. Access to this site was for field survey was denied by the landowners.

Wildlife

The potential effects on wildlife resources were assessed using information on known populations or suitable habitat. Permanent impacts to wildlife habitat could occur in areas that would be inundated or permanently disturbed by project features such as the dam, access roads, and pump stations. Temporary impacts to habitat from pipelines and staging areas would be reclaimed following construction. Effects to waterbirds and aquatic and riverine mammals from changes in hydrology were based on potential effects to riparian vegetation.

- Enlargement of Ralph Price Reservoir would result in the loss of 77 acres of elk and mule deer winter range and habitat for other terrestrial wildlife species.
- Construction of Chimney Hollow Reservoir under the Proposed Action would result in the loss of 810 acres of elk winter range, mule deer winter range and concentration area, and black bear foraging area. A slightly smaller Chimney Hollow Reservoir under Alternatives 3 and 4 would impact similar habitats on about 675 acres. Habitat for migratory birds, northern leopard frog, common garter snake, and other species would be impacted at Chimney Hollow Reservoir.
- Construction of Jasper East Reservoir would impact about 480 acres of moose and mule deer summer range and 24 acres of elk winter range. Elk movement in the area could shift as a result of the new reservoir.
- Construction of Rockwell Reservoir would affect about 312 acres of summer range for moose and mule deer and 73 acres of elk winter range. About 300 acres of greater sage grouse habitat would be lost.

- Construction of Dry Creek Reservoir would result in the loss of about 650 acres of elk and mule deer winter range.

Threatened and Endangered Species

Federally threatened and endangered species are protected under the Endangered Species Act. Potential direct and indirect effects to threatened or endangered species were evaluated for each alternative.

- All of the alternatives would result in depletions that affect Colorado River endangered fish downstream of the Windy Gap diversion. Future Windy Gap depletions in all alternatives are expected to be covered by the Recovery Plan for Upper Colorado River endangered fish. As a result, the WGFP would have no effect to the endangered fish species if the steps outlined in the Recovery Plan and Programmatic Biological Opinion are followed.
- Construction of Rockwell Reservoir would result in the loss of less than 10 acres of potential lynx habitat.

Land Use and Ownership

Potential effects to existing land ownership were evaluated by overlaying proposed project facilities for each alternative on land ownership maps. Potential conflicts with local land use regulations were also evaluated for each of the alternative reservoir sites. Predicted construction traffic volumes and visitor estimates were used to evaluate short and long-term effects to local traffic.

- Enlargement of Ralph Price Reservoir would occur entirely on City of Longmont property. Traffic would increase on U.S. 36 and County Road 80 during construction.
- Construction of Chimney Hollow Reservoir would require acquisition or easements on private and Reclamation land, and relocation of 3.8 miles of Western's transmission line. Traffic would increase on County Road 18E and County Road 31 during construction. Recreation traffic on County Road 18E would also increase when the reservoir is complete.
- Construction of Jasper East Reservoir would require acquisition of Reclamation managed land and relocation of the Willow Creek Pump station and a portion of the canal (facilities that are part of the C-BT Project). County Road 40 to Willow Creek would need to be relocated and a right-of-way through private land would have to be obtained.
- Construction of Rockwell Reservoir would require acquisition of private land, including four residences. Bureau of Land Management property would also be affected and realignment of County Road 57 would be required. Traffic would increase on these county roads and U.S. 40 during construction.
- Private, state, and Reclamation managed property would be affected by construction of Dry Creek Reservoir. Three private residences and a llama operation would be impacted. Traffic on County Road 31 would increase during construction.
- No elements associated with the construction of alternative reservoirs and facilities were identified that would directly conflict with local land use plans or other regulations. The review process in Larimer, Grand, and Boulder Counties would further evaluate the effects of the actions and any conditions for approval.

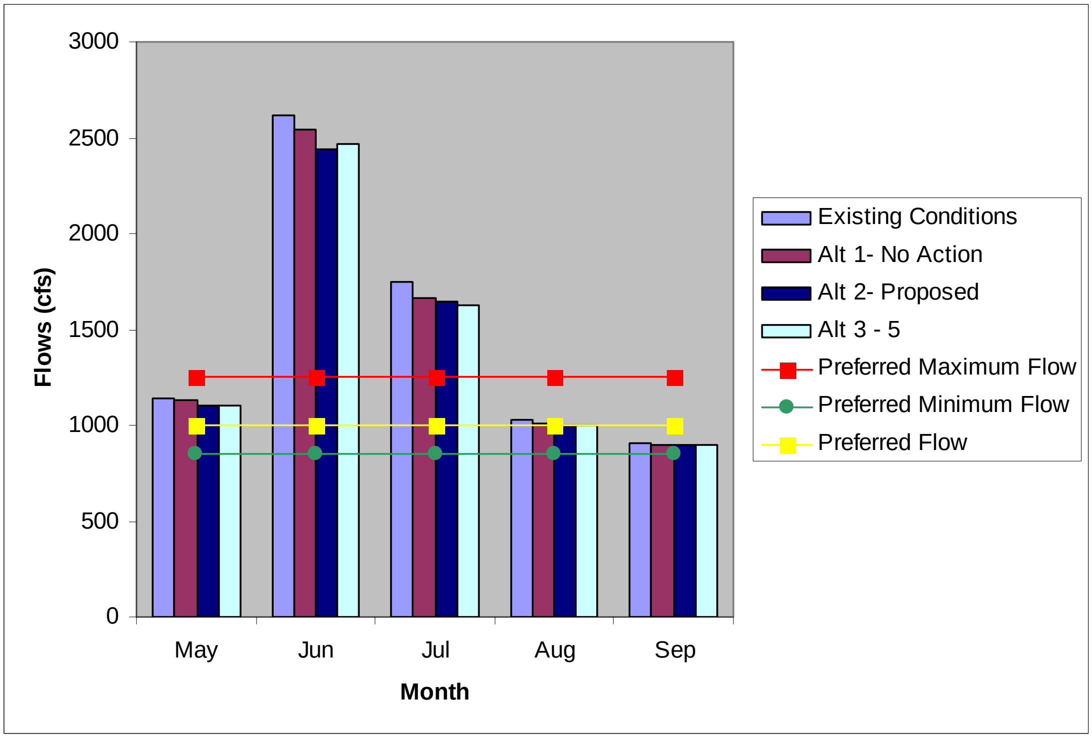
Recreation

Potential recreation effects were based primarily on changes in hydrologic conditions at reservoirs and streams in the study area. Changes in preferred flows for rafting and kayaking in the Colorado River were used to evaluate the effect on river recreation.

Potential effects to rafting and kayaking on the Colorado River were evaluated for Byers Canyon below Hot Sulphur Springs, and in the Big Gore Canyon and Pumphouse reaches of the Colorado River below Kremmling. Daily hydrologic data from 1950 to 1996 were used to estimate the change in the number of days when preferred rafting and kayaking flows would occur in these reaches of the river.

- There would be no change in the number of days that flows exceed the minimum kayaking flows in Byers Canyon in 29 years of the 47-year study period. In the remaining 18 years, there would be an estimated average decrease of 8 days per year with flows less than the preferred kayaking minimum of 400 cfs under the No Action alternative and an estimated average of 12 fewer days per year for the action alternatives.
- For Big Gore Canyon, there would be no change from existing conditions in the number of days that preferred rafting flows of 850 to 1,250 cfs occur for any of the alternatives in 37 years of the 47-year study period. Preferred rafting flows in Gore Canyon would occur about 24 days less under the No Action alternative compared to existing conditions over the 47-year study period. Under the Proposed Action, preferred rafting flows would occur about 23 days less than existing conditions over the 47 years. On average, this would be about 2.3 days per year with fewer preferred rafting flows during the 10 years when flows fall outside of the preferred range. The greatest decrease in the number of days with preferred flows for rafting in the driest year would be 11 days under all of the alternatives. Average monthly flows and preferred flows for rafting are shown in Figure ES-8.
- The number of days preferred kayaking flows between 1,100 and 2,200 cfs occur in Big Gore Canyon and the Pumphouse reach would not change in 32 years of the 47-year study period for any of the alternatives. Over the 47-year study period, there would be about 1 more day of preferred kayaking flows under the No Action alternative and Alternative 4 compared to existing conditions. On average during the 15 years, when preferred flows are not met, there would be about 1 less day per year in the preferred rafting flow range under Alternatives 2, 3, and 5. The greatest change in the number of days with preferred flows for kayaking in the driest year would be 15 days fewer under all of the alternatives, with an increase of up to 7 days with preferred kayaking flows under the No Action alternative and 6 more days under the Proposed Action.
- There would be no change from existing conditions in the number of days when preferred rafting and kayaking flows in the Pumphouse reach are between 2,000 to 3,000 cfs in 28 years of the 47-year study period under all alternatives. Over the 47-year period, there would be 6 more days of preferred flows under the No Action alternative and 20 fewer days under the Proposed Action. On average during the 19 years where flow changes occur, there would be about 1 less day per year in the preferred rafting flow range under all of the alternatives The greatest decrease in the preferred flow range in a single year would be 17 days fewer under all of the action alternatives except Alternative 5, which would have 5 fewer days. The greatest increase in the number of days of preferred flows in a year would be 11 days under the No Action alternative compared to an increase of 3 days under the Proposed Action and 4 to 8 days under the other alternatives.

Figure ES-8. Average monthly streamflows on the Colorado River through Big Gore Canyon for rafting.



- No measurable effect to angler user days on the Colorado River or associated economic effects were identified for any of the alternatives.
- Access to Granby Reservoir boat ramps at Arapaho Bay, Stillwater, and Sunset would diminish in some months, primarily under the Proposed Action due to lower water levels.
- Kayaking opportunities in North St. Vrain Creek would be reduced in July under the No Action alternative.
- Access to the South Bay-South boat ramp in Horsetooth Reservoir would be impacted under the Proposed Action in September and by all alternatives in dry years.
- Chimney Hollow Reservoir would provide nonmotorized boating, fishing, and hiking opportunities under Larimer County management, with 50,000 visitors estimated annually.
- No managing agency has been identified for other potential new reservoirs, but recreation development is possible if a managing entity is found.

Socioeconomics

Socioeconomic effects evaluated include the cost of alternatives, impact of construction and operation on employment and spending, and the effects of hydrologic changes to recreation resources, such as boating and fishing.

Table ES-8. Project, direct labor, and operation and maintenance costs by alternative.

Alternative	Total Project Costs	Direct Labor	Annual O&M Costs
	Millions of 2005 dollars		
Alternative 1 – No Action	$31	$8	No change
Alternative 2 – Proposed Action	$223[**]	$47	$0.79
Alternative 3	$240	$49	$1.37
Alternative 4	$252	$52	$1.73
Alternative 5	$288	$60	$2.24

[*]Cost for Chimney Hollow Reservoir in 2007 dollars has increased 17 percent to $261 million.

- Enlargement of Ralph Price Reservoir under the No Action alternative would cost about $31 million (Table ES-8). The cost of the action alternatives in 2005 dollars, ranges from $223 million for the Proposed Action to $288 million for Alternative 5.
- All of the alternatives would increase local and regional employment and construction-related spending.
- The alternatives would generate additional hydropower revenues ranging from $850,000 for the No Action alternative to $1.4 million for Alternative 5. Western would use this energy to fill existing contracts entered into following original construction of the Windy Gap Project.
- Hydrologic changes that reduce or increase the number of days that preferred flows for boating in the Colorado River occur, could impact recreation-associated spending. Assuming a decrease in the number of days of preferred flows results in a total loss in recreation user days, the annualized cost or benefit to recreational boating based on changes in flow preferences over the 47-year study period is shown in Table ES-9.

Table ES-9. Annualized cost (-) or benefit (+) from recreational boating on the Colorado River by alternative.

Alternative	Byers Canyon (kayaking)	Big Gore Canyon (rafting and kayaking)	Pumphouse	
			Kayaking	Rafting
Alternative 1 – No Action	-$416	-$1,458	+$349	+$2,097
Alternative 2 – Proposed Action	-$416	-$1,393	-$1,397	-$6,989
Alternative 3	-$416	-$1,393	-$1,397	-$7,339
Alternative 4	-$416	-$1,151	-$1,048	-$9,437
Alternative 5	-$416	-$1,635	-$349	-$1,747

- The economic effect for the worst-case individual year (based on the 47-year study period) when preferred flows would not be available, would result in a loss of about 429 visitor days for commercial rafting in Big Gore Canyon with a value of about $31,000. A decrease in the number of days with preferred kayaking flows in Big Gore Canyon and Pumphouse would result in the loss of about 3,375 visitor days with a value of about $246,000. A reduction in preferred flows for rafting in Pumphouse would result in a loss of 3,875 user days with a value of $279,000. This analysis is a "worst case" scenario, which assumes no boating when flows are outside of the preferred range.

- Some years would have an increase in boating days within the preferred ranges and would result in 675 to 2,475 additional visitor days with a value of $49,275 to $180,675.

CUMULATIVE EFFECTS

Several reasonably foreseeable actions are anticipated to occur regardless of the implementation of any of the action alternatives or the No Action alternative. Reasonably foreseeable future actions, when combined with past and present actions and the alternatives evaluated in this EIS, may result in cumulative effects. Reasonably foreseeable effects were classified as either water-based or land-based actions that might have effects overlapping those of the WGFP.

Water-based Reasonably Foreseeable Actions

- Denver Water Moffat Collection System Project
- Increased water use from population growth in Grand and Summit counties
- Reduction of Xcel Energy's Shoshone Power Plant call
- Changes in releases from Williams Fork and Wolford Mountain reservoirs to meet flow recommendations (10,825 AF of water) for endangered fish
- Increase in Wolford Mountain Reservoir contract demand
- Expiration of Denver Water's contract with Big Lake Ditch in 2013
- Climatic change and global warming (not quantitatively assessed)
- Mountain pine beetle killed trees (not quantitatively assessed)

Land-based Reasonably Foreseeable Actions

- Various residential developments near new reservoir sites
- Western's replacement of the transmission line from the Granby Pumping Plant to the Windy Gap substation
- Larimer County open space development near Chimney Hollow Reservoir

Cumulative Resource Effects

Future implementation of water-based reasonably foreseeable actions would result in changes in the amount and timing of Colorado River streamflows. In general, less water would be available for diversion by the WGFP. Firm yield for the Proposed Action would be about 2,500 AF less than under the direct effect model run (24,000 AF). The hydrologic changes associated with the WGFP would be slightly less than those described for direct effects because of the lower water diversions. Water quality in the Colorado River from lower overall flows and increased wastewater discharges upstream of Windy Gap Reservoir would result in higher ammonia concentrations and possibly lower inorganic phosphorus levels with assumed improvements in wastewater treatment. Water quality in the Three Lakes, Carter Lake, and Horsetooth Reservoir would be similar to that under direct effects. Less fish habitat would be available in the Colorado River from the cumulative decrease in streamflows. Preferred recreational boating flows in the Big Gore Canyon and Pumphouse reaches of the Colorado River would occur less frequently, primarily because of lower Blue River flows from increased Denver Water demands. The economic effects of reduced preferred flows for boating also would be greater than under direct effects. Other resource effects would be similar to those described for direct effects.

MITIGATION

The Subdistrict has identified potential mitigation measures to reduce the impacts associated with implementation of the proposed WGFP. Most of these mitigation measures are applicable to all alternatives, but several are specific to the Proposed Action as noted. The inclusion of these mitigation measures does not imply that all measures listed will be implemented. Several mitigation measures under consideration will require additional hydrologic and water quality modeling, as well as coordination with cooperating agencies and other entities to accurately evaluate their value and effectiveness. These additional evaluations will be conducted between release of the DEIS and preparation of the Final EIS. In addition, it is anticipated that other mitigation strategies may be identified from the comments received on the DEIS. The Final EIS will include the mitigation measures that will be implemented for the selected alternative.

- To reduce potential drawdowns in Granby Reservoir under the Proposed Action, it may be possible to modify prepositioning operations to deliver less C-BT or Windy Gap water to Chimney Hollow Reservoir during dry years. Additional hydrologic evaluations would be conducted to determine if changes in the timing of water deliveries to the East Slope can reduce impacts to Granby Reservoir while still meeting the purpose and need for the project.
- The Subdistrict will commit to continued participation and funding of the ongoing Nutrient Studies, with participation and collaboration by Reclamation, Northern Water and Grand County, to better understand water quality issues in the Three Lakes system and provide guidance for future management decisions
- The Subdistrict will work with Grand County, the Colorado Division of Wildlife (CDOW), and others to determine if increasing bypass flows in the Colorado River from the existing minimum flow of 90 cfs to 135 cfs while Windy Gap is pumping during July and August would result in temperature reductions downstream of Windy Gap that would measurably benefit the trout fishery. If studies indicate that increased bypass flows would be effective, the Subdistrict would consider increasing required bypass flows under certain water supply conditions.
- A variety of best management practices will be implemented during and following construction to reduce erosion, protect water quality, suppress dust and noise, revegetate disturbed areas, and protect or avoid important wildlife habitat.
- All permanent wetland impacts will be replaced by purchasing credit in a wetland bank and on-site wetland creation.
- The Subdistrict will participate in the Recovery Program for endangered Colorado River fish.
- Opportunities for improvements to aquatic life habitat in the Colorado River and mitigation of impacts to fish will be coordinated with the CDOW, Grand County and other responsible agencies.
- Per an agreement with Larimer County Parks and Open Lands, Chimney Hollow Reservoir will be managed as open space. A plan for habitat restoration and enhancement, including development of a sport fishery at Chimney Hollow Reservoir, would be developed with Larimer County and CDOW. Similar agreements would be sought for other reservoir sites.
- The Subdistrict will curtail Colorado River diversions during the annual Big Gore Race, typically held the third week in August, if flows at the Kremmling gage are below 2,200 cfs.

- Additional evaluation and mitigation for adverse effects to eligible cultural resources will be conducted in coordination with Reclamation and the State Historic Preservation Officer.
- Additional specific mitigation measures are discussed in the DEIS.

WHAT'S NEXT?

Public hearings will be held after release of the DEIS. The time, date, and location of future opportunities for comments will be mailed to those on the Reclamation's mailing list and will be posted on Reclamation's website. Public notice on the availability of the DEIS also will be posted in local newspapers and copies of the DEIS will be placed in local libraries. Reclamation welcomes all comments during the 60-day comment period. Written and oral comments may also be made at the public hearings. Comments on the DEIS can be sent by:

Mail: Will Tully, Bureau of Reclamation
11056 West County Rd. 18E
Loveland, CO 80537

Fax: Will Tully, 970-663-3212

E-mail: wtully@gp.usbr.gov (with *Windy Gap Draft EIS Comment* as the subject line)

Copies of the DEIS and related documents are available online from Reclamation's website at: http://www.usbr.gov/gp/nepa/quarterly.cfm#ecao

Paper copies of the DEIS may be obtained by calling Kara Lamb at 970-962-4326.

Acronyms and Abbreviations

ac	acute
AF	acre-feet
APCD	Air Pollution Control Division
APE	Area of potential effect
APFR	Alternative Plan Formulation Report
ARNA	Arapaho National Recreation Area
BATHTUB	Water quality model
BESTSM	Boyle Engineering Stream Simulation Model
BLM	Bureau of Land Management
BMP	Best management practices
BTWF	Big Thompson Watershed Forum
CAA	Clean Air Act
C-BT	Colorado-Big Thompson Project
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDSS	Colorado Decision Support System Model
CEQ	Council of Environmental Quality
cfs	cubic feet per sect
ch	chronic
Chla	chlorophyll *a*
cm	centimeter
CNHP	Colorado Natural Heritage Program
Corps	U.S. Army Corps of Engineers
CRWCD	Colorado River Water Conservation District
CWCB	Colorado Water Conservation Board
CWCWD	Central Weld County Water District
dis	dissolved
DL	Detection limit
DM	Daily maximum
DO	Dissolved oxygen
EIS	Environmental Impact Statement
elsp	early life stage present
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	feet
FWS	U.S. Fish and Wildlife Service
GCWIN	Grand County Water Information Network
GW	gigawatts
GWH	gigawatt-hourgpcd
gpcd	gallons per capita per day
HOD	hypolimnetic oxygen demand
HSS	Hot Sulphur Springs
L	liter
LTWD	Little Thompson Water District
m	meter
M&E	Monitoring and Evaluation
MBTA	Migratory Bird Treaty Act
mg	milligram
mg/L	milligrams per liter
MOD	metalimnetic oxygen demand
MOU	Memorandum of Understanding
MPWCD	Middle Park Water Conservancy District
MWAT	Maximum Weekly Average Temperature

MWAT	Maximum weekly average temperature
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NCWCD	Northern Colorado Water Conservancy District
NEPA	National Environmental Policy Act
Non-Participants	Windy Gap unit holders not participating in the Firming Project
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWCCOG	Northwest Colorado Council of Governments
NWI	National Wetland Inventory
O&M	Operation and maintenance
P	Phosphorus
PACSM	Platte and Colorado Simulations Model
Participants	Windy Gap Firming Project Participants
PBO	Programmatic Biological Opinion
Platte River	Platte River Power Authority
Reclamation	U.S. Bureau of Reclamation
RFO	Return flow obligation
ROW	Right-of-way
SD	Secchi-disk depth
SEO	State Engineers Office
SHPO	State Historic Preservation Officer
sp	spawning
SU	Standard Unit
Subdistrict	Municipal Subdistrict, Northern Colorado Water Conservation District
T&E	Threatened and Endangered
T&O	Taste and odor
TCP	Traditional Cultural Property
TDS	Total dissolved solids
Three Lakes	Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir
TKN	Total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TRec	Total recoverable
TSI	Trophic State Index
TSS	Total suspended solids
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCFC	Willow Creek Feeder Canal
WD	Whirling disease
Western	Western Area Power Administration
WGFP	Windy Gap Firming Project
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division
WWTP	Wastewater treatment plant
WY	Water Year (October 1 - September 30)
µg/L	micrograms per liter
µS	microSiemens

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APPENDICES

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Chapter 1. Purpose and Need

Existing Windy Gap Reservoir, Grand County, Colorado

The purpose of the Windy Gap Firming Project is to deliver a firm annual yield of about 30,000 AF of water from the existing Windy Gap Project to meet a portion of the water deliveries anticipated from the original Windy Gap Project and to provide up to 3,000 AF of storage to firm water deliveries for the Middle Park Water Conservancy District. Firm water deliveries from the Windy Gap Project are needed to meet a portion of the existing and future demands of the Project Participants.

1.1 Introduction

The proposed Windy Gap Firming Project (WGFP) would entail construction of a new water storage reservoir that would provide more reliable water deliveries to Front Range and West Slope communities and industry. Due to limitations and constraints with the existing system, the current Windy Gap facilities, which were completed in 1985, are unable to deliver the anticipated firm yield of water. Water deliveries from the West Slope are limited by storage capacity in Granby Reservoir and by the delivery capacity of the Adams Tunnel, which delivers water from Grand Lake to the East Slope. The desired condition is to add water storage and related facilities to the existing Windy Gap operations capable of delivering a firm annual yield of 30,000 AF to Project Participants. The intent of the WGFP is only to improve the yield from an existing project and existing Windy Gap water rights.

The Municipal Subdistrict, Northern Colorado Water Conservancy District (Subdistrict), acting by and through the Windy Gap Firming Project Water Activity Enterprise, the project proponent, is proposing to improve the firm yield from the existing Windy Gap Project water supply. The Subdistrict's Proposed Action is the construction of Chimney Hollow Reservoir to store Windy Gap Project water. To improve yield, the Subdistrict also is requesting integration of the Colorado-Big Thompson Project (C-BT) and Windy Gap Project operations so that C-BT water can be stored in Chimney Hollow Reservoir. The Proposed Action would require new connections to C-BT East Slope facilities and continued use of C-BT storage and conveyance systems and other existing pipelines, canals, and diversions to deliver Windy Gap water to Project Participants.

The original Windy Gap Project was completed by the Subdistrict in 1985. Since that time, the Windy Gap Project has not been able to reliably deliver water supplies to Windy Gap Project unit holders (allottees). In addition, the Windy Gap Project does not currently provide annual carry-over water storage for the Middle Park Water Conservancy District (MPWCD). Because of the deficiency in water deliveries and lack of storage, the Windy Gap Project allottees and MPWCD have not been able to fully rely on Windy Gap water for meeting a portion of their annual water demand. As a result, a group of the Windy Gap Project unit holders, working through the Subdistrict, have initiated the proposed WGFP to complete the Windy Gap Project by firming all or a portion of their individual Windy Gap units to meet a portion of existing and future municipal and industrial water requirements. The MPWCD is participating in the proposed WGFP to obtain storage to firm its Windy Gap water, and hence improve the reliability of its Windy Gap water supply for users in Grand and Summit counties, Colorado.

The Subdistrict is currently seeking approval from the Bureau of Reclamation (Reclamation) for additional physical connections to C-BT facilities in order to implement the proposed WGFP. The WGFP includes additional storage that could only be accomplished through one or more conveyance connections to the C-BT Project. Such connections would require approval from Reclamation. Because approval from Reclamation is a discretionary federal action and subject to compliance with the National Environmental Policy Act (NEPA), this Environmental Impact Statement (EIS) was prepared to evaluate the potential environmental consequences of the Proposed Action and other alternatives for firming the Windy Gap water supply. The U.S. Army Corps of Engineers (Corps), Western Area Power Administration (Western), and Grand County are cooperating agencies. The Corps has regulatory authority under the Clean Water Act for actions that require the placement of dredge or fill material in a water of the United States. Western is participating as a cooperating agency because it has jurisdiction over the transmission line that would be relocated in some alternatives. Western would need to acquire a new easement for the relocated line as well as construct, operate, and maintain the line. Western has responsibilities for marketing additional power that may be generated as a result of the WGFP. All cooperating agencies have contributed to preparation of the EIS.

Chapter 1 provides a description of the purpose and need for the project, background material on the Windy Gap Project, a summary of the results of scoping and public involvement including issues of concern, and a discussion of the decision process. Chapter 2 describes the four action alternatives that were developed for detailed analysis in the EIS and a no action alternative. A summary of the impacts for each alternative is included in Chapter 2. Baseline information on natural resources, cultural resources, and socioeconomic resources in the project area and an analysis of the potential direct, indirect, and cumulative effects for each of the alternatives is provided in Chapter 3. Chapters 4 and 5 provide information on consultation and coordination, list of preparers, and references.

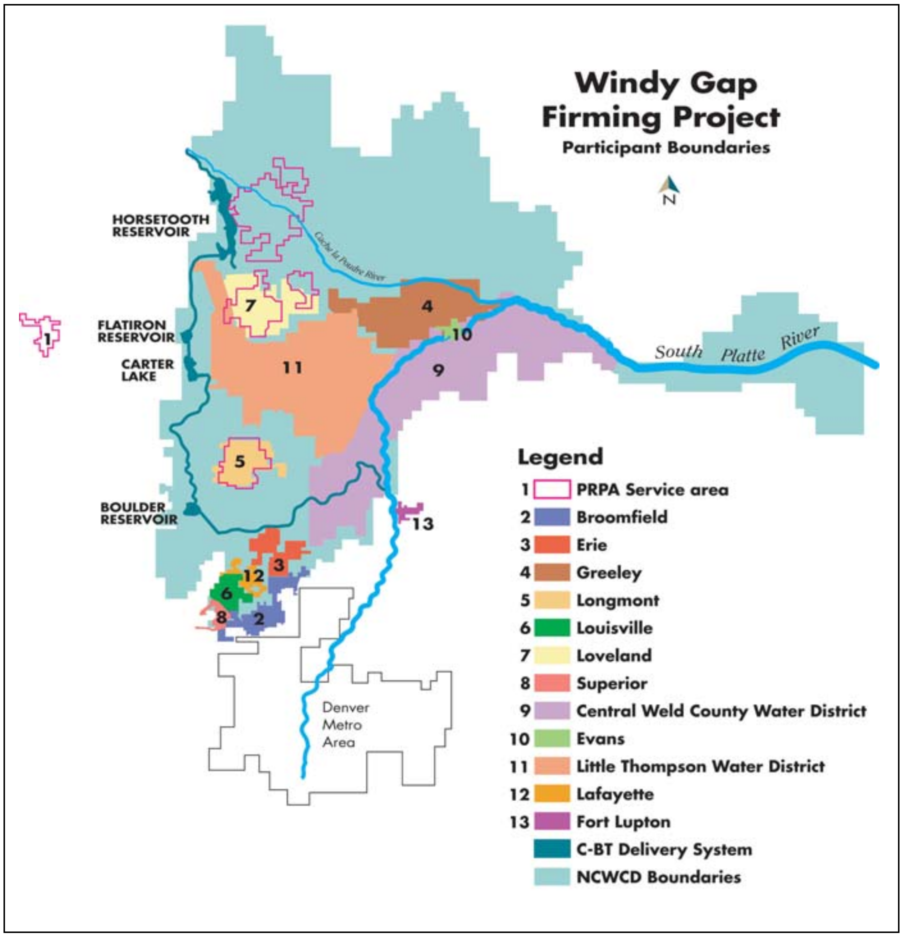
1.2 Windy Gap Firming Project Participants

The original Windy Gap Project was developed, and is owned and operated, by the Municipal Subdistrict, Northern Colorado Water Conservancy District, which is a water conservancy district organized under the Colorado Water Conservancy Act. The WGFP is being developed, and will be owned and operated, by the Municipal Subdistrict, Northern Colorado Water Conservancy District, acting by and through the Windy Gap Firming Project Water Activity Enterprise, which is a water activity enterprise of the Municipal Subdistrict organized under Colorado Revised Statutes (C.R.S.) §§ 37-45.1-101 et seq. For purposes of simplicity in this document, the Windy Gap Firming Project Water Activity Enterprise will be referred to as the "Subdistrict." On those rare occasions when the Municipal Subdistrict, Northern Colorado Water Conservancy District (the owner of the Enterprise) is referenced, its full name will be used. All of the Windy Gap Project unit holders participating in the proposed WGFP and the MPWCD are referred to collectively as the Project Participants.

Project Participants in the WGFP that own, lease, or that are in the process of acquiring units of Windy Gap Project water include municipalities, rural domestic water districts, and an industrial water user. Project Participants located on the East Slope of the Continental Divide are listed below and the service area for these entities is shown in Figure 1-1.

- City and County of Broomfield
- Central Weld County Water District (CWCWD)
- Town of Erie
- City of Evans
- City of Fort Lupton
- City of Greeley
- City of Lafayette
- Little Thompson Water District (LTWD)
- City of Longmont
- City of Louisville
- City of Loveland
- Platte River Power Authority (Platte River)
- Town of Superior

Figure 1-1. Participant boundaries for East Slope Project Participants.

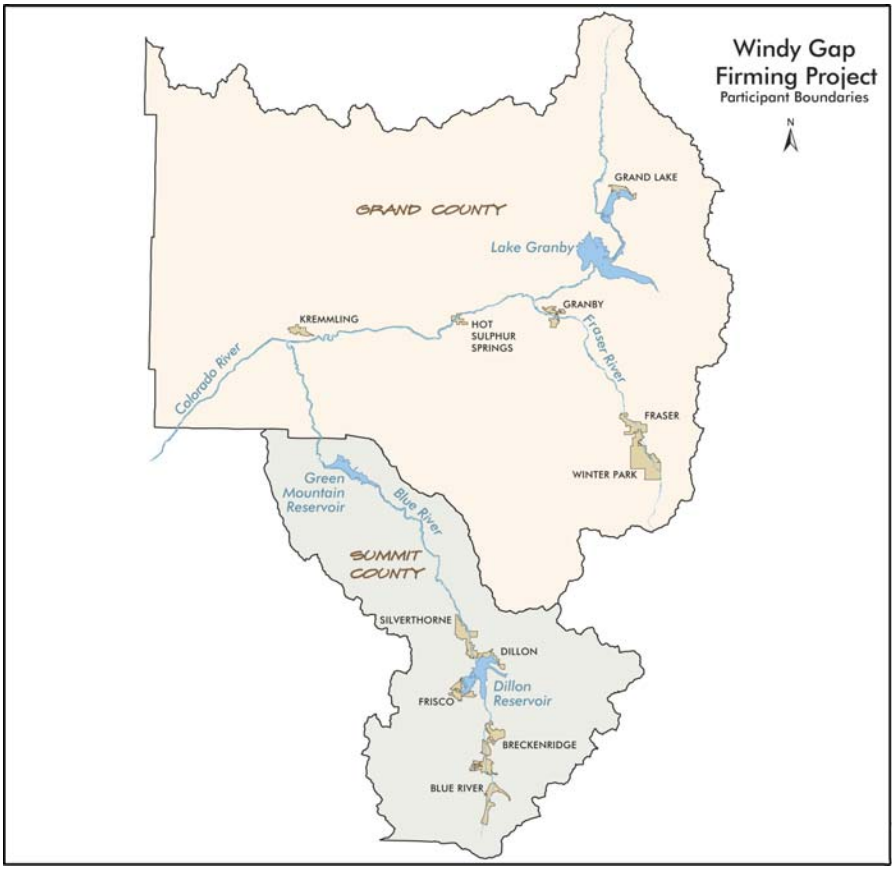


Not all owners of Windy Gap units are participating in the WGFP. The City of Boulder and the Town of Estes Park collectively own 40 Windy Gap units, but are not participating in the proposed WGFP because they have other sources of water supply and/or storage for Windy Gap Project water that currently meet their needs. Delivery of water to Windy Gap unit holders not participating in the WGFP will be similar to current operations, although the amount of deliveries may increase with time as demand grows. The amount of water delivered to these entities will not be expanded or diminished by the WGFP.

The MPWCD also receives Windy Gap water, according to the terms outlined in the 1985 Supplement to the 1980 Agreement Concerning the Windy Gap Project and Azure Reservoir and Power Project, which states, "the Municipal Subdistrict, Northern Colorado Water Conservancy District will dedicate and set aside annually, but non-cumulatively, at no cost to Middle Park, 3,000 acre-feet (AF) of water in Granby Reservoir that is produced each year from Subdistrict water supplies and any water so stored in Granby Reservoir shall be the last of any Subdistrict water to be spilled from Granby Reservoir." This water is for beneficial use without waste, either directly or by exchange or substitution, in the MPWCD. The direct beneficial uses do not include instream uses or industrial uses. According to the 1985 Agreement, MPWCD's Windy Gap water stored in Granby Reservoir cannot be carried over to the next year.

The MPWCD is a wholesale water supplier for 67 water providers and users in Grand and Summit counties on the West Slope of the Continental Divide (Figure 1-2) that have contracts with MPWCD for portions of its 3,000 AF allotment of Windy Gap Project water. The water providers, also known as contractees, include towns, water districts,

Figure 1-2. West Slope service area for the MPWCD.



agricultural water suppliers, consumers, and ski areas. The largest contractees, which account for about two-thirds of the water served by MPWCD, include

- Grand County Water and Sanitation District
- Snake River Water District
- Summit County
- Three Lakes Water and Sanitation District
- Town of Breckenridge
- Town of Fraser
- Town of Frisco
- Town of Granby
- Town of Kremmling
- Town of Silverthorne
- Winter Park Water and Sanitation District

Smaller contract holders include subdivisions, homeowner associations, and private individual homeowners.

1.3 Purpose and Need Statement

1.3.1 Municipal Subdistrict

The purpose of the Windy Gap Firming Project is to deliver a firm annual yield of about 30,000 AF of water from the existing Windy Gap Project to meet a portion of the water deliveries anticipated from the original Windy Gap Project and to provide up to 3,000 AF of storage to firm water deliveries for the MPWCD. Firm water deliveries from the Windy Gap Project are needed to meet a portion of the existing and future demands of the Project Participants.

1.3.2 Western Area Power Administration

Western would be required to relocate approximately 3.8 miles of their Estes to Lyons 115-kV Transmission Line under proposals that include Chimney Hollow Reservoir. The line would be moved to protect it from inundation by the reservoir. Western needs to ensure that the line is moved to a location that will allow Western to continue to adequately and efficiently operate and maintain it and to access it in emergencies.

1.4 Background

1.4.1 Colorado-Big Thompson Project

The Colorado-Big Thompson Project was developed by the Bureau of Reclamation on behalf of the Northern Colorado Water Conservancy District between 1938 and 1957. The project was designed to provide water for agricultural, municipal, and industrial beneficial uses. The C-BT Project provides supplemental water to 30 cities and towns and is used to help irrigate more than 600,000 acres of northeastern Colorado farmland. On average, about 220,000 AF of water is delivered to northeast Colorado.

Twelve reservoirs, 35 miles of tunnels, 95 miles of canals, and 700 miles of transmission lines comprise the complex C-BT collection, distribution, and power system. West of the Continental Divide, Willow Creek and Shadow Mountain reservoirs, Grand Lake and Granby Reservoir collect and store C-BT water from the upper Colorado River basin (Figure 1-3). Water is pumped from Granby Reservoir into Shadow Mountain Reservoir where it flows by gravity into Grand Lake. From there, the 13.1-mile Adams Tunnel transports the water under the Continental Divide to the East Slope.

Once the water reaches the East Slope, it is used to generate electricity as it falls almost ½ mile through five power plants on its way to Colorado's Front Range. Carter Lake, Horsetooth Reservoir, and Boulder Reservoir store the water. C-BT water is released as needed to supplement native water supplies in the South Platte River basin.

1.4.2 Original Windy Gap Project

During the 1960s, the cities of Boulder, Greeley, Longmont, Loveland, Fort Collins, and the Town of Estes Park determined that additional water supplies were needed to meet their projected municipal demands. The Municipal Subdistrict, Northern Colorado Water Conservancy District, consisting of the incorporated areas of the six entities, was formed in 1970 to develop the Windy Gap Project. Prior to project construction, the Platte River Power Authority acquired all of the City of Fort Collins' allotment contracts, as well as one-half of the City of Loveland's and one-half of the Town of Estes Park's contracts. Allotment contracts are the instruments used to allocate Windy Gap Project water. Each unit of Windy Gap water represents a yield of up to 100 AF. Windy Gap units, similar to C-BT units, can be transferred. The Windy Gap unit holders have changed since the original project was completed.

> The EIS for the original Windy Gap Project was completed in 1981. The project was constructed and has been in operation since 1985.

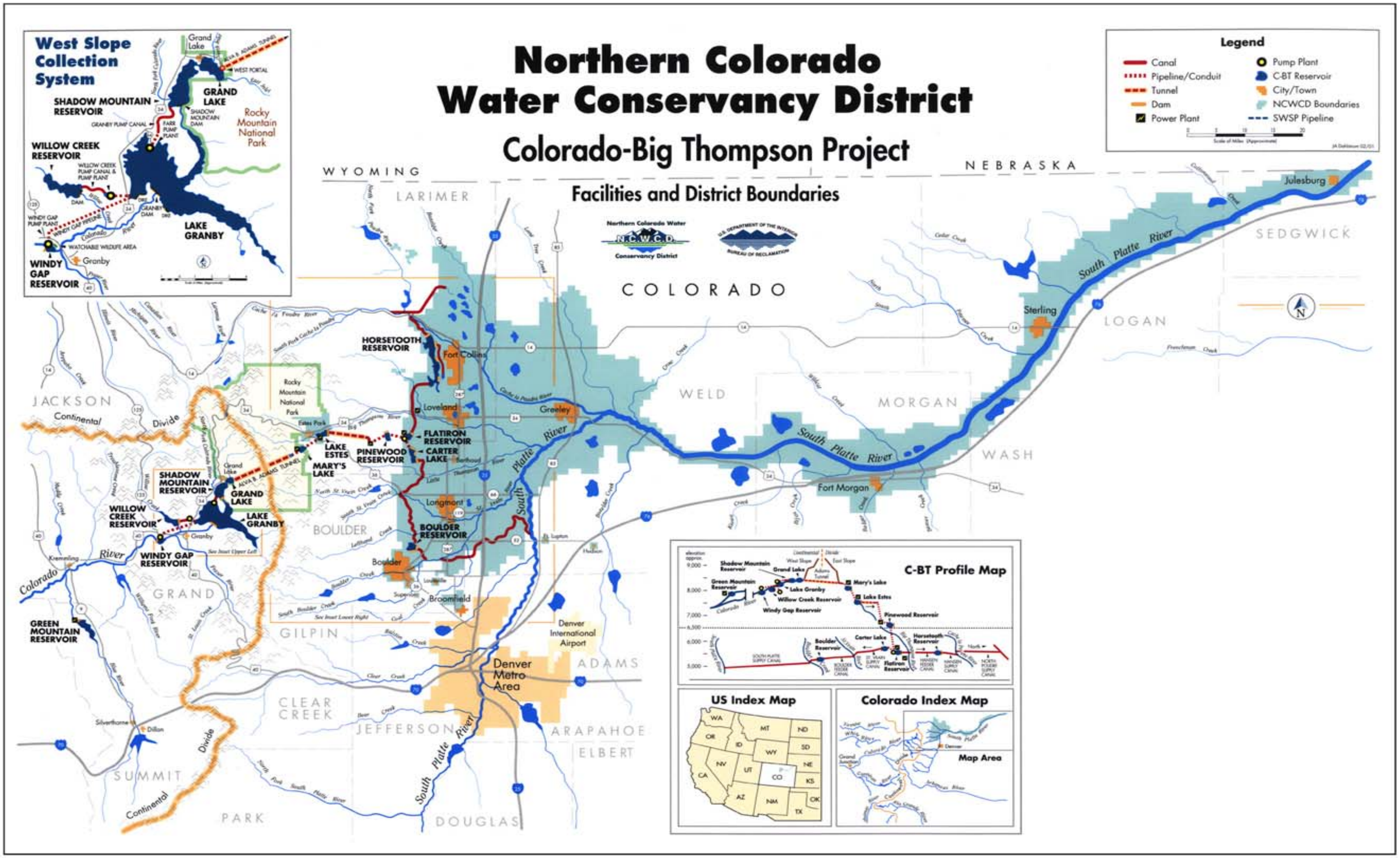
Currently, Windy Gap Project water is stored and conveyed through C-BT Project facilities prior to delivery to Windy Gap Project allottees. The Windy Gap Project consists of a diversion dam on the Colorado River, a 445-AF reservoir, a pumping plant, and a 6-mile pipeline to Granby Reservoir. Figure 1-3 shows existing Project facilities on the West Slope and the C-BT facilities used to deliver water to the East Slope. Because most of the MPWCD contractees on the West Slope use Windy Gap water to replace out-of-priority diversions, their Windy Gap water is released directly from Granby Reservoir and no other delivery structures are required.

1.4.2.1 Windy Gap Project Environmental Impact Statement

In April 1981, Reclamation completed the Final EIS on the effects of using C-BT Project facilities for the "storage, carriage and delivery" of Windy Gap Project water. The 1981 Record of Decision (ROD) for the original Windy Gap Project EIS allowed Reclamation to negotiate a contract with the Municipal Subdistrict, Northern Colorado Water Conservancy District and the NCWCD for the storage, conveyance, and delivery of Windy Gap Project water using facilities of the C-BT Project.

The original EIS determined that about 56,000 AF of water could be diverted annually from the Colorado River and that about 48,000 AF would be available to East Slope Windy Gap unit holders after subtracting 3,000 AF for MPWCD and allowances for various storage and conveyances losses. Windy Gap diversions are limited to a rate of 600 cfs and occur primarily during the months of April through July. Total Windy Gap diversions are measured at the Adams Tunnel and are limited to a maximum of 90,000 AF in any one year and a maximum of 650,000 AF during any consecutive 10-year period pursuant to the Agreement Concerning the Windy Gap Project and Azure Reservoir and Power Project, dated April 30, 1980 and the Windy Gap water rights.

Figure 1-3. Colorado-Big-Thompson and existing Windy Gap Project features.



1.4.2.2 Relationship of the Original Windy Gap EIS to Current Firming Project EIS

The WGFP EIS evaluates the potential effects of alternatives associated with firming the yield of the water diverted under the terms of the original Windy Gap Project EIS. The proposed Firming Project would not exceed the average annual diversion of 56,000 AF included in the 1981 EIS and ROD or any other diversion-related limitations or water rights. Additional reservoir storage capacity is needed in the WGFP because of the limitations in the C-BT system to store Windy Gap water when it is available. The Firming Project EIS evaluates the effects of any new physical disturbances or changes in operation needed by the WGFP, as well as changed conditions since the 1981 EIS was completed. As described below, the original EIS included a number of mitigation measures to offset impacts, several of which are ongoing.

1.4.2.3 Mitigation Measures Included in the Original Windy Gap EIS

The Windy Gap Project EIS and ROD, as well as subsequent agreements, included a variety of mitigation measures to compensate and offset the effects associated with construction of the Windy Gap Project and water diversions. Operational mitigation measures are still in place and funding and compensatory mitigation measures have been paid. Mitigation measures are summarized below.

Minimum Streamflow. A Memorandum of Understanding (June 23, 1980) between the Municipal Subdistrict, Northern Colorado Water Conservancy District, NCWCD, and Colorado Division of Wildlife established the following minimum streamflows on a 24-mile reach of the Colorado River downstream of the Windy Gap Project to the mouth of the Blue River:

- From the Windy Gap Diversion Point to the mouth of the Williams Fork River: 90 cfs
- From the mouth of the Williams Fork River to the mouth of Troublesome Creek: 135 cfs
- From the mouth of Troublesome Creek to the mouth of the Blue River: 150 cfs
- In addition, flushing flows of 450 cfs for 50 hours during the period of April 1 through June 30 are required once every 3 years.

Endangered Species. Endangered Species Act Section 7 Consultation with the U.S. Fish and Wildlife Service concluded with a Biological Opinion (March 13, 1981) determination that Windy Gap depletions, with the conservation measures listed below, is not likely to jeopardize the existence of the endangered squawfish or humpback chub. The Subdistrict agreed to payment of $100,000 for a habitat manipulation project and $450,000 for biological investigations on the Colorado River as conservation measures to compensate for the adverse effects of the Windy Gap Project. Specific conservation and recovery measures included:

- The establishment of backwater habitat areas along the mainstem of the Colorado River
- Support of a field research team for 3 years to evaluate habitat improvement techniques for endangered fish
- Bypass flow agreements with CDOW for trout habitat was also determined to benefit Colorado River endangered fish downstream of the project area

Compensatory Mitigation. Compensatory mitigation was established in the Agreement Concerning the Windy Gap Project and the Azure Reservoir and Power Project dated April 30, 1980, entered into by the Municipal Subdistrict, Northern Colorado Water Conservancy District with several West Slope entities who had been opposed to the project because of anticipated West Slope impacts.

Following negotiations between the Municipal Subdistrict, Northern Colorado Water Conservancy District and the Colorado River Water Conservation

> Mitigation measures for the original Windy Gap Project included about $11.5 million to develop West Slope water storage, fund diversion and water quality improvements, and support endangered species recovery. Non-monetary measures included minimum streamflow commitments on the Colorado River and 3,000 AF of water for the MPWCD.

District (CRWCD), a settlement was reached and mitigation measures established. Parties to this agreement included: the CRWCD, Northwest Colorado Council of Governments (NWCCOG), Grand County, MPWCD, Three Lakes Water and Sanitation District, the Towns of Granby and Hot Sulphur Springs, Winter Park Water and Sanitation District, and several ranchers. The purpose of this agreement was to provide compensation to West Slope entities from the transbasin diversion of water and associated impacts. Principal compensatory mitigation measures included:

- A commitment by the Subdistrict to fund the construction of the Azure Reservoir and Power Plant, or if infeasible, fund an alternative project or a cash payment of $10 million to the CRWCD
- Payment of $25,000 to Grand County for salinity studies of the Colorado River
- Payment of $150,000 to the Town of Hot Sulphur Springs for assistance in improving its water treatment facility and $270,000 for improving its wastewater treatment facility
- Payment of $500,000 to plan, construct, and design facilities needed for ranchers to maintain their diversion structures on the Colorado River
- An agreement by the Subdistrict to subordinate its Windy Gap decrees to all present and future in-basin irrigation, domestic and municipal uses, excluding industrial uses, on the Colorado and Fraser rivers and their tributaries above the Windy Gap Reservoir site
- An agreement by the Subdistrict to volumetric limits, which included a maximum single-year diversion of 90,000 AF/year and a maximum of 650,000 AF during any consecutive 10-year period. Per the 1985 Supplement to the 1980 Azure Settlement Agreement, these diversion limitations apply to deliveries through the Adams Tunnel, as opposed to diversions at Windy Gap Reservoir
- An agreement by the Subdistrict to bypass flows necessary to meet senior downstream water rights
- An agreement by the NCWCD to allow Grand County use of a rock and gravel quarry on their property
- An agreement by the Subdistrict to develop a Watchable Wildlife Area at Windy Gap Reservoir, including construction of three islands for waterfowl nesting

In return for these mitigation measures, West Slope interests agreed to drop objections to the Windy Gap conditional water right decrees and cooperate with all the necessary permitting requirements to allow construction of the project.

A supplement to the 1980 Settlement Agreement was later signed on March 29, 1985 by the Subdistrict, CRWCD, NWCCOG, Grand County commissioners, and the MPWCD. This agreement was implemented after the planned Azure reservoir was determined infeasible. The 1985 agreement included the following compensation to West Slope entities:

- Payment of $10.2 million to fund construction of Wolford Mountain Reservoir on Muddy Creek north of Kremmling and release of obligations for funding of the Azure Project
- The Subdistrict agreed set aside annually, but non-cumulatively, at no cost to the MPWCD, 3,000 AF of water in Granby Reservoir that is produced each year from Windy Gap supplies, for beneficial use without waste in the MPWCD for all beneficial uses, except instream uses and industrial uses
- Subordination of Windy Gap water rights to either Rock Creek or Wolford Mountain projects; Wolford Mountain Reservoir was built in 1996

1.5 Need for the Project

1.5.1 Current Windy Gap Project Operations

Windy Gap Project water is currently diverted from the Colorado River just downstream of the confluence of the Colorado and Fraser Rivers at Windy Gap Reservoir (Figure 1-4). Once collected,

Figure 1-4. Windy Gap Reservoir facilities.

it is pumped to Granby Reservoir for storage and conveyance through C-BT Project facilities and ultimate delivery to Windy Gap project allottees on the East Slope.

MPWCD's Windy Gap water is stored in Granby Reservoir and released as requested to replace stream diversions or ground water use by contract holders at various locations in Grand and Summit counties. MPWCD water users do not take direct delivery of Windy Gap water, but rather use it to augment other water diversions.

1.5.2 Windy Gap Project Delivery Shortage

In the original Windy Gap EIS, firm annual deliveries to the allottees of the Windy Gap Project were estimated to be about 48,000 AF, following conveyance and evaporation losses and allocations to the MPWCD. Because each unit of Windy Gap water is entitled to 1/480th of the annual yield of the Windy Gap Project, a unit was expected to produce a yield of 100 AF per year. Actual Windy Gap yield between 1985 and 2004 averaged less than 10,000 AF per year, which is an average annual yield to the Project Participants of about 20 AF/unit, or about 20 percent of the anticipated deliveries (Boyle Engineering 2005a). However, Windy Gap diversions were less than allowable immediately following construction because demand was less than available supplies. Had Windy Gap unit holders used all available Windy Gap water, the average long-term yield (using hydrology from 1950 to 1996) would have been about 55 to 60 AF per unit (Boyle Engineering 2005a).

No Windy Gap water was diverted in the 7 years between 1985 and 2006 because of either a lack of available storage space in Granby Reservoir, or Windy Gap water rights were not in priority during dry years. During this period, no Windy Gap pumping occurred in 1986, 1996 through 2000, and in 2002; only 300 AF were pumped in 2004. The lack of pumping in all years but 2002 and 2004 was due to a lack of available storage space in Granby Reservoir and/or limited demand for Windy Gap water. No Windy Gap water was diverted in 2002 because the junior water right never came into priority and a dry year in 2004 also limited pumping. Because of the inability of the Windy Gap Project to provide reliable yields in both wet and dry years, the current firm yield is zero. Firm yield is typically defined as the amount of water that can be delivered on a reliable basis in all years and is typically determined by yield in dry years. For the Windy Gap Project, lack of available storage space in wet years also affects yield.

A similar evaluation of the firm annual water storage and yield available for use by the MPWCD indicates its firm yield is essentially zero. Although water may be available for diversion for MPWCD in the early spring, there are a number of years when storage in Granby Reservoir is not available to hold its supplies. Because MPWCD uses its Windy Gap water to augment or replace previous water diversions, releases from Granby Reservoir typically do not occur until September or October. Consequently, Windy Gap water stored for the MPWCD during spring runoff in wet years is often spilled prior to its release for augmentation later in the year.

Windy Gap allottees and the MPWCD have not been able to rely on Windy Gap water for water deliveries in some dry or wet years. A summary of the reasons why the annual firm yield and deliveries from the Windy Gap Project have been substantially less than 48,000 AF are as follows:

- In dry years, the Windy Gap Project has not been able to divert water because more senior water rights upstream and downstream have a higher priority to divert water and "call out" the more junior Windy Gap Project water right. In addition, the Windy Gap Project is required to bypass water to maintain certain minimum stream flows downstream of the Windy Gap diversion dam. Thus, the Windy Gap Project cannot divert if stream flows immediately below the diversion dam on the Colorado River are less than 90 cfs, if flows at the Williams Fork confluence are less than 135 cfs, or if flows at the Troublesome Creek confluence are less than 150 cfs.
- Under the contract between the Municipal Subdistrict, Northern Colorado Water Conservancy District, NCWCD, and Reclamation, water conveyed and stored for the C-BT Project has priority over water conveyed and stored for the Windy Gap Project. In wet years when the C-BT system is full, there is no conveyance or storage capacity in the C-BT system for Windy Gap Project water. Windy Gap Project water stored in the C-BT system is sometimes spilled from the system to make room for C-BT Project water. Thus, Windy Gap Project water cannot be stored or carried over in some wet years.
- The Windy Gap Project was built to meet both current and future needs of the Project allottees. During the years immediately after construction, some of the allottees' demands did not require the full use of their Windy Gap Project water, so not all available water was diverted. As demand increased, the need for Windy Gap Project water also increased.

While the inability to divert water in dry years was anticipated when the Windy Gap Project was constructed, the inability to divert and store during an extended set of wet years, such as the late 1990s, was not. Because of the deficiency in deliveries, Project Participants requested that the Subdistrict pursue measures through a joint project to firm Windy Gap water deliveries. Project Participants determined that a cooperative project was the most efficient means to firm Windy Gap water deliveries rather than each entity developing storage for its own share of Windy Gap water.

Windy Gap water diversions are limited in wet years because of a lack of available storage and in dry years because water rights are not in priority.

1.6 Overview of Water Supplies and Demand Projections for Project Participants

Project Participants are responsible for developing and acquiring safe and reliable water supplies to meet the needs of the users they serve. Acquiring adequate water supplies to meet anticipated future needs requires long-term planning because of the time needed to secure water supplies, satisfy permitting and regulatory requirements, and construct infrastructure. Municipalities typically prepare a comprehensive plan to provide direction for growth and development within a community considering the anticipated types of land uses and population forecasts. Typically, these comprehensive land use plans undergo some form of public review and are formally adopted by a city council or other elected body. Public works and water utility departments respond to the comprehensive plan by seeking to secure reliable sources of water and the efficient use of this water to meet community needs. Industrial water users likewise develop operational plans and demand estimates to identify existing and anticipated water requirements.

Reclamation conducted an independent evaluation of the estimated current and future water requirements for each of the Project Participants to determine the need for the proposed project. The following discussion provides an overview of the existing water supplies, projected water demand, and the need for the proposed WGFP. Additional information on the Project Participants water supply and projected demand is included in the *Windy Gap Firming Project Purpose and Need Report* (ERO and Harvey Economics 2005).

1.6.1 Sources of Water Supply

Each Project Participant has developed a unique portfolio of water supply sources to meet existing and anticipated water needs. A diversity of water supply sources is generally preferred to ensure reliable deliveries. Water supplies for East Slope Project Participants generally include multiple sources, such as direct flow diversion rights from the Big Thompson River, St. Vrain River, and Cache la Poudre River, ownership of shares of ditch water from various irrigation companies, storage rights in existing reservoirs, ground water, and transbasin water imported from the West Slope.

Transbasin water primarily includes ownership of units in the C-BT Project, which diverts water from the West Slope, stores it in several principal reservoirs including Granby Reservoir on the West Slope, and Carter Lake, Horsetooth Reservoir, and Boulder Reservoir on the East Slope, and then delivers the water through pipelines, canals, and discharges to streams for C-BT unit holders. Project Participants that own units of the Windy Gap Project likewise receive delivery of water, when it is available, through the C-BT delivery system. Unlike C-BT water, Windy Gap water can be used to extinction, thus allowing this water to be captured and reused multiple times.

As a conservancy district, MPWCD's role is to contract and allocate delivery of water from the Windy Gap Project to various water users in Grand and Summit counties. The source of Windy Gap supply for the MPWCD consists of diversions from the Colorado River at the Windy Gap pump station, which are then stored in Granby Reservoir. Windy Gap water primarily supplements other water supply sources for Grand and Summit County water users, although some small water users rely exclusively on Windy Gap water. MPWCD also allocates water from Wolford Mountain Reservoir located north of Kremmling, Colorado.

Firm yield, also referred to as the dry year yield, is an estimate of the amount of water that is available during a defined period or condition. The definition period often encompasses a 50-year historical record that includes several dry years. Extreme droughts are excluded from firm yield planning because the amount of water and cost associated with meeting these needs are typically not feasible. Because water yield from the various water supply sources can fluctuate substantially from year to year, water providers require adequate storage to capture flows during wet years to meet their dry year water needs. Table 1-1 provides a compilation of the current annual firm water supplies available for each Project Participant.

Firm annual water supply deliveries from streams, ditches, and reservoirs depend on each year's precipitation and any carryover reservoir storage. Annual deliveries of C-BT Project water also vary from year to year depending on available water supplies, the needs of shareholders, and the annual quota established by the NCWCD Board of Directors. The C-BT Project was established to provide a supplemental water supply to East Slope water users within the boundaries of the NCWCD. C-BT quotas are typically adjusted to deliver more water in dry years. This is the opposite situation from most water rights in Colorado because the C-BT Project was designed to provide more supplemental water in dry years when native water

Table 1-1. Summary of Participant 2005 annual firm water supply (potable and nonpotable).

Participant	Annual Firm Yield (AF)	Participant	Annual Firm Yield (AF)
Broomfield	13,739	LTWD	5,510
CWCWD	2,786	Longmont	30,963
Erie	2,145	Louisville	5,063
Evans	9,298	Loveland	17,792
Fort Lupton	3,538	MPWCD	0
Greeley	43,850	Platte River	0
Lafayette	4,534	Superior	1,544
TOTAL			**140,762**

supplies yield less water. Historically, the C-BT Project has delivered 1 AF per unit in dry years and as little as 0.5 AF per unit in wet years or in extremely dry years, such as the drought of 2002–2004 when the C-BT Project was limited by the actual supply of water that it could deliver. Based on analysis of hydrology and C-BT operations through historical drought periods from 1950 to present, NCWCD has determined that the firm yield of the C-BT Project is 0.6 AF per unit. This yield per unit is assumed for all Project Participants that own C-BT units.

Many of the Project Participants reuse or are planning to reuse available water supplies to minimize the acquisition of new supplies. Colorado water law allows for the reuse of transbasin imports such as the Windy Gap Project. However, the Repayment Contract between the NCWCD and Reclamation specifies that C-BT Project water can only be used once by the allotment contract holder and all return flows after the first use are then used to supplement streamflows for diversions downstream. In some cases, a portion of South Platte River native water transferred from agricultural to municipal use can also be reused, depending on the conditions in the water rights decree.

Water reuse may include either the capture and treatment of effluent for direct reuse or the use of an effluent supply to meet return flow obligations or augmentation requirements. Direct reuse typically involves diversion from a wastewater treatment plant, and then conveyance to storage or distribution as nonpotable reuse for irrigation of parks, golf courses, and landscaping. Water reuse allows a portion of outdoor water uses to be met without using raw water treated to drinking water standards (potable water). Several Project Participants, including Broomfield, Louisville, and Superior, have developed water reuse treatment facilities, including conveyance and storage. The Platte River Power Authority relies on reuse water to meet the cooling needs of the Rawhide Energy Station. Because consumptive use is less in the winter, reusable water is often captured and stored for summer irrigation. None of the Project Participants reclaim water for potable uses. For some Participants, effluent is reused to meet downstream augmentation or return flow obligations. Reuse for these purposes does not directly satisfy nonpotable demands identified for a Participant, but it helps meet the other legal or contractual needs of the Participant.

Firm yield values in Table 1-1 do not include reuse water. Although Windy Gap water is reusable, it does not currently provide a firm annual yield. Some Participants have other sources of water that can be reused, and these are discussed under the individual Participants water supply and demand in Section 1.7.

1.6.2 Water Demand

The 14 WGFP Participants include a variety of water providers and users including cities, towns, rural domestic water districts, a wholesale water supplier, and an electric utility. These water providers and users are located in the counties of Broomfield, Boulder, Larimer, Grand, Summit, and Weld. The water consuming groups served by these providers are comprised of residential, commercial, industrial, agri-business, agricultural, recreational, campus-based educational institutions, and power generation. The following sections provide information on population growth, historical water use, conservation efforts, and future water requirements of the Project Participants.

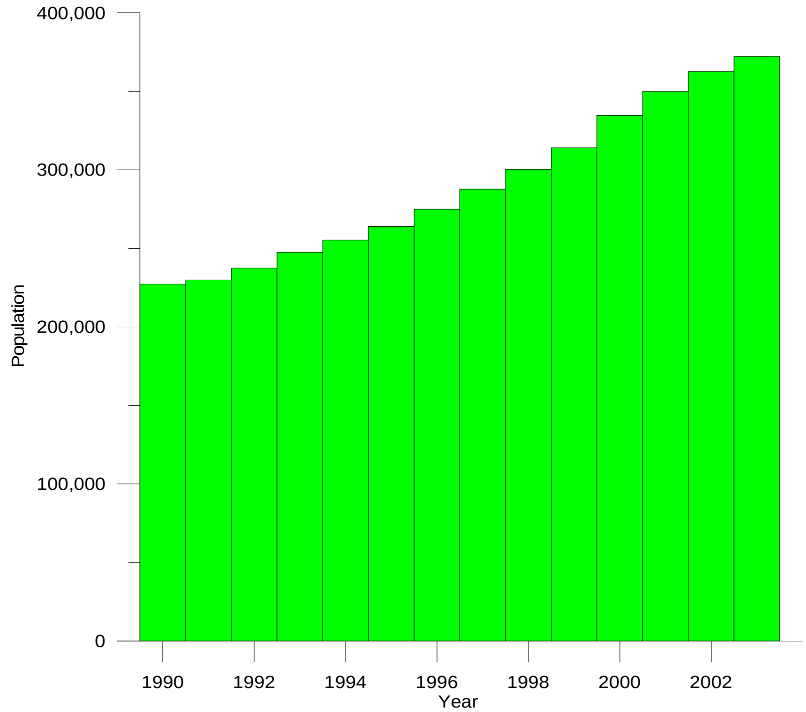
1.6.2.1 Population Growth

During the 1990s, Colorado's economy was in the top five nationally, driven by the technology sector, tourism, and economic diversification (Parker Colorado Economic Development Council 2003). From 1990 to 2000, the state added one million residents to its population. About 60 percent of this growth was attributable to in-migration (Colorado Office of Economic Development 2004). A large part of the growth in the period between 1990 and 2002 occurred in the region where the Windy Gap Participants are located. Boulder County experienced a 23 percent increase in population; Larimer County's population increased 41 percent, and Weld County's population grew by 54 percent. Some of the growth in northern counties was due to relatively higher housing costs in adjacent areas, particularly Boulder and Denver.

The combined average annual population growth rate for Project Participants, excluding MPWCD and Platte River Power Authority, was 3.9 percent from

1990 through 2003. This rapid increase in population, from about 227,000 in 1990 to about 372,000 in 2003, is characteristic of the economic development that occurred in northern Colorado during this period (Figure 1-5).

Figure 1-5. Population growth for Windy Gap Participants, 1990 to 2003.

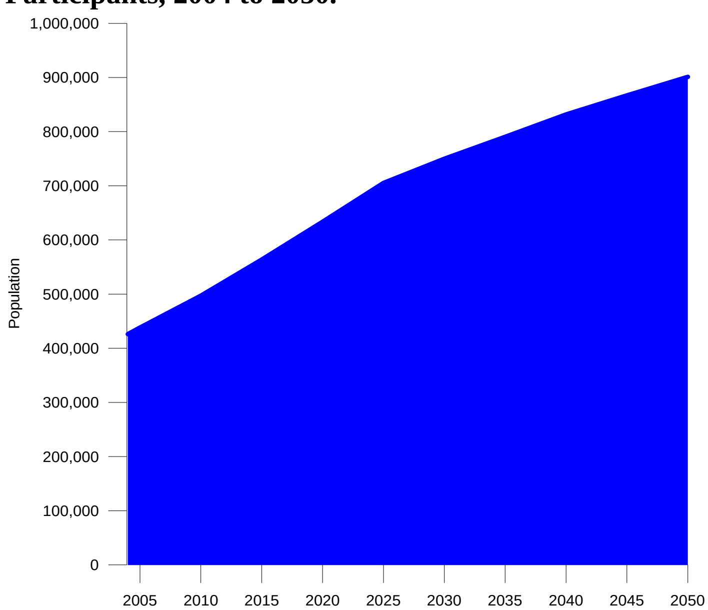


Note: This graphic excludes MPWCD due to lack of historical data and the Platte River Power Authority because it does not directly serve a population.
Source: Harvey Economics 2004.

The combined population for 13 Project Participants (excluding Platte River) is projected to increase from about 426,000 in 2004 to about 750,000 by 2030 and 901,000 by 2050 (Figure 1-6). The projected population increase of the combined Participants indicates an increase of 324,000 persons, or 76 percent through 2030. This is equivalent to an average annual growth rate of about 2.2 percent per year during this period, which is comparable to the projected average annual growth rate of 2.1 percent by the Colorado State Demographer through 2030 for counties within which these Participants are located (DOLA 2004a).

Population growth rate projections for Project Participants, excluding Platte River, are estimated at 1.6 percent from 2004 through 2050, which is less than the 2.2 percent from 2004 through 2030. This indicates a slowdown in growth rates as the Participants get larger and as some approach build-out. Half the Project Participants are predicted to reach residential population build-out before 2050, although commercial and industrial growth is predicted to continue for these communities beyond 2050. Figure 1-7 depicts 2003 and 2030 population projections for the Project Participants, excluding Platte River because it is a power utility.

Figure 1-6. Population projections for Windy Gap Participants, 2004 to 2050.

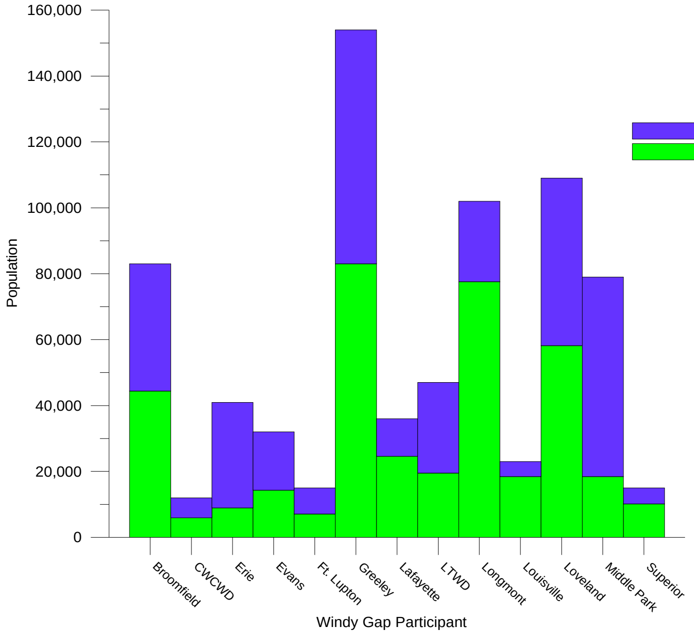


Note: Platte River is excluded from the figure.

1.6.2.2 Historical Water Requirements

Past and future water requirements for the Project Participants are composed of potable and nonpotable deliveries to end users and water losses from the point of raw water diversion to the individual water taps. MPWCD does not deliver potable water supply and Platte River only provides a small amount of potable water for use at the Rawhide Energy Station. All of the other Participants provide potable water

Figure 1-7. Estimated 2003 and projected 2030 population for Windy Gap Participants.



Source: ERO and Harvey Economics 2005.

deliveries to customers. Potable water deliveries are typically made to residential, commercial, and industrial customers as well as parks, golf courses, and other public uses, depending on the economic and demographic makeup of the water provider. The larger cities serve a diversified base of customers that include residential and various commercial and industrial uses such as food processors, high-tech firms and others, whereas the smaller communities primarily serve residential and agricultural customers.

Because it is a relatively new practice, nonpotable delivery systems do not have a long track record in northern Colorado; in 1990 only three Participants delivered nonpotable water. As of 2004, 10 of the 14 Project Participants delivered about 12,400 AF of nonpotable water to customers for outdoor irrigation. Nonpotable deliveries are typically conveyed through existing ditch systems that previously served agricultural lands. Parks, school grounds, golf courses, and open space are increasingly served by nonpotable water systems, if they are large enough or accessible, to avoid drinking water treatment costs and to take advantage of available water resources.

Total potable and nonpotable water requirements for Participants (excluding Platte River and MPWCD) are summarized in Table 1-2. For these Participants, combined total raw water requirements, including average losses of 13.7 percent, reached a maximum of about 104,400 AF in 2000 and decreased to less than 90,000 AF in 2003. The variations in total water requirements for these Project Participants are indicative of the effects of drought, drought response measures imposed by Participants in order to ensure that essential water needs were met, and implementation of conservation measures.

In 2004, MPWCD contractees requested 2,680 AF of Windy Gap water. Historically, delivery of water to the MPWCD has ranged from 0 to 624 AF per year to augment water uses from other sources. A

Table 1-2. Total water deliveries and raw water requirements for WGFP Participants, 1998 to 2003.

Year	Potable Deliveries	Nonpotable Deliveries	Total Deliveries	Total Raw Water Requirements with System Losses
	AF			
1998	65,473	10,440	75,913	88,539
1999	62,949	10,815	73,764	85,839
2000	76,902	12,252	89,154	103,804
2001	74,611	12,180	86,791	100,879
2002	71,431	13,856	85,287	98,839
2003	65,363	12,355	77,719	89,571

total of about 4,200 AF of water on average is delivered to the Rawhide Energy Station for the Platte River Power Authority. This includes about 3,300 AF on average of effluent from the City of Fort Collins for use in cooling and 950 AF taken directly from Horsetooth Reservoir and used for boiler make-up water and potable water needs.

1.6.2.3 Water Conservation

The conservation of water through the efficient use of water supplies and demand management programs is becoming standard operating practice among water providers and consumers in Colorado. Recent drought conditions in Colorado emphasized the need to continually evaluate methods to conserve water resources not only during droughts, but also during "normal" years.

> Water use per capita for Windy Gap Participants dropped 37 percent between 1988 and 2003.

Water conservation includes both supply-side and demand-side management. Supply-side conservation includes a variety of measures to make the most of existing supplies, including detection and repair of leaks to reduce losses, metering of water use, and reuse. Demand-side conservation includes changes in landscaping and watering practices, use of water efficient indoor appliances, education programs, water rate structure incentives, and rebates.

Water conservation is an important strategy used by the Project Participants to improve the efficiency of water use and delivery to reduce overall demand. All Participants have an incentive to use water efficiently, which leads to reduced costs associated with the supply, treatment, and distribution of water. Common measures by Project Participants to reduce household water use include requirements and rebates for water efficient fixtures and appliances, regulations or incentives to reduce outdoor water use, including limits on the number of watering days and the times of the day, use of Xeriscaping™, and educational programs. All of the municipal Project Participants are 100 percent metered to encourage reduced water use. Most Project Participants use an increasing block rate structure to promote conservation. Other Project Participants have found that a uniform water rate in combination with other conservation measures effectively reduces water use. Industrial water users served by municipalities and water districts are likewise encouraged to implement measures to reduce demand. Platte River's conservation effort includes use of effluent for all of its cooling needs and the reuse and recycling of water to extinction.

Project Participants also have implemented various measures to improve the efficiency and delivery of water supplies. A number of the Project Participants have experienced rapid expansion of their systems in recent years; therefore, because the majority of their transmission and distribution systems are new, system losses are minimal. Supply-side measures used by Participants include leak detection, pipe replacement and lining, and monitoring. Technological improvements at water treatment and wastewater facilities also contribute to water savings.

Participants are involved in a number of programs to reduce water use and improve conservation measures. In 2005, the cities and towns of Broomfield, Lafayette, Longmont, Louisville, and Superior signed the Denver Metropolitan Local Governments' Water Stewards Memorandum of Understanding, a commitment to water conservation and stewardship. The Boulder-based Center for Resource Conservation offers a water conservation program that includes an irrigation audit program and suggestions for irrigation improvements. Erie, Lafayette, Greeley, Longmont and Louisville participate in this program. All WGFP Participants have conservation plans and under the requirements of the Water Conservation Act of 2004 (Colorado House Bill 04-1365), water providers will continue to improve conservation measures and reduce water use in the future. In addition, the Water Efficiency Grant Program Act of 2005 (Colorado House Bill 1254) created a grant program to provide entities with financial assistance to implement water conservation measures and promote water conservation education and public outreach to assist with reductions in water use.

The NCWCD has long been a leader in agricultural water conservation; however, in recognition of the growing municipal water use within its boundaries, NCWCD has become much more active in urban water conservation (NCWCD 2004). With a special emphasis on potential savings from turf watering, NCWCD has established the Turf and Urban Landscape Water Management and Conservation Program. This program focuses on educating and training turf professionals, groundskeepers, and all persons responsible for turf care. NCWCD's program is grounded in horticulture research and scientific approaches to irrigation system design and practice. The educational component includes a host of fairs and other outreach efforts, while serving as a resource to homeowners.

One measure of the effectiveness of water conservation programs is an evaluation of customers' water use rates as expressed in gallons per capita per day (gpcd). Participant total water use, which includes residential, commercial, and industrial water uses, averaged 194 gpcd when summed for each of the individual participants or 188 gpcd when weighted by total population and water use from 1998 to 2003 (Table 1-3). The lower water use values when weighted by population reflect larger communities that serve more customers with multi-family dwellings compared with smaller rural communities that have lower densities and larger lots. Water use rates for individual WGFP Participants are illustrated in Figure 1-8. The effectiveness of conservation measures is indicated by comparison of Participant water use rates from 1988 (NCWCD 1991), which averaged 263 gpcd with the simple average of 194 gpcd for WGFP Participants for 1998 to 2003. This indicates a 37 percent decrease in water use rates since 1988.

Overall, the Project Participants exhibit lower or comparable water use rates per capita compared with other Colorado water users, recognizing the geographic and service area differences. The Statewide Water Supply Initiative Report (CDM 2004) found that statewide gpcd ranged between 206 and 332; the South Platte River basin was the lowest in the state with 206 gpcd. The statewide average from this study was 210 gpcd (CDM 2004). Potable water use for the Denver Water service area averaged about 201 gallons per day for 1998 to 2003 (Denver Water 1998-2003). For the Upper Colorado River basin in year 1993, the U.S. Environmental Protection Agency reported an average water use of 242 gpcd (EPA 2003). This same EPA report includes the Platte River basin as part of the Missouri Region with a water use rate of 194 gpcd. Additionally, a report prepared by Western Resource Advocates indicates that for 13 large cities in the Western U.S., water use rates averaged about 229 gpcd in 2001 (Western Resource Advocates 2003). A University of Utah study (Isaacson 2005) in the intermountain west found that average water use rates for nine cities with population and climatic conditions similar to the Participants had an average water use of 224 gpcd. These comparisons indicate that on average the Project Participants exhibit water use rates that are less than or equal to broad regional values.

To provide a comparable measure of water use with individual Participants, a regional water use average was calculated based on the Colorado statewide average of 210 gpcd and the nine representative

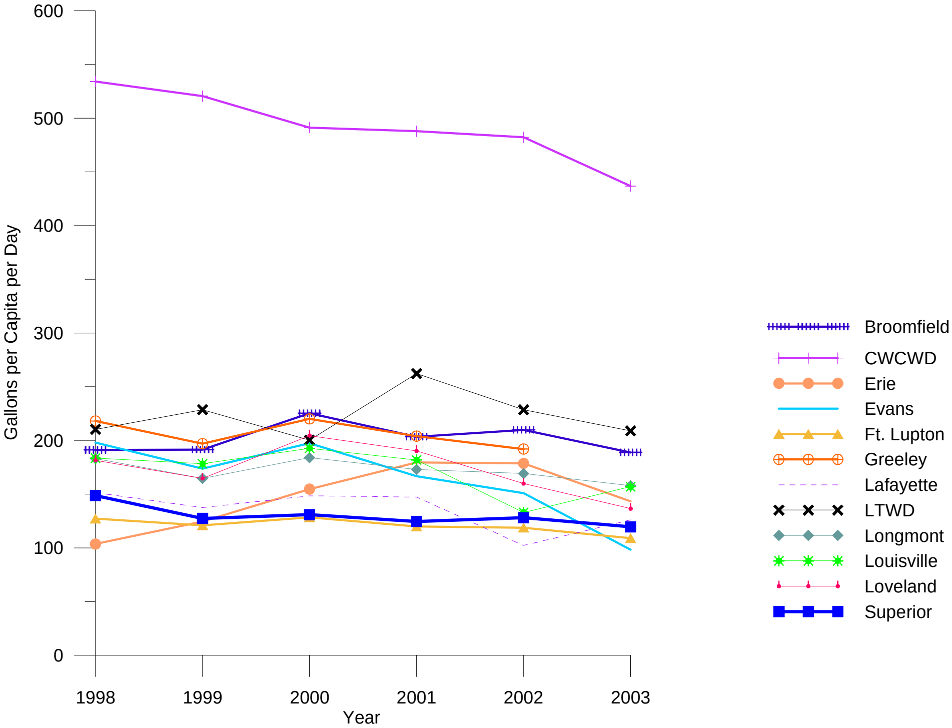
Table 1-3. Potable water use in gallons per capita per day for WGFP Participants, 1998 to 2003.[1]

Year	Simple Average of Individual Project Participants	Overall Average[2]
1998	203	193
1999	194	180
2000	206	201
2001	203	191
2002	188	176
2003	172	N.A.
Average	194	188

[1] MPWCD and Platte River are excluded from these data. 2003 data for Greeley and Longmont was unavailable.
[2] GPCD based on total Participant population and water use.

Source: Information provided by Project Participants, 2004.

Figure 1-8. Total water use rates for WGFP Participants, 1998 to 2003.



Notes:

MPWCD and Platte River are excluded from these data.

CWCWD is not directly comparable with other water providers because nonresidential demands, including agricultural and dairy users account for nearly two-thirds of total CWCWD demand. Residential water use for CWCWD is about 162 gpcd.

The LTWD acquired the Arkins Water Association in 1999 and the Town of Mead in 2001 and 2002, which temporarily increased per capita use.

communities from the University of Utah study of 224 gpcd. The average from these two sources provides a regional water use value of 217 gpcd. Individual water use for each of the Project Participants is below this average for all Participants except Central Weld County Water District (CWCWD) and the Little Thompson Water District (LTWD). Higher total water use rates for these two rural water districts are due to the characteristics of the customers that they currently serve.

The CWCWD provides water to various agricultural and dairy users, such as Aurora Dairy, as well as the Fort St. Vrain Power Generation Station. As a result, total water use averaged 492 gpcd from 1998 through 2003. Nonresidential water demands account for almost two-thirds of the total CWCWD water demands; thus, total water use is not directly comparable with other Participants or regional measures of water use. Residential water use rates for CWCWD typically average below 165 gpcd, which is similar to other Participants. CWCWD encourages conservation for all of its water users including the use of non-treated water whenever possible by dairies and other agricultural businesses.

The LTWD water use averaged 224 gpcd for 1998 to 2003, as compared with the regional average of 217 gpcd. Residential gpcd for LTWD since 1998 is comparable with other Participants at about 174 gpcd on average. LTWD also serves dairies and other agricultural uses, which tend to increase its gpcd figures. In addition, LTWD acquired the Arkins Water Association and began serving the Town of Mead, which temporarily increased water use for several years. The LTWD conservation program includes encouragement of dual water systems for new developments.

In summary, water conservation is actively practiced among the Participants, and the current level of water conservation, which includes the low water usage during the 2002-2003 drought, is built into the water demand projections. Water use as measured by total gpcd has declined in the last 15 years and the demand projections assume that the recent lower levels will continue. Variations in total potable gpcd from year to year are heavily influenced by weather and drought-related restrictions.

The effectiveness of water conservation measures are best evaluated over the long term. It is possible that per capita water use will continue to decline in the future as recent conservation measures are fully implemented and the public becomes more educated in the efficient use of water. For some Project Participants, gpcd values could increase slightly in the future as communities reach residential build-out, but commercial growth continues. Drought restrictions, which clearly have an effect on water demand patterns, are not assumed to be in place in the future as more normal hydrologic conditions resume.

Participant current water use is reasonable compared with regional water use. Rural water districts that serve large agribusinesses have the highest water use and rates and the effect on per capita water use is magnified by a relatively small population base. This finding suggests that a reasonable level of efficient water use is being practiced by most Participants' customers.

To meet future water requirements will require continued improvements in water conservation in addition to the proposed WGFP. Projected future water requirements indicate that even with the WGFP, Participants will need additional conserva-tion savings and/or additional water sources to meet future water needs.

1.6.3 Future Water Requirements

The 2005 estimated raw water requirements for Project Participants, excluding the MPWCD, is about 120,000 AF. Water requirements are projected to increase to about 205,000 AF by 2030 and to 251,000 AF by 2050. Water needs in Grand and Summit counties, which are partially served by the MPWCD, are projected to increase about 17,000 AF by 2030 to meet residential and commercial potable demand. Projected water demand for each of the WGFP Participants over the next 50 years is shown in Table 1-4.

Total water demand for East Slope Windy Gap Participants is projected to increase about 85,000 AF by 2030. West Slope water demand in Grand and Summit Counties is projected to increase about 17,000 AF by 2030.

Table 1-4. WGFP Participant total projected future raw water requirements.

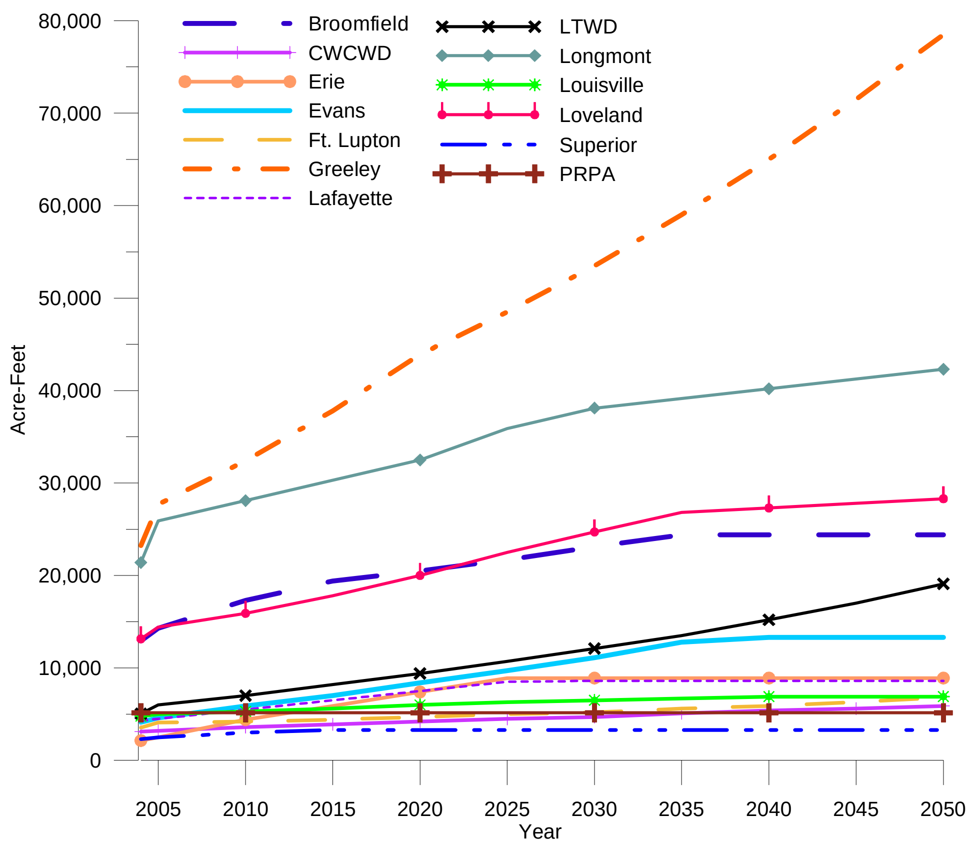
Participant	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
					AF					
Broomfield	14,300	17,300	19,400	20,500	21,700	23,100	24,400	24,400	24,400	24,400
CWCWD	3,200	3,600	3,900	4,200	4,500	4,700	5,100	5,400	5,600	5,900
Erie	2,500	4,400	5,900	7,400	8,900	8,900	8,900	8,900	8,900	8,900
Evans	4,600	5,900	7,000	8,400	9,700	11,100	12,800	13,300	13,300	13,300
Fort Lupton	4,100	4,200	4,400	4,700	5,000	5,200	5,600	5,900	6,300	6,800
Greeley	27,700	32,400	37,800	43,900	48,500	53,500	59,000	65,000	71,500	78,500
Lafayette	4,500	5,500	6,500	7,500	8,500	8,600	8,600	8,600	8,600	8,600
LTWD	6,000	7,000	8,200	9,400	10,700	12,100	13,500	15,200	17,000	19,100
Longmont[1]	25,900	28,100	30,300	32,500	35,900	38,100	39,150	40,200	41,250	42,300
Louisville	5,000	5,300	5,600	6,000	6,300	6,500	6,700	6,900	6,900	6,900
Loveland	14,400	15,900	17,800	20,000	22,500	24,700	26,800	27,300	27,800	28,300
MPWCD[2]	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Platte River[3]	5,150	5,150	5,150	5,150	5,150	5,150	5,150	5,150	5,150	5,150
Superior	2,500	3,000	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Total	119,850	137,750	155,250	172,950	190,650	204,950	219,000	229,550	240,000	251,450

[1] Longmont projects a build-out demand of 42,300 AF in 2048.
[2] An incremental increase in water demand for Grand and Summit counties of 17,000 AF by 2030 above existing use is projected.
[3] Platte River Power Authority needs 5,150 AF of reusable water to meet existing needs. Future water needs are expected to increase with the demand for additional power generation, but these amounts have not been determined.

The combined average annual increase in water demand for the Project Participants is about 3 percent from 2004 through 2030 and about 2 percent from 2004 through 2050. Water demands increase at a somewhat higher annual rate than population because of commercial and industrial growth. Increasing nonpotable water use also drives total water requirements beyond population growth rates. Because Windy Gap water can be reused, Participant's need Windy Gap water to help meet nonpotable irrigation and augmentation requirements and thus extend available water supplies. Total projected water requirements for individual Project Participants from 2004 through 2050 are shown in Figure 1-9.

Project Participants are continually updating water demand projections. Current water projections may vary slightly from the estimates in 2005, but the need to firm Windy Gap water supplies has not changed.

Figure 1-9. Projected total water requirements for WGFP Participants, 2004 to 2050.



MPWCD is not included in this graphic.

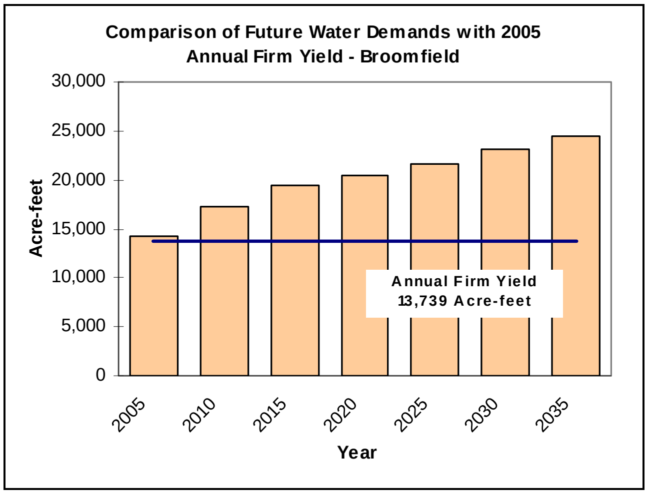
Source: ERO and Harvey Economics 2005.

1.7 Participant Water Supply and Demands

This section summarizes the existing water supply, growth and population trend, water demand, and need for water for each of the Project Participants. Additional information is included in the *WGFP Purpose and Need Report* (ERO and Harvey Economics 2005).

1.7.1 City and County of Broomfield

The City and County of Broomfield is north of Denver and borders the intersection of Adams, Boulder, Jefferson, and Weld counties. Until the 1950s, only 100 people lived in the area. By 2004, Broomfield's population exceeded 46,000. In 2001, Broomfield citizens voted to establish the City and County of Broomfield.



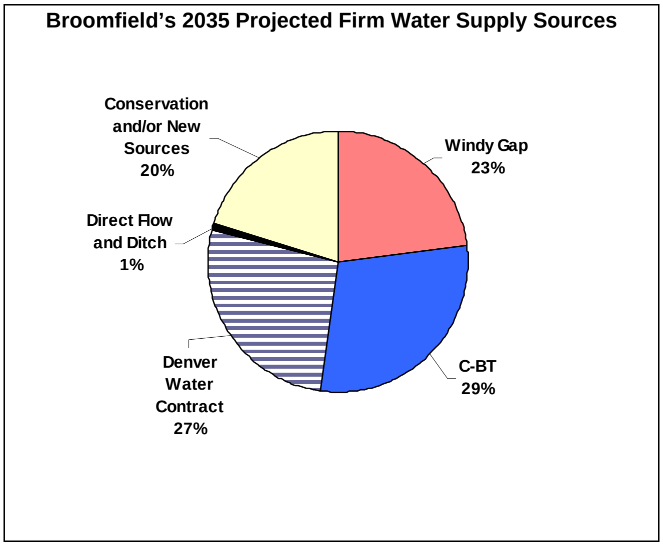
Water Supply. Broomfield relies primarily on C-BT Project water and Denver Water for its potable water supply. The City owns 56 units of Windy Gap water, which is used when available or through the Windy Gap in-lieu program, which allows for borrowing C-BT water under certain conditions. Broomfield's nonpotable water supply includes flows from Clear Creek, Coal Creek, Walnut Creek, and Big Dry Creek and reuse of Windy Gap effluent when available. Broomfield also owns ditch and reservoir shares that are used outside the City and County boundaries for nonpotable uses including drought-tolerant sod production and biosolid disposal in Weld County. Broomfield recently completed a water reuse system that allows the capture of Windy Gap effluent to assist in meeting nonpotable irrigation needs. Although the current firm yield of this reuse water is zero, it is projected to provide 3,100 AF of reuse water if the WGFP is implemented. Broomfield's current firm water supply is 13,739 AF.

Growth and Population Trend. Broomfield experienced steady growth in population and employment from 1980 through 1990, but the pace of that growth accelerated from 1990 through 2004. Population almost doubled from 24,640 in 1990 to 46,400 in 2004—an average annual growth rate of almost 5 percent. Employment rose three-fold from 1990 to 2004, experiencing an average annual growth rate of 9 percent. Broomfield's employment growth has benefited from its location along a major highway between Denver and Boulder.

Current Water Demand. Broomfield's Water Department service area includes the entire County, plus the Jefferson County Airport and the Mile High Water District. Total potable water use for Broomfield peaked at about 10,100 AF in 2002, dropping in 2003 due to drought and related water use restrictions. Potable residential water deliveries nearly doubled between 1992 and 2003. Residential water use comprises an average of about 70 percent of total use. Commercial water use represents about one-fourth of total Broomfield water use; these water demands have been growing at a slightly slower pace than residential water use. Total water use per capita per day has varied within a fairly narrow range during the 1990s, averaging 188 gpcd. Residential water use has averaged 132 gpcd from 1992 through 2003.

Projected Water Demand. Broomfield's population is projected to peak at 83,300 residents in 2025 based on a 2.9 percent annual increase from 2004 through build-out in about 2035. This indicates an 80 percent increase in population in 20 years. Employment in Broomfield is expected to grow faster than population, doubling by 2025 and continuing to grow beyond that. Total firm water requirements are projected to increase from 14,300 AF in 2005 to 24,400 AF in 2035. About 86 percent of future demand is for potable needs and the remainder for nonpotable uses.

Water Need. Broomfield's existing water supplies are sufficient to meet current water needs during



average years of precipitation. Currently, water demand may exceed available firm water supplies during dry years, depending on C-BT deliveries. Broomfield's projected 2035 water requirements exceed available firm supplies by about 10,700 AF. Firming Broomfield's Windy Gap water would provide a firm annual yield of about 5,600 AF to meet potable needs plus sufficient reusable effluent (3,100 AF) to meet the majority of anticipated nonpotable demands. A firm Windy Gap water supply would provide Broomfield about 23 percent of the City's 2035 water supply requirement, not counting the potential reuse of Windy Gap water.

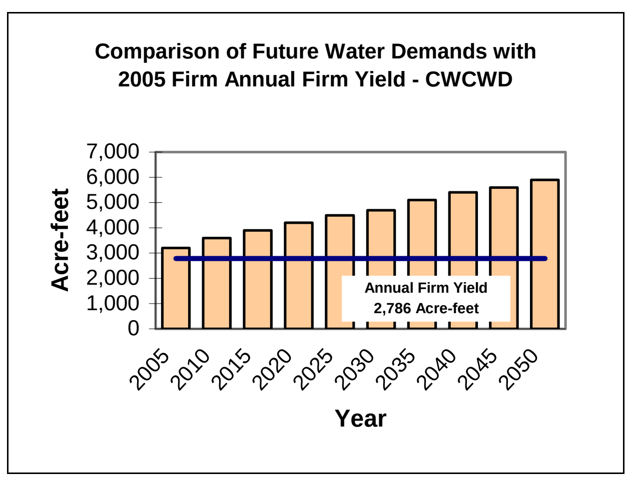
1.7.2 Central Weld County Water District

Central Weld County Water District (CWCWD) was created in 1965 to serve a large rural portion of Weld County. The CWCWD's total service area is about 250 square miles generally located south of Greeley and spanning along the South Platte River to the area along I-25 south of Dacono.

Existing Water Supply. The CWCWD's water supply consists of two main water categories: water owned by CWCWD that is treated and delivered to rural customers; and water that is transferred to CWCWD, treated, and delivered to towns in the service area. The primary source of water owned by CWCWD is C-BT Project water, a small number of ditch shares in the Greeley-Loveland Irrigation Company, and 1 unit of Windy Gap water. The CWCWD does not have a firm source of supply for reuse because 99 percent of its water supply is from the C-BT Project, which is not reusable. Additionally, because CWCWD serves primarily rural customers with its Windy Gap water and CWCWD does not operate a wastewater facility, there are no plans for reuse of Windy Gap water. CWCWD's current firm water supply is 2,786 AF. In addition to the water owned by CWCWD, it receives, treats, and delivers C-BT water to eight small communities—Dacono, Kersey, Milliken, LaSalle, Gilcrest, Platteville, Left Hand, and Aristocrat. In 2005, CWCWD began providing water to the communities of Firestone and Frederick. The water supply and demand for Firestone and Frederick were not included in the evaluation because CWCWD's 1 unit of Windy Gap water is used to meet the needs of existing rural customers.

Growth and Population Trend. CWCWD service area population was estimated at about 5,200 in 2002 not including the communities that provide raw water to CWCWD for treatment. Between 1999 and 2002, the number of taps in the CWCWD service area grew at an average annual rate of 8.2 percent, or a total of about 27 percent.

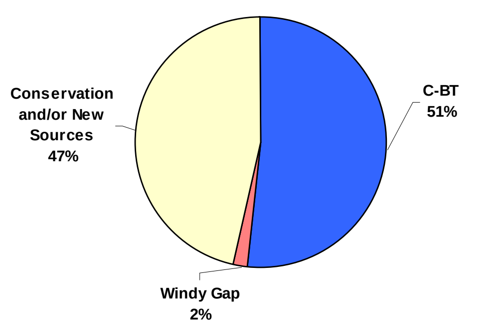
Current Water Demand. CWCWD supplies water to rural customers within District boundaries. Nonresidential demands accounted for nearly two-thirds of total CWCWD demand in 2002. Nonresidential demand is mostly attributable to various agricultural and dairy users, with Aurora Dairy and Fort St. Vrain Power Generation representing the largest users. Total 2002 water demand was about 2,800 AF. Residential water use within the CWCWD service area was about 162 gpcd from 1999 to 2002. The CWCWD also treats



water for the eight communities previously mentioned. Because the CWCWD is only responsible for providing treatment and not the raw water, these communities were not included in the demand evaluation. Total water use averaged almost 500 gpcd for the same period, but two-thirds of CWCWD water demand was for agricultural and industrial users.

Projected Water Demand. The population in the CWCWD service area is expected to reach about 16,000 by 2050 based on the estimated growth in residential taps. To arrive at projected residential demand, historical residential use patterns were analyzed. Residential taps are expected to grow at an annual rate of about 4.6 percent until 2010, and then decline over time to about 1.2 percent by 2050. Projections of future nonresidential demands are based on the continuation of the historical average of 3.5 new taps per year. Total water requirements for the CWCWD are estimated to be 5,900 AF per year by 2050.

CWCWD's 2050 Projected Firm Water Supply Sources



Water Need. CWCWD existing water supplies are sufficient to meet current water needs during average years of precipitation, but water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. Projected water demand exceeds the firm supply by about 1,900 AF in 2030, and by 2050 a shortage of about 3,100 AF is anticipated. Firming CWCWD's single Windy Gap unit would provide about 100 AF of water, or less than 2 percent of its 2050 water supply.

1.7.3 Town of Erie

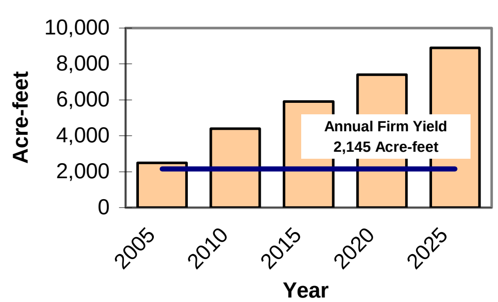
The Town of Erie is in Boulder County, Colorado just north of the City of Lafayette. Prior to 1995, the Town of Erie was small and rural in nature, but considerable growth has occurred since then.

Water Supply. Erie's water supply has grown over the last 10 years to keep pace with rapid population growth. Erie has purchased C-BT Project water since 1992 to the present, which currently provides more than 90 percent of Erie's water supply. Other water sources include the ownership and planned acquisition of up to 20 units of Windy Gap water, reservoir storage rights, and various ditch shares. Erie does not currently have a firm supply of water for reuse. When available, effluent from Windy Gap water is used via an exchange to irrigate parks and open space. Erie estimates about 50 percent of its Windy Gap water could be reused if the WGFP is implemented. The current estimated firm annual water supply for the Town of Erie is 2,145 AF.

Growth and Population Trend. Erie's population has grown from about 1,260 in 1990 to 6,300 in 2000; the population in 2004 was about 10,390. From 1990 to 2004, Erie's population increased 729 percent with a 744 percent increase in the number of housing units.

Current Water Demand. Encompassing about 14 square miles, the Town of Erie and its water department serve most customers within its service area. No large industrial or other water users were served as of mid-2004. From 1997 through 2003, total water deliveries for the Town of Erie increased six fold. In 2002, residential water use comprised 76

Comparison of Future Water Demands with 2005 Annual Firm Yield - Erie



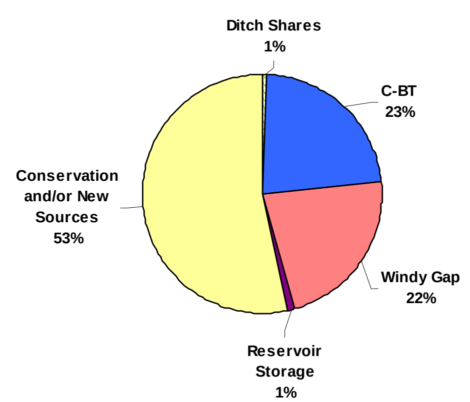
Annual firm yield does not include reuse water.

percent of total water sales, and residential use has averaged 88 percent of total water sales from 1997 through 2004. In 2003 and 2004, commercial water sales accounted for more than 15 percent of total water sales. The Town of Erie initiated nonpotable water use in 2001 and averaged about 80 AF of deliveries between 2001 and 2003. Total water requirements for the Town of Erie increased from 229 AF in 1995 to a high of 2,025 AF in 2002. From 2000 to 2003, total water use averaged 164 gpcd and residential water use averaged 129 gpcd.

Projected Water Demand. The projected population forecast for Erie is based on an annual rate of growth of almost 13 percent through 2007, 6 percent through 2017, and 4 percent to build-out in 2025. Population at build-out is estimated at about 40,700 with about 14,600 housing units. Total Erie water requirements are expected to increase from about 2,500 AF in 2005 to 8,900 AF in 2025. This represents about a 260 percent increase over that period of time. About 96 percent of future water demand is needed for potable uses and the remainder for nonpotable irrigation.

Water Need. Existing water supplies are currently sufficient to meet Erie's water needs during average years of precipitation. Currently, water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. A firm water supply shortage of about 6,800 AF is estimated by build-out in 2025. Firming Erie's Windy Gap Project water supply would provide up to 2,000 AF of water, or about 22 percent of the Town's projected 2025 water supply need, not including the reuse of about 50 percent of the Windy Gap yield to meet irrigation demands.

Erie's 2025 Projected Firm Water Supply Sources



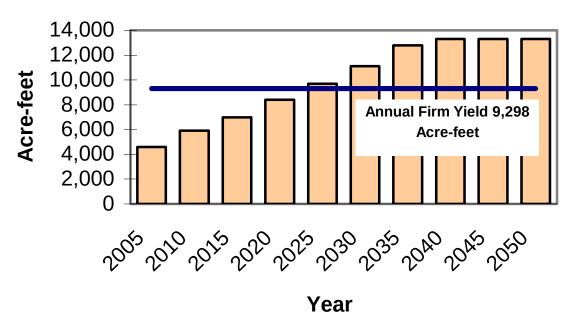
1.7.4 City of Evans

The City of Evans is in south-central Weld County just south of the City of Greeley. Evans is a highly diversified and stable community experiencing significant growth and development.

Existing Water Supply. The City of Evans currently relies on transbasin water from the C-BT Project and five local ditch companies for its potable water supply. Evans recently completed a lease/purchase for 5 units of Windy Gap water. All of Evans' potable water is treated by the City of Greeley. Evans provides raw water to Greeley each year equal to Evans' projected water demand, plus an additional amount to account for losses incurred by Greeley. Evans' nonpotable water supply includes the Evans Town Ditch, which currently exceeds the City's nonpotable demand. The current firm annual water supply available to Evans is about 9,298 AF. In addition, Evans receives return flow credit from native water sources, which provide a variable supply of about 400 AF of reuse water for meeting return flow obligations. Evans estimates up to 85 percent of its Windy Gap water could be reused if the WGFP is implemented.

Growth and Population Trend. Between 2000 and 2002, the City of Evans ranked among the fastest growing cities in Colorado. Over this period, Evans grew at an average annual rate of 7 percent. Between 1990 and 2004, Evan's population grew

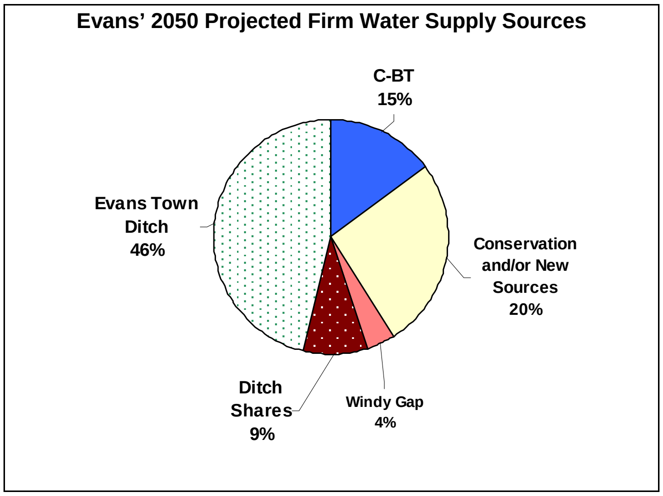
Comparison of Future Water Demands with 2005 Annual Firm Yield - Evans



Annual firm yield does not include reuse water.

from about 5,900 to 15,000.

Current Water Demand. The City of Evans is responsible for providing water to the residential, commercial, industrial and public users located within its service area. About 95 percent of Evans' customers are residential. Evans currently serves 14,860 residents within the city limits and provides water to 2,394 residents within the Arrowhead and Hill-N-Park subdivisions. Currently, no large water users are served by the City. Total water requirements to meet potable and nonpotable water needs since 2000 have ranged from about 3,700 to 4,600 AF per year. Over the period 1990-2002, total water use averaged 188 gpcd and residential water use averaged 157 gpcd.

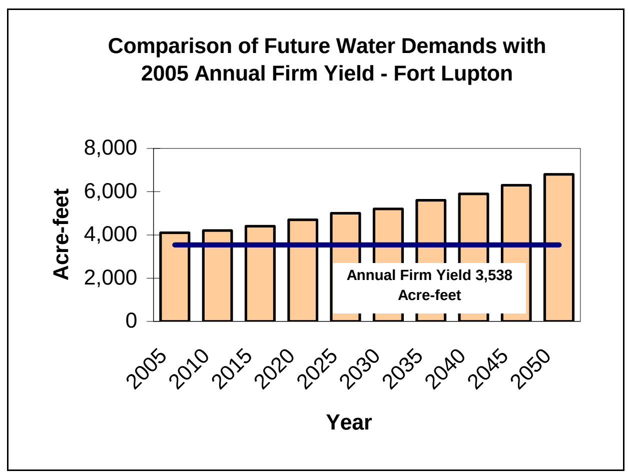


Projected Water Demand. The projected population forecast for Evans is based on an assumed annual rate of growth of 4 percent through 2010, 3 percent through 2020, and 2.5 percent thereafter. The City of Evans service area population is expected to peak at about 40,000 residents by 2037. Total raw water requirements to meet this anticipated population is about 13,300 AF per year.

Water Need. Evans' existing total firm water supply exceeds current demand during average years of precipitation; however, not all water supplies are currently available for meeting potable water needs. Water demand is expected to exceed available firm water supplies by about 2025, which would affect the ability of Evans to meet dry year water needs, depending on C-BT deliveries. However, the Evans Town Ditch, which is included in Evans' total water supply, currently can only be used for nonpotable uses because the water is only available downstream of Greeley's water treatment plant, which treats water for Evans. Thus, a shortage in firm potable water supplies may occur much sooner. Based on total water supply, without accounting for source of water, a firm water supply shortage of about 4,000 AF is anticipated by about 2040 when demand is expected to peak. Firming Evans' 5 Windy Gap units would provide the City with about 500 AF of water or about 4 percent of the City's projected 2050 water supply requirement, not including the reuse of about 85 percent of the Windy Gap yield to meet return flow obligations.

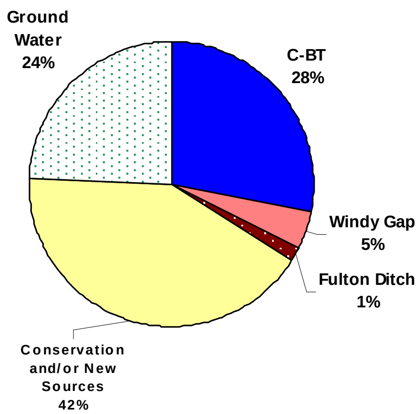
1.7.5 City of Fort Lupton

The City of Fort Lupton is in south-central Weld County about 25 miles north of Denver. Nearby cities include Brighton, Platteville, Firestone, Frederick, and Dacono. Fort Lupton began as a trading fort in 1836; since that time, the community has expanded with its business, agriculture, and oil and gas-based economy.



Existing Water Supply. Historically, the City relied on ground water to meet its municipal water needs. With increasing growth and development along the Front Range, the quality of the ground water from Fort Lupton's wells in the South Platte River alluvium has gradually declined. For this reason, the City decided to acquire C-BT Project water in 1997 and blend this water with ground water to maintain acceptable water quality until 2005 when ground water was no longer used for drinking water. Fort Lupton recently purchased 3

Fort Lupton's 2050 Projected Firm Water Supply Sources



units of Windy Gap Project water from Greeley. In addition, Fort Lupton owns shares in the Fulton Ditch, which provides water for irrigation. Fort Lupton does not currently have any sources of water available for reuse, but estimates that up to 80 percent of its Windy Gap water could be reused if the WGFP is implemented. Firm annual water supplies currently available to Fort Lupton total 3,538 AF.

Growth and Population Trend. The City of Fort Lupton's 2003 population is estimated at 7,071, and the City's service area is coincident with its city limits. From 1990 through 2003, population grew at an average annual rate of 2.5 percent. Total water taps increased by an average annual rate of 2.9 percent from 1997 through 2003. Annual growth rates have fluctuated since 1990, with the most significant growth occurring in 2000 and 2001.

Current Water Demand. Residential use has traditionally comprised the majority of potable water demands in the City of Fort Lupton, accounting for an average of 77 percent during the 1997 to 2003 period. A large portion of the remainder of Fort Lupton's water demand comes from nonpotable water needs. From 1997 through 2003, the Thermo Cogeneration power plant used an average of 1,625 AF of water annually, while other nonpotable users, including the City's parks and schools, outdoor irrigation and golf course, used 550 AF annually on average. Total water demand for Fort Lupton has ranged from about 3,000 to 4,000 AF per year over the past 5 years. Total potable water use has averaged 123 gpcd and residential water use has averaged 97 gpcd from 1997 to 2003.

Projected Water Demand. Based on an annual growth rate of 2.5 percent, the City of Fort Lupton is expected to reach nearly 24,000 by 2050. Residential, commercial, industrial, schools, city parks and irrigation water usage are all expected to track population growth. The City's current and future use for golf course irrigation is expected to remain steady from 2003 to 2050. Total raw water requirements of about 6,800 AF are projected by 2050, of which about 60 percent would meet potable water demand and 40 percent would meet nonpotable water needs, including the Thermo Cogeneration facility.

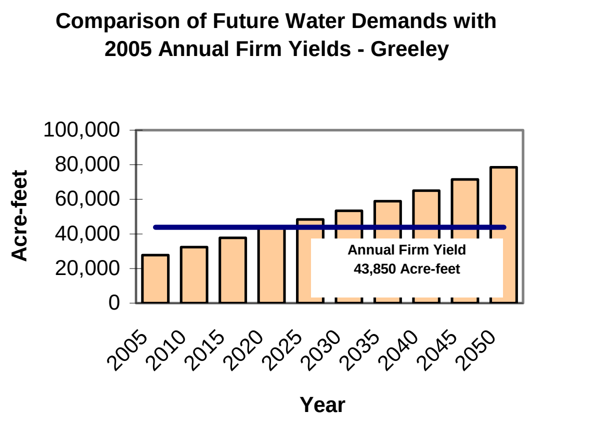
Water Need. Existing water supplies are currently sufficient to meet Fort Lupton's water needs during average years of precipitation. Currently, water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. By 2030, Fort Lupton's firm water demand is projected to exceed supply by about 1,700 AF; by 2050 about 3,300 AF of additional water would be needed to meet Fort Lupton's water needs. Firming Fort Lupton's 3 units of Windy Gap water would provide Fort Lupton with about 300 AF of water, or about 5 percent of its projected 2050 water supply, not including reuse of up to 80 percent of Windy Gap water.

1.7.6 City of Greeley

Greeley, the largest city in Weld County, is about 50 miles north of Denver. The City is located in a semi-arid environment that receives about 12 inches of precipitation annually. Greeley was originally an agricultural-based community, but continues to diversify and support a variety of businesses and commercial industries.

Subsequent to the completion of the *WGFP Purpose and Need Report* (ERO and Harvey Economics 2005) prepared for this EIS, Greeley and Harvey Economics conducted additional evaluations and demand forecasting for the Halligan-Seaman Water Management Project. The Halligan-Seaman evaluation was based on more recent water consumption data and a different forecasting methodology, but the results were generally consistent with the *WGFP Purpose and Need Report*. The results of the additional evaluation, while varying slightly from those produced for the WGFP EIS, confirmed Greeley's need for participation in the WGFP and securing future water supplies. Pertinent differences between the two studies are noted in the following discussion.

Existing Water Supply. Greeley's water supply system is diverse and complex, and uses carryover storage from existing reservoirs, proactive water management, conservation, and system integration to increase the efficiency and yield of the City's water rights. Water supplies include the C-BT



Annual firm yield does not include reuse water.

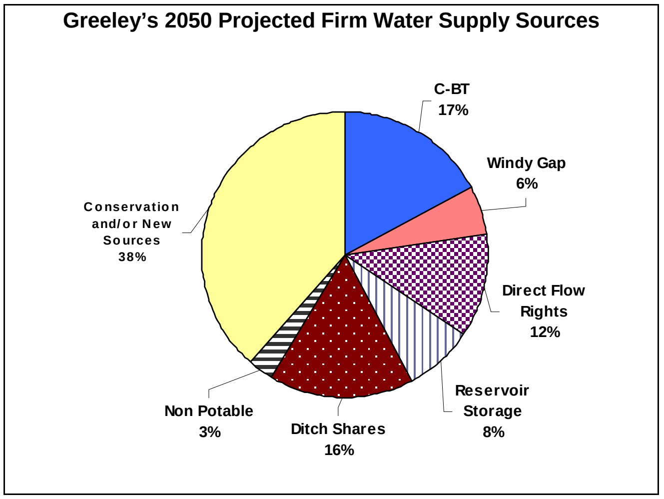
Project, direct flow rights from the Cache la Poudre River, irrigation ditch shares, and mountain reservoir storage. Although legally available, about one-third of ditch shares in the Greeley-Loveland System are currently in agricultural leases and not available for immediate potable or nonpotable use. Greeley owns 64 units of Windy Gap water. As described in Greeley's Water Master Plan, Greeley has been pursuing the potential sale/lease of 20 of its Windy Gap units as a way to help fund storage for Greeley's remaining Windy Gap units. Greeley recently sold 3 Windy Gap units to Ft. Lupton, leased 5 units to Evans with an option to purchase, and has a lease/purchase agreement with the Little Thompson Water District for 12 units.

Greeley's current firm water supply is about 43,850 AF, which does not include any return flow obligations (RFOs) or wholly consumable supply, native, or Windy Gap water, needed to meet RFOs. However, the 43,850 AF does include about 2,350 AF of nonpotable water used for irrigation. Greeley estimates that it would be able to reuse about 80 percent of Windy Gap water if firmed, not as a potable supply because of the geographical and physical constraints, but as a supply to meet Greeley's RFOs.

Growth and Population Trend. The City of Greeley has grown from a rural community of 20,400 in 1950 to the second largest city in northern Colorado, with a population of 83,000 in 2003. Greeley's population doubled from 1960 to 1980. Population growth from 1970 to 1990 averaged about 2.2 percent per year, while population growth during the 1990s was about 2.5 percent per year.

Current Water Demand. Greeley delivers water to residential and commercial users within its service area in addition to deliveries and water treatment contracts with entities outside of its service area. Greeley provides wholesale water to the City of Evans, a Kodak plant, part of the Town of Windsor, part of the Town of Milliken, plus Garden City. These entities provide Greeley with raw water and associated water rights and Greeley treats and delivers potable water to the respective customers at master meters. The water demands associated with these customers are excluded from consideration in this analysis because Greeley is not responsible for providing any future water requirements. Greeley continues to provide water to other customers outside the City in the Greeley service area that have historically been served. This includes customers along Greeley's water transmission lines and certain agricultural customers. Greeley's water demands between 1993 and 2003 have ranged from about 19,000 to 25,000 AF. Total water use per capita, excluding wholesale accounts and those outside city limits, averaged 202 gpcd from 1993 to 2002. Single family residential water use per capita, inside Greeley city limits, averaged 194 gpcd between 1993 and 2002. Greeley residential water use, which includes single and multi-family residents use was determined to be 146 gpcd for the period from 1997 to 2005 for the Seaman-Halligan Project (Harvey pers. comm. 2007).

Projected Water Demand. Greeley's population forecast indicates an increase from 83,000 in 2003 to 126,300 in 2020, at the historical growth rate of 2.5 percent per year. By 2050, Greeley's population is projected to be 228,800 based on a 2 percent growth rate between 2020 and 2050. A total raw water requirement of about 53,500 AF is estimated by 2030, and a need of 78,500 AF is estimated by 2050



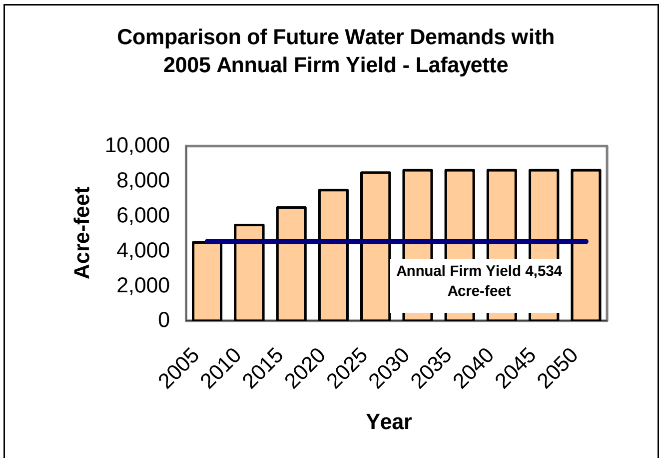
to meet potable and nonpotable water demand. Water demand forecasts for the Seaman-Halligan Project indicate a greater near-term water demand in the next 5 to 20 years, but a similar long-term demand by 2050 compared to the evaluation conducted for the WGFP. The Halligan-Seaman water demand forecast was based on population projections and average recent gpcd values, while the WGFP demand forecast was based on projections of land use type. Similar results for both demand forecasting methods corroborate Greeley's water need assessment.

Water Need. Greeley's existing water supplies are currently sufficient to meet water needs during average years of precipitation, as well as dry years. By about 2020, Greeley's water demand is expected to exceed available firm water supplies. A water supply shortage of about 9,700 AF is anticipated by 2030, and a shortage of about 34,700 AF is anticipated by 2050. Firming 44 units of Greeley's Windy Gap water could provide an annual yield of up to 4,400 AF. In the near term, the City needs the reusable effluent from Windy Gap water to meet return flow obligations and augmentation for existing operations and for added flexibility in managing its water portfolio. An annual Windy Gap water supply of 4,400 AF would provide Greeley about 6 percent of its projected 2050 water supply requirement. In addition, about 80 percent of Windy Gap water could be reused if firmed to meet Greeley's return flow obligations and augmentation requirements.

1.7.7 City of Lafayette

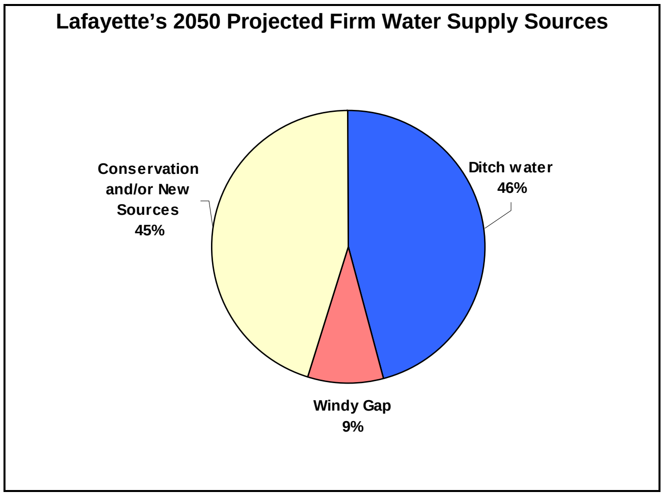
The City of Lafayette is located just east of the City of Boulder on the eastern edge of Boulder County. Bordering communities include the cities of Louisville and Broomfield, and the towns of Superior and Erie. Like many communities along the rapidly growing U.S. Highway 36 corridor, the City of Lafayette experienced significant growth in population over the last decade.

Existing Water Supply. The City of Lafayette's raw water supply is based primarily on shared ownership in several ditch and reservoir companies with diversions from Boulder Creek and South Boulder Creek. Lafayette's ownership in three reservoirs also provides storage capacity prior to water treatment and delivery. In addition, Lafayette recently joined the NCWCD and has acquired C-BT units. Lafayette has purchased 1 Windy Gap unit from Left Hand Water District and is in the process of acquiring an additional 7 units. The City is evaluating implementation of a reuse program for landscape irrigation and currently exchanges effluent for diversions from South Boulder Creek. Reuse of existing native water provides an average yield of about 200 AF. Lafayette plans to fully use all available effluent associated with Windy Gap water if firmed, which, accounting for consumptive use and losses, typically is about 80 percent depending on season of use and the reclaimed water system. The estimated firm annual water supply for the City of Lafayette is currently 4,534 AF not counting reuse water.



Annual firm yield does not include reuse water.

Growth and Population Trend. Lafayette's current service area population is estimated at about 25,500 persons. From 1979 to 2002, the City's population grew at an average annual rate of 4.6 percent. Annual growth rates for both population and the number of residential units have fluctuated. Significant growth, ranging from 8 to 10 percent per year, occurred during the early 1980s and mid-1990s, followed by periods of slower growth. In 1995, Lafayette imposed growth restrictions that limited the number of new residential dwelling permits.



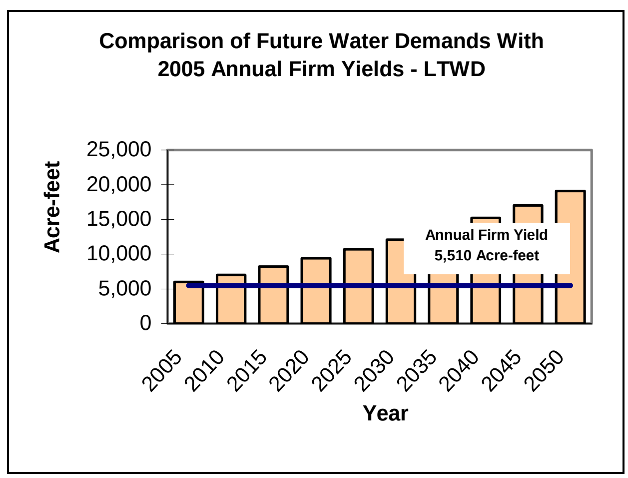
Current Water Demand. The City of Lafayette is responsible for providing water to residential, commercial, industrial, and irrigation users within the City's boundaries. In addition, the City also provides water to the East Boulder County and Baseline Water Districts to serve certain rural residential customers. As of 2004, Lafayette did not serve any large water users. Current total water demands of 4,079 AF per year serve a population within the City of 24,637 people and an additional 359 residential taps outside the City's limits. Total water use has averaged 134 gpcd and residential water use has averaged 108 gpcd for 1993 to 2003.

Projected Water Demand. Projected future growth rates of less than 2 percent indicate a build-out population estimate of about 36,000 in 2026. Future water demand projections are estimated at a rate consistent with population growth. Total raw water requirements by 2026 are estimated to be 8,600 AF, of which about 87 percent would meet potable water demand and the remainder would be used to meet nonpotable use requirements.

Water Need. Existing water supplies are currently sufficient to meet Lafayette's water needs during average years of precipitation; however water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. By build-out in about 2026, Lafayette's water demand is expected to exceed firm water supply by about 4,100 AF. Firming 8 units of Lafayette's Windy Gap water would provide a firm annual yield of about 800 AF, of which about 80 percent could be reused for nonpotable irrigation requirements. A firm Windy Gap water supply would provide Lafayette about 9 percent of the City's projected 2030 water supply requirement, not counting the reuse potential.

1.7.8 Little Thompson Water District

The Little Thompson Water District (LTWD) is a special governmental water district with customers in Larimer, Weld, and Boulder counties. The 300-square mile LTWD service area is generally bounded by the City of Loveland on the north, Longs Peak Water District on the south, the City of Greeley, the South Platte River and the St. Vrain River on the east, and the foothills on the west. The LTWD provides treated water to homes and businesses within the District.

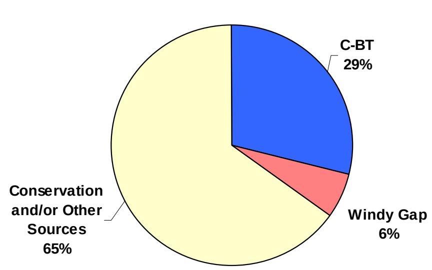


Water Supply. Currently, the LTWD relies almost entirely on C-BT water to meet its municipal and commercial water requirements. Ditch shares and direct flow rights do not provide any firm yield. The LTWD is acquiring 12 units of Windy Gap water from the City of Greeley through a lease/purchase agreement. LTWD does not currently have any sources of water that can be reused, but projects about 80 percent of Windy Gap water could be captured and reused if the project is firmed. The LTWD current firm water supply is 5,510 AF.

Growth and Population Trends. The population in the LTWD has almost doubled from about 10,800 in 1991 to 19,500 in 2003. During this time, the number of taps increased about 3.9 percent annually, excluding the LTWD expansion to become the primary service provider for the Arkins Water Association and the Town of Mead.

Current Water Demand. The LTWD provides treated water to nearly 20,000 persons in its service area. LTWD also provides treated water as a wholesale distributor to the North Carter Lake Water District, Long Peaks Water District, Town of Berthoud, and the City of Loveland. Because the LTWD is not responsible for providing the raw water for these customers, these deliveries were not included in the demand evaluation. The LTWD also serves an estimated eight to ten large agricultural and dairy water users. Total raw water requirements for the LTWD ranged from 4,000 to 5,000 AF per year between 2000 and 2003. Residential water use averaged 174 gpcd between 1998 and 2003. Total water use for the same period was 224 gpcd and is influenced by the presence of dairies and other agricultural users in the LTWD service area. In addition, LTWD acquired the Arkins Water Association and began serving the Town of Mead, which temporarily increased water use for several years.

LTWD's 2050 Projected Firm Water Supply Sources



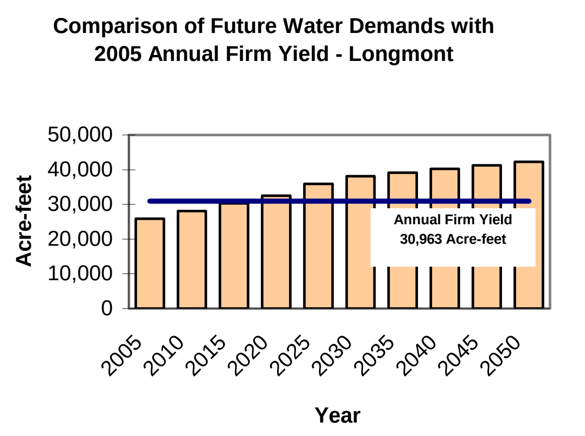
Projected Water Demand. Projected population growth in the area served by the LTWD based on historical growth in the District and northern Front Range growth projections by the Colorado Demography Office indicate a population of about 76,500 by 2050. Between 2005 and 2050, the total number of taps is projected to increase by 26,700, or an average annual rate of 2.8 percent, driven by growth in the number of residential taps. Projected demands were calculated by multiplying per tap use by the total number of taps. Total raw water requirements for the LTWD are expected to reach about 12,000 AF by 2030 and 19,000 AF by 2050.

Water Need. Existing water supplies are currently sufficient to meet the LTWD's water needs during average years of precipitation. Currently, water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. Projected 2030 water requirements exceed available firm supplies by about 6,600 AF. By 2050, demand is estimated to exceed current firm water supplies by about 13,600 AF excluding the St. Vrain Lakes Development. Firming LTWD's Windy Gap water would provide a firm annual yield of about 1,200 AF for potable needs plus about 80 percent would be available as reusable effluent to meet a portion of nonpotable demands. A firm Windy Gap water supply would provide the LTWD about 6 percent of the District's projected 2050 water supply requirement.

1.7.9 City of Longmont

The City of Longmont is the second largest and fastest growing city in Boulder County. Longmont is located about 16 miles northwest of the City of Boulder. The City was founded in 1871 and was named after the nearby Longs Peak. Similar to most urban areas along the Front Range, Longmont has experienced steady growth over the past 20 years.

Water Supply. Longmont's raw water sources come from the St. Vrain Creek basin and from the Colorado River basin. St. Vrain basin water facilities include Ralph Price Reservoir, the North Pipeline on North St. Vrain Creek, and the South Pipeline on South St. Vrain Creek. Other St. Vrain basin supplies include ownership in mutual and private ditch and reservoir companies that divert from St. Vrain Creek east of Lyons, Colorado. Colorado River basin supplies consist of the C-BT Project water and 80 units of Windy Gap Project water. Longmont's total current firm annual water supply is 30,963 AF. In addition, non-Windy Gap reusable effluent currently provides about 1,000 AF on average for nonpotable uses and the City estimates it would be able to reuse about 62 percent of Windy Gap water.

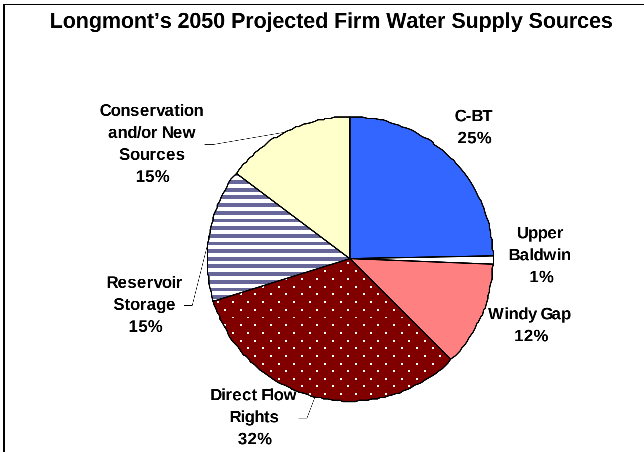


Annual firm yield does not include reuse water.

Growth and Population Trend. Longmont's population has grown from about 43,000 in 1980 to about 77,300 in 2002. Between 1990 and 2000, the increase was about 39 percent, for an average annual rate of 3.4 percent.

Current Water Demand. The City of Longmont supplies potable water inside its city limits, outside the city limits to a limited degree, and to nonpotable customers. In addition, Longmont treats water for the Town of Lyons, but this water is supplied by Lyons and is, therefore, not included in the historical demands or projections. Single family metered residential use accounts for about 80 percent of total metered residential water use inside the city, on average. Three large industrial water users—ConAgra, Amgen, and Royal Crest Dairy—represent about one-third of commercial and industrial water use. Their use has been relatively steady in recent years. In 2003, total Longmont water demand from all sources amounted to 20,900 AF. Longmont's water requirements have increased by 25 percent since 1990. Longmont's water use has averaged about 190 gpcd from 1994 to 2003, but excluding large commercial and industrial demands reduces total water use to about 175 gpcd.

Projected Water Demand. Longmont's population is projected to increase from 77,000 in 2002 to 104,000 by 2025. Raw water requirements to meet this projected demand indicate an increase from about 25,900 AF in 2005 to 38,100 by 2030, and 42,300 AF at build-out. Water demand would continue to increase even after population levels off to meet commercial and industrial needs. The increase in water use from 2005 to 2030 is about 47 percent, or an average annual rate of 1.6 percent. This compares to an average annual growth rate of 1.7 percent from 1990 through 2003 for Longmont treated water deliveries. This projection is in line with recent population projections in the City's Comprehensive Plan and is less than recent historical growth rates. Commercial and industrial water use is expected to grow disproportionably as Longmont approaches build-out. Longmont's nonpotable water demands are expected to increase almost 50 percent by 2030.



Water Need. Longmont's water demand is expected to exceed available firm water supplies by about 2017, which would affect the ability of the City to meet dry year water needs depending on C-BT deliveries. A shortage in annual firm yield of about 7,000 AF is projected by 2030 and about 11,000 AF in 2050. Firming Longmont's Windy Gap water supply would provide about 5,125 AF of water based on the City's storage request and preliminary modeling, or about 12 percent of the

City's 2050 firm water supply. Firming Windy Gap water would provide reusable effluent of about 62 percent, which would contribute to meeting nonpotable water demand.

1.7.10 City of Louisville

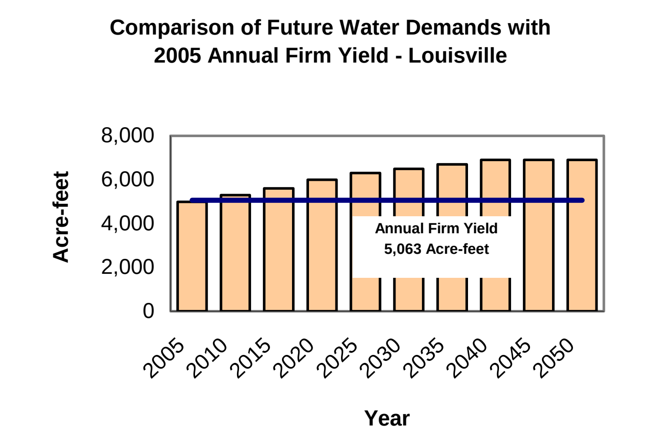
The City of Louisville is located in Boulder County about 6 miles east of the City of Boulder and 25 miles northwest of Denver. Louisville supports a residential community and associated commercial and industrial businesses. Louisville city limits cover an area of about 8.6 square miles including 1,700 acres of designated open space.

Existing Water Supply. The City of Louisville's primary sources of water supply include direct flow rights from South Boulder Creek and C-BT Project water. Ownership of shares in the Marshall Division of the Farmers Reservoir and Irrigation Company also contributes to the firm water supply. Louisville owns 6 units of Windy Gap water and is lease/purchasing an additional 3 units from Greeley. Louisville's current firm water supply is 5,063 AF. In addition, about 300 AF of water is currently available for nonpotable reuse from native sources, and this could increase incrementally up to 900 AF in the future. Reuse water from the wastewater treatment plant is used for golf course and sports field irrigation. Louisville would reuse about 45 percent of its firmed Windy Gap water for irrigation.

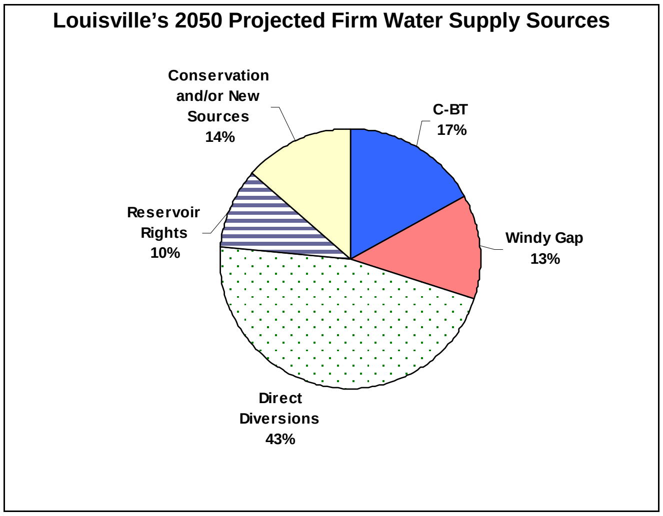
Growth and Population Trend. The City of Louisville's 2003 population was estimated at 18,387. From 1990 through 2003, population grew 49 percent, or at an average annual rate of 3.1 percent. The average annual growth rate for the total number of residential water taps was 0.2 percent from 1998 through 2003, and commercial water taps increased at an average annual rate of 7.1 percent in the same period. Population grew most significantly in the early and mid-1990s, while residential water taps have remained almost the same since 1998. Commercial growth has been considerable since 1998. The commercial sector is anticipated to generate the majority of future growth in water taps and usage in the City of Louisville.

Current Water Demand. The City of Louisville is responsible for providing water to residential, commercial, industrial, and irrigation users within the City's boundaries. The City also provides water to several residential and one commercial customer just outside the city limits. Louisville's largest water user is StorageTek. Residential users have historically accounted for the majority of total deliveries at 66 percent; commercial users accounted for an average of 23 percent of total potable water use. Louisville's total water requirements have ranged from about 4,300 to 6,300 AF per year from 1998 to 2003. From 1998 through 2003, residential water use averaged 112 gpcd. Total water use per capita per day averaged 171 gallons.

Projected Water Demand. The City of Louisville's is projected to reach a residential build-out population of 23,000 by 2025. A 1 percent growth rate in population and a 1.5 percent growth rate in commercial square footage were used to estimate future water demands. The City anticipates that commercial square footage would remain stable to 2007, and then increase at an annual growth rate of 1.5 percent. Based on the projected rate of growth, the City of Louisville would reach residential build-out by 2025 and commercial build-out by 2045. A total raw water requirement of about 6,900 AF per year is estimated for 2050. Total water requirements are anticipated to increase by 38 percent from 2003 through 2050, or at an average annual rate of 0.7 percent.



Annual firm yield does not include reuse water.



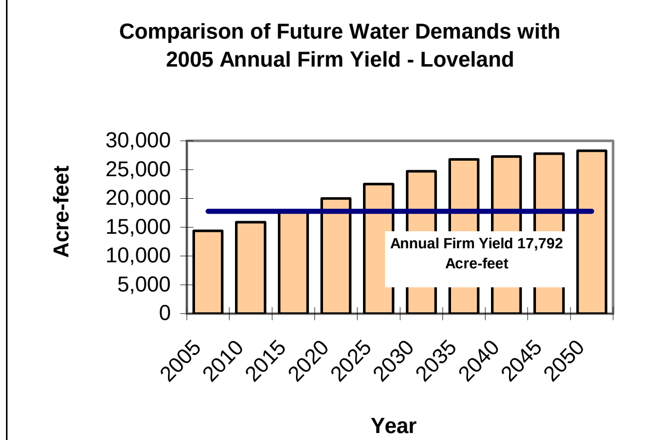
Water Need. Existing water supplies are currently sufficient to meet the Louisville's water needs during average years of precipitation. Currently, water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. The City of Louisville is estimated to reach residential build-out by 2025 and commercial build-out by 2045. In 2050, a firm water supply shortage of about 1,800 AF is anticipated. Firming Louisville's 9 Windy Gap units would provide the City with up to 900 AF of water, or about 13 percent of the City's 2050 projected water supply need. Reuse of native water supplies up to 900 AF and capture and reuse of an estimated 45 percent of Windy Gap effluent also could contribute to meeting nonpotable demands. Although Louisville's future nonpotable water supply appears to be adequate to meet those needs, the City would need to develop additional water to meet potable water requirements.

1.7.11 City of Loveland

The City of Loveland is located 50 miles north of Denver in southeastern Larimer County. Loveland has experienced rapid population growth between 1990 and 2003 within the 23.5 square miles of the city limits.

Existing Water Supply. The City of Loveland has two categories of water supply—transbasin supplies and transferred native ditch water rights. Transbasin supplies consist of C-BT and Windy Gap water. Transferred native ditch rights are diverted directly from the Big Thompson River to the water treatment facility for use in meeting potable water demand or stored in Green Ridge Glade Reservoir. A portion of the ditch shares not transferred for municipal use currently provides a nonpotable water source for meeting park and golf course irrigation needs. Loveland owns 40 units of Windy Gap water. Loveland's current firm water supply is 17,792 AF including about 1,000 AF of nonpotable water. In addition, the City has limited capability for reuse of native water and is evaluating options for the potential reuse of a firm Windy Gap supply.

Growth and Population Trend. In 2003, the City of Loveland had a population inside its city limits of 58,170, but the Loveland Water Utility also serves over 5,000 additional customers within Loveland's Growth Management Area (GMA). From 1990 through 2003, Loveland's population grew by about 20,800, or more than a 50 percent increase.



Annual firm yield does not include reuse water.

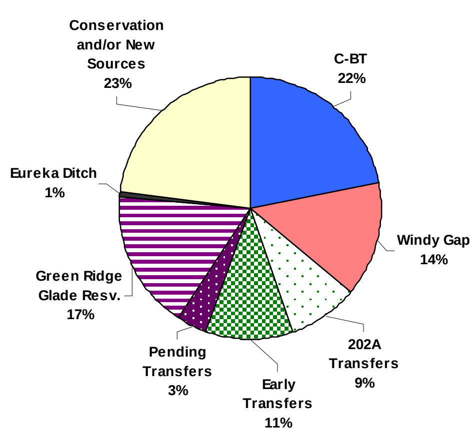
Current Water Demand. The City of Loveland potable water demand includes residential and nonresidential water use inside and outside the City, ranch water picked up by water haulers, construction water delivered through fire hydrants, and wholesale water marketed to the Little Thompson Water District, Fort Collins-Loveland Water District, and the City of Greeley. Total potable water sales to Loveland service area end users increased by 3,250 AF between 1990 and 2002, or about 50 percent. About 80 percent of Loveland's total water deliveries were dedicated to residential use over this time period. Commercial water use accounted for 15 percent of water use, while the remainder was accounted for by industrial, city, ranch water, construction water and wholesale water deliveries.

Total water requirements, including potable and nonpotable demand and system losses, increased from 9,200 AF to 13,167 AF between 1990 and 2002. Residential gpcd has fluctuated within a narrow range from 1990 to 2003, with an average over that period of 117 gpcd. Total water use averaged 172 gpcd during the same period. Loveland serves industrial and commercial users outside its service area, which increases gpcd. Loveland also has sold wholesale water in the past, although this practice was greatly reduced in 2003.

Projected Water Demand. Population forecasts for the City of Loveland estimate an annual growth rate between 1.7 percent and 2.7 percent. This rate of population change is well below the historical growth rate experienced from 1990 to 2003, but similar to Larimer County growth projections. The service area population is projected to reach about 127,000 by 2035. Employment growth projections range between 1.3 and 2.6 percent from 2005 to 2030. By 2050, water demand is estimated to be about 28,300 AF.

Water Need. Loveland's existing water supplies are currently sufficient to meet water needs. Loveland's water demand is expected to exceed available firm water supplies by about 2015, which may affect the ability of the City to meet dry year water needs depending on C-BT deliveries. A firm yield shortage of about 6,900 AF in 2030 and about 10,500 AF in 2050 is projected, if Loveland relies only on existing usable supplies. Firming the Windy Gap water supply would provide Loveland about 4,000 AF of water, or about 14 percent of the City's projected 2050 water supply. To increase its firm yield, Loveland is currently pursuing acquisition of 1,000 AF of additional storage in the WGFP from Platte River. If this transaction is completed, it would not change overall WGFP storage requirements of 90,000 AF, but would slightly increase the firm yield to Loveland. Reuse of Windy Gap water also would contribute to meeting nonpotable demands.

Loveland's 2050 Projected Firm Water Supply Sources



1.7.12 Middle Park Water Conservancy District

The Middle Park Water Conservancy District was formed in 1950 as a direct result of the development of the C-BT Project. The MPWCD serves as a representative of water interests in Grand and Summit counties and administers distribution of water from several projects to a variety of water users including municipal, private, and water and sanitation districts. MPWCD currently allocates water supplies from the Windy Gap Project and Wolford Mountain Reservoir.

Existing Water Supply. Agreements resulting from the construction of the original Windy Gap Project require that the Municipal Subdistrict, Northern Colorado Water Conservancy District, dedicate and set aside annually, but non-cumulatively, the first 3,000 AF of water in Granby Reservoir that is produced each water year from Subdistrict water supplies, for beneficial use without waste, either directly or by exchange or substitution, in MPWCD. Windy Gap water stored in Granby Reservoir for the MPWCD is the last to be spilled if the reservoir fills. If MPWCD's Windy Gap water is not used in the year it was diverted, it cannot be carried over for the following year.

MPWCD also receives 3,000 AF of storage in Wolford Mountain Reservoir in an agreement with the CRWCD. MPWCD allocates Wolford Mountain water to 28 contractees in Summit and Grand County similar to Windy Gap water.

Growth and Population Trend. In 2000, the population of Grand County was 12,900 and Summit County had 25,700 residents. Population projections indicate a Grand County population of 28,800 and a Summit County population of 50,400 by 2030 (DOLA 2004b). These figures do not include seasonal residents or visitors to either county, both of which have substantial recreation tourism in the summer and winter.

Current Water Demand. The MPWCD is a wholesale water supplier for 67 water providers and users in Grand and Summit counties. These water providers have contracts with MPWCD to use Windy Gap water, as requested and as available, on an annual basis. The water providers, also known as contractees, include towns, water districts, agricultural water users, and ski areas. The MPWCD contractees use MPWCD water for augmentation purposes in conjunction with other supplies. Some of the larger contract holders of MPWCD Windy Gap water rely on a variety of other primary sources of water to meet their total demand including surface water diversions, ditches, exchange agreements, and alluvial ground water. In addition, the MPWCD uses its water supply for exchanges, trades, and other agreements with other Colorado water providers. Currently, MPWCD's Windy Gap water is a supplemental supply to contract entities and only a portion of each individual entity's water supply. However, MPWCD water is the sole source of water for a number of small private augmentation water users, such as subdivisions and private landowners. Delivery of Windy Gap water to the MPWCD has historically ranged from 0 to 624 AF, although 2,680 AF was requested by contractees in 2004. Estimated water demand totaled 11,159 AF in 2000 for both Grand and Summit counties—3,132 AF in Grand County and 8,027 AF in Summit County.

Projected Water Demand. The MPWCD does not prepare its own water demand projections. MPWCD's role is simply to respond to the needs of its contractees to the limit of its water supplies. Future water demand or allotment needs for MPWCD are based on previous studies and an examination of the overall future water resource requirements for Grand and Summit counties as an indication of contractees' demands.

By 2030, Summit County year-round population is projected to increase by 96 percent from 2000, and Grand County year-round population is expected to increase by 123 percent over that same 30-year period. Summit County employment is expected to increase by 138 percent, or 29,900 employees, between 2000 and 2030. Grand County employment is expected to increase by 144 percent, or 12,000 employees, during that same period (DOLA 2004c). Water used for snowmaking and livestock is not anticipated to change substantially in the future. Summit and Grand counties are likely to experience substantial increases in water demand between 2000 and 2030, primarily from residential and commercial growth. Total potable demand by 2030 is projected to increase by about 17,000 AF, including 13,500 AF for residential use and 3,750 AF for commercial use. The *Upper Colorado River Study* (Hydrosphere 2003a) projected total demand at build-out of about 32,000 AF.

Water Need. The MPWCD is anticipating needing additional reliable sources of water supply to meet both current demand and anticipated future demands. While actual use has varied from year to year, the projected future increase in residential and commercial demand of about 17,000 AF by 2030 indicates a substantial shortage. The Windy Gap Project would provide the MPWCD with up to 3,000 AF of storage to assist in meet existing and future demands. Colorado water law does not allow the MPWCD to reuse Windy Gap water because the water would be used within the basin of diversion. Currently almost 90 percent of the Windy Gap Project water is contracted for. Additional sources of water would be needed to meet the remainder of future demands.

1.7.13 Platte River Power Authority

Platte River Power Authority (Platte River) is a joint action governmental entity owned by the municipalities of Estes Park, Fort Collins, Longmont, and Loveland. Platte River was established in 1973 to meet the wholesale electric energy requirements of these municipalities. The Rawhide Energy Station (Rawhide) is owned and operated by Platte River and provides electric power.

Existing Water Supply. Platte River owns 160 units of Windy Gap water. Platte River's raw water supply is based on the availability of Windy Gap water and a Reuse Agreement with Fort Collins and the Water Supply and Storage Company (WSSC). Up to 4,200 AF of reusable effluent is delivered from the City of Fort Collins for use at Rawhide under the Reuse Agreement. In return, Platte River provides Fort Collins with an equivalent amount of Windy Gap water. Platte River direct flow rights, reservoir storage rights in Hamilton Reservoir, and a limited number of native ditch shares in Larimer County Canal No. 2 provide other minor sources of water. In addition, Platte River takes delivery of 950 AF of its Windy Gap water directly from Horsetooth Reservoir via an existing 10-inch pipeline when water is available. Platte River's water reuse program has two components: 1) the majority of the water used for cooling is effluent supplied by Fort Collins under the Reuse Agreement; 2) Platte River continues to recycle and reuse this cooling water to extinction. The current operation to meet Platte River's water supply needs is subject to the availability of Windy Gap water and these deliveries are not reliable.

Growth and Population Trend. Platte River is seeking to firm 51.5 of the 160 Windy Gap units that it currently owns to meet the current needs of the existing power facility. Energy load projections for Platte River indicate a continued increase for demand for electric power within Platte River's owner municipalities as these areas continue to grow. Future water demands would be based upon increased power requirements and related generating facility development to meet those electricity demands.

Current Water Demand. Platte River's current operational water demand averages about 4,520 AF per year. This includes 3,261 AF on average of effluent from the City of Fort Collins for use primarily for cooling, and 950 AF of relatively cleaner water taken directly from Horsetooth Reservoir and used for boiler make-up water and potable water. About 630 AF of water provides an operational reserve to meet fluctuations in water demand, or if not required, the water is leased. Platte River has an additional need for 309 AF to meet well and ditch augmentation requirements and a long-term lease obligation with Larimer County.

Projected Water Demand. Although Platte River may need additional water in the future associated with expansion of power generation capacity as demand for electricity increases, its participation in the WGFP is based on providing a firm reliable source of Windy Gap water to meet its current water requirements. Additional power generation is likely to be needed within the next 15 years. Platte River is currently evaluating options for meeting future new power generation needs. Water demands for Platte River's portion of new thermal power generation would be about the same proportion as that used for current coal-fired generation. A location for the future generation facility has not yet been determined. Platte River's Windy Gap Project units not included in the proposed WGFP may be used to help meet the water requirements of such new generation. Future water demands would be based on the timing of power generation needs.

Water Need. Platte River's participation in the WGFP is to meet the water needs for their current power generation facility, not to meet future water needs for expansion of power generating capacity. Platte River needs a firm annual supply of 5,150 AF of water to meet its obligations under the Reuse Agreement that supplies the current operational needs for the Rawhide Energy Station. The Reuse Agreement between Platte River, Fort Collins, and WSSC requires the availability of Windy Gap water. Platte River is currently considering transferring 1,000 AF of storage in the WGFP to the City of Loveland. This transaction, if completed, would not affect overall project storage requirements of 90,000 AF, but Platte River's firm yield from the WGFP would decrease.

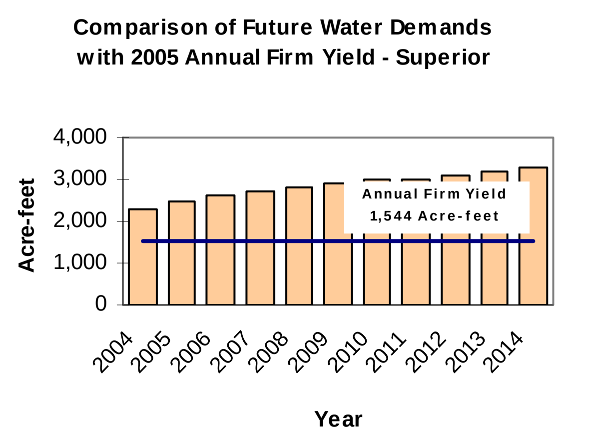
There are numerous scenarios, i.e., drought, under which there is no assurance that Platte River's water supplies will be sufficient or available when needed. Without the firming of the Windy Gap units, the ongoing operation of the Rawhide Energy Station is vulnerable to curtailed operations.

1.7.14 Town of Superior

The Town of Superior is located in southeast Boulder County and northern Jefferson County and is considered part of the greater Denver Metropolitan Area. The Town of Superior was founded in 1896 and remained small until the early 1990s when the Rock Creek Ranch residential development began construction. The Town has grown rapidly during the past decade, but residential growth has tapered off.

Water Supply. Currently, the Town of Superior relies primarily on C-BT water and local ditch water to meet its municipal and commercial water requirements. Windy Gap water, when available, is also used to meet potable water needs and is captured and reused for nonpotable irrigation. The

Town of Superior currently owns 15 units of Windy Gap water, after the sale of 7 units to the Town of Erie. If Windy Gap water is firmed, the City estimates that about 32 percent could be reused for irrigation. Superior's current firm annual water supply is 1,544 AF.



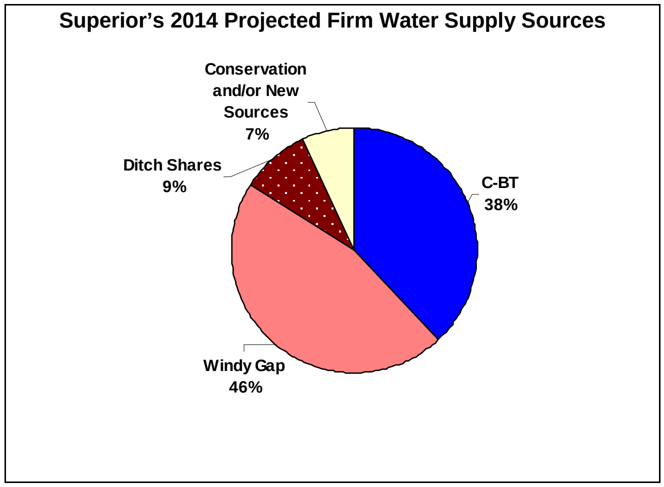
Annual firm yield does not include reuse water.

Growth and Population Trend. As population growth commenced in the early 1990s, average annual growth became extraordinary, with an average population increase of 33 percent from 1990 through 2004. Since 2000, the average annual population growth has slowed in relative terms but still exceeds 5 percent on an annual basis. The growth in the number of water taps also slowed after 2000, but still grew more than 20 percent between 2000 and 2003. As of 2004, the Town of Superior's population was estimated at 11,000.

Current Water Demand. Superior does not serve any other communities with water nor does it receive water from other communities. Superior's total water deliveries more than tripled between 1995 and 2003, and average annual growth in water deliveries was 33.5 percent from 1995 through 2003. Total water requirements have increased from 1,127 AF in 1997 to 2,277 AF in 2003. From 1995 to 2003, Superior's total water use averaged 135 gpcd.

Projected Water Demand. The Town of Superior is projected to reach build-out in 2014, when the population of the town reaches 15,400. Compared with the 2004 population estimate of 11,000, the Town is expected to experience an average annual growth of 3.4 percent. Potable water deliveries are expected to increase by 211 AF from 2004 through 2014. Total potable water usage is projected to exceed 1,700 AF by 2014. The Town of Superior plans to maximize the use of nonpotable water for outdoor uses in the future. Total increases in nonpotable use call for a doubling from 2004 level of 700 AF to 1,400 AF at build-out. Total water requirements are projected to increase from 2,500 AF in 2005 to 3,300 AF in 2014.

Water Need. Superior's existing water supplies are sufficient to meet current water needs during average years of precipitation. Beginning in 2005, water demand could exceed available firm water supplies during dry years, depending on C-BT deliveries. A shortage in firm yield of about 1,800 AF is anticipated by build-out in 2014 if the WGFP is not completed. Firming Superior's Windy Gap water supply would provide up to 1,500 AF of water, or about 46 percent of the Town's projected 2014 water supply. Reuse of Windy Gap water also would contribute to meeting future nonpotable water demand.



1.8 Windy Gap Firming Project Participant Water Needs

1.8.1 Projected Shortages in Firm Yield

The evaluation of the water supplies and demands for each Project Participant indicates that projected water demand would exceed available firm yield in the near future. Project Participants have a firm water supply of about 141,000 AF and a demand of about 120,000 AF in 2005. By 2030, the cumulative water demand for all East Slope Project Participants is projected to reach about 205,000 AF, which would result in a shortage in firm yield of about 64,000 AF. Water demand for East Slope Participants is projected to increase to about 251,000 AF by 2050 and shortages in firm yield at that time would increase to more than 110,000 AF. An additional water demand of up to 17,000 AF by 2030 is projected for West Slope water users partially served by the MPWCD. The lack of a reliable firm water supply would affect the ability of all of these entities to meet anticipated water needs in dry years. The projected shortages in firm water supply over the 2005 to 2050 year period are shown in Table 1-5.

Existing water supplies will meet the current water needs for most Project Participants during average years of precipitation, but supply shortages in dry years are expected to occur within the next 20 years for all of the Project Participants. For many East Slope Participants, a deficit in firm yield could occur soon, depending upon C-BT yields. Other Project Participants have a foreseeable future need for their Windy Gap water supply before 2025.

Project Participants have implemented a variety of effective conservation measures to reduce water demand. Additional improvements in water use efficiency and delivery systems are expected to continue in the future and are an important component in meeting future water supply requirements. While continued conservation is necessary, it would not eliminate the need for the proposed WGFP and for some Participants the development of additional sources of new water. Projected future water requirements indicate that even with the WGFP, Participants will need additional conservation savings or additional water sources to meet from about 10 to 65 percent of 2050 future water needs.

1.8.2 Project Participant Firm Yield Goals

To meet a portion of identified current and future water demands, Project Participants are proposing to improve yields from the existing Windy Gap Project. The proposed WGFP is based on the existing water rights associated with the original Windy Gap Project and does not expand on those rights or the diversion amounts in the original 1981 Windy Gap Project EIS. The proposed WGFP does not necessarily meet all the future water requirements for each Participant, but rather seeks to improve the yield of each Participant's Windy Gap water delivery. Project Participants may seek additional water supplies through other projects, but the intent of the WGFP is only to improve the yield from an existing project and existing Windy Gap water rights.

The proposed WGFP would not firm all of the original 480 Windy Gap units (48,000 AF based on 100 AF/unit) because some Windy Gap owners are not participating in the project. In addition, some Firming Project Participants are not firming all of the units they own. Firming Project Participants own 439 Windy Gap units (Table 1-6). The remainder of the units is owned by the City of Boulder and the Town of Estes Park who are not participating in the WGFP. A total of 344.5 Windy Gap units are included in the WGFP

Several Participants do not currently own Windy Gap units, but are leasing or in the process of purchasing units. The Little Thompson Water District has a lease purchase agreement to acquire 12 units of Windy Gap water from the City of Greeley; likewise, the City of Evans has a lease purchase agreement to acquire 5 units from Greeley.

Louisville has a long-term lease of 3 units from Greeley. The City of Lafayette has acquired 1 Windy Gap unit and is in the process of acquiring an additional 7 units. Erie recently acquired 7 units from Superior and plans to acquire 6 units from other unit holders. In addition, the City of Loveland is pursuing acquisition of 1,000 AF of Platte River's storage in the project. If completed, this change would not affect overall WGFP water storage needs of 90,000 AF or water diversions, but would slightly increase Loveland's yield and slightly decrease Platte River's yield.

> A 64,000 AF shortage in firm water supplies is projected for East Slope Participants by 2030. By 2050, the firm yield shortage would be over 110,000 AF.

Table 1-5. Projected cumulative surplus or shortage (-) in firm annual yield for Windy Gap Participants.

Participant	Firm Supply	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	Year of Projected Shortage
						AF						
Broomfield	13,739	-561	-3,561	-5,661	-6,761	-7,961	-9,361	-10,661	-10,661	-10,661	-10,661	2005
CWCWD	2,786	-414	-814	-1,114	-1,414	-1,714	-1,914	-2,314	-2,614	-2,814	-3,114	2005
Erie	2,145	-355	-2,255	-3,755	-5,255	-6,755	-6,755	-6,755	-6,755	-6,755	-6,755	2005
Evans	9,298	4,698	3,398	2,298	898	-402	-1,802	-3,502	-4,002	-4,002	-4,002	2025
Fort Lupton	3,538	-562	-662	-862	-1,162	-1,462	-1,662	-2,062	-2,362	-2,762	-3,262	2005
Greeley	43,850	16,150	11,450	6,050	-50	-4,650	-9,650	-15,150	-21,150	-27,650	-34,650	2020
Lafayette	4,534	34	-966	-1,966	-2,966	-3,966	-4,066	-4,066	-4,066	-4,066	-4,066	2006
LTWD	5,510	-490	-1,490	-2,690	-3,890	-5,190	-6,590	-7,990	-9,690	-11,490	-13,590	2005
Longmont	30,963	5,063	2,863	663	-1,537	-4,937	-7,137	-8,187	-9,237	-10,287	-11,337	2017
Louisville	5,063	63	-237	-537	-937	-1,237	-1,437	-1,637	-1,837	-1,837	-1,837	2006
Loveland	17,792	3,392	1,892	-8	-2,208	-4,708	-6,908	-9,008	-9,508	-10,008	-10,508	2015
MPWCD[1]	0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Platte River	0	-5,150	-5,150	-5,150	-5,150	-5,150	-5,150	-5,150	-5,150	-5,150	-5,150	2005
Superior	1,544	-956	-1,456	-1,756	-1,756	-1,756	-1,756	-1,756	-1,756	-1,756	-1,756	2005
Cumulative Total [2]	**140,762**	**20,912**	**3,012**	**-14,488**	**-32,188**	**-49,888**	**-64,188**	**-78,238**	**-88,788**	**-99,238**	**-110,688**	

[1] Grand and Summit Counties 2000 total water demand based on the UPCO Study (Hydrosphere 2003a) is about 11,000 AF. Sources other than Windy Gap are currently used to meet water demands. The MPWCD has an immediate need for Windy Gap water for use in augmentation of other withdrawals and diversions.

[2] The cumulative total includes the total firm supply of all participants and the collective surplus or shortage in firm annual yield. Participants individually meet any shortages.

Table 1-6. Project Participant Windy Gap units, storage request, and firm yield goals.

Participant	Windy Gap units	Windy Gap units in WGFP	Storage request (AF)	Firm Yield Goal (AF)
Broomfield	56	56	25,200	5,600
CWCWD	1	1	330	100
Erie [1]	14	20	6,000	2,000
Evans[1]	0	5	1,750	500
Fort Lupton	3	3	1,050	300
Greeley	64	44	7,000	4,400
Lafayette[1]	1	8	1,800	800
LTWD[1]	0	12	4,850	1,200
Longmont[1]	80	80	13,000	5,125
Louisville[1]	6	9	2,700	900
Loveland	40	40	6,000	4,000
MPWCD[2]	0	0	3,000	3,000[1]
Platte River	160	51.5	13,000	5,150
Superior	15	15	4,500	1,500
TOTAL	**440**	**344.5**	**90,180**	**34,575**

[1] Acquiring additional Windy Gap units.

[2] The MPWCD does not own Windy Gap units, but is requesting firming storage for its Windy Gap water. The estimated firm yield for the MPWCD and other Participants for each of the alternatives is discussed in Chapter 3.

Because the Windy Gap Project water rights are junior to many water rights in the Colorado River basin, the WGFP would not be able to divert and store water every year. Thus, diversions during wet years would be stored for use during dry years. As more water is stored, the firm yield approaches 100 AF per unit.

While theoretically each unit of Windy Gap Project water would provide a yield of 100 AF, the actual firm yield depends on the amount of storage volume constructed and the actual project operation for each alternative. Project Participants have each requested storage in the Firming Project based on several factors, including their projected need, preliminary yield estimates, and the cost of storage. Storage requests for all Participants total 90,180 AF and the firm yield goal is 34,575 AF (Table 1-6). This includes 31,575 AF for Windy Gap allottees and 3,000 AF for the MPWCD. Firm yield goals for Windy Gap allottees would firm 315 units of the 480 units in the original Windy Gap Project at a yield of 100 AF/unit. The storage request for some Participants may provide a firm yield of close to 100 AF per Windy Gap unit. For Participants with lower storage requests in relation to the number of Windy Gap units they own, the yield would be less.

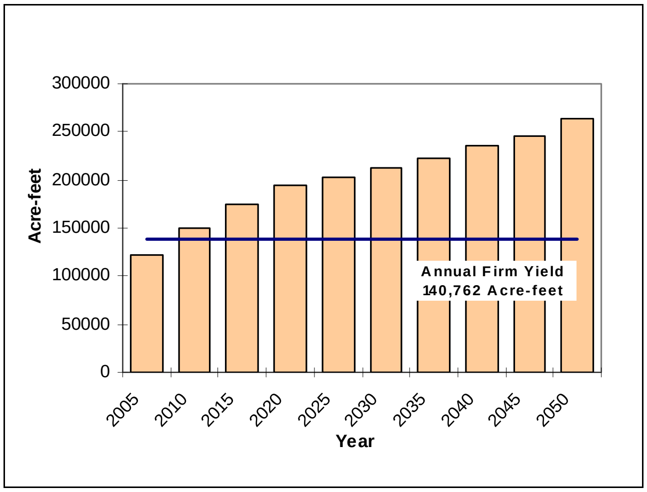
Firm yield for the WGFP also depends on future water development in the Colorado River basin and its effect on Windy Gap water rights; thus, actual firm yield may differ from firm yield goals. Chapter 3 provides an analysis of the estimated firm yield associated with each of the alternatives described in Chapter 2 and the contribution of the WGFP in meeting projected water needs.

About 90,000 AF of new storage is needed to meet Participants' firm yield goals.

1.8.3 Summary

Projected water demands indicate that the Project Participants individually and collectively will have a shortage in annual firm yield in the near future (Figure 1-10). The projected shortage in firm water supply supports the purpose and need of the proposed WGFP to firm about 30,000 AF of Windy

Figure 1-10. Combined future total water raw water requirements and current annual firm yield for WGFP Participants.



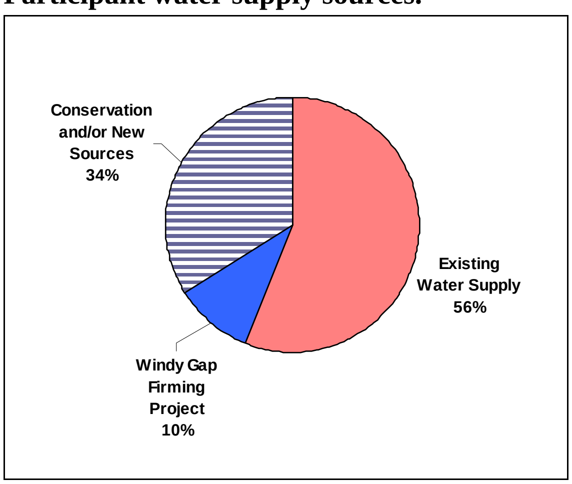
Gap Project water for East Slope Project Participants and provide up to 3,000 AF firming storage of Windy Gap water for the MPWCD. The WGFP would provide about 10 percent of the cumulative water supply needs for the Participants in the year 2050 (Figure 1-11). Other new sources of water including conservation measures would be needed to meet projected shortfalls.

1.9 Scoping and Issues

1.9.1 Scoping

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 EIS. 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 September to November 2003), Reclamation sought and received input from the public, interested organizations, and agencies to help identify issues for evaluation in the EIS.

Figure 1-11. Summary of projected 2050 Participant water supply sources.



Several methods were used to inform the public and solicit comments, including public information meetings in July 2003, publication of a Notice of Intent in the Federal Register on September 8, 2003, and distribution of a scoping announcement prior to three public scoping meetings in Granby, Loveland, and Lyons, Colorado. An agency scoping meeting also was held to gather input from federal, state, and local government agencies. More information on the public involvement process is included in Chapter 4 *Consultation and Coordination*.

1.9.2 Key Issues Identified for Analysis in the EIS

Reclamation received about 160 written submissions during the scoping period on a broad range of potential issues. A detailed scoping report describing the public scoping process and the comments received was released on December 19, 2003 (ERO 2003a). A copy of the scoping report is located on Reclamation's website at http://www.usbr.gov/gp/nepa/quarterly.cfm#ecao, or is available by contacting the U.S. Bureau of Reclamation Eastern Colorado Area Office.

Based on comments received during scoping meetings and in consultation with cooperating agencies, Reclamation identified major issues for evaluation in the EIS as listed below. Because some of the alternatives presented during scoping have changed during the course of the NEPA investigation, comments related to previously considered reservoir sites are no longer applicable.

In addition to these primary issues, the EIS briefly addresses other minor issues.

1.9.2.1 Water Resources

- How would Firming Project diversions impact streamflow in the Colorado River and East Slope streams?
- Would there be any changes in the operation of existing reservoirs, including Granby Reservoir, Shadow Mountain, and Grand Lake (collectively referred to as the Three Lakes) on the West Slope and Carter Lake and Horsetooth Reservoir on the East Slope?
- What would be the impact to water quality in the Colorado River, the Three Lakes and East Slope streams and reservoirs, including any new reservoirs?
- Would there be any water quality impacts to the Fraser River?
- Would there be impacts to ground water recharge in Grand County?

1.9.2.2 Biological Resources

- What would be the effect to riparian and wetland vegetation at existing and new reservoir sites and along affected streams?
- Would there be an impact to threatened or endangered species including downstream Colorado River endangered fish?
- What would be the potential effect to native vegetation communities and sensitive plant species?
- How would changes in Colorado River flow and water quality affect aquatic life, including the potential for the spread of whirling disease on the West and East Slope?
- How would wildlife species and habitat be affected by construction of new reservoirs?

1.9.2.3 Recreation

- How would kayaking and rafting be affected by changes in Colorado River flow?
- Would storage changes in the Granby Reservoir and East Slope C-BT reservoirs affect water based recreation?
- What recreational activities would occur at new reservoirs and who would be responsible for management?

1.9.2.4 Cultural Resources

- Would significant cultural resources be affected by new reservoirs or other facilities?

1.9.2.5 Land Use

- Would any private lands, residences, or commercial properties be affected by new reservoirs?
- Would there be any impact to county open space properties?
- How would land ownership change?
- How would land use near new reservoirs change?
- How would new facilities affect transportation, both during construction and over the long-term?

1.9.2.6 Socioeconomics

- What are the economic consequences of reservoir construction to local communities?
- How would property values be affected by new reservoirs?
- How would tourism on the West Slope be affected by potential changes in water-based recreation?
- How would the project be financed?

1.9.2.7 Other Issues

- Would the proposed Firming Project conflict with the purpose of the C-BT Project?
- What is the relationship between the proposed Firming Project and operation of the C-BT Project in conformance with Senate Document 80, which provides the operating conditions for the C-BT Project?
- Would the storage of C-BT water in a new Windy Gap reservoir require an amendment to the exiting Carriage Contract between the NCWCD and Reclamation?

1.10 The Decision Process

A number of decisions, permits, and approvals are needed from federal, state, and local agencies to implement WGFP alternatives. Reclamation is responsible for NEPA compliance and other decisions associated with use and connection to C-BT facilities, any changes in C-BT operations, and use of Reclamation land. The Corps of Engineers, as a cooperating agency, is assisting with preparation and review of the EIS and has regulatory authority for any Section 404 dredge and fill permitting requirements under the Clean Water Act. The Western Area Power Administration, a federal power marketing agency in the U.S. Department of Energy, will make a decision on the relocation of a transmission line for the Chimney Hollow Reservoir alternative. Both the Corps and Western are using this EIS to meet NEPA compliance requirements for their federal actions associated with the WGFP.

1.10.1 Reclamation Decisions

As the lead agency, Reclamation is responsible for preparation of the EIS and Record of Decision. In addition, Reclamation must make several decisions regarding potential actions associated with implementation of the Proposed Action or other alternatives. All of the action alternatives would involve a physical connection of WGFP conveyance facilities on the East Slope to C-BT facilities. Reclamation will need to decide whether to allow for this connection. The No Action Alternative does not require any authorization by Reclamation.

Because the Proposed Action includes the storage of C-BT water in a new Firming Project facility (a concept referred to as prepositioning), Reclamation also will need to make a decision regarding accounting changes in the C-BT system to allow water storage and exchange between the two projects to occur. Implementation of prepositioning may require modification or replacement of the existing conveyance and storage contract between Reclamation, the Subdistrict, and the NCWCD.

Reclamation action will be needed if Jasper East Reservoir is constructed because the reservoir would be partially located on Reclamation property and use of these lands would likely result in the sale or exchange of property with the Subdistrict. In addition, construction of Jasper East Reservoir would require relocation of the Willow Creek Pump Station and Canal. Reclamation will need to make a decision regarding the relocation of these C-BT facilities if Jasper East Reservoir is constructed.

1.10.2 Senate Document 80 and Section 14 Analyses

Prior to entering into a contract that would allow use of C-BT excess capacity, Reclamation must determine that the excess capacity contract is consistent with the provisions of Senate Document 80 (SD 80) and Reclamation's authority under Section 14 of the Reclamation Project Act of 1939 (43 U.S.C. §389). This determination will be made available at a later time and is not part of this EIS. However, following is an explanation of the factors that will be considered in making this determination.

1.10.2.1 Senate Document 80

The "Manner of Operation of Project Facilities and Auxiliary Features" ("Manner of Operation") is set forth on pages 2 through 5 of SD 80 and is incorporated into the Blue River Decrees, which decreed water rights for the C-BT Project. The Manner of Operation states that the C-BT Project, "… must be operated in such a manner as to most nearly effect the following primary purposes:"

1. To preserve the vested and future rights in irrigation.
2. To preserve the fishing and recreational facilities and the scenic attractions of Grand Lake, the Colorado River, and the Rocky Mountain National Park.
3. To preserve the present surface elevations of the water in Grand Lake and to prevent a variation in these elevations greater than their normal fluctuation.
4. To so conserve and make use of these waters for irrigation, power, industrial development, and other purposes, as to create the greatest benefits.
5. To maintain conditions of river flow for the benefit of domestic and sanitary uses of this water.

To accomplish these purposes, Manner of Operation goes on to state that the project, "… should be operated by an unprejudiced agency in a fair and efficient manner, equitable to all parties having interests therein…" and in conformity with lettered 12 stipulations.

Reclamation's determination will consider the effects of the proposed project on Reclamation's ability to continue meeting the five primary purposes of the C-BT Project and whether or not the C-BT Project can continue to be operated in accordance with lettered stipulations (a) through (l) in the Manner of Operation.

> Reclamation will decide on whether to allow the Subdistrict to connect Windy Gap facilities to the C-BT Project and whether to allow storage of C-BT water in a new Windy Gap reservoir.

1.10.2.2 Section 14 of the Reclamation Project Act of 1939

Section 14 of the Reclamation Project Act of 1939 ("Section 14") provides in part as follows:

> "The Secretary is further authorized, for the purpose of orderly and economical construction or operation and maintenance of any project, to enter into such contracts for exchange or replacement of water, water rights, or electric energy, or for the adjustment of water rights, as in his judgment are necessary and in the interests of the United States and the project."

Section 14 requires a finding that the exchanges contemplated under the proposed project are (1) for the purpose of orderly and economical operation and maintenance of the C-BT Project and (2) necessary and in the interests of the United States and the C-BT Project. Reclamation's determination will document whether or not the proposed project and anticipated contract or contract amendment(s) meet these two requirements of Section 14.

This determination will be developed, and made public, prior to execution of a contract or contract amendment that would allow implementation of any of the action alternatives considered in this EIS.

1.10.3 Other Permits and Approvals

Implementation of any of the action alternatives requires compliance with applicable federal, state, and local regulatory agencies laws, approvals, review, and permitting requirements. Permitting requirements may vary with alternative. The No Action alternative also may be subject to various regulatory actions and permits. Principal federal, state, and local environmental compliance requirements associated with implementation of the Firming Project are listed in Table 1-7.

Grand County as a cooperating agency is providing input and review of the EIS. Grand County has regulatory authority under Colorado H.B. 1041, which allows counties to regulate activities designated as matters of state interest. Under Resolution No. 1978-5-4, Grand County regulates municipal and industrial water projects within Grand County. Grand County granted a 1041 permit for the construction of the original Windy Gap Reservoir and pipeline. Construction of a new reservoir in Grand County would be subject to additional 1041 review and permitting.

1.10.4 The EIS Process

This Draft EIS evaluates the effects to the environment of the No Action alternative, the Proposed Action, and other alternatives. It was prepared in accordance with the NEPA of 1969 and amendments, Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-15-8), and the Bureau of Reclamation NEPA Handbook.

The Draft EIS will be released to the public for a 60-day comment period. During this period, Reclamation will hold several open houses for the public to learn more about the alternative actions and comment on the DEIS. Following receipt of comments, Reclamation will respond to substantive comments on the alternatives and the impact analysis in the Final EIS. A Final EIS will be completed about 3 to 4 months following close of the comment period on the Draft EIS. Reclamation's decision on the Proposed Action and other alternatives will be documented in a Record of Decision.

> Reclamation will take public comments on the Draft EIS for 60 days.

Table 1-7. Environmental compliance requirements.

Agency	Statute, Regulation, or Order	Purpose	Project Application
		Federal	
BUREAU OF RECLAMATION	National Environmental Policy Act	Applies to federal actions that may significantly affect the quality of the environment	All action alternatives are subject to NEPA compliance because of connection to C-BT facilities owned by Reclamation
	National Historic Preservation Act, Section 106	Protection of historic and cultural resources in coordination with the State Historic Preservation Office	Surface disturbing activities, where cultural resources have been identified
	Easement	Required for use of Reclamation property	Construction of Jasper East reservoir and pipeline connections for Chimney Hollow or Dry Creek reservoirs are partially located on Reclamation property
	Executive Order 11990, Protection of Wetlands	Requires avoidance of adverse wetland impacts where practicable and mitigation if necessary	Disturbances to wetlands
	Executive Order 11988, Floodplain Management	Requires avoidance of adverse floodplain impacts were practicable and mitigation if necessary	Disturbances within stream floodplains
	Executive Order 12898, Environmental Justice	Requires consideration of disproportionate impacts to minority or low income populations	Socioeconomic effects to be evaluated for all alternatives
	Endangered Species Act	Protection of federally listed threatened or endangered species	Potential impacts to Colorado River endangered fish species, lynx, Preble's meadow jumping mouse or other federally listed species
U.S. ARMY CORPS OF ENGINEERS	Clean Water Act – Section 404 Permit to discharge dredge and fill material	Authorizes placement of fill or dredge material in waters of the U.S. including wetlands	Surface disturbances associated with construction of dams, pipelines, or other infrastructure that affect wetlands or waters of the U.S.
U.S. FISH AND WILDLIFE SERVICE	Fish and Wildlife Coordination Act	Consideration of fish and wildlife conservation for water resource development projects	Development of mitigation measures for adverse effects to fish and wildlife
	Migratory Bird Treaty Act	Protects migratory birds	Surface disturbance that may harm or injure migratory birds and nesting

Agency	Statute, Regulation, or Order	Purpose	Project Application
WESTERN AREA POWER ADMINISTRATION	DOE NEPA Implementing Procedures and applicable environmental and cultural resources protection statutes.	Applies to DOE actions that may significantly affect the quality of the environment.	Western's need to relocate transmission lines under certain alternatives.
ENVIRONMENTAL PROTECTION AGENCY	EIS review and 404 review	Protection of wetland, air, water quality and other environmental resources	Review of potential environmental effects
	State of Colorado		
DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT-WATER QUALITY CONTROL DIVISION	Section 401 water quality certification	Certifies that authorized Section 404 activities meet state water quality standards	Applicable for all disturbances that require Section 404 permitting
	National Pollution Discharge Elimination System Permit for Stormwater	Protection of water resources from discharges associated with construction activities	Applicable to all surface construction activities greater than one acre
	Construction Dewatering 402 Permit	Protects surface water from dewatering ground water during construction	Excavations for pipelines, dam construction or other activities that require dewatering
DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT-AIR POLLUTION CONTROL DIVISION	Air Pollution Emission Notice	Protection of air quality from construction activities including vehicle emissions and fugitive dust	Excavation, grading, and blasting for construction of dams, pipelines, roads, borrow areas, and other surface disturbances
	Open Burning Permit	Control open burning	Land clearing activities that result in burning trees or other materials
COLORADO DIVISION OF WILDLIFE	Review and comment on proposed action and mitigation measures	Protection of fish and wildlife resources	Changes in stream flows, inundation of streams, creation of lake habitat, impacts to terrestrial wildlife habitat from project development
OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION, COLORADO STATE HISTORIC PRESERVATION OFFICER	Coordination of Section 106 compliance with Reclamation	Determination of eligibility of cultural resources for the National Register of Historic Places, significance of impacts, and appropriate mitigation measures	Surface disturbing activities, where cultural resources have been identified
COLORADO DIVISION OF MINERALS AND GEOLOGY	Mining and reclamation permit	Mining and reclamation permits for borrow areas	Excavations needed for dam construction

Agency	Statute, Regulation, or Order	Purpose	Project Application
Local			
LARIMER COUNTY	Location and extent review	Evaluation of public use, structures or utilities for conformance with master plan	Required for construction of Chimney Hollow or Dry Creek reservoirs
	Special Use Review	Protect the health, safety, and welfare of Larimer County residents	Required for construction of Chimney Hollow or Dry Creek reservoirs
GRAND COUNTY	1041 – Matters of State Interest	Evaluation of impacts on county resources	Required for construction of new reservoirs and related facilities in Grand County
	Special Use Review	Protect the health, safety, and welfare of Grand County residents	Required for construction of new reservoirs and related facilities in Grand County
BOULDER COUNTY	1041 – Matters of State Interest	Evaluation of impacts on county resources	Required for expansion of Ralph Price Reservoir
	Location and Extent Review	Evaluation of proposed public or quasi-public facilities to ensure that the location and extent of the facilities are in conformance with the Boulder County Comprehensive Plan	Required for expansion of Ralph Price Reservoir
	Special Use Review	To determine the compatibility of the use with the site and surrounding land and uses and the adequacy of services	Required for expansion of Ralph Price Reservoir

Chapter 2. Proposed Action and Alternatives

Chimney Hollow Reservoir Site

The Municipal Subdistrict's Proposed Action is to construct a new 90,000 AF Chimney Hollow Reservoir on the East Slope near Carter Lake and to allow the storage of C-BT Project water in the new reservoir to improve Windy Gap yield.

This chapter describes the alternatives considered to deliver a firm annual yield of about 30,000 AF from the existing Windy Gap Project and provide 3,000 AF of storage for MPWCD. Five alternatives, including the Proposed Action and a No Action alternative, were selected for detailed analysis in the EIS. All action alternatives include development of 90,000 AF of new storage in either a single reservoir on the East Slope or a combination of East and West Slope reservoirs. The reservoir alternatives included in the EIS are:

1. No Action — Project Participants would maximize delivery of Windy Gap water within the capacity of existing facilities under the existing contractual arrangement between Reclamation and the Subdistrict without any new Reclamation action or new C-BT connections. In addition, the City of Longmont would evaluate the enlargement of Ralph Price Reservoir for storage of its Windy Gap water.
2. Proposed Action by the Subdistrict — Chimney Hollow Reservoir (90,000 AF) with prepositioning (allowing storage of C-BT water in Chimney Hollow Reservoir)
3. Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)
4. Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)
5. Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

This chapter discusses the alternative selection process, describes the key components of each alternative including the facilities, operation plan, cost, and provides a summary comparison of alternative features and resource effects. In addition, Section 2.8 describes the identification of reasonably foreseeable actions used in the cumulative effects evaluation.

2.1 Alternative Selection Process

The goal of the alternative selection process was to identify a reasonable range of alternatives to meet the purpose and need of the proposed WGFP. NEPA regulations do not specify the number of alternatives that need to be considered in the EIS, but indicate that a reasonable range of alternatives should be evaluated. The Council on Environmental Quality (CEQ) defines reasonable alternatives as "those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant" (CEQ 1986). CEQ regulations also require that all reasonable alternatives, including no action, are rigorously explored and objectively evaluated and that the reasons for eliminating alternatives are discussed (40 CFR 150.14).

In addition to satisfying NEPA requirements, projects subject to permitting by the U.S. Army Corps of Engineers under the Clean Water Act also must comply with Section 404(b)(1) Guidelines (40 CFR, Part 230) for discharge of dredge and fill material into waters of the U.S. These Guidelines specify "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (Section 230.10(a)). An alternative is considered practicable if "it is capable of being done after taking into consideration cost, existing technology, and logistics in the light of overall project purposes" (Section 230.10(a)(2)). Practicable alternatives under the Guidelines assume that "alternatives that do not involve special aquatic sites are available, unless clearly demonstrated otherwise" (Section 230.3(q)). Guidelines also assume that "all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise" (Section 230.10(a)(3)).

The alternatives analysis required for Section 404(b)(1) can be conducted either as a separate analysis for 404 permitting or incorporated into the NEPA process. Reclamation and the Corps have agreed that an integrated approach for the alternatives analysis is appropriate to satisfy NEPA and 404(b)(1) requirements. Integration of both NEPA and 404(b)(1) Guidelines ensures that the alternatives selected for evaluation in the EIS are both reasonable and practical.

2.1.1 Development of Alternatives

The development of potential alternatives for firming the yield of the Windy Gap Project began with a study conducted by the Subdistrict. The results of this study were documented in an Alternative Plan Formulation Report (APFR) (Boyle and EDAW 2003). The APFR identified several categories of alternatives, including new reservoir sites, enlargement or re-regulation of existing reservoirs, development of ground water storage, and re-regulation of existing reservoirs. In addition, nonstructural measures that did not require new infrastructure were evaluated. Hydrologic modeling results conducted for the APFR and subsequent analyses for the EIS indicate that to meet Project Participant's goal of a consistent annual firm yield of about 30,000 AF would require around 90,000 AF of new storage. The storage goal includes 3,000 AF of new storage for MPWCD to improve the firm yield of their Windy Gap water.

The APFR began with a broad range of potential project elements followed by successive phases of screening and evaluation to identify potentially feasible alternatives. A total of 171 different project elements, which include individual storage features, were evaluated. The analysis resulted in the identification of seven possible alternatives that were presented during the public and agency scoping meetings held in the fall of 2003. The seven possible alternatives were:

- Chimney Hollow Reservoir
- Little Thompson Reservoir
- Cactus Hill Reservoir
- Chimney Hollow Reservoir and Jasper North A Reservoir
- Jasper North Reservoir and Rawhide Reservoir

- Jasper North Reservoir and Chimney Hollow Reservoir
- Chimney Hollow and Rawhide Reservoir

Reclamation and the Corps reviewed the results of the APFR to determine the adequacy of the preliminary identification of potential alternatives and the analyses that were conducted to select alternatives. Both agencies concurred that the APFR provided an excellent compilation of data and alternatives analysis. However, further refinement of the alternative screening and selection process was needed to address the requirements of the 404(b)(1) Guidelines. To comply with 404(b)(1) Guidelines, Reclamation, in concert with the Corps, reevaluated all of the alternatives identified in the APFR, as well as several new alternatives identified following completion of the APFR and scoping.

2.1.2 Alternative Screening

Three successive levels of screening were applied to the range of potential alternatives to narrow the list of alternatives for consideration in the EIS. The 404(b)(1) Guidelines were used as the primary screening tool for the evaluation of alternatives. These Guidelines include five categories of screening criteria—purpose and need, logistics, technology, environmental consequences, and the costs to construct the project (40 CFR 230.10). Cost was not used to screen potential WGFP alternatives because it did not adequately differentiate alternatives.

Additional detail on the screening and evaluation of alternatives is found in the Windy Gap Firming Project Alternatives Report (ERO 2005).

2.1.2.1 Level 1 Alternative Screening

The initial Level 1 screening of alternatives considered four categories of 404(b)(1) criteria — purpose and need, logistics, technical, and environmental. These categories are described below.

Purpose and Need Screening Criteria

Alternatives that clearly would not meet or reasonably contribute to meeting the Participants' water supply requirements were eliminated from further consideration. This criterion did not eliminate potential reservoir storage alternatives, but did eliminate other types of alternatives. The ability to meet the project purpose and need, including yield requirements, was used again to evaluate alternatives in Level 3 screening.

Alternatives were screened using Clean Water Act Section 404(b)(1) criteria:

- Purpose and Need
- Logistics
- Technology
- Environmental Consequences

Logistical Screening Criteria

Logistical screening criteria included land use and the size and number of reservoirs.

Land Use. Potential alternatives were eliminated based on incompatibility with existing land use. Types of incompatible land use included designated Wild and Scenic or Recreational rivers, Wilderness Areas, Superfund sites, sites that require relocation of an Interstate Highway, and sites that would require Congressional Action and adversely affect existing Reclamation projects.

Size and Number of Reservoirs. A minimum reservoir size and maximum number of reservoirs criterion were used to screen out small reservoirs and to limit the environmental effects associated with multiple reservoir sites. In addition, yield and operational considerations affected the size and number of reservoirs that can practicably be used to meet the project purpose and need.

Based on yield calculations and Participant water storage requests, about 90,000 AF of storage is needed to meet the project purpose and need. Because of the capacity limitation in conveying water from the West Slope to the East Slope via the Adams Tunnel, new storage is needed on the East Slope so that water is readily available for delivery to East Slope Participants. Having a portion of the needed storage on the West Slope would allow Windy Gap diversions to be stored immediately without the potential for spilling from Granby Reservoir if the Adams Tunnel is delivering C-BT water at capacity or is otherwise unavailable. However, too much storage on the West Slope may reduce the reliability of the Firming Project because of the dependence on the operation of the Adams

Tunnel and other facilities to convey water to East Slope Participants.

Potential reservoir sites were screened using two different size criteria for East and West Slope reservoirs. Hydrologic modeling indicates that at least 20,000 AF of storage is needed on the West Slope to provide sufficient yield when combined with an East Slope reservoir. Thus, reservoir sites with less than 20,000 AF of storage on the West Slope were eliminated from further consideration. A stand-alone East Slope reservoir site would need to have a storage capacity of about 90,000 AF to meet project needs. If 20,000 AF of storage is available on the West Slope, then about 70,000 AF of East Slope storage is required. West Slope storage greater than 20,000 AF would reduce East Slope storage requirements. A minimum reservoir size of 30,000 AF on the East Slope was considered reasonable for the purpose of selecting reservoir sites for consideration because at least twice this amount of storage (60,000 AF) would be needed on the East Slope based on the available West Slope storage options.

A single large reservoir would typically have less total disturbance than two smaller reservoirs with combined equivalent volume. The incremental environmental effects associated with multiple reservoir sites are likely greater than if the disturbance is concentrated at fewer locations. Multiple reservoirs also require the construction of additional pipelines, pumping stations, and other conveyance structures that increase environmental disturbance and reduce the operational efficiency. Multiple small reservoir sites typically have greater surface area and greater evaporation rates than larger deeper reservoirs. Thus, large deep reservoirs conserve water resources by reducing evaporation losses compared to multiple smaller reservoirs. In consideration of the potential environmental impacts, operational inefficiencies, evaporative water loss associated with multiple reservoir sites, and conveyance and energy requirements, alternative configurations were limited to no more than two reservoir sites on the East Slope.

Technical Screening Criteria

Constructability and safety factors eliminated reservoir sites near or on mine sites.

Environmental Screening Criteria

Environmental screening criteria included an evaluation of potential effects to wetlands and perennial streams.

Wetlands. Potential reservoir sites were eliminated from consideration if they contained more than 25 acres of wetlands or if fens (a special category of wetlands) were known to be present. Wetland determinations were based on National Wetland Inventory (NWI) mapping by the U.S. Fish and Wildlife Service or field investigations.

Perennial Streams. Perennial streams provide year-round flows and often support aquatic ecosystems. Potential reservoir sites located on perennial streams were eliminated from consideration to avoid potential impacts to flowing streams and the associated aquatic life and habitat. Perennial streams were identified based on the presence of a solid blue line on U.S. Geological Survey Quadrangle Maps (scale = 1:24,000). Thus, potential reservoir sites were limited to ephemeral or intermittent streams. Existing reservoirs located on perennial streams were an exception to this criterion because these streams have already been impacted.

Alternatives Considered in Level 1 Screening:

The following sections provide a brief discussion of the alternatives remaining following Level 1 screening and the rationale for eliminating those alternatives that were screened out.

New Reservoirs. A total of 124 potential new reservoir sites identified for analysis were eliminated by the Level 1 screening criteria. Thirteen new reservoirs were carried forward for further analysis in Level 2, including ten East Slope reservoir sites and three West Slope reservoir sites (Table 2-1).

Enlarge Existing Reservoirs. Application of the Level 1 screening criteria eliminated the potential enlargements of 26 existing reservoirs. The enlargement of three East Slope reservoirs was carried forward for further screening in Level 2 (Table 2-1).

Table 2-1. Reservoir alternatives remaining following Level 1 screening.

Reservoir Site	River Basin
New Reservoirs—East Slope	
Glade	Cache la Poudre
Cactus Hill	Cache la Poudre
Rawhide North	Cache la Poudre
Dowe Flats	St. Vrain
Stone Canyon	St. Vrain
Chimney Hollow	Big Thompson
Meadow Hollow	Big Thompson
Sprenger Ranch	Big Thompson
Dry Creek	Big Thompson
Wildcat	Big Thompson
New Reservoirs—West Slope	
Jasper East	Colorado
Rockwell/Mueller Creek	Colorado
Mt. Chauncey South	Colorado
Enlarge Existing Reservoirs—East Slope	
Halligan	Cache la Poudre
Seaman	Cache la Poudre
Hertha	Big Thompson

Aquifer Storage. Bedrock and alluvial aquifers were considered as possible storage options, but were eliminated because of the limited storage capacity and uncertainty in providing long-term storage. Aquifer storage does not provide sufficient storage potential for meeting the project purpose and need.

Re-regulation of Existing Reservoirs. This alternative was evaluated to determine if sufficient additional storage space could be made available within existing non-C-BT reservoirs to store Windy Gap water. Re-regulation of existing reservoirs was eliminated as a potential alternative because existing reservoirs are already being operated in an effort to maximize yield; therefore, the re-operation potential and amount of storage available would be minimal. Storage in existing reservoirs is typically fully committed to firm other water supplies and is generally not available when Windy Gap water is diverted. Re-regulation of existing reservoirs would not contribute to meeting the project purpose and need.

Nonstructural Alternatives. Nonstructural measures primarily involve modification to existing operations without significant new structural features. Nonstructural alternatives were evaluated primarily on their ability to firm Windy Gap Project water supplies as defined by the project purpose and need, as well as logistical considerations.

Most nonstructural measures, involve use or integration of the WGFP with the C-BT Project, and included:

- Unlimited and limited borrowing from C-BT
- Modified borrowing of C-BT water
- Buying C-BT storage
- Interruptible supply contracts
- Purchase/leaseback contracts or dry year options on C-BT units
- Prepositioning

All nonstructural measures, except prepositioning, were eliminated from further consideration for one or more reasons including conflicts with C-BT operations, adverse impacts on water deliveries to C-BT unit holders, and the inability to firm Windy Gap water. Prepositioning is a method of operation in which C-BT water is prepositioned or stored in advance in an East Slope reservoir, such as Chimney Hollow. Space created in Granby Reservoir by prepositioning would be filled with Windy Gap water, which would then be exchanged for C-BT water stored in Chimney Hollow. This arrangement ensures temporary space in Granby Reservoir to store Windy Gap water. Total allowable C-BT storage would not change and the existing C-BT water rights and diversions would not be expanded. Prepositioning is a component of the Proposed Action.

> Alternatives that did not meet Level 1 screening criteria were eliminated from further consideration.

Integration with Denver Water's Moffat Collection System was another nonstructural alternative eliminated from consideration. This alternative is primarily a method of conveyance and does not address storage requirements or provide the firm yield identified in the purpose and need. There is insufficient capacity in South Boulder Creek to convey Windy Gap water and Denver's Moffat system water, in addition water right and environmental issues limit the practicality of this alternative.

Other Alternatives. Additional alternatives were identified during scoping, but were eliminated for the reasons noted below.

Around-the-horn delivery. This proposal involved leaving water in the Fraser River that would normally be delivered to Broomfield through Denver's Moffat System. This water could then be diverted at Windy Gap Reservoir and delivered to Broomfield through the Windy Gap/C-BT system. This conveyance option was suggested as a method to improve Fraser River flows and offset effects of possible additional Denver Water diversions from the Fraser System. This alternative does not contribute to meeting the purpose and need of the Firming Project or offset any effects of the WGFP and would exceed the capacity of East Slope delivery infrastructure to deliver the water to Broomfield.

South Platte River storage and exchange for C-BT water. This alternative included the development of storage on the South Platte River to capture Windy Gap water for reuse and exchange upstream for C-BT water. This alternative was eliminated because most Participants have commitments or plans for reuse of Windy Gap water, and any reuse of Windy Gap water depends on the reliable delivery of the first use of the water. This alternative does not meet the purpose and need of firming Windy Gap water, but rather provides a potential mechanism to capture and reuse Windy Gap water and perhaps other reusable water.

Interruptible supply contracts. These types of contracts are used to provide water in dry years, but do not provide a long-term reliable supply of water to meet the purpose and need of the proposed Firming Project.

Storage in Horsetooth Reservoir. Dedicating storage space in Horsetooth Reservoir for Windy Gap firming would reduce the storage and yield for the C-BT Project and injure C-BT unit holders. A change in the purpose of the C-BT Project would require Congressional action. This alternative was eliminated from consideration because it would adversely affect C-BT unit holders contrary to Reclamation obligations associated with the establishment of the C-BT Project authorized by Congress.

Water conservation. Water conservation measures play an important role in reducing demand and extending supplies for each of the Project Participants. Participants have implemented a variety of conservation measures over the past 15 years, which has substantially reduced water use. Additional incremental improvements in water conservation in the future are expected to contribute to meeting Participants' future water needs, but conservation alone does not meet all of the projected water supply requirements or eliminate the need for firming existing Windy Gap Project water supplies. Past conservation is included in the demand projections in Chapter 1. Future water use projections are based on average water use during the 1998–2003 period, including significantly reduced water use in the drought of 2002-2003, which resulted in conservatively low per capita water use. Conservation measures will continue to reduce demand and conserve available supplies in the future, but they do not provide an immediate source of water to meet near-term demand projections.

Joint West Slope storage project. This alternative included locating a reservoir site in the Fraser River basin that could be jointly used for storing Windy Gap water and water for West Slope use. To store Windy Gap water in the upper Fraser River basin would require either a pipeline from the existing Windy Gap diversion site on the Colorado River or a change in the point of diversion. Because a suitable location for a Fraser Valley reservoir has not been identified, the logistical constraints, legal requirements associated with delivery of Windy Gap water to a Fraser Valley reservoir, and the uncertainties associated with the timing of construction of a Fraser Valley reservoir, this alternative was eliminated from consideration.

2.1.2.2 Level 2 Alternative Screening

Level 2 screening was based on storage options that would have the least potential effect on wetlands.

The five reservoir sites with the least wetland impact for each of the three storage categories—new reservoirs (East and West Slope) and reservoir enlargement—were selected for further evaluation. Level 2 screening eliminated five new East Slope reservoir sites. All three potential new West Slope reservoirs sites and three East Slope reservoir enlargements were retained for further consideration. Reservoir sites with the least wetland impact are indicated by shading in Table 2-2. These sites were carried forward for further evaluation in Level 3 alternative screening.

Level 2 screening selected alternatives with the least impact to wetlands.

Table 2-2. Level 2 alternative screening.

Reservoir Site[1]	Reservoir Size (AF)	Wetlands (acres)
New Reservoirs—East Slope		
Glade	61,000 – 303,000	6-40
Cactus Hill	104,071	14
Rawhide North	43,100	1
Dowe Flats	55,000 – 119,000	18
Stone Canyon	31,800	0
Chimney Hollow	60,000 – 110,000	2
Meadow Hollow	60,000	6
Sprenger Ranch	92,700	1
Dry Creek	21,000 – 62,300	3–6
Wildcat	60,000	13
New Reservoirs—West Slope		
Jasper East	21,800	19
Rockwell/Mueller Creek	20,000 – 30,000	3–18
Mt. Chauncey South	23,500	7
Enlarge Existing Reservoirs—East Slope		
Halligan	35,300 – 62,900	18
Seaman	3,200 – 38,000	18
Hertha	74,300	1

[1]Shaded reservoir sites had the least impact on wetlands and were evaluated in Level 3 Screening.

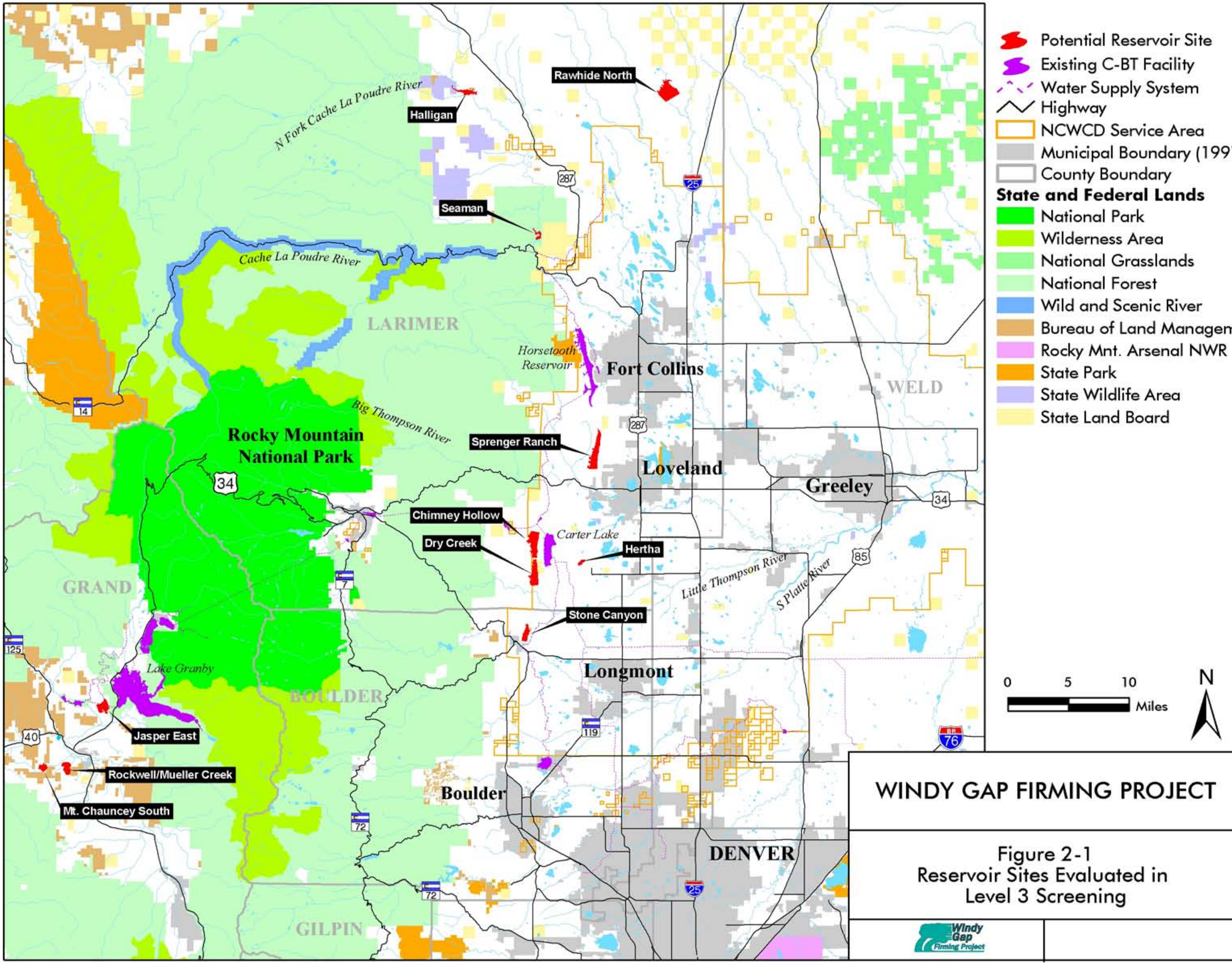
2.1.2.3 Level 3 Alternative Screening

The third level of alternatives analysis evaluated the 11 remaining reservoir alternatives based on their ability to meet the purpose and need of the proposed project, along with consideration of additional logistical and environmental factors. Reservoir sites evaluated in Level 3 are shown in Figure 2-1. Prepositioning was also evaluated to determine its potential for improving yield and meeting the project purpose and need. A discussion of each of the remaining alternatives and the rationale for inclusion or exclusion in the EIS follows.

Level 3 screening examined remaining alternatives in more detail based on their ability to meet the purpose and need of the proposed project, along with consideration of additional logistical and environmental factors.

Alternatives Evaluated in Level 3 Screening:

Rawhide North. This potential 43,000 AF reservoir site is located about 20 miles north of Fort Collins. Although located near the Platte River Power Authority, it would be over 35 miles from other East Slope Participants. This alternative was eliminated from further consideration for several reasons: the yield would be low because of the evaporation loss from a shallow reservoir; there would be logistical constraints and inefficiency associated with water conveyance north to the reservoir and then back south to Participants; and the environmental effects associated with construction of extensive conveyance, along with the need to build at least one additional East Slope reservoir. In addition, there would be additional environmental effects from the greater water diversions that would be needed to make up for higher evaporation losses. Because of the inability of the Rawhide North Reservoir site to effectively contribute to meeting the firm yield requirements of the project purpose and need and other logistical and environmental impacts, this alternative was eliminated.



WINDY GAP FIRMING PROJECT

Figure 2-1
Reservoir Sites Evaluated in
Level 3 Screening

Stone Canyon. The Stone Canyon reservoir site is located about 1 mile northeast of the Town of Lyons. With a maximum storage capacity of about 32,000 AF, it would need to be combined with at least one additional East Slope reservoir to meet total storage requirements. This site was occupied by nine homes in 2005 and about 80 acres of two Boulder County open space properties—Indian Mountain, an archeologically sensitive area and Natural Landmark; and Rabbit Mountain-Dowe Flats, which contains land restricted in perpetuity for use by American Indians. Boulder County has indicated that it is not willing to sell the open space property or have it used for a reservoir (Koopman 2004).

The Stone Canyon reservoir site was eliminated from further consideration because of the numerous conflicting land uses and the natural and cultural resource values associated with these lands. While the Subdistrict may have the authority to condemn property for reservoir construction, placement of a reservoir on this location would potentially require condemnation of county open space and other private property. Consultation with the United Tribes of Colorado on the impact to Traditional Cultural Property committed to ceremonial and educational uses in perpetuity by multiple tribes would need to be conducted. These conflicting land uses would likely substantially increase the time required to complete the project and Participants have a near term need for the water. In addition, a second East Slope reservoir would need to be combined with the Stone Canyon Reservoir to meet project storage requirements, and the environmental effects from two East Slope reservoirs are likely to be greater than alternatives with a single East Slope reservoir.

Chimney Hollow. The Chimney Hollow reservoir site is located in a hogback valley just west of Carter Lake and about 8 miles southwest of the City of Loveland. The reservoir site has potential storage capacity of 40,000 to 110,000 AF and could serve as a stand-alone facility. At sizes less than 90,000 AF, it would need to be combined with another East or West Slope reservoir. This reservoir site was selected as the Proposed Action (Alternative 2) by the Subdistrict and is also included as a 70,000 AF Reservoir in Alternatives 3 and 4.

Sprenger Ranch. The Sprenger Ranch reservoir site (92,700 AF) is located about 5 miles west of the City of Loveland. The reservoir site was occupied by about 15 residences in 2005, and overlaps portions of two Larimer County Open Space parcels—Rimrock and Devils Backbone. The Rimrock Open Space was established because of its aesthetic and ecological values, portions of which include a highly significant Colorado Natural Heritage Conservation Site (Larimer County 2001). The Devils Backbone Open Space supports imperiled foothills plant communities, and likely supports imperiled butterfly species that have been documented nearby within similar habitat (Larimer County 2004). Larimer County has indicated that it would not be willing to sell or enter into an agreement that would permit construction of a dam and reservoir that would impact county open space (Buffington 2004).

The Sprenger Ranch reservoir site was eliminated from further consideration because of the environmental values present and the conflict with existing land uses. Similar to the Stone Canyon site, it is likely that condemnation proceedings would be required to obtain Larimer County Open Space and possibly other private land for construction of a reservoir at this location. Extended legal proceedings are likely to substantially increase the time required to construct a reservoir at this location and the Participants have a near term need.

Dry Creek. The Dry Creek reservoir site is located southeast of Carter Lake and due south of the Chimney Hollow reservoir site. The Dry Creek reservoir site is located on private and state-owned land and would affect three residences. A reservoir at this location could be constructed to a size ranging from 21,000 AF to about 62,000 AF. To meet the firm yield requirement for the Firming Project, this reservoir would need to be combined with an additional East or West Slope reservoir. This potential reservoir site was selected for additional evaluation in the EIS in Alternative 5 and is described in Section 2.7.

Halligan Reservoir. Halligan Reservoir is an existing 6,400 acre-foot reservoir located about 23 miles northwest of Fort Collins on the North Fork of the Cache la Poudre River. The Cities of Fort Collins and Greeley, and others are currently evaluating the potential to enlarge this reservoir. The City of Fort Collins has indicated that the full expansion capacity of an enlarged Halligan is fully allocated (Janonis 2004). As such, capacity is not sufficient for storage of Windy Gap water in this facility. The practicality of delivering and storing Windy Gap water at a reservoir site almost 40 miles from Carter Lake, where Windy Gap water is currently delivered, also would involve numerous logistical issues including the need for extensive pipeline construction and pumping facilities with high energy requirements, in addition to the environmental effects associated with water conveyance facilities. For these reasons, enlargement of Halligan Reservoir was eliminated from further consideration for Windy Gap Firming storage.

Seaman Reservoir. Seaman Reservoir is an existing reservoir located on the North Fork of the Cache la Poudre River downstream from Halligan Reservoir and about 10 miles northwest of Fort Collins. The City of Greeley and others are currently evaluating the potential for enlarging this reservoir to meet a portion of their future water storage needs. The North Fork of the Poudre River currently contains critical habitat for the threatened Preble's meadow jumping mouse. The City of Greeley and others have fully subscribed all of the available capacity of an enlarged Seaman Reservoir (Koch 2004). Similar to the Halligan Reservoir enlargement, there are also substantial logistical difficulties and environmental concerns in conveying water to Seaman Reservoir and then delivering water south to Participants. Potential effects to wetlands and a perennial stream are also higher compared to other new East Slope reservoir locations. For these reasons, enlargement of Seaman Reservoir was eliminated from further consideration

Hertha Reservoir. The existing Hertha Reservoir site is located about 6 miles southwest of the City of Loveland and about 2 miles east of Carter Lake Reservoir. Expansion of Hertha Reservoir to about 74,000 AF of storage capacity is possible with construction of about 2 miles of dam that would encircle and enlarge the existing reservoir. This small reservoir currently serves the Handy Ditch Company. The Hertha Reservoir site also contains Rainbow Lake Estates, a residential subdivision containing at least 32 completed homes with an assessed individual value of $300,000 to $500,000, plus 39 additional lots for sale or homes under construction as of 2005.

In order to acquire the right to use and enlarge Hertha Reservoir, the Subdistrict would have to condemn the land at the reservoir site and most likely some interest in the water rights associated with the existing reservoir because reservoir enlargement would likely interfere with those water rights. Several government entities own shares in the Handy Ditch Company, and thus own an interest in the water rights associated with the Hertha Reservoir. It is unclear under present law whether the Subdistrict has the legal power to condemn property owned by other government entities. The Hertha Reservoir site was eliminated from further consideration because of the conflicting land uses and the amount of time it would likely take to acquire both the property and the water rights.

Jasper East. The Jasper East reservoir site is located between Willow Creek Reservoir and Granby Reservoir in Grand County. This potential reservoir site has a storage capacity of up to about 22,000 AF. The site is located in an area of irrigated pastureland. Reservoir construction at this site would require relocating County Road 40 and the Willow Creek Pump Station and a portion of the Willow Creek Canal, which are features of the C-BT Project. No homes are presently on this site. A potential reservoir at this site would need to be paired with additional East Slope storage. The Jasper East reservoir site was selected as a potential alternative in combination with Chimney Hollow Reservoir and is discussed for Alternative 3.

Rockwell/Mueller Creek. The Rockwell/Mueller Creek Reservoir site (Rockwell) is located about 2 miles southwest of the Town of Granby on the West Slope. This reservoir site has up to 35,000 AF of storage capacity. Current land use includes pastureland and four residences. A pipeline and pump station would be required to deliver water to Rockwell Reservoir and back to Windy Gap Reservoir. This reservoir site, in combination with either Chimney Hollow Reservoir or Dry Creek Reservoir, was included in Alternatives 4 and 5, as discussed in Section 2.6 and Section 2.7.

Mt. Chauncey South. The Mt. Chauncey South potential reservoir site is located at the headwater of Reed Creek about 4 miles southwest of the Town of Granby. This reservoir is located at an elevation of about 9,200 feet and is about 3 miles south of Windy Gap Reservoir. Construction of a reservoir at this elevation introduces several operating inefficiencies compared to lower elevation West Slope sites including 1,400 feet of pumping lift and the need for a bi-directional conveyance facility from Windy Gap Reservoir. Energy requirements for operation would be higher than either the Rockwell Reservoir or Jasper East Reservoir sites, which are located at elevations similar to Granby Reservoir. New roads, dam construction and pipeline installation in steep terrain would require substantial disturbance to native vegetation communities. Based on NWI mapping, the impact to wetlands could be greater than Rockwell Reservoir. While wetland effects may be less than the Jasper East reservoir site, the Jasper East wetlands appear to be supported primarily by irrigated pasturelands and ditch leakage. The Mt. Chauncey South reservoir site is also located in potential habitat for the federally listed threatened lynx (CDOW 2005a).

This site was eliminated from further consideration because of the substantial operational inefficiency of locating a reservoir at this elevation, the high energy requirements needed for pumping, the environmental disturbance associated with construction of facilities in primarily undisturbed and steep terrain, and the presence of potential lynx habitat. The Mt. Chauncey South reservoir site does not provide any logistical or environmental advantages over the Jasper East or Rockwell reservoir sites.

Prepositioning. Hydrologic modeling was used to determine whether prepositioning would improve yield when used with a stand-alone 90,000 AF Chimney Hollow Reservoir. Results indicate that prepositioning improves project yield, and that without prepositioning, total project yield is reduced by about 15 percent. The reduction in firm yield for individual Participants would range from 0 to 30 percent depending on the number of Windy Gap units they own, demand, and requested storage for Chimney Hollow Reservoir. Without prepositioning, all Windy Gap diversions must either be stored in Granby Reservoir or delivered directly through the Adams and Olympus Tunnels into Chimney Hollow if Granby Reservoir is full. The WGFP is particularly reliant on available capacity in the Adams and Olympus Tunnels in wet years when Granby Reservoir typically fills. Without prepositioning, yield is substantially reduced because a lack of available space in the tunnels would reduce Windy Gap diversions in wet years.

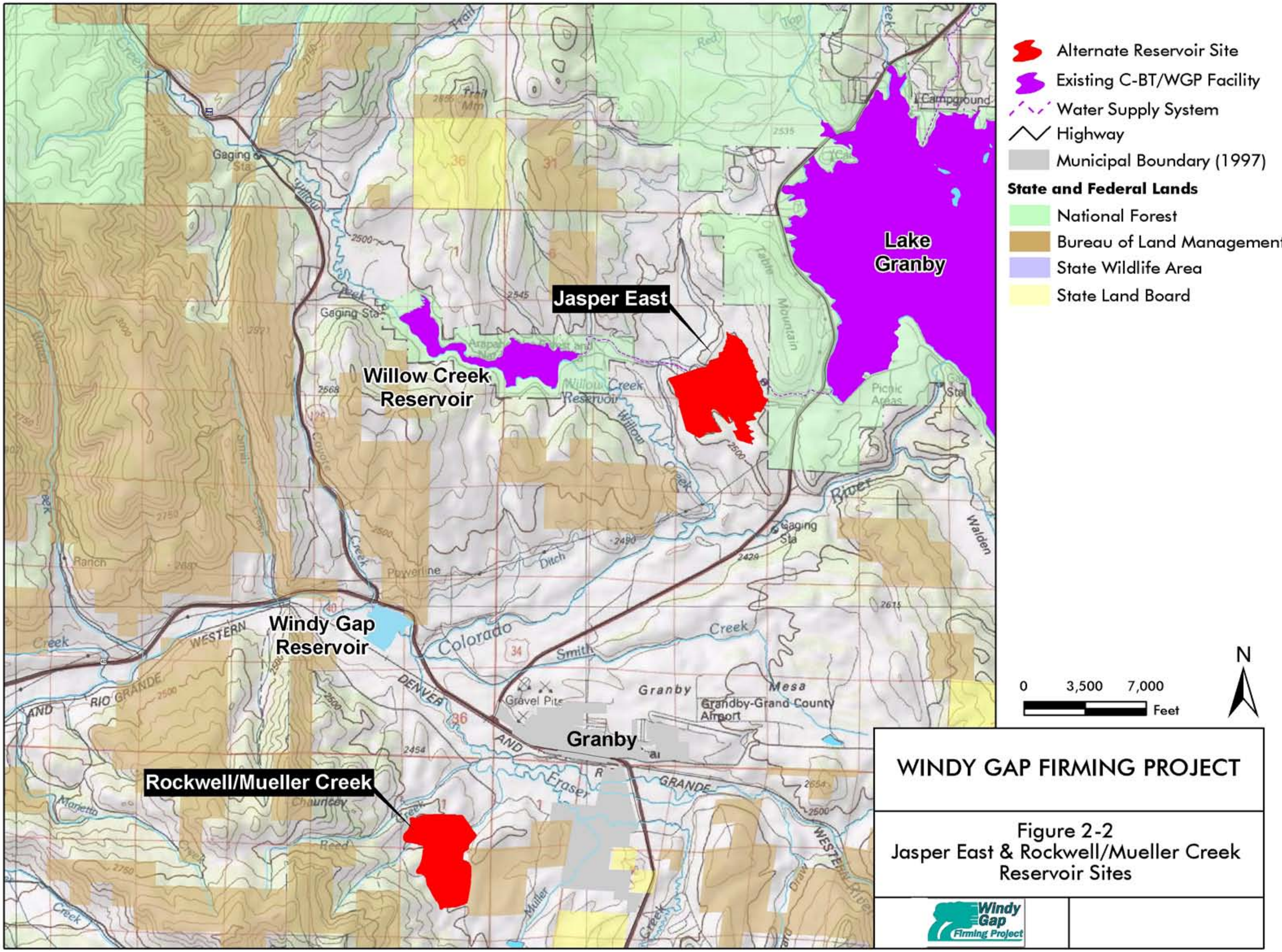
Chimney Hollow Reservoir without prepositioning was eliminated as an alternative because of the substantial reduction in yield and because it would not provide adequate yield to meet the water needs for all of the Participants. Prepositioning is a component of the Proposed Action in combination with Chimney Hollow Reservoir as discussed in Section 2.4.

2.1.2.4 Alternatives Selected for NEPA Analysis

Based on the screening and evaluation of potential alternatives, four reservoir sites appear feasible to meet the purpose and need for the proposed WGFP. Potential reservoir sites include Jasper East and Rockwell on the West Slope (Figure 2-2) and Chimney Hollow and Dry Creek on the East Slope (Figure 2-3).

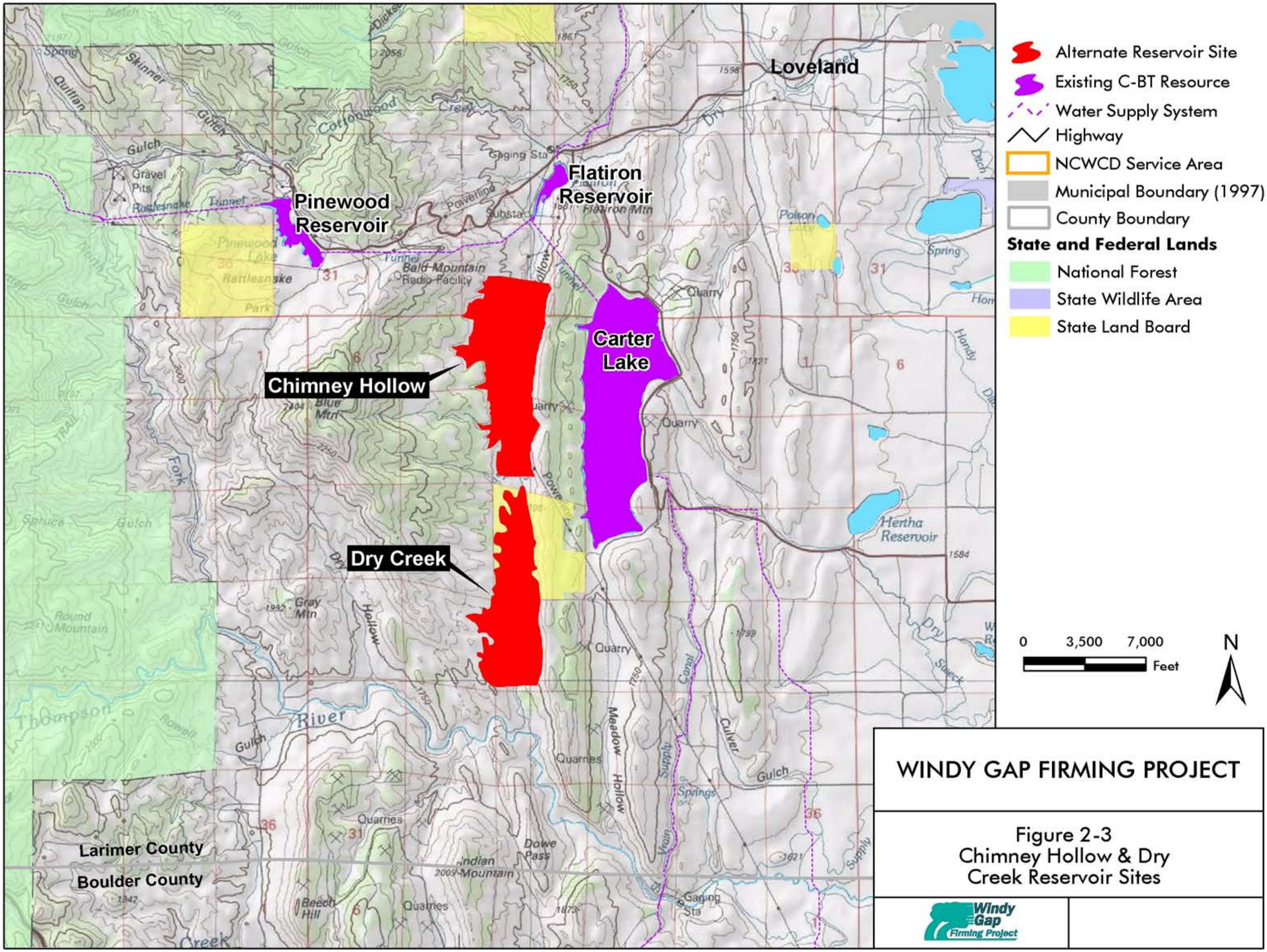
The Chimney Hollow Reservoir site has the capacity to meet total storage requirements of 90,000 AF. The other reservoir sites would need to be used in combination to provide adequate storage. A smaller Chimney Hollow could be combined with either of the two potential West Slope reservoirs.

The Dry Creek reservoir site, which has a maximum storage capacity of about 60,000 AF, could be combined with a 30,000 AF Rockwell Reservoir on the West Slope to provide 90,000 AF of storage. A Dry Creek and Jasper East combination is not feasible because Jasper East storage capacity is limited to about 22,000 AF.



WINDY GAP FIRMING PROJECT

Figure 2-2
Jasper East & Rockwell/Mueller Creek Reservoir Sites



WINDY GAP FIRMING PROJECT

Figure 2-3
Chimney Hollow & Dry Creek Reservoir Sites

Windy Gap Firming Project

The alternatives analysis concluded that the following reservoirs, individually or in combination, provide a reasonable range of alternatives for meeting the project purpose and need, satisfying technical/logistic considerations, while minimizing environmental effects and should be considered for additional evaluation in the EIS.

- Chimney Hollow Reservoir (90,000 AF) with prepositioning
- Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF)
- Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF)
- Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF)

The Subdistrict's proposed action is to construct a 90,000 AF Chimney Hollow Reservoir using prepositioning to improve yield. The following sections describe the components and operational characteristics of the No Action alternative and four action alternatives. Chapter 3 provides information on the estimated yield and the potential environmental consequences for each alternative.

2.2 Alternative 1—No Action Alternative

NEPA regulations require analysis of a No Action Alternative (CEQ Guidelines 1502.14). No action does not necessarily require continuation of current conditions or the status quo, but rather a reasonable projection of future conditions or actions if none of the action alternatives are implemented. No action, in the context of this EIS, means no actions or approvals by Reclamation. No action from Reclamation's perspective is what is reasonably likely to occur with continuation of the existing contractual arrangement between Reclamation and the Subdistrict for the delivery of Windy Gap water through the C-BT system without a new or amended contract for additional connection of new Windy Gap Firming infrastructure to C-BT facilities. The No Action Alternative is described below and was analyzed along with the action alternatives to provide a basis for comparison.

2.2.1 Current Windy Gap Project Operations

The current Windy Gap Project has been in operation since 1985. Windy Gap Project water is diverted from the Colorado River just downstream of the confluence of the Colorado and Fraser Rivers at Windy Gap Reservoir (Figure 1-3). Once collected, it is pumped to Granby Reservoir for storage and is conveyed to the East Slope via the Adams Tunnel to Carter Lake, another C-BT reservoir. Granby Reservoir is the only long-term storage facility for Windy Gap water prior to delivery to Windy Gap Participants. Carter Lake and Horsetooth Reservoir provide only short-term conveyance of Windy Gap water. From Carter Lake, Windy Gap water is distributed using conveyance through C-BT facilities including the Hansen Feeder Canal and Horsetooth Reservoir for Project Participants to the north, and the St. Vrain Supply Canal, Boulder Feeder Canal, and Boulder Creek Supply Canal for Participants to the south. In addition, the Southern Water Supply Pipeline out of Carter Lake provides delivery to six Project Participants to the south. No Windy Gap water is stored in East Slope C-BT storage reservoirs. Storage capacity of Windy Gap water for most Project Participants once delivery is taken is limited; therefore, most Participants typically only order delivery of Windy Gap water from Granby Reservoir as needed.

The current Windy Gap Project, according to the terms outlined in the 1985 Supplement to the 1980 Agreement Concerning the Windy Gap Project and Azure Reservoir and Power Project, requires the Municipal Subdistrict, Northern Colorado Water Conservancy District to dedicate and set aside annually, but non-cumulatively, at no cost to MPWCD, the first 3,000 AF of water in Granby Reservoir that is produced each water year from Windy Gap water supplies. This water is for beneficial use without waste, either directly or by exchange or substitution, in the MPWCD. The direct beneficial uses do not include instream uses or industrial uses. In the event of a Granby Reservoir spill, MPWCD's Windy Gap water stored in the reservoir is the last of any Windy Gap water to be spilled. MPWCD's Windy Gap water stored in Granby Reservoir cannot be carried over to the next year.

2.2.2 Participant Operations under the No Action Alternative

If Reclamation does not approve a contract to connect new WGFP facilities to C-BT facilities as required for the action alternatives, Project Participants in the near term would maximize delivery of Windy Gap water according to their demand, water rights, availability of storage in Granby Reservoir, and existing Adams Tunnel conveyance constraints. The City of Longmont is the only Participant that currently has an option to develop storage independently if the WGFP is not implemented. Most Participants indicate that, in the long term, they would seek other storage options, individually or jointly, to firm Windy Gap water because of their need for reliable Windy Gap deliveries and the substantial investment in existing infrastructure. However, no specific reservoir sites have been identified by Participants other than the City of Longmont.

Those Participants that do not have a currently defined storage option, would take delivery of Windy Gap water whenever it is available within the capacity of their existing water systems and delivery points under the terms of the existing Carriage Contract between Reclamation and the Municipal Subdistrict, Northern Colorado Water Conservancy District. Participants that would operate under this scenario include Broomfield, Central Weld County Water District, Erie, Evans, Fort Lupton, Greeley, Little Thompson Water District, Louisville, Loveland, Platte River, and Superior. The City of Lafayette anticipates that it would withdraw from participating in the WGFP and dispose of existing Windy Gap units and not pursue acquisition of future units if the WGFP is not implemented.

The City of Longmont indicates that it would develop storage facilities for Windy Gap water independently, if the Firming Project is not approved and completed. The City would evaluate the enlargement of the existing Ralph Price Reservoir (Button Rock Dam) located on North St. Vrain Creek or Union Reservoir located east of the City. The enlargement of Ralph Price Reservoir by 13,000 AF would be the City's preferred option because Union Reservoir would not have sufficient capacity for Windy Gap water and other planned sources of water that could be stored. Also, conveyance and distribution would be more efficient from the higher elevation Ralph Price Reservoir (Figure 2-4). Additional description of the infrastructure and operation of Ralph Price Reservoir is included in Section 2.2.2.1.

MPWCD would continue to use Windy Gap water when available to provide augmentation flows for other water diversions in a manner similar to current operations. MPWCD can store up to 3,000 AF of Windy Gap water in Granby Reservoir each year if Windy Gap water can be diverted and storage space is available.

Hydrologic modeling of the No Action alternative was used to estimate the amount of Colorado River diversions, storage requirements, and yield for Project Participants based on the near-term maximization of Windy Gap deliveries with the addition of storage in an enlarged Ralph Price Reservoir by the City of Longmont. The following assumptions also were used in the analysis:

- There would be no change in the existing Windy Gap or C-BT facilities for the conveyance or storage of Windy Gap water.
- East Slope Participants would continue to divert and take Windy Gap water from existing Participant delivery points, subject to existing conveyance limitations in delivering water from Granby Reservoir to the East Slope via the Adams Tunnel and existing East Slope C-BT conveyance facilities.

> Under No Action, Reclamation would not approve the connection of new WGFP facilities to C-BT facilities. The Subdistrict would maximize the delivery of Windy Gap water to participants under existing agreements between Reclamation and the Subdistrict. Participants would seek to maximize their delivery of Windy Gap water using existing facilities. In addition, the City of Longmont would enlarge Ralph Price Reservoir to firm its Windy Gap water. The City of Lafayette would not participate in the Windy Gap Project.

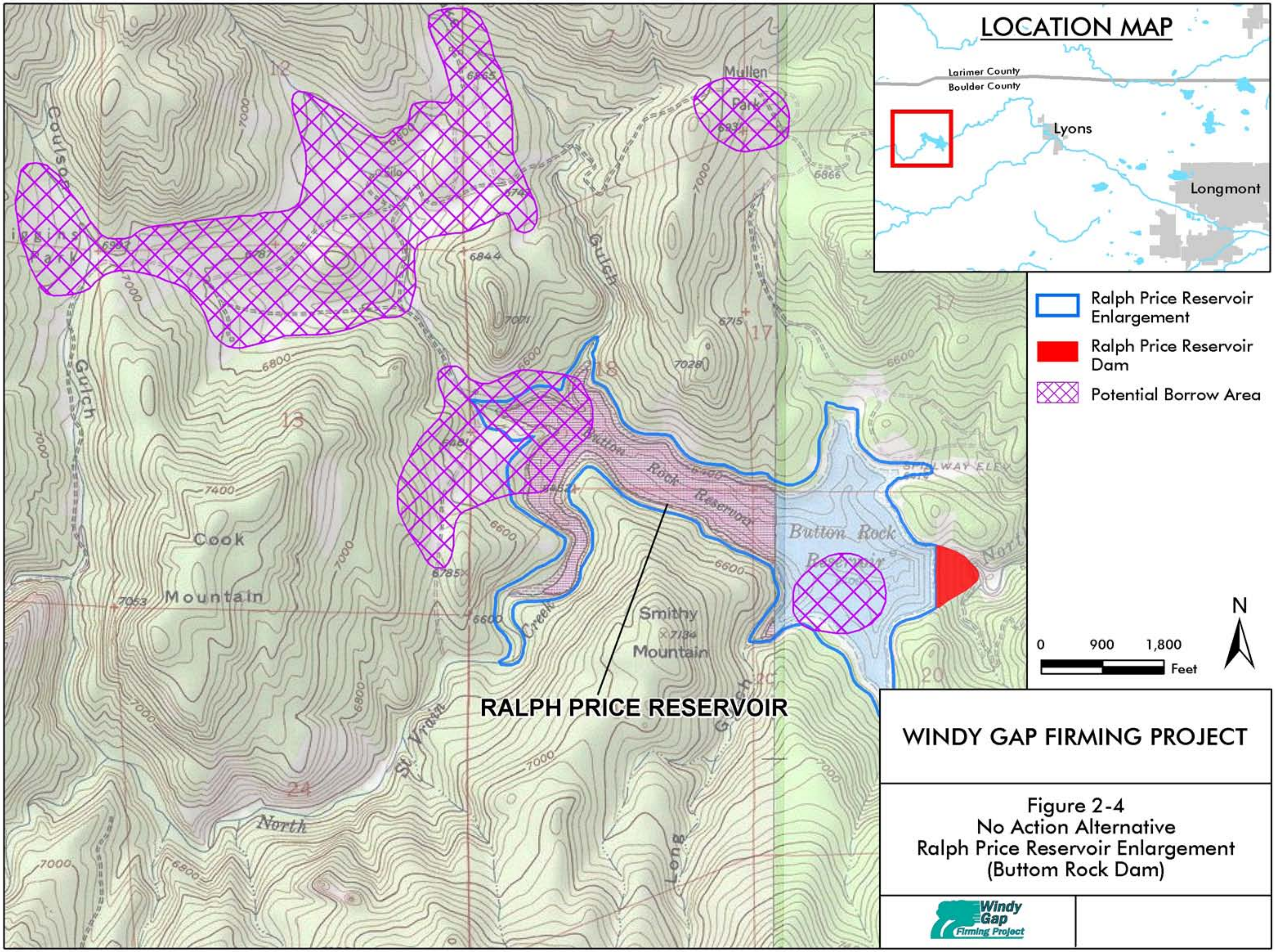


Figure 2-4
No Action Alternative
Ralph Price Reservoir Enlargement
(Buttom Rock Dam)

- The amount of water diverted from the Colorado River would be subject to existing Windy Gap water rights.
- WGFP Participants would adhere to conditions in the 1981 Record of Decision and associated agreements that limit or place conditions on the timing or amount of water that can be pumped by the Windy Gap Project.
- Project Participant demand for Windy Gap water would be the same as identified in the Windy Gap Firming Project Purpose and Need Report as discussed in Chapter 1 and described in Section 3.5.2.9 of the Draft EIS.

Over the long term, most Participants would begin investigating other options to develop storage for their Windy Gap water. The types of storage that might be used for Windy Gap water include gravel pits, new reservoirs, enlargement of existing reservoirs, or options not yet identified. The construction of multiple new storage facilities also would require additional infrastructure to convey, pump, and distribute water outside of the C-BT system. The amount of water that could be delivered to new reservoirs would still be limited by the terms of the existing Carriage Contract. Because most Participants have not identified specific facilities to store Windy Gap water independently, the physical disturbance and associated resource effects, as well as the hydrologic consequences of future storage are unknown.

Ralph Price Reservoir

Continued operation and delivery of Windy Gap Project water to Participants would not require NEPA compliance or a permit from the Corps, but the enlargement of Ralph Price Reservoir is likely to result in a discharge to a regulated water of the U.S., which is subject to Corps permitting requirements and other NEPA compliance. Other future projects by the Participants to develop additional storage could likewise be subject to Corps jurisdiction and NEPA compliance. Because a No Action alternative that completely avoids Corps jurisdiction has not been identified, the Corps' No Action alternative is assumed to be the same as Reclamation's.

> The City of Longmont would enlarge the existing Ralph Price Reservoir by 13,000 AF under the No Action alternative.

2.2.2.1 Infrastructure and Operations for Ralph Price Reservoir Enlargement

Detailed design studies for the enlargement of Ralph Price Reservoir have not been conducted. As a result, specific information on the construction, material requirements, scheduling, and detailed cost is not available. The following provides a description of the estimated requirements for the enlargement of Ralph Price Reservoir and its operation.

Dam and Spillway. The existing 16,000 AF Ralph Price Reservoir would be enlarged to about 29,000 AF to provide 13,000 AF of additional storage. The existing Button Rock dam would be raised 50 feet, from a current normal high water elevation of 6,400 feet to 6,450 feet. The surface area of the reservoir would increase from about 227 acres to 304 acres. Based on preliminary studies, an earth and rockfill dam would probably be used to raise the existing dam (Woodward-Clyde 1987). An enlarged spillway would be required and possibly some modifications to the existing inlet and outlet works.

Conveyance and Operation. No new conveyance infrastructure would be needed to deliver water to the enlarged Ralph Price Reservoir or from the reservoir to the City of Longmont. Windy Gap water delivered from the West Slope through existing C-BT facilities would be released to St. Vrain Creek via the St. Vrain Supply Canal and exchanged up to the enlarged Ralph Price Reservoir by capturing an equivalent amount of water from North St. Vrain Creek in the reservoir. Water released from Ralph Price Reservoir would flow about 2 miles in North St. Vrain Creek and would then be diverted at the existing Longmont Dam diversion structure for delivery to City water treatment plants using existing infrastructure.

Access, Borrow Areas, and Power. Existing Boulder County Road 80 and City roads would provide access to the dam and reservoir for construction. Several potential borrow area sources for dam enlargement were identified in the Woodward-Clyde study (Figure 2-4). The amount, type, and source of borrow material would depend on final dam design. Access to most borrow areas would require temporarily draining the reservoir. Existing power lines to the reservoir would provide power during construction and operation of the enlarged reservoir.

Construction Program. Raising Button Rock dam would require draining the reservoir and establishing staging areas. The work force needed to raise the dam and rebuild a spillway is estimated to average 50 people, peaking at about 100 people at the height of construction (Boyle Engineering 2005d).

Cost and Schedule. Preliminary cost estimates for raising Button Rock Dam were made during a feasibility study in 1987 (Woodward-Clyde 1987). Based on this information, the estimated cost of raising the dam 50 feet is about $31 million in 2003 dollars. Construction of the reservoir enlargement and other improvements would take about 2 years.

Public Access and Recreation. Ralph Price Reservoir is currently part of the Button Rock Preserve, which provides fishing, hiking, and wildlife viewing opportunities. Similar activities would be maintained following reservoir enlargement, although public access would be restricted during construction.

2.3 Activities Common to All Action Alternatives

Each of the Project Participants has requested a defined amount of storage in the proposed Firming Project. The amount of storage requested was based on the number of Windy Gap units that each Participant owns or intends to acquire, the projected yield or firm delivery, and the cost of storage. All action alternatives include 3,000 AF of storage for the MPWCD.

Sections 2.4 to 2.7 provide a description of the infrastructure, operations plan, construction program, public access, and recreation potential for each of the action alternatives. Additional detailed description on the project components is found in the Windy Gap EIS Alternatives Description Report (Boyle 2005b).

A number of the construction-related features are similar for the action alternatives. Unless noted otherwise, all pipelines would be buried. A permanent easement of about 50 to 80 feet and an additional temporary easement of 100 feet would be needed during pipeline construction. Following construction, areas temporarily disturbed during pipeline construction would be reclaimed and revegetated with native species, or with existing species in agricultural areas. Borrow areas outside of the area of inundation, staging areas, and other areas of temporary disturbance needed for construction would likewise be revegetated.

Blasting would be necessary at all of the reservoir sites to: 1) obtain a suitable foundation for the dam prior to placement of the embankment materials; 2) produce suitable rock for the upstream and downstream slopes of the dam from the borrow areas; and 3) construct water conveyance facilities, temporary or permanent access roads, and other project features. Blasting activities could take place throughout the construction period depending on the contractor's plans for producing and stockpiling rock for use in the dam.

2.4 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Construction of a 90,000 AF Chimney Hollow Reservoir, along with the ability to store or preposition C-BT water in the new reservoir is the Proposed Action by the Subdistrict. Water would be conveyed to Chimney Hollow Reservoir via a new pipeline connection to existing East Slope C-BT facilities. Connections between Chimney Hollow Reservoir and Carter Lake would allow delivery of water to Participants using existing infrastructure.

The Chimney Hollow Reservoir site is located in Larimer County about 8 miles southwest of the Loveland, Colorado and ½ mile west of Carter Lake (Figure 2-5). The reservoir would be built in a hogback valley along an intermittent drainage at an elevation of about 5,600 feet.

2.4.1 Infrastructure

2.4.1.1 Dam and Spillway

Chimney Hollow Reservoir would require construction of a 346-foot-high dam to impound about 90,000 AF of water. The maximum normal pool elevation would be 5,866 feet. The reservoir at the maximum water surface elevation would inundate about 742 acres. Preliminary design indicates a rockfill dam type would be appropriate, but the specific type of rockfill dam would not be determined until final design. Appurtenances to the dam would include a spillway to convey a peak discharge of about 2,100 cfs. A 36-foot-high saddle dam would be required at the southern end of the reservoir.

2.4.1.2 Conveyance

Water would be conveyed to the East Slope via existing C-BT facilities as far as the upper end of the Flatiron Penstocks (Figure 2-6). Water would be conveyed to Chimney Hollow Reservoir using a new buried penstock pipeline to the pressure conduit between the Bald Mountain Tunnel surge tank and the Flatiron Penstock valve house. Other new conveyance facilities would include pipelines and an energy dissipation facility from the Flatiron Penstocks to the Chimney Hollow inlet/outlet along with connections to the existing Carter Lake pressure conduit. Modifications in the various pipeline connections may be made during final design.

2.4.1.3 Access, Borrow Areas, and Power

Primary access to Chimney Hollow Reservoir would be from Pole Hill Road below the dam site. A new permanent access road about 1.5 miles long on the northwest side of the reservoir would provide access for construction, maintenance, and public recreation access after the reservoir is completed. The final road layout would be determined in coordination with Larimer County. Construction access to the saddle dam on the southern end of the reservoir would be located along or near an existing transmission line maintenance road. This road would be closed to public access.

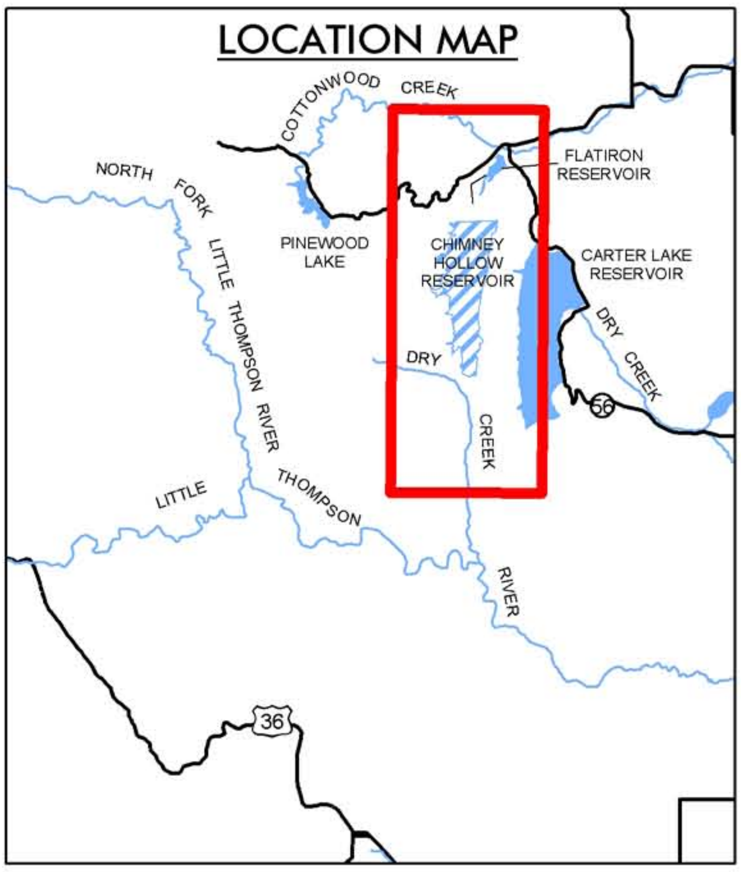
Construction materials for the dams would be taken from borrow areas within the reservoir basin. Two primary borrow sources have been identified: 1) granite bedrock along the west rim of the reservoir for use as rockfill in the dam shell; and 2) fine-grained material in the central part of the reservoir for use as low permeability material in the core of the dam. The need for off-site borrow material would depend on the type of dam constructed and quality of the material from within the reservoir site. Off-site borrow material may be needed for concrete production, or bitumen if an asphaltic core rockfill dam is used. Commercial sources for these materials are available in the region if needed.

Power supply to the reservoir and conveyance facilities would come from the existing facilities associated with the Flatiron Power Plant. A substation may be needed to step down voltage.

2.4.1.4 Transmission Line Relocation

The existing 115-kV transmission line located in Chimney Hollow would need to be relocated to construct the reservoir. The transmission line is owned by Western and was constructed as part of the original C-BT Project. The existing line is constructed on wood H-frame structures and is part

Chimney Hollow Reservoir Site



Inlet - Outlet Tunnel
Spillway and Channel
New Pipeline
Potential Disturbance Area
Transmission Line Corridor
Chimney Hollow Reservoir
Dam

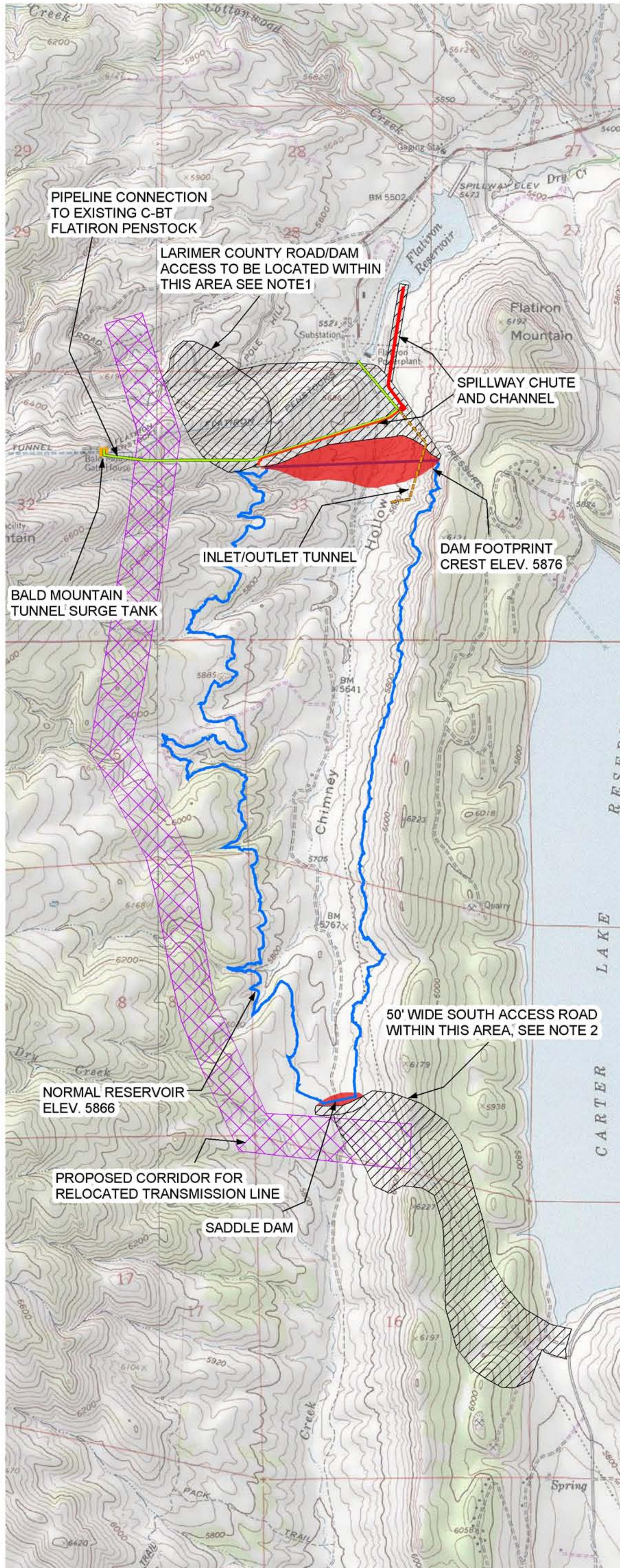
NOTES:

1. FINAL LOCATION OF DAM CREST ACCESS ROAD TO BE DETERMINED THROUGH LARIMER COUNTY PARK PLANNING PROCESS.
2. SOUTH ACCESS ROAD DURING CONSTRUCTION - GATED WITH NO PUBLIC ACCESS FOLLOWING CONSTRUCTION.

0 2,000 4,000 Feet

N

"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003

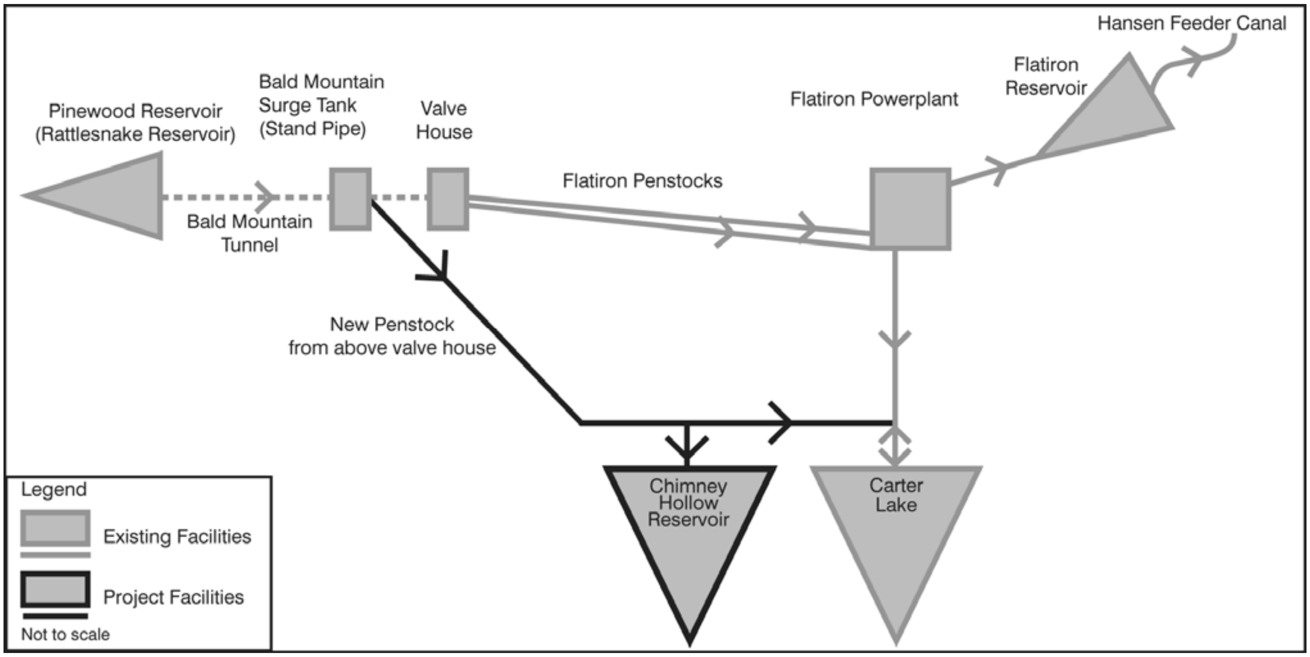


WINDY GAP FIRMING PROJECT

Figure 2-5
Alternative 2, Proposed Action Chimney Hollow Reservoir (90,000 AF)

Windy Gap Firming Project

Figure 2-6. Chimney Hollow Reservoir connection schematic.



of a 27-mile line with terminals at the Estes Powerplant and at the Lyons Substation (Western 2004).

About 3.8 miles of the transmission line would be relocated to the west side of the proposed reservoir. Western, Larimer County, and the Subdistrict identified a 750-foot wide corridor as a suitable location for line relocation. Selection of the line relocation corridor was based on visual simulations used to reduce transmission line visibility, minimize removal of existing trees, and with consideration of planned Larimer County Parks and Open Land trails, and construction accessibility. The specific transmission line location, pole placement, and spacing would be identified by Western during final design. The location of access roads for transmission line installation and maintenance also would be determined during final design. A 100-foot-wide right-of-way across Subdistrict and Larimer County land would be required for the relocated line. The new line would connect with the existing alignment on the north and south ends of the proposed reservoir. Western considered additional re-route alternatives for the transmission line but rejected them from further consideration in the EIS. The basis for rejecting these alternatives is related to their relative cost and increased environmental impacts. Reroutes located to the east of the proposed Chimney Hollow Reservoir were rejected based on increased visual impacts to local residents and users of the Larimer County Parks, the difficulty of constructing on steep terrain; increased potential for soil erosion on steep terrain, poor access for maintenance and emergency access, and increased costs for construction and maintenance. Other alternatives were considerably longer, impacted more private landowners, and resulted in more visual impacts.

> A new pipeline connection to C-BT facilities on the East Slope would be needed to deliver Windy Gap water to Chimney Hollow Reservoir.

Removal of the existing transmission and relocation of the transmission line would take between 2 and 4 months, depending on weather and other factors. The new section of line would be installed before the old section is removed. Sequencing the action in this way allows the old line to remain in service to serve customer electrical loads during the installation of the relocated section. Electrical service disruption is minimized. Once the new line is constructed, it is connected to the system and the old line is disconnected and removed. Dismantling and removing the old line section would be accomplished by removing the conductor and pulling the old structures out of the ground using cranes. The holes would then be backfilled. The old structures would be removed and disposed of in appropriately licensed landfills, or recycled to landowners or others having a use for them. The new section of line would be constructed with augured foundations. The steel structures may either be placed into the augured holes and then backfilled with concrete or poured foundations made with reinforced concrete to which the structures would be bolted. Concrete is hauled to the site in trucks. The steel structures would be lifted into place with cranes. Once the structures are in place, the hardware (e.g., conductor supports and insulators) would be attached to the structures. The conductor would then be installed and tensioned. Cleanup of the ROW, erosion control measures, and any required revegetation would be the last step in the installation process. Equipment would consist of pickup trucks, a truck-mounted auger, cement trucks, crane, trucks with conductor spools, and tensioning and pulling equipment. Western uses existing access to the extent possible and typically does not construct access roads unless necessary. Access road requirements would be determined during the design phase.

According to Western's capital improvement plan, the transmission line is scheduled for upgrading in 2010 to a 230-kV, double circuit line. Thus, the relocated line would be rebuilt with larger structures and conductors for operation at 230-kV. The rebuilt line would use single steel poles up to 110 feet tall. Poles would be placed at intervals varying between 900 feet and 1,200 feet, depending on the terrain. Western would remove trees that could negatively impact the reliable operation of the transmission line (e.g., trees that could grow tall enough to cause arcing between the tree and the conductors or could fall into the conductors or structures). Western would promote the growth of low-growing native plants on the ROW. To minimize the visibility of the transmission line, nonspecular, nonreflective wire would be used. Nonreflective insulators also would be used and possibly Corten steel poles that have a rusted nonreflective surface and dark brown color. Western would design the transmission line in conformance with Suggested Practices for Protection of Raptors on Power lines (APLIC 1994) and Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006). The estimated cost for removal of the existing transmission line and construction of the new line is $4.5 million and would be paid for jointly by the Subdistrict and Western. Western would be responsible for oversight and contracting for the relocation.

Western's proposal for removal of the existing transmission line and its relocation includes as part of the proposed action several standard construction and mitigation measures listed in Table 2-3.

Table 2-3. Western's Standard Construction Mitigation Measures.

Mitigation Action
General
The contractor shall limit the movement of crews and equipment to the ROW, including access routes. The contractor shall limit movement on the ROW to minimize damage to residential yards, grazing land, crops, orchards, and property, and shall avoid damage to property.
The contractor shall coordinate with the landowners to avoid impacting the normal function of irrigation devices during project construction and operation.
When weather and ground conditions permit, obliterate all construction-caused deep ruts that are hazardous to farming operations and to movement of equipment. Such ruts shall be leveled, filled and graded, or otherwise eliminated in an approved manner. Ruts, scars, and compacted soils in hay meadows, alfalfa fields, pastures, and cultivated productive lands shall have the soil loosened and leveled by scarifying, harrowing, disking, or other approved methods. Damage to ditches, tile drains, terraces, roads, and other features of the land shall be corrected. At the end of each construction season and before final acceptance of the work in these agricultural areas, all ruts shall be obliterated, and all trails and areas that are hard-packed as a result of construction operations shall be loosened and leveled. The land and facilities shall be restored as nearly as practicable to the original condition.
Construction trails not required for maintenance access shall be restored to the original contour and made impassable to vehicular traffic. The surfaces of such construction trails shall be scarified as needed to provide a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion.

Mitigation Action
Construction staging areas shall be located and arranged in a manner to preserve trees and vegetation to the maximum practicable extent. On abandonment, all storage and construction materials and debris shall be removed from the site. The area shall be regraded, as required, so that all surfaces drain naturally, blend with the natural terrain, and are left in a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion.
Borrow pits shall be excavated so that water will not collect and stand therein. Before being abandoned, the sides of borrow pits shall be brought to stable slopes, with slope intersections shaped to carry the natural contour of adjacent undisturbed terrain into the pit or borrow area, giving a natural appearance. Piles of excess soil or other borrow shall be shaped to provide a natural appearance.
The Contractor shall make all necessary provisions in conformance with safety requirements for maintaining the flow of public traffic and shall conduct his construction operations so as to offer the least possible obstruction and inconvenience to public traffic.
Erosion
Water turnoff bars or small terraces shall be constructed across all ROW trails on hillsides to prevent water erosion and to facilitate natural revegetation on the trails.
Environmental
The contractor and Western shall comply with all applicable federal, state, and local environmental laws, orders, and regulations. Prior to construction, all supervisory construction personnel will be instructed on the protection of cultural and ecological resources.
The contractor shall exercise care to preserve the natural landscape. Construction activities shall be conducted to minimize scarring or defacing of the natural surroundings in the vicinity of the work. Except where clearing is required for permanent works, approved construction roads, or excavation operations, vegetation shall be preserved and shall be protected from damage by the contractor's construction operations and equipment.
Vegetation
On completion of the work, all work areas except access trails shall be scarified or left in a condition that will facilitate natural revegetation (unless reseeding, mulching, or other specific requirements apply), provide for proper drainage, and prevent erosion. All destruction, scarring, damage, or defacing of the landscape resulting from the contractor's operations shall be repaired by the contractor.

Mitigation Action
Wildlife
Western would design the transmission line in conformance with Suggested Practices for Protection of Raptors on Power lines (APLIC 1994) and Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006).
Waste
Construction activities shall be performed by methods that prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into flowing streams or dry water courses, lakes, and underground water sources. Such pollutants and wastes include, but are not restricted to, refuse, garbage, cement, concrete, sanitary waste, industrial waste, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.
Burning or burying of waste materials on the ROW or at the construction site will not be allowed. The contractor shall remove all waste materials from the construction area. All materials resulting from the contractor's clearing operations shall be removed from the ROW and disposed of in accordance with applicable regulations.
Water
Dewatering work for structure foundations or earthwork operations adjacent to, or encroaching on, streams or water courses will not be performed without prior notice to appropriate state agencies and compliance with applicable NPDES requirements.
Excavated material or other construction materials shall not be stockpiled or deposited near or on streambanks, lake shorelines, or other water course perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the actual water source itself.
Waste waters from construction operations shall not enter streams, water courses, or other surface waters without use of such turbidity control methods as settling ponds, gravel-filter entrapment dikes, filter fences, approved flocculating processes that are not harmful to fish, recirculation systems for washing of aggregates, or other approved methods. Any such waste waters discharged into surface waters shall be essentially free of suspended material.
Minimize activities in riparian areas or span riparian areas. Avoid disturbance to riparian vegetation whenever practical.

Mitigation Action
Air
The contractor shall utilize such practicable methods and devices as are reasonably available to control, prevent, and otherwise minimize atmospheric emissions or discharges of air contaminants.
Equipment and vehicles that show excessive emissions of exhaust gases due to poor engine adjustments, or other inefficient operating conditions, shall not be operated until corrective repairs or adjustments are made.
Electromagnetic Fields
Western will apply necessary mitigation to eliminate problems of induced currents and voltages onto conductive objects sharing a ROW, to the mutual satisfaction of the parties involved. Western will install fence grounds on all fences that cross or are parallel to the proposed line.

2.4.2 Operations

Windy Gap water would be diverted from the existing point of diversion at Windy Gap Reservoir and Pump Plant located below the confluence of the Fraser and Colorado Rivers, near the Town of Granby. The existing Windy Gap pipeline would pump water to Granby Reservoir, which would then be delivered to the East Slope using existing C-BT facilities. Water would be routed to Chimney Hollow Reservoir using the new pipeline connections discussed previously in Section 2.4.1.2. No new West Slope infrastructure is needed to divert or convey water to the East Slope. In addition to storage in Chimney Hollow, Windy Gap water may also be stored in Granby Reservoir when unused capacity is available.

The delivery of Windy Gap water to the East Slope, either for storage or to meet Participant demand depends on several factors including the physical and legal availability of water for diversion, storage space in Granby Reservoir, capacity in the Adams Tunnel, and space in Chimney Hollow Reservoir. Instantaneous delivery of Windy Gap water as allowed by the existing Carriage Contract between Reclamation, the NCWCD, and Municipal Subdistrict, Northern Colorado Water Conservancy District allows Windy Gap water in Granby Reservoir to be immediately delivered out of Carter Lake or Horsetooth Reservoir on the East Slope, with the same amount of water being exchanged with C-BT. Instantaneous deliveries reduce conveyance constraints in the Adams Tunnel or if space is not available in Chimney Hollow to take direct deliveries.

Prepositioning would be used to facilitate delivery of Windy Gap water and increase yield. Prepositioning would involve the use of available Adams Tunnel capacity to deliver C-BT water into Chimney Hollow to occupy storage space that is not occupied by Windy Gap water. Delivery of C-BT water to Chimney Hollow in this manner would maintain Chimney Hollow full most of the time. The delivery of C-BT water from Granby Reservoir into Chimney Hollow would create space for Windy Gap water in Granby Reservoir. When Windy Gap water is diverted into Granby Reservoir, the C-BT water in Chimney Hollow would be exchanged for a like amount of Windy Gap water in Granby Reservoir. The amount of C-BT water delivered to Chimney Hollow in any month generally would coincide with the amount of Windy Gap water released to meet Participant demands, which range from about 1,000 AF to 3,000 AF per month throughout the year. Prepositioning would not require any additional structural facilities to operate and would not change the storage or yield of C-BT Project water.

> MPWCD's Windy Gap water would be stored in Chimney Hollow Reservoir and exchanged back to the West Slope as needed.

Participants would take delivery of Windy Gap water from Chimney Hollow Reservoir via releases through existing C-BT facilities. Deliveries to Participants to the north would be made via the Flatiron Afterbay to the Charles Hansen Feeder Canal. Deliveries to the south would be released from Chimney Hollow to a tie-in with the Carter Lake Pressure Tunnel and then Carter Lake. Windy Gap water would then be released to the St. Vrain Supply Canal and/or the Southern Water Supply Pipeline.

MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit Counties. MPWCD 3,000 AF of water would be stored in Chimney Hollow Reservoir and then exchanged back to Granby Reservoir where releases to the Colorado River would be made to offset depletions.

Prepositioning is a method of water operation in which C-BT water is “prepositioned,” or stored in advance, in Chimney Hollow Reservoir. By storing C-BT water in Chimney Hollow, additional storage space for Windy Gap water could be made available in Granby Reservoir. As a result, there would be fewer instances when Windy Gap water could not be diverted. Total allowable C-BT storage would not change and the existing C-BT water rights and diversions would not be expanded.

Releases would either directly replace depletions for uses on the Colorado River or replace by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD’s Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.4.3 Construction Program

Construction of Chimney Hollow dam and the associated pipeline, roads, and related facilities would take from 3 to 5 years. Construction sequencing includes construction of the new access road, relocation of the transmission line, development of borrow areas, excavation of the dam foundation, and construction of inlet and outlet facilities, spillway, and delivery pipelines. Construction staging areas would include the permanent reservoir pool, an area below the dam, and possibly Reclamation Flatiron facilities.

The work force needed to construct proposed facilities depends on the final design specifications and contractor construction equipment and construction methods. The average work force based on a 4-year construction schedule and reduced activity during the winter is 235 people. Peak employment is estimated to reach about 500 people.

The majority of the construction material for the dam would be excavated on-site. Truck deliveries for steel, cement, fuel, and other materials would be needed. Average truck deliveries are estimated at five trucks per day, with peak truck traffic of 10 truck deliveries per day. Pipe delivery would add about three additional trucks per day.

2.4.4 Cost

The estimated total construction cost for Chimney Hollow Reservoir and associated facilities is $223 million in 2005 dollars. This includes about $208 million for the dam, reservoir, and appurtenances, and about $15 million for conveyance facilities. Reservoir construction costs are estimated to have increased about 17 percent since the 2005 cost estimate. Included in the cost is $4.5 million for relocation of Western’s transmission line. Routine operation and maintenance (O&M) activities are estimated to be about $500,000 annually for the reservoir and dam. This is based on an equivalent labor force of four full-time personnel and direct costs for equipment, parts, and contractor services. Annual O&M costs for the conveyance facilities including power costs are estimated to be about $295,000. Power costs would be minimal because deliveries in and out of the reservoir would be by gravity.

The capital cost for constructing Chimney Hollow Reservoir and facilities would be about $223 million in 2005 dollars.

2.4.5 Public Access and Recreation

The proposed Chimney Hollow Reservoir site is currently owned by the Subdistrict and is not open to the public. Larimer County Parks and Open Lands own about 1,800 acres of land adjacent to the west side of the reservoir site. Larimer County and the Subdistrict entered into an Intergovernmental Agreement that includes a recreational lease of about 1,600 acres of Subdistrict property to the County at no fee (Larimer County - Municipal Subdistrict 2004). The recreational lease is contingent on construction of Chimney Hollow Reservoir. Larimer County recreation plans for this property include nonmotorized boating (except for small electric motors on watercraft), hiking, biking, and horseback riding. Anticipated recreation features include a parking area, trails, boat dock and ramp, picnic facilities, and vault toilets. About 10 miles of trail would be constructed on both County and Subdistrict land. No overnight camping would be allowed.

Larimer County would be responsible for all development, building, management, and maintenance of recreation facilities. The County also would provide patrol and law enforcement for Subdistrict property. As part of reservoir construction, the Subdistrict would construct a public access road to recreation facilities on the northwest side of the reservoir.

Larimer County Parks and Open Lands would develop and manage recreation at Chimney Hollow Reservoir along with the adjacent County Open Space property.

Larimer County would prepare a recreation management plan for County and Subdistrict property prior to completion of the reservoir. The recreation management plan would be developed with water quality protection as an essential goal. Recreation improvements and general public access would be completed about the same time as the reservoir. Prior to that, Larimer County may conduct tours or allow limited public access to county property.

2.5 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Alternative 3 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Jasper East Reservoir on the West Slope. The availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Jasper East or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water could be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not substantially improve yield if a new West Slope reservoir is available.

The 70,000 AF Chimney Hollow Reservoir would be at the same location as the 90,000-AF reservoir described in Alternative 2. Under this alternative, Western would remove a section of the existing Estes-Lyons 115-kV Transmission Line and relocate it as described in Section 2.4.1.4. The Jasper East Reservoir site is located in Grand County about 4 miles north of the Town of Granby and 1 mile west of Granby Reservoir. Jasper East Reservoir would be built in undulating terrain along an unnamed intermittent drainage at an elevation of about 8,100 feet.

2.5.1 Infrastructure

2.5.1.1 Dams and Spillway

The configuration for a 70,000 AF Chimney Hollow Reservoir would be the same as the larger reservoir described for Alternative 2; however, the main dam and saddle dams would be smaller. The maximum normal pool elevation would be about 5,838 feet and the area of reservoir inundation would be 627 acres (Figure 2-7). The spillway size would be similar to the 90,000 AF Chimney Hollow Reservoir.

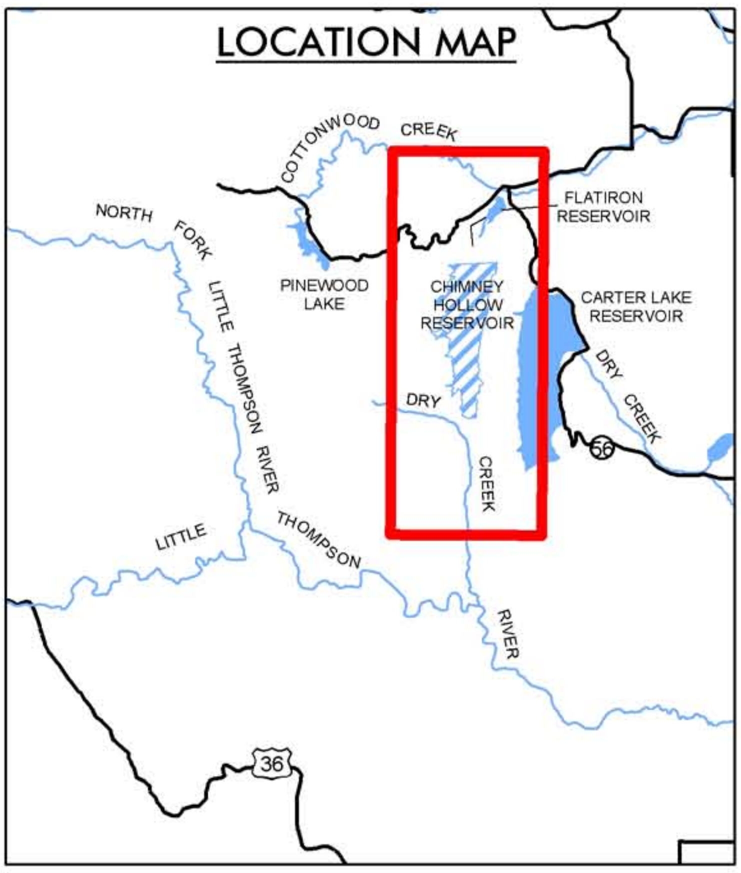
Construction of Jasper East Reservoir would require three separate earthfill dams (Figure 2-8). The 20,000 AF reservoir would have a maximum normal pool elevation of about 8,180 feet and inundate 434 acres. A 5-foot-wide spillway on the largest dam would be routed to the natural drainage.

2.5.1.2 Conveyance

Deliveries to and from Jasper East would require a new connection to the existing Windy Gap Pipeline. Diversions at the existing Windy Gap Reservoir would be pumped to Jasper East via a new pipeline off the existing pipeline at a connection less than 1 mile south of the reservoir (Figure 2-9). Water from Jasper East would be delivered to Granby Reservoir using the new pipeline back down to the existing Windy Gap pipeline, where a new booster pump would assist in the delivery to Granby Reservoir. The pump station building would be about 75 feet by 50 feet, with a height of less than 50 feet. The new buried pipeline would be about 10 feet in diameter and 4,800 feet in length.

A new 1-mile pipeline would be needed to connect Jasper East Reservoir to the existing Windy Gap pipeline that delivers water to Granby Reservoir.

Jasper East may inundate about 500 feet of the existing Windy Gap pipeline at the south end of the reservoir. Additional survey and analysis during final design would determine if alterations in design are needed.



Inlet - Outlet Tunnel

Spillway and Channel

New Pipeline

Potential Disturbance Area

Transmission Line Corridor

Chimney Hollow Reservoir

Dam

NOTES:

1. FINAL LOCATION OF DAM CREST ACCESS ROAD TO BE DETERMINED THROUGH LARIMER COUNTY PARK PLANNING PROCESS.
2. SOUTH ACCESS ROAD DURING CONSTRUCTION - GATED WITH NO PUBLIC ACCESS FOLLOWING CONSTRUCTION.

0 2,000 4,000 Feet

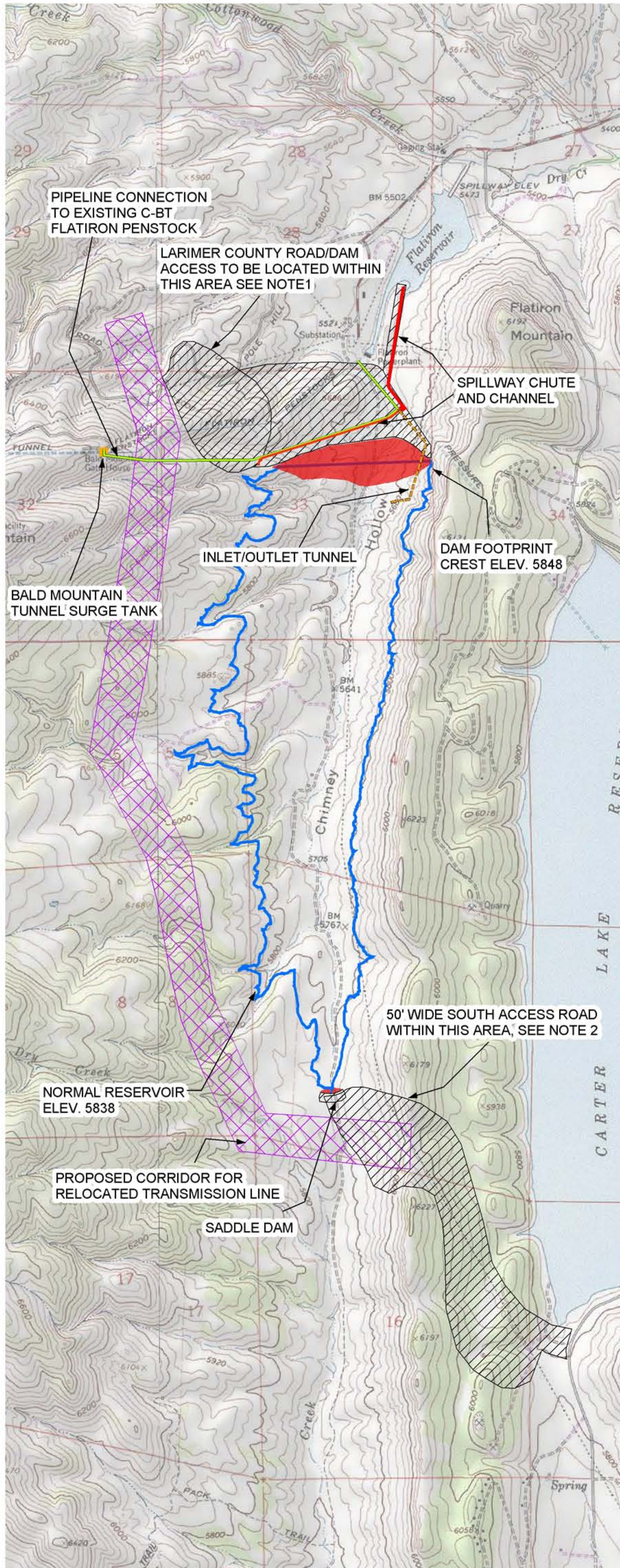
N

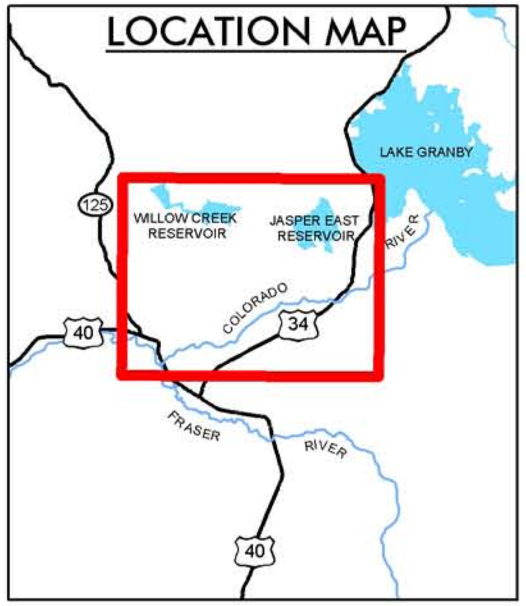
"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003

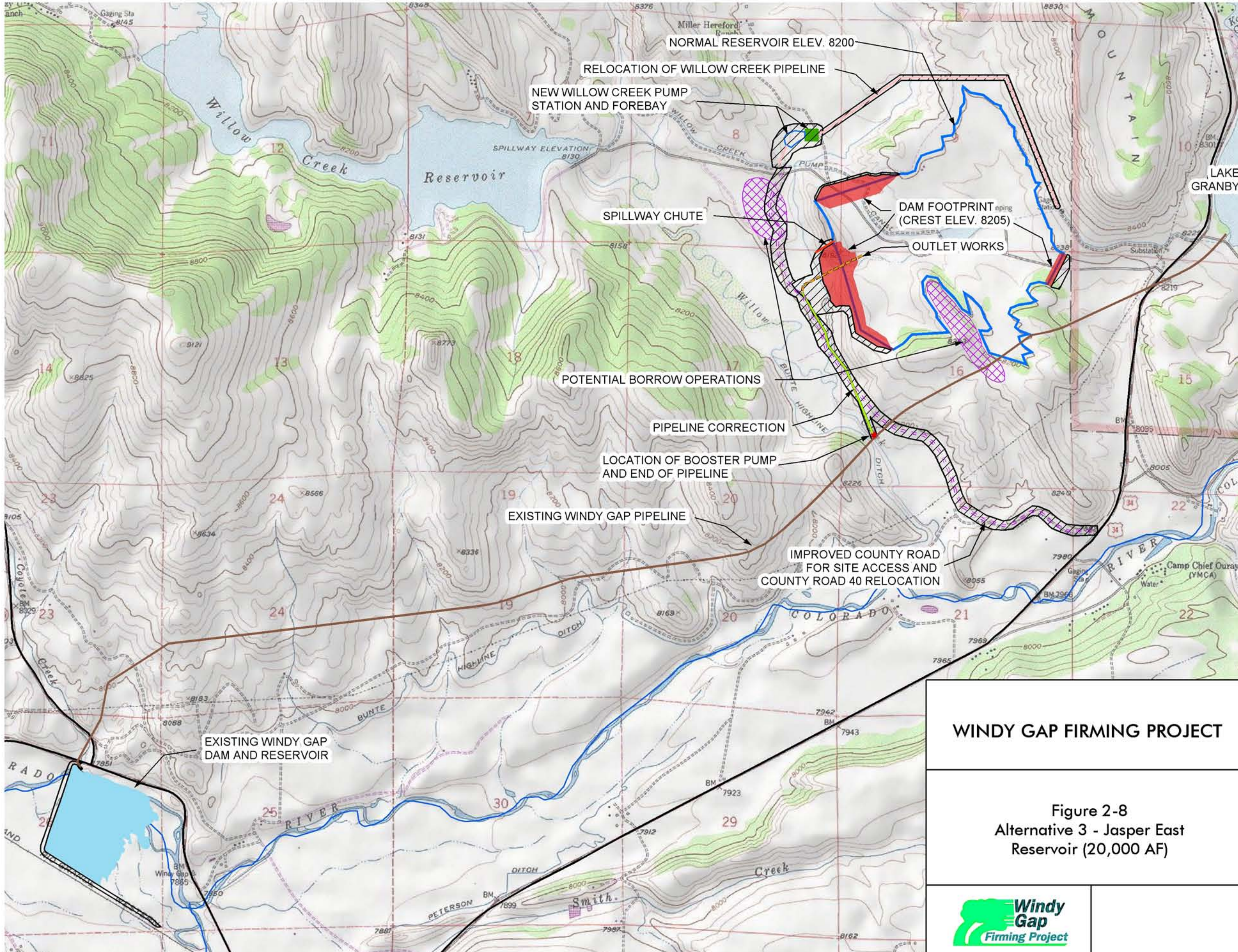
WINDY GAP FIRMING PROJECT

Figure 2-7
Alternative 3 - Chimney Hollow Reservoir (70,000 AF)

Windy Gap Firming Project







- Inlet - Outlet Tunnel
- Spillway and Channel
- New Pipeline
- Willow Creek Pipeline Relocation
- Existing Windy Gap Pipeline
- Potential Disturbance Area
- Borrow Area
- Jasper East Reservoir
- Dam

GEOLOGIC REFERENCE:

"GEOLOGIC MAP OF THE TRAIL MOUNTAIN QUADRANGLE, GRAND COUNTY, COLORADO", MAP GQ-1156, U.S. GEOLOGICAL SURVEY, 1974.

TOPOGRAPHY REFERENCE:
"COLORADO-SEAMLESS USGS TOPOGRAPHIC MAPS ON CD-ROM", TOPO VERSION 2.6.4, NATIONAL GEOGRAPHIC, 2000.

0 2,200 4,400 Feet

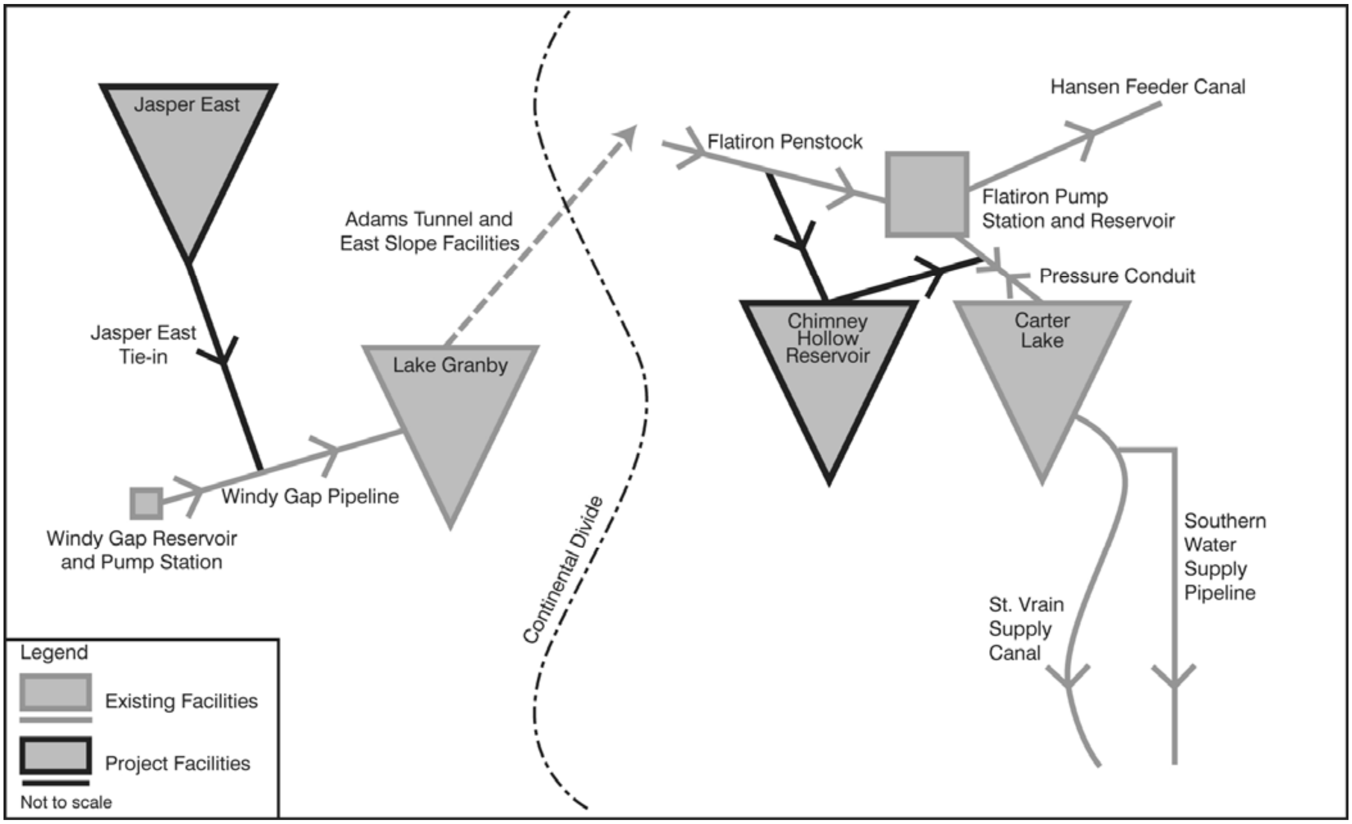
N

WINDY GAP FIRMING PROJECT

Figure 2-8
Alternative 3 - Jasper East Reservoir (20,000 AF)

Windy Gap Firming Project

Figure 2-9. Chimney Hollow Reservoir and Jasper East Reservoir connection schematic.



Water would be conveyed from the West Slope to Chimney Hollow Reservoir via existing C-BT facilities to the upper end of the existing Flatiron Penstock, where a new buried penstock would deliver water to Chimney Hollow or Carter Lake as described for Alternative 2.

2.5.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities required for the 70,000 AF Chimney Hollow Reservoir would be the same as Alternative 2.

Initial construction access to the Jasper East Reservoir site would be off County Road 40 from U.S. Highway 34. However, the new reservoir would inundate about 1.2 miles of County Road 40 and require the eventual relocation of the road. A new access road would be constructed using a combination of existing and new roads including, County Road 405 off Highway 34, an unimproved dirt road east of the reservoir, and about 5,600 feet of new road. Access to C-BT facilities, Willow Creek Reservoir Arapaho National Recreation Area, and private lands would be provided during and following reservoir construction.

The availability of suitable material for the Jasper East dam construction within the project limits is unknown, but it is anticipated that material from overburden deposits could be used. Filter and drain material is available from an existing Willow Creek gravel pit located nearby. Riprap and bedding material is believed to be available from basalt bedrock located adjacent to the reservoir.

The power supply to Jasper East Reservoir and Jasper East pump station would use the existing transmission lines present near the site. A substation to reduce the voltage for these facilities would likely be needed.

2.5.1.4 Relocation of Willow Creek Pump Station and Pipeline

Construction of Jasper East Reservoir would require relocation of the Willow Creek Pump Station, forebay, and portions of the canal and pipeline that would be inundated by the new reservoir. The

Willow Creek Pump Station and facilities are part of the C-BT Project that conveys water from Willow Creek Reservoir to Granby Reservoir. The preliminary design includes relocation of these facilities to the north of Jasper East Reservoir (Figure 2-8). Materials from the existing pump station would be salvaged as much as possible for the new facility, but a new 50 feet by 75 feet building would need to be constructed. A new 2.5-acre forebay would be constructed and about 8,800 feet of new pipeline and possibly some canal would be constructed to reconnect Willow Creek conveyance facilities. New facilities would have the same capacity as the existing facilities.

Jasper East Reservoir Site

2.5.2 Operations

Windy Gap diversions would first be delivered to Chimney Hollow Reservoir, depending on the availability of space in the Adams Tunnel for conveyance to the East Slope. If the Adams Tunnel is full, then diversions would be delivered to Jasper East for storage. Releases to Participants would first be made from Jasper East and then out of Chimney Hollow when necessary. The general goal for filling and emptying the reservoirs is to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in the Adams Tunnel is available by delivering to Chimney Hollow first and then by releasing from Jasper East. Once Windy Gap water enters Granby Reservoir, it is available for delivery to meet Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery. In addition to storage in Chimney Hollow and Jasper East, Windy Gap water may also be stored in Granby Reservoir when unused capacity is available.

In general, the water levels in Chimney Hollow would fluctuate based on available Windy Gap supplies and Participant water demands. Chimney Hollow would typically be fuller during wet years and drawn down during dry years. Jasper East water levels would fluctuate more than Chimney Hollow because there may be years when all available Windy Gap water is delivered to the East Slope. Jasper East also would tend to be drawn down more quickly within a year than Chimney Hollow because the priority would be to deliver Windy Gap water stored in Jasper East to meet Participant demands or to Chimney Hollow where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

Deliveries of Windy Gap water to Participants from Chimney Hollow Reservoir through releases to C-BT facilities would be the same as current operations and as described for Alternative 2.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit Counties. MPWCD 3,000 AF of water would be stored in either Chimney Hollow or Jasper East Reservoirs and released to the Colorado River to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.5.3 Construction Program

Construction of a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2. The smaller dam would not substantially change the size of the work force, construction traffic, and amount of construction material. Construction of the dam and associated facilities is estimated to take from 2.5 to 5 years.

Construction of Jasper East Reservoir also is estimated to take 2.5 to 5 years. Construction sequencing includes the development of staging areas, relocation of the Willow Creek Pumping Station, relocation of County Road 40 followed by development of borrow areas, dam construction, spillways, and pipeline and booster pump installation.

Assuming both reservoir sites are constructed concurrently, an average workforce of about 190 people at Chimney Hollow and an additional 65 people at Jasper East would be needed. Reclamation would need a staff of about 15 people during the relocation of Willow Creek Pump Station facilities. The combined peak workforce for both sites would reach about 570 people.

Most construction materials for the Jasper East dams would be excavated from materials within the reservoir basin or adjacent areas. The amount of concrete needed for spillway and outlet works would not warrant an on-site batch plant; therefore, two to six concrete trucks per day would be needed during construction of these facilities. Including traffic for other supplies, the average truck traffic to the site would be five vehicles per day, peaking at 10 vehicles per day. If pipe is delivered concurrent with dam construction, an additional three trucks per day would travel to the site.

2.5.4 Cost

The estimated cost for construction of a 70,000 AF Chimney Hollow Reservoir and associated facilities is $180 million in 2005 dollars. Included in the cost is $4.5 million for relocation of Western's transmission line. Operation and maintenance costs for the reservoir would be $500,000 annually in addition to $295,000 for O&M of conveyance facilities.

> The capital cost for constructing Chimney Hollow Reservoir and Jasper East Reservoir would be about $240 million in 2005 dollars.

Construction of Jasper East Reservoir and associated facilities is estimated to cost $60 million. This includes $31 million for dam construction, $14 million for the pipeline and the booster pump station, and $15 to $21 million for relocating the Willow Creek Pump Station and Canal. Total O&M costs for the reservoir, pipeline, and facilities are estimated at $329,000 annually. About half of this cost is for the incremental increase in power requirements to pump water from Jasper East to Granby Reservoir.

The total capital cost for this alternative is about $240 million in 2005 dollars. The total annual O&M cost would be about $1.38 million.

2.5.5 Public Access and Recreation

Public access and recreation at Chimney Hollow Reservoir would be the same as Alternative 2. Larimer County Parks and Open Lands would manage the property and develop the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Jasper East Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at Jasper East and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

2.6 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Alternative 4 is a combination of a 70,000 AF Chimney Hollow Reservoir on the East Slope and a 20,000 AF Rockwell/Mueller Creek Reservoir (Rockwell) on the West Slope. As with the Jasper East Reservoir site, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Rockwell or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water would be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not substantially improve yield if a new West Slope reservoir is available.

The 70,000 AF Chimney Hollow Reservoir location is identical to that described for Alternative 3. Under this alternative, Western would remove a section of the existing Estes-Lyons 115-kV Transmission Line and relocate it as described in Section 2.4.1.4. The Rockwell Reservoir site is located in Grand County about 1.5 miles southwest of the Town of Granby. Rockwell Reservoir would be built on the intermittent Rockwell Creek and Mueller Creek drainages at an elevation of about 8,100 feet.

2.6.1 Infrastructure

2.6.1.1 Dams and Spillway

The configuration, dam, and spillway for a 70,000 AF Chimney Hollow Reservoir would be the same as Alternative 3.

Construction of Rockwell Reservoir would require two earthfill dams (Figure 2-10). The main dam would be on Rockwell Creek with a smaller dam on the southeast side of the reservoir. The main dam would have a height of 205 feet and the smaller dam a height of 45 feet. The normal surface area of the 20,000 AF reservoir would inundate 294 acres. Because the reservoir would be located directly above the Town of Granby, it would be considered a high hazard (Class 1) facility as defined by Colorado State Engineer's criteria. This requires a spillway design capable of passing 100 percent of a flood resulting from a probable maximum precipitation event. The spillway design to meet this criterion would be about 10 feet wide and 2,700 feet long.

Rockwell/Mueller Creek Reservoir Site

2.6.1.2 Conveyance

Deliveries to and from Rockwell Reservoir would require a new connection to the existing Windy Gap Pump Station and Pipeline. Diversions at the existing Windy Gap Reservoir would be pumped using the existing Windy Gap Pump Station to Rockwell Reservoir. Because the water surface elevation of Rockwell is lower than Granby Reservoir, the existing pump facility probably would be adequate (Figure 2-11). Water from Rockwell Reservoir would be delivered to Granby Reservoir using the same pipeline with the addition of a booster pump near Windy Gap Reservoir. The pump station building would be about 75 feet by 50 feet with a height of less than 50 feet. The new buried pipeline would be about 10 feet in diameter and 17,600 feet in length from the Windy Gap Pump Station to the Rockwell Reservoir inlet/outlet works. The pipeline would follow County Road 57 and previously disturbed areas to the extent possible, and would cross the Colorado River immediately downstream of Windy Gap Reservoir.

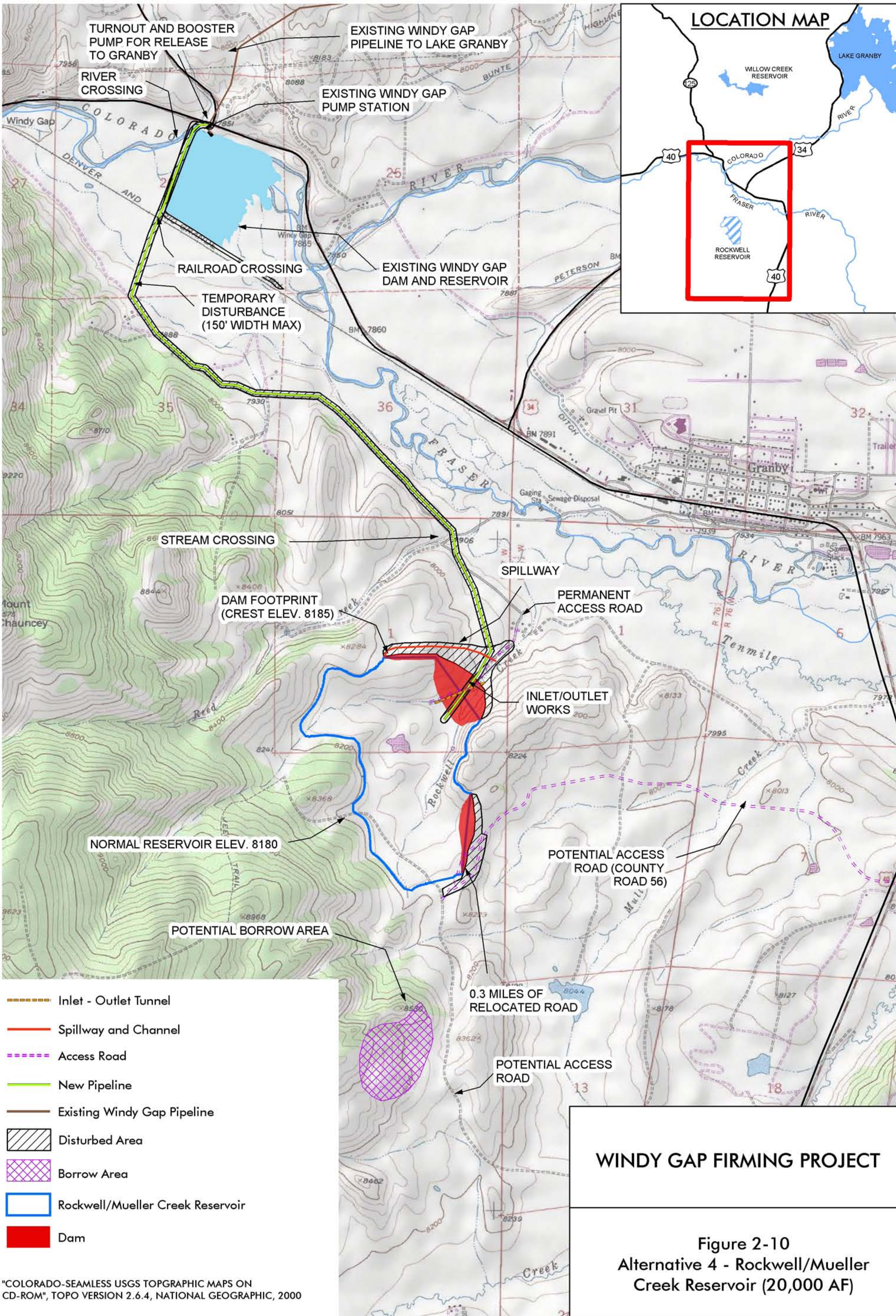
A new 2.2-mile pipeline would be needed to deliver water from the existing Windy Gap Reservoir to Rockwell Reservoir and then back to the existing Windy Gap pipeline.

Water would be conveyed from the West Slope to Chimney Hollow Reservoir via existing C-BT facilities to the upper end of the existing Flatiron Penstock, where a new buried penstock would deliver water to Chimney Hollow or Carter Lake as described for Alternative 2.

2.6.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities for the 70,000 AF Chimney Hollow Reservoir would be the same as Alternatives 3.

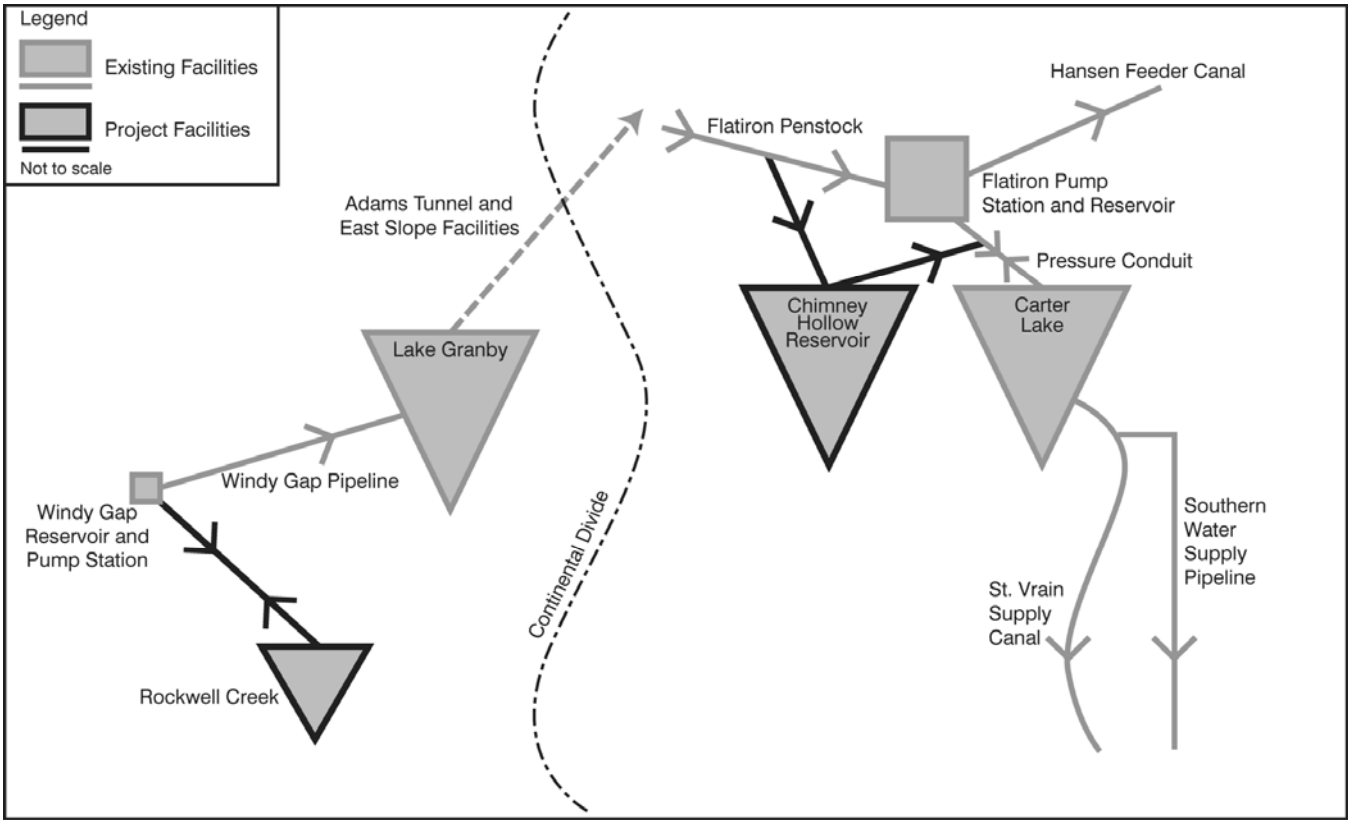
Access to the Rockwell Reservoir site would likely be via two gravel roads on the east and north. The north route is accessible via U.S. Highway 40 and County Road 57. The east route along County Road 56 is accessible from U.S. Highway 40. An additional access road option from the south could be used. Improvements to existing roads may be needed to provide adequate access for equipment and trucks during construction.



WINDY GAP FIRMING PROJECT

Figure 2-10
Alternative 4 - Rockwell/Mueller Creek Reservoir (20,000 AF)

Figure 2-11. Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir connection schematic.



The availability of suitable material for construction of Rockwell dam within the reservoir footprint is unknown, but it is anticipated that material from overburden deposits and the underlying fine-grain bedrock could be used. If on-site material is not suitable, a potential borrow area is located less than 1 mile to the south. Based on available geologic mapping, filter and drain material may not be available on-site and would probably have to be imported, perhaps from the quarry near Jasper East. Basalt material from this quarry might also be needed to provide riprap and bedding material.

The power supply to Rockwell Reservoir and the new booster pump station would come from the existing transmission line near the Windy Gap Pump Station. A substation to reduce the voltage for these facilities would likely be needed.

2.6.2 Operations

Deliveries to Chimney Hollow would be the same as described for Alternatives 2 and 3. Rockwell Reservoir would be operated the same as described for Jasper East Reservoir in Alternative 3. Windy Gap diversions would first be delivered to Chimney Hollow Reservoir depending on the availability of space in the Adams Tunnel for conveyance to the East Slope. If the Adams Tunnel is full, then diversions would be delivered to Rockwell Reservoir for storage. Releases to Participants would first be made from Rockwell Reservoir and then out of Chimney Hollow Reservoir. The general goal for filling and emptying the reservoirs would be to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in the Adams Tunnel is available by delivering to Chimney Hollow Reservoir first and then releasing from Rockwell Reservoir. Once Windy Gap water enters Granby Reservoir, it would be available for delivery to a Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery.

In general, water levels in Chimney Hollow would fluctuate based on available Windy Gap supplies and demands. Chimney Hollow would typically be fuller during wet years and drawn down during dry years. Rockwell Reservoir water levels would fluctuate more than Chimney Hollow because there may be years when all available Windy Gap water is delivered to the East Slope. Rockwell Reservoir also would typically be drawn down more quickly within a year than Chimney Hollow because the priority would be to deliver Windy Gap water stored in Rockwell to meet Participant demands or to Chimney Hollow where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

Deliveries of Windy Gap water to Participants from Chimney Hollow Reservoir through releases to C-BT facilities would be the same as current operations as described for Alternative 2.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit Counties. MPWCD 3,000 AF of water would be stored either in Chimney Hollow or Rockwell reservoirs and released to the Colorado River (either directly or by exchange) to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.6.3 Construction Program

The construction program for a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2.

Construction of Rockwell Reservoir is estimated to take from 2.5 to 4.5 years. Construction sequencing includes the development of staging areas and borrow areas, dam construction, spillways, and pipeline and booster pump installation.

Assuming both reservoir sites are constructed concurrently, an average workforce of about 190 people at Chimney Hollow and 76 people at Rockwell Reservoir would be needed. The combined peak workforce for both sites would reach about 585 people.

The majority of the construction materials for the Rockwell dams would be excavated from the reservoir basin or adjacent areas; however, riprap for slope protection on the dam would likely have to come from off-site. The estimated duration of riprap placement is 15 months with an average traffic volume of 13 trucks per day. The amount of concrete needed for spillway and outlet works does not warrant an on-site batch plant; therefore, an average of about 4.5 concrete trucks per day would be needed during placement of concrete. Including traffic for other supplies, the average truck traffic to the site would be about 18 vehicles per day, peaking at as many as 45 vehicles per day during dam construction. Assuming 50 percent of the bedding material needed for pipeline placement comes from off-site locations, and that removal of excess excavated material and pipeline deliveries occur concurrently, then about 26 trucks per day would access the project area during this phase of construction.

2.6.4 Cost

The estimated cost for construction of Chimney Hollow Reservoir and associated facilities is $180 million in 2005 dollars. Included in the cost is $4.5 million for relocation of Western's transmission line. Operation and maintenance costs for the reservoir would be $500,000 annually in addition to $295,000 for O&M of conveyance facilities. These costs are the same as Alternative 4.

> The capital cost for constructing Chimney Hollow and Rockwell reservoirs would be about $252 million in 2005 dollars.

Construction of Rockwell Reservoir and associated facilities is estimated to cost about $72 million. This includes $37 million for dam construction, $24 million for the pipeline, and $11 million for the booster pump station. Total O&M costs for the reservoir, pipeline, and facilities are estimated at about $935,000 annually. About $207,000 of this cost is for the incremental increase in power requirements above existing pumping costs to pump water from Rockwell Reservoir to Granby Reservoir.

The total estimated capital construction cost for this alternative is about $252 million. Total annual O&M costs would be about $1.73 million.

2.6.5 Public Access and Recreation

Public access and recreation at Chimney Hollow Reservoir would be the same as Alternative 2. Larimer County Parks and Open Lands would lease the property and develop the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Rockwell Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at Rockwell Reservoir and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

Dry Creek Reservoir Site

2.7 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Alternative 5 is a combination of a 60,000 AF Dry Creek Reservoir on the East Slope and a 30,000 AF Rockwell/Mueller Creek Reservoir on the West Slope. As with the Alternatives 3 and 4, the availability of a new West Slope reservoir would allow water diversions from the existing Windy Gap Reservoir to be routed to either Rockwell Reservoir or Granby Reservoir. Thus, when Granby Reservoir is full or the Adams Tunnel is at capacity, Windy Gap water could be diverted and stored until there is sufficient capacity to transfer water to Chimney Hollow Reservoir. Prepositioning is not a component of this alternative because it would not substantially improve yield if a new West Slope reservoir is available.

The 60,000 AF Dry Creek Reservoir site is located in the drainage just south of Chimney Hollow about 12 miles southwest of Loveland, Colorado. The Dry Creek dam would be built on the intermittent Dry Creek drainage, which is a tributary to the Little Thomson River. The reservoir surface would be at an elevation of about 5,800 feet. Rockwell Reservoir is at the same location as described for Alternative 4.

2.7.1 Infrastructure

2.7.1.1 Dams and Spillway

The general the infrastructure for a 30,000 AF Rockwell Reservoir is the same as the 20,000 AF reservoir described in Alternative 4. The reservoir and dam footprints would be larger than the smaller reservoir size (Figure 2-12). The increased reservoir size would require a third small dam on the south side of the reservoir. The main dam on Rockwell Creek would have a height of about 235 feet, the eastern dam would have a height of 80 feet, and the southern dam a height of 20 feet. The area of inundation would be about 348 acres. The spillway would be similar to the 20,000 AF reservoir size.

Construction of a 60,000 AF Dry Creek Reservoir would require a single rockfill dam (Figure 2-13). The dam would have a height of 310 feet. The normal surface area of the full reservoir would inundate 589 acres. A 25-foot spillway width with a chute of about 3,000 feet would be needed.

2.7.1.2 Conveyance

Water deliveries to and from Rockwell Reservoir would require a new pipeline and connection to the existing Windy Gap Pump Station and Pipeline as described in Alternative 4 (Figure 2-14).

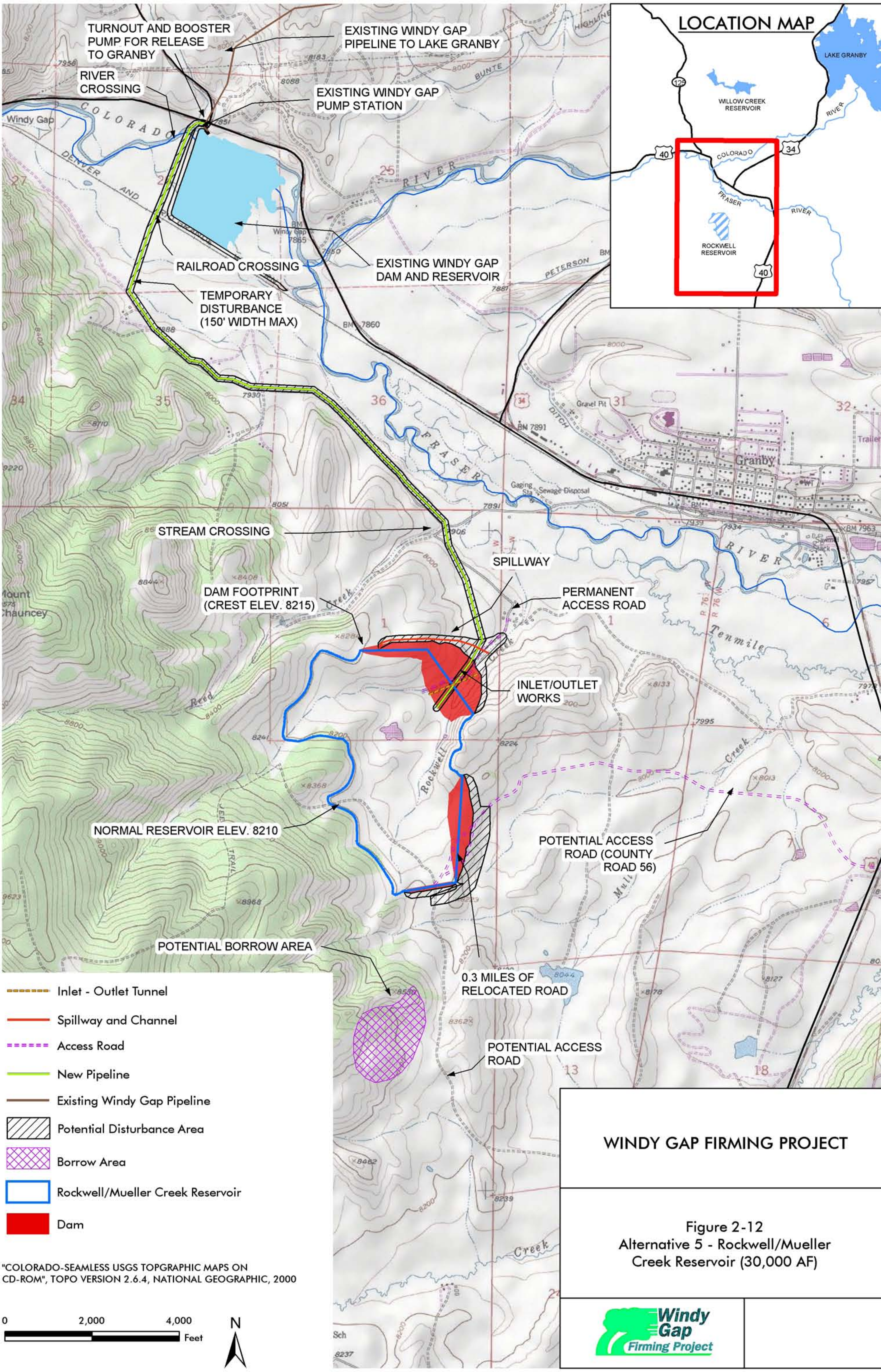
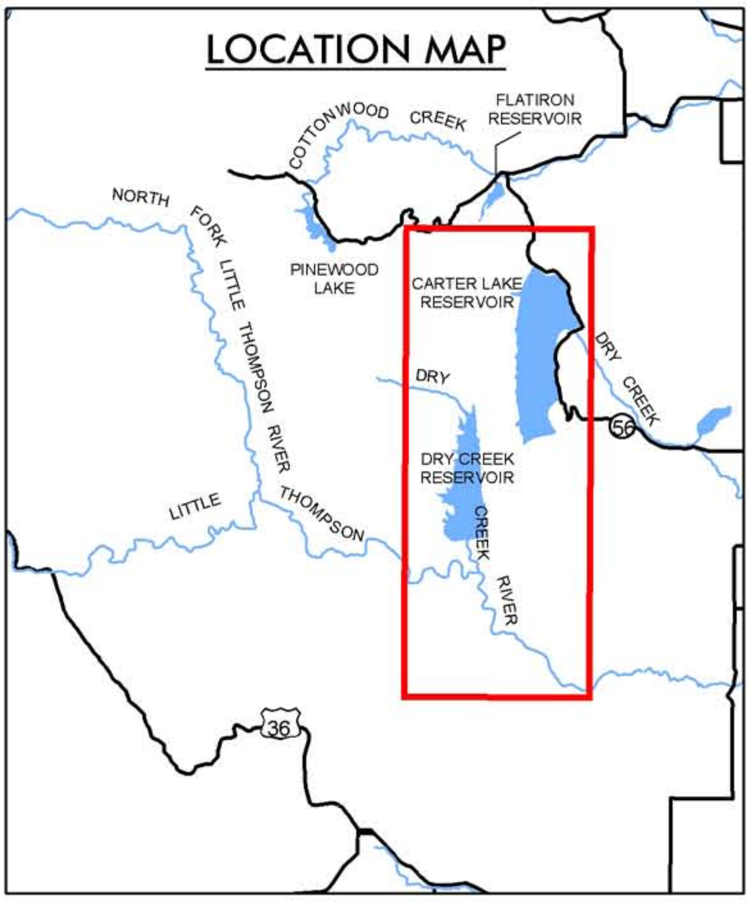
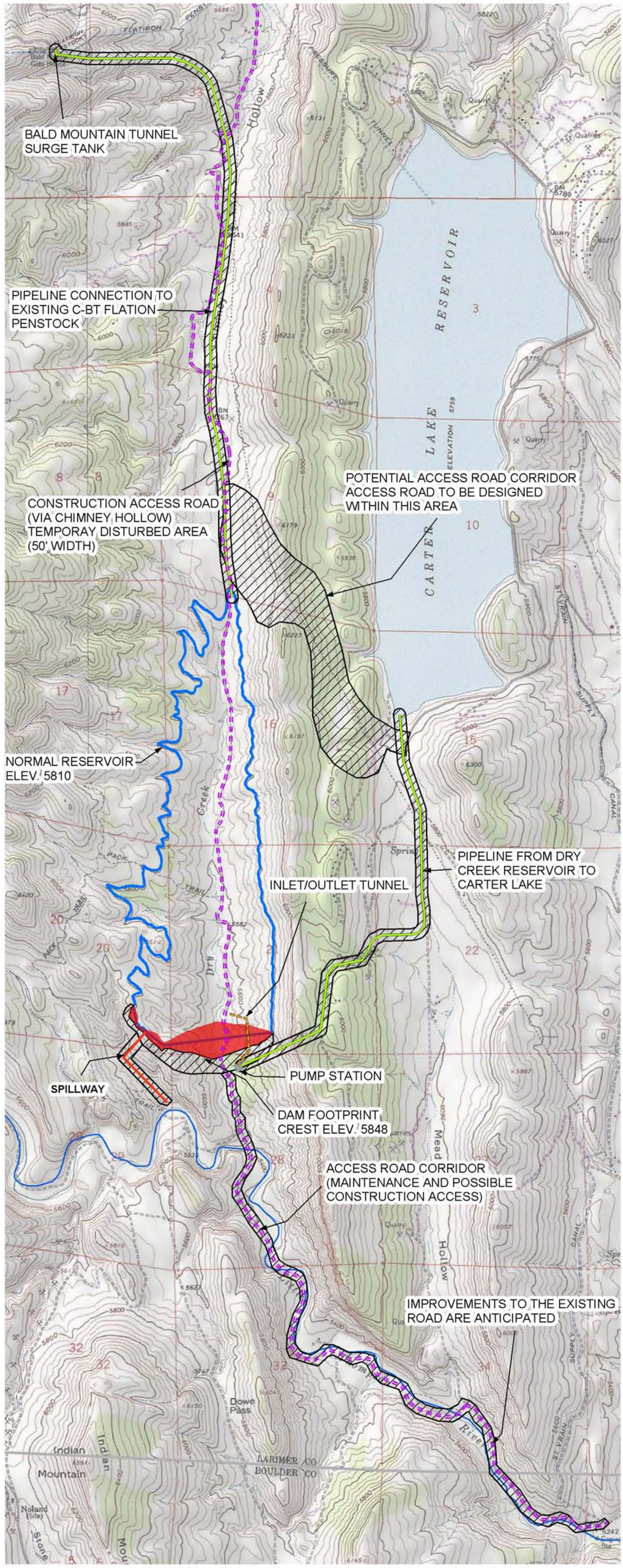


Figure 2-12
Alternative 5 - Rockwell/Mueller Creek Reservoir (30,000 AF)





Inlet - Outlet Tunnel

Spillway and Channel

Access Road

New Pipeline

County Line

Potential Disturbance Area

Dry Creek Reservoir

Dry Creek Dam

0 2,500 5,000 Feet

N

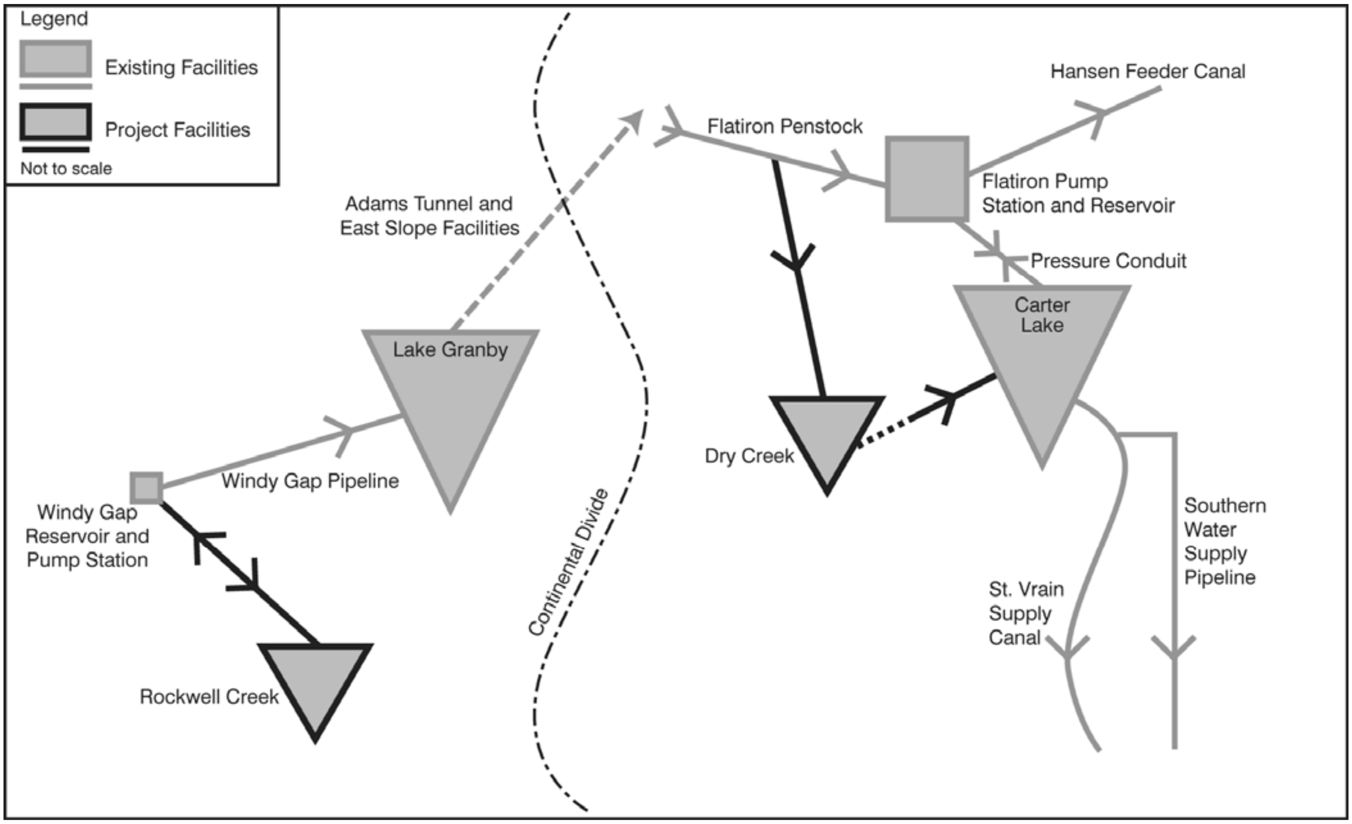
"USGS MAP OF THE CARTER LAKE RESERVOIR QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO"
SITE SPECIFIC TOPOGRAPHY BASED ON AERIAL SURVEY, APRIL 2003

WINDY GAP FIRMING PROJECT

Figure 2-13
Alternative 5 - Dry Creek Reservoir (60,000 AF)

Windy Gap Firming Project

Figure 2-14. Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir connection schematic.



Delivery of Windy Gap water to Dry Creek Reservoir would require a new pipeline originating above the existing penstock valve house and traversing down the ridge to the south of the existing Flatiron Penstocks (as described for Alternative 2), then turning south through Chimney Hollow to the upper end of Dry Creek Reservoir. Releases from Dry Creek Reservoir would be made from the dam outlet and pumped via a new tunnel conduit through the ridge to the east, then flow by a gravity pipeline into the southern end of Carter Lake. Once in Carter Lake, deliveries could be made to St. Vrain Supply Canal or Southern Water Supply Pipeline for Participants to the south. Deliveries to Participants north of Carter Lake would be made by releases to the Carter Lake Pressure Tunnel to Flatiron Reservoir and other C-BT conveyance facilities.

To convey Windy Gap water to Dry Creek Reservoir would require a new 3.4-mile pipeline connection to C-BT facilities. A new 2.1-mile pipeline also would be needed to deliver water from Dry Creek Reservoir to Carter Lake.

A new 108-inch pipeline from the C-BT connection to Dry Creek Reservoir would be about 18,000 feet in length. A turnout to allow deliveries to the existing Flatiron Reservoir would be about 2,900 feet in length. The Dry Creek Reservoir outlet pipeline to Carter Lake would be about 11,100 feet long and have a diameter of 36 inches.

2.7.1.3 Access, Borrow Areas, and Power

Access, borrow areas, and power facilities for the 30,000 AF Rockwell Reservoir would be the same as described for Alternative 4. However, the larger dams and the addition of a third dam would require more borrow material than the 20,000 AF reservoir.

Proposed construction access to the Dry Creek Reservoir site would be from the north through Chimney Hollow. The existing unimproved roads in Chimney Hollow would need to be upgraded. Secondary access options that may need to be considered include use of an existing road along the Little Thompson Valley or across the hogback south of Carter Lake. Construction access roads would need to be improved to a width of 40 feet. Following construction, roads could be reclaimed to some extent, although access would need to be provided for maintenance.

The availability of suitable material for construction of the Dry Creek dam within the project limits is unknown, but it is anticipated that fine-grain embankment material and suitable material for rockfill may be present in the valley bottom. Coarse grained sand and gravel material does not appear to be present on-site, but available granitic material could be quarried and crushed, or off-site commercial sources could be used. Granitic bedrock on the west side of the reservoir site could probably be used for riprap.

The power supply to Dry Creek Reservoir and conveyance facilities would come from the existing facilities associated with the Flatiron Power Plant. A substation may be needed to step down voltage.

2.7.2 Operations

The operation of Dry Creek and Rockwell reservoirs would be similar to the Chimney Hollow and Rockwell Reservoir combination described in Alternative 4. Deliveries to Rockwell Reservoir would be made using the existing Windy Gap Pump Station and a new bi-directional pipeline. Releases would be made to the pipeline running north, where a turnout would run the water through a booster pump for delivery to Granby Reservoir via the existing Windy Gap Pipeline.

Windy Gap diversions would first be delivered to Dry Creek Reservoir as limited by available capacity in the Adams Tunnel. If the Adams Tunnel is full, then diversions would be delivered to Rockwell Reservoir for storage. The general goal for filling and emptying the reservoirs is to move Windy Gap water to the East Slope as soon as possible. This can be done physically when space in Adams Tunnel is available by delivering to Dry Creek Reservoir first and then releasing from Rockwell Reservoir for delivery to Dry Creek Reservoir. Instantaneous delivery of Windy Gap water to the East Slope also helps to accomplish this goal. Once Windy Gap water enters Granby Reservoir, it is available for delivery to met Windy Gap demand out of East Slope C-BT storage in Carter Lake or Horsetooth Reservoir via instantaneous delivery.

In general, water levels in Dry Creek Reservoir would fluctuate based on available Windy Gap supplies and demands. Dry Creek Reservoir would typically be fuller during wet years and drawn down during dry years. Rockwell Reservoir water levels would fluctuate more than Dry Creek Reservoir because there may be years when all available Windy Gap water is delivered to the East Slope. Rockwell Reservoir also would tend to be drawn down more quickly within a year than Dry Creek Reservoir because the priority would be to delivery Windy Gap water stored in Rockwell Reservoir to meet Participant demands or to Dry Creek Reservoir where it is available on the East Slope and deliveries are not constrained by available capacity in the Adams Tunnel.

The MPWCD would use its Windy Gap water as a source of augmentation water to replace out-of-priority depletions in Grand or Summit county. MPWCD 3,000 AF of water would be stored either in Dry Creek or Rockwell reservoirs and released to the Colorado River (either directly or by exchange) to offset depletions. Releases would either directly replace depletions for uses on the Colorado River or be replaced by exchange if depletions occur in the Willow Creek, Fraser River, or Blue River basins. MPWCD's Windy Gap water is assumed to be evenly delivered from September to March based on the location and types of uses and generally when its contractees require augmentation supplies.

2.7.3 Construction

The construction program for a Rockwell Reservoir would be similar to that described for Alternative 4. The larger dam may require more time to complete but, in general, construction activities would be similar. The size of the workforce and level of construction traffic also would be similar.

Construction of the Dry Creek dam and appurtenances is estimated to take from 2.5 to 4.5 years. Construction sequencing includes the establishment of staging areas, development of borrow areas, and construction of the dam, spillways, and pipelines including the outlet boring to Carter Lake.

Assuming both reservoirs are constructed concurrently, an average workforce of about 210 people at Dry Creek Reservoir and an additional 92 people at Rockwell Reservoir would be needed. The combined peak workforce for both reservoirs would reach about 657 people.

Most construction materials for the Dry Creek dam would be excavated from the reservoir basin. Depending on the type of rockfill dam selected, the cement for a concrete face or bitumen for an asphalt core would be trucked to the site. The average traffic during dam construction is estimated at five vehicles per day with peak deliveries of 10 vehicles per day. An additional three trucks per day would deliver pipe during construction of the pipelines.

2.7.4 Cost

The estimated cost for construction of Dry Creek Reservoir and associated facilities is about $200 million in 2005 dollars. This includes $157 million for the dam and about $43 million for pipelines and a pumping station. Operation and maintenance costs for the Dry Creek Reservoir and facilities would be $1.3 million annually including $500,000 for the reservoir and $800,000 for the conveyance facilities. Average annual power costs of $314,000 are including in conveyance costs.

Total capital costs to construct Dry Creek and Rockwell reservoirs would be about $288 million in 2005 dollars.

The construction of a 30,000 AF Rockwell Reservoir and associated facilities is estimated to cost about $88 million. This includes $53 million for dam construction, $24 million for the pipeline, and $11 million for the booster pump station. Total O&M costs for the reservoir, pipeline, and facilities are estimated at about $935,000 annually. About $207,000 of this cost is for the incremental increase in power requirements above existing pumping costs to pump water from Rockwell Reservoir to Granby Reservoir.

The total capital construction costs for this alternative would be about $288 million. Total annual O&M costs would average $2.24 million.

2.7.5 Public Access and Recreation

Public access and recreation at Dry Creek Reservoir could be similar to Alternative 2. Larimer County Parks and Open Lands may be interested in leasing the property and developing the area for nonmotorized boating, hiking, and picnicking.

There are currently no plans for recreation development or public access at the Rockwell Reservoir or the Dry Creek Reservoir site. The Subdistrict would not operate or manage recreation facilities, but would consider leasing the area to a government agency or other entity that would take responsibility for developing and managing recreation facilities. It is assumed that an entity would be interested in managing recreation at these reservoirs and that uses would be similar to those planned for Chimney Hollow Reservoir. If no recreation management entity is found, the reservoir would be closed to public access.

2.8 Determination of Reasonably Foreseeable Actions

Several reasonably foreseeable actions are anticipated to occur in the future regardless of the implementation of any of the action alternatives or the no action alternative. Reasonably foreseeable future actions, when combined with past and present actions and the alternatives evaluated in this EIS, may result in cumulative effects. This section describes the process for identifying reasonably foreseeable actions, as well as those actions that were not considered reasonably foreseeable or that would not have any overlapping impacts with the WGFP. The cumulative effects of the reasonably foreseeable actions for affected resources are evaluated in Chapter 3.

2.8.1 Identifying Reasonably Foreseeable Actions

Potential future actions were identified through public and agency scoping, input from cooperating agencies and local agencies, and available data on known projects or actions under consideration. Actions that meet all of the following criteria were considered reasonably foreseeable and were included in the cumulative effects analysis:

- The action would occur within the same geographic area where effects from the alternative WGFP actions are expected to occur.

- The action would affect the same environmental resources as the WGFP alternatives and measurably contribute to the total resource impact.
- There is reasonable certainty as to the likelihood of the action occurring; the action is not speculative.
- There is sufficient information available to define the action and conduct a meaningful analysis.

2.8.2 Reasonably Foreseeable Actions

The WGFP would result in two primary types of action, one from the diversion and storage of water from the Colorado River and the second from the surface disturbance required for construction of reservoirs and associated facilities. Reasonably foreseeable effects were classified as either water-based or land-based actions that might have effects overlapping those of the WGFP. Those future actions that meet the criteria for being reasonably foreseeable are described below.

2.8.2.1 Water-Based Actions

Denver Water Moffat Collection System Project. The Moffat Collection System Project is currently proposed by Denver Water (Denver) to develop 18,000 AF/year of new annual yield to the Moffat Treatment Plant to meet future raw water demands on the East Slope. This project is anticipated to result in additional diversions, primarily from the upper Fraser River and Williams Fork River basins. Denver's proposed additional Fraser River diversions would be located upstream of the Windy Gap Project diversion site on the Colorado River and would directly affect the availability of water for the WGFP. The Moffat Collection System Project EIS is currently being prepared by the Corps. For the purpose of hydrologic modeling for the WGFP, it was assumed that Denver maximizes future diversions from the Fraser River basin. In 2005, Denver provided output from its Platte and Colorado Simulations Model (PACSM) run that includes Denver's total system demand at about 393,000 AF/year, which would be full use of its existing system including the safety factor, plus 18,000 AF of new firm yield generated by the Moffat Collection System Project. Denver's current demand is 285,000 AF/year; therefore, an increase in demand of 108,000 AF/year was considered for the cumulative effects analysis. Following completion of the hydrologic analysis for the WGFP, Denver completed their modeling for the Moffat Collection System Project EIS and considered a total system demand of 363,000 AF/year, which does not include use of the 30,000 AF/year safety factor. Thus, Denver's water use and diversions, primarily from the Blue River and to a lesser degree in the Fraser River and Williams Fork, is overstated in the cumulative effects hydrology used in the WGFP analysis.

Population Growth in Grand and Summit Counties. The population in Grand and Summit Counties is expected to more than double over the next 25 years, from a year-round population of about 39,000 in 2005 to about 79,000 in 2030 (ERO and Harvey Economics 2005). Most growth in Grand County is likely to occur in the Fraser River basin upstream of the Windy Gap Project diversion site on the Colorado River. Future increases in water use in Summit County would occur primarily in the Blue River basin, a tributary to the Colorado River downstream of Windy Gap's point of diversion. Increased water use and wastewater discharges are expected to result in changes in streamflow and water quality and contribute to cumulative effects. Urban growth in Grand and Summit Counties was based on build-out municipal and industrial demands of 16,168 AF for Grand County and 17,940 AF for Summit County as identified in the *Upper Colorado River Basin Study* (AMEC 2003a). In 2000, water demand in Grand County was about 3,100 AF and in Summit County was about 7,700 AF.

Reduction of Xcel Energy's Shoshone Power Plant Call. Denver Water and Xcel Energy have negotiated an agreement to periodically invoke a relaxation of the junior Shoshone call for hydropower generation on the Colorado River[1]. The agreement to relax the call could result in a one-turbine call of 704 cfs, which would be managed in

[1] The Shoshone Hydro Plant owned by Xcel Energy, is a large senior water right on the Colorado River 8 miles east of Glenwood Springs. At flows less than 1,408 cfs, it is the most senior water right on the River and can "call" water downstream from junior water rights upstream, including the Moffat Tunnel, C-BT Project, Windy Gap, and other water rights.

such a way to avoid a Cameo Call by the Grand Valley Water users[2]. The Shoshone call could be increased above 704 cfs as needed to keep the Cameo water rights satisfied. The Shoshone call relaxation could be invoked if, in March, Denver predicts its total system storage to be at or below 80 percent on July 1 that year, and the March 1 Natural Resources Conservation Service (NRCS) forecast for Colorado River flows at Kremmling or Dotsero are at or below 85 percent of average. The Shoshone call relaxation could be invoked between March 14 and May 20. Denver would make available 15 percent of the "net water" stored or diverted by Denver by virtue of the call relaxation for Xcel Energy. Net water is water stored less water subsequently spilled after filling. In addition, Denver would make available 10 percent of the net water stored or diverted by Denver by virtue of the call relaxation to West Slope entities. The West Slope beneficiaries and the timing and amount of deliveries are not specified, but would be determined by Denver and the Colorado River Water Conservation District (CRWCD). The term of this agreement is from January 1, 2007 through February 28, 2032.

Changes in Releases from Williams Fork and Wolford Mountain Reservoirs to Meet Flow Recommendations for Endangered Fish. An agreement which extends through July 1, 2009 between the City and County of Denver, the Colorado Water Conservation Board (CWCB) and the USFWS exists for the interim provision of water to the 15-Mile Reach of the Colorado River near Grand Junction as part of the Recovery Program to benefit endangered fish. A similar agreement exists between the CRWCD, CWCB, and the USFWS. These agreements provide for the total release of 10,825 AF of water annually from both Williams Fork and Wolford Mountain Reservoirs (5,412.5 AF from each reservoir) to meet USFWS flow recommendations for the 15-Mile Reach. These contracts expire in 2009 and 2010, respectively, and both Denver and the CRWCD have said they do not plan to continue making these releases from Williams Fork and Wolford Mountain Reservoirs in the future. The source and location of future water releases of 10,825 AF/year has not been determined. For the purposes of this analysis, it was assumed that the releases would be made from a reservoir located downstream of Kremmling and outside the study area considered for the cumulative effects analysis.

Wolford Mountain Reservoir Contract Demand. The CRWCD projects that the demand for contract water out of Wolford Mountain Reservoir will increase in the future. Currently, there is about 8,750 AF/year of available contract water in Wolford Mountain Reservoir (Colorado Springs has a lease for contract water from Wolford Mountain Reservoir that reduces the firm yield of the contract pool from 10,000 AF/year to 8,750 AF/year). The CRWCD indicates that the full 8,750 AF/year will likely be contracted for by 2030. In addition, MPWCD has 3,000 AF/year of storage in Wolford Mountain Reservoir, of which 613 AF/year is owed to Denver under the Clinton Reservoir Agreement. The CRWCD indicated that the remaining 2,387 AF/year will likely be contracted for by 2030. Therefore, the total additional future demand for contract water from Wolford Mountain Reservoir is assumed to be 11,137 AF/year by 2030.

Expiration of Denver Water's Contract with Big Lake Ditch in 2013. The Big Lake Ditch is a senior irrigation right in the Williams Fork basin that diverts below Denver's Williams Fork collection system and above Williams Fork Reservoir. Big Lake Ditch diversions are currently delivered for irrigation above Williams Fork Reservoir and for use in the Reeder Creek drainage, which is a tributary of the Colorado River. Return flows associated with irrigation in the Reeder Creek drainage return to the Colorado River between the confluence with the Williams Fork River and the confluence with the Blue River.

In 1963, Denver entered into a contract with Bethel Hereford Ranch Inc., which owned and operated the Big Lake Ditch, whereby Denver purchased the Ranch's water rights. Bethel Hereford was granted a 40-year lease to continue its operation under the condition that the Big Lake Ditch water rights are not called if needed by Denver. The 1963 agreement was superseded by a 1998 agreement, which extended the operation of the Big Lake Ditch through 2013, and provided more detail on the conditions under which Denver would need the

[2] The Cameo Call is a senior water right owned by five entities near Grand Junction. The water is used primarily for irrigation and power.

water. The 1998 agreement expires November 1, 2013 and Denver does not plan to extend the existing contract. After the contract expires in 2013, the Big Lake Ditch can no longer divert water under the enlargement decree for 111 cfs for irrigation in the Reeder Creek drainage. As a result, future Big Lake Ditch water right diversions to the Reeder Creek basin will be abandoned, which will allow Denver to capture additional water from the Williams Fork and store the water in Williams Fork Reservoir during all years that its Williams Fork Reservoir water rights are in priority.

Climatic Change and Global Warming. Climate change and global warming may affect the WGFP and other water users in the Colorado River and South Platte River basins. Climate changes may affect precipitation, Colorado River streamflow, and the amount of water available for diversion by the WGFP. Temperature records and climatic modeling indicates higher temperatures, which can result in earlier snowmelt and runoff, higher evaporation rates, and increased water demands (National Research Council 2007).

The amount and direction of climatic change has been the subject of several studies. Climatic models have predicted warming, but predictions on changes in precipitation in the Colorado River basin range from substantial increases to substantial decreases (IPPC 2001). One study of climatic changes in the Colorado River basin predicted modest decreases in precipitation and modest increases in temperature (Christensen et al. 2004). The National Research Council (2007) suggests that future warmer temperatures will reduce Colorado River streamflow and water supplies. Differences in model predictions indicate the uncertainty in estimating future conditions.

A reduction in precipitation and streamflow would reduce the amount water available for diversion by the WGFP, while conversely, an increase in precipitation would increase the frequency and amount of diversions. Reductions in Colorado River streamflow would generally reduce the amount of water available to the more junior water rights holders in the basin, including the WGFP. Although climatic change might be considered reasonably foreseeable, there is no accepted science for transforming the general concept of variations in global temperature into incremental changes in streamflow at particular locations. Hydrologic changes attributable to global climate change are a possibility; however, potential impacts have not been quantitatively estimated in the EIS because of the uncertainties associated with predicting change and the effects.

Mountain Pine Beetle Killed Trees. Severe mountain pine beetle infestation in Grand County and other parts of Colorado are significantly impacting the lodgepole pine forest. Many trees have been killed and remaining large trees are likely to die in the near future. The loss of these trees has several implications in the upper Colorado River watershed within the project area depending on harvest activities, the composition and age class of the forest, forest fire, and other factors. A reduction in live tree cover in even-aged stands is likely to result in an increase in water yield until replacement vegetation is established (Stednick 2008). In mixed-age forests, other vegetation may replace dying lodgepole pines and water yield can decrease. Where trees are harvested or killed by beetles, soils can warm increasing the rate of nitrification, which could increase nitrate concentrations in runoff (Stednick 2008). The potential for wildfire also increases in pine beetle damaged forests, which could result in increased runoff along with sediment and nutrient increases in the Colorado River basin.

Watershed impacts from pine beetle killed trees or possible fires would impact the watershed in a similar manner under all of the alternatives. An increase in runoff could result in a change in the timing and amount of water available for diversion until new vegetation is established. Runoff with higher sediment and nutrients, including Windy Gap water pumped to Granby Reservoir would reduce water quality in the Three Lakes system and the Colorado River under all alternatives. Because the hydrologic and water quality implications of pine beetle killed trees would be somewhat similar for all alternatives and because evaluating the effects would require a substantial number of assumptions on likely conditions in the watershed, a detailed analysis of the range of potential effects of this reasonably foreseeable action was not conducted in the EIS.

2.8.2.2 Land-Based Actions

Land Development. A variety of new land developments are expected to occur in the vicinity of the potential WGFP reservoir sites in Larimer and Grand Counties. Land use changes or developments within about 5 miles of the Jasper East and Rockwell Reservoir site were identified to provide a context for assessing potential local cumulative effects of multiple land disturbances. Near Jasper East, this includes about 1,590 acres of planned residential and commercial development southwest of the Town of Granby and about 980 acres of planned residential development at C-Lazy-U Preserves located north of the reservoir site (Hale pers. comm. 2005; Campbell pers. comm. 2006) (Figure 2-15). Near the Rockwell Reservoir site, about 4,770 acres of residential, commercial, and mixed development would occur in the Granby Ranch area.

Western is proposing to replace portions of the existing Granby Pumping Plant to the Windy Gap Transmission Line (Western 2008). The transmission line runs between the Windy Gap Substation located northwest of Windy Gap Reservoir and the Granby Pumping Plant on the north side of Granby Reservoir. The purpose of the project is to increase power reliability and quality of electrical service to residents in Grand County and other users in the region. The proposed transmission line replacement is an independent project and is not related to the WGFP. Several transmission line alternatives are under consideration as part of an ongoing EIS. The transmission line could be rebuilt in the right-of-way of the existing line or a new route could be selected. Vertical steel monopoles would be used for the new line rather than the existing wooden H-frame poles.

On the East Slope, several land developments are planned near potential reservoir sites. As of June 2007, about 1,440 acres of land located within about 5 miles of Chimney Hollow and 1,460 acres of land within about 5 miles of Dry Creek Reservoir were under county development review for subdivision, dispersed residential development, commercial development, and/or special review for a proposed change in land use (Larimer County 2007) (Figure 2-16).

Larimer County Open Space. Larimer County Parks and Open Lands acquired about 1,800 acres of land adjacent to the proposed Chimney Hollow Reservoir site. The County intends to manage this property for recreation use in the future regardless of whether Chimney Hollow Reservoir is constructed.

Population Growth and in the Northern Front Range. Continued population growth and urban development is expected to occur in the northern Front Range Colorado communities served by many of the Firming Project Participants regardless of the proposed WGFP.

2.8.3 Actions Not Considered Reasonably Foreseeable

A number of other potential actions that could occur in the future, but that were not considered reasonably foreseeable were identified. A brief summary of potential actions on the West and East Slope and the reasons why they are not reasonably foreseeable are listed in Table 2-4. Although these actions are not currently considered reasonably foreseeable, they could occur at some point in the future; however, based on the best available information, these actions did not meet the criteria for reasonably foreseeable actions. Also discussed are several actions that are part of the existing conditions and thus are not considered as reasonably foreseeable actions.

2.9 Identification of Reclamation's Preferred Alternative

Alternative 2, construction of Chimney Hollow Reservoir with prepositioning, is the Bureau of Reclamation's preferred alternative. A final alternative will be selected following public review and comment on the Draft EIS. Any changes in the preferred alternative will be discussed in the Final EIS and Record of Decision.

2.10 Summary

2.10.1 Comparison of Alternative Features

Table 2-5 provides a summary comparing the major features associated with each of the four action alternatives.

2.10.2 Comparison of Alternative Impacts

Table 2-6 summarizes the direct and indirect resource effects of the alternatives. Table 2-7 summarizes the cumulative resource effects of the alternatives.

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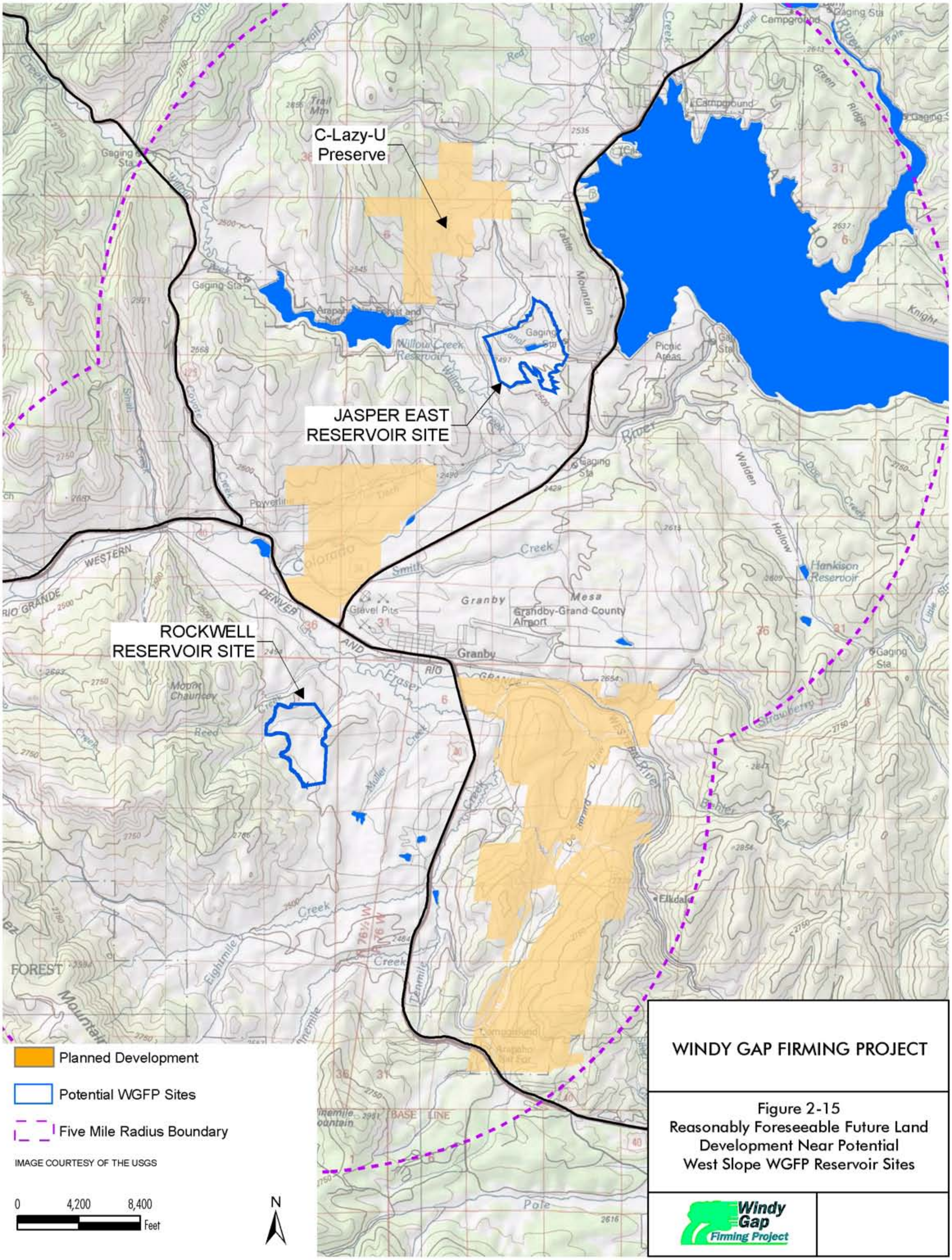


Figure 2-15
Reasonably Foreseeable Future Land Development Near Potential West Slope WGFP Reservoir Sites

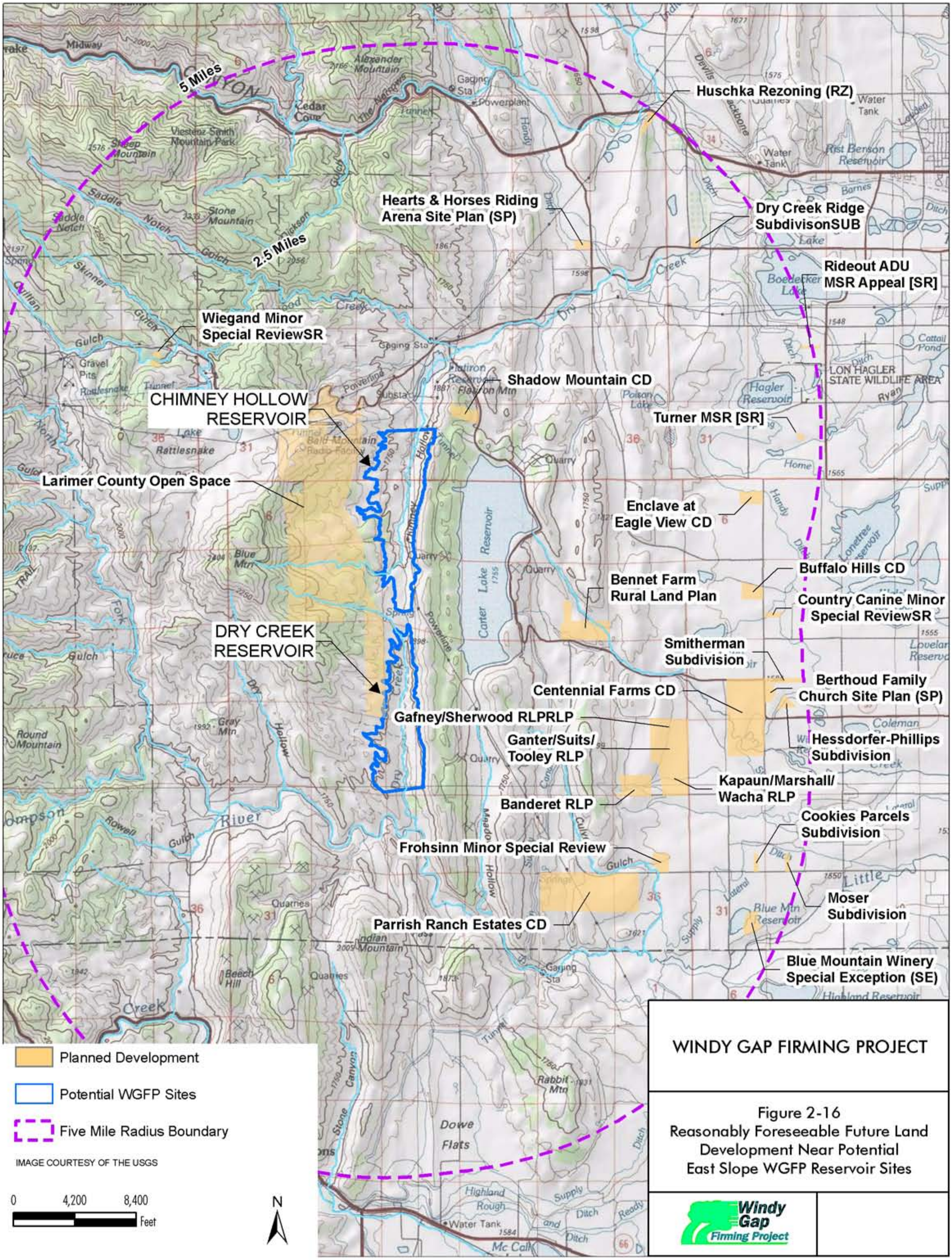


Figure 2-16
Reasonably Foreseeable Future Land Development Near Potential East Slope WGFP Reservoir Sites

Table 2-4. Actions not considered reasonably foreseeable.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
West Slope				
Reduction in USFS Bypass Flows — Denver Water	Fraser River Basin	Water-based	Denver Water has an agreement with the U.S. Forest Service for bypass flows on several streams. During drought conditions, bypass flows can be reduced under an existing emergency clause, which can reduce flows in the Fraser and Colorado Rivers.	This agreement is currently in place and is included in the hydrologic modeling for the WGFP to the extent that it has occurred in the past. This is an ongoing action reflected in existing conditions. No new agreements are pending that are reasonably likely to occur in the future.
Wolcott Reservoir — Cooperative agreement among West and East Slope entities, including, Aurora, CRWCD, Denver, Water, NCWCD, Eagle River Water and Sanitation District, Upper Eagle Regional Water Authority, and Vail Associates	Eagle County	Water-based	Feasibility studies are being conducted to evaluate construction of Wolcott Reservoir on Alkali Creek, a tributary to the Eagle River. The reservoir could serve several purposes including meeting release requirements for endangered fish species in the lower Colorado River per the Final Programmatic Biological Opinion, water supply storage for West Slope water users, facilitation of trans-mountain exchanges, and enhancing environmental conditions in the Eagle and Colorado Rivers. If implemented, this project would replace current releases from Williams Fork Reservoir and Wolford Mountain Reservoir and reduce flows in the Colorado River below these facilities.	Development of Wolcott Reservoir is at the planning stage and no decision has made to pursue this project. Several reservoir sizes ranging from 55,000 AF to 105,000 AF have been evaluated, along with various operational scenarios. No federal NEPA action has been initiated. Any assumptions on whether Wolcott Reservoir would be constructed, its size, and how it would operate are speculative. The cumulative effects hydrologic analysis for the EIS assumed that releases from Williams Fork Reservoir and Wolford Mountain Reservoir would not continue.
Sulphur Gulch Reservoir — Northern Colorado Water Conservancy District, Municipal Subdistrict, Northern Colorado Water Conservancy District, and Denver Water	Mesa County	Water-based	Sulphur Gulch is a potential site for construction of a 16,000 AF reservoir. Similar to Wolcott Reservoir, this site has been preliminarily studied as a possible location for storing water pumped from the Colorado River that could be used to provide releases for the East Slope's portion of the 10,825 AF of water required under the Final Programmatic Biological Opinion. The potential effect to Colorado River streamflow would be similar to a Wolcott Reservoir.	Preliminary studies have been conducted, 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.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Webster Hill Reservoir — West Anvil Water and Power Company	Garfield County	Water-based	This project includes a potential 20,000 AF reservoir on the Colorado River below the Roaring Fork River that would provide flows for endangered fish similar to the Sulphur Gulch Reservoir with effects on Colorado River flow similar to Wolcott or Sulphur Gulch reservoirs.	This reservoir site has been preliminary investigated, but no determination has been made on whether to pursue this project. Any assumptions on whether it would be constructed and how it would be operated are speculative.
Changes in Blue River Operations — Reclamation	Summit County	Water-based	When the WGFP EIS process began in 2003, Reclamation was about to be involved in litigation initiated by several West Slope entities over operation of Green Mountain Reservoir and operational limitations associated with the Heeney slide at the reservoir. At that time the outcome of the litigation was unknown but it was anticipated that any settlement could result in changes in Green Mountain operation that could affect operation of Williams Fork Reservoir, Wolford Mountain Reservoir, Granby Reservoir, and consequently flow in the Colorado River. In December 2005 Reclamation settled the litigation when an agreement among the plaintiffs and defendants was signed. The settlement involves a sharing of shortages between the C-BT and western slope interests when the shortage is due to an operational limitation on Green Mountain Reservoir. If shortages are due to hydrologic conditions they are not shared.	It is anticipated that the settlement agreement will result in minimal changes to operations of Green Mountain Reservoir and flows in the Blue River on an infrequent basis.
Denver Water Cooperative Projects — Denver Water	East Slope	Water-based	Denver Water may evaluate future water supply projects with other entities that could potentially use portions of Denver Water rights or infrastructure. Some of these projects could potentially affect flows in the upper Colorado River.	Denver Water currently has no arrangements pending with entities outside of its Combined Service Area. Potential cooperative projects are not well defined at this time and any assumptions on the nature of the projects and cumulative impacts with the WGFP would be speculative.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Wolford Mountain Reservoir Expansion — Colorado River Water Conservation District	Grand County	Water-based	Preliminary evaluations have indicated the potential to raise the existing Wolford Mountain Reservoir spillway and create 5,000 to 7,500 AF of additional storage. Increased storage in Wolford Mountain could change the timing or release of flows to Muddy Creek and the Colorado River.	The benefits and availability of water for this project are still under evaluation and no decision has been made to pursue this project. Any assumptions on the development of this project are speculative at this time.
Fraser Valley Water Supply — Multiple Grand County water users	Grand County	Water-based	The Upper Colorado River study (UPCO) Management Team sponsored a preliminary evaluation of structural alternatives to help meet projected water needs in Grand County. Several potential reservoir sites and related facilities in Grand County were identified. New storage in the Fraser River Basin could affect flows in the Fraser River and Colorado River.	The potential location, size, operation, and feasibility of new water storage facilities in Grand County are unknown at this time. Insufficient information is available for any meaningful analysis of a projects contribution to cumulative effects.
Eagle River Project — Aurora, Colorado Springs, Vail, Vail Associates, CRWCD	Eagle County	Water-based	East Slope and West Slope entities have explored opportunities for developing storage for Homestake II water rights in the Eagle River Basin, including additional Eagle River diversions and pumping using existing reservoirs. Water development in the Eagle River could affect flows in the Colorado River.	Potential options to develop these water rights have been discussed for a number of years, but there are no immediate plans for implementation of a project. Any assumptions on the development of this project are speculative at this time
Future Development of West Slope Water Rights — Multiple Municipalities	Grand Junction, Eagle, Pitkin, and Garfield Counties	Water-based	Increased municipal and industrial water use associated with population growth could affect flows in the Colorado River.	Future growth and development in communities within the Colorado River Basin are possible, but the effect of any additional water uses this far downstream from the WGFP are not likely to measurably contribute the cumulative effects analysis.
Oil Shale Development — Shell Oil and others	Rio Blanca	Oil development with water needs	Development of oil shale could require a substantial volume of water for production that would require diversion and storage of additional water sources in the Colorado River basin. Exercise of conditional oil shale water rights that are senior to Windy Gap are unlikely to directly impact Windy Gap diversions that are already called downstream by the Shoshone Power Plant.	The economic and technical feasibility of oil shale production is currently being studied. It is not known specifically what the future water requirements would be.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
East Slope				
Northern Integrated Supply Project (NISP) — NCWCD and 17 Municipal Participants	Larimer and Weld Counties	Water-based	The Northern Colorado Water Conservancy District, representing 12 municipalities and water districts, is proposing to develop reservoir storage to provide additional water supplies. The Corps, as the lead agency, is currently evaluating potential alternatives including diversion of water from the Cache la Poudre River for storage in Glade Reservoir north of Fort Collins and diversions from the South Platte River to Galeton Reservoir, as well as other storage options. This project would primarily affect flows in the Cache la Poudre and South Platte rivers.	Information on currently identified sources of water and storage locations for the NISP Project indicate that this project would have little or no interaction or overlap with the area of potential effect for the WGFP. Planned NISP diversions from the Cache la Poudre River or South Platte River would not affect operation of the WGFP or vice versa.
Halligan-Seaman Reservoir Expansion — Fort Collins, Greeley, and Others	Larimer County	Water-based	This project proposes the enlargement of Halligan and Seaman Reservoirs on the North Fork of the Cache la Poudre River to expand storage capacity to meet municipal water needs, improve water management efficiency, and provide drought protection. The Corps of Engineers is the lead agency conducting the NEPA evaluation for this project. This project would affect flows in the North Fork of the Cache la Poudre and the mainstem of the Cache la Poudre River.	Information on currently identified sources of water and storage locations for the Halligan-Seaman Project indicate that this project would have little or no interaction or overlap with the area of potential effect for the WGFP. Planned Halligan-Seaman diversions from the North Fork of the Cache la Poudre River and the Cache la Poudre River would not affect operation of the WGFP or vice versa.
Union Creek Reservoir — City of Longmont	Boulder County	Water-based	The City of Longmont has investigated the potential for enlargement of Union Creek Reservoir to improve the City's water storage capacity.	The City of Longmont has no immediate plan for enlargement of Union Creek Reservoir for at least 15 years and at that time would evaluate the need. The potential reservoir sizing and operations are not known and would be speculative to consider for the cumulative effects analysis.

Action — Sponsor	Location	Type of Action	Description/Potential Effect	Reasons why Actions is Not Reasonably Foreseeable
Firming Remaining Windy Gap Project Units Not Included in Firming Project — Municipal Subdistrict, NCWCD	East and West Slope	Water-based	The proposed WGFP would not firm all of the units of Windy Gap water. The units not included in the Firming Project include those owned by Estes Park and Boulder. In addition, several WGFP Participants are not firming all of their units in the proposed Firming Project and may firm these units in a future project. Firming remaining Windy Gap units would increase Colorado River diversions and could require additional storage.	Entities that own Windy Gap units not included in the Firming Project may decide to improve the firm yield of these units through storage development or other projects in the future. At the time of the EIS, no specific projects have been identified to firm the yield of those units not included in the proposed Firming Project. Assumptions on the potential actions and the effects in combination with the WGFP are speculative
Miscellaneous Water Right Purchases, Transfers, and Exchanges — Various Entities	East Slope	Water-based	At any given time, a variety of water-related transactions are occurring, including conversion of agricultural water rights to municipal use, changes in points of diversion, sales of C-BT Project water, ditch shares, or other water rights. Specific effects to streams from future water use on the East Slope are unknown.	It is difficult to predict with any certainty what transactions may occur in the future. Assumptions on the potential actions and effects in combination with the WGFP are speculative.

Table 2-5. Comparison of Action Alternative features.

Alternative Feature	Alternative 2 Chimney Hollow (Proposed Action)	Alternative 3 Chimney Hollow/Jasper East		Alternative 4 Chimney Hollow/Rockwell		Alternative 5 Dry Creek/Rockwell	
	Chimney Hollow	**Chimney Hollow**	**Jasper East**	**Chimney Hollow**	**Rockwell**	**Dry Creek**	**Rockwell**
Storage capacity (AF)	90,000	70,000	20,000	70,000	20,000	60,000	30,000
Reservoir footprint (acres)	742	627	434	627	294	589	348
Dam(s) and spillway (acres)	56	47	51	47	41	42	78
Total area (acres)	798	674	485	674	335	631	426
Total combined area (acres)	**798**	**1,159**		**1,009**		**1,057**	
Conveyance	New 1.2-mile pipeline connection with C-BT facilities	New 1.2-mile pipeline connection with C-BT facilities	New 0.9-mile pipeline connection to existing Windy Gap Pipeline	New 1.2-mile pipeline connection with C-BT facilities	New 3.3-mile pipeline connection to Windy Gap Pipeline	New 3.4-mile pipeline connection with C-BT and 0.5-mile pipeline turnout to Flatiron Reservoir; new 2.1-mile pipeline from Dry Creek Reservoir to Carter Lake	New 3.3-mile pipeline connection to Windy Gap Pipeline
Facility relocation	Relocation of about 3.8 miles of transmission line	Relocation of about 3.8 miles of transmission line	Relocation of Willow Creek Canal and Pump Station	Relocation of about 3.8 miles of transmission line	—	—	—
Roads	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	Relocation of about 2.4 miles of CR 40	New 1.5-mile permanent reservoir access road. Construction and maintenance access road	Relocation of 0.3 miles of CR 56. New construction and maintenance access road	Construction and maintenance access roads, with several potential options	Relocation of 0.5 miles of CR 56. New construction and maintenance access road

Alternative Feature	Alternative 2 Chimney Hollow (Proposed Action)	Alternative 3 Chimney Hollow/Jasper East		Alternative 4 Chimney Hollow/Rockwell		Alternative 5 Dry Creek/Rockwell	
	Chimney Hollow	Chimney Hollow	Jasper East	Chimney Hollow	Rockwell	Dry Creek	Rockwell
Borrow areas	In reservoir footprint	In reservoir footprint	Off-site 25-acre borrow area	In reservoir footprint	Off-site 56-acre borrow area	In reservoir footprint	Off-site 56-acre borrow area
Recreation	Larimer County would manage the reservoir site as open space	Larimer County would manage the reservoir site as open space	Recreation use is possible, but managing entity unknown	Larimer County would manage the reservoir site as open space	Recreation use is possible, but managing entity unknown	Similar recreation use as Chimney Hollow is possible, but managing entity unknown	Recreation use is possible, but managing entity unknown
CONSTRUCTION COST (in 2005 dollars)							
Dam and Reservoir	$208,600,000*	$165,200,000*	$31,100,000	$165,200,000*	$37,400,000	$157,000,000	$53,200,000
Conveyance	$14,800,000	$14,800,000	$29,000,000**	$14,800,000	$35,000,000	$42,500,000	$35,000,000
Total Capital Cost	$223,400,000	$180,000000	$60,100,000	$180,000000	$72,400,000	$199,500,000	$88,200,000
Total Alt. Cost	**$223,400,000**	**$240,100,000**		**$252,400,000**		**$287,700,000**	
ANNUAL OPERATION AND MAINTENANCE COST (in 2005 dollars)							
Dam and Reservoir	$500,000	$500,000	$250,000	$500,000	$250,000	$500,000	$250,000
Conveyance	$295,000	$295,000	$167,000	$295,000	$478,000	$495,000	$478,000
Power	—	—	$162,000	—	$207,000	$314,000	$207,000
Total O&M Cost	$795,000	$795,000	$579,000	$795,000	$935,000	$1,309,000	$935,000
Total Alt. O&M Cost	**$795,000**	**$1,375,000**		**$1,730,000**		**$2,240,000**	

*This includes the estimated cost of $4.5 million for relocation of Western's transmission line at Chimney Hollow Reservoir.

**Cost includes $15 million to relocate the Willow Creek Pump Station and Canal.

Table 2-6. Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
	Enlargement of Ralph Price Reservoir by 13,000 AF for storage of the City of Longmont's Windy Gap water	A 90,000 AF Chimney Hollow Reservoir with prepositioning to allow storage of C-BT water in Chimney Hollow	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Jasper East Reservoir	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Rockwell Reservoir	A 60,000 AF Dry Creek Reservoir and a 30,000 AF Rockwell Reservoir
SURFACE WATER HYDROLOGY					
West Slope					
WG diversions (avg. existing conditions = 36,532 AF)					
WG diversions (avg. annual)	43,573 AF	46,084 AF	48,052 AF	47,997 AF	48,483 AF
WG diversions (avg. annual wet year)	63,870 AF	73,923 AF	78,940 AF	78,775 AF	77,543 AF
WG diversions (avg. annual dry year)	Same as existing conditions	Same as existing conditions	Same as existing conditions	Same as existing conditions	Same as existing conditions
Avg. annual decrease in Colo. R. flow blw. WG Res.	8%	14%	14%	14%	14%
Avg. annual decrease in Colo. R. flow blw. Blue R.	2%	3%	3%	3%	3%
Avg. annual reduction in Willow Creek flow	7%	14%	12%	12%	12%
Change in Grand L./Shadow Mountain Res. storage	None	None	None	None	None
Average monthly decrease in Granby Res. storage	3 to 5%	7 to 13%	4 to 6%	4 to 6%	4 to 6%
East Slope					
Big Thompson R. at L. Estes (avg. mo. flow increase)	0 to 1%	1 to 9%	0 to 4%	0 to 4%	0 to 5%
Big Thompson R. at Loveland (max mo. increase)	0 to 9.8 cfs	0 to 5.1 cfs	0 to 5.1 cfs	0 to 5.1 cfs	0 to 5.1 cfs
North St. Vrain Crk. (avg. monthly flow change)	-45 cfs to +18 cfs	No change	No change	No change	No change
St. Vrain Crk. at Longmont. (max. mo. flow increase)	0.8 to 11.3 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs	0.5 to 6.4 cfs
Big Dry Crk. At Broomfield (max. mo. flow increase)	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs	3.4 to 8.5 cfs
Coal Creek (max. mo. flow increase)	3.2 to 3.4 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs	3.3 to 4.0 cfs
Avg. mo. decrease in Carter Lake storage	0 to 2%	0 to 1%	0 to 1%	0 to 1%	0 to 1%
Avg. mo. decrease in Horsetooth Res. storage	0 to 1%	3 to 8%	0 to 2%	0 to 2%	0 to 3%
WGFP firm yield	1,229 AF	26,559 AF	25,849 AF	25,849 AF	26,629 AF
GROUND WATER HYDROLOGY Ground water levels	Predicted average monthly decreases in Colorado River stream stage of less than 1.5 inches below the Windy Gap diversion and about 2.0 inches below the Blue River; small changes in Willow Creek streamflow and small increases in East Slope river stream stage would measurably affect alluvial ground water levels only within tens of feet from streams. Predicted average decreases in Granby Reservoir, Carter Lake, and Horsetooth Reservoir water levels also would have minimal effect on local alluvial ground water levels.	Similar to No Action, although the decrease in average monthly Colorado River stream stage would be about 2.6 inches below the Windy Gap diversion and 3.4 inches below the Blue River. Willow Creek streamflow decreases would be slightly more than No Action and streamflow increases in East Slope streams slightly more. Reservoir elevations would also be lower than No Action. Changes in water levels would have minimal effect on local alluvial ground water levels and well production near streams and reservoirs.	Similar to the Proposed Action although changes in stream stage would be slightly different (smaller in May and June and less than 1 inch greater in July and August). Changes in reservoir levels would be less for the Proposed Action.	Similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels less.	Similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels less.
Ground water quality	Predicted water quality changes in the Colorado River, Willow Creek, East Slope streams, and in all affected reservoirs may affect alluvial ground water, but effect would be minor or not measurable.	Similar to No Action, although surface water quality changes that influence ground water quality would be greater.	Similar to No Action, although surface water quality changes that influence ground water quality would be greater.	Similar to No Action, although surface water quality changes that influence ground water quality would be greater.	Similar to No Action, although surface water quality changes that influence ground water quality would be greater.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
STREAM MORPHOLOGY AND FLOODPLAINS					
West Slope	Colorado River flow below Windy Gap Reservoir that currently exceed the 2-year peak discharge 4% of the time, would occur about 3% of the time. At the Kremmling Gage peak flow discharge would occur about 1% less frequently. Projected changes in peak flows and channel maintenance flows are unlikely to substantially affect channel morphology or change sediment transport. Flushing flows greater than 450 cfs would occur 38 days per year on average. Flows would remain adequate to transport fine sediment and prevent deposition. Changes in the magnitude, timing, and frequency of Granby Reservoir spills are not expected to alter channel morphology or sediment transport. Willow Creek flow equal to or greater than the 2-year peak flow discharge would occur <1% less frequently. Adequate flow should be available to maintain channel capacity, provide periodic scouring, and transport sediment in the Colorado River and Willow Creek. The potential for flooding on the Colorado River and Willow Creek would decrease with lower flows.	Similar to No Action except that flows equal to or greater than 2-year peak flow would occur slightly less frequently. Flushing flows greater than 450 cfs would occur 36 days per year on average.	Similar to No Action, except that flows equal to or greater than the 2-year peak flow would occur slightly less frequently. Flushing flows greater than 450 cfs would occur 35 days per year on average. Jasper East Reservoir could potentially capture flood flows in this small watershed.	Similar to No Action, except that flows equal to or greater than the 2-year peak flow would occur slightly less frequently. Flushing flows greater than 450 cfs would occur 35 days per year on average. Rockwell Reservoir could potentially capture flood flows in this small watershed.	Similar to No Action, except that flows equal to or greater than the 2-year peak flow would occur slightly less frequently. Flushing flows greater than 450 cfs would occur 35 days per year on average. Rockwell Reservoir could potentially capture flood flows in this small watershed.
East Slope	Predicted changes in North St. Vrain Creek and St. Vrain Creek flow upstream of Lyons would be well within the historical range of flow and are unlikely to measurably affect stream morphology or sediment transport. A larger Ralph Price Reservoir could reduce the potential for downstream flooding. Relatively small increases in flow in the Big Thompson River and below WWTPs in St. Vrain Creek, Big Dry Creek, and Coal Creek are unlikely to measurably affect channel morphology. These flow increases would not substantially increase the risk of flooding.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Dry Creek Reservoir could potentially capture flood flows in this small watershed.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **West Slope** **Abbreviations:** TP = total phosphorus P = phosphorus TN = total nitrogen DO = dissolved oxygen Chlorophyll *a* = a measure of algae Trophic state = a measure of productivity	**Colorado River.** For average July 25 flows: stream temperature would increase up to 0.5°C, DO would decrease 0.1 mg/L, ammonia would increase 1.3 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: stream temperature would increase up to 4.0°C, DO would decrease 0.5 mg/L, ammonia would increase 9.1 µg/L, and inorganic P would increase up to 5.1 µg/L. Water quality would remain within standards, with the exception of increased potential for exceeding the temperature standard and DO spawning standard at several locations when diversions reduce flow to the minimum streamflow. **Willow Creek.** No change in temperature, slight increase in nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 6.3%, TN would increase 0.3%, no change in average chlorophyll *a*, clarity, trophic state, minimum DO would decrease 2.2%. Temperature, DO, and dissolved manganese would continue to exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 5.6%, TN would increase 1.1%, average chlorophyll *a* would increase 1.8%, no change in clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would increase 0.4%, average chlorophyll *a* would increase 4.2%, clarity would decrease 3.8%, no change in trophic state, minimum DO decreases 11.1%. Lower DO would contribute to continued exceedance of manganese standard.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.6°C, DO would decrease 0.1 mg/L, ammonia would increase 1.7 µg/L, and inorganic P would increase up to 1.5 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: stream temperature would increase up to 4.0°C, DO would decrease 0.6 mg/L, ammonia would increase 9.3 µg/L, and inorganic P would increase up to 5.7 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** A 0.2°C decrease in temperature, slight increase in nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 12.7%, TN would increase 0.7%, average chlorophyll *a* would increase 2.4%, no change in clarity or trophic state, minimum DO would decrease 4.4%. Temperature, DO, and dissolved manganese would continue to exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 11.3%, TN would increase 1.8%, average chlorophyll *a* would increase 1.8%, no change in clarity, or trophic state. Minimum DO would decrease 1.4%. Decrease in DO would contribute to continued exceedance of manganese standard. **Grand Lake.** TP concentrations would increase 12.0%, TN would increase 1.6%, average chlorophyll *a* would increase 6.1%, clarity would decrease 3.8%, no change in trophic state, minimum DO would decrease 7.4%. Lower DO would contribute to continued exceedance of manganese standard.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.8°C, DO would decrease 0.1 mg/L, ammonia would increase 1.6 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: stream temperature would increase up to 4.0°C, DO would decrease 0.5 mg/L, ammonia would decrease 8.9 µg/L, and inorganic P would increase up to 5.0 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 4.0%, TN would decrease 2.1%, no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. Temperature would continue to exceed standards. No improvement in DO and manganese, which currently exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 8.1%, TN would increase 0.4%, average chlorophyll *a* would increase 1.8%, no change in clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would decrease 0.4%, average chlorophyll *a* would increase 4.2%, clarity would decrease 3.8%, no change in trophic state, minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of manganese standard. **Jasper East Reservoir.** Predicted to be oligotrophic-mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.8°C, DO would decrease 0.1 mg/L, ammonia would increase 1.6 µg/L, and inorganic P would increase up to 0.9 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: stream temperature would increase up to 4.0°C, DO would decrease 0.5 mg/L, ammonia would increase 8.9 µg/L, and inorganic P would increase up to 5.0 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 3.2%, TN would decrease 2.8%, no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No improvement in DO and manganese, which currently exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 4.8%, TN would decrease 0.7%, no change in average chlorophyll *a*, clarity, trophic state or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 6.0%, TN would decrease 0.4%, average chlorophyll *a* would increase 2.0%, clarity would decrease 3.8%, no change in trophic state, minimum DO would decrease 5.6%. Lower DO would contribute to continued exceedance of manganese standard. **Rockwell Reservoir.** Predicted to be oligotrophic-mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.7°C, DO would decrease 0.1 mg/L, ammonia would increase 1.5 µg/L, and inorganic P would increase up to 0.8 µg/L. Assuming diversions to the minimum 90 cfs streamflow for July 25: stream temperature would increase up to 4.0°C, DO would decrease 0.5 mg/L, ammonia would increase 8.9 µg/L, and inorganic P would increase up to 4.9 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** Same as Proposed Action. **Granby Reservoir.** TP concentrations would increase 1.6%, TN would decrease 3.5%, no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No improvement in DO and manganese, which currently exceed standards. **Shadow Mountain Reservoir.** TP concentrations would increase 3.2%, TN would decrease 1.1%, no change in average chlorophyll *a*, clarity, trophic state or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would increase 4.8%, TN would decrease 0.8%, average chlorophyll *a* would increase 2.0%, no change in clarity, or trophic state, minimum DO decreases 5.6%. Lower DO would contribute to continued exceedance of manganese standard. **Rockwell Reservoir.** Same as Alternative 4.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **East Slope** Note: Water quality would not exceed standards in East Slope streams or reservoirs except as noted.	**N. St. Vrain Creek.** Depending on flow, temperature would increase up to 1°C and decrease up to 5°C. DO would range from a decrease of 0.5 mg/L to an increase of 2.0 mg/L. **St. Vrain Creek.** Estimated ammonia concentrations below Longmont WWTP would increase the most in October (to 2.7 mg/L) and would be higher than action alternatives because of potentially higher maximum WWTP discharges. **Big Thompson River.** Nitrogen and phosphorus concentrations from the Adams Tunnel would increase, but would be less than other alternatives because imports would be lower. Ammonia concentrations would decrease slightly below Loveland WWTP. **Big Dry Creek and Coal Creek.** Increased WWTP discharges would increase ammonia concentration and the potential for exceeding the water quality standard. **Cache la Poudre River.** Estimated ammonia concentrations would increase the most in November (to 1.4 mg/L). **Carter Lake.** TP concentrations would increase 5.1%, TN would increase 1.8%, average chlorophyll *a* would increase 5.6%, clarity would decrease 3.6%, no change in trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 5.1%, TN would increase 2.6%, average chlorophyll *a* would increase 5.7%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedances of the manganese standard. **Ralph Price Reservoir.** TP concentrations would decrease 3.9%, TN would decrease 5.9%, average chlorophyll *a* would decrease 33.0%, no change in clarity or trophic state, slight DO increase.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Estimated ammonia concentrations below Loveland WWTP would increase the most in October (to 2.5 mg/L). **Big Thompson River.** Greater nitrogen and phosphorus imports than No Action. Ammonia concentrations would decrease below Loveland WWTP. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Estimated ammonia concentrations would increase the most in January (to 1.4 mg/L). **Carter Lake.** TP concentrations would increase 9.1%, TN would increase 4%, average chlorophyll *a* would increase 11.1%, clarity would decrease 3.6%, no change in trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 11.1%, TN would increase 5.8%, average chlorophyll *a* would increase 11.4%, clarity would decrease 3.8%, no change in trophic state, slight DO decrease. Lower DO would contribute to continued exceedances of the manganese standard. **Chimney Hollow Reservoir.** Predicted to be oligotrophic, slightly lower water quality than Alternatives 3 and 4.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** TP concentrations would increase 3.0%, TN would increase 1.3%, no change in average chlorophyll *a*, clarity would decrease 3.6%, no change in trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 4%, TN would increase 4.0%, average chlorophyll *a* would increase 5.7%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedances of the manganese standard. **Chimney Hollow Reservoir.** Similar to Proposed Action with slightly better water quality.	**N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** Same as Alternative 3. **Horsetooth Reservoir.** TP concentrations would increase 4.0%, TN would increases 3.6%, average chlorophyll *a* would increase 5.7%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedances of the manganese standard. **Chimney Hollow Reservoir.** Similar to Proposed Action with slightly better water quality.	**N. St. Vrain Creek.** No effect. **N. St. Vrain Creek.** No effect. **St. Vrain Creek.** Same as Proposed Action. **Big Thompson River.** Same as Proposed Action. **Big Dry Creek and Coal Creek.** Same as No Action. **Cache la Poudre River.** Same as Proposed Action. **Carter Lake.** TP concentrations would increase 3.0%, TN would increase 1.8%, average chlorophyll *a* would increases 5.6%, clarity would decrease 3.6%, no change in trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 3.0%, TN would increase 3.6%, average chlorophyll *a* would increase 5.7%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedances of the manganese standard. **Dry Creek Reservoir.** Predicted to be oligotrophic.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
Aquatic Resources					
West Slope	A reduction in fish habitat would occur in the Colorado River below Windy Gap Reservoir with occasional increases in habitat. Adult rainbow trout habitat would decrease up to 9% in 3 out of 10 years above Williams Fork. Juvenile rainbow trout habitat would decrease up to 3% in 1 out of 10 years. Juvenile brown trout habitat would decrease up to 9% in 1 out of 10 years above the Blue River. Adult brown trout habitat in Willow Creek would decrease up to 9% in 2 out of 10 years and juvenile trout up to 6% in 2 out of 10 years. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations, with the greatest impact occurring above the Blue River. The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the summer, but measurable impacts to fish populations are not expected because flow reductions in July and August would be infrequent. Streamflow changes are unlikely to affect macroinvertebrate populations. No change in fish populations are predicted for the Three Lakes.	A greater reduction available fish habitat than the No Action alternative below Windy Gap Reservoir. The greatest reductions in fish habitat would occur during high runoff for a few months in the early spring and summer. A decrease in habitat at this time would have less impact than changes in flow during other times of the year when less habitat is available. Adult rainbow trout habitat in the Colorado River below Windy Gap Reservoir in average years would decrease up to 24% in 4 out of 10 years. Juvenile rainbow trout habitat would decrease up to 15% below Williams Fork in 1 out of 10 years. Adult and juvenile brown trout habitat would decrease less than 19% in 2 out of 10 years. Willow Creek adult brown trout habitat would decrease up to 21% in 2 out of 10 years. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations. The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the summer, but measurable impacts to fish populations are not expected because flow reductions in July and August would be infrequent. No change in fish populations are predicted for the Three Lakes.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.
East Slope	Projected increases in flow in the Big Thompson River, Big Dry Creek, and Coal Creek would slightly enhance fish habitat. A slight reduction in fish habitat in North St. Vrain Creek and St. Vrain Creek above Lyons is possible with reduced flow in some summer months, but higher flows in the fall and winter would benefit fish habitat. Changes in reservoir storage and water quality in Carter Lake and Horsetooth Reservoir would not measurably impact fish habitat. A larger Ralph Price Reservoir would benefit fish, but productivity would remain low.	Effects to East Slope fish in streams and reservoirs would be similar to No Action, except there would be no impact in North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow would support a fishery similar to other Front Range reservoirs.	Similar to Proposed Action. Jasper East Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Similar to Proposed Action. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Similar to Proposed Action. Dry Creek Reservoir would support a fishery similar to Chimney Hollow Reservoir. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
VEGETATION	Enlargement of Ralph Price Reservoir would inundate about 77 acres of mostly upland native forest. Impacts to riparian vegetation from reduced flows on the Colorado River, Willow Creek, and East Slope streams are expected to be negligible based on lack of impact to stream morphology, small changes in stream stage, and ground water levels. Water levels would be lower at Granby Reservoir, Carter Lake, and Horsetooth Reservoir, but would fall within the historical range of operations and are unlikely to affect the limited riparian vegetation bordering these reservoirs.	Construction of Chimney Hollow Reservoir would permanently impact 788 acres of vegetation and temporarily disturb 123 acres. Upland native shrublands, native and mixed grasslands, and native forest would have the most impact. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Construction of Chimney Hollow Reservoir would permanently impact 669 acres of vegetation and temporarily disturb 131 acres. Jasper East Reservoir construction would permanently impact 436 acres and temporarily disturb 114 acres. Grasslands and irrigated meadows would be impacted the most at Jasper East. Total permanent vegetation impact for both reservoirs would be 1,157 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Same impacts as Alternative 3 for Chimney Hollow Reservoir. Construction of Rockwell Reservoir would permanently impact 304 acres of vegetation and temporarily disturb 151 acres. Upland native shrubs would be impacted the most. Total permanent vegetation impacts for both reservoirs would be 973 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Construction of Dry Creek Reservoir would permanently impact 647 acres and temporarily disturb 149 acres. Upland native forests, mixed grasslands, and native shrubland would be most affected. Construction of Rockwell Reservoir would permanently impact 378 acres and temporarily disturb 105 acres. Total permanent vegetation impacts for both reservoirs would be 1,025 acres. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.
WETLANDS AND OTHER WATERS	Ralph Price Reservoir enlargement would inundate about 0.3 acre of wetlands and about 0.1 acre of North St. Vrain Creek. Dam construction could result in additional impacts to St. Vrain Creek.	About 1.6 acres of wetlands would be permanently impacted and about 0.1 acre temporarily disturbed. Permanent effects to other waters would be about 1.3 acre.	Chimney Hollow Reservoir would permanently impact 1.5 acres of wetlands and temporarily disturb about 0.1 acre. Permanent effect to other waters would be about 1.3 acre. Construction of Jasper East Reservoir would permanently affect 21.2 acres of wetlands and temporarily disturb 4.8 acres. Permanent effects to other waters would be about 6.3 acre. Total permanent wetland impacts for both reservoirs would be 22.7 acres.	Chimney Hollow Reservoir wetland and water impacts would be the same as Alternative 3. Permanent wetland impacts at Rockwell Reservoir would be 3 to 13.6 acres with a temporary wetland impact of 2 to 5 acres. Permanent effects to other waters would be 3.6 acres. Total permanent wetland impacts for both reservoirs would range from 4.5 to 15.1 acres pending field studies.	Dry Creek Reservoir construction would permanently impact 6.2 acres of wetlands and temporarily disturb 0.3 acre. Permanent effects to other waters would be 2.8 acres. Rockwell Reservoir permanent wetland impacts would be 3 to 15.6 acres with a temporary impact of 2 to 5 acres. Permanent effects to other waters would be 3.7 acres. Total permanent wetlands impacts for both reservoirs would range from 9.2 to 21.8 acres.
WILDLIFE	Loss of 77 acres of elk and mule deer winter range and white-tailed deer, black bear, and mountain lion overall range. Loss of habitat for other terrestrial wildlife species and birds, as well as displacement of wildlife during construction. No known loss to raptor nests, but suitable habitat is present for several species. Bald eagles, osprey, and waterfowl may benefit from a larger reservoir. Loss of about 0.1 acre of potential habitat for northern leopard frog and gartersnake.	Loss of 810 acres of elk winter range, mule deer winter range and concentration areas, and black bear fall concentration areas. Expansion of mountain lion and black bear conflict areas possible with planned recreation activity. Fragmentation of habitat that would alter local movement patterns by elk, deer, and other wildlife. Loss of foraging and nest habitat for a variety of bird, mammal, and reptile species. No known raptor nests would be directly affected. A golden eagle nest on the hogback ¼ -mile east of the reservoir is outside of the CDOW recommended buffer. About 7 acres of bald eagle winter range would be temporarily impacted, but the reservoir would provide bald eagle foraging habitat. Potential habitat for northern	Chimney Hollow Reservoir would result in the permanent loss of 675 acres of elk winter range, mule deer winter range and concentration areas, and black bear fall concentration areas. Other effects at Chimney Hollow would be similar to the Proposed Action. Jasper East Reservoir would result in the loss of about 480 acres of moose and mule deer summer range and 24 acres of elk winter range. The new reservoir could displace or shift elk movement toward U.S. 34 or residential development. About 93 acres of black bear summer concentration area would be impacted. Habitat for ground-nesting and tree-nesting birds would be lost or disturbed. About 3 acres of bald eagle	Chimney Hollow Reservoir effects would be the same as Alternative 3. Rockwell Reservoir would result in the permanent loss of 312 acres of summer range for moose and mule deer and 73 acres of elk winter range. Habitat for primarily ground-nesting birds would be lost as well as a variety of terrestrial mammals. No known raptor nests would be impacted. Bald eagle winter range would be temporarily affected where the pipeline crosses the Colorado River. The reservoir would provide foraging habitat for bald eagle, osprey, and other water birds. Potential habitat for the state threatened boreal toad and state species of concern northern leopard frog and common gartersnake would be lost in	Dry Creek Reservoir would permanently impact 650 acres of elk winter range, mule winter range and winter concentration areas. About 619 acres of black bear fall concentration area and overall mountain lion habitat would be lost. A red-tailed hawk nest would be lost and habitat for other migratory bird species. There would a permanent impact to 165 acres of bald eagle winter range, but the reservoir would provide foraging habitat. About 8.5 acres of known northern leopard frog habitat would be lost and about 30 acres of suitable common gartersnake habitat would be lost. Habitat for a variety of CNHP-tracked butterfly species would be lost.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
WILDLIFE (CONT'D)		leopard frog (2.5 acres) and common gartersnake (50 acres) would be lost. Habitat for several CNHP-tracked butterfly species would be lost.	winter range would be lost. The new reservoir would provide foraging habitat for bald eagle, osprey, and waterfowl. Loss of 125 acres of potential greater sage grouse habitat, which could affect eastward expansion of a known population. Sagebrush could also provide habitat for sage sparrow a CNHP tracked species.	riparian areas. The loss of 290 acres of sagebrush habitat within a sage grouse production and brood rearing area would adversely affect a declining population.	Impacts at the Rockwell Reservoir site would be similar to Alternative 4. Differences include a loss of 393 acres of moose and mule deer summer range and 97 acres of elk winter range. Also there would be a permanent impact to 334 acres of sage grouse breeding and brood rearing habitat.
THREATENED AND ENDANGERED	No effect to threatened or endangered species. Future Windy Gap diversions to the Colorado River were incorporated in the Recovery Plan; thus, there would be no additional impact to Colorado River endangered fish species.	Same as No Action.	Same as No Action.	Same as No Action, but the loss of about 5 acres of potential lynx habitat, may affect, but is unlikely to adversely affect lynx.	Same as No Action, but the loss of about 9 acres of potential lynx habitat, may affect, but is unlikely to adversely affect lynx
GEOLOGY	Excavation of geologic material for dam construction would be needed. No known geological hazards. No known oil/gas, mineral, or coal bearing resources would be affected. Aggregate sources could be affected. No known paleontological resources would be affected.	Borrow area excavation of geologic material for dam construction would be needed. No known geological hazards. No known oil/gas, mineral, coal bearing, or aggregate resources would be affected. A sandstone quarry on the east hogback could be affected by an access road. Plant and invertebrate fossils could be present in excavation of sandstone formations.	Chimney Hollow Reservoir effects would be the same as the Proposed Action. At Jasper East Reservoir there are no known geological hazards or oil/gas, mineral, or coal bearing resources that would be affected. Excavation in the Troublesome Formation could expose mammal fossils.	Chimney Hollow Reservoir effects would be the same as Alternative 3. At Rockwell Reservoir there are no known geological hazards or oil/gas, mineral, or coal bearing resources that would be affected. Excavation in the Troublesome Formation could expose mammal fossils.	Rockwell Reservoir effects would be the same as Alternative 3. At Dry Creek Reservoir there are no known geological hazards or oil/gas, mineral, coal bearing, or aggregate resources that would be affected. A sandstone quarry on the east hogback could be affected by the pipeline to Carter Lake. No known paleontological resources would be affected.
SOILS	Enlargement of Ralph Price Reservoir would result in the permanent inundation of 77 acres of soils, with possible other disturbances from dam construction and borrow area excavations. Shoreline erosion and sedimentation are likely to be minor. Temporary erosion from construction-related disturbances would occur until revegetation. Poor topsoil suitability could make revegetation difficult in some areas.	A permanent loss of 794 acres of soil resources. Temporary soil impacts to about 130 acres. Shoreline erosion during the first several years following construction. Seasonal fluctuations in water levels would be less than 2 feet, which would reduce the exposed shoreline subject to erosion. Sedimentation from other sources in the basin would be minimal. The potential for wind erosion is moderate and for water erosion is severe until revegetation is complete. About 67 acres of temporarily disturbed soils have fair suitability for topsoil and 62 acres have poor suitability.	A permanent loss of 671 acres of soil resources with construction of Chimney Hollow Reservoir and a temporary impact to 149 acres. Erosion potential is similar to the Proposed Action. Jasper East Reservoir would result in the loss of 491 acres of soil and a temporary disturbance of 125 acres. Shoreline erosion is likely with fluctuations in water levels up to 72 feet. Sediment delivery to the reservoir from local sources would be low. The potential for wind erosion is moderate and for water erosion is high. About 93 acres of temporary disturbances have poor topsoil suitability and 32 acres have fair suitability. Total permanent soil loss for both reservoirs would be 1,162 acres.	Soil impacts for Chimney Hollow Reservoir would be the same as Alternative 3. Rockwell Reservoir would result in a permanent loss of 315 acres of soil and a temporary disturbance of 155 acres. Shoreline erosion is likely with fluctuations in water levels up to 102 feet. Local sources of sediment delivery to the reservoir would be low. The wind erosion hazard is low to moderate and the water erosion is high for most soils. Temporarily disturbed soils mostly have poor topsoil suitability, which could impact revegetation. Total permanent soil loss for both reservoirs would be 986 acres.	Dry Creek Reservoir construction would result in a permanent impact to 633 acres of soils and a temporary disturbance of 158 acres. Some shoreline erosion is likely primarily during the first few years with seasonal fluctuations of up to 17 feet. The undisturbed watershed would have limited sources of local sediment delivery to the reservoir. Wind erosion hazard is moderate and water erosion is moderate to severe on steep slopes. About 74 acres of temporarily disturbed lands have poor topsoil suitability and 71 acres have fair suitability. Rockwell Reservoir would permanently disturb 393 acres and temporarily disturb 161 acres. Total permanent soil loss for both reservoirs would be 1,026 acres.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
AIR QUALITY	Vehicle emissions and fugitive dust generated during the 30-month construction period would result in minor localized and temporary effects to air quality. Exceedance of air quality standards is unlikely.	Similar types of temporary impacts as No Action, but a 3- to 5-year construction period and greater area of surface disturbance, with greater dust and emissions. No exceedances of air quality standards likely. Negligible vehicle emissions from recreation visitors to the reservoir over the long term.	Similar temporary impacts as the Proposed Action over a 2.5 to 5 year period, but impacts would occur at both the Jasper East and Chimney Hollow reservoir sites.	Similar temporary impacts as the Proposed Action over a 2.5 to 4.5 year period, but impacts would occur at both the Rockwell and Chimney Hollow reservoir sites.	Similar temporary impacts as the Proposed Action over a 2.5 to 4.5 year period, but impacts would occur at both the Dry Creek and Rockwell reservoir sites.
NOISE	Construction equipment, earth moving equipment, blasting, and other activities would temporarily increase noise levels. Noise levels at several residences about 200 feet from the dam could reach 83 dB(A), which would exceed Larimer County noise standards.	Construction-related activities would temporarily increase noise levels for residents on the hogback ridge to the east of the dam. Noise levels are predicted to reach about 71 dB(A) near these homes, which is within Larimer County standards. Long-term noise levels from a substation would be within County standards. Recreation-related noise levels are expected to minor over the long term.	Noise-related impacts for Chimney Hollow would be the same as the Proposed Action. Residents close to the Jasper East Reservoir site could experience noise levels up to about 65 dB(A) during construction.	Noise-related impacts for Chimney Hollow would be the same as the Proposed Action. Residents close to the Jasper East Reservoir site could experience noise levels up to about 71 dB(A) during construction.	Noise-related impacts for Rockwell Reservoir would be the same as the Proposed Action. Residents near the Dry Creek Reservoir site could experience noise levels of up to 71 dB(A) during construction. Tunnel boring near Carter Lake could result in noise levels up to 83 dB(A) for nearby residents, which exceeds Larimer County standards.
LAND USE	Reservoir enlargement would be on City of Longmont property. Land use would not change, but public access would be temporarily suspended during construction. No private homes would be directly impacted. During the estimated 2-year construction period, traffic on U.S. 36 and CR 80 would increase. Traffic on CR 80 would increase about 63%.	The Subdistrict owns 84% of the reservoir project area, but would need to acquire several small private parcels and an easement from Reclamation for pipeline connections. Construction access also may require easements across private, Reclamation, and State land. Relocation of Western's transmission line would require easements across Larimer County, Subdistrict, and Reclamation land. No prime farmland would be impacted. No private homes would need to be acquired. The currently undeveloped land use would change to day-use recreation activities. During construction, traffic on CR 18E would increase about 79%. Traffic on CR 31 could also increase at the southern construction access point. Following construction traffic from an estimated 50,000 annual recreation visitors a year would occur on CR 18.	Land acquisition and easements for a smaller Chimney Hollow would be less, but similar to the Proposed Action. Other impacts would also be similar. Jasper East Reservoir would be built on land mostly owned by the NCWCD that would need to be acquired by the Subdistrict. About 70 acres of Reclamation land would need to be acquired by a land exchange or a contract. Realignment of CR 40 would require acquisition of private and NCWCD land. About 313 acres of irrigated hay meadows would be lost. No prime farmland would be impacted. No private homes would need to be acquired. During construction, traffic volume on U.S. 34 and CR 40 would increase. Traffic on U.S. 34 would increase about 8%.	Chimney Hollow impacts would be the same as Alternative 4. Construction of Rockwell Reservoir would require acquisition of about 443 acres of private land including four homes. About 29 acres of BLM land at the reservoir site and 56 acres at a borrow area would require acquisition and/or a special use permit. An easement across mostly private land would also be needed for the pipeline to Windy Gap Reservoir. A portion of CR 57 would need to be realigned. Existing land uses of pasture land, livestock grazing, and private residential use would be lost. No prime farmland would be impacted. Traffic on CR 56 and CR 57 would increase during construction. U.S. 40 traffic near CR 57 would increase 5% and U.S. 40 near CR 56 would increase 4%.	The Subdistrict would need to acquire about 459 acres of private land, 230 acres of State land, and 18 acres of Reclamation property for construction of Dry Creek Reservoir and facilities. Reservoir construction would impact three homes and displace a commercial llama operation. No prime farmland would be impacted. Traffic during construction on CR 18E would increase about 72%. If access from the south is used, then traffic on CR 31 also would increase. Rockwell Reservoir construction would require acquisition of about 504 acres of private property and 51 acres of BLM land at the reservoir site. Other impacts would be similar to Alternative 4.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
RECREATION **West Slope**	In the Big Gore Canyon of the Colorado River, there would be no change from existing conditions in the number of days that preferred rafting flows of 850 to 1,250 cfs occur for any of the alternatives in 37 years of the 47-year study period. Preferred rafting flows in Big Gore Canyon would occur about 24 days less compared to existing conditions over the 47-year study period. The greatest decrease in the number of days with preferred flows for rafting in the driest year would be 11 days under all of the alternatives. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would not change in 32 years of the 47-year study period for any of the alternatives. Over the 47-year study period, there would be about 1 more day of preferred kayaking flows compared to existing conditions. The greatest decrease in the number of days with preferred flows for kayaking in the driest year would be 15 days under all of the alternatives. There would be no change from existing conditions in the number of days when preferred rafting and kayaking flows in the Pumphouse reach are between 2,000 to 3,000 cfs in 28 years of the 47-year study period for any of the alternatives. Over the 47-year period, there would be 6 more days of preferred flows in this range. The greatest decrease in the number of days with preferred flows in the driest year would be 17 days under all of the alternatives. Recreation in Grand Lake and Shadow Mountain Reservoir would not be affected. Granby Reservoir surface area in the summer would decrease less than 2% on average, boat ramps would remain accessible, except in dry years when water levels could drop below the Arapaho Bay boat ramp in August.	In the Big Gore Canyon of the Colorado, there would be about 23 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 4 days less over the 47 year study period compared to existing conditions. There would be about 20 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions. Granby Reservoir surface area would decrease 6% on average in the summer. Boat ramps would remain accessible except in dry years when water levels could drop below the Arapaho Bay boat ramp in May and August, and possibly the Stillwater and Sunset boat ramps for a portion of the summer.	In the Big Gore Canyon of the Colorado, there would be about 23 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 4 days less over the 47 year study period compared to existing conditions. There would be about 21 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions.	In the Big Gore Canyon of the Colorado, there would be about 19 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 3 days more over the 47 year study period compared to existing conditions. There would be about 27 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions.	In the Big Gore Canyon of the Colorado, there would be about 27 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 1 days less over the 47 year study period compared to existing conditions. There would be about 5 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
RECREATION **East Slope**	Kayaking opportunities in North St. Vrain Creek below Longmont Reservoir would be reduced in July when flows drop below 150 cfs. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. Recreation at Ralph Price Reservoir would be suspended for 2 years until construction is completed. Average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth surface area would not change. Boat ramp access could be reduced in dry years.	No effect on North St. Vrain flows or kayaking. Increased flows in the Big Thompson River would maintain existing kayaking. Average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth surface area would decrease up to 5%. Water levels could drop below Horsetooth's South Bay-South boat ramp in September and in dry years access to several boat ramps could be affected. Chimney Hollow Reservoir would provide day use fishing, boating, and hiking opportunities with up to 50,000 annual visitors.	Similar to the Proposed Action except Horsetooth Reservoir average monthly water surface area would decrease less than 1%. Jasper East Reservoir could provide recreation an opportunity if a managing entity is found although wide fluctuations in water levels could reduce suitability.	Same as Alternative 3. Rockwell Reservoir could provide recreation an opportunity if a managing entity is found although wide fluctuations in water levels could reduce suitability.	Same as Alternative 3. Dry Creek reservoir could provide recreation opportunities similar to Chimney Hollow if a managing entity is found. Rockwell Reservoir could provide recreation an opportunity if a managing entity is found although wide fluctuations in water levels could reduce suitability.
CULTURAL RESOURCES	No known NRHP cultural resources would be impacted, but additional field survey would be needed prior to construction.	Twelve cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Chimney Hollow Reservoir. These sites include features of the C-BT Project, transmission lines, a prehistoric lithic scatter, a historic ranch, a prospecting pit, and a stock pond.	Chimney Hollow cultural resource effects would be the same as the Proposed Action. Eight cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Jasper East Reservoir. These sites include two prehistoric quarries, a prehistoric lithic scatter, and features of Willow Creek Reservoir—part of the C-BT Project.	Chimney Hollow cultural resources would be the same as the Proposed Action. One potential cultural resource site potentially eligible for the NRHP could be affected by construction of Rockwell Reservoir. The pipeline would cross the Denver and Rio Grande rail line, which elsewhere has been determined eligible.	Two cultural resource sites eligible or potentially eligible for the NRHP could be affected by construction of Dry Creek Reservoir. These sites include a historic quarry and the Carter Lake Historic Area. Cultural resources at Rockwell Reservoir would be the same as Alternative 4.
VISUAL RESOURCES	Visual quality would diminish temporarily during construction from earthwork, vegetation clearing, dust, and traffic. Visual quality at Ralph Price Reservoir would not change substantially from existing conditions, but an additional 77 acres of open water would replace forest land. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 108 acres more than existing conditions. Small decreases in Carter Lake and Horsetooth Reservoir storage would not be noticeable. Lower streamflows could potentially reduce the visual quality of the Colorado River, but for most viewers these changes would not be discernible for any of the alternatives.	Temporary visual impacts during construction similar to No Action. Chimney Hollow Reservoir would be visible primarily from homes along the hogback to the east. The dam would be visible from locations to the north up to 2.5 miles away including Reclamation offices, scattered residences, and CR 18E. The relocated transmission line would be visible from the lake and homes on the hogback. Because Chimney Hollow would remain near full, shoreline exposure would be limited. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 270 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would increase less than 73 acres on average in the summer.	Visual effects at Chimney Hollow would be similar to the Proposed Action although the dam would be about 30 feet lower and slightly less visible. Jasper East Reservoir and dam would be visible from scattered residential homes to the west and portions of the Arapaho National Recreation Area, as well as the relocated CR 40. Fluctuations in water levels would expose large areas of shoreline, but water levels would be highest in the summer. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 155 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would increase less than 24 acres on average in the summer.	Visual effects at Chimney Hollow would be the same as Alternative 3. Rockwell Reservoir dams would be visible from the Town of Granby, Grand Elk, Granby Ranch, and U.S. 40. Views of the reservoir would be limited to scattered homes at higher elevations. Same effects as Alternative 3 for Granby Reservoir, Carter Lake, and Horsetooth Reservoir.	Dry Creek Reservoir would introduce a substantial visual change to the valley, but there are few observation points because most of the area is undeveloped. The dam would be visible from several rural roads and residences. Visual effects of Rockwell Reservoir would be similar to Alternative 4 although the dams would be slightly higher and more visible. Same effects as Alternative 3 for Granby Reservoir, Carter Lake, and Horsetooth Reservoir.

Table 2-6 (cont'd). Comparison of direct and indirect effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SOCIOECONOMICS	The average workforce during the 2-year construction period would be 50 employees, with about $8 million of the $31 million total project cost going to direct labor. The project would generate about $73 million in total economic output and 69 temporary jobs. Because recreation at Ralph Price Reservoir would be closed during construction, there would be a loss of revenue to the City of Longmont. Minority or low-income populations would not be disproportionately impacted. Hydrologic changes that reduce or increase the number of days that preferred flows for boating in the Colorado River occur, could impact recreation-associated spending. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would be an increase in recreation revenue of about $600 per year due reductions in high flows that currently limit kayaking or rafting. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would result in: a loss of about 429 user days for commercial rafting in Big Gore Canyon with a value of about $31,000; a loss of about 3,375 user days for kayaking in Big Gore Canyon and Pumphouse with a value of about $246,000; and a loss of about 900 user days for rafting in Pumphouse with a value of about $66,000. Water deliveries to the East Slope would generate a net increase of about 19 GWH of hydropower energy with a production value of $1.1 million.	The average workforce during the 3- to 5-year construction period would be 235 employees, with about $47 million of the $223 million total project cost going to direct labor. If half of the project costs were spent in Larimer and Weld counties, the project would generate about $292 million in total economic output and would create 127 temporary jobs. Reservoir operation would require four new employees. Larimer County would spend about $1 million for recreation development with annual recreation O&M costs of $265,000. Minority or low-income populations would not be disproportionately impacted. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $10,000 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would be the same as No Action for commercial rafting in Big Gore Canyon and kayaking in Big Gore Canyon and Pumphouse. The reduction in preferred flow days for rafting in Pumphouse for the driest year would result in a loss of 3,825 user days with a value of about $279,000. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	The average workforce for construction of Chimney Hollow Reservoir during the 2.5- to 5-year construction period would be 190 employees and 65 employees for Jasper East Reservoir. About $49 million of the $240 million total project cost would go to direct labor. If half of the project costs were spent in Larimer and Weld County, the project would generate about $236 million in total economic output and 102 temporary jobs. Total economic output in Grand County would be about $35 million and would create 30 temporary jobs. Jasper East Reservoir operation would require two new employees. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $10,500 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would be the same as No Action for commercial rafting in Big Gore Canyon and kayaking in Big Gore Canyon and Pumphouse. The reduction in preferred flows for rafting in Pumphouse for the driest year would be the same as the Proposed Action. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	Economic effects for Chimney Hollow Reservoir would be the same as Alternative 3. Construction of Rockwell Reservoir would require an average workforce during the 2.5- to 4.5-year construction period of 76 employees. For both reservoirs about $52 million of the $252 million total project cost would go to direct labor. Total economic output in Grand County would be about $41 million and 30 temporary jobs would be created. Rockwell Reservoir operation would require two new employees. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $12,000 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would be the same as No Action for commercial rafting in Big Gore Canyon and kayaking in Big Gore Canyon and Pumphouse. The reduction in preferred flows for rafting in Pumphouse for the driest year would be the same as the Proposed Action. Water deliveries to the East Slope would generate a net increase of about 26 GWH of hydropower energy with a production value of $1.5 million.	The average workforce for construction of Dry Creek Reservoir during the 2.5- to 4.5-year construction period would be 210 employees and 92 employees at Rockwell Reservoir. About $60 million of the $288 million total project cost would go to direct labor. If half of the project costs were spent in Larimer and Weld County, the project would generate about $236 million in total economic output and 112 temporary jobs. Total economic output in Grand County would be about $51 million and would create 42 temporary jobs. Minority or low-income populations would not be disproportionately impacted at either reservoir site. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $4,000 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would be the same as No Action for commercial rafting in Big Gore Canyon and kayaking in Big Gore Canyon and Pumphouse. The reduction in the number of preferred flow days for rafting in Pumphouse for the driest year would result in a loss of 1,125 user days with a value of about $82,000. Water deliveries to the East Slope would generate a net increase of about 29 GWH of hydropower energy with a production value of $1.7 million.

Table 2-7. Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
	Enlargement of Ralph Price Reservoir by 13,000 AF for storage of the City of Longmont's Windy Gap water	A 90,000 AF Chimney Hollow Reservoir with prepositioning to allow storage of C-BT water in Chimney Hollow	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Jasper East Reservoir	A 70,000 AF Chimney Hollow Reservoir and a 20,000 AF Rockwell Reservoir	A 60,000 AF Dry Creek Reservoir and a 30,000 AF Rockwell Reservoir
SURFACE WATER HYDROLOGY					
West Slope					
WG diversions (avg. existing conditions = 36,532 AF)					
WG diversions (avg. annual)	38,973 AF	40,791 AF	All hydrologic changes similar to Alternative 5.	All hydrologic changes similar to Alternative 5.	42,991 AF
WG diversions (avg. annual wet year)	62,118 AF	69,417 AF			71,669 AF
WG diversions (avg. annual dry year)	3,860 AF	3,860 AF			3,860 AF
Avg. annual decrease in Colo. R. flow blw. WG Res.	14%	20%			20%
Avg. annual decrease in Colo. R. flow blw. Blue R.	11%	13%			13%
Avg. annual reduction in Willow Creek flow	9%	15%			13%
Change in Grand L./Shadow Mountain Res. storage	None	None			None
Average monthly decrease in Granby Res. storage	4 to 7%	9 to 16%			6 to 8%
East Slope					
Big Thompson R. at L. Estes (avg. mo. flow increase)	0 to 1%	3 to 4%	All hydrologic changes similar to Alternative 5.	All hydrologic changes similar to Alternative 5.	1 to 2%
Big Thompson R. at Loveland (max mo. flow increase)	0 to 9.8 cfs	0 to 4.8 cfs			0 to 4.8 cfs
North St. Vrain Crk. (avg. monthly flow change)	-42 cfs to +18 cfs	No change			No change
St. Vrain Crk.-Longmont. (max. mo. flow increase)	0.8 to 11.3 cfs	0.5 to 6.1 cfs			0.5 to 6.1 cfs
Big Dry Crk.-Broomfield (max. mo. flow increase)	3.4 to 8.5 cfs	3.0 to 7.6 cfs			3.0 to 7.6 cfs
Coal Creek (max. mo. flow increase)	3.2 to 3.4 cfs	2.7 to 3.3 cfs			2.7 to 3.3 cfs
Avg. mo. decrease in Carter Lake storage	0 to 1%	0 to 1%			0 to 1%
Avg. mo. decrease in Horsetooth Res. storage	0%	2 to 7%			0 to 3%
WGFP firm yield	579 AF	24,045 AF			23,967 AF
GROUND WATER HYDROLOGY Ground water levels	Predicted average monthly decreases in Colorado River stream stage of about 2.3 inches below the Windy Gap diversion and up to 11 inches below the Blue River; small changes in Willow Creek streamflow and small increases in East Slope river stream stage would measurably affect alluvial ground water levels only within tens of feet from streams. Predicted average decreases in Granby Reservoir, Carter Lake, and Horsetooth Reservoir water levels also would have minimal effect on local alluvial ground water levels.	Similar to No Action, although the decrease in average monthly Colorado River stream stage of about 4 inches below the Windy Gap diversion and about 12 inches below the Blue River. Willow Creek streamflow decreases would be slightly more than No Action and streamflow increases in East Slope streams slightly more. Reservoir elevations would also be lower than No Action. Changes in water levels would have minimal effect on local alluvial ground water levels and well production near streams and reservoirs.	Similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels less.	Similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels less.	Similar to the Proposed Action although changes in stream stage would be slightly smaller and changes in reservoir levels less.
Ground water quality	Predicted water quality changes in the Colorado River, Willow Creek, East Slope streams, and in all affected reservoirs would result in minor to unmeasurable affects to alluvial ground water quality.	Similar to No Action although surface water quality changes that influence ground water quality would be greater.	Similar to No Action although surface water quality changes that influence ground water quality would be greater.	Similar to No Action although surface water quality changes that influence ground water quality would be greater.	Similar to No Action although surface water quality changes that influence ground water quality would be greater.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
STREAM MORPHOLOGY AND FLOODPLAINS					
West Slope	Colorado River flow below Windy Gap Reservoir that currently exceed the 2-year peak discharge about 4% of the time, would occur about 2.5% of the time. At the Kremmling Gage 2-year peak flow discharge would occur about 2% less frequently. Projected changes in peak flows and channel maintenance flows are unlikely to substantially affect channel morphology or change sediment transport. Flushing flows would remain adequate to transport fine sediment and prevent deposition. Changes in the magnitude, timing, and frequency of Granby Reservoir spills are not expected to alter channel morphology or sediment transport. Willow Creek flow equal to or greater than the 2-year peak flow discharge would occur <1% less frequently. Adequate flow should be available to maintain channel capacity, provide periodic scouring, and transport sediment in the Colorado River and Willow Creek. The potential for flooding on the Colorado River and Willow Creek would decrease with lower flows.	Similar to No Action except that Colorado River flows equal to or greater than 2-year peak flow would occur slightly less frequently.	Similar to No Action except that Colorado River flows equal to or exceeding the 2-year peak flow would occur slightly less frequently. Jasper East Reservoir could potentially capture flood flows in this small watershed.	Similar to No Action except that Colorado River flows equal to or exceeding the 2-year peak flow would occur slightly less frequently. Rockwell Reservoir could potentially capture flood flows in this small watershed.	Similar to No Action except that Colorado River flows equal to or exceeding the 2-year peak flow would occur slightly less frequently. Rockwell Reservoir could potentially capture flood flows in this small watershed.
East Slope	Predicted changes in North St. Vrain Creek and St. Vrain Creek flow upstream of Lyons would be well within the historical range of flow and are unlikely to measurably affect stream morphology or sediment transport. A larger Ralph Price Reservoir could reduce the potential for downstream flooding. Relatively small increases in flow in the Big Thompson River and below WWTPs in St. Vrain Creek, Big Dry Creek, and Coal Creek are unlikely to measurably affect channel morphology. These flow increases would not substantially increase the risk of flooding.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow Reservoir could potentially capture flood flows in this small watershed.	Similar to the No Action, except there would be no effect to North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Dry Creek Reservoir could potentially capture flood flows in this small watershed.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **West Slope** **Abbreviations:** TP = total phosphorus P = phosphorus TN = total nitrogen DO = dissolved oxygen Chlorophyll *a* = a measure of algae Trophic state = a measure of productivity	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.4°C, DO would decrease <0.1 mg/L, ammonia would increase 9.5 µg/L, and inorganic P would decrease up to 4.6 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: stream temperature would increase up to 4.1°C, DO would decrease 0.5 mg/L, ammonia would increase 16.3 µg/L, and inorganic P would decrease up to 4.0 µg/L. Water quality would remain within standards, with the exception of increased potential for exceeding the temperature standard and DO spawning standard at several locations when diversions reduce flow to the minimum streamflow. **Willow Creek.** Less than a 0.2°C decrease in temperature, slight increase in nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would decrease 3.2%, TN would increase 3.1%, no change in average chlorophyll *a*, no change in clarity, trophic state, or minimum DO. Temperature would continue to exceed standards. No improvement in DO and manganese, which currently exceed standards. **Shadow Mountain Reservoir.** TP concentrations would decrease 1.6%, TN would increase 2.9%, no change in average chlorophyll *a*, clarity, trophic state, or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would decrease 1.2%, TN would increase 1.6%, no change in average chlorophyll *a*, clarity trophic state, minimum DO would decrease 11.1%. Lower DO would contribute to continued exceedance of manganese standard.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.6°C, DO would decrease 0.1 mg/L, ammonia would increase 11.1 µg/L, and inorganic P would decrease up to 3.8 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: stream temperature would increase up to 4.1°C, DO would decrease 0.6 mg/L, ammonia would increase 16.7 µg/L, and inorganic P would increase up to 3.7 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** Similar to No Action with slightly higher nutrient and metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would increase 2.4%, TN would increase 3.8%, no change in average chlorophyll *a*, clarity, or trophic state, minimum DO would decrease 4.4%. Temperature would continue to exceed standards. Lower DO would contribute to continued exceedance of DO and dissolved manganese standards. **Shadow Mountain Reservoir.** TP concentrations would increase 3.2%, TN would increase 3.6%, no change in average chlorophyll *a*, clarity, or trophic state. Minimum DO would decrease 1.4%. Decrease in DO would contribute to continued exceedance of manganese standard. **Grand Lake.** TP concentrations would increase 4.8%, TN would increase 3.2%, average chlorophyll *a* would increase 2.0%, clarity would decrease 3.8%, no change in trophic state, minimum DO would decrease 7.4%. Lower DO would contribute to continued exceedance of manganese standard.	Water quality effects on the West Slope similar to Alternative 5. **Jasper East Reservoir.** Not modeled, for cumulative effects analysis, but would be similar to Rockwell Reservoir in Alternative 5.	Water quality effects on the West Slope similar to Alternative 5.	**Colorado River.** With average July 25 flows: stream temperature would increase up to 0.7°C, DO would decrease 0.1 mg/L, ammonia would increase 10.7 µg/L, and inorganic P would decrease up to 4.7 µg/L. Assuming diversions to the minimum 90 cfs streamflow on July 25: stream temperature would increase up to 4.1°C, DO would decrease 0.6 mg/L, ammonia would increase 16.4 µg/L, and inorganic P would decrease up to 4.7 µg/L. Water quality standards would be met, except as noted for No Action. **Willow Creek.** Similar nutrient concentrations as Proposed Action; slightly higher metal concentrations. Water quality would remain within standards. **Granby Reservoir.** TP concentrations would decrease 13.5%, TN would increase 4.8%, average chlorophyll *a*, would decrease 2.4%, no change in clarity, trophic state, or minimum DO. Temperature would continue to exceed standards. No improvement in DO and manganese, which currently exceed standards. **Shadow Mountain Reservoir.** TP concentrations would decrease 9.7%, TN would increase 4.0%, average chlorophyll *a* would decrease 5.3%, clarity would improve 5.0%, no change in trophic state or minimum DO. No change in manganese concentrations, which currently exceed the standard. **Grand Lake.** TP concentrations would decrease 7.2%, TN would increase 3.6%, average chlorophyll *a* would decrease 6.1%, clarity would improve 3.8%, no change in trophic state, minimum DO decreases 5.6%. Lower DO would contribute to continued exceedance of manganese standard. **Rockwell Reservoir.** Predicted to be mesotrophic and retain some TN and P, reducing nutrient delivery to Granby Reservoir.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SURFACE WATER QUALITY **East Slope** Note: Water quality would not exceed standards in East Slope streams or reservoirs except as noted.	**East Slope Streams.** Cumulative water quality effects to North St. Vrain Creek, St. Vrain Creek, Big Thompson River, Big Dry, Creek, Coal Creek, and the Cache la Poudre River would be nearly identical to direct effects summarized in Table 2-6 **Carter Lake.** No change in TP concentration, TN would increase 2.2%, no change in average chlorophyll *a*, clarity, trophic state, slight DO decrease. **Horsetooth Reservoir.** No change in TP concentrations, TN would increase 3.3%, average chlorophyll *a* would increase 2.9%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedance of the manganese standard. **Ralph Price Reservoir.** TP concentrations would decrease 3.9%, TN would decrease 5.9%, average chlorophyll *a* would decrease 33%, no change in clarity or trophic state, slight DO increase.	**East Slope Streams.** Cumulative water quality effects to St. Vrain Creek, Big Thompson River, Big Dry, Creek, Coal Creek, and the Cache la Poudre River would be nearly identical to direct effects summarized in Table 2-6. There would be no effect to North St. Vrain Creek. **Carter Lake.** TP concentrations would increase 5.1%, TN would increase 4.9%, average chlorophyll *a* would increase 11.1%, no change in clarity or trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 6.1%, TN would increase 6.6%, average chlorophyll *a* would increase 8.6%, clarity would decrease 3.8%, no change in trophic state, slight DO decrease. Lower DO would contribute to continued exceedance of the manganese standard. **Chimney Hollow Reservoir.** Predicted to be oligotrophic, slightly lower water quality than Alternatives 3 and 4.	Similar water quality effects on the East Slope as Alternative 5.	Similar water quality effects on the East Slope as Alternative 5.	**East Slope Streams.** Same as Proposed Action. **Carter Lake.** TP concentrations would decrease 2.0%, TN would increase 4.4%, average chlorophyll *a* would increases 5.6%, no change in clarity or trophic state, slight DO decrease. **Horsetooth Reservoir.** TP concentrations would increase 3.0%, TN would increase 6.2%, average chlorophyll *a* would increase 2.9%, no change in clarity or trophic state, slight DO decrease. Lower DO would contribute to continued exceedance of the manganese standard. **Dry Creek Reservoir.** Predicted to be oligotrophic.
AQUATIC RESOURCES **West Slope**	A reduction in fish habitat would occur in the Colorado River below Windy Gap Reservoir with occasional increases in habitat. Adult rainbow trout habitat would decrease up to 29% in 4 out of 10 years above Williams Fork. Juvenile rainbow trout habitat would decrease up to 6% in 2 out of 10 years. Juvenile and adult brown trout habitat would decrease up to 18% in 1 out of 10 years above the Blue River. Adult brown trout habitat in Willow Creek would decrease up to 17% in 2 out of 10 years and juvenile trout up to 11% in 2 out of 10 years. A decrease in fish habitat would occur in dry years due to reasonably foreseeable actions. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations, with the greatest impact occurring above the Blue River. The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the	Fish habitat would mostly decrease below Windy Gap Reservoir, but reductions in high flow increase habitat in high runoff months. Adult rainbow trout habitat in the Colorado River below Windy Gap Reservoir in average years would decrease up to 30% in 4 out of 10 years. Juvenile rainbow trout habitat would decrease up to 22% above Troublesome Creek in 0.5 out of 10 years. Adult and juvenile brown trout habitat would decrease less than 24% in 2 out of 10 years below the Blue River. A decrease in fish habitat would occur in dry years due to reasonably foreseeable actions. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations. The potential for exceedance of the aquatic life temperature standard would increase at lower flows in the summer, but measurable impacts to fish populations are not expected because	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
AQUATIC RESOURCES (CONT'D) **West Slope**	summer, but measurable impacts to fish populations are not expected because flow reductions in July and August would be infrequent. No change in fish populations are predicted for the Three Lakes.	flow reductions in July and August would be infrequent. Willow Creek adult brown trout habitat would decrease up to 21% in 2 out of 10 years. No change in fish populations are predicted for the Three Lakes.			
AQUATIC RESOURCES **East Slope**	Projected increases in flow in the Big Thompson River, Big Dry Creek, and Coal Creek would slightly enhance fish habitat. A slight reduction in fish habitat in North St. Vrain Creek and St. Vrain Creek above Lyons is possible with reduced flow in some summer months, but higher flows in the fall and winter would benefit fish habitat. Changes in reservoir storage and water quality in Carter Lake and Horsetooth Reservoir would not measurably impact fish habitat. A larger Ralph Price Reservoir would benefit fish, but productivity would remain low.	Effects to East Slope fish in streams and reservoirs would be similar to No Action, except there would be no impact in North St. Vrain Creek or St. Vrain Creek upstream of Lyons. Chimney Hollow would support a fishery similar to other Front Range reservoirs.	Similar to Proposed Action. Jasper East Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Similar to Proposed Action. Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.	Similar to Proposed Action. Dry Creek Reservoir would support a fishery similar to Chimney Hollow Reservoir Rockwell Reservoir would support a fishery, but large fluctuations in water levels may reduce productivity.
VEGETATION	No reasonably foreseeable land-based actions identified that would contribute to cumulative vegetation effects. Colorado River streamflow would decrease with anticipated reasonably foreseeable actions in the future. However, impacts to riparian vegetation from reduced flows on the Colorado River are expected to be negligible based on lack of impact to stream morphology, small changes in stream stage, and ground water levels. Similar minor effects are possible for lower flows in Willow Creek and higher flows in East Slope streams. Water levels would be lower at Granby Reservoir, Carter Lake, and Horsetooth Reservoir, but would fall within the historical range of operations and are unlikely to affect the limited riparian vegetation bordering these reservoirs.	Development of recreation facilities on Larimer County Chimney Hollow Open Space lands adjacent to reservoir would contribute a minor cumulative disturbance to vegetation in the Chimney Hollow basin. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Similar effects as the Proposed Action at Chimney Hollow. Planned residential development on a portion of a 980 acre parcel in the Jasper East Reservoir basin would add to the cumulative vegetation disturbance from reservoir construction. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Similar effects as the Proposed Action at Chimney Hollow. No reasonably foreseeable land-based actions were identified in the Rockwell Reservoir basin that would contribute to cumulative effects. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.	Development of Chimney Hollow open space to the north of Dry Creek Reservoir would contribute minor additional impacts to vegetation. Impacts to riparian vegetation would be similar to No Action although the decrease in Colorado River and Willow streamflow would be greater, as would the decrease in water levels in existing reservoirs.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
WETLANDS AND OTHER WATERS	No reasonably foreseeable land-based actions identified that would contribute to cumulative wetland effects.	Development of Chimney Hollow Open Space is unlikely to contribute cumulative effects to wetlands.	Wetland impacts from development of C-Lazy-U Preservers near Jasper East Reservoir could contribute to cumulative wetland impacts, but no specific impacts have been identified.	Similar to Proposed Action for Chimney Hollow Reservoir. No reasonably foreseeable land-based actions near Rockwell Reservoir were identified that would contribute to cumulative wetland effects.	Chimney Hollow Open Space development is unlikely to contribute cumulative wetland impacts with those from Dry Creek Reservoir construction. No reasonably foreseeable land-based actions near Rockwell Reservoir were identified that would contribute to cumulative wetland effects.
WILDLIFE	No reasonably foreseeable land-based actions identified that would contribute to cumulative wildlife effects.	Reasonably foreseeable land developments within 5 miles of Chimney Hollow Reservoir could result in the incremental loss of 1,440 acres of wildlife habitat for a total cumulative loss of 2,240 acres of wildlife habitat. Cumulative loss of elk winter range would be 866 acres, loss of mule deer winter range would be 2,090 acres, and loss of bald eagle winter range would be 1,382 acres.	Reasonably foreseeable land developments within 5 miles of Chimney Hollow Reservoir could result in a total cumulative loss of 2,115 acres of wildlife habitat. Cumulative loss of elk winter range would be 741 acres, loss of mule deer winter range would be 1,965 acres, and a similar amount of bald eagle winter range as the Proposed Action. Reasonably foreseeable land development within 5 miles of Jasper East Reservoir could result in the incremental loss of 2,570 acres of wildlife habitat for a total cumulative loss of about 3,005 acres of habitat. Cumulative loss of elk winter range would be 1,254 acres, loss of moose winter range would be 327 acres, and loss of bald eagle winter range would be 222 acres. A cumulative loss in sage grouse habitat is also likely, but unquantified.	Chimney Hollow effects would be the same as Alternative 3. Reasonably foreseeable land development within 5 miles of Rockwell East Reservoir could result in the incremental loss of 4,770 acres of wildlife habitat for a total cumulative loss of about 5,105 acres of habitat. Cumulative loss of elk winter range would be 3,173 acres. A cumulative loss of 740 acres of sage grouse habitat could result in the complete loss of this declining population.	Reasonably foreseeable land developments within 5 miles of Dry Creek Reservoir could result in the incremental loss of 1,460 acres of wildlife habitat for a total cumulative loss of 2,091 acres of wildlife habitat. Cumulative loss of elk winter range would be 682 acres, loss of mule deer winter range would be 1,934 acres, and loss of bald eagle winter range would be 1,574 acres. Reasonably foreseeable land development within 5 miles of Rockwell Reservoir could result in a total cumulative loss of about 5,196 acres of wildlife habitat. Cumulative loss of elk winter range would be 3,197 acres. A cumulative loss of 784 acres of sage grouse habitat could result in the complete loss of this declining population.
THREATENED AND ENDANGERED	No effect to threatened or endangered species. Future Windy Gap diversions to the Colorado River were incorporated in the Recovery Plan for endangered fish species; other future reasonably foreseeable water depletions would be subject to the Recovery Program requirements.	Same as No Action.	Same as No Action.	Same as No Action, but incremental effects to potential lynx habitat are possible with reasonably foreseeable future land development. This may affect, but is unlikely to adversely affect lynx.	Same as No Action, but incremental effects to potential lynx habitat are possible with reasonably foreseeable future land development. This may affect, but is unlikely to adversely affect lynx.
GEOLOGY	No reasonably foreseeable land-based actions identified that would contribute to cumulative geology effects.	Same as No Action.	Same as No Action.	Same as No Action.	Same as No Action.
SOILS	No reasonably foreseeable land-based actions identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative soil effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative soil effects.
AIR QUALITY	No reasonably foreseeable land-based actions identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative air quality effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative air quality effects.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
NOISE	No reasonably foreseeable land-based actions identified that would contribute to cumulative noise effects.	Recreation on Larimer County open space lands adjacent to Chimney Hollow would result in a minor long-term increase in noise.	Same as Proposed Action.	Same as Proposed Action.	No reasonably foreseeable land-based actions identified that would contribute to cumulative noise effects.
LAND USE	No reasonably foreseeable land-based actions identified that would contribute to cumulative land use effects.	Reasonably foreseeable residential land developments on 1,440 acres within 5 miles of the Chimney Hollow Reservoir site would contribute to the cumulative loss in undeveloped land use in the region. Larimer County development of Chimney Hollow Open Space would contribute to a cumulative increase in recreation based land use.	Similar to Proposed Action for Chimney Hollow. Future planned residential and commercial land development on 1,590 acres within 5 miles of Jasper East Reservoir would contribute to a possible cumulative loss in agricultural land use and a reduction in undeveloped open land.	Similar to Proposed Action for Chimney Hollow. Future planned residential, commercial, and mixed land development on 4,770 acres within 5 miles of Rockwell Reservoir would contribute to a possible cumulative loss in agricultural land use and a reduction in undeveloped open land.	Reasonably foreseeable residential land developments on 1,460 acres within 5 miles of the Dry Creek Reservoir site would contribute to the cumulative loss in undeveloped land in the region. Rockwell Reservoir land use effects would be similar to Alternative 4.
RECREATION **West Slope**	In the Big Gore Canyon of the Colorado River, there would be no change from existing conditions in the number of days that preferred rafting flows of 850 to 1,250 cfs occur for any of the alternatives in 13 years of the 47-year study period. Preferred rafting flows in Big Gore Canyon would occur about 40 days less compared to existing conditions over the 47-year study period. The greatest decrease in the number of days with preferred flows for rafting in the driest year would be 23 days. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would not change in 7 years of the 47-year study period for any of the alternatives. Over the 47-year study period, there would be about 190 fewer days of preferred kayaking flows compared to existing conditions. The greatest decrease in the number of days with preferred flows for kayaking in the driest year would be 56 days under all of the alternatives. There would be no change from existing conditions in the number of days when preferred rafting and kayaking flows in the Pumphouse reach are between 2,000 to 3,000 cfs in 21 years of the 47-year study period for any of the alternatives. Over the 47-year period, there would be 206 fewer days of preferred flows in this	In the Big Gore Canyon of the Colorado, there would be about 56 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The greatest decrease in the number of days with preferred flows for rafting in the driest year would be 31 days. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 207 days less over the 47 year study period compared to existing conditions. There would be about 190 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions. The greatest decrease in the number of days with preferred flows in the driest year would be 14 days. Granby Reservoir surface area would decrease 7% on average in the summer. Boat ramps would remain accessible except in average and dry years when water levels could drop below the Arapaho Bay and Stillwater boat ramps in May.	Similar to Alternative 5.	Similar to Alternative 5.	In the Big Gore Canyon of the Colorado, there would be about 62 days less within the preferred rafting flow range of 850 to 1,250 cfs over the 47 year study period. The greatest decrease in the number of days with preferred flows for rafting in the driest year would be 31 days. The number of days preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and the Pumphouse reach occur would be about 200 days less over the 47 year study period compared to existing conditions. There would be about 209 fewer days of preferred kayaking flows between 2,000 to 3,000 in the Pumphouse reach of the Colorado River over the 47-year period compared to existing conditions. The greatest decrease in the number of days with preferred flows in the driest year would be 14 days. Similar to the Proposed Action except: Granby Reservoir surface area during the summer would decrease less than 4% on average.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
RECREATION (CONT'D) **West Slope**	range. The greatest decrease in the number of days with preferred flows in the driest year would be 15 days. Recreation in Grand Lake and Shadow Mountain Reservoir would not be affected. Granby Reservoir surface area in the summer would decrease less than 3% on average, boat ramps would remain accessible, except in average and dry years when water levels could drop below the Arapaho Bay boat ramp in May.				
RECREATION **East Slope**	Kayaking opportunities in North St. Vrain Creek below Longmont Reservoir would be reduced in July when flows drop below 150 cfs. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. Recreation at Ralph Price Reservoir would be suspended for 2 years until construction is completed. Water surface area in Carter Lake and Horsetooth Reservoir would change little on average. Boat ramp access could be reduced in dry years.	No effect on North St. Vrain flows or kayaking. Increased flows in the Big Thompson River would maintain acceptable kayaking flows. Average monthly water surface area in Carter Lake would decrease less than 1% and Horsetooth surface area would decrease up to 4%. Water levels could drop below the South Bay-South boat ramp in September and in dry years access to several boat ramps could be affected. Larimer County development of open space at Chimney Hollow and on adjacent county lands would result in a cumulative increase in recreation opportunities in the area.	Same as Alternative 5.	Same as Alternative 5.	Similar to the Proposed Action except: Horsetooth Reservoir average monthly water surface area would decrease less than 2%.
CULTURAL RESOURCES	No reasonably foreseeable land-based actions identified that would contribute to cumulative cultural effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative cultural effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative cultural effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative cultural effects.	No reasonably foreseeable land-based actions identified that would contribute to cumulative cultural effects.
VISUAL RESOURCES	No reasonably foreseeable land-based actions identified that would contribute to cumulative visual quality effects. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 160 acres more than existing conditions. Small decreases in Carter Lake and Horsetooth Reservoir storage would not be noticeable.	Reasonably foreseeable land developments and development of Larimer County Chimney Hollow Open Space would result a cumulative change to the local landscape. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 348 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would be less than 72 acres on average in the summer.	Visual effects at Chimney Hollow would be similar to the Proposed Action. Reasonably foreseeable land developments near Jasper East Reservoir would result a cumulative change to the local landscape. Granby Reservoir, Carter Lake, and Horsetooth Reservoir effects similar to Alternative 5.	Visual effects at Chimney Hollow would be the same as Alternative 3. Reasonably foreseeable land developments near Rockwell Reservoir would result a cumulative change to the local landscape. Granby Reservoir, Carter Lake, and Horsetooth Reservoir effects similar to Alternative 5.	Reasonably foreseeable land developments near Dry Creek Reservoir would result a cumulative change to the local landscape. Cumulative visual effects of Rockwell Reservoir would be similar to Alternative 4. Lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 166 acres more than existing conditions. Small decreases in Carter Lake storage would not be noticeable. Exposed shoreline at Horsetooth Reservoir would be less than 25 acres on average in the summer.

Table 2-7 (cont'd). Comparison of cumulative effects by alternative.

Impact Topic	Alternative 1 No Action	Alternative 2 Proposed Action Chimney Hollow Reservoir	Alternative 3 Chimney Hollow Reservoir and Jasper East Reservoir	Alternative 4 Chimney Hollow Reservoir and Rockwell Reservoir	Alternative 5 Dry Creek Reservoir and Rockwell Reservoir
SOCIOECONOMICS	Hydrologic changes that reduce or increase the number of days that preferred flows for boating in the Colorado River occur, could impact recreation-associated spending. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $141,000 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would result in: a loss of about 900 user days for commercial rafting in Big Gore Canyon with a value of about $65,000; a loss of about 12,600 user days for kayaking in Big Gore Canyon and Pumphouse with a value of about $919,800; and a loss of 3.375 user days for rafting in Pumphouse with a value of about $246,000. Water deliveries to the East Slope would generate a net increase of about 15 GWH of hydropower energy with a production value of $850,000.	Future local land developments occurring during Chimney Hollow Reservoir construction would result in temporary cumulative increases in employment and income. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $143,000 per year. The economic effect for the driest modeled year when there is a decrease in the number of days in the preferred flow range, would result in: a loss of about 1,200 user days for commercial rafting in Big Gore Canyon with a value of about $88,000; a loss of 12,600 user days for kayaking in Big Gore Canyon and Pumphouse with a value of about $919,800; and loss of 3,150 user days for rafting in Pumphouse with a value of about $230,000. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.2 million.	Future local land developments occurring during Chimney Hollow Reservoir and Jasper East Reservoir construction would result in temporary cumulative increases in employment and income. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $147,000 per year. The economic effect for the driest modeled when there is a decrease in the number of days in the preferred flow range, would be the same as the Proposed Action. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.2 million.	Future local land developments occurring during Chimney Hollow Reservoir and Rockwell Reservoir construction would result in temporary cumulative increases in employment and income. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $147,000 per year. The economic effect for the driest modeled when there is a decrease in the number of days in the preferred flow range, would be the same as the Proposed Action. Water deliveries to the East Slope would generate a net increase of about 21 GWH of hydropower energy with a production value of $1.5 million.	Future local land developments occurring during Dry Creek Reservoir and Rockwell Reservoir construction would result in temporary cumulative increases in employment and income. The annualized net economic effect from a change in the number of preferred boating days (assuming a total loss of boating use) on the Colorado River would result in a decrease in recreation revenue of about $147,000 per year. The economic effect for the driest modeled when there is a decrease in the number of days in the preferred flow range, would be the same as the Proposed Action. Water deliveries to the East Slope would generate a net increase of about 25 GWH of hydropower energy with a production value of $1.4 million.

Chapter 3. Affected Environment and Environmental Consequences

Chimney Hollow Valley and Flatiron Penstock

3.1 Introduction

This chapter describes the affected environment and environmental consequences associated with each WGFP alternative. Section 3.2 provides an overview of the content of the affected environment section. Section 3.3 describes the process used to determine potential environmental effects. Section 3.4 discusses the East and West Slope area of potential effect or study area used in the evaluation of resource impacts. Section 3.5 to Section 3.22 present the affected environment and environmental effects for each resource of concern. Section 3.23 discuss the relationship between short-term uses and long-term productivity and Section 3.24 describes irreversible an irretrievable commitment of resources. Section 3.25 summarizes mitigation measures to reduce potential environmental effects.

3.2 Description of the Affected Environment

The affected environment section for each resource describes the existing conditions for the area of potential effect associated with each alternative. Information on the affected environment was collected from a variety of sources depending on the resource, but typically included field observations and data collection, published reports and studies, modeling, and personal contacts with agencies or individuals with expertise on the resource. The affected environment reflects any past activities that have affected the resource and that contributed to the current status of the resource. For this reason, the time periods presented for displaying historical conditions depends on-site-specific data available for each particular resource. The affected environment characterizes the existing conditions and provides a measure for comparing future changes to the resource from implementation of any alternative.

3.3 Determination of Environmental Effects

Potential environmental effects are identified for each alternative based on the analyses conducted for the EIS, review of relevant scientific literature, information from previous studies, and the best professional judgment of resource specialists. The effects analysis presents the scientific and analytical basis for comparison of alternatives.

Effects can be either beneficial or adverse and can be classified as direct or indirect (40 CFR 1508.8). Direct effects "are caused by the action and occur at the same place and time." Indirect effects "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." Cumulative effects are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The terms "effect" and "impact" have the same meaning and are used interchangeably.

Effects also can be characterized by the duration of the effect. Short-term effects include actions that temporarily affect a resource, such as vegetation disturbance during construction on lands that are later reclaimed and revegetated. Short-term effects for this project are defined as those effects occurring between the beginning of construction through completion of reclamation, or a total of about 5 years. Long-term effects include those actions that would affect a resource for the duration of the project, such as the change in land use from construction of a new reservoir. NEPA requires consideration of the relationship of short-term uses and long-term productivity for each resource. Both short-term and long-term effects are included in the discussion of resource effects in Section 3.23.

NEPA also requires discussion of any irreversible and irretrievable commitments of resources that would result from implementing the alternatives. These effects are summarized for each resource in Section 3.24.

The discussion of resources potentially affected by the alternative actions includes an evaluation of the issues identified during scoping at the beginning of the project as described in Section 1.9. Emphasis is given to resources of concern where adverse or beneficial effects are likely to occur. Less emphasis is given to resources where the effect is likely to be minor and/or short term. For some actions there would be no resource effects. For example, Western's action of removing and relocating the transmission line for alternatives that include Chimney Hollow Reservoir would not impact surface water, ground water, geology, aquatic life, water supply, agriculture, wetlands, or floodplains.

The methods and any assumptions used to evaluate effects are described for each resource. Effects are quantified where possible using measurement indicators pertinent to the specific resource, such as changes in the amount of streamflow, stream temperature, acres, and dollars for economic effects. Where applicable, effects are discussed in relation to regulatory standards or compliance with existing laws or commitments. Mitigation measures are identified where possible to avoid or reduce the effect of the action. A summary of unavoidable

> The effects analysis includes a comparison of resource impacts for each alternative. This includes a comparison of the Proposed Action and other action alternatives to the No Action alternative, as well as a comparison to existing conditions. Information is presented in this manner because the Corps is a cooperating agency and will use the information in their evaluation of the proposed project under the 404(b)(1) guidelines and 404 regulations. In that process the Corps will compare the effects of the proposed action against the existing conditions. For Reclamation purposes, action alternatives are compared to the No Action alternative for determining effects. For these reason, the information in this EIS is presented so the reader can compare the action alternatives to either the no action alternative or existing conditions.

adverse effects, even with implementation of mitigation measures, is included for each resource. NEPA requires disclosure of adverse and beneficial effects, but does not require that projects have no effect or no net effect.

For some resources and some locations, the effects are similar for all alternatives and the discussion of effects is consolidated to reduce repetition. Tables 2-6 and 2-7 in Chapter 2 summarize the resource direct and cumulative effects.

3.4 Area of Potential Effect

The area of potential effect—or study area—used in the description of the affected environment and in the evaluation of the environmental effects varies by alternative and resource. All alternatives include actions that result in effects on both the east and west sides of the Continental Divide. The West Slope study area includes areas where changes in streamflow, lake level, or water quality may occur, including Granby Reservoir and the Colorado River below Granby Reservoir to Gore Canyon below the confluence with the Blue River. Below Gore Canyon, the hydrologic effects of the alternatives diminish, and potential impacts to aquatic and other resources are less likely. Also included in the West Slope portion of the study area is Willow Creek below Willow Creek Reservoir. Potential effects to Grand Lake and Shadow Mountain Reservoir are limited primarily to water quality and aquatic resources because there would be no change in the water level of these reservoirs. Direct effects in the West Slope study area include the surface disturbance associated with construction of either Jasper East Reservoir or Rockwell Reservoir and the associated facilities.

On the East Slope, the study area includes areas with projected hydrologic changes, including portions of the Big Thompson River below Lake Estes, North St. Vrain Creek, St. Vrain Creek, Big Dry Creek, and Coal Creek. Downstream effects on the South Platte River from increases in streamflow are projected to be minimal; thus, the effects study area is limited to stream segments experiencing measurable change. Carter Lake and Horsetooth Reservoir are included in the study area because there would be a change in reservoir levels. The Chimney Hollow and Dry Creek reservoir sites are included in the East Slope study area along with the existing Ralph Price Reservoir included in the No Action alternative. The impacts associated with removal and relocation of 3.8 miles of Western's Estes Lyon 115-kV Transmission Line are included in all appropriate resource impact discussion for the alternatives that include the Chimney Hollow Reservoir.

3.5 Surface Water Hydrology

3.5.1 Affected Environment

3.5.1.1 Area of Potential Effect

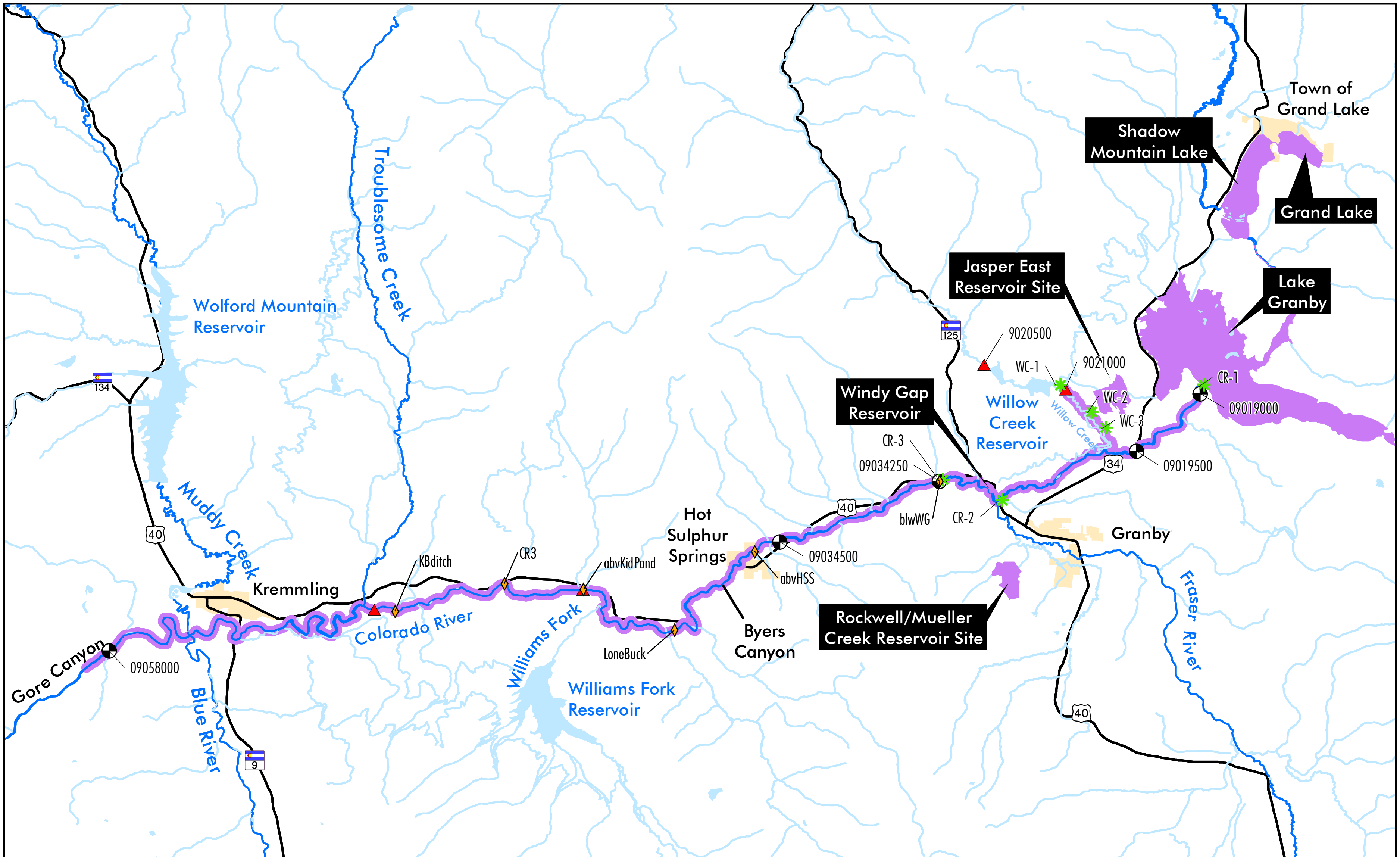
The area of potential effect used to describe hydrologic changes to streams and reservoirs comprises the Upper Colorado River basin on the West Slope where Windy Gap water is diverted (Figure 3-1) and affected tributaries on the East Slope in the South Platte River basin in northeast Colorado that receive Windy Gap water or WWTP return flow following use of Windy Gap water (Figure 3-2). Stream segments and lakes and reservoirs in the study area include:

West Slope

- Colorado River below Granby Reservoir to Gore Canyon
- Willow Creek below Willow Creek Reservoir
- Granby Reservoir
- Jasper East Reservoir
- Rockwell/Mueller Creek Reservoir

East Slope

- St. Vrain and North St. Vrain creeks
- Big Thompson River below Lake Estes
- Big Dry Creek
- Cache la Poudre River below Greeley WWTP
- Coal Creek
- Ralph Price Reservoir
- Carter Lake
- Horsetooth Reservoir
- Chimney Hollow Reservoir
- Dry Creek Reservoir



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- NCWCD Stream Gaging Station
- USGS Stream Gaging Station and Water Quality Monitoring Location
- NCWCD Water Quality Monitoring Location
- NCWCD 2007 Stream Temperature Measurement Site
- City
- Lake or Reservoir
- Study Area Reservoir
- Study Area Stream
- Major Streams
- Minor Streams
- Highway

0 2 4 Miles

1 Inch = 4 Miles

N

Figure 3-1
West Slope Water Resource Study Area

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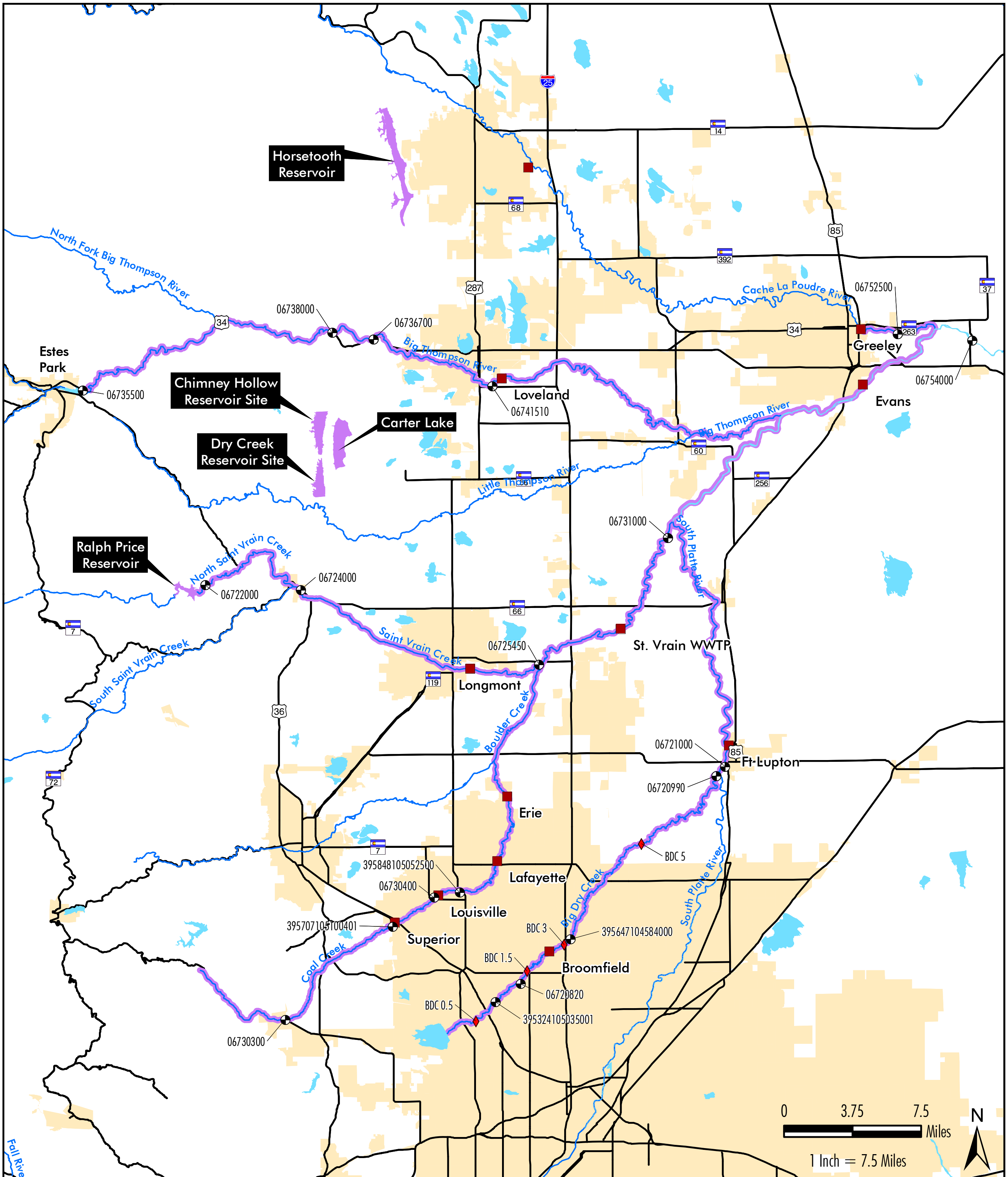
November 2007



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USGS Stream Gaging Station and Water Quality Monitoring Location

BDCWA Water Quality Monitoring Location

Waste Water Treatment Plant

Lake or Reservoir

Study Area Reservoir

Highway

Study Area Stream

Major Streams

City

Figure 3-2
East Slope Water Resource Study Area

Prepared for: Windy Gap Firming Project
File: 2390 EIS\WR_EastSlopeWaterResource.mxd (JP)
May 2008

Some lakes, reservoirs and stream segments within the study area would not be affected by alternative actions and are not discussed. Grand Lake, Shadow Mountain Reservoir, and Willow Creek Reservoir are part of C-BT's West Slope water collection and distribution system, but storage in these reservoirs would not change from existing conditions for any alternative. Operating criteria for Grand Lake and Shadow Mountain Reservoir require maintenance of stable water surface elevations in these reservoirs with fluctuations of less than 1 foot in accordance with Senate Document 80. The *Surface Water Quality* section addresses potential effects to Shadow Mountain Reservoir and Granby Reservoir from the passage of additional water through the system. Although potential new reservoirs would be located on ephemeral or intermittent streams, the existing downstream flows in these streams would be maintained by bypassing native flows. A substantial change in streamflow below new reservoirs would be unlikely, although seepage below dams could result in slightly increased flows and/or more consistent flow.

The downstream extent for resource evaluations on the West Slope is based on hydrologic changes under the alternatives. Colorado River average monthly flow changes, as a percentage of total streamflow, would be less than 10 percent downstream of the confluence with the Blue River due to gains from the contributing drainage basin and tributary inflow. Resource effects would likewise diminish downstream as flows increase and the percentage change from existing conditions decreases; thus, the study area for surface water hydrology does not extend below the Kremmling gage located downstream of the Blue River confluence. The Fraser River is not included in the study area because none of the alternatives would affect Fraser River flows.

Because Windy Gap water is fully consumable, most Participants intend to reuse Windy Gap effluent and return flows either through nonpotable reuse systems, as an exchange supply, as return flow credit, or as augmentation water. Thus, there would be little to no net effect on river flows if water is reused or is used to replace other diversions and depletions. Streams not expected to see a change in flow are the South Platte River from Evans' and Fort Lupton's wastewater treatment plants (WWTPs) because these cities intend to use their Windy Gap return flows for augmentation of depletions. Similarly, there would be no net change in Cache la Poudre River flows downstream of the City of Greeley WWTP because Greeley intends to use its Windy Gap return flows for augmentation of depletions and to offset return flow obligations. Other East Slope streams that would experience an increase in WWTP return flows are discussed.

3.5.1.2 Data Sources

Hydrologic data from the U.S. Geological Survey (USGS), NCWCD, Reclamation, Colorado Division of Water Resources, Denver Water Department, Colorado River Water Conservation District (CRWCD), the Upper Colorado River Basin Study, and WGFP Participants were used to describe existing conditions and estimate future conditions on affected streams and reservoirs. A computer model, described in Section 3.5.2.2, was used to project hydrologic changes for each alternative. Additional information on water resources is found in the Water Resources Technical Report (ERO and Boyle 2007).

3.5.1.3 Water Rights, Agreements, and Contracts

The WGFP would use the existing water right decrees and stipulations associated with the original Windy Gap Project constructed in 1985. The Windy Gap Project was awarded water right decrees for a total diversion of up to 600 cfs from the Colorado River (Case Nos. 88CW169 and 89CW298).

The water rights decrees include the "Agreement Concerning the Windy Gap Project and the Azure Reservoir and Power Project" dated April 30, 1980, entered into by the Municipal Subdistrict-NCWCD, and numerous West Slope parties, and the "Supplement to the Agreement of April 30, 1980" dated March 29, 1985, entered into by the Municipal Subdistrict-NCWCD, CRWCD, Northwest Colorado Council of Governments, Grand County Commissioners, and Middle Park Water Conservancy District. These agreements provide mitigation (described in Section 1.4.2.3) to West Slope entities from the transbasin diversion of water and associated impacts of the Windy Gap Project, and satisfy the Supreme Court ruling of September 14, 1979 that the conditional water right could not be granted until the Subdistrict formulated a plan to adequately mitigate any potential harm to prospective users within the upper Colorado River basin as specified in C.R.S. 37-45-118(1)(b)(IV). In return for these mitigation measures, West Slope interests agreed to withdraw objections to the Windy Gap Project conditional water right decrees and cooperate with all the necessary permitting requirements for construction of the project. The Subdistrict has fulfilled the short-term obligations under these agreements, and is continuing to operate the Windy Gap Project in accordance with the long-term obligations of these agreements and Colorado State law.

The Municipal Subdistrict-NCWCD entered into an "Amendatory Contract for the Introduction, Storage, Carriage and Delivery of Water for the Municipal Subdistrict, Northern Colorado Water Conservancy District, Colorado-Big Thompson Project, Colorado," Contract No. 4-07-70-W0107 (Carriage Contract) with the United States of America and the NCWCD on March 1, 1990. The Carriage Contract defines the rights and obligations of the Municipal Subdistrict-NCWCD with respect to the use of the facilities of the C-BT Project to introduce, store, carry, and deliver water diverted by the Windy Gap Project. An amendment to the Carriage Contract or an additional contract will be required to implement one or more of the action alternatives in the WGFP.

In January 2007, the Colorado State Engineer (SEO) (Simpson 2007) indicated that the Proposed Action to deliver and store water in Chimney Hollow Reservoir using prepositioning could be administered in compliance with current water right decrees and within the priority system. The SEO also indicated that if Jasper East or Rockwell/Mueller Creek reservoirs were selected for construction, a change in the water right would be required to store water in a new West Slope reservoir.

3.5.1.4 West Slope Surface Water Hydrology

Colorado River

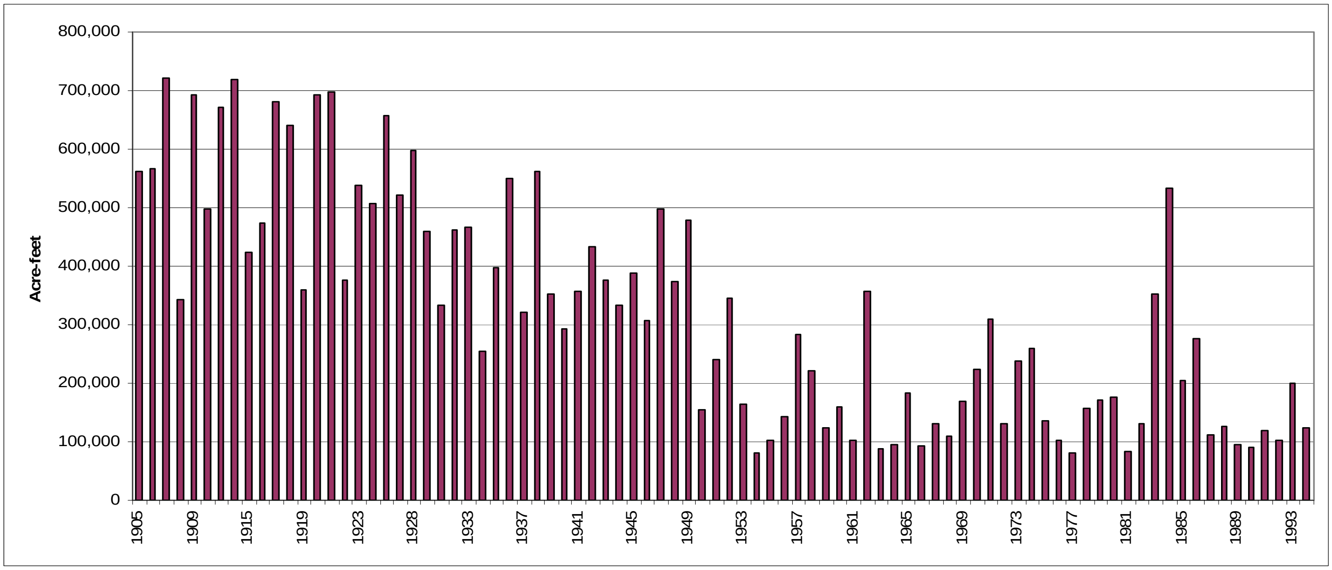
The Colorado River study area for the hydrologic analysis starts at the outlet from Granby Reservoir and ends at the USGS gage located below the confluence with the Blue River near Kremmling, at the upstream end of Gore Canyon (Figure 3-1). The distance from Granby Reservoir to Gore Canyon is about 44 river miles and the distance from the Windy Gap Reservoir diversion to Gore Canyon is about 35 river miles. The major lakes and storage reservoirs in the upper Colorado River watershed include Grand Lake, Shadow Mountain Reservoir, Granby Reservoir, Willow Creek Reservoir, Williams Fork Reservoir, and Wolford Mountain Reservoir (Figure 3-1).

Average annual streamflow in the Colorado River has changed over time as a result of increased water use in the basin and transmountain diversions as indicated by average annual historical flows at Hot Sulphur Springs (Figure 3-3). Primary water uses that have reduced Colorado River streamflow include the Denver Water Moffat Collection system, which began diversions from the Fraser River in 1937 and the C-BT Project, which included construction of Granby Reservoir and Shadow Mountain Reservoir in 1947. The Windy Gap Project began diversions from the Colorado River in 1985. Other developments in the upper Colorado River basin have included diversions for agricultural irrigation and municipal growth and development. Many of the irrigation diversions in Grand County and the Grand Ditch transbasin diversion began in the late 1800s. Average annual streamflow in the Colorado River at Hot Sulphur Springs between 1905 and 1949 was 486,209 AF and between 1950 and 1994 streamflow averaged 175,264 AF.

The Colorado River and its tributaries experience widely variable seasonal fluctuations in flows, with the largest flows resulting from snowmelt. Approximately 75 percent of the total annual flow occurs during the spring and early summer runoff period of May through mid-July. Average daily historical flow on the Colorado River at the Hot Sulphur gage for several time periods is shown in Figure 3-4. Average daily flow in the Colorado has decreased since about 1950 as the result of the C-BT Project, the Moffat Collection System, the Windy Gap Project, and other water development in the basin.

Upper Colorado River streamflow is influenced by operation of Granby Reservoir. Completed in 1951, spills from Granby Reservoir have occurred historically from February through October, with the

Figure 3-3. Colorado River average annual flow at Hot Sulphur Springs, 1904 to 1994.

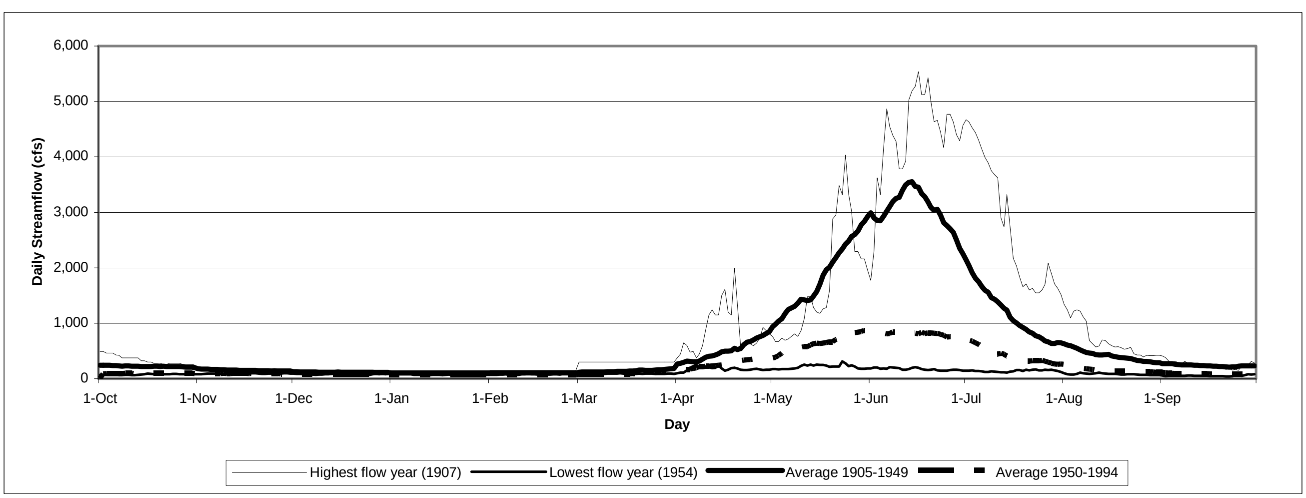


largest spills occurring in May and June (Reclamation 2006).

The U.S. Department of the Interior developed the Principles to Govern the Release of Water at Granby Reservoir Dam to provide Fishery Flows immediately downstream in the Colorado River (Secretarial Decision Document 1961). The Principles were developed "to preserve at all times that section of the Colorado River between the reservoir to be constructed near Granby Reservoir and the mouth of the Fraser River as a live stream, and also to insure an adequate supply for irrigation, for sanitary purposes, for the preservation of scenic attractions, and for the preservation of fish life." The schedule of releases from Granby Reservoir is: 20 cubic feet per second (cfs) from September through April; 75 cfs from May through July; and 40 cfs in August. The bypass flow requirement may be reduced from May through September when the advanced forecast of inflow to the Three Lakes System and Willow Creek Reservoir is less than 230,000 AF (Boyle 2003, 2006a). Bypass flows were estimated to be reduced by 15 to 30 percent (as stipulated) for a portion of the period from May through August in 15 years between 1950 and 1996.

A Memorandum of Understanding (Azure Settlement Agreement, June 23, 1980) between the Municipal Subdistrict, NCWCD, and CDOW

Figure 3-4. Colorado River average daily flow at Hot Sulphur Springs, 1904 to 1994.



established instream flow requirements on the 24-mile reach of the Colorado River downstream of the Windy Gap diversion to the mouth of the Blue River to support the fishery. These instream flow requirements and a periodic flushing flow include:

- From the Windy Gap diversion point to the mouth of the Williams Fork River, 90 cfs
- From the mouth of the Williams Fork River to the mouth of Troublesome Creek, 135 cfs
- From the mouth of Troublesome Creek to the mouth of the Blue River, 150 cfs
- If equivalent flows do not otherwise occur, a flushing flow release from Windy Gap Reservoir of 450 cfs for 50 consecutive hours must occur once every 3 years within the months of April, May, or June

A number of existing tunnels, canals, and pipelines and diversions occur on the upper Colorado River and its tributaries. Several of these transport water from the Colorado River basin to the East Slope. Information on water diversions was taken from the Colorado Division of Water Resources CDSS database (Boyle and Riverside 2000). Several of the larger diversions include:

In-Basin Direct Flow Water Users

- Public Service Company's Shoshone Hydropower right, which began in 1905, with a decreed right for 1,408 cfs
- Grand County water users, most of whom began diverting water from the Fraser River, Colorado River, and Willow Creek in the early to mid-1900s, with a net absolute right for about 527 cfs on these three streams
- Numerous diversions and water storage rights on the Williams Fork River, Muddy Creek, and Blue River, most of which began diverting water in the early to mid-1900s, with a net absolute right for about 2,400 cfs

Transbasin Water Users

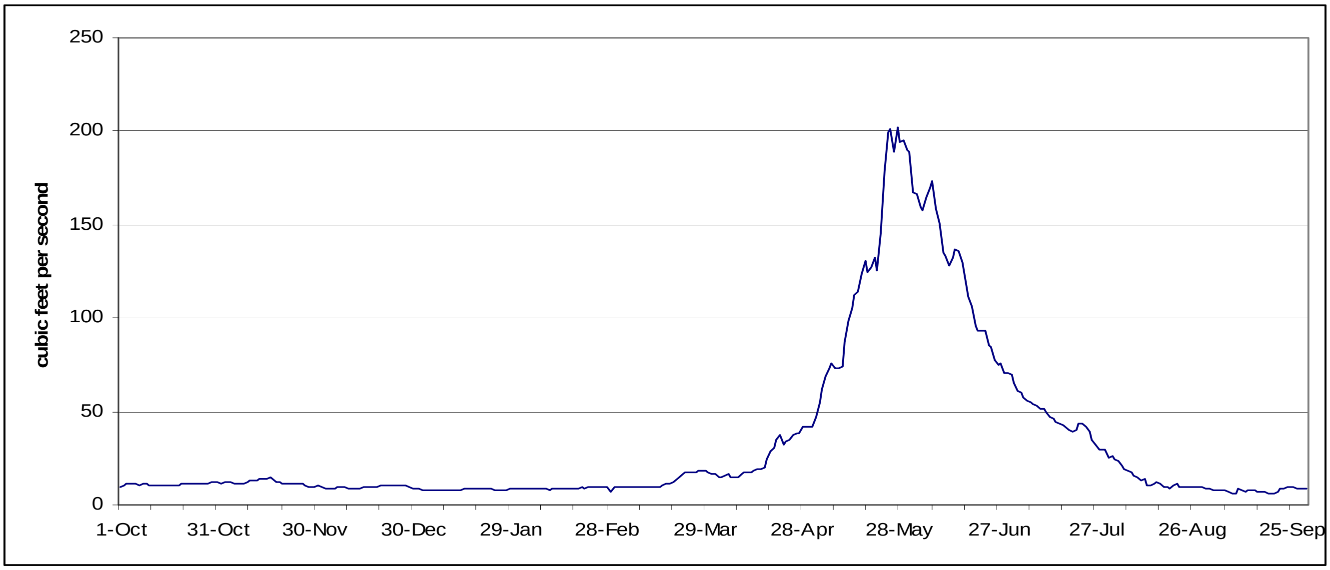
- Grand Ditch, which began diverting in 1890, with a net absolute right for 524.6 cfs
- The C-BT Project, which began diverting water in 1947, with decreed rights of 550 cfs at the Adams Tunnel, 1,100 cfs at Granby Pump Canal, and 400 cfs for the Willow Creek Feeder Canal
- Denver Water, which began diverting water from the Fraser River in 1937 via the Moffat Tunnel, with a net absolute right for 928 cfs and a net conditional right for 352 cfs
- Windy Gap, which began diverting water in 1985, with a decreed diversion right of 600 cfs

Windy Gap Project water is diverted from the Colorado River at Windy Gap Reservoir and pumped to Granby Reservoir for storage and delivery to the East Slope via the Adams Tunnel as needed (Figure 3-1). Since Windy Gap diversions began in 1985, no water was diverted in 1986, 1996 through 2000, and 2002, and diversions occurred for only two days in 2004 because either the water rights were not in priority in dry years, or there was no storage capacity available in Granby Reservoir in wet years. About 95 percent of past Windy Gap diversions occurred in May and June. The maximum Windy Gap diversion rate is 600 cfs. The greatest annual Windy Gap diversion to date was 64,200 AF in 2003, of which 90 percent of the water was diverted in May and June. The original Windy Gap Project provided for average annual diversions of 56,000 AF, with a maximum single year diversion of 90,000 AF/year and a maximum of 650,000 AF during any consecutive 10-year period. Per the 1980 Azure Settlement Agreement, these diversion limitations apply to deliveries through the Adams Tunnel, as opposed to diversions at Windy Gap Reservoir.

Willow Creek

Willow Creek is a tributary that enters the Colorado River about 4 miles below Granby Reservoir (Figure 3-1). The flow of lower Willow Creek is regulated by Willow Creek Reservoir, from which about 30,000 AF of water is diverted annually to Granby Reservoir via the Willow Creek Feeder Canal (WCFC) as part of the C-BT Project. Average daily flows in Willow Creek below Willow Creek Reservoir at the gage about 2.5 miles above the Colorado River confluence is shown in Figure 3-5. Four ditches divert up to about 36 cfs of water annually from Willow Creek below the reservoir. There is a Colorado Water Conservation Board (CWCB) instream flow requirement of 7 cfs, during the nonirrigation season, for Willow Creek below Willow Creek Reservoir. However, NCWCD's current operations result in the release or bypass of

Figure 3-5. Willow Creek average daily flow, 1953 to 2004.



at least 7 cfs below the reservoir from May 1 through September 30 to maintain a "live" stream in Willow Creek.

Granby Reservoir

With a surface area of about 7,300 acres, Granby Reservoir is the second largest reservoir in Colorado and serves as the primary storage reservoir in the C-BT system (Figure 3-1). Major tributaries flowing into the reservoir are Arapaho Creek, Stillwater Creek, Columbine Creek, and the Roaring Fork River. Water also is pumped to the reservoir from Willow Creek Reservoir and Windy Gap Reservoir. Granby Reservoir is currently the only C-BT reservoir in which Windy Gap water can be stored. Outflow is either through spills or releases to the Colorado River or to Shadow Mountain Reservoir via the Farr Pumping Plant and Granby Pump Canal and eventually through the Adams Tunnel to the East Slope. The surface water elevation of the lake can vary considerably depending on precipitation and operations (Figure 3-6).

Jasper East Study Area

The Jasper East Reservoir site contains an unnamed intermittent stream tributary to Church Creek, which is tributary to Willow Creek (Figure 3-1). Precipitation and snowmelt are the main sources of water supply in the 960-acre watershed, but natural flows are supplemented by irrigation return flow and seepage from the Willow Creek Pump Canal and forebay. No historical gage flow data for this drainage is available.

Rockwell/Mueller Creek Study Area

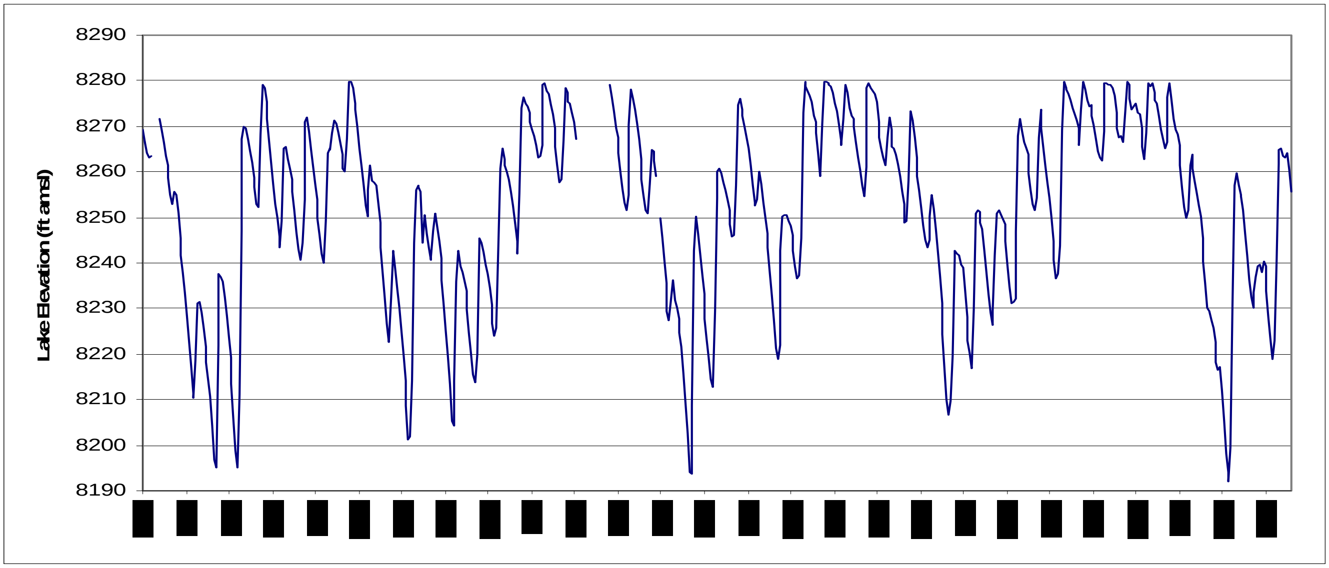
Rockwell and Mueller creeks flow intermittently through the Rockwell/Mueller Creek Reservoir site (Rockwell) (Figure 3-1). Precipitation and snowmelt are the main sources of water supply to these creeks in this 1,360-acre watershed. No historical gage flow data for either stream is available.

3.5.1.5 East Slope Surface Water Hydrology

North St. Vrain Creek and St. Vrain Creek

North St. Vrain and St. Vrain creeks are perennial streams with headwaters at the Continental Divide (Figure 3-7). Streamflow typically peaks in June from snowmelt runoff. North St. Vrain Creek flow is influenced by releases from Ralph Price Reservoir, diversions by the City of Longmont at Longmont Reservoir, and diversions by others downstream of these reservoirs. City diversions average about 6 to 7 cfs during November to March and 10 to 20 cfs during other months. Longmont voluntarily bypasses up to 8 cfs below Ralph Price Reservoir and there is a junior CWCB 21 cfs minimum streamflow for all of North St. Vrain Creek (CDWR 2007). St. Vrain Creek begins at the confluence of North and South St. Vrain creeks near

Figure 3-6. Granby Reservoir historical elevations, 1953 to 2006.



the Town of Lyons and flows about 40 miles to its confluence with the South Platte River.

Big Thompson River

The Big Thompson River, a large tributary to the South Platte River, is a perennial stream about 75 miles long, with headwaters in Rocky Mountain National Park (Figure 3-2). The C-BT Project diverts Big Thompson River water at Lake Estes via the Olympus Tunnel and at Dille Tunnel near the canyon mouth for power generation and returns the water to the Big Thompson River at the Big Thompson Power Plant. The C-BT Project also diverts Big Thompson River water under its direct flow water rights at Olympus and Dille Tunnels for storage in Carter Lake and Horsetooth Reservoir.

Coal Creek and Big Dry Creek

Coal Creek is a small perennial stream with a watershed that flows from the Continental Divide east through the communities of Superior, Louisville, Lafayette and Erie. Coal Creek is tributary to Boulder Creek (Figure 3-2). Big Dry Creek, a small perennial stream about 25 miles long, begins in the foothills west of Rocky Flats and flows northeast to its confluence with the South Platte River. Both these creeks receive wastewater discharges from several WGFP Participants.

Chimney Hollow

Chimney Hollow is a small, intermittent stream located in a 3,000-acre watershed (Figure 3-2). Several ephemeral drainages, some of which contain springs and seeps, flow into Chimney Hollow. Chimney Hollow flows into Flatiron Reservoir, which is part of the C-BT Project distribution system. There is no historical gage flow data for Chimney Hollow Creek.

Dry Creek

Dry Creek is a small stream with intermittent flow in a 2,530-acre watershed (Figure 3-2). Seeps and springs, as well as rainfall and snowmelt, contribute to streamflow. Dry Creek is a tributary to the Little Thompson River. No historical gage flow data for Dry Creek is available.

Ralph Price Reservoir

Ralph Price Reservoir is the primary water supply for the City of Longmont (Figure 3-2). The reservoir stores water from North St. Vrain Creek. The 227-acre reservoir is operated so that it is typically full from June until October. The storage contents then drop to about 75 percent of capacity by March and the reservoir refills during spring runoff.

Carter Lake

Carter Lake is a 1,110-acre reservoir owned by Reclamation and operated and maintained by the NCWCD as part of the C-BT Project (Figure 3-2). The reservoir supplies water to various Front Range and eastern plains cities and water districts, and the agricultural community in Boulder, Larimer, and Weld counties. Water for the reservoir is supplied

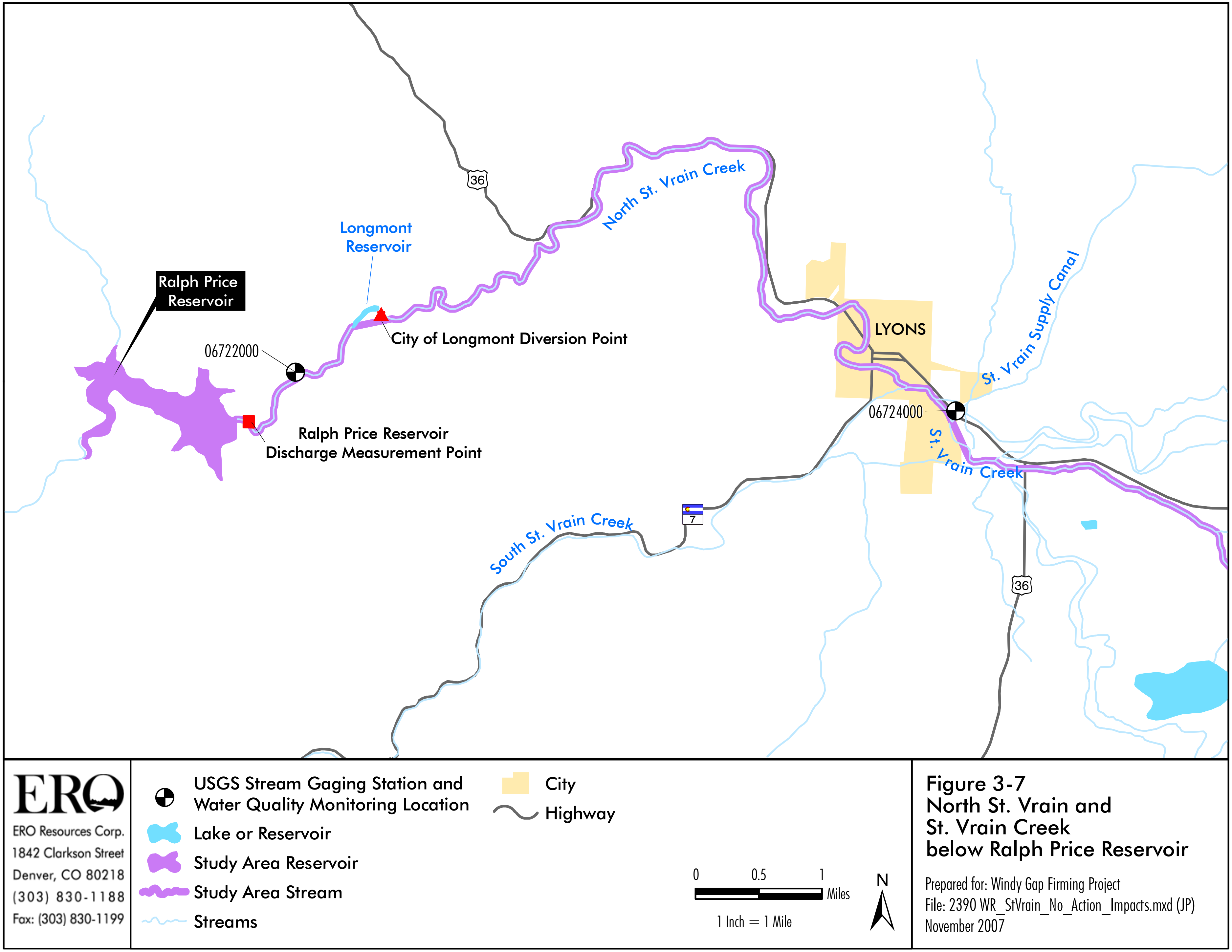


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Figure 3-7
North St. Vrain and St. Vrain Creek below Ralph Price Reservoir

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November 2007

by transmountain diversions from the Upper Colorado River and the Big Thompson River. C-BT and Windy Gap water is delivered to Carter Lake by pumping water from Flatiron Reservoir. Reservoir deliveries to C-BT and Windy Gap unit holders occur via the St. Vrain Supply Canal and the Southern Water Supply Pipeline.

Horsetooth Reservoir

Horsetooth Reservoir supplies water to the City of Fort Collins and the City of Greeley, as well as several other smaller cities, water districts, rural domestic suppliers, industries, and the agricultural community in the Poudre River basin (Figure 3-2). Horsetooth Reservoir is owned by Reclamation and is operated and maintained by the NCWCD as part of the C-BT Project. Transmountain water from the West Slope and Big Thompson River is delivered to Horsetooth Reservoir via the Hansen Feeder Canal. The main outlet is through Horsetooth Dam to the Poudre River via the Hansen Supply Canal.

3.5.1.6 Hydropower Generation

The C-BT Project includes six hydroelectric power generation facilities. All of the facilities are located on the East Slope except the Green Mountain Power Plant, which is below Green Mountain Reservoir on the Blue River. The five power plants on the East Slope generate power as water is conveyed from Grand Lake via the Adams Tunnel and multiple pipelines, siphons, tunnels, forebays, and afterbays. The Marys Lake Powerplant south of Estes Park is the first East Slope facility and has a generating capacity of about 8.1 megawatts (MW). From here water is delivered through the Prospect Mountain Conduit and Tunnel to the Estes Powerplant on Lake Estes. The Estes Powerplant has a generating capacity of 45 MW. Water from Lakes Estes is released through the Olympus Siphon and Tunnel and Pole Hill Tunnel and Canal to the Pole Hill Powerplant which has a capacity of 33.3 MW. Water in the Big Thompson River is also used to generate power at the Big Thompson Power Plant located about 9 miles west of Loveland. This facility has a generating capacity of 4.5 MW. From the Pole Hill Power Plant, water is conveyed to the Flatiron Power Plant located near Carter Lake. The Flatiron facility has a generating capacity of 71.5 MW.

The power produced by C-BT operations is distributed and marketed by the Department of Energy's Western Area Power Administration (Western). Western sells power in Colorado, Wyoming, eastern Nebraska and northeastern Kansas to wholesale customers such as towns, rural electric cooperatives, and irrigation districts.

3.5.2 Environmental Effects

3.5.2.1 Issues

Water resource issues identified during scoping were the potential impact to the Colorado River, Fraser River, and South Platte River basins from alterations in the quantity and timing of flows. Concerns were expressed on the effect to instream flows, water rights, and the amount of water remaining on the West Slope. Potential changes in water levels and the operation of existing reservoirs and any new reservoirs was expressed as a concern. Other issues included the ability of the WGFP to meet projected yields and whether there would be a change in the operation of West Slope reservoirs.

3.5.2.2 Method for Effects Analysis

A water allocation computer model was used to analyze the WGFP alternatives and to estimate the amount of Windy Gap water that could reliably be delivered. Two models were used—the Boyle Engineering Stream Simulation Model (BESTSM) was used in conjunction with the Upper Colorado Water Resource Planning Model from the Colorado Decision Support System (CDSS Model). BESTSM focuses on East Slope facilities and operations and the CDSS Model focuses on the representation of the Colorado River basin. A brief discussion on model operation is given below, but more detailed information on the model configuration, parameters, and assumptions is found in the Windy Gap Firming Project Modeling Report, the Addendum to the WGFP Modeling Report, and the WGFP Water Resources Technical Report (Boyle 2003, 2006a; ERO and Boyle 2007).

A model study period of 1950 to 1996 was used. The 46-year study period contains a mixture of dry years, wet years, and average years reflective of the range of historical hydrologic conditions. The study period includes the operation of the C-BT Project, which was in full operation by 1954. The study period ends in 1996 because at the time the model was developed, CDSS Model data were only available to this date. Extension of the model period to 2002, which was an extreme drought year, was evaluated, but the WGFP alternatives do not impact flows in severe drought years like 2002 because Windy Gap water rights would not be in priority. The addition of a WGFP reservoir would not change Windy Gap diversions in a dry year.

Three model configurations—historical, baseline, and future conditions—were developed. The historical model configuration was used to calibrate the model and accurately simulate C-BT and Windy Gap operations under historical conditions. The baseline model configuration was then used to analyze the effects of each alternative and make comparisons to existing conditions. The future conditions model configuration evaluated reasonably foreseeable actions for the cumulative effects analysis.

The model was used to estimate streamflow and stream stage for the Colorado River, Willow Creek, and Big Thompson River below Lake Estes to the Thompson Feeder Canal. The model also was used to estimate reservoir volumes, surface area, and elevation for Granby Reservoir, Carter Lake, and Horsetooth Reservoir. Similar reservoir data were generated for potential new reservoirs. The model operates on a monthly time step for the entire study period. Monthly data were then disaggregated to daily values based on historical USGS records (Boyle 2005c), although a modified approach was needed to disaggregate monthly flows below Granby Reservoir in spill months because of the variability in the amount, timing, and duration of spills. Appendix A includes hydrologic model output and comparisons of changes in streamflow, stream stage, reservoir elevation and area, and other parameters for each of the alternatives.

A separate analysis was used to estimate changes in streamflow for East Slope streams, including North St. Vrain and St. Vrain creeks for the No Action alternative and other streams for all alternatives that are expected to receive additional flows below WWTPs. Projected streamflow changes to North St. Vrain and upper St. Vrain Creek were based on historical releases from Ralph Price Reservoir, projected exchanges of Windy Gap water from the St. Vrain Supply Canal to Ralph Price Reservoir, and the City of Longmont's projected Windy Gap water demand and associated releases from Ralph Price Reservoir (ERO and Boyle 2007). For streams with a projected increase in WWTPs return flow from additional Windy Gap water use, including the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek, estimates were made of the average and maximum streamflow increases likely to occur below WGFP Participant WWTP locations (Boyle 2006b). Should Windy Gap Participants change their share of storage in a new reservoir as described in Chapter 1, Section 1.8.2, the amount of return flow to the various East Slope streams below WWTPs could vary slightly from the values used in this analysis.

3.5.2.3 Facilities and Stream Segments Affected by Windy Gap Operations

Windy Gap Project water is diverted from the Colorado River just downstream of the confluence with the Fraser River at Windy Gap Reservoir. Once diverted, it is pumped to Granby Reservoir for storage. Upon introduction into the C-BT system, Windy Gap diversions are subject to a 10 percent "diversion shrink" per the existing Carriage Contract between the Subdistrict and Reclamation, with the shrink amount credited to the C-BT Project. Similarly, each year at the end of March, a 10 percent carryover shrink is assessed on any Windy Gap water remaining in Granby Reservoir, with the shrink amount being stored in the Granby Reservoir C-BT account. C-BT may receive additional shrink credit under the alternatives, due to increased Windy Gap diversions, as well as reintroduction shrink with East Slope storage alternatives; however, C-BT may receive less carryover shrink because the WGFP Participants would store the majority of their Windy Gap water in new firming reservoirs as opposed to Granby Reservoir.

Windy Gap water in Granby Reservoir is delivered to the East Slope via "instantaneous delivery," which involves an exchange for C-BT water. As specified in the Carriage Contract, instantaneous delivery involves a C-BT release from Carter Lake or Horsetooth Reservoir in exchange for Windy Gap water stored in Granby Reservoir. Granby Reservoir is currently the only long-term storage facility for

Windy Gap water prior to delivery to Participants. However, under the alternatives, Windy Gap water also would be delivered to a firming project reservoir outside the C-BT system for storage.

Windy Gap diversions and operations affect the C-BT Project because C-BT facilities are used for the storage and conveyance of Windy Gap water and both C-BT and Windy Gap water is stored in Granby Reservoir. Windy Gap diversions and operations also affect flows in the Colorado River below Granby Reservoir, Willow Creek, St. Vrain Creek, Big Thompson River, and several East Slope rivers that receive Participants' WWTP return flows. The sections below provide an overview of the various facilities and stream segments with projected changes in flow and the reasons for changes under the No Action and action alternatives.

Colorado River below Granby Reservoir

Flows in the Colorado River below Granby Reservoir are a function of instream flow requirements and Granby Reservoir spills. Storage of Windy Gap water in Granby Reservoir would vary for each alternative, resulting in differences in the spill of Windy Gap water. Differences in Granby Reservoir spills under the various alternatives would occur because of variations in Windy Gap operations, including the amount of shrink paid to the C-BT Project due to Windy Gap diversions and carryover storage, instantaneous deliveries, and prepositioning of water under the Proposed Action. For example, variations in the amount of shrink paid to the C-BT Project would affect C-BT contents in Granby Reservoir and consequently the timing and amount of C-BT spills.

Colorado River flows below Windy Gap Reservoir also would be affected by differences in Windy Gap diversions among the alternatives. With firming storage, Windy Gap diversions would primarily be higher in wet years because more water is available and additional storage capacity typically would be available. Under existing conditions, there is no conveyance or storage capacity in the C-BT system for Windy Gap water when Granby Reservoir fills. Therefore, under existing conditions and the No Action alternative, Windy Gap diversions would be limited or curtailed in most wet years.

Willow Creek

The C-BT Project diverts water from Willow Creek for delivery to Granby Reservoir via the Willow Creek Feeder Canal (WCFC). Although WCFC diversions are a C-BT Project operation, they can be affected by Windy Gap diversions and operations. When space in Granby Reservoir is not a limiting factor on the amount that can be diverted from Willow Creek, there would be no difference in WCFC diversions or Willow Creek flows among the alternatives. However, when Granby Reservoir fills, differences in WCFC diversions can occur. C-BT operations take precedence over Windy Gap Project operations; therefore, the first water spilled from Granby Reservoir is Windy Gap. Instead of pumping water from Willow Creek to force Windy Gap water to spill, Windy Gap water in Granby Reservoir is exchanged with C-BT water in Willow Creek Reservoir. This results in a spill of Windy Gap water from Willow Creek Reservoir. The amount of Windy Gap water exchanged to Willow Creek Reservoir is the lesser of the amount of Windy Gap water in Granby Reservoir or the amount that can be physically and legally pumped from Willow Creek. The degree to which WCFC diversions would be different among the alternatives is a function of Windy Gap storage in Granby Reservoir and the amount of Windy Gap water exchanged to C-BT in place of WCFC diversions.

Differences in WCFC diversions among the alternatives also could occur due to differences in Granby Reservoir C-BT contents. Differences in C-BT contents in Granby Reservoir among the alternatives would occur primarily from differences in Windy Gap diversions and the shrink paid to the C-BT Project, prepositioning, and instantaneous deliveries. C-BT water diverted from the Colorado River for storage in Granby Reservoir takes priority over pumping from Willow Creek. As such, WCFC diversions depend on both C-BT and Windy Gap contents in Granby.

North St. Vrain and St. Vrain Creek

Changes in St. Vrain Creek flows due to Windy Gap operations would occur only under the No Action alternative. Longmont's Windy Gap water would be released to St. Vrain Creek via the St. Vrain Supply Canal out of Carter Lake and exchanged upstream to the enlarged Ralph Price Reservoir. This operation would affect flows in the North St. Vrain Creek below Ralph Price Reservoir and in St. Vrain Creek to the intersection with the St. Vrain Supply Canal. Windy Gap deliveries to Longmont would be conveyed using existing infrastructure.

Big Thompson River

The C-BT Project diverts water under direct flow water rights from the Big Thompson River at the Olympus and Dille Tunnels for storage in Carter Lake and Horsetooth Reservoir. The C-BT Project also diverts water from the Big Thompson River for power generation. These power diversions are referred to as "skim diversions" because the water is returned to the Big Thompson River at the Big Thompson Power Plant. C-BT deliveries to Chimney Hollow under the Proposed Action and instantaneous C-BT deliveries to meet Windy Gap demands affect the available capacity in Olympus Tunnel, Carter Lake, and Horsetooth Reservoir, which in turn affect C-BT diversions from the Big Thompson River. Small changes in the flow of the Big Thompson River below Lake Estes (below the Olympus and Dille Tunnels) would occur under all alternatives due to differences in C-BT diversions from the Big Thompson River for power generation.

Other East Slope Streams

With a WGFP online, use of Windy Gap water would increase and, as a result, there would be additional return flows to East Slope streams (Big Dry Creek, Big Thompson River, Coal Creek and St. Vrain Creek) within the South Platte River watershed attributable to indoor and outdoor use of Windy Gap water. Additional Windy Gap return flows attributable to indoor use would occur primarily at Participants' WWTPs. Additional Windy Gap return flows attributable to outdoor irrigation use would occur at various locations throughout the Participants' service areas.

C-BT Deliveries

C-BT Project demands and deliveries would not change as a result of implementation of any of the WGFP alternatives. C-BT deliveries would continue to meet demands without any shortages under all alternatives and the amount of C-BT water delivered would not exceed current amounts. The WGFP would be able to continue use of C-BT facilities for the storage and delivery of Windy Gap water; however, Windy Gap operations cannot negatively impact C-BT Project operations or delivery. The WGFP is intended to use excess capacity in the C-BT System.

Loss of C-BT Water from Reservoir Evaporation

Evaporative losses charged to the C-BT Project from the major C-BT reservoirs would decrease less than 2 percent under the WGFP alternatives due to changes in operations under the alternatives. Less Windy Gap water would be stored in Granby Reservoir under the alternatives and more Windy Gap water would be stored in the WGFP reservoirs. As a result, the total evaporative losses charged to C-BT in Granby Reservoir would be lower.

Due to the integrated operations of the Three Lakes system, evaporative losses at Granby Reservoir, Shadow Mountain, and Grand Lake are replaced by C-BT diversions to storage and the Windy Gap shrink paid to the C-BT Project. The 10 percent diversion shrink and 10 percent carryover shrink paid by the WGFP to the C-BT Project are intended to offset evaporation and conveyance losses due to the introduction, storage, and delivery of Windy Gap water. Therefore, evaporative losses in all C-BT reservoirs are charged to the C-BT Project regardless of the Windy Gap contents in that facility. Evaporation losses in potential new Windy Gap reservoirs would be allocated pro rata to each account in the reservoir based on the amount stored in each account. There would be no change in evaporative losses under any alternative for Willow Creek Reservoir, Shadow Mountain Reservoir, or Grand Lake. Long-term storage of C-BT water in Chimney Hollow Reservoir would only occur under the Proposed Action. C-BT water could reside in Chimney Hollow or Dry Creek reservoirs under Alternative 3, 4, or 5 for short periods due to reintroduction shrink; however, the amount stored would be small and the associated evaporative losses minimal.

C-BT and Windy Gap Spills from Granby Reservoir

Spills from Granby Reservoir would change under all alternatives. Compared to existing conditions, C-BT spills from Granby Reservoir under all alternatives would change little over the long term; however, Windy Gap spills would be reduced substantially, particularly under the Proposed Action (Table 3-1). Windy Gap spills in Table 3-1 include the spill of Windy Gap water from Willow Creek

Reservoir. Windy Gap water is exchanged with C-BT water in Willow Creek Reservoir and spilled instead of pumping C-BT water to Granby Reservoir and spilling Windy Gap water from Granby Reservoir. Actual Granby Reservoir spills may vary from model predictions because preemptive releases early in the year could be used in anticipation of future spills which would change the timing and amount of releases.

Table 3-1. Modeled average annual C-BT and Windy Gap spills for existing conditions and the alternatives.

Alternative	C-BT Spills	Windy Gap Spills	Total Spills
	AF		
Existing Conditions	23,712	17,331	41,042
Alt 1 – No Action	23,083	13,471	36,554
Alt 2 – Proposed Action	24,180	5,042	29,222
Alt 3	22,981	8,460	31,440
Alt 4	22,988	8,472	31,460
Alt 5	22,832	8,529	31,361

3.5.2.4 Summary Comparison of Hydrologic Changes

Model simulations were developed to compare hydrologic changes at various locations for each alternative. A summary of annual changes in flow for the study period (1950 to 1996) at key locations on the Colorado River within C-BT system facilities and the Big Thompson River is shown in Table 3-2, Table 3-3, and Table 3-4. These summary tables present flow conditions under average, dry, and wet year conditions. Average values include the entire 46-year period of record. Dry and wet year averages are defined as the average of the five wettest and five driest years in the study period. The five driest years were 1954, 1966, 1977, 1981, and 1989 and the five wettest years were 1957, 1983, 1984, 1986, and 1995, based on the estimated virgin flow below Granby Reservoir.

The following sections provide additional detailed discussion comparing the projected changes in hydrologic conditions under each alternative.

3.5.2.5 C-BT and Windy Gap Project Operations and Diversions

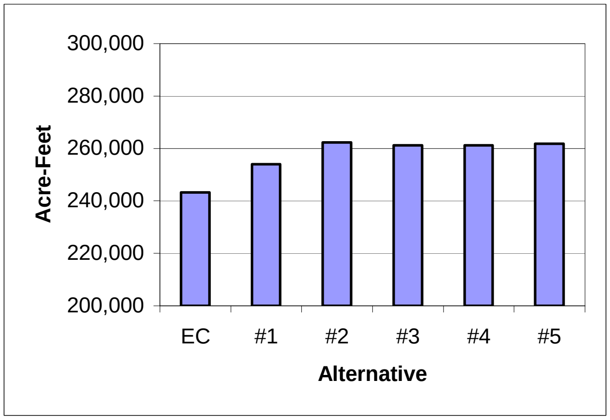
Adams Tunnel Diversions

Adams Tunnel deliveries include both C-BT and Windy Gap water and are made based on water demand on the East Slope. The tunnel diversions to the East Slope include C-BT deliveries to Carter Lake, Horsetooth Reservoir, and to meet C-BT demands, above Flatiron Reservoir and along the Big Thompson River. In addition, because Windy Gap deliveries are made via instantaneous delivery, they are reflected as C-BT deliveries through the tunnel to replace corresponding releases made from Carter Lake or Horsetooth Reservoir. Windy Gap diversions from the Colorado River either go to Granby Reservoir under the Proposed Action or to Granby Reservoir and one of the new West Slope reservoirs under the other action alternatives. Windy Gap water would be moved to new East Slope storage (Chimney Hollow or Dry Creek reservoir) under all the alternatives as soon as possible so that water would be available to meet demand. Windy Gap water can be delivered out of Carter Lake and Horsetooth Reservoir, with the water replaced by Adams Tunnel deliveries or exchanged with for an equal amount of C-BT water through an instantaneous delivery as described in Section 2.4.2.

Table 3-2 to Table 3-4 show C-BT, Windy Gap and total deliveries through Adams Tunnel. Windy Gap deliveries include C-BT deliveries through Adams Tunnel to replace: 1) instantaneous deliveries out of Carter Lake and Horsetooth Reservoir; 2) C-BT water delivered to Chimney Hollow under Alternative 2; 3) Windy Gap water delivered directly through the tunnel to meet demands; or 4) for storage in East Slope firming reservoirs under Alternatives 3 through 5. Total annual Adams Tunnel deliveries average about 243,000 AF under existing conditions (Table 3-2). Under the No Action alternative, Adams Tunnel deliveries would increase about 10,700 AF compared to an increase of about 19,100 AF under the Proposed Action. Alternatives 3, 4, and 5 would result in Adams Tunnel deliveries about 18,000 AF to 18,600 AF greater than existing conditions. Changes in total

Adams Tunnel deliveries are illustrated in Figure 3-8.

Figure 3-8. Average annual Adams Tunnel deliveries by alternative.



Deliveries through the Adams Tunnel for all alternatives would be greatest from December through June when C-BT water is delivered to Carter Lake, Horsetooth, and Chimney Hollow Reservoir to refill those reservoirs and meet storage targets. Adams Tunnel deliveries under No Action would be exchanged to storage in Ralph Price Reservoir. Currently, Carter Lake is typically filled by the end of May and Horsetooth Reservoir by the end of June, after which Adams Tunnel deliveries decrease. The Adams Tunnel is typically shut down for maintenance during the last two weeks in October, first two weeks in November, last week in March and first two weeks in April. Therefore, total Adams Tunnel deliveries in those months would typically be less than other months because of these outages under existing conditions and all alternatives. In addition, it was assumed that maintenance time on the Adams Tunnel may increase by about 10 percent with a Firming Project online. This additional maintenance was assumed to occur in March.

The monthly amounts of C-BT water delivered to Chimney Hollow under the Proposed Action would be relatively constant and generally coincide with the amount of Windy Gap water released to meet Participant demands, which would range from about 1,000 AF to 2,400 AF/month throughout the year. Average monthly tunnel deliveries under the Proposed Action would be approximately 1,590 AF higher than existing conditions and 690 AF higher than No Action. However, March deliveries would be about 4,600 AF lower on average when additional tunnel maintenance is occurring. Average monthly deliveries through the tunnel from September through January would be slightly higher under the Proposed Action than for the other action alternatives because of C-BT deliveries from Granby Reservoir to Chimney Hollow for prepositioning. Under the other alternatives, Windy Gap deliveries through the tunnel during the winter months would be more sporadic and only made to meet Windy Gap demands if Windy Gap water is available in either Jasper East or Rockwell reservoirs or Granby Reservoir.

Adams Tunnel deliveries are generally higher in dry years than average and wet years primarily because C-BT deliveries to the East Slope would be higher (Table 3-3). However, dry year Adams Tunnel deliveries under No Action would increase less than 2,000 AF over existing conditions because there would typically be little to no Windy Gap water in Granby Reservoir available for delivery (Table 3-3). Tunnel deliveries under the Proposed Action would be about 19,000 AF greater than existing conditions in dry years, while deliveries under Alternatives 3 and 4 would be about 5,400 AF greater than existing conditions and deliveries under Alternative 5 about 11,800 AF greater than existing conditions. C-BT deliveries would increase less than 1 percent under No Action, the Proposed Action, and Alternative 5 and decrease less than 1 percent under Alternatives 3 and 4 in dry years.

In wet years, C-BT deliveries are typically lower because the C-BT quota is lower (Table 3-4). Adams Tunnel wet year deliveries would be higher under all alternatives compared to existing conditions because Granby Reservoir fills by June and all Windy Gap water is spilled, resulting in little to no instantaneous Windy Gap delivery to meet demand. Wet year Windy Gap tunnel deliveries under No Action would increase about 17,800 AF compared to existing conditions to meet demand and for storage in Ralph Price Reservoir (Table 3-4). C-BT deliveries to the East Slope under No Action would decrease about 1,500 AF in wet years. Windy Gap deliveries under the Proposed Action would increase about 18,300 AF compared to existing conditions, while C-BT deliveries to the East Slope would be almost 7,000 AF lower in wet years. The

Table 3-2. Comparison of <u>average</u> annual flow and diversion amounts (AF) at key locations.

Location	Existing Conditions	Alternative 1			Alternative 2			Alternative 3			Alternative 4			Alternative 5		
		No Action			Proposed Action - Chimney Hollow w/Pre-positioning			Chimney Hollow w/Jasper East			Chimney Hollow w/Rockwell/Mueller Creek			Dry Creek w/Rockwell/Mueller Creek		
	Avg. Annual Flow	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percen t Diff.	Avg. Annual Flow	Diff.	Perce nt Diff.
Adams Tunnel C-BT deliveries	231,679	231,509	-170	<1%	231,196	-483	<1%	230,795	-884	<1%	230,800	-879	<1%	231,041	-638	<1%
Adams Tunnel Windy Gap deliveries	11,500	22,410	10,910	49%	31,045	19,545	63%	30,411	18,911	62%	30,433	18,933	62%	30,782	19,282	63%
Total Adams Tunnel Deliveries	243,179	253,919	10,740	4%	262,240	19,061	8%	261,206	18,027	7%	261,223	18,044	7%	261,822	18,644	8%
Granby Reservoir Spills	38,707	34,508	-4,199	-11%	28,624	-10,083	-26%	30,671	-8,037	-21%	30,690	-8,017	-21%	30,551	-8,157	-21%
Colorado River below Granby Reservoir	59,385	55,343	-4,042	-7%	50,220	-9,165	-15%	52,071	-7,313	-12%	52,091	-7,294	-12%	51,903	-7,482	-13%
Willow Creek Feeder diversions	36,172	37,544	1,372	4%	38,760	2,588	7%	38,349	2,177	6%	38,339	2,167	6%	38,438	2,266	6%
Willow Creek at the confluence with the Colorado River	18,294	16,933	-1,361	-7%	15,727	-2,567	-14%	16,138	-2,156	-12%	16,148	-2,146	-12%	16,049	-2,245	-12%
Colorado River above the Windy Gap diversion	187,889	182,487	-5,403	-3%	176,158	-11,731	-6%	178,421	-9,468	-5%	178,451	-9,438	-5%	178,164	-9,725	-5%
Windy Gap diversions	36,532	43,573	7,041	19%	46,084	9,552	26%	48,052	11,520	32%	47,997	11,466	31%	48,483	11,951	33%
Colorado River below Windy Gap	151,358	138,914	-12,444	-8%	130,075	-21,283	-14%	130,370	-20,988	-14%	130,453	-20,904	-14%	129,681	-21,676	-14%
Colorado River at Hot Sulphur Springs	156,475	144,023	-12,452	-8%	135,176	-21,299	-14%	135,472	-21,003	-13%	135,555	-20,920	-13%	134,783	-21,692	-14%
Colorado River below the confluence with the Williams Fork River	246,931	234,481	-12,450	-5%	225,634	-21,296	-9%	225,930	-21,001	-9%	226,013	-20,918	-8%	225,241	-21,690	-9%
Colorado River above the confluence with Troublesome Creek	252,443	239,993	-12,450	-5%	231,147	-21,296	-8%	231,442	-21,001	-8%	231,526	-20,917	-8%	230,753	-21,689	-9%
Colorado River above the confluence with the Blue River	379,050	366,605	-12,445	-3%	357,760	-21,291	-6%	358,055	-20,995	-6%	358,139	-20,912	-6%	357,366	-21,684	-6%
Colorado River near Kremmling	701,801	689,357	-12,444	-2%	680,512	-21,289	-3%	680,807	-20,994	-3%	680,890	-20,910	-3%	680,118	-21,683	-3%
C-BT Diversions from the Big Thompson River (Olympus & Dille)	27,990	27,632	-358	-1%	25,048	-2,942	-11%	27,062	-928	-3%	27,062	-928	-3%	26,616	-1,374	-5%
Big Thompson River below Lake Estes	66,701	67,145	444	1%	69,884	3,183	5%	67,666	965	1%	67,667	966	1%	68,146	1,445	2%
Big Thompson River at the Canyon Gage	89,367	89,725	358	0%	92,308	2,942	3%	90,294	928	1%	90,295	928	1%	90,740	1,374	2%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. There is no change in tributary inflows for the Fraser River, Williams Fork, Troublesome Creek, Muddy Creek, or Blue River for any alternative.

Granby Reservoir spills do not include Windy Gap spills from Willow Creek Reservoir, which are included in Table 3-1.

Table 3-3. Comparison of average annual dry year flow and diversion amounts (AF) at key locations.

Location	Existing Conditions	Alternative 1			Alternative 2			Alternative 3			Alternative 4			Alternative 5		
		No Action			Proposed Action - Chimney Hollow w/Pre-positioning			Chimney Hollow w/Jasper East			Chimney Hollow w/Rockwell/Mueller Creek			Dry Creek w/Rockwell/Mueller Creek		
	Avg. Annual Flow	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.
Adams Tunnel C-BT deliveries	304,061	304,299	238	<1%	304,863	802	<1%	303,636	-425	<1%	303,640	-421	<1%	304,219	158	<1%
Adams Tunnel Windy Gap deliveries	10,126	11,858	1,732	17%	28,349	18,223	180%	15,913	29,959	296%	15,968	5,842	58%	21,766	11,640	115%
Total Adams Tunnel deliveries	314,187	316,157	1,970	1%	333,210	19,024	6%	319,549	5,362	2%	319,608	5,421	2%	325,985	11,799	4%
Granby Reservoir Spills	0	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Colorado River below Granby Reservoir	21,946	21,946	0	0%	21,946	0	0%	21,946	0	0%	21,946	0	0%	21,946	0	0%
Willow Creek Feeder diversions	22,200	22,200	0	0%	22,200	0	0%	22,200	0	0%	22,200	0	0%	22,200	0	0%
Willow Creek at the confluence with the Colorado River	3,962	3,962	0	0%	3,962	0	0%	3,962	0	0%	3,962	0	0%	3,962	0	0%
Colorado River above the Windy Gap diversion	74,938	74,938	0	0%	74,939	0	0%	74,938	0	0%	74,938	0	0%	74,938	0	0%
Windy Gap diversions	7,804	7,804	0	0%	7,804	0	0%	7,804	0	0%	7,804	0	0%	7,804	0	0%
Colorado River below Windy Gap	67,134	67,134	0	0%	67,134	0	0%	67,134	0	0%	67,134	0	0%	67,134	0	0%
Colorado River at Hot Sulphur Springs	70,656	70,656	0	0%	70,655	-1	0%	70,655	-1	0%	70,655	-1	0%	70,655	-1	0%
Colorado River below the confluence with the Williams Fork River	147,416	147,416	0	0%	147,416	0	0%	147,416	0	0%	147,416	0	0%	147,416	0	0%
Colorado River above the confluence with Troublesome Creek	149,898	149,898	0	0%	149,898	0	0%	149,898	0	0%	149,898	0	0%	149,898	0	0%
Colorado River above the confluence with the Blue River	229,222	229,222	0	0%	229,222	0	0%	229,222	0	0%	229,222	0	0%	229,222	0	0%
Colorado River near Kremmling	450,286	450,286	0	0%	450,286	0	0%	450,286	0	0%	450,286	0	0%	450,286	0	0%
C-BT Diversions from the Big Thompson River (Olympus & Dille)	551	475	-76	-14%	0	-551	-100%	0	-551	-100%	0	-551	-100%	0	-551	-100%
Big Thompson River below Lake Estes	53,535	53,611	76	0%	54,086	551	1%	54,086	551	1%	54,086	551	1%	54,086	551	1%
Big Thompson River at the Canyon Gage	67,160	67,237	76	0%	67,711	551	1%	67,711	551	1%	67,711	551	1%	67,711	551	1%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. There is no change in tributary inflows for the Fraser River, Williams Fork, Troublesome Creek, Muddy Creek, or Blue River for any alternative.

Granby Reservoir spills do not include Windy Gap spills from Willow Creek Reservoir, which are included in Table 3-1.

Table 3-4. Comparison of average annual wet year flow and diversion amount (AF) at key locations.

Location	Existing Conditions	Alternative 1			Alternative 2			Alternative 3			Alternative 4			Alternative 5		
		No Action			Proposed Action - Chimney Hollow w/Pre-positioning			Chimney Hollow w/Jasper East			Chimney Hollow w/Rockwell/Mueller Creek			Dry Creek w/Rockwell/Mueller Creek		
	Avg. Annual Flow	Avg. Annual Flow	Diff.	Per-cent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.	Avg. Annual Flow	Diff.	Percent Diff.
Adams Tunnel C-BT deliveries	168,706	167,182	-1,524	1%	161,816	-6,890	4%	165,747	-2,959	2%	165,750	-2,956	2%	164,840	-3,866	2%
Adams Tunnel Windy Gap deliveries	12,081	29,879	17,798	147%	30,343	18,262	151%	40,085	28,004	232%	40,103	28,022	232%	37,810	25,729	213%
Total Adams Tunnel deliveries	180,787	197,062	16,274	9%	192,159	11,372	6%	205,832	25,044	14%	205,853	25,066	14%	202,650	21,863	12%
Granby Reservoir Spills	129,094	120,328	-8,766	-7%	112,911	-16,184	-13%	115,706	-13,389	-10%	115,725	-13,370	-10%	114,236	-14,858	-12%
Colorado River below Granby Reservoir	144,383	136,621	-7,762	-5%	130,271	-14,112	-10%	132,355	-12,028	-8%	132,374	-12,009	-8%	130,886	-13,497	-9%
Willow Creek Feeder diversions	33,685	39,335	5,650	17%	40,417	6,732	20%	39,953	6,268	19%	39,953	6,268	19%	39,935	6,250	19%
Willow Creek at the confluence with the Colorado River	52,778	47,128	-5,650	-11%	46,046	-6,732	-13%	46,510	-6,268	-12%	46,510	-6,268	-12%	46,528	-6,250	-12%
Colorado River above the Windy Gap diversion	403,835	390,423	-13,412	-3%	382,991	-20,844	-5%	385,539	-18,296	-5%	385,558	-18,277	-5%	384,087	-19,748	-5%
Windy Gap diversions	38,512	63,870	25,357	66%	73,923	35,411	92%	78,940	40,428	105%	78,775	40,262	105%	77,543	39,031	101%
Colorado River below Windy Gap	365,323	326,553	-38,769	-11%	309,068	-56,255	-15%	306,599	-58,724	-16%	306,784	-58,539	-16%	306,544	-58,779	-16%
Colorado River at Hot Sulphur Springs	369,677	330,908	-38,769	-10%	313,423	-56,254	-15%	310,954	-58,723	-16%	311,138	-58,539	-16%	310,898	-58,778	-16%
Colorado River below the confluence with the Williams Fork River	509,758	470,989	-38,769	-8%	453,505	-56,253	-11%	451,035	-58,723	-12%	451,220	-58,539	-11%	450,980	-58,778	-12%
Colorado River above the confluence with Troublesome Creek	519,392	480,623	-38,770	-7%	463,138	-56,254	-11%	460,669	-58,724	-11%	460,853	-58,539	-11%	460,614	-58,778	-11%
Colorado River above the confluence with the Blue River	706,315	667,545	-38,769	-5%	650,061	-56,253	-8%	647,591	-58,723	-8%	647,776	-58,539	-8%	647,536	-58,778	-8%
Colorado River near Kremmling	1,217,038	1,178,269	-38,769	-3%	1,160,785	-56,253	-5%	1,158,315	-58,723	-5%	1,158,500	-58,538	-5%	1,158,260	-58,778	-5%
C-BT Diversions from the Big Thompson River (Olympus & Dille)	67,946	68,253	308	0%	67,386	-560	-1%	67,902	-43	0%	67,906	-40	0%	67,938	-8	0%
Big Thompson River below Lake Estes	72,849	72,874	25	0%	74,765	1,916	3%	72,874	25	0%	72,874	25	0%	72,874	25	0%
Big Thompson River at the Canyon Gage	108,593	108,285	-308	0%	109,153	560	1%	108,636	43	0%	108,633	40	0%	108,601	8	0%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. There is no change in tributary inflows for the Fraser River, Williams Fork, Troublesome Creek, Muddy Creek, or Blue River for any alternative.

Granby Reservoir spills do not include Windy Gap spills from Willow Creek Reservoir, which are included in Table 3-1.

greatest increase in Adams Tunnel deliveries over existing conditions would occur under Alternatives 3 and 4 (25,100 AF) with a slightly lower increase of about 21,900 AF under Alternative 5. C-BT deliveries to the East Slope would decrease by about 3,000 to 4,000 AF under Alternatives 3, 4, and 5 in wet years.

Windy Gap Diversions

All alternatives involve additional diversions from the Colorado River at the existing Windy Gap Reservoir. Windy Gap diversions would be constrained by several factors, including:

- Downstream senior water right calls and instream flow requirements
- Decree limitations
- Physical supply
- Pump station and Windy Gap pipeline conveyance limitations
- Available space in Granby Reservoir
- Available space in Firming Project reservoirs
- Available space in Adams Tunnel

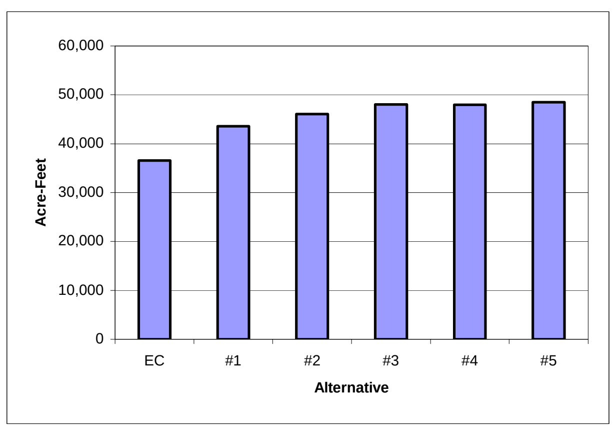
The degree to which these constraints apply (timing and amount) would vary among the alternatives, resulting in differences in Windy Gap diversions. Figure 3-9 shows differences in predicted average annual diversions for each alternative. In an average year, Windy Gap diversions would be greatest in May and then June. Considerably smaller diversions would occur in April, July, and August.

Under the No Action alternative, Windy Gap water would be delivered first to Granby Reservoir and then to Ralph Price Reservoir (for Longmont) if there is available space in Adams Tunnel. Average annual Windy Gap diversions would be about 43,600 AF compared to 36,500 AF under existing conditions (Table 3-2). There would be no difference in Windy Gap diversions between existing conditions and No Action in years that Granby Reservoir does not fill because there would be no difference in the supply available to Windy Gap and available storage capacity would not be a constraint. However, when Granby Reservoir fills, Windy Gap cannot divert under existing conditions. Under No Action, Longmont could still divert Windy Gap water to Ralph Price Reservoir when Granby Reservoir is full as long as there is space in the Adams Tunnel and the St. Vrain Supply Canal.

Under the Proposed Action, Windy Gap diversions would be delivered to Granby Reservoir and exchanged with C-BT water in Chimney Hollow Reservoir. This would relieve the need to deliver Windy Gap water through Adams Tunnel to Chimney Hollow during the diversion season because this operation would be accomplished via an exchange. Average annual Windy Gap diversions would be about 46,100 AF under the Proposed Action or about 26 percent greater than existing conditions and about 7 percent greater than No Action (Table 3-2).

Under Alternative 3, Windy Gap diversions would first be delivered to Chimney Hollow, limited by available space in Adams Tunnel. If the Adams Tunnel is full, Windy Gap diversions would be delivered to Jasper East and then to Granby Reservoir to the extent space is available. This configuration minimizes Windy Gap spills from Granby Reservoir and maximizes space available in Jasper East for Windy Gap diversions when Granby Reservoir and the Adams Tunnel are full. Alternative 4 would operate in a similar fashion with Rockwell Reservoir and Alternative 5 with Dry Creek and Rockwell reservoirs. Average annual Windy Gap diversions under Alternatives 3, 4, and 5 would be about 2,000 AF higher than the Proposed Action due primarily to differences in diversions in wet years in July and August and the timing and amount of spills from Granby Reservoir.

Figure 3-9. Average annual Windy Gap diversions by alternative.



In dry years, average annual Windy Gap diversions would be relatively low in comparison with average and wet year diversions and there would be no difference among the alternatives and existing conditions (Table 3-3). Windy Gap diversions would be limited by the physically and legally available supply in the Colorado River in dry years, which would not vary among alternatives. Available space in Granby Reservoir and the firming project reservoirs would not be limiting factors. Annual Windy Gap diversions in an average dry year would be the same as existing conditions for all alternatives, or about 7,804 AF (Table 3-3). This is an average of the five driest years (1954, 1966, 1977, 1981, and 1989). In those years, Windy Gap diversions would range from approximately 300 AF in 1954 to 19,430 AF in 1989. The more severe the dry year, the less Windy Gap water would be pumped.

In wet years under existing conditions, Windy Gap diversions in May and June are often limited by available space in Granby Reservoir. Under No Action, Windy Gap diversions would continue in July and August after Granby Reservoir fills to the extent there is space available in the tunnel to deliver water to St. Vrain Creek and exchange it to Ralph Price Reservoir. Under the Proposed Action, additional Windy Gap would be diverted to Granby Reservoir in July and August to the extent there is space in Granby Reservoir created by delivery of C-BT water to Chimney Hollow Reservoir. The additional West Slope storage space available in Alternatives 3, 4, and 5 also would allow substantially greater Windy Gap diversions in wet years. In wet years, Chimney Hollow would typically fill by the end of June or July under the Proposed Action, whereas under Alternatives 3, 4, and 5, Chimney Hollow, Jasper East or Rockwell reservoirs would typically not fill until the end of July or August, primarily due to tunnel capacity constraints. Wet year Windy Gap diversions are about 38,500 AF under existing conditions, compared to an estimated 63,900 AF under No Action, 73,900 AF under the Proposed Action, and a high of 78,900 AF under Alternative 3 (Table 3-4).

Willow Creek Feeder Canal Diversions

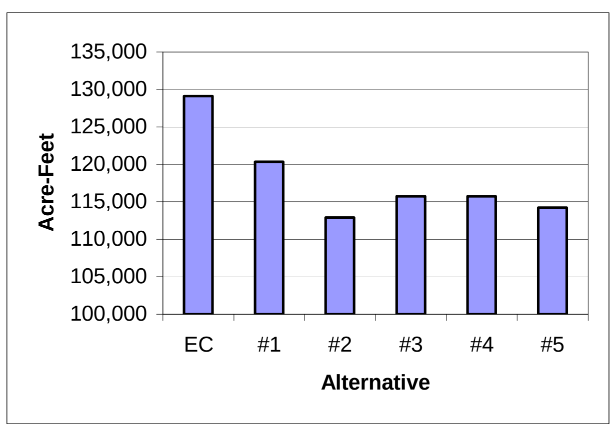
As described in Section 3.5.2.3, Willow Creek Feeder Canal diversions are affected by changes in Granby Reservoir storage. Average annual WCFC diversions would increase about 4 percent from existing conditions under No Action and about 7 percent under the Proposed Action (Table 3-2) primarily because of the reduction in Windy Gap water stored in Granby Reservoir under the alternatives. Alternatives 3, 4, and 5 would increase WCFC diversions about 6 percent on average. During average and wet years (Table 3-4), the increased diversions would occur primarily in June, July, and August and, thus, would decrease Willow Creek flows in the same months for all alternatives. Predicted changes in WCFC diversions may be overestimated somewhat because the WGFP model does not forecast Granby Reservoir spills and actual reservoir operations could reduce spills. There would be no change in WCFC diversions during dry years for any alternative (Table 3-3).

Granby Reservoir Spills

C-BT storage in Granby Reservoir takes precedence over Windy Gap storage. Granby Reservoir generally only spills in wet years and the first water spilled is Windy Gap water in proportion to the amounts in each Participant's account, followed by water in the MPWCD account, and finally the C-BT account spills if necessary. Granby Reservoir spills during wet years would decrease about 7 percent under No Action, compared to a 13 percent decrease under the Proposed Action, 10 percent for Alternatives 3 and 4, and 12 percent for Alternative 5 (Table 3-4 and Figure 3-10).

Windy Gap spills would be lowest under the Proposed Action because storage of Windy Gap water in Granby Reservoir would be protected from

Figure 3-10. Average annual wet year Granby Reservoir spills by alternative.

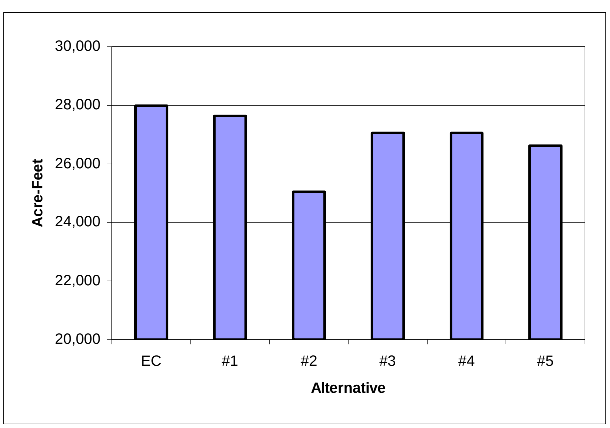


spilling to the degree that there is C-BT water in Participant storage accounts in Chimney Hollow. Participants could store Windy Gap water in Granby Reservoir if their Chimney Hollow account is full of Windy Gap water; however, this water is subject to spilling. When total C-BT contents in Granby Reservoir and Chimney Hollow combined reaches 539,568 AF, which is the physical capacity of Granby Reservoir, C-BT would stop storing water at Granby Reservoir. This would prevent the C-BT Project from storing more water in Granby Reservoir than it could without prepositioning and spilling "protected" Windy Gap water. Under Alternatives 3, 4, and 5, Windy Gap water would be stored in Granby Reservoir when West Slope firming storage and the Adams Tunnel are full, which is then subject to spill.

C-BT Diversions from the Big Thompson River

Average annual C-BT diversions from the Big Thompson River for power generation would decrease slightly under all alternatives due to a reduction in the available capacity in the Olympus Tunnel. Differences in Carter Lake and Horsetooth Reservoir content among the alternatives also could cause differences in skim diversions for power. To the degree that there are differences in Carter Lake and Horsetooth contents among alternatives, C-BT deliveries to these reservoirs to meet storage targets could vary, which could cause differences in skim diversions if available capacity in Olympus Tunnel is affected and limiting. Average annual Big Thompson River diversions would decrease about 1 percent under No Action and 11 percent under the Proposed Action (Figure 3-11). Big Thompson River diversions would decrease by 5 percent or less for the other alternatives. Most of the Big Thompson diversions occur in May, June, and July. As discussed in Section 3.5.2.7, the reduction in Big Thompson diversions for power would increase streamflow in the Big Thompson River between Lake Estes and the Big Thompson Power Plant near the mouth of the canyon. Effects to power generation are discussed in the following section.

Figure 3-11. Average annual CB-T diversions from the Big Thompson River by alternative.



Hydropower Generation

The WGFP would result in energy use and energy generation from additional water conveyance in the C-BT system. Additional pumping would be needed to convey Windy Gap water from Granby Reservoir to Grand Lake and from Flatiron Reservoir to Carter Lake. Additional hydropower would be generated at the five East Slope power plants from the increased water deliveries. There would be no change in hydropower production at the Green Mountain Powerplant for any alternative.

The net change in C-BT hydropower production was calculated for each alternative based on changes in Windy Gap diversions and delivery through the C-BT system. Net C-BT Project power generation was defined as the difference between the total energy generated at Marys Lake, Estes, Pole Hill, Flatiron, and Big Thompson Powerplants and the total energy used for the Willow Creek Pump Canal, Granby Pump Canal, and Flatiron Unit #3. Existing conditions include generation and pumping from an average annual delivery of 11,500 AF of Windy Gap water. Table 3-5 provides a summary comparing net hydropower generation between the alternatives and existing conditions. All alternatives would result in a net increase in annual energy production ranging from about 19 gigawatts (GW) under No Action to a maximum increase of about 30 GW under Alternative 3. The action alternatives would generate less than 2 percent more power than No Action because similar amounts of water would be delivered through the Adams Tunnel. The approximate 5 percent increase in average annual power generation from existing conditions under the action alternatives would be sold and distributed by Western. However, the additional increase in power is still below the projected power generation expected from the original Windy Gap Project. The 5 percent increase to the C-BT generation would not affect the amount of Loveland Area Projects (LAP) energy Western markets because the increased

Table 3-5. Comparison of net annual C-BT power generation between alternatives.

Power Generation	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Annual average (GWH)	510	529	536	540	536	536
Annual maximum (GWH)	642	645	662	664	660	660
Annual minimum (GWH)	326	343	380	386	382	382
Difference in annual average from existing conditions (GWH)	—	19	26	30	26	26
Difference in annual average from existing conditions (%)	—	3.7%	5.1%	5.8%	5.1%	5.1%

amount of energy is already included in the currently marketed LAP resource. Since Western's total LAP firm energy commitment already includes C-BT generation based on an anticipated average Windy Gap diversion of 56,000 AF, the alternatives would reduce average annual energy purchases to support current contractual commitments and would not increase the marketable LAP energy.

3.5.2.6 West Slope Streams and Existing Reservoirs

Colorado River

Colorado River above the Windy Gap Diversion. Flows in the Colorado River above Windy Gap Reservoir reflect the outflow from Granby Reservoir, tributary inflows from Willow Creek and the Fraser River, Colorado River mainstem irrigation diversions, and ungaged gains/losses to the river including ground water irrigation return flows. Differences in flows above Windy Gap among alternatives in average and wet years would be the result of changes in Granby Reservoir spills and changes in Willow Creek flow due to differences in WCFC diversions. In dry years, flows in the Colorado River above Windy Gap would be the same for all alternatives because there would be no change in Granby Reservoir spills or WCFC diversions (Table 3-3).

Average annual Colorado River flows above Windy Gap Reservoir would decrease about 3 percent under No Action, compared to a decrease of 6 percent under the Proposed Action and 5 percent for Alternatives 3, 4, and 5 (Table 3-2). In wet years, average annual Colorado River flows above Windy Gap would decrease about 3 percent under No Action and would decrease about 5 percent for the other alternatives (Table 3-4).

For all alternatives, the majority of the changes in flow above Windy Gap would occur in average and wet years from June to August (Figure 3-12). The largest volume of flow change would occur in June, but the largest percent change in monthly flow would occur in July. Average July flows would decrease about 6 percent under No Action, 11 percent under the Proposed Action, and about a 10 percent under Alternatives 3, 4, and 5.

Table 3-6 illustrates the magnitude of daily flow changes from existing conditions and the percent of time that flows would change under the alternatives from May through August when most Windy Gap diversions would occur. Under the Proposed Action, Colorado River flow above the Windy Gap diversion would not change from existing conditions about 76 percent of the time. Due to the re-timing of spills from Lake Granby, daily flows would increase about 10 percent of the time, and the remainder of the time flows would decrease under the Proposed Action. Flows decreases would be similar for other action alternatives and less under No Action.

Colorado River below the Windy Gap Diversion. Colorado River streamflow below Windy Gap Reservoir to the top of Gore Canyon reflects Windy Gap diversions, irrigation and municipal diversions and return flows, ground water inflows, and tributary inflows from Williams Fork, Troublesome Creek, Muddy Creek, and the Blue River.

Figure 3-12. Colorado River above Windy Gap – average daily flows by alternative.

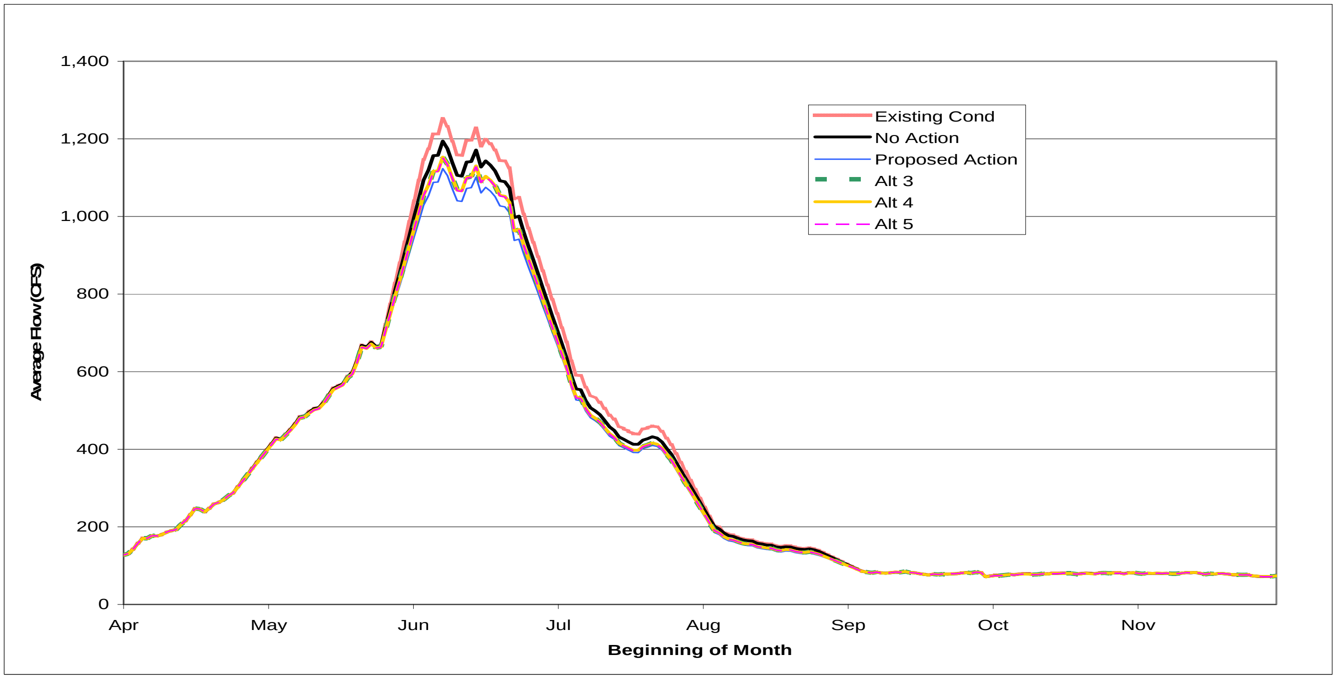


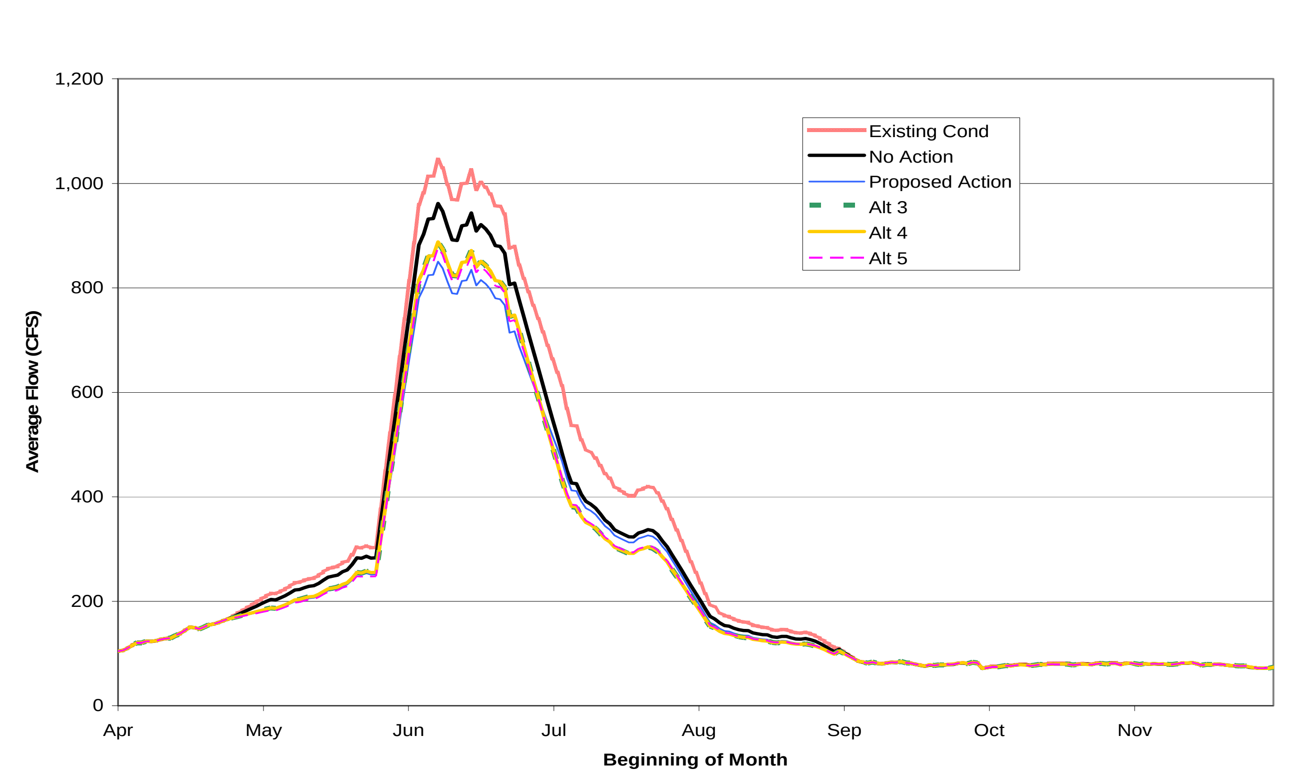
Table 3-6. Colorado River above Windy Gap – daily flow changes compared to existing conditions.

Daily Flow Changes (cfs)	Percentage of days in May through August that flow changes would occur				
	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
+1 to + 157	1.7%	9.7%	3.3%	3.3%	2.8%
0 cfs	89.4%	76.1%	84.6%	84.6%	84.2%
-1 to -10	2.4%	2.1%	1.8%	1.8%	1.5%
-11 to -100	2.7%	3.9%	3.7%	3.7%	4.7%
-101 to -200	1.6%	3.2%	2.6%	2.7%	2.7%
-201 to -300	0.7%	1.6%	1.2%	1.2%	1.2%
-301 to -500	0.3%	1.4%	1.1%	1.1%	1.2%
-501 to -1,000	0.7%	1.2%	1.1%	1.1%	0.9%
-1,001 to -2,398	0.4%	0.9%	0.6%	0.6%	0.6%

The largest percent reduction in Colorado River streamflow for all alternatives would occur in the stream reach below the Windy Gap diversion to Hot Sulphur Springs. Average annual Colorado River flows below the Windy Gap diversion would be about 8 percent lower under the No Action alternative compared to existing conditions (Table 3-2). Average annual streamflow for the Proposed Action and other alternatives would be about 14 percent lower than existing conditions and 6 percent lower than No Action below the Windy Gap diversion. Reductions in streamflow would occur primarily from May through August for all alternatives, which coincides with the Windy Gap diversion season (Figure 3-13).

The greatest volume reduction would occur during peak runoff in June, but the largest percent decrease in flow would occur in July. Reductions in Colorado River streamflow below Windy Gap in July would range from about 20 percent for No Action to 23 percent for the Proposed Action, to 28 percent for Alternatives 3, 4, and 5. There would be

Figure 3-13. Colorado River below Windy Gap – average daily flows by alternative.



little to no change in flow from September to April under average or wet years (Figure 3-13) for any alternative. In dry years, there would be no change in flow from existing conditions for any alternative (Table 3-3).

The frequency that the Windy Gap project would divert from the Colorado River resulting in flows near the 90 cfs minimum flow below Windy Gap Reservoir was evaluated and compared to existing conditions. Daily hydrologic data from the 47-year hydrologic period of record for May to August was tabulated to determine how many days flows below the Windy Gap diversion were less than 100 cfs (near the 90 cfs minimum flow) as a result of Windy Gap diversions (Table 3-7). In May and June there would be no change from existing conditions for any of the alternatives in the number of days that flows are below 100 cfs. In July, diversions to the minimum streamflow would increase by 3 days compared to existing conditions under the No Action alternative and diversions to the minimum flow would increase by 10 days under the action alternatives over the 47-year hydrologic period.

Under existing conditions, Windy Gap diversions reduce Colorado River streamflow to the minimum streamflow about 1.5 percent of the days in July. The additional diversions under the No Action alternative would increase the percentage of time that flows are at the minimum streamflow about 0.2 percent and the action alternatives would increase

Table 3-7. Number of days flows below the Windy Gap diversion would be less than 100 cfs over the 47-year study period as a result of Windy Gap pumping.

Alternative	May	June	July	August
Existing Conditions	180	13	22	84
Alt 1 – No Action	180	13	25	108
Alt 2 – Proposed Action and Alt 3 – 5*	180	13	32	138

*Results indicate the effects under the Proposed Action. Alternatives 3, 4, and 5 would have a few more days because diversions are slightly greater than the Proposed Action.

the frequency about 0.7 percent. In August, the No Action alternative would increase the number of days near the minimum streamflow by 24 days over the 47-year study period compared to existing conditions and days near the minimum streamflow would increase by about 54 days under the action alternatives. Under existing conditions, Windy Gap diversions reduce flows in the Colorado River near the minimum streamflow about 5.7 percent of the days in August. This would increase to 7.4 percent under the No Action alternative and about 9.5 percent of the days under the action alternatives.

The percent reduction in Colorado River streamflow decreases downstream with additional inflows from tributaries. Average annual Colorado River flow at the Kremmling gage below the confluence with the Blue River would decrease about 2 percent under No Action compared to 3 percent for the Proposed Action and other alternatives (Table 3-2). Average July streamflow near Kremmling would decrease about 5 percent under No Action, compared to 6 percent for the Proposed Action and 7 percent for the other alternatives (Figure 3-14). There would be no change in dry year flows (Table 3-3). In wet years, average annual streamflow near Kremmling would decrease 3 percent under No Action and 5 percent for other alternatives (Table 3-4).

There would be no change in Colorado River flow below Windy Gap at Hot Sulphur Springs and Kremmling about 68 percent of the time from May through August under any of the action alternatives (Table 3-8). Daily flow decreases of 1 to 100 cfs would occur about 13 percent of the time under the Proposed Action and slightly less for other alternatives. Larger flow decreases for the action alternatives would occur about 18 to 21 percent of the time during that period. The No Action alternative would experience no change in flows about 71 percent of the time.

Willow Creek

Increased WCFC diversions under all alternatives would reduce average flows in Willow Creek below Willow Creek Reservoir. Average annual flows would decrease about 7 percent under No Action compared to 14 percent for the Proposed Action and 12 percent for other alternatives (Table 3-2). Lower flows would occur from May to November with the greatest volume reductions occurring in June and the greatest percent change in July (Figure 3-15).

Figure 3-14. Colorado River near Kremmling – average daily flows by alternative.

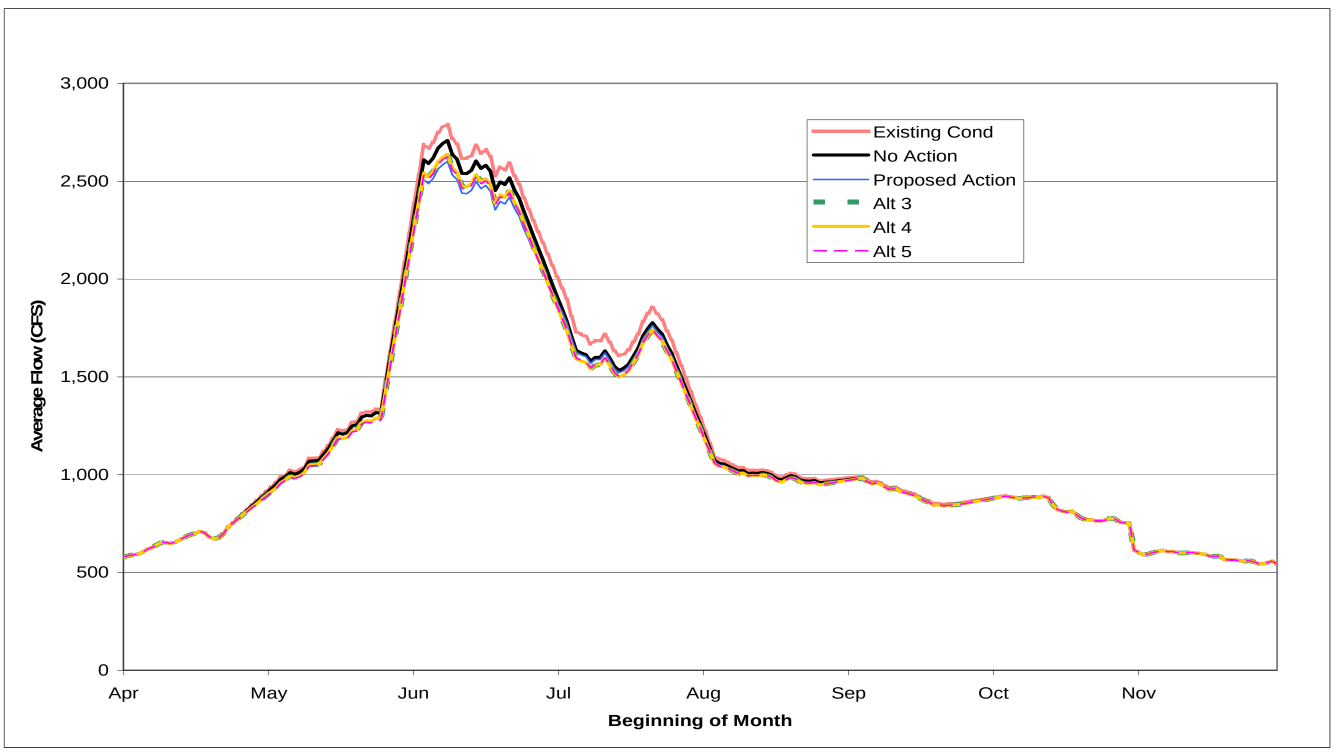


Table 3-8. Colorado River below Windy Gap (Hot Sulphur Springs to Kremmling) – daily flow changes compared to existing conditions from May to August.

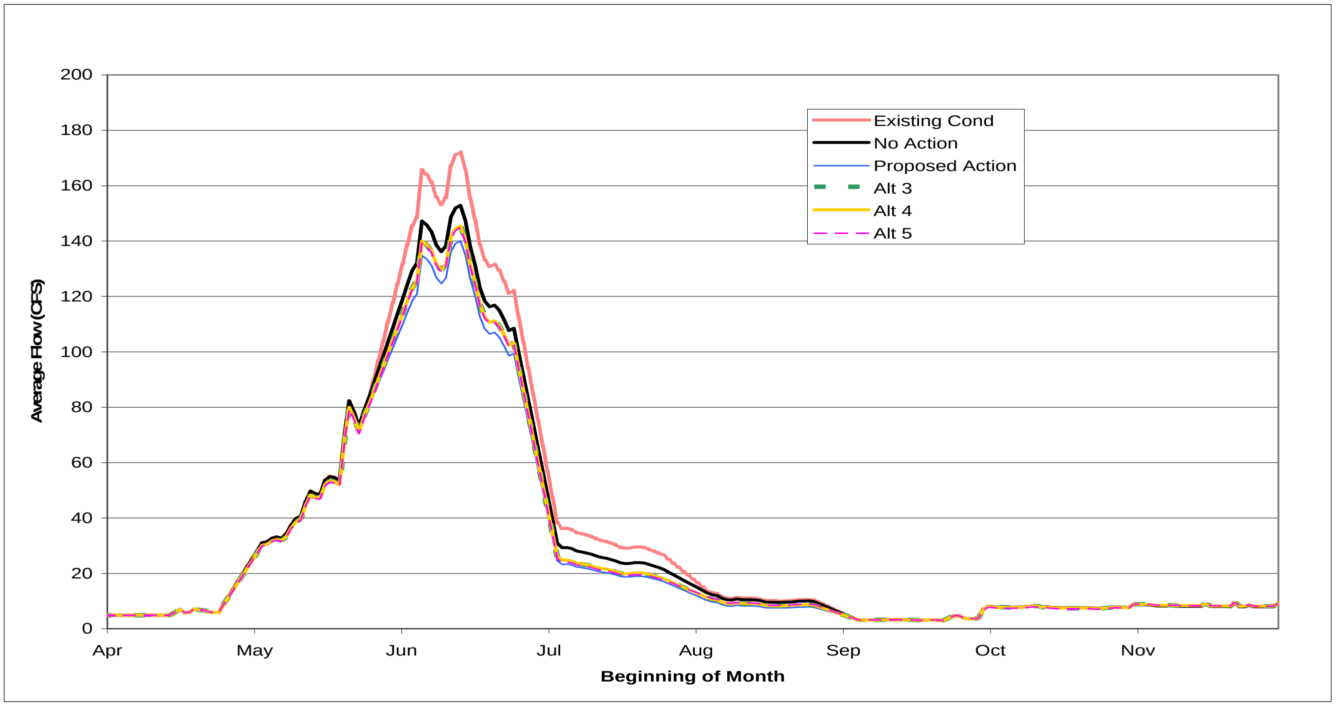
Daily Flow Changes (cfs)	Percentage of days in May through August that flow changes would occur				
	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
+1 to + 24	1.8%	1.3%	0.6%	0.6%	0.5%
0	71.4%	67.5%	68%	68%	68.5%
-1 to -10	1.1%	2%	2%	2.1%	0.7%
-11 to -100	10.9%	10.9%	8.3%	8.3%	9.4%
-101 to -200	6.8%	5.2%	7.2%	7.2%	6.7%
-201 to -300	2.2%	3.5%	4.5%	4.5%	3.8%
-301 to -500	3%	4.2%	4.9%	4.9%	5.4%
-501 to -1,000	1.7%	4%	3.4%	3.4%	3.8%
-1,001 to -2,682	0.6%	1.4%	1.2%	1.2%	1.2%

Granby Reservoir

Granby Reservoir storage content would vary monthly for all alternatives in average, wet, and dry years. Differences in Granby Reservoir content between existing conditions and the alternatives occur for several reasons:

- *Differences in the storage of Windy Gap water in Granby Reservoir.* Under existing conditions, Windy Gap water can only be stored in Granby Reservoir when space is available. Under the Proposed Action, Windy Gap water diverted to Granby Reservoir would be exchanged with C-BT water in Chimney Hollow until Chimney Hollow is full of Windy Gap water, subject to volumetric limits in the decree. Any additional Windy Gap water diverted above

Figure 3-15. Willow Creek at Colorado River – average daily flows by alternative.



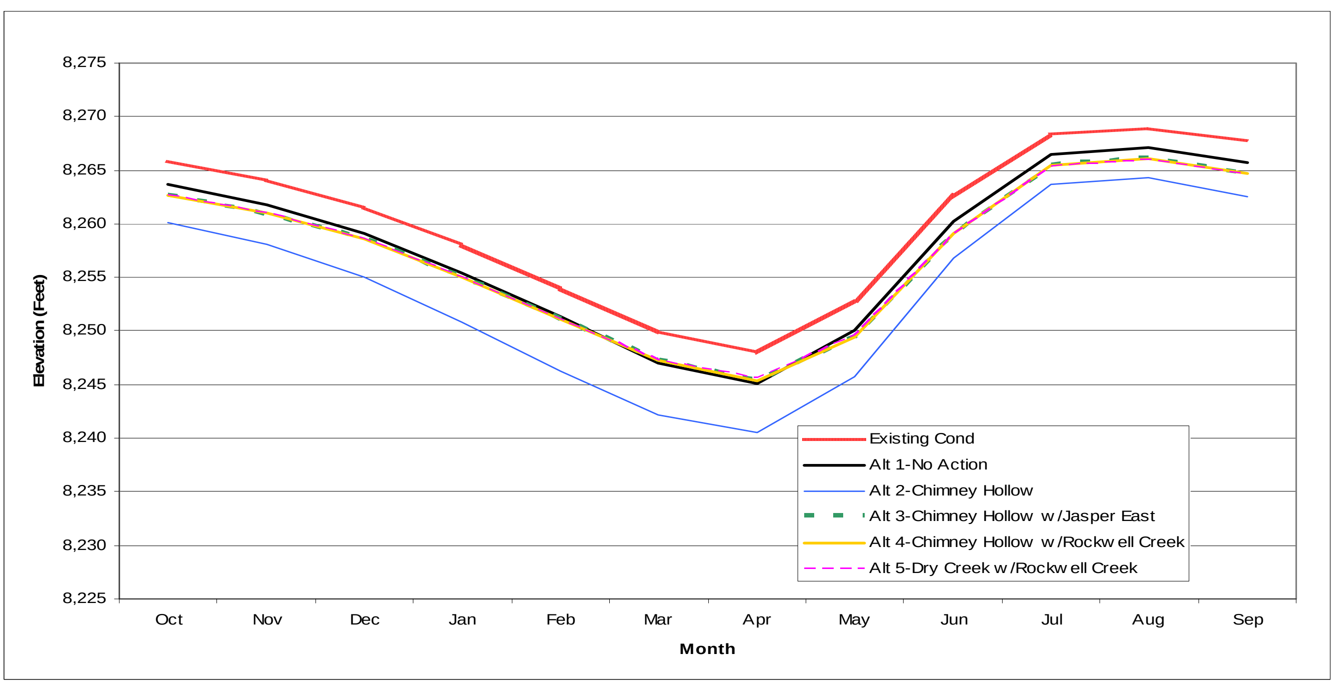
the capacity of Chimney Hollow would be stored in Granby Reservoir. Other action alternatives would have new reservoirs in which to store Windy Gap water or an enlarged reservoir under No Action in addition to Granby Reservoir. Differences in Windy Gap storage in Granby Reservoir would result in differences in instantaneous deliveries to meet Windy Gap demands, which also would affect Granby Reservoir contents.

- *Differences in Windy Gap demand.* Differences in the magnitude and timing of Windy Gap deliveries to meet demands would affect Granby Reservoir storage content.
- *Variations in the amount of Windy Gap shrink paid to the C-BT Project.* Differences in Windy Gap diversions among alternatives affect the amount of shrink paid. The Proposed Action includes a shrink charge when Windy Gap water is initially diverted to Granby Reservoir and a reintroduction shrink when the water is delivered out of Chimney Hollow to the WGFP participants. All East Slope firming reservoirs include a reintroduction shrink, whereas West Slope firming reservoirs do not. In other words, diversion shrink is only paid once when Windy Gap water is diverted and stored in a West Slope firming reservoir.
- *Differences in Adams Tunnel maintenance.* A projected 10 percent increase in tunnel maintenance in March would affect C-BT and Windy Gap contents in Granby Reservoir.

In an average year, the monthly storage content in Granby Reservoir would be about 3 to 5 percent lower than existing conditions under the No Action alternative. The largest change in the monthly volume of Granby Reservoir that would occur in an average year would be under the Proposed Action, with a 13 percent decrease in content from February to April. Summer reservoir content under the Proposed Action would be about 7 to 9 percent lower than existing conditions. Other action alternatives would result in monthly decreases in Granby Reservoir content similar to No Action, but with slightly greater decreases in the spring and summer. Figure 3-16 shows changes in the average monthly surface elevation of Granby Reservoir for each alternative.

In dry years, the percent decrease from existing conditions in Granby Reservoir volume is generally

Figure 3-16. Granby Reservoir estimated average monthly surface elevation by alternative.



less than average years for No Action and all the action alternatives. However, under the Proposed Action monthly storage would decrease up to 13 percent (8 feet in surface water elevation) in September of dry years. In addition, when there is a series of dry years, Granby Reservoir levels could drop as much as 23 feet under the Proposed Action. The larger changes in Granby Reservoir storage during consecutive dry years would occur primarily under the Proposed Action from delivery of C-BT water to Chimney Hollow Reservoir to replace releases to meet Windy Gap demands.

Although the amount of water stored in Granby Reservoir is substantially higher in wet years, all alternatives would result in lower storage than existing conditions. Under No Action, monthly lake storage would range from 0 to 8 percent lower than existing conditions during wet years. The Proposed Action would result in monthly storage levels of 1 to 16 percent less than existing conditions, while other alternatives would range from 1 percent to 8 percent lower in wet years. When Granby Reservoir fills with C-BT water, there would be very little difference between the alternatives because differences in C-BT operations and contents in Granby Reservoir due to Windy Gap would be relatively small.

3.5.2.7 East Slope Streams and Existing Reservoirs

Big Thompson River

Due to lower skim diversion for power generation, the Big Thompson River from Lake Estes to the canyon mouth would experience a slight increase in flow under all alternatives (Table 3-2). Under No Action, average streamflow below Lake Estes would increase less than 1 percent in June and July, with negligible to no change in other months. The Proposed Action would result in increased Big Thompson flows of up to 9 percent in May and July in average years and up to 5 percent in June of wet years. Alternatives 3, 4, and 5 would result in Big Thompson River flow increases of 4 to 5 percent in May, with less than a 2 percent change in other months in an average year. There would be no change in Big Thompson River flows during dry years for any alternative.

North St. Vrain Creek and St. Vrain Creek

Under the No Action alternative, the flow of North St. Vrain Creek below Ralph Price Reservoir, as well as St. Vrain Creek in the approximately 1-mile stretch from the confluence of the North and South forks to the St. Vrain Supply Canal, would change due to exchanges of Windy Gap water to storage in an enlarged Ralph Price Reservoir and Windy Gap releases from the reservoir to meet Longmont's demands. Flows in these reaches would decrease primarily in May and July, when water is North St. Vrain water is stored in Ralph Price Reservoir in exchange for Windy Gap deliveries to St. Vrain Creek at the St. Vrain Supply Canal. Releases from Ralph Price Reservoir to meet Longmont's Windy Gap demands would occur throughout the year (Table 3-9). Flows in these reaches would increase in September and October when releases exceed the amount exchanged to storage.

Longmont's diversions from North St. Vrain Creek at Longmont Pipeline to meet demand would increase during most months of the year; additional diversions related to exchanging Windy Gap water upstream would occur in May, July, and August (Table 3-9). Longmont's average net diversions to storage in Ralph Price Reservoir in May, July, and August would increase by 15 cfs, 45 cfs, and 3 cfs, respectively. This would reduce the average flow of North St. Vrain Creek below Ralph Price Reservoir and Longmont's pipeline by about 10 percent in May, 25 percent in July, and 3 percent in August. The average monthly flow in June below Ralph Price Reservoir would not change because average monthly diversions to storage at Ralph Price Reservoir would be offset by Windy Gap releases to meet Longmont's demands.

Diversions by Longmont from the North St. Vrain at the Longmont Pipeline are limited by the pipeline's physical capacity of 28.5 cfs. From July to October, Longmont typically uses most of that pipeline capacity for its existing diversions. As a result, flow changes below Longmont's Pipeline would occur if Longmont could not divert the entire Windy Gap release from Ralph Price Reservoir at Longmont Reservoir. Longmont would divert any excess Windy Gap release that cannot be diverted at the Longmont Pipeline farther downstream above the St. Vrain Supply Canal. The flow of St. Vrain Creek would not change downstream of the St. Vrain

Table 3-9. North St. Vrain Creek and St. Vrain Creek average monthly streamflow under the No Action alternative.

Month	North St. Vrain between Ralph Price Reservoir and Longmont Reservoir			North St. Vrain below Longmont Reservoir			St. Vrain at Lyons USGS Gage		
	Exist. Cond. (cfs)	No Action (cfs)	% Change	Exist. Cond. (cfs)	No Action (cfs)	% Change	Exist. Cond. (cfs)	No Action (cfs)	% Change
January	24	28	18%	13	13	0%	14	14	0%
February	23	27	18%	13	13	0%	13	13	0%
March	24	28	17%	12	12	-0%	20	20	0%
April	46	48	4%	29	29	0%	91	91	0%
May	155	140	-10%	133	118	-11%	297	282	-5%
June	274	277	1%	250	250	0%	528	528	0%
July	179	134	-25%	147	107	-27%	296	256	-13%
August	89	86	-3%	59	58	-3%	135	133	-1%
September	42	60	43%	19	32	67%	67	80	19%
October	26	43	67%	8	15	90%	39	46	18%
November	23	27	18%	13	13	0%	24	24	0%
December	23	27	19%	13	13	0%	17	17	0%

Supply Canal because Windy Gap water would be released to St. Vrain Creek at the St. Vrain Supply Canal in exchange for diversions to storage in Ralph Price Reservoir. Also, Windy Gap releases from Ralph Price Reservoir would be diverted by Longmont upstream of this point.

Streams that Receive Windy Gap Return Flow

Under all alternatives, Windy Gap deliveries to East Slope Participants would be more reliable and there would be greater and more consistent return flows to East Slope streams. Windy Gap return flows attributable to indoor use of Windy Gap water occur primarily at Participants' WWTPs (Figure 3-2). Additional Windy Gap return flows from outdoor irrigation use would occur at various locations within Participants' service areas. However, for the purpose of analyzing affects, it was assumed that return flows attributable to outdoor irrigation use (50 percent of total) would accrue to the stream at each Participant's WWTP.

Maximum East Slope return flow increases would occur under the No Action alternative because the demand for Windy Gap water would be highest under this alternative and, therefore, the maximum Windy Gap delivery would be greatest under No Action. However, average return flows would be less under No Action than the action alternatives because average deliveries would be less. Table 3-10 compares the average and maximum flow increases attributable to additional Windy Gap return flows under the No Action alternative to the existing average maximum monthly flows at the nearest USGS gage. There would be no net change in streamflow from November to March between the No Action alternative and existing conditions because either Participants do not intend to use their Windy Gap supplies in those months, reusable effluent is stored for use later in summer months, or reusable Windy Gap return flows are used to offset depletions or augment return flow obligations. The USGS gage flows presented are the closest measured flows to the location where additional returns would occur at Participants' WWTPs. No adjustments were made to gage flows to account for gains/losses that may occur between the gages and WWTPs. In Coal Creek and St. Vrain Creek, return flows would increase at more than one location and these flows have not been added together in Table 3-10.

Table 3-10. East Slope streamflow increases from Windy Gap return flows under the No Action alternative.

Stream Segment	Flow Condition[1]	Apr	May	Jun	Jul	Aug	Sep	Oct
		cfs						
Big Dry Creek above Broomfield WWTP (USGS gage 06720820, adjusted for average historical Broomfield WWTP effluent, 1995-2004)	Existing average flow	13.3	28.9	51.1	41.5	38.5	23.6	10.1
	Existing maximum flow	19	40.5	73.2	86.5	49	40.3	16.2
	Average flow increase	1.5	2.6	3.1	3.7	3.7	3.1	1.5
	Maximum flow increase	3.5	5.9	7.0	8.5	8.5	7.0	3.4
Coal Creek below Superior, above Louisville, Lafayette and Erie WWTPs (USGS gage 06730400)	Existing average flow	12.3	13.1	7	2.8	4.1	2.1	2.6
	Existing maximum flow	36	35	13	4.3	15	3.1	3.8
	Average flow increases above gage	0.8	1.4	1.2	0.9	0.7	0.6	0.5
	Maximum flow increase above gage	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Average flow increases below gage	1.5	2.8	2.3	1.8	1.3	1.2	1.0
	Maximum flow increase below gage	3.3	3.3	3.4	3.3	3.3	3.4	3.2
St. Vrain Creek below Longmont WWTP (USGS gage 06725450)	Existing average flow	76	234	348	175	148	101	68
	Existing maximum flow	259	1,155	1,227	485	185	152	159
	Average flow increase	2.2	0.8	0.9	10.7	10.5	10.3	9.3
	Maximum flow increase	3.0	0.8	0.9	11.0	11.0	11.3	10.8
St. Vrain Creek below LTWD WWTP (USGS gage 06731000)	Existing average flow	178	472	627	313	231	184	160
	Existing maximum flow	622	2,362	2,316	972	653	292	398
	Average flow increase	0.3	0.7	0.8	0.9	0.9	0.7	0.3
	Maximum flow increase	0.8	1.3	1.5	1.5	1.5	1.5	0.7
Big Thompson River below Loveland WWTP (USGS gage 06741510)	Existing average flow	41	251	296	129	84	37	28
	Existing maximum flow	292	2,078	1,493	418	153	84	66
	Average flow increase	0	1.4	1.2	2.0	3.5	3.9	2.8
	Maximum flow increase	0	1.6	1.6	3.2	6.4	9.8	9.4

[1] Existing average and maximum flow are at stream gage locations. Average and maximum flow increases are at Participants' WWTPs and dispersed return flow locations from outdoor use.

Because the yield for the Proposed Action and other action alternatives is similar, the projected increase in East Slope return flows would be similar. The maximum potential flow change in East Slope streams due to additional Windy Gap return flows under the action alternatives was compared to existing conditions and the average maximum monthly flows at the nearest USGS gage (Table 3-11). These flow changes are an estimate of the greatest possible flow changes; there would be smaller flow changes in years when the demand for Windy Gap water is lower and subsequently Windy

Table 3-11. East Slope streamflow increases from Windy Gap return flows under Alternatives 2, 3, 4, and 5.

Stream Segment[1]	cfs	Apr	May	Jun	Jul	Aug	Sep	Oct
Big Dry Creek above Broomfield WWTP (USGS gage 06720820, adjusted for average historical Broomfield WWTP effluent, 1995-2004)	Existing average flow	13.3	28.9	51.1	41.5	38.5	23.6	10.1
	Existing maximum flow	19	40.5	73.2	86.5	49	40.3	16.2
	Maximum flow increase	3.5	5.9	7	8.5	8.5	7	3.4
Coal Creek below Superior, above Louisville, Lafayette, and Erie WWTPs (USGS gage 06730400)	Existing average flow	12.3	13.1	7	2.8	4.1	2.1	2.6
	Existing maximum flow	36	35	13	4.3	15	3.1	3.8
	Maximum flow increase above gage	1.6	1.6	1.6	1.6	1.6	1.6	1.5
	Maximum flow increase below gage	3.5	3.7	3.9	4	4	3.9	3.3
St. Vrain Creek below Longmont WWTP (USGS gage 06725450)	Existing average flow	76	234	348	175	148	101	68
	Existing maximum flow	259	1,155	1,227	485	185	152	159
	Maximum flow increase	1.7	0.5	0.5	6.2	6.2	6.4	6.1
St. Vrain Creek below LTWD WWTP (USGS gage 06731000)	Existing average flow	177	400	535	214	164	124	103
	Existing maximum flow	856	2256	2203	852	410	592	286
	Maximum flow increase	0.8	1.3	1.5	1.8	1.8	1.5	0.7
Big Thompson River below Loveland WWTP (USGS gage 06741510)	Existing average flow	41	251	296	129	84	37	28
	Existing maximum flow	292	2,078	1,493	418	153	84	111
	Maximum flow increase	0	0.8	0.8	1.6	3.3	5.1	4.9

[1] Existing average flow and maximum flow are at stream gage locations. Maximum flow increases are at Participants' WWTPs and dispersed return flow locations from outdoor use.

Gap return flows would be less. Streamflow would increase during the months of April through October, but there would be no change in streamflow from November to March.

It is important to note that Windy Gap water is reusable to extinction. The majority of Participants reuse Windy Gap effluent either through nonpotable reuse systems, as an exchange supply, as return flow credit, or as augmentation water. Each Participant's anticipated first use and reuse of its Windy Gap supplies was taken into account when estimating Windy Gap return flows to East Slope streams.

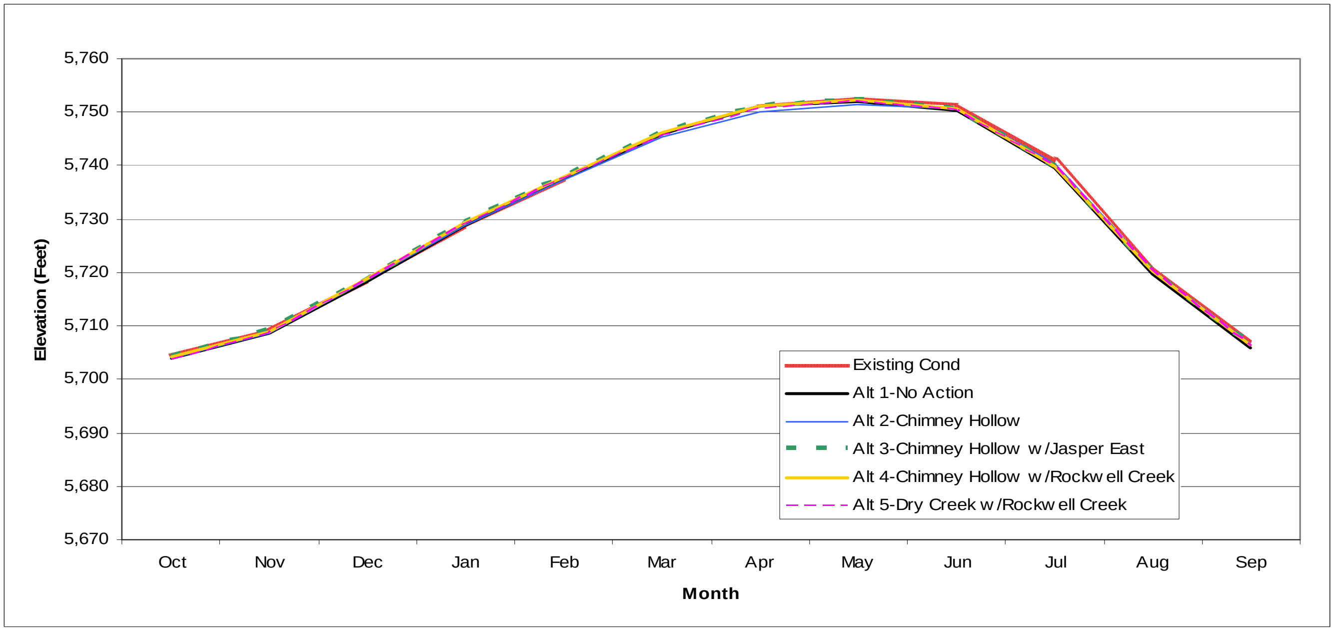
Windy Gap Participants may also increase their reuse capabilities in the future, which would reduce return flows.

Carter Lake

In general, Carter Lake contents would be less than existing conditions under all alternatives due primarily to differences in C-BT deliveries from Carter Lake to meet Windy Gap demands via instantaneous deliveries. Under the Proposed Action, C-BT deliveries to Chimney Hollow could reduce C-BT deliveries to Carter Lake if available capacity in the Adams Tunnel is limited or C-BT contents in Granby Reservoir are exhausted.

Average monthly Carter Lake contents under No Action would decrease from about 30 AF to 1,300 AF compared to existing conditions. The largest monthly change in the volume of water stored in Carter Lake that would occur under the No Action alternative would be a 2 percent reduction in average years, a 1 percent reduction in dry years and a 3 percent reduction in wet years. The maximum monthly lake elevation change under No Action would be a decrease of 1 foot in average years (Figure 3-17), less than 1 foot in dry years, and 2 feet in wet years. Similar changes in reservoir content would occur under the Proposed Action, with a maximum monthly decrease of 1 percent in average years, a 2 percent reduction in dry years, and a 3 percent reduction in wet years. The

Figure 3-17. Carter Lake estimated average monthly surface elevation for all alternatives.



maximum monthly lake elevation would decrease 1 foot in average and dry years and would decrease 2 feet in wet years under the Proposed Action. Carter Lake monthly elevations would decrease by 2 feet or less on average for Alternatives 3, 4, and 5.

For all alternatives, the greatest change would occur in summer months. There is little difference from existing conditions in average years under all alternatives during winter months because Windy Gap demands would be less compared to summer months and there would be less or no Windy Gap water in Granby Reservoir available for delivery. In wet and dry years under the Proposed Action, Windy Gap deliveries would be made almost exclusively from Chimney Hollow during the winter months, as opposed to instantaneous deliveries from Carter Lake under existing conditions.

During periods of consecutive dry years, Carter Lake could be as much as 7 feet lower than existing conditions under No Action due to differences in Windy Gap demands and instantaneous deliveries out of Carter Lake. In more severe dry years when C-BT contents in Granby Reservoir are exhausted, Carter Lake under the Proposed Action could be as much as 27 feet lower; however, the chance of a decrease in the elevation of Carter Lake exceeding 4 feet in any given year would be about 6 percent. Under the Proposed Action, C-BT contents in Granby Reservoir would be exhausted earlier in dry year sequences due to C-BT deliveries to Chimney Hollow in previous years. As a result, the amount of C-BT water available for delivery to Carter Lake and Horsetooth Reservoir would be less, and consequently C-BT contents in those reservoirs would be less.

Horsetooth Reservoir

As with Carter Lake, differences in Horsetooth Reservoir content for the alternatives would primarily be due to differences in instantaneous C-BT deliveries from Horsetooth to meet Windy Gap demands. This is less of a factor for Horsetooth Reservoir than Carter Lake because there is less Windy Gap demand north of Horsetooth versus south of Carter Lake. In addition, for the Proposed Action, differences in Horsetooth Reservoir content would be primarily due to C-BT deliveries to Chimney Hollow Reservoir, which could reduce C-BT deliveries to Horsetooth if available capacity in the Adams Tunnel was limiting or C-BT contents in Granby Reservoir were exhausted in more severe dry years.

The average monthly volume of water in Horsetooth Reservoir under No Action would decrease in average years from about 100 AF to 700 AF compared to existing conditions. This would be less than a 1 percent reduction in average, dry, and wet years. The decrease in monthly average lake elevation under No Action would be less than 1 foot in average and dry years and plus or minus 1 foot in wet years (Figure 3-18).

The average monthly decrease in Horsetooth Reservoir storage under the Proposed Action would range from about 3,000 AF to 10,600 AF compared to existing conditions. The largest change in the average monthly volume of Horsetooth Reservoir that would occur under the Proposed Action would be an 8 percent reduction in the spring of average years, a 12 percent reduction in July during dry years, and a 9 percent reduction in the spring of wet years. The estimated maximum average monthly elevation change would occur primarily in the spring and summer (6 feet in average years, 7 feet in wet years, and 9 feet in dry years) and would be greater for the Proposed Action than other alternatives (Figure 3-18). Horsetooth Reservoir contents under the Proposed Action could be up to 35 to 40 feet lower than existing conditions in successive dry years if C-BT contents in Granby Reservoir are exhausted due to C-BT deliveries to Chimney Hollow Reservoir in previous years. The chance of a decrease in Horsetooth of more than 10 feet in any given year would be about 15 percent.

Average monthly Horsetooth Reservoir contents would be up to 2 percent lower than existing conditions for Alternatives 3 and 4, and up to 3 percent lower under Alternative 5. Average monthly content in Horsetooth would be higher under Alternatives 3 and 4 than other alternatives and existing conditions in winter months, particularly during wet years. Typically there would be less Windy Gap water in Granby Reservoir in the winter months under Alternative 3 or 4; therefore, Windy Gap deliveries would be made from Chimney Hollow, Jasper East, or Rockwell in those months as opposed to instantaneous delivery from Horsetooth.

3.5.2.8 New and Enlarged Reservoirs

Ralph Price Reservoir

Ralph Price Reservoir storage would only change under the No Action alternative. It was assumed that operation of the existing storage of about 16,200 AF would not change (except for evaporation losses) due to the enlargement. Fluctuations in reservoir storage associated with the 13,000 AF of additional storage would be due to evaporation, exchanges of Windy Gap water to storage and Windy Gap releases to meet Longmont's demands (Figure 3-19).

Figure 3-18. Horsetooth Reservoir estimated average monthly surface elevation for all alternatives.

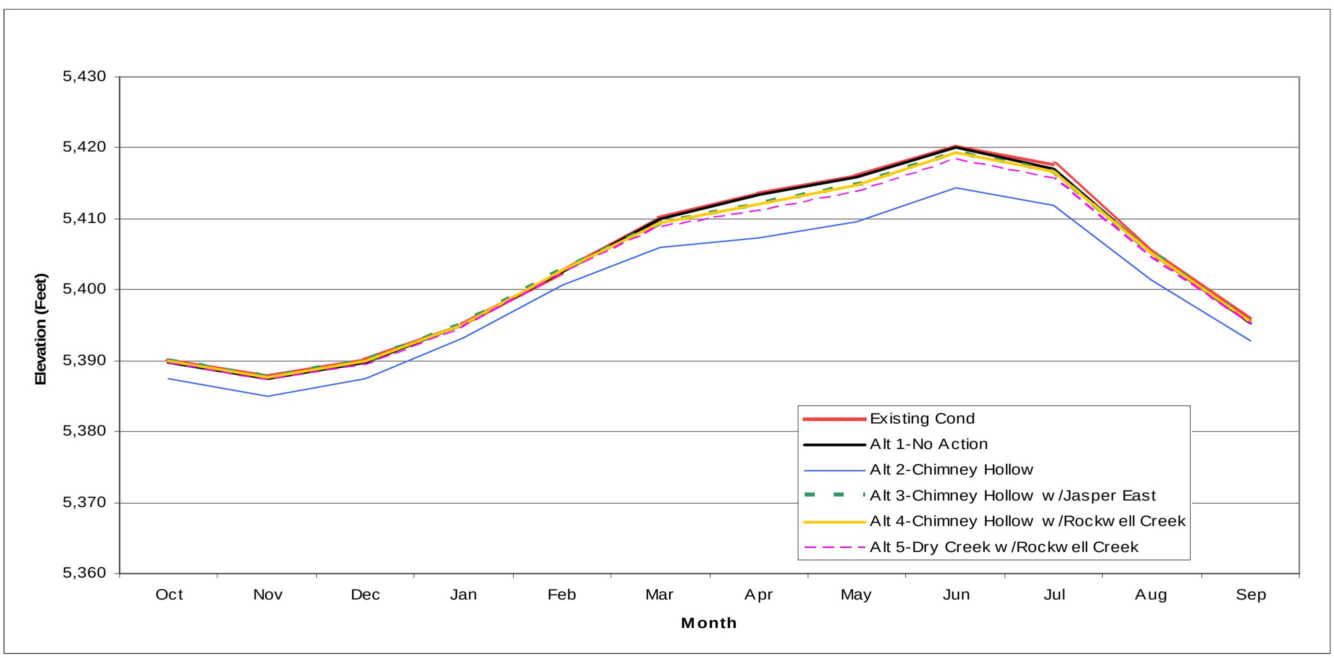
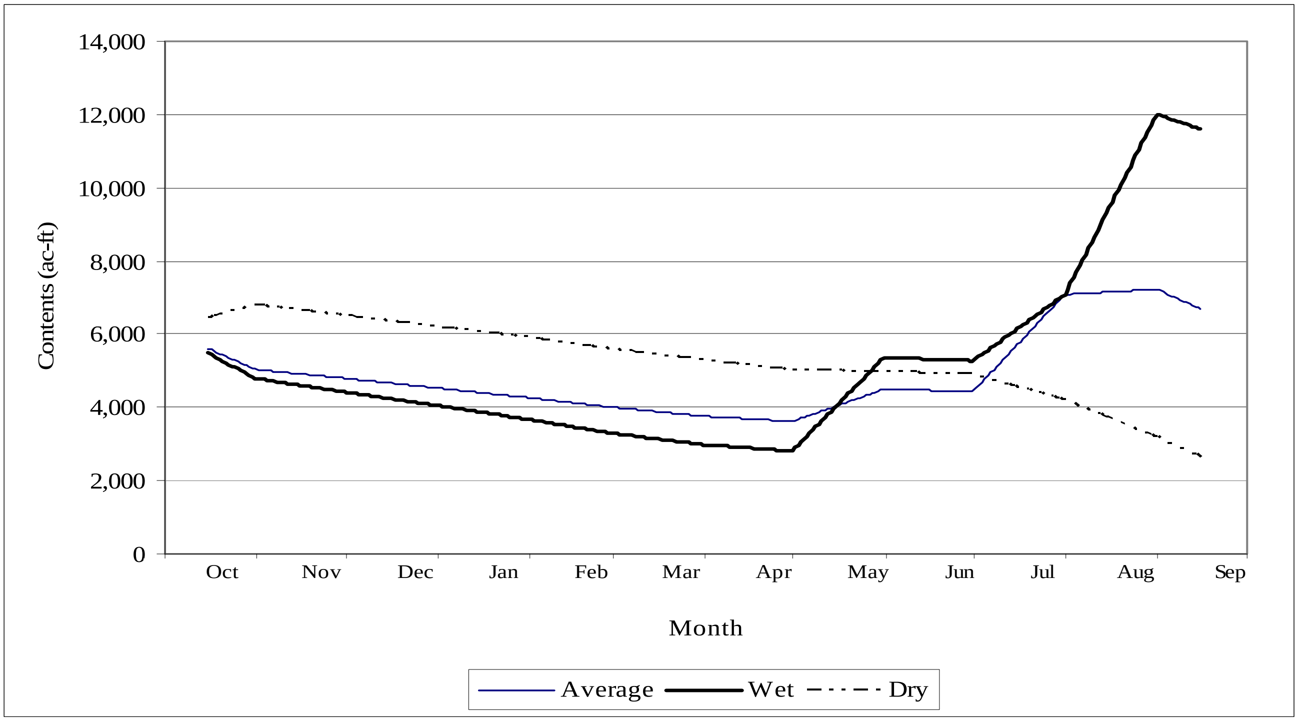


Figure 3-19. Ralph Price Reservoir daily content for 13,000 AF of new storage.



Chimney Hollow Reservoir

A 90,000 AF Chimney Hollow Reservoir would remain nearly full with both C-BT and Windy Gap water under the Proposed Action (Figure 3-20). Small fluctuations reflect evaporation losses and deliveries to meet demands. Windy Gap contents in Chimney Hollow typically would increase during the runoff season when Windy Gap water is diverted and exchanged into Chimney Hollow and would decrease through the remainder of the year as releases are made to meet Windy Gap demands. During dry year sequences, less Windy Gap water would be diverted and stored in Chimney Hollow; consequently, C-BT contents would be highest in those years under the Proposed Action.

Storage in a 70,000 AF Chimney Hollow Reservoir under Alternatives 3 and 4 would increase during the runoff season as Chimney Hollow fills and decrease through the remainder of the year as releases are made to meet Windy Gap demands (Figure 3-21). Chimney Hollow would fill during periods of two or more consecutive wet years. The reservoir contents appear higher at the beginning of the water year in dry years because during the model study period, the years preceding dry years were generally wetter than the years preceding wet or average years. Therefore, the reservoir contents would be higher carried over from a wet year, but would drop throughout the year under dry conditions. Chimney Hollow contents would be lowest following consecutive dry years.

Jasper East Reservoir

The volume of water in Jasper East Reservoir would fluctuate considerably throughout the year and from year to year under Alternative 3 (Figure 3-22).

In general, Jasper East would fill during the Windy Gap diversion season and then empty prior to the following diversion season as releases are made to meet Windy Gap demands. Releasing Windy Gap water from Jasper East to meet demands prior to releasing from Chimney Hollow would maximize the space available in Jasper East for Windy Gap diversions when Granby Reservoir and the Adams Tunnel are full. Jasper East Reservoir would not fill in dry year sequences because Windy Gap diversions would be limited by the physically and legally accessible supply available for diversion. However, in most average and wet years, Jasper East would fill as long as there are sufficient supplies after Windy Gap diversions to Chimney Hollow Reservoir.

Figure 3-20. Chimney Hollow Reservoir daily content under the Proposed Action.

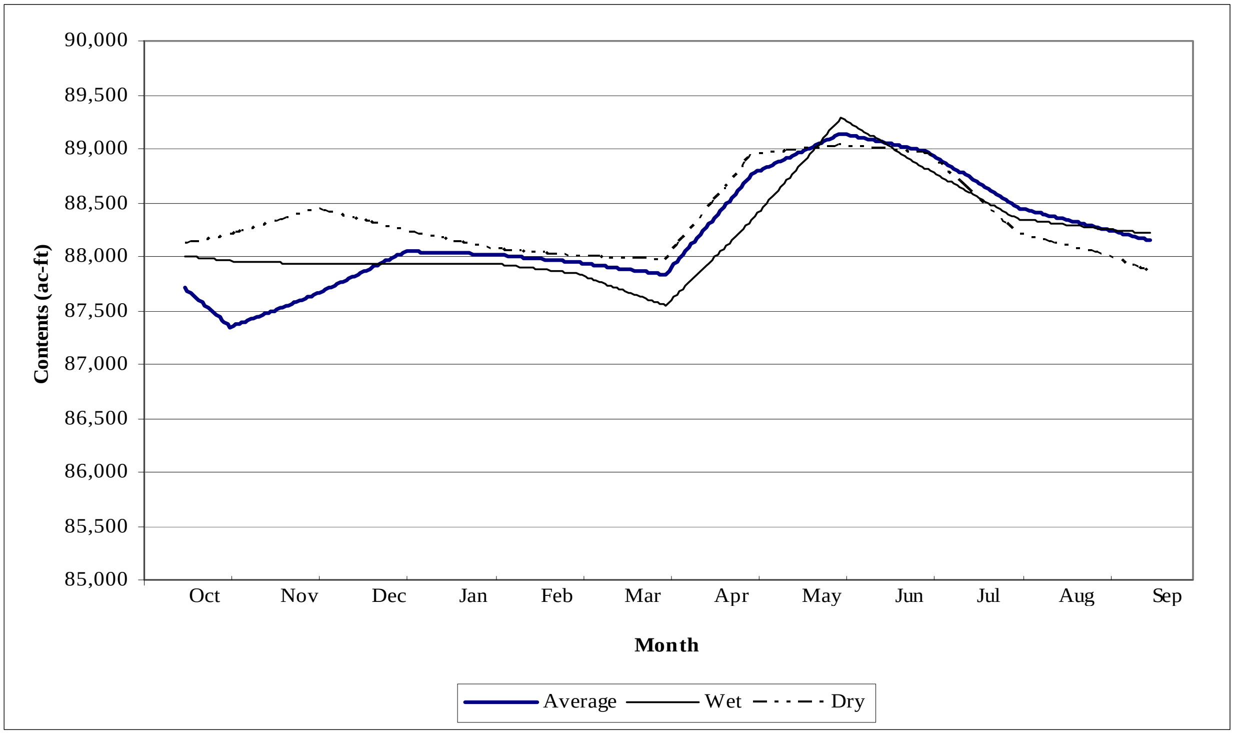


Figure 3-21. Chimney Hollow Reservoir daily content under Alternatives 3 and 4.

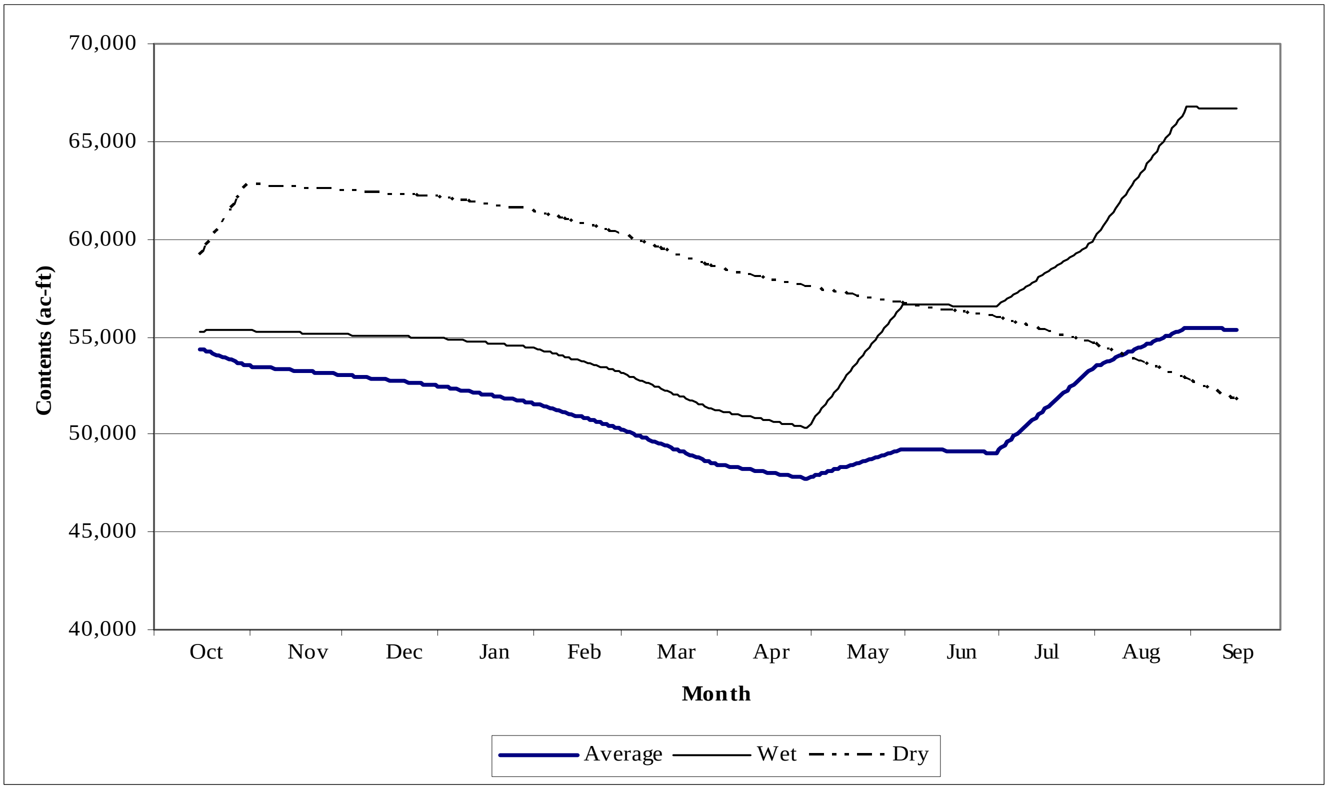
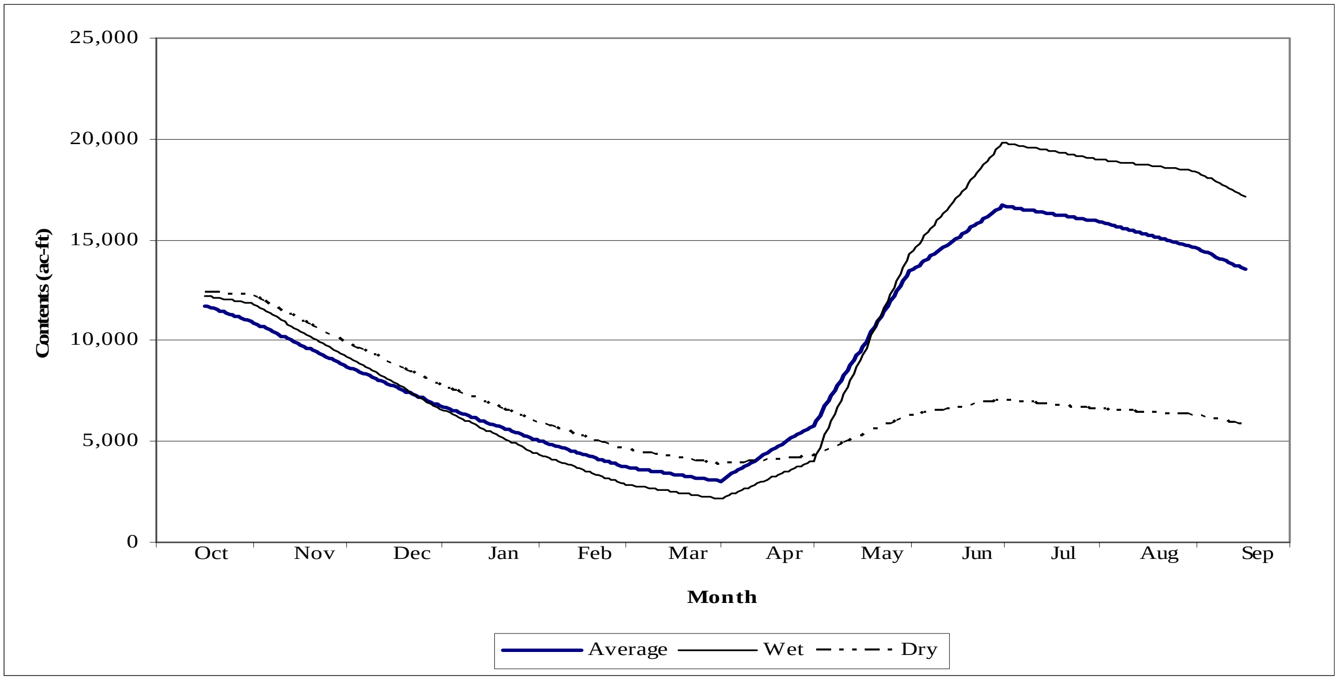


Figure 3-22. Jasper East Reservoir daily content under Alternative 3.



Dry Creek Reservoir

Dry Creek Reservoir under Alternative 5 would operate the same as Chimney Hollow Reservoir in Alternatives 3 and 4. Storage in a 60,000 AF Dry Creek Reservoir would increase during the runoff season and decrease through the remainder of the year as releases are made to meet Windy Gap demands (Figure 3-23). Dry Creek would fill during periods of two or more consecutive wet years. The reservoir contents appear higher at the beginning of the water year in dry years because, during the model study period, the years preceding dry years were generally wetter than the years preceding wet or average years. Therefore, the reservoir contents would initially be higher carried over from a wet year, but would drop throughout the year under dry conditions. Dry Creek Reservoir contents would be lowest following consecutive dry years.

Rockwell/Mueller Creek Reservoir

A 20,000 AF Rockwell Reservoir under Alternative 4 or a 30,000 AF reservoir under Alternative 5 would operate similarly to Jasper East Reservoir. Rockwell Reservoir would be more efficient in terms of storage versus surface area than Jasper East and thus would have less evaporative loss. However, the difference in evaporation would result in a negligible difference in reservoir contents, Windy Gap diversions, and Colorado River flow between alternatives. Rockwell Reservoir would fill from Windy Gap diversions in the runoff season and then decrease over the year as water is released to meet demand. Figure 3-24 shows annual fluctuations for a 30,000 AF Rockwell Reservoir. A 20,000 AF Rockwell Reservoir would follow a similar pattern of fill and drain. Because Windy Gap water would be moved to the East Slope as soon as possible, reservoir content would fluctuates widely.

Figure 3-23. Dry Creek Reservoir daily content under Alternative 5.

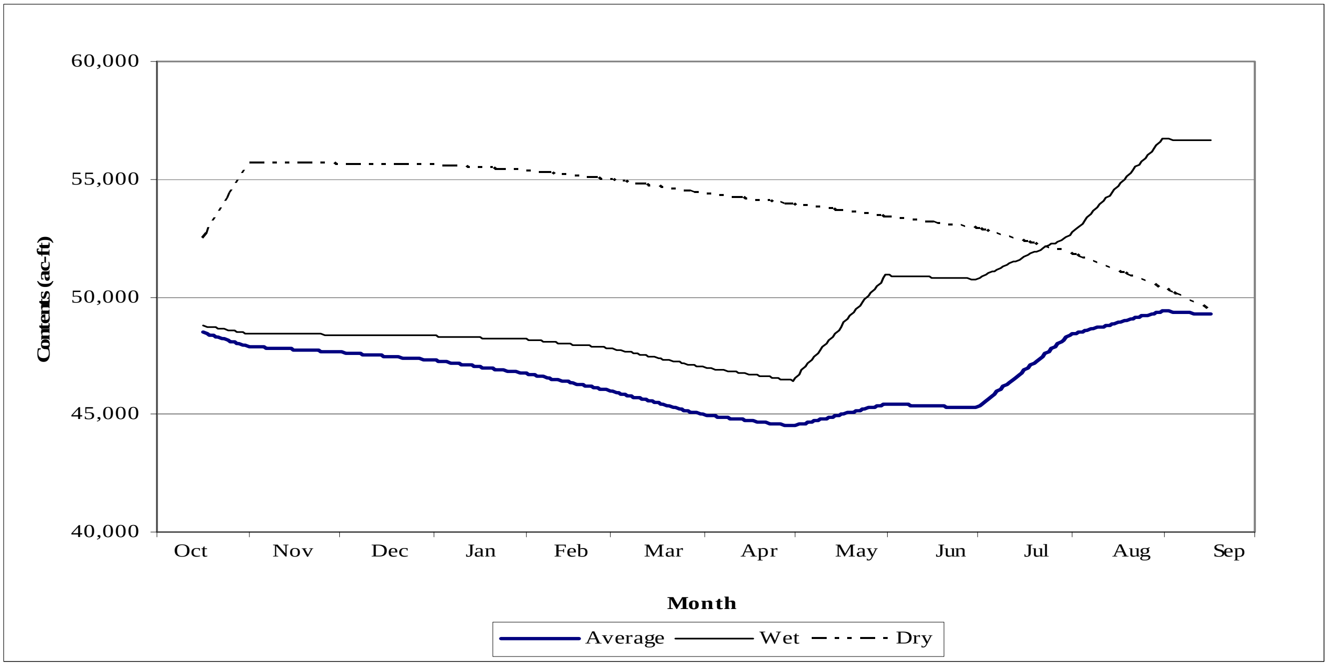
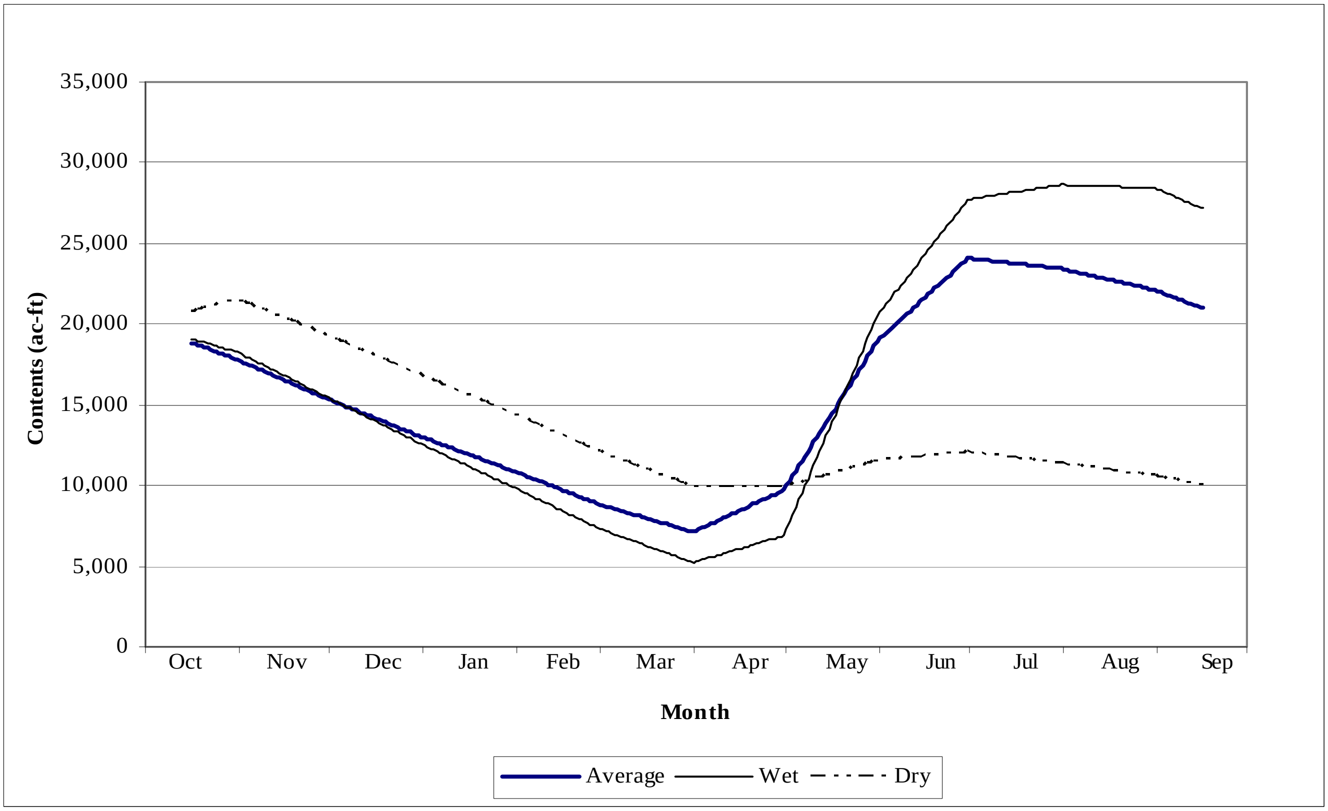


Figure 3-24. Rockwell Reservoir (30,000 AF) daily content under Alternative 5.



3.5.2.9 Windy Gap Firming Project Yield

The projected average and firm water yield to Participants in the WGFP was calculated for each alternative (Table 3-12).

Table 3-12. Windy Gap Participant demand, average, and firm yield.

Condition/ Alternative	Demand	Average Yield	Firm Yield
	AF		
Existing Conditions	20,825	11,372	0
Alternative 1 No Action	36,665	21,936	1,229
Alternative 2 Proposed Action Chimney Hollow	29,130	29,010	26,559
Alternative 3 Chimney Hollow and Jasper East	28,420	28,259	25,849
Alternative 4 Chimney Hollow and Rockwell	28,420	28,284	25,849
Alternative 5 Dry Creek and Rockwell	29,200	29,071	26,629

Demand for Windy Gap water increases from existing conditions for all alternatives. The higher future demand under the No Action alternative would occur because Participants would try to maximize their use of Windy Gap water when it is available. Under the action alternatives, the Participants' demands reflect the amount of Windy Gap water that could be delivered each year without any shortage, which is defined as the firm yield. In other words, the Participants would operate the Windy Gap Project to provide firm yield based on the amount of available storage. While Windy Gap demands would be higher under No Action, average Windy Gap deliveries would be less than the action alternatives because C-BT storage space would be unavailable for Windy Gap in wet years and an enlarged Ralph Price Reservoir would provide the only additional firming storage. As a result, Windy Gap spills would be higher and there would be little to no Windy Gap water carried over to meet demands in dry years and consecutive wet years.

The No Action alternative would have a firm yield of about 1,229 AF/year due to the additional storage at Ralph Price Reservoir compared to existing conditions firm yield of zero (Table 3-12). This yield would only accrue to the City of Longmont. The firm yield for other Participants would remain zero under the No Action alternative.

The yield for the action alternatives would be similar because the storage volumes would be the same. The Proposed Action would have a firm yield of about 26,600 AF including the yield for MPWCD. Alternative 5 would have a slightly higher yield and Alternatives 3 and 4 would have a slightly lower yield. Individual Participant firm yield under the Proposed Action is shown in Table 3-13.

All action alternatives include 3,000 AF of storage for MPWCD's Windy Gap water. Under existing conditions, MPWCD can only store its Windy Gap water in Granby Reservoir; therefore, MPWCD's firm yield is zero. Under the No Action alternative, the firm yield for the MPWCD would remain zero, but average yield would increase from about 100 AF to 2,000 AF because of an increase in the MPWCD's demand for Windy Gap water in the future. Under the action alternatives, the firm annual yield to the MPWCD would be 429 AF and the average yield would be about 2,900 AF.

Table 3-13. Windy Gap Firming Project Participant firm yield for the Proposed Action.

Participant	Firm Yield (AF)[1]
Broomfield	5,600
CWCWD	93
Erie	1,840
Evans	455
Ft. Lupton	265
Greeley	2,230
Lafayette	610
Longmont	4,515
Louisville	825
Loveland	2,075
LTWD	1,200
MPWCD	429
Platte River	5,050
Superior	1,380

[1] Values rounded.

The water demand for Windy Gap unit holders not in the Firming Project would increase in the future for all alternatives and as a result, the average yield to non-Participants would increase. Windy Gap average yield for non-Participants would increase from about 140 AF under existing conditions to about 2,200 AF for the No Action alternative and 2,300 AF under the action alternatives. Windy Gap yield for non-Participants would increase because more storage for non-Participant water would be available in Granby Reservoir, and because the WGFP Participant's water would be stored in firming reservoir(s) and consequently non-Participant Windy Gap spills from Granby Reservoir would decrease. The firm yield to non-Participants would remain zero under all alternatives.

3.5.3 Cumulative Effects

Several water-based reasonably foreseeable actions on the West Slope were considered in the evaluation of cumulative hydrologic effects. These actions, as described in more detail in Chapter 2, Section 2.8, are:

- Denver Water Moffat Collection System Project
- Urban growth in Grand and Summit County
- Changes in releases from Williams Fork and Wolford Mountain reservoirs for endangered fish
- Wolford Mountain Reservoir contract demand
- Expiration of Denver Water's contract with Big Lake Ditch
- Periodic reduction of Xcel Energy's Shoshone Power Plant call

The same models used for the assessment of direct hydrologic effects were used for cumulative effects. The future operation of the Shoshone Power Plant call reduction was not reflected in the model because it would only occur under certain conditions, which are difficult to include in the model because the conditions are based on forecasted values. Thus, the effect of this future action is discussed separately. Additional information on reasonably foreseeable actions and cumulative effects and how they were addressed in the model is found in the Water Resource Technical Report (ERO and Boyle 2007).

The year 2030 was used as the time period for the assessment of cumulative effects because it is projected that the full demand for WGFP water would occur by then, as would most of the reasonably foreseeable actions.

3.5.3.1 Summary Comparison of Hydrologic Changes

Model simulations of hydrologic changes with reasonably foreseeable actions in place for each alternative were generated and are summarized in Table 3-14, Table 3-15, and Table 3-16. These tables indicate average changes from existing conditions for the 1950 to 1996 study period and for the five wettest and five driest years similar to those presented in the direct effects discussion in Section 3.5.2.4. Because of the similarity in the effects of Alternatives 3, 4, and 5, the cumulative effects analysis used the results of Alternative 5 as representative of these three alternatives.

3.5.3.2 Facilities, Streams, and Lakes Affected by Reasonably Foreseeable Actions

Four major Colorado River tributaries—Fraser River, Williams Fork River, Muddy Creek, and Blue River—would experience changes in flow from reasonably foreseeable actions. WGFP alternatives would not affect flow in these tributaries. Reasonably foreseeable actions that affect tributary flow to the Colorado River are briefly discussed below as are other future actions that could affect Colorado River flow.

Fraser River

Average annual flows in the Fraser River at the mouth would be about 91,000 AF under existing conditions and 79,700 AF in the future for all alternatives (Table 3-14). The reduction in flow in the Fraser River in the future would be due primarily to Denver Water's (Denver) additional transbasin diversions through Moffat Tunnel and urban growth and increased water use in Grand County. Denver's average annual demand for Fraser River deliveries through the Moffat Tunnel would increase by about 9,300 AF, and depletions associated with future water use in the Fraser River basin would increase by about 1,600 AF compared to existing conditions.

Table 3-14. Cumulative effects – comparison of average annual year flow and diversion amounts (AF) at key locations.

Location	Existing Conditions	Alternative 1—No Action			Alternative 2—Chimney Hollow w/Pre-positioning			Alternative 5—Dry Creek w/Rockwell Creek		
	Avg. Annual Flow	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.
Adams Tunnel diversions	243,179	251,943	8,764	4%	259,583	16,404	7%	258,933	15,755	6%
Granby Reservoir spills	38,707	31,896	-6,812	-18%	26,142	-12,566	-32%	27,890	-10,817	-28%
Colorado River below Granby Reservoir	59,385	52,976	-6,409	-11%	47,880	-11,505	-19%	49,403	-9,981	-17%
Willow Creek feeder diversions	36,172	37,828	1,656	5%	39,010	2,837	8%	38,586	2,414	7%
Willow Creek at the confluence with the Colorado River	18,294	16,685	-1,609	-9%	15,516	-2,777	-15%	15,939	-2,354	-13%
Fraser River at the confluence with the Colorado River	91,025	79,725	-11,300	-12%	79,729	-11,296	-12%	79,714	-11,311	-12%
Colorado River above Windy Gap diversion	187,889	168,544	-19,345	-10%	162,279	-25,611	-14%	164,211	-23,679	-13%
Windy Gap diversions	36,532	38,973	2,441	7%	40,791	4,259	12%	42,991	6,459	18%
Colorado River below Windy Gap	151,358	129,571	-21,787	-14%	121,488	-29,870	-20%	121,220	-30,138	-20%
Colorado River at Hot Sulphur Springs	156,475	134,095	-22,380	-14%	126,006	-30,469	-19%	125,738	-30,737	-20%
Colorado River above the confluence with the Williams Fork River	154,031	131,649	-22,382	-15%	123,559	-30,472	-20%	123,291	-30,740	-20%
Williams Fork River at the confluence with the Colorado River	90,083	95,345	5,262	6%	95,346	5,263	6%	95,346	5,263	6%
Colorado River below the confluence with the Williams Fork River	246,931	229,807	-17,124	-7%	221,718	-25,213	-10%	221,450	-25,481	-10%
Colorado River above the confluence with Troublesome Creek	252,443	227,567	-24,876	-10%	219,479	-32,964	-13%	219,210	-33,233	-13%
Troublesome Creek at the confluence with the Colorado River	52,396	52,425	29	0%	52,425	29	0%	52,425	29	0%
Colorado River above the confluence with the Blue River	379,050	354,135	-24,915	-7%	346,048	-33,002	-9%	345,781	-33,270	-9%
Blue River at the confluence with the Colorado River	313,612	258,663	-54,949	-18%	258,677	-54,935	-18%	258,678	-54,933	-18%
Colorado River near Kremmling	701,801	621,912	-79,889	-11%	613,838	-87,963	-13%	613,572	-88,229	-13%
Colorado River above Pumphouse	696,777	616,888	-79,889	-11%	608,814	-87,963	-13%	608,548	-88,229	-13%
Muddy Creek at the confluence with the Colorado River	65,522	65,502	-20	0%	65,503	-19	0%	65,504	-18	0%
C-BT Diversions from the Big Thompson River	27,990	27,638	-352	-1%	25,154	-2,836	-10%	26,934	-1,056	-4%
Big Thompson River below Lake Estes	66,701	67,118	417	1%	69,684	2,983	4%	67,809	1,108	2%
Big Thompson River at the Canyon Gage	89,367	89,718	352	0%	92,203	2,836	3%	90,422	1,056	1%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. Granby Reservoir spills do not include Windy Gap Spills from Willow Creek Reservoir.

Table 3-15. Cumulative effects – comparison of average annual dry year flow and diversion amounts (AF) at key locations.

Location	Existing Conditions	Alternative 1—No Action			Alternative 2—Chimney Hollow w/Pre-positioning			Alternative 5—Dry Creek w/Rockwell Creek		
	Avg. Annual Flow	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.
Adams Tunnel diversions	314,187	314,886	699	0%	331,654	17,468	6%	324,347	10,160	3%
Granby Reservoir spills	0	0	0	0%	0	0	0%	0	0	0%
Colorado River below Granby Reservoir	21,946	21,946	0	0%	21,946	0	0%	21,946	0	0%
Willow Creek feeder diversions	22,200	22,190	-10	0%	22,190	-10	0%	22,190	-10	0%
Willow Creek at the confluence with the Colorado River	3,962	3,962	0	0%	3,962	0	0%	3,962	0	0%
Fraser River at the confluence with the Colorado River	35,432	30,879	-4,553	-13%	30,787	-4,645	-13%	30,787	-4,645	-13%
Colorado River above Windy Gap diversion	74,938	70,377	-4,561	-6%	70,284	-4,654	-6%	70,284	-4,654	-6%
Windy Gap diversions	7,804	3,860	-3,944	-51%	3,860	-3,944	-51%	3,860	-3,944	-51%
Colorado River below Windy Gap	67,134	66,517	-617	-1%	66,424	-710	-1%	66,424	-710	-1%
Colorado River at Hot Sulphur Springs	70,656	69,494	-1,162	-2%	69,402	-1,254	-2%	69,402	-1,254	-2%
Colorado River above the confluence with the Williams Fork River	67,380	66,187	-1,194	-2%	66,094	-1,286	-2%	66,094	-1,286	-2%
Williams Fork River at the confluence with the Colorado River	77,202	80,600	3,398	4%	80,659	3,456	4%	80,659	3,456	4%
Colorado River below the confluence with the Williams Fork River	147,416	149,639	2,223	2%	149,605	2,188	1%	149,605	2,188	1%
Colorado River above the confluence with Troublesome Creek	149,898	143,765	-6,133	-4%	143,730	-6,168	-4%	143,730	-6,168	-4%
Troublesome Creek at the confluence with the Colorado River	27,418	27,494	77	0%	27,494	77	0%	27,494	77	0%
Colorado River above the confluence with the Blue River	229,222	226,876	-2,346	-1%	226,593	-2,629	-1%	226,593	-2,629	-1%
Blue River at the confluence with the Colorado River	213,141	193,013	-20,128	-9%	192,944	-20,198	-9%	192,943	-20,198	-9%
Colorado River near Kremmling	450,286	427,728	-22,558	-5%	427,376	-22,911	-5%	427,375	-22,911	-5%
Colorado River above Pumphouse	445,113	422,555	-22,558	-5%	422,202	-22,911	-5%	422,202	-22,911	-5%
Muddy Creek at the confluence with the Colorado River	42,760	46,396	3,636	9%	46,147	3,387	8%	46,147	3,387	8%
C-BT Diversions from the Big Thompson River	551	687	136	25%	0	-551	-100%	0	-551	-100%
Big Thompson River below Lake Estes	53,535	53,399	-136	0%	54,086	551	1%	54,086	551	1%
Big Thompson River at the Canyon Gage	67,160	67,024	-136	0%	67,711	551	1%	67,711	551	1%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. Granby Reservoir spills do not include Windy Gap Spills from Willow Creek Reservoir.

Table 3-16. Cumulative effects – comparison of average annual wet year flows and diversion amounts (AF) at key locations.

Location	Existing Conditions	Alternative 1—No Action			Alternative 2—Chimney Hollow w/Pre-positioning			Alternative 5—Dry Creek w/Rockwell Creek		
	Avg. Annual Flow	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.	Avg. Annual Flow	Difference	Percent Diff.
Adams Tunnel diversions	180,787	195,934	15,147	8%	189,327	8,540	5%	199,666	18,879	10%
Granby Reservoir spills	129,094	115,508	-13,586	-11%	110,794	-18,301	-14%	111,191	-17,904	-14%
Colorado River below Granby Reservoir	144,383	132,303	-12,080	-8%	128,133	-16,250	-11%	128,342	-16,040	-11%
Willow Creek feeder diversions	33,685	39,707	6,022	18%	40,417	6,732	20%	40,317	6,632	20%
Willow Creek at the confluence with the Colorado River	52,778	46,756	-6,022	-11%	46,046	-6,732	-13%	46,146	-6,632	-13%
Fraser River at the confluence with the Colorado River	178,477	156,645	-21,832	-12%	156,715	-21,762	-12%	156,501	-21,976	-12%
Colorado River above Windy Gap diversion	403,835	363,899	-39,935	-10%	359,091	-44,744	-11%	359,185	-44,650	-11%
Windy Gap diversions	38,512	62,118	23,606	61%	69,417	30,905	80%	71,699	33,186	86%
Colorado River below Windy Gap	365,323	301,782	-63,541	-17%	289,674	-75,649	-21%	287,486	-77,836	-21%
Colorado River at Hot Sulphur Springs	369,677	305,471	-64,206	-17%	293,363	-76,314	-21%	291,175	-78,501	-21%
Colorado River above the confluence with the Williams Fork River	369,268	305,065	-64,204	-17%	292,957	-76,311	-21%	290,769	-78,499	-21%
Williams Fork River at the confluence with the Colorado River	138,018	145,540	7,522	5%	145,541	7,522	5%	145,541	7,522	5%
Colorado River below the confluence with the Williams Fork River	509,758	453,068	-56,691	-11%	440,960	-68,798	-13%	438,772	-70,986	-14%
Colorado River above the confluence with Troublesome Creek	519,392	455,774	-63,618	-12%	443,667	-75,725	-15%	441,479	-77,913	-15%
Troublesome Creek at the confluence with the Colorado River	92,324	92,325	1	0%	92,325	1	0%	92,325	1	0%
Colorado River above the confluence with the Blue River	706,315	642,668	-63,646	-9%	630,562	-75,752	-11%	628,373	-77,941	-11%
Blue River at the confluence with the Colorado River	493,554	412,397	-81,157	-16%	412,284	-81,271	-16%	412,393	-81,161	-16%
Colorado River near Kremmling	1,217,038	1,072,235	-144,803	-12%	1,060,014	-157,024	-13%	1,057,934	-159,104	-13%
Colorado River above Pumphouse	1,212,435	1,067,632	-144,803	-12%	1,055,411	-157,024	-13%	1,053,331	-159,104	-13%
Muddy Creek at confluence with the Colorado River	86,980	86,999	19	0%	86,999	20	0%	86,998	19	0%
C-BT Diversions from the Big Thompson River	67,946	68,058	112	0%	66,763	-1,182	-2%	67,915	-30	0%
Big Thompson River below Lake Estes	72,849	72,874	25	0%	74,701	1,851	3%	72,874	25	0%
Big Thompson River at the Canyon Gage	108,593	108,480	-112	0%	109,775	1,182	1%	108,623	30	0%

Note: Differences indicate a volume (AF) or percent change compared to existing conditions. A positive difference denotes an increase in flow. Granby Reservoir spills do not include Windy Gap Spills from Willow Creek Reservoir.

Other diversions in the Fraser River basin that would be affected by reasonably foreseeable actions would reduce average annual flows at the mouth of the Fraser River by about 400 AF. Thus, the total reduction in average annual flows at the mouth of the Fraser River in the future would be about 11,300 AF (Table 3-14).

Williams Fork River

Average annual flows in the Williams Fork River at the mouth would be about 90,100 AF under existing conditions and 95,300 AF in the future for all alternatives (Table 3-14). Changes in the quantity and timing of flows in the Williams Fork River would be primarily due to the combined effects of the following reasonably foreseeable actions.

- Denver Water would no longer release 5,412.5 AF/year from Williams Fork Reservoir for endangered fish. These releases are typically made in the fall when flows drop below the FWS flow recommendations. Thus, fall flows would decrease compared to existing conditions. Denver's additional transbasin diversions from the Fraser, Williams Fork, and Blue rivers would result in increased exchange releases from Williams Fork Reservoir to cover Denver's out-of-priority depletions and increased substitution releases to cover Denver's out-of-priority storage in Dillon Reservoir when Green Mountain Reservoir does not fill. The net effect of additional exchange releases and reductions in fish flow releases would be offset by a corresponding change in the amount of water stored in Williams Fork on average. As a result, changes in Williams Fork Reservoir operations (storage and releases) would affect the timing of flows below the reservoir, but the change in the average annual quantity of flow due to these future actions would be relatively small.
- Denver's future growth and implementation of the Moffat Collection System Project would result in about 2,000 AF of additional transbasin diversions from the Williams Fork River basin in the future.
- Big Lake Ditch diversions would decrease, deliveries to the Reeder Creek drainage for irrigation would be curtailed, and all Big Lake Ditch return flows would accrue to the Williams Fork River. These changes would result in approximately 8,800 AF/year less depletion and a corresponding increase in flows on average in the Williams Fork River basin versus existing conditions. The reduction in Big Lake Ditch diversions would not increase the physical supply available to Denver Water to divert through Jones Tunnel, but would increase the supply available for storage in Williams Fork Reservoir.

Other diversions in the Williams Fork River basin also would be affected due to reasonably foreseeable actions. The combined effect of the future actions described above would increase average annual flows at the mouth of Williams Fork River by approximately 5,300 AF compared to existing conditions. Average annual flows in the Colorado River downstream of the Reeder Creek drainage would decrease by about 7,750 AF/year due to reduction in Big Lake Ditch return flows. This difference in flows in the Colorado River would occur below the confluence of the Williams Fork River and above the confluence with Troublesome Creek.

Muddy Creek

Average annual flows in Muddy Creek at the mouth are about 65,500 AF under existing conditions and would be the same in the future for all alternatives (Table 3-14). Flows in Muddy Creek are influenced by Wolford Mountain Reservoir operations. Wolford Mountain Reservoir's primary operations include releases to cover Denver's and Colorado Springs' substitution requirements for out-of-priority diversions when Green Mountain Reservoir does not fill, releases to cover contract demands, and releases for endangered fish flow requirements. The following reasonably foreseeable actions would have the greatest effect on Wolford Mountain Reservoir operations.

- Endangered fish flow releases of 5,412.5 AF/year would no longer be made from Wolford Mountain Reservoir, which would reduce flows in the fall. However, less water would be stored during the runoff season to replace these releases, so flows during runoff would increase on average below the reservoir due to differences in the amounts stored and the timing and quantity of spills.

- The future demand for contract water from Wolford Mountain Reservoir is anticipated to increase to about 11,100 AF/year by 2030 (Boyle 2006a). Releases from Wolford Mountain Reservoir would be required to cover future monthly depletions if the depletions are out of priority. The specific entities that would contract for this water in the future and the locations of the depletions have not been identified. Of the total future contract demand, the average annual modeled release from Wolford Mountain Reservoir to meet this demand would increase about 7,325 AF/year primarily during winter months and in summer months of dry years versus existing conditions. However, more water would be stored during the runoff season to replace these releases, so flows during runoff decrease on average below the reservoir compared to existing conditions.
- Wolford Mountain Reservoir's substitution releases for Denver and Colorado Springs also would be affected by reasonably foreseeable actions that would reduce flows in the Blue River and Colorado River and increase the call on the Colorado River. The amount of water diverted out of priority by Denver and Colorado Springs in relation to Green Mountain Reservoir would increase in the future. As a result, substitution releases from Wolford Mountain would increase in the future in dry years compared to existing conditions.

The net effect of the future actions would have little effect on average annual Muddy Creek flows for any alternative (Table 3-14). There would be changes in the timing of flows below the reservoir but minimal change in the quantity of flows on an average annual basis. In the future, flows generally would increase on average from August through March. In these months, additional reservoir releases to meet increased contract demands and substitution requirements would exceed the reduction in releases to meet fish flow requirements on average. Flows would generally decrease on average during the runoff season because more water would be stored to replace releases and spills would be reduced. Average annual dry year flows in Muddy Creek would increase about 8 to 9 percent under the alternatives compared to existing conditions (Table 3-15); however, there would be no change in wet year flows (Table 3-16).

Blue River

Average annual flows in the Blue River at the mouth is about 313,600 AF under existing conditions and would be about 258,700 AF in the future for all alternatives (Table 3-14). The reduction in flows in the Blue River in the future would be due primarily to Denver's additional transbasin diversions through Roberts Tunnel and increased depletions due to urban growth in the Blue River basin. Denver's average annual delivery through the Roberts Tunnel would increase by about 54,000 AF and depletions associated with urban growth in Summit County would increase by about 3,000 AF in the future compared to existing conditions. Additional diversions in Summit County due to growth in outdoor water use and snowmaking demands would result in both additional depletions and changes in return flows. There also would be some effect on other diversions in the Blue River basin, and Dillon Reservoir and Green Mountain Reservoir operations due to reasonably foreseeable actions. The net effect would be an average annual reduction in flow of about 55,000 AF at the mouth of the Blue River (Table 3-14).

Colorado River

Streamflow changes in the Colorado River are possible in some dry years from implementation of the Shoshone call reduction. The triggers to invoke a relaxation of the Shoshone call are based on forecasts of Denver's total system storage and the March 1 NRCS forecast for Colorado River flows at Kremmling or Dotsero. The relaxation of the Shoshone call would allow diversions that would otherwise be called out to divert water in-priority even if they are junior to the Shoshone Power Plant water rights. Because more diversions would be made in-priority, releases from reservoirs such as Green Mountain, Wolford Mountain, and Williams Fork for exchange or substitution purposes would also be less. In-priority diversion increases and reduced reservoir releases for exchange and/or substitution would decrease flows in the Upper Colorado River basin during the relaxation period. Colorado River flows at Dotsero would not be affected outside of the relaxation period.

The magnitude and timing of flow reductions attributable to a Shoshone call relaxation could vary widely from year-to-year and would depend on many factors including streamflows, reservoir storage contents, project operations, and bypass/instream flow requirements. Based on historical July 1 storage contents in Denver's reservoirs and available streamflow forecast data for the Colorado River at Dotsero, the Shoshone call relaxation may have been invoked in about 8 to 10 years during the period from 1947 through 2002, or roughly 1 out of every 6 to 7 years.

The key projects/water rights that would benefit from a Shoshone call relaxation include the Continental-Hoosier Project, Green Mountain Reservoir, Wolford Mountain Reservoir, Denver (Moffat Tunnel, Williams Fork Reservoir, Roberts Tunnel, and Dillon Reservoir), Windy Gap, and the Homestake Project. These projects/facilities would be able to divert more water in-priority even though they are junior to the Shoshone Power Plant water rights. Because more diversions would be made in-priority, releases from reservoirs such as Green Mountain, Wolford Mountain, and Williams Fork Reservoir for exchange or substitution purposes would be less. Increased in-priority diversions and reduced reservoir releases for exchange and/or substitution would decrease flows in the Upper Colorado River basin primarily in the Williams Fork River, Muddy Creek, Blue River, and Colorado River mainstem below the Windy Gap diversion during the relaxation period. The only changes in flows outside of the relaxation period would be due to differences in substitution releases from Wolford Mountain and Williams Fork reservoirs. However, differences in substitution releases would not change flows in the Colorado River below the confluence with the Blue River because these releases are made in lieu of Green Mountain Reservoir Historic User's Pool releases to pay back Green Mountain Reservoir. Flows in the Fraser River basin during the relaxation period would likely not be affected because Denver diversions occur regardless of the Shoshone call. Denver exchanges cover out-of-priority diversions in the Fraser River basin with releases from Williams Fork Reservoir. In 2003 and 2004, the flow reductions due to a relaxation of the Shoshone call totaled 21,234 AF and 26,841 AF, respectively.

3.5.3.3 C-BT and Windy Gap Project Operations and Diversions

Windy Gap Diversions

In general, the reason for the differences in streamflow, reservoir content, diversions, and operations between existing conditions, No Action, and the action alternatives in the future are similar to those discussed in detail for direct effects in Section 3.5.2.5. Windy Gap diversions would generally be less in the future under all alternatives for several reasons:

- The amount of water available for diversion at Windy Gap would decrease in the future because the Fraser River inflow to the Colorado River would decrease on average. Denver's increased demand and the Moffat Collection System Project would increase diversions from the upper Fraser River basin. In addition, growth in Grand County would increase water use and diversions in the Fraser River basin. Denver's and Grand County's increased diversions and depletions in the Fraser River basin are located upstream of the Windy Gap diversion site on the Colorado River and are senior in priority to Windy Gap; therefore, these future actions would reduce the amount of water available for diversion at Windy Gap.
- Additional diversions in Grand County due to growth in outdoor use and snowmaking demands would result in both additional depletions and changes in return flows. For example, additional snowmaking diversions would decrease flows in winter months but increase flows in the summer months due to return flows. Therefore, the change in flows available at Windy Gap would be a combination of the effect of additional diversions and changes in the timing and quantity of return flows.
- The amount of water available for diversion at Windy Gap would change due to

differences in Granby Reservoir spills and WCFC diversions in the future. However, differences in spills and WCFC diversions would typically occur in wet years when Windy Gap diversions are often constrained by other factors (decree limitations and available space in the C-BT system and the firming project reservoirs), as opposed to the physical supply at Windy Gap.

- The amount of water legally available for diversion at Windy Gap would decrease in the future because of downstream calls. In average and wet years, Windy Gap diversions are typically controlled by the 90-cfs minimum downstream flow requirement. In dry years, the amount Windy Gap must bypass to satisfy downstream senior rights are often controlled by the Shoshone Power Plant water rights. The reasonably foreseeable actions could at times change the call on the Colorado River downstream of Windy Gap. In this case, the amount of water legally available to Windy Gap would change. The largest effect from foreseeable actions would be Denver's additional diversions through Roberts Tunnel and depletions associated with urban growth in Summit County. These actions would reduce the amount of Blue River inflow to the Colorado River, which is upstream of the Shoshone Power Plant diversion. As a result, the amount of flow at the Shoshone Power Plant would decrease in the future. The flow that Windy Gap must bypass to satisfy downstream senior rights would be higher on average because the flow available to meet the Shoshone call would decrease in the future.

As a result of reasonably foreseeable actions and the effects on the WGFP, several changes in C-BT operations would occur compared to the direct effects discussed in Section 3.5.2.5. Adams Tunnel deliveries to the East Slope would be less for all alternatives compared to direct effects because of lower Windy Gap diversions. Willow Creek Feeder Canal diversions would be higher in the future because there would be more space available in Granby Reservoir in wet years. Granby Reservoir spills would decrease in the future primarily because less Windy Gap water would be pumped and, therefore, Windy Gap spills would be less. There would be minor differences in C-BT Big Thompson River diversions in the future compared to direct effects with lower Windy Gap imports. Streamflow changes in the Colorado River and elsewhere would also change as discussed below for each location.

Hydropower Generation

Increased net hydropower generation with reasonably foreseeable actions in place would be slightly less than under direct effects because less Windy Gap water would be delivered through the C-BT system. The No Action alternative would result in a net annual increase in power generation of about 15 GW compared to 21 GW for the Proposed Action and about 25 GW for other alternatives (Table 3-17). The Proposed Action would result in about a 4 percent increase in power production compared to existing conditions, and about 1 percent more power than the No Action alternative.

Table 3-17. Comparison of net C-BT hydropower generation between alternatives—cumulative effects.

Power Generation	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Annual Average (GWH)	510	526	532	535	531	531
Annual Maximum (GWH)	642	640	661	663	658	659
Annual Minimum (GWH)	326	343	375	380	376	376
Difference in Annual Average from Existing Conditions (GWH)	—	15	21	25	21	21
Difference in Annual Average from Existing Conditions (%)	—	3%	4.2%	4.8%	4.1%	4.1%

3.5.3.4 West Slope Streams and Existing Reservoirs

Colorado River

Colorado River above the Windy Gap diversion. Average annual Colorado River flows above Windy Gap Reservoir would decrease about 10 percent under No Action compared to a decrease of about 14 percent for the Proposed Action and 13 percent for other alternatives (Table 3-14). There would be no change in flow about 79 percent of the time under No Action and about 77 percent of the time for the action alternatives. Decreases in flow occur about 15 percent of the time and the remainder of the time small increases in flow occur under all alternatives. Changes in Granby Reservoir spills, WCFC diversions, and additional diversions on the Frasier River from the Moffat Collection System Project and Grand County water use contribute to changes in streamflow. Average daily flows on the Colorado River above Windy Gap are shown in Figure 3-25.

Colorado River below the Windy Gap diversion. Average annual streamflow on the Colorado River immediately below the Windy Gap diversion would decrease about 14 percent under No Action and about 20 percent for the Proposed Action and other alternatives (Table 3-14). Reasonably foreseeable future actions would account for about 38 percent of the change in streamflow from existing conditions and the remainder would be from Windy Gap diversions, and changes in the timing and amount of Granby Reservoir spills, and WCFC diversions. In dry years, there would be about a 1 percent decrease in average annual flow for all alternatives (Table 3-15). Wet year flow reductions would be about 10 percent under No Action and 11 percent for the action alternatives (Table 3-16). All alternatives indicate similar changes in the percentage of days that flows change from May to August. There would be no change in Colorado River flows at Hot Sulphur Springs about 7 percent of the time, a decrease in flows about 70 percent of the time, and an increase in flows about 24 percent of the time (Table 3-18). Decreases in flow of less than 100 cfs would occur about 45 percent of the time. Average daily flows on the Colorado River below Windy Gap are shown in Figure 3-26.

Figure 3-25. Colorado River above Windy Gap – average daily flows with reasonably foreseeable actions.

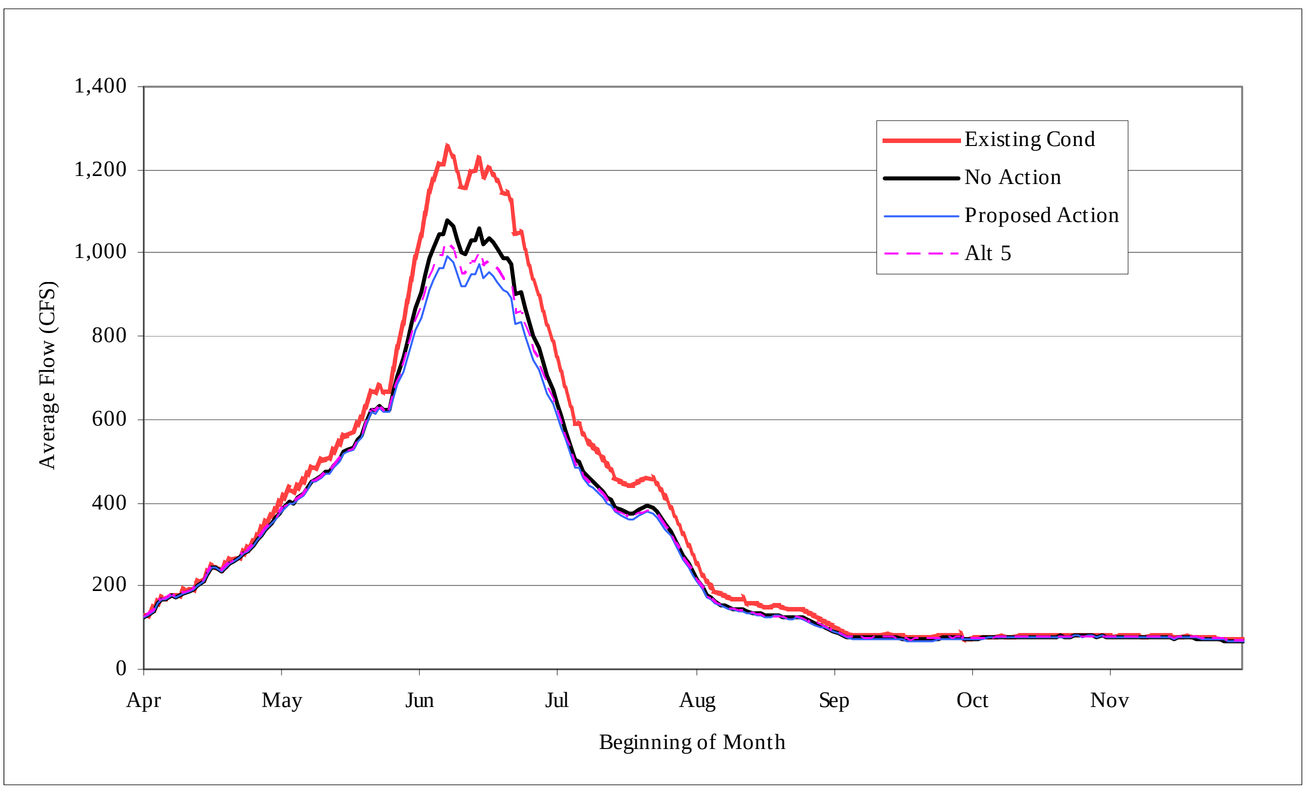
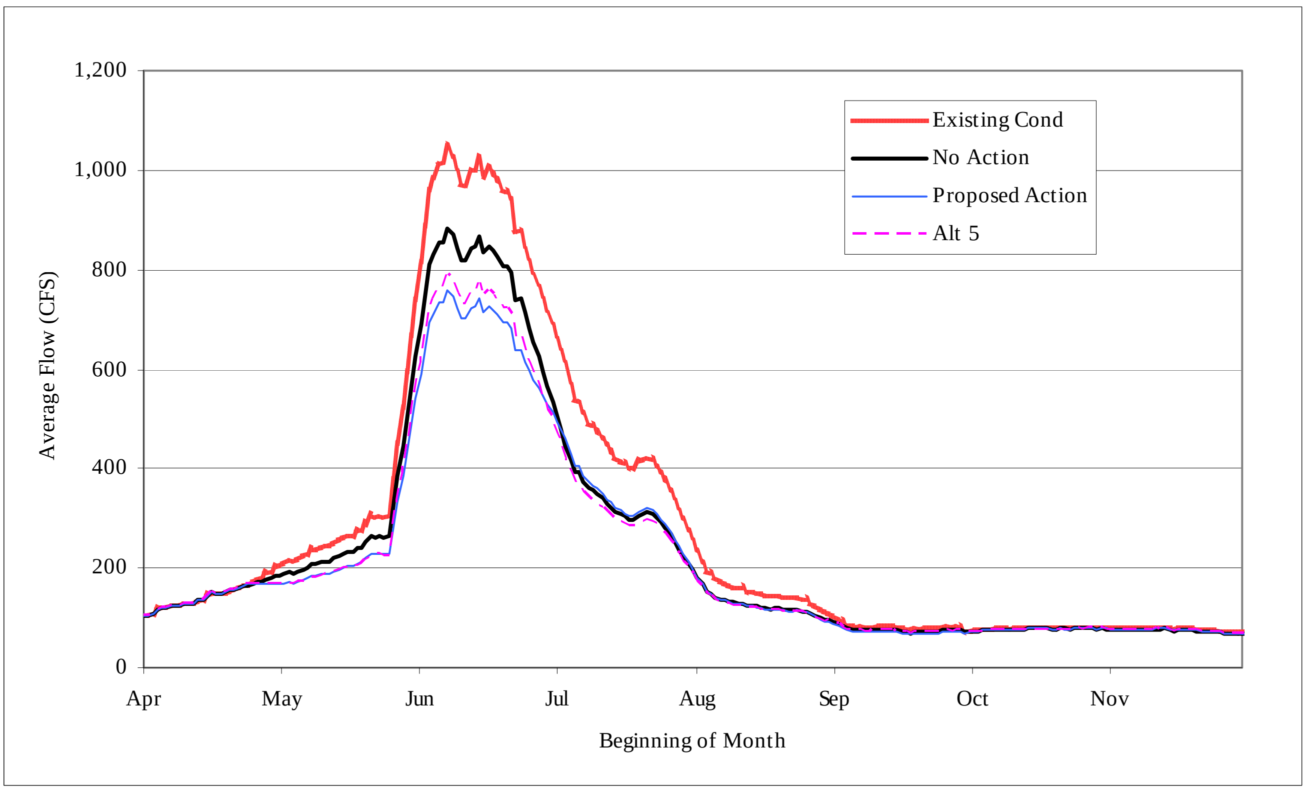


Table 3-18. Colorado River below Windy Gap (Hot Sulphur Springs) – daily flow changes compared to existing conditions from May to August.

Daily Flow Changes (cfs)	Percentage of days in May through August that flow changes would occur		
	No Action	Proposed Action	Alter-natives 3 to 5
+1 to +159	24.9%	24.2%	23%
0	6.6%	7.25%	7.4%
-1 to -10	20.4%	20.7%	19.9%
-11 to -100	26.4%	25.6%	24.2%
-101 to -200	7.95%	5.5%	7.2%
-201 to -300	4.4%	3.5%	4.2%
-301 to -500	4.65%	5.9%	6.3%
-501 to -1,000	3%	4.3%	5%
-1,001 to -2,977	1.7%	3%	2.7%

Figure 3-26. Colorado River below Windy Gap – average daily flows with reasonably foreseeable actions.



Average annual streamflow in the Colorado River below the Blue River confluence near Kremmling would decrease about 11 percent under No Action and about 13 percent under the Proposed Action and other alternatives (Table 3-14). About 79 percent of the reductions in flows near Kremmling would be related to reasonably foreseeable actions, including changes in Blue River flows from Denver's future increases in demand, additional Summit County water use, the elimination of flow releases for endangered fish, additional contract deliveries from Wolford Mountain

Reservoir, and other upstream reasonably foreseeable actions. The Windy Gap project would account for the remainder of the flow change. In dry years, both the Proposed Action and No Action would result in annual flows about 5 percent less than existing conditions (Table 3-15). Wet year average annual flow reductions under the Proposed Action would be about 13 percent less than existing conditions and about 1 percent less than No Action (Table 3-16). Daily Colorado River streamflow decreases from May to June at the Kremmling gage would occur about 86 percent of the time under all alternatives (Table 3-19). Average daily flows on the Colorado River below Windy Gap are shown in Figure 3-27.

Willow Creek

Average annual flows in Willow Creek would decrease about 9 percent under No Action, 15 percent under the Proposed Action, and 13 percent under other alternatives (Table 3-14). Reasonably foreseeable actions do not directly affect Willow Creek flow, but changes in Windy Gap diversions and contents in Granby Reservoir as a result of future actions would affect WCFC diversions and, therefore, Willow Creek flows.

Granby Reservoir

Reasonably foreseeable actions would indirectly affect Granby Reservoir storage by reducing Windy Gap diversions and, therefore, Windy Gap storage in Granby Reservoir. C-BT contents in Granby Reservoir would be lower than direct effects because shrink payments would be less. The average monthly storage in Granby Reservoir would be about 4 to 17 percent lower than existing conditions under the No Action alternative, compared to about 9 to 16 percent lower under the Proposed Action and 6 to 8 percent lower under other alternatives. In dry years, monthly lake storage would be up to 7 percent less under the No Action alternative and Alternatives 3, 4, and 5, and from 7 to 17 percent less under the Proposed Action. Consecutive dry years could result in a decrease in the reservoir surface elevation of up to 33 feet under the Proposed Action, with less of a decrease under other alternatives.

3.5.3.5 East Slope Streams and Existing Reservoirs

Big Thompson River

Average annual Big Thompson River flows below Lake Estes would increase about 1 percent under No Action compared to 4 percent for the Proposed Action and 2 percent for other alternatives (Table 3-14) due to changes in skim diversions. Dry year flow increases would be less than 1 percent under all alternatives (Table 3-15).

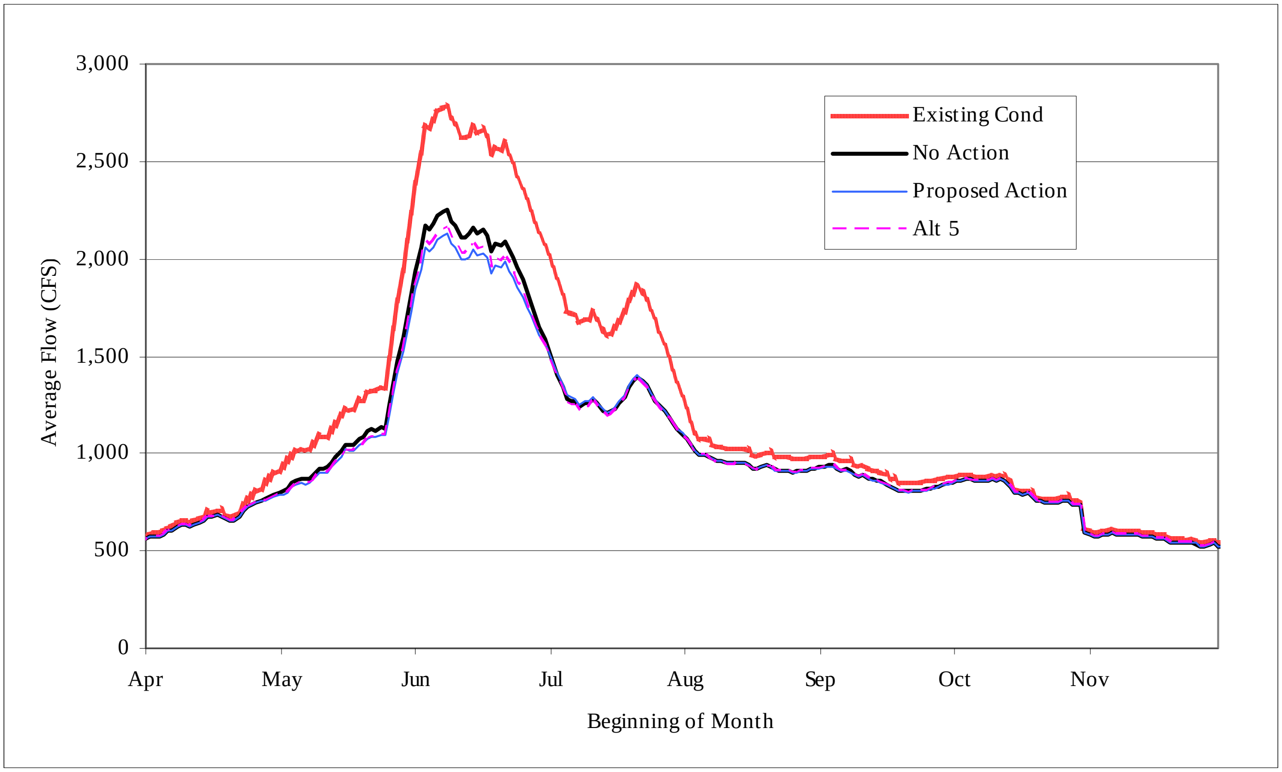
North St. Vrain Creek and St. Vrain Creek

Changes in flow in North St. Vrain Creek below Ralph Price Reservoir and in St. Vrain Creek to the St. Vrain Supply Canal would only occur under the No Action alternative. Changes in streamflow in these reaches would be slightly smaller with reasonably foreseeable actions than under direct effects shown in Table 3-9 because of lower Windy Gap diversions and conveyance to the East Slope.

Table 3-19. Colorado River below Windy Gap (Kremmling) – daily flow changes compared to existing conditions from May to August.

Daily Flow Changes (cfs)	Percentage of days in May through August that flow changes would occur		
	No Action	**Proposed Action**	**Alter-natives 3 to 5**
+1 to +197	14.5%	13.3%	13.4%
0	1.3%	1.3%	1.3%
-1 to -10	1.8%	1.6%	1.6%
-11 to -100	25.9%	27.1%	26.7%
-101 to -200	16.6%	15.5%	14.8%
-201 to -300	7.4%	7.5%	8.5%
-301 to -500	11.2%	11.5%	11%
-501 to -1,000	14.7%	13.6%	14%
-1,001 to -3,465	6.6%	8.6%	8.8%

Figure 3-27. Colorado River near Kremmling – average daily flows with reasonably foreseeable actions.



Streams that Receive Windy Gap Return Flow

East Slope streamflows below Participant WWTPs on Big Dry Creek, Coal Creek, St. Vrain Creek, and the Big Thompson River would increase from existing conditions, but would be slightly less than those described for direct effects because of lower Windy Gap imports. Under the No Action alternative, average and maximum streamflows would decrease less than 1 cfs from the values shown for direct effects in Table 3-10. For the Proposed Action and other action alternatives, East Slope return flows would decrease less than 2 cfs compared to the values shown in Table 3-11.

Carter Lake

Average monthly storage in Carter Lake would decrease less than 1 percent or less than 1 foot under all alternatives compared to existing conditions. Dry year changes in reservoir storage would be similar and wet year storage would decrease less than 3 percent for all alternatives. Occasionally, in severe dry years when C-BT contents in Granby Reservoir are exhausted, Carter Lake contents under the Proposed Action would be as much as 29 feet lower than existing conditions and No Action. C-BT contents in Granby Reservoir would be exhausted earlier in dry year sequences due to C-BT deliveries to Chimney Hollow in previous years. As a result, the amount of C-BT water available for delivery to Carter Lake would be less.

Horsetooth Reservoir

Average year and dry year monthly storage in Horsetooth Reservoir would decrease less than 1 percent under the No Action alternative compared to existing conditions. Wet year storage would decrease up to 2 percent under No Action. The Proposed Action would reduce average monthly reservoir storage from 2 to 7 percent with up to a 10 percent decrease in dry years and up to an 8 percent decrease in wet years. Alternatives 3 through 5 would reduce average monthly reservoir storage less than 2 percent, dry year storage would decrease up to 6 percent, and wet year storage would decrease less than 1 percent. Similar to Carter Lake, consecutive dry years could occasionally result in a decrease in Horsetooth Reservoir water levels of 35 to 40 feet under the Proposed Action.

3.5.3.6 New and Enlarged Reservoirs

Ralph Price

The additional 13,000 AF of storage in Ralph Price Reservoir under the No Action alternative would fluctuate with exchanges of Windy Gap water storage and releases to meet the City of Longmont's demand. The amount of water stored in the future would be slightly less than under direct effects because there would be less Windy Gap water available.

Chimney Hollow Reservoir

Chimney Hollow Reservoir would operate as described for direct effects, although slightly less Windy Gap water would be available for storage with reasonably foreseeable actions in place. While Chimney Hollow remains near full most of the year, a greater percentage of the water would be C-BT storage.

Dry Creek Reservoir

Dry Creek Reservoir would operate similar to direct effects, with slightly greater fluctuations in the future with less Windy Gap water available for diversion.

Jasper East and Rockwell Reservoirs

These reservoirs would operate in a similar manner as direct effects. Reservoir storage would fluctuate widely seasonally and from year to year depending on available Windy Gap water and water demand.

3.5.3.7 Windy Gap Firm Yield

The yield for the action alternatives would be similar because the storage volumes would be the same. Firm yield would be about 20 percent lower than direct effects for the action alternatives because less Windy Gap water is available for diversion with reasonably foreseeable actions in place. The Proposed Action would have a slightly higher firm yield of 24,045 AF than Alternatives 3 through 5 (23,967 AF) (Table 3-20). The No Action alternative would have a firm yield of 579 AF because of the additional storage at Ralph Price Reservoir. The firm yield under existing conditions is zero. Individual Participant firm yield for the Proposed Action are shown in Table 3-21.

Under the No Action alternative, the firm yield for the MPWCD would remain zero. Under the action alternatives, the firm annual yield to MPWCD would be 429 AF, which closely reflects the minimum amount of Windy Gap water pumped during the study period less the shrink payment. The average yield to MPWCD for each of the action alternatives would be close to 3,000 AF.

The demand for Windy Gap unit holders not in the Firming Project would increase in the future for all alternatives and, as a result, the average yield to non-Participants would increase from about 140 AF/year

Table 3-20. Windy Gap Participant demand, average yield, and firm yield—cumulative effects.

Condition/ Alternative	Demand	Average Yield	Firm Yield
	AF		
Existing Conditions	20,825	11,372	0
Alt 1 – No Action	36,645	20,071	579
Alt 2 – Proposed Action (Chimney Hollow)	26,616	26,375	24,045
Alt 3 – 5	26,583	26,340	23,967

Table 3-21. Windy Gap Firming Project Participant firm yield for the Proposed Action—cumulative effects.

Participant	Firm Yield (AF)[1]
Broomfield	4,995
CWCWD	75
Erie	1,500
Evans	395
Ft. Lupton	235
Greeley	2,125
Lafayette	515
Longmont	4,315
Louisville	675
Loveland	1,965
LTWD	1,035
MPWCD	429
Platte River	4,660
Superior	1,125

[1] Values rounded.

under existing conditions to about 2,000 AF for all alternatives. The firm yield to non-Participants would remain zero under all alternatives.

3.5.4 Proposed Mitigation

To reduce potential drawdowns in Granby Reservoir under the Proposed Action, it may be possible to modify prepositioning operations to deliver less C-BT or Windy Gap water to Chimney Hollow Reservoir during dry years. Additional hydrologic evaluations would be conducted before completion of the Final EIS to determine if changes in the timing of water deliveries to the East Slope can reduce impacts to Granby Reservoir while still meeting the purpose and need for the project.

3.5.5 Unavoidable Adverse Effects

All alternatives would result in an increase in water diversions from the Colorado River below the Windy Gap Reservoir. Streamflow on the Colorado River would generally decrease below the diversion and streamflow on Willow Creek below Willow Creek Reservoir also would decrease during the spring and summer. Spills of water to the Colorado River from Granby Reservoir would decrease under all alternatives. Granby Reservoir water levels would be lower, as would Carter Lake, and Horsetooth Reservoir. Streamflow on the East Slope would increase slightly on the Big Thompson River below Lake Estes and on St. Vrain Creek, Big Dry Creek, and Coal Creek below Participant WWTPs. Monthly streamflow increases and decreases would occur on the North St. Vrain Creek and St. Vrain Creek under the No Action alternative.

3.6 Ground Water

3.6.1 Affected Environment

3.6.1.1 Area of Potential Effect

Areas of potential affect to ground water hydrology and ground water quality are shallow alluvial aquifers located along East and West Slope streams and reservoirs and hydraulically connected bedrock aquifers that would be affected by the project alternatives.

3.6.1.2 Data Sources

Information on the hydrogeology, ground water use and ground water quality for the study areas was obtained from the U.S. Geological Survey, Colorado Geological Survey, Colorado Division of Water Resources and Chronic (1980). More detailed information is provided in the Water Resources Technical Report (ERO and Boyle 2007), Stream Water Quality Technical Report (ERO and AMEC 2008a), and Lake and Reservoir Water Quality Technical Report (AMEC 2008a)

3.6.1.3 West Slope Ground Water Hydrology and Quality

Hydrogeology and Ground Water Use

The geology of the Colorado River from Granby Reservoir to Gore Canyon is variable and relatively complex (ERO and Boyle 2006). Geologic units exposed at the surface include Quaternary-aged alluvium, colluvium, landslide deposits, and glacial outwash, Tertiary-aged sediments, Cretaceous-aged sedimentary rocks and volcanic rocks, and Precambrian-aged igneous and metamorphic rocks. In general, the width of the floodplain and the thickness of the alluvium are controlled by the bedrock geology. In reaches of the river that flow through areas of erosionally resistant bedrock units, the floodplain tends to be narrow, relatively straight, and contains little if any alluvium. In areas of less resistant bedrock geology, the floodplain is relatively wide, meandering, and contains significant thicknesses of alluvium.

Because the Colorado River drainage is the lowest area topographically, the river is most likely a discharge area for aquifers or water-bearing zones in bedrock formations that are crossed by the river. Surficial deposits along the Colorado River, such as alluvium, are usually connected hydraulically to the river. There may be areas where older alluvial terraces may no longer be directly connected to the river because of more recent erosion and downcutting by the river, isolating the older units. Alluvium also may receive water from underlying or adjacent bedrock aquifers. In addition to alluvium, other small surficial aquifers include glacial outwash or other similar unconsolidated deposits. Numerous wells are located near the Colorado River within the study area, most less than 100 feet deep and completed in the alluvium.

The Jasper East and Rockwell study areas are underlain by the Troublesome Formation, except in the narrow valleys associated with Willow, Rockwell, and Mueller creeks, where limited Quaternary-aged alluvium is present, and in other areas where Quaternary-aged terrace gravels and landslide deposits are present (ERO and Boyle 2006). The Troublesome Formation, about 1,000 feet thick, consists of interbedded siltstone and mudstone or shale, with less abundant sandstone and conglomerate, and minor amounts of limestone. This formation is the primary water-yielding unit in the study area. In addition, alluvial deposits may yield water in useable quantities, particularly downstream of the proposed Rockwell Reservoir on the south side of the Fraser River valley. Most of the wells in the study areas are completed at depths exceeding 100 feet.

The general geology of the Granby Lake area is Precambrian-aged granitic and metamorphic rocks to the east side, and Tertiary-aged sedimentary rocks, primarily the Troublesome Formation, underlying the reservoir and to the west. In various areas these rocks are overlain by Quaternary-aged alluvium and glacial drift. Hundreds of water supply wells are located along the lake, most of which are more than 100 feet deep and are screened at a depth of 50 feet or greater.

Ground Water Quality

Reported water quality data results (Apodaca and Bails 2000; Bauch and Bails 2004; Topper 2003) indicate that alluvial ground water along the Colorado River has low nutrient concentrations, low dissolved solid concentration (average of 120 mg/L), low alkalinity (less than 100 mg/L) and low hardness (average of 50 mg/L). Compared to bedrock ground water quality in this area, alluvial ground water is lower in calcium, bicarbonate, chloride, sodium and sulfate. Bedrock ground water along the Colorado River has much higher total dissolved solids, iron, and manganese concentrations than alluvial ground water. At the Jasper East and Rockwell reservoir sites, Troublesome Formation ground water is typically a calcium bicarbonate water with a total dissolved concentration of 200 mg/L and a hardness of less than 90 mg/L (Bauch and Bails 2004; Topper 2003). Water wells located next to Granby Reservoir are used for domestic purposes and are assumed to be of potable quality

3.6.1.4 East Slope Ground Water Hydrology and Quality

The western portion of the Chimney Hollow and Dry Creek study areas are underlain by a series of Precambrian age metamorphic bedrock units. The eastern half of the study areas are underlain by sedimentary rocks that consist of conglomerate, sandstone, siltstone, shale, and minor amounts of limestone. Within both study areas, a thin layer of Quaternary-aged alluvium and and/or colluvium occurs along the banks of Dry Creek and Chimney Hollow (ERO and Boyle 2006).

The occurrence of ground water in the Dry Creek and Chimney Hollow study areas is limited to fractures in the well-cemented sedimentary rocks and Precambrian-age bedrock. Limited quantities of ground water also may exist in the relatively thin and limited unconsolidated alluvial and colluvial deposits, but it is unlikely that the thin surficial deposits yield sufficient ground water for domestic or stock water use. Very few existing wells are located within the Dry Creek and Chimney Hollow reservoir footprints; only one well is shallower than 200 feet.

The hydrogeology and availability of ground water at Carter Lake and Horsetooth Reservoir is similar to that of the Dry Creek and Chimney Hollow study areas. Only one well is located within 100 feet of Horsetooth Reservoir and it is screened more than 150 feet below ground surface. No wells are located within 100 feet of Carter Lake or Ralph Price Reservoir. The Ralph Price Reservoir area is composed of Precambrian-aged granitic rocks; useable quantities of ground water occur in fractured Precambrian-aged crystalline metamorphic rocks.

Ground water quality at the potential reservoir locations on the East Slope is unknown due to a lack of data.

3.6.2 Environmental Effects

3.6.2.1 Issues

Ground water issues of concern identified during scoping were the potential effects to ground water wells near reservoir sites and ground water aquifer recharge along the Colorado River.

3.6.2.2 Method for Effects Analysis

Potential effects to ground water resources could occur where there is a hydraulic connection between ground water and affected streams and reservoirs. Impacts to ground water hydrology and quality were evaluated by reviewing expected changes in stream stage, reservoir levels, and changes in the water quality of streams and existing reservoirs, as well as the expected water quality of new reservoirs.

3.6.2.3 Ground Water Hydrology

Ground water along streams, existing reservoirs, and potential new reservoirs may be affected by the WGFP as a result of the following:

- Changes in existing reservoir elevations
- Water storage in new reservoirs
- Changes in stream stage

Lake surface elevations in Granby Reservoir, Carter Lake and Horsetooth Reservoir would be lowered during some months under all alternatives. However, at all of the reservoir locations, the ground water flow direction is controlled by topography, which in general slopes toward the reservoirs. With the exception of areas below the dams, ground water is most likely moving toward the reservoirs and would, in general, be only slightly affected by changes in reservoir elevation. The occasional large decreases in reservoir elevations during a series of dry years could result in temporary changes in ground water levels near the reservoirs. Seepage from the reservoirs is mostly controlled by the nature of the geology and the engineering design of the impoundment. The anticipated small changes in the elevations of existing reservoirs would not significantly change the rate of seepage below dams. The historical variation in the lake surface elevation of Granby Reservoir (nearly 90 feet) is larger than the expected change due to any alternative.

There would be no change in water surface elevations at Grand Lake, Shadow Mountain, or Willow Creek reservoirs for any of the WGFP alternatives; hence, ground water near these reservoirs would not be affected.

Potential effects to ground water levels at new reservoirs are unlikely because the direction of ground water flow is generally toward the reservoir site and the relatively low hydraulic conductivity of the bedrock units would limit the influence of a new reservoir. The potential new reservoirs are located in areas of relatively low topography that are typically the discharge areas for bedrock aquifers. Therefore, ground water levels would not be affected by new water storage because ground water would be, in general, moving toward the reservoirs. Even if a new reservoir is located in a bedrock recharge area, impounding additional surface water may result in positive effects, such as reducing typical seasonal variability in recharge, thereby increasing ground water availability. Seepage losses through or beneath new impoundment(s) could raise ground water levels below the dams. Depending on current ground water conditions and actual seepage losses, higher ground water levels below the dam are possible.

The average June change in Colorado River stream stage under the Proposed Action would be a decrease of about 2.6 inches in the river below Windy Gap Reservoir and about 3.4 inches in the river near Kremmling compared to decreases of less than 2.0 inches under No Action and with other alternatives falling between these values (ERO and Boyle 2007). These stage changes are smaller than the natural variability of existing stage changes in the river due to seasonal flow changes. Alluvial wells located along the river currently pump during stage changes of as much as several feet. Other months would see smaller decreases. It is unlikely that small changes in stream stage would measurably affect alluvial ground water levels beyond tens of feet from the river or impact water production from nearby alluvial aquifers or wells. Changes in recharge to the alluvial aquifer would be small and would be measurable (in inches of water elevation decline) only close to the river. However, it may be difficult to separate the changes in river stage due to Windy Gap diversions from the natural seasonal variability in river stage. Similar small decreases in stream stage on Willow Creek would unlikely measurably affect nearby wells.

Because of the nature of ground water hydraulics, which is controlled by resistance to flow of the granular alluvium, any change in river stage would be reduced to smaller changes in ground water levels as a function of the permeability (hydraulic conductivity) of the alluvial material and distance from the river. Also, because much of the Colorado River system receives recharge from adjacent bedrock units, head changes some distance from the river would likely be much less than the river stage change, if any.

No data is available to evaluate potential impacts to every alluvial well along the Colorado River. However, several generalizations can be made with respect to potential impacts to alluvial wells. A 1-foot or less change in river stage would not change the water supply available to a well, but it would change the total saturated thickness and, therefore, the total available water column that can be drawn down during pumping, which could affect the pumping rate under some conditions. The greater the distance a well is from the river, the less the impact would be from a change in river stage. For alluvial wells located near the river in permeable (high hydraulic conductivity) alluvium typical of coarse grained material and with reasonable saturated thicknesses (meaning that the saturated thickness is more than adequate to supply the well demand at the site specific hydraulic conductivity), a 1-foot or smaller change in river stage would be unlikely to have any impact on the well's pumping rate. For alluvial wells located near the river in low to moderate permeability material and a relatively thin saturated thickness, a stage change could reduce the productivity of the well. For a well completed in moderately permeable material, but with a reasonable saturated thickness (as defined above), a 1-foot stage change would unlikely result in measurable changes in well production. Thus, impacts to the amount of water or the rate of production from alluvial wells along the Colorado River is unlikely from the small predicted changes in stream stage under all of the alternatives.

Projected increases in streamflow for several East Slope streams from additional water imports would be unlikely to affect stream stage by more than a few inches because the water in these streams spreads out within wide alluvial channels. Therefore, nearby alluvial ground water levels would not be expected to change more than a few inches.

3.6.2.4 Ground Water Quality

As discussed in *Water Quality* (Section 3.8), the predicted change in water quality in the existing reservoirs under all alternatives is relatively small. Given the small predicted changes in ground water levels adjacent to the reservoirs, it is unlikely that ground water quality would be affected by any alternative. The predicted water quality of the new reservoirs under the various alternatives is expected to be similar to that of existing reservoirs. Because seepage from the new reservoirs is expected to be small, and surface water quality is generally better relative to typical background ground water quality, it is unlikely that ground water quality near the potential new reservoirs would be negatively affected.

Colorado River water quality model results for the various alternatives indicate that there may be some changes in water quality, such as specific conductance, which could increase as much as 10 percent in some parts of the Colorado River assuming average streamflows (see Section 3.8.2.4). The percent change of other modeled water quality parameters is predicted to be less than 10 percent. Assuming diversions that would reduce streamflows to the minimum instream flow, there may be some changes in water quality that could increase as much as 38 to 45 percent in some parts of the Colorado River. Similar changes in alluvial ground water quality along the Colorado River would be expected.

In the Upper Colorado River basin, bedrock water quality is much poorer than the alluvial water it flows toward. The predicted changes in Colorado River stage during Windy Gap diversions would slightly reduce the water level in the alluvium, thus increasing the amount of bedrock water recharging the alluvial aquifer. Ground water flow from bedrock to the alluvium is probably controlled more by the low hydraulic conductivity of the bedrock than it is by the water level in the alluvium and, therefore, it is likely that the ground water flow from the bedrock would change only slightly as a result of small water level changes in the alluvium. Also, the water level changes in the alluvium would be within the range of natural variability and the changes would attenuate farther from the river. Therefore, it is expected that any changes to alluvial water quality as a result of reduced stream levels during Windy Gap diversions would not be measurable. Bedrock aquifers would not be expected to be affected by changes in river flow or quality.

Hydrologic modeling of Willow Creek showed that ground water inflow is a source of water to Willow Creek below Willow Creek Reservoir. It is unlikely that changes in the water quality of Willow Creek predicted for the WGFP alternatives described in Section 3.8 would affect ground water quality near the creek because the creek is not losing water to ground water.

The water quality of North St. Vrain Creek is expected to improve from existing conditions under the No Action alternative due to releases from Ralph Price Reservoir, which would have slightly improved water quality because of its increased volume and depth. Therefore, there would be no negative effects to ground water quality at Ralph Price Reservoir or along North St. Vrain Creek and St. Vrain Creek. Water quality changes to the Big Thompson River between Lake Estes and the Hansen Feeder Canal are predicted to be very small and are not expected to affect ground water quality near the river.

For the other East Slope streams where small water quality changes are predicted to occur under all alternatives due to changes in Participants' WWTP return flows, there may be minor changes to alluvial ground water quality near the streams. This includes the Cache la Poudre River below Greeley's WWTP, the Big Thompson River below Loveland's WWTP, St. Vrain Creek below Longmont's and the Little Thompson Water District's WWTPs, Big Dry Creek below Broomfield's WWTP and Coal Creek below Superior's, Louisville's, Lafayette's and Erie's WWTPs.

3.6.3 Cumulative Effects

The effects to ground water would be very similar to those expected under direct effects for all alternatives. Changes in ground water levels and ground water quality are expected to be minor to immeasurable. The average June decrease in Colorado River stage would be about 4 inches below Windy Gap Reservoir and 1 foot near Kremmling under the Proposed Action and less for other alternatives. This would not result in changes in water production from nearby alluvial water aquifers or wells. The expected changes in ground water levels due to a 1 foot decrease in stream stage would not be measurable beyond tens of feet from the river.

3.6.4 Proposed Mitigation

Because no significant effects to ground water hydrology or quality for any alternative are expected; no mitigation is proposed for ground water aquifers in the project area.

3.6.5 Unavoidable Adverse Effects

Changes in existing reservoir elevations, storage in new reservoirs, and changes in stream stage expected to occur under the project alternatives would have negligible to no effect on nearby ground water hydrology. The predicted minor changes in stream or reservoir water quality under the all alternatives is unlikely to adversely affect nearby ground water quality.

3.7 Stream Morphology and Floodplains

3.7.1 Affected Environment

3.7.1.1 Regulatory Framework

Executive Order 11988 requires agencies to avoid developments that result in adverse impacts to floodplains. The purpose of the order is to prevent increased flood risk at and downstream of a proposed development. The existing diversion from the Colorado River at Windy Gap Reservoir is located within the river's floodplain.

3.7.1.2 Area of Potential Effect

The area of potential effect used to describe morphological changes to stream channels and banks is composed of the streams that would experience changes in flows as a result of the alternatives. On the West Slope, this includes the Colorado River from below Granby Reservoir to Gore Canyon, as well as Willow Creek below Willow Creek Reservoir. On the East Slope, this includes the Big Thompson River below Lake Estes and North St. Vrain Creek and St. Vrain Creek below Ralph Price Reservoir for the No Action alternative. Hydrologic flow changes would also occur below Participant

WWTPs on St. Vrain Creek, the Big Thompson River, Big Dry Creek, and Coal Creek.

3.7.1.3 Data Sources

Information on streamflow and stream morphology for the study areas was obtained from the U.S. Geological Survey, Colorado Division of Water Resources, USDA Forest Service, Colorado State University, and previous relevant studies of the Colorado River completed for the 1981 Windy Gap Project EIS. More detailed information is provided in the Water Resources Technical Report (ERO and Boyle 2007).

3.7.1.4 West Slope Stream Morphology and Sedimentation

The flow of the Colorado River is affected by storage in Granby Reservoir, Shadow Mountain Reservoir and Grand Lake, stream diversions, return flows, tributary and ground water inflows, and natural precipitation events. Numerous diversions for agricultural and domestic water needs are present. Although the flow of the Colorado River has been quite variable, in part due to diversions and storage, only minor changes in river morphology (shape and structure) have been detected between 1938 and 2005 below Granby Reservoir and below Windy Gap Reservoir (Ward and Eckhardt 1981; ERO and Boyle 2007).

A recent comparison of aerial photographs of the Colorado River between Granby Reservoir and the top of Gore Canyon taken from 1972 to 1974, the 1990s, and in 2005 show that, with the exception of the addition of Windy Gap Reservoir, there have only been minor noticeable changes in river morphology. In addition, recent cross-sectional analyses completed for the aquatic resource analysis, located 8 to 10 miles downstream of Windy Gap Reservoir, showed no evidence of recent changes to stream morphology or sediment deposition in the Colorado River near Parshall (Miller 2008).

Sediment discharges to the Colorado River are derived from upstream sources, tributary inflows, overland flow, channel bed and banks (Ward and Eckhardt 1981). The igneous and metamorphic rocks of the Colorado River headwaters are fairly resistant to weathering and, therefore, contribute little sediment to the river. A previous study showed that the Colorado River channel bed and banks are well armored (Ward and Eckhardt 1981). This study determined that the largest tributary source of sediment in the study area is Troublesome Creek; other tributaries are minor sources. The sediment supply was found to be low, so that the transport capacity of the river has greatly exceeded supply (Ward and Eckhardt 1981). Although there has been growth and development in the upper Colorado River watershed since 1981, no major wildfires, flash floods, or alterations to the river channel have occurred that have substantially increased sediment loading to the Colorado River. Construction of Windy Gap Reservoir has likely decreased sediment loading to the river below the dam by capturing sediment.

Channel maintenance flows are the flows considered necessary to maintain the physical characteristics of a stream channel and are critical to ensuring unimpaired flow and sediment conveyance. They provide the benefits of conveying water and eroded materials from tributaries without aggradation or degradation, preventing vegetation establishment in the channel, sustaining aquatic ecosystems, temporarily storing flood flows on the floodplain, and maintaining healthy streambank and floodplain vegetation (Schmidt and Potyondy 2004). Channel maintenance flows include a range of flow volumes. The lower limit of channel maintenance flows has been defined as 80 percent of the 1.5-year discharge and the upper limit as the 25-year instantaneous peak flow (Schmidt and Potyondy 2004).

The flow of the Colorado River was altered substantially after construction of Granby Reservoir and when increased C-BT diversions began in 1947. However, over the last six decades, the river has remained stable despite changes in the timing and quantity of flows. The form and structure of the channel, banks, and floodplain have changed very little. The river has continued to convey sediment without aggradation or degradation of the stream channel. The upper Colorado River is a morphologically stable stream.

The 2.5-mile segment of Willow Creek from Willow Creek Reservoir to the Colorado River has a sinuous channel that flows across gently sloping topography. Willow Creek has two small tributaries below the reservoir. The base flow of Willow Creek is about 10 cfs, which occurs during 7 months of the year.

Scouring flows exceeding 1,000 cfs have occurred infrequently. Sediment supply in Willow Creek below the reservoir is limited due to the reservoir and because alluvium and soils underlying the creek and its tributaries are shallow, overlying exposed bedrock in much of the Willow Creek watershed below the reservoir.

The width of the Colorado River floodplain, as indicated by unconsolidated deposits from geologic mapping, is variable within the study area, depending on the location of resistant bedrock units; in general, it varies between ¼ to ½ mile wide (Izett 1968, Izett and Barclay 1973, Schroeder 1995). The floodplain of Willow Creek is about ¼ mile wide (Izett 1974). The floodplains of the intermittent streams located at the proposed new reservoir sites (Jasper East and Rockwell) are narrow (250 feet or less) (Izett 1974; Schroeder 1995).

3.7.1.5 East Slope Stream Morphology and Sedimentation

East Slope streamflows, stream morphology, and sediment loads have been thoroughly altered by land use practices that began with the 1859 gold rush (Wohl et al. 1998). The primary influences are flow regulation and diversions, which have reduced seasonal flood peaks and increased base flows. Irrigation of agricultural fields has raised the regional water table. Urban development and the increase in nonporous surfaces have influenced the timing and delivery of stormwater runoff to streams. Reduced peak streamflows have resulted in greater sediment deposition and considerable narrowing of channels. These changes in surface and subsurface flows facilitated the growth of riparian vegetation. Damming of streams has reduced the amount of sediment carried by streams. Stream channels and banks along the Front Range urban corridor are generally unstable and considered by hydrologists and stream morphologists to be in a state of disequilibrium (Wohl et al. 1998). Channel patterns continue to change, channels and banks are actively eroding and scouring, and channel downcutting and excessive sediment deposition are occurring.

The width of the alluvial floodplain based on geologic mapping for the East Slope streams is generally less than ¼ mile in the foothills (North St. Vrain Creek and the Big Thompson River below Lake Estes to the base of the foothills) and about 1 mile wide on the plains. At the proposed Chimney Hollow and Dry Creek Reservoir sites, through which small streams flow intermittently, the floodplain ranges from 500 to 1,000 feet wide (Braddock et al. 1988).

3.7.2 Environmental Effects

3.7.2.1 Issues

Identified issues of concern were the potential for changes in streamflow in the Colorado River and other streams to affect stream channel characteristics, sediment deposition, and transport. Streamflow changes that could affect the potential for flooding were also a concern.

3.7.2.2 Method for Effects Analysis

Potential effects to stream morphology were evaluated for each alternative. Significant changes in the frequency and magnitude of channel maintenance flows could affect the morphology of a stream channel and alter sediment transport and the rate of sediment deposition in a stream. In addition, such changes may affect the distribution of riparian vegetation located along streams. Decreases in streamflow could result in the reduction of the sediment transport capacity of the river and could cause aggradation and vegetation encroachment into the stream channel. Increases in streamflow could result in increased streambed and bank erosion, degradation, and increased sediment transport in the streams. Increases in streamflows also could flood and potentially diminish or scour riparian vegetation along the edges of a stream.

Stream morphology, including its channel, banks, floodplain, and drainage area, can be altered by natural activities such as flooding, erosion, vegetation encroachment, or mud and debris flows. Human activity, such as damming and reservoir regulation, water diversions and return flows, land use changes, and construction activities, can also alter stream morphology. Factors affecting channel dynamics include flow (i.e., frequency, magnitude, and duration), bed and bank material size and distribution, stream channel vegetation, sediment transport capacity, and sediment supply. As water flows over the channel bed and along the banks, it exerts a force in the direction of flow that, if large and frequent enough, will move the bed and bank material. This may cause the channel to become unstable and move laterally. If the force of the water is too small to move bed and bank material, or is too infrequent and causes movement only rarely, then the channel will be stable (Leopold et al. 1995).

Sediment particles are transported in flowing water by rolling or sliding along the streambed, moving above the bed with resting periods on the bed, or in suspension in the water. The first two processes help shape the bed and influence bed roughness and channel stability. The amount of material transported or deposited in a channel under a given set of conditions depends on variables that influence the quantity and type of sediment transported in the channel, and on variables that influence the capacity of the channel to transport sediment. Deposition of sediment eroded and transported from upstream can raise the streambed, which is referred to as aggradation. Lowering of the streambed, called degradation, can occur from scouring of sediments during high streamflows.

Potential impacts to stream morphology and sedimentation were examined for the Colorado River by evaluating changes in flushing flows, analyzing flow duration curves (changes in the volume of flow over time), and by comparing changes in the range of channel maintenance flows. For Willow Creek, the flow duration curve was developed and evaluated. For East Slope streams, the changes in streamflow were compared to existing flows to qualitatively assess potential effects to morphology and flooding.

3.7.2.3 West Slope Streams

Colorado River

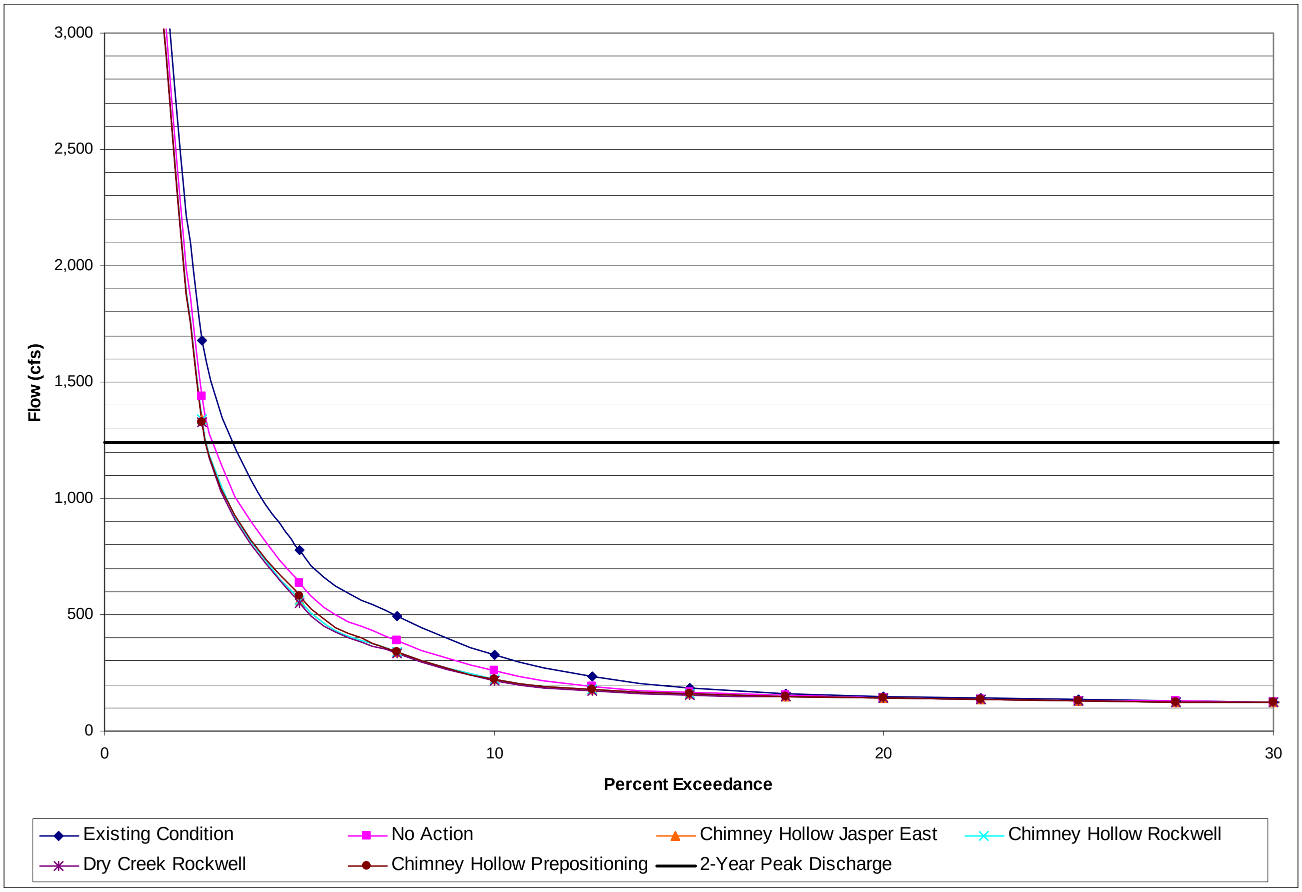
Previous evaluation and modeling of the Colorado River for the original Windy Gap Project EIS (USDI 1981) indicated that no significant increases in sediment transport or the rate of sediment deposition would occur downstream of the Windy Gap diversion with a proposed average withdrawal of 56,000 AF/year (Ward and Eckhardt 1981). Ward and Eckhardt's study (1981) is still relevant because the average annual reductions in streamflow that were anticipated for the original Windy Gap Project are greater than would occur under any of the WGFP alternatives, including No Action. In addition, the sediment transport rate of the river far exceeds the sediment supply to the river and no aggradation of the channel is likely. The previous study of bed materials and movement concluded that the required flushing flow of 450 cfs below Windy Gap Reservoir for 50 hours during the period from April 1 to June 30 every 3 years should be sufficient to transport fine sediments (<2mm) and prevent aggradation (Ward 1981). These flushing flows are part of a 1980 MOU between the Municipal Subdistrict, Northern Colorado River Water Conservancy District, NCWCD, and CDOW for the original Windy Gap Project. Flows equal to or greater than 450 cfs currently occur in the Colorado River below Windy Gap Reservoir for 45 days per year on average and about 100 days in wet years (Table 3-22). All alternatives would reduce the frequency of flows greater than 450 cfs, but flushing flows would remain more than adequate to transport fine sediment.

Many of the morphologic characteristics of a channel are formed when a streamflows at its bankfull discharge (1½- to 2-year peak flow) (Rosgen 1996). A change in the duration of flows greater than bankfull discharge could affect channel morphology. The 2-year peak discharge in the Colorado River at Hot Sulphur Springs was estimated to be 1,240 cfs under existing conditions (Figure 3-28). Streamflows of this volume or

Table 3-22. Flushing flows in Colorado River below Windy Gap Reservoir.

	Wet Year (10% of All Years)		Average Year	
	Period of Flow 450 cfs or Greater	Number of Days of Flow 450 cfs or Greater	Period of Flow 450 cfs or Greater	Number of Days of Flow 450 cfs or Greater
Existing Conditions	May 3-Aug 13	103	May 30-July 13	45
Alt 1 – No Action	May 3-Aug 4	94	May 30-July 6	38
Alt 2 – Proposed Action	May 5-Aug 3	93	May 31-July 5	36
Alt 3 – 5	May 5-Aug 3	93	May 31-July 4	35

Figure 3-28. Flow duration curve—Colorado River at Hot Sulphur Springs.



greater would be exceeded about 4 percent of the time (percentage of days during the study period) under existing conditions. Under all alternatives, the 2-year peak discharge at the Hot Sulphur Springs gage would be exceeded about 3 percent of the time, or about 1 percent less frequently than under existing conditions. The slight reduction in the percentage of time that the 2-year peak discharge would be exceeded below the Windy Gap diversion is unlikely to significantly affect stream morphology or change sediment transport or deposition. A similar review of flow duration curves for the Colorado River at the Kremmling gage indicates that 2-year peak flows would occur about 1 percent less frequently under the action alternatives compared to existing conditions.

Another method to evaluate stream channel morphology is to compare changes in the range of channel maintenance flows (Schmidt and Potyondy 2004). An evaluation was completed for the Colorado River at the Hot Sulphur Springs gage below the Windy Gap diversion to compare changes in the magnitude, range, timing, and frequency of channel maintenance flows under the alternatives. In general, channel maintenance flows would occur about 1 percent less frequently in a given year than existing conditions under all alternatives, but the magnitude of such flows in a year when channel maintenance flows occur would be 2 to 4 percent greater. The differences in channel maintenance flows between existing conditions and the alternatives would be small and unlikely to measurably alter channel morphology or sediment movement at Hot Sulphur Springs.

The magnitude, timing and frequency of channel maintenance flows in the Colorado River below Granby Reservoir also would change as a result of changes in spills. When spills are not occurring, the flow of the river below Granby Reservoir is controlled by instream flows; therefore, it is difficult to define a range of channel maintenance flows based on peak flow events. The changes in the magnitude, timing, and frequency of spills that would occur under the alternatives are not expected to alter channel morphology or sediment movement in the Colorado River below Granby Reservoir because the spills that would occur under all alternatives would continue to provide flows sufficient to maintain channel capacity, provide periodic scouring, and transport sediment.

Willow Creek

The 2-year peak discharge of 80 cfs for Willow Creek was estimated to have been exceeded about 5 percent of the time under existing conditions. Under all alternatives, the 2-year peak discharge duration would decrease less than 1 percent from existing conditions. It is unlikely this small change would measurably affect stream morphology or change sediment transport or deposition in Willow Creek.

West Slope Floodplains

The project would reduce the magnitude of peak snowmelt runoff flows in the Colorado River during years when the WGFP could divert water, resulting in a decrease in flood risk below Windy Gap Reservoir. In addition, reduced spills from Granby Reservoir would decrease the potential for flooding in the river below Granby Reservoir. Expected flow decreases in Willow Creek would reduce flooding potential in that watershed. Potential new reservoirs would capture flood flows that might occur within their watersheds. The narrow floodplains associated with the intermittent streams at the Jasper East and Rockwell reservoirs sites (Alternatives 3, 4, and 5) would be altered. There would be no new facilities or improvements within any other floodplains.

3.7.2.4 East Slope Streams

North St. Vrain Creek and St. Vrain Creeks

Under the No Action alternative, streamflows in the reach between Ralph Price Reservoir and the St. Vrain Supply Canal would change due to exchanges of Windy Gap water to storage in Ralph Price Reservoir and releases from Ralph Price Reservoir to meet Longmont's future Windy Gap demands. Although there would be both increases and decreases in flow during several months of the year (Table 3-9), the volume of changes would be well within the historical range of flows. In addition, the North St. Vrain Creek channel, like many foothill creeks, has a channel that is stabilized by bedrock or boulders. For these reasons, it would be unlikely that changes in flow would alter the morphology of the stream or affect sediment movement.

Big Thompson River below Lake Estes

Under all alternatives, minor flow increases in the Big Thompson River from Lake Estes to the Hansen Feeder Canal would occur in April through November, with the greatest increases in May and July. It is not expected that the flow increases (a maximum of 18 cfs in July) would measurably alter stream morphology or sediment transport and deposition. The estimated change in flow would be well within the historical range of flows, which exceed 500 cfs during high flows.

Streams that Receive Windy Gap Return Flows

The predicted streamflow increases for the East Slope stream segments that receive Windy Gap return flows (Big Dry Creek, Coal Creek, St. Vrain Creek, and Big Thompson River) are unlikely to substantially alter stream morphology and sedimentation. The increased flows would be small compared to the spring and early summer flows and would be well within the capacity of the stream channels. In addition, streams on the East Slope have not experienced natural streamflow conditions for more than 100 years, and are not in equilibrium with respect to channel forming and channel moving processes, erosion, or sediment loading, movement and deposition. Given the magnitude of the flow increases (less than 12 cfs under all alternatives), it would be difficult to measurably differentiate changes to stream morphology and sedimentation due to changes in Participants' WWTP return flows from the many other ongoing actions influencing East Slope streamflow conditions.

East Slope Floodplains

The small changes in streamflows that would occur under all alternatives to East Slope streams could increase the potential for flooding; however, the estimated flow increases would be small compared to flood flows caused by snowmelt runoff or large storm events. Potential new reservoirs would capture flood flows that might occur within their watersheds. The only floodplains that would be altered by the project alternatives are those that would be within the footprints of proposed new reservoirs (Chimney Hollow, Dry Creek, or the enlarged Ralph Price Reservoir). There would be no new facilities or improvements within other floodplains.

3.7.3 Cumulative Effects

The effects to stream morphology and sedimentation would be very similar to those expected under direct effects. As with direct effects, changes in streamflow under cumulative effects for all alternatives are not expected to significantly affect stream morphology or change sediment transport or deposition. Windy Gap diversions would be less under the cumulative effects evaluation but, streamflow reductions by other reasonably foreseeable actions would result in less flow in the Colorado River, particularly downstream of the Blue River. Colorado River flow below Windy Gap Reservoir that currently exceeds the 2-year peak discharge 4 percent of the time would occur about 2.5 percent of the time, or about 1.5 percent less frequently. At the Kremmling gage there would be less than a 2 percent decrease in the frequency of occurrence of channel forming 2-year peak flows under all of the alternatives. The slight changes in the frequency of channel forming flows are unlikely to significantly affect stream morphology or change sediment transport or deposition. East Slope streamflow increases would be less than direct effects because less water would be delivered, so cumulative would be slightly less than described for direct effects.

3.7.4 Proposed Mitigation

Because no significant effects to stream morphology or floodplains for any alternative are expected; no mitigation is proposed.

3.7.5 Unavoidable Adverse Effects

Flow increases or decreases projected for all of the alternatives would have minor to negligible adverse effects and are not expected to significantly alter stream channel morphology or sediment transport and deposition in any of the East or West Slope streams in the project area.

3.8 Surface Water Quality

3.8.1 Affected Environment

3.8.1.1 Area of Potential Effect

The area of potential effect for evaluating surface water quality is essentially the same as described for water resources in Section 3.5. Changes in streamflow or reservoir operation have the potential to impact the chemical, physical, and biological properties of water.

Streams evaluated in the West Slope study area (Figure 3-1) are 1) the Colorado River downstream of Granby Reservoir to Gore Canyon below the confluence with the Blue River, and 2) Willow Creek below Willow Creek Reservoir. Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir are included in the study area, as well as potential new reservoirs at the Jasper East and Rockwell reservoir sites. Windy Gap Reservoir is a small in-channel reservoir and would have water quality similar to that of the Colorado River; therefore, it was not evaluated separately. The East Slope study area (Figure 3-2) includes the Big Thompson River below Lake Estes (where additional Windy Gap deliveries would increase flows) and downstream of Participant WWTPs on Big Dry Creek, Coal Creek, St. Vrain Creek, the Big Thompson River, and the Cache la Poudre River. North St. Vrain Creek below Ralph Price Reservoir could also be affected under the No Action alternative (Figure 3-7). East Slope reservoirs in the study area are Carter Lake, Horsetooth Reservoir, and Ralph Price Reservoir, along with potential new reservoirs at Chimney Hollow and Dry Creek.

Water quality effects to the other reservoirs in the C-BT system were not specifically evaluated because the reservoirs have very short residence times and the water quality would be the same as the major inflows. The other reservoirs in the C-BT System are Marys Lake, Lake Estes, Pinewood Reservoir, and Flatiron Reservoir. Because water quality effects at Carter Lake would be minor, impacts to Boulder Reservoir, which receives water from Carter Lake, should be minimal. Green Mountain Reservoir and Willow Creek Reservoir were not included in the study area because they would not be affected by any alternative.

3.8.1.2 Data Sources

Data used for the evaluation of water quality effects were obtained from the USGS, Reclamation, Big Dry Creek Watershed Forum, Dry Creek Watershed Association, Colorado Department of Public Health and Environment, U.S. Weather Service, U.S. EPA, University of Colorado, Grand County, NCWCD, and WGFP Participants. Various reports and studies on existing water quality also were reviewed to characterize existing water quality and model or estimate future water quality under the alternative actions. Section 3.8.2.3 provides information on the methods used for analyzing water quality effects. More information on the stream and reservoir water quality analysis is found in two technical reports—Stream Water Quality Technical Report (ERO and AMEC 2008a) and the Lake and Reservoir Water Quality Report (AMEC 2008a).

3.8.1.3 West Slope Affected Environment

Colorado River

Colorado River water is generally of good quality throughout the study area. Both natural and man-made activities influence the river's quality. Weathering and erosion of geologic material contributes salts and trace elements to the river. Ground water connected to underlying bedrock contributes dissolved solids, calcium, sulfate, iron, and manganese to the river. The hot springs at Hot Sulphur Springs discharge about 50 gallons per minute to the Colorado River at a temperature of about 105°F and a total dissolved solids (TDS) concentration of 1,200 mg/L (Barrett and Pearl 1978). According to the Hot Sulphur Resort and Spa, their pools are fed with over 200,000 gallons per day (140 gpm) of spring water ranging from 104 to 126ºF (HSSRAS 2007). Troublesome Creek, a tributary to the Colorado River near Kremmling, contributes elevated concentrations of iron and suspended sediment to the Colorado River from erodible geologic formations (NWCOG 2002).

Other influences to the Colorado River that affect water quality include various water uses and changes in the hydrologic regime such as diversions by the C-BT Project, Windy Gap, Moffat Collection System, municipal, commercial, and irrigation water uses as described in Section 3.5.1.4. Effluent discharge from WWTPs also affects water quality. The community of Hot Sulphur Springs WWTP has a capacity to discharge up to 90,000 gallons per day (gpd) to the Colorado River (EPA 2006). This is the only WWTP source of discharge directly to the Colorado River in the study area, but discharges to tributaries also influence Colorado River water quality. The Kremmling WWTP discharges to Muddy Creek, a tributary to the Colorado River. The Fraser River has elevated sediment and nutrient concentrations due to human activities in the basin, including four municipal WWTP discharges to the Fraser River:

- Winter Park Water and Sanitation District (up to 0.45 million gpd)
- Fraser Sanitation District (up to 1 million gpd)
- Tabernash Meadows Water and Sanitation District (up to 0.1 million gpd)
- Granby Sanitation District (up to 0.995 million gpd)

Nonpoint sources of discharge that affect Colorado River water quality are surface runoff from roads, developments, irrigation return flows, and agricultural lands. Irrigation return flows may contribute to higher temperatures, as well as additional sediment, nutrient, and pesticide loadings and mineral leaching from the soils (Spahr et al. 2000). Livestock are likely another source of increased sediment and nutrients to the Colorado River.

Table 3-23 summarizes the range and average water quality for several parameters at three locations along the Colorado River. There have been few measured water quality exceedances, but several samples have had dissolved oxygen (DO) concentrations that exceeded the standard at sites below Windy Gap Reservoir and near Kremmling.

The establishment of the diatom *Didymosphenia germinate* (didymo) in the Colorado River has been a concern because of the potential affect on nutrient cycling, food web dynamics, and invertebrate populations (Velarde, pers. comm. 2008). Didymo is a nonnative single-celled organism (algae) that can create thick mats of biomass that grow on rock and plants with the potential for periodic nuisance blooms (Spaulding 2007). Its spread is not well understood, but the transfer of cells from fishing

Table 3-23. Colorado River historical water quality values at three locations.

Parameter	Upstream of Fraser River[1]		Below Windy Gap Reservoir[2]		Near Kremmling[3]	
	Range	Avg.	Range	Avg.	Range	Avg.
Temperature (°C)	3.1 - 17.6	9.3	0 - 22	7.7	0 - 22	9.9
Specific conductivity (μS/cm)	85 - 239	146	61 - 277	129	150 - 428	238
Suspended sediment (mg/L)	3.2 - 46.4	14.8	2.8 - 26	12.4	NA	NA
Dissolved oxygen (mg/L)	3.3 - 12.1	8.9	4.3 - 12.1	9.1	5.3 - 11.4	8.3
pH	6.6 - 8.5	7.7	6.6 - 9.5	8.2	7.4 - 8.6	8.2
Ammonia (mg/L)	0.02 - 0.11	0.06	0.005 - 0.14	0.04	0.003 - 0.11	0.02
Nitrate and nitrite (mg/L)	0.019 - 0.2	0.08	0.03 - 0.85	0.14	0.01 - 0.24	0.09
Total phosphorus (mg/L)	0.03 - 0.76	0.08	0.01 - 0.99	0.14	0.01 - 0.27	0.04
Sodium (mg/L)	3.3 - 9.9	6.4	0.2 - 8.7	5.8	5 - 25	9.7
Total iron (μg/L)	32 - 1,100	709	210 - 700	505	360 - 2,500	NA
Manganese (μg/L)	45 - 175	100	1 - 175	60	10.8 - 143	37.3
Selenium (μg/L)	NA	NA	0.3 - 2	0.86	<1 - 1	<1

[1] Data from 1991 to 2004.
[2] Data from 1981 to 2004.
[3] Data from 1976 to 2004.
Source: Earthinfo 2006; NCWCD 2006.

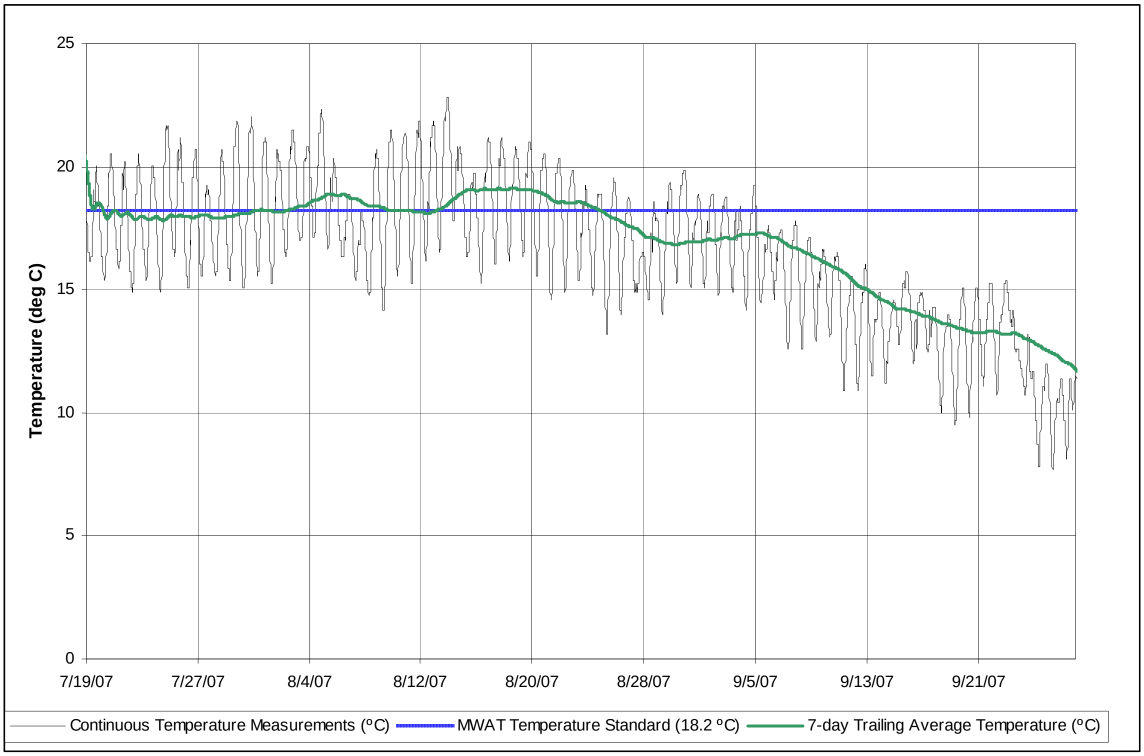
equipment, boots, and waders is though to be one mechanism (Id).

The USGS has collected grab temperature samples for many years on the Colorado River, usually at intervals of once or twice per month and less frequently during the winter (Earthinfo 2006). It is not possible from this data to determine if the chronic temperature standards have been exceeded. However, in 2007 Grand County collected stream temperatures every 15 minutes during July, August, and September at six locations on the Colorado River (Clements 2007). The most upstream sample location was below Windy Gap Reservoir and the lowest location was at the KB Ditch above the confluence with Troublesome Creek (Figure 3-1). The results of this data collection indicate that the maximum weekly average temperature standard of 18.2ºC was exceeded in late July and August 2007 at every site except for the site below the Williams Fork River near Parshall and the most downstream site near the KB Ditch. Colorado River water temperatures at the Lone Buck site upstream of the Williams Fork in 2007 are shown in Figure 3-29. The 7-day trailing average temperature is a calculated average temperature of all continuous temperature data collected during the previous week up to a particular point in time. Figure 3-29 shows that the average weekly temperature of the Colorado River in 2007 exceeded the temperature standard during much of the period between mid-July and late August.

Willow Creek

Water quality characteristics for Willow Creek below Willow Creek Reservoir to the confluence with the Colorado River are shown in Table 3-24. Occasional exceedances of the water quality standard for temperature, pH, ammonia, total iron, and copper have occurred; however, water quality has generally been good. No algae or chlorophyll data is available for Willow Creek. The Three Lakes Water and Sanitation District operates a recently upgraded WWTP (Three Lakes WWTP) with a 2 million gpd capacity that discharges to Church Creek, a tributary to Willow Creek. Effluent from the Three Lakes WWTP is likely the primary source of ammonia in Willow Creek; however, other nutrient sources include livestock, agriculture, natural erosion, roads, residential development, and upstream land uses.

Figure 3-29. Colorado River temperatures at Lone Buck in 2007.



Source: Clements 2007.

Table 3-24. Willow Creek historical water quality values.

Parameter	Range[1]	Mean
Stream temperature (°C)	0 - 27	7.2
Specific conductivity (µS/cm)	65 - 240	124
Suspended sediment (mg/L)	3.2 - 50	20.7
Dissolved oxygen (mg/L)	3.7 - 12	8.7
pH	6.3 - 8.8	7.7
Ammonia (mg/L)	0.01 - 0.44	0.1
Nitrate and nitrite (mg/L)	0.025 - 2.9	0.5
Total phosphorus (mg/L)	0.03 - 0.59	0.14
Sodium (mg/L)	3.9 - 17	8.7
Iron, total (µg/L)	62 - 1,600	775
Iron, dissolved (µg/L)	3 - 160	92.5
Manganese (µg/L)	38 - 180	100
Copper (µg/L)	1 - 12	3.4

[1] Data collection ranges from 1956 to 2002.
Source: Earthinfo 2006; NCWCD 2006.

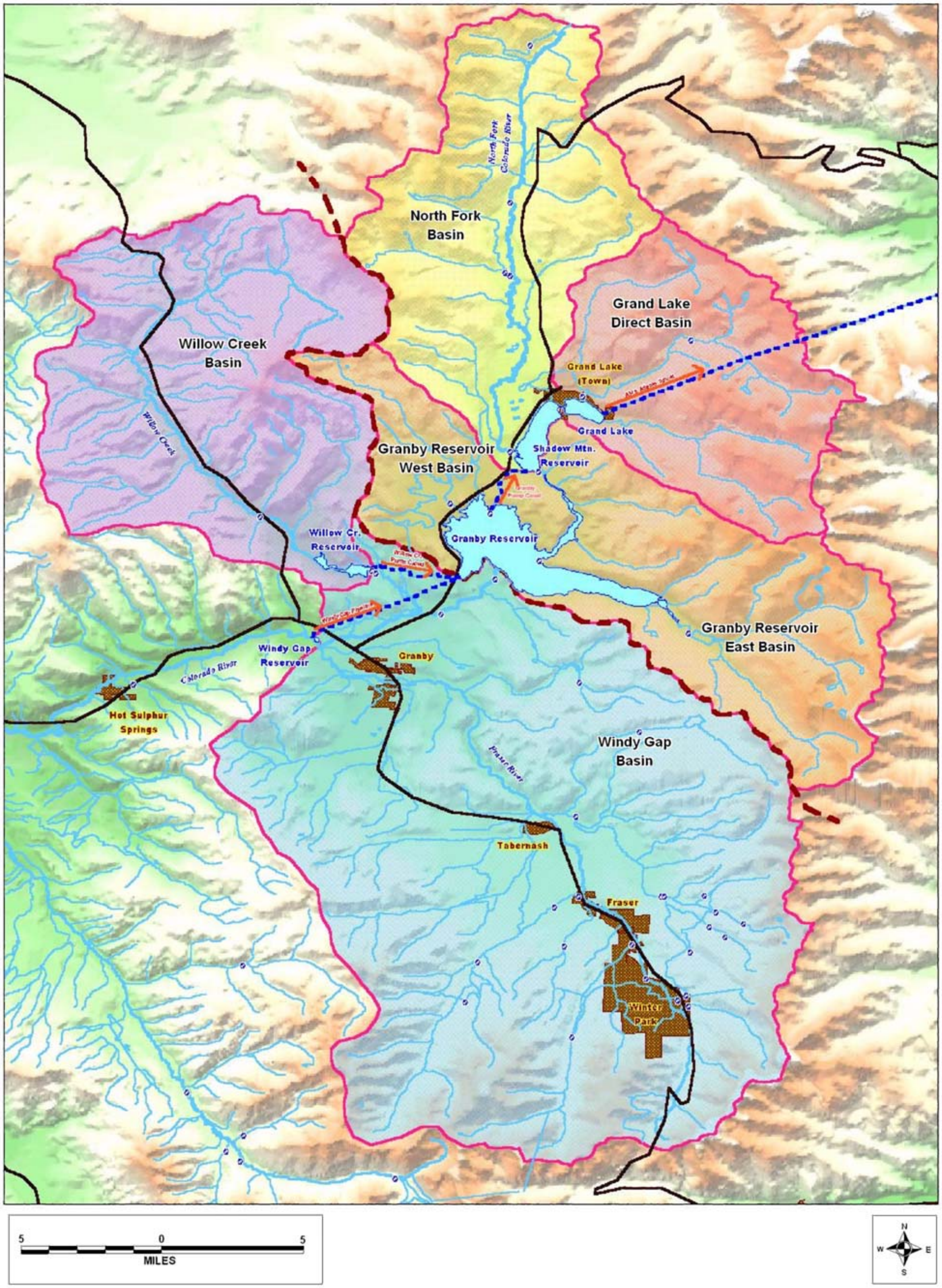
Streams at New Reservoir Sites

No water quality data are available for the unnamed tributary that flows through the proposed Jasper East Reservoir site or for Rockwell and Mueller creeks, which flow through the Rockwell Reservoir site. Water quality at the Jasper Reservoir site is influenced by livestock grazing, hay production, and irrigation return flows. Water quality in Rockwell and Mueller creeks is influenced by roads and livestock.

The Three Lakes System

Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir are often referred to as the Three Lakes System (Figure 3-30). These three water bodies are operated together as part of the C-BT Project. During the runoff season, water flows from Grand Lake through Shadow Mountain Reservoir, and is stored in Granby Reservoir. When water is needed on the East Slope, water is pumped up from Granby Reservoir through Shadow Mountain Reservoir to Grand Lake, and then flows east through the Adams Tunnel. Because water can flow

Figure 3-30. Three Lakes System watersheds.



either direction, the entire watershed has an impact on all three water bodies. Additional input to the Three Lakes System comes via pumping from Windy Gap Reservoir on the Colorado River below the confluence with the Fraser River and from Willow Creek Reservoir via the Willow Creek Pump Canal. Thus, water input from the Fraser River (Windy Gap basin) and Willow Creek basin also influence water quality in the Three Lakes System. The existing conditions for each of the Three Lakes are discussed separately below.

Granby Reservoir

Granby Reservoir is the second largest reservoir in Colorado and serves as the primary storage reservoir in the C-BT Project. Major tributaries include Arapaho Creek, Stillwater Creek, Columbine Creek, and the Roaring Fork River. Water is also pumped to Granby Reservoir from Willow Creek Reservoir and Windy Gap Reservoir. Outflow is to the Colorado River and to Shadow Mountain (via the Farr Pumping Plant). Granby Reservoir's physical characteristics and hydrology are described in Table 3-25.

Table 3-25. Physical characteristics of Granby Reservoir.

Metric	Value
Volume	539,758 AF
Surface Area	7,256 acres
Mean Depth	74 feet
Maximum Depth	221 feet
Shoreline	40 miles
Hydraulic Residence Time	0.9 to 1.8 years

Measures at maximum capacity. Residence time based on annual average content and total annual outflow flow.
Source: Hydrosphere 2003a; NCWCD 2007a.

Table 3-26 provides a summary comparison of water quality in Granby Reservoir for 2000 to 2007 with applicable standards. Following is a brief discussion of the existing water quality in Granby Reservoir for key parameters.

Major Ions and Trace Elements. The median concentrations of major ions (calcium, magnesium, sodium, potassium, chloride, sulfate, and bicarbonate) are typical of nonpolluted watersheds. Together, they make up most of the TDS, which is closely approximated by specific conductance. Copper is of concern for aquatic life; however, insufficient data are available to evaluate whether the standard is being met. Available data indicate an exceedance of the acute standard on one day. Dissolved iron and dissolved manganese concentrations, which can be a problem for water providers at elevated concentrations, show higher values in the hypolimnion versus the epilimnion. This is common in lakes and reservoirs that experience low DO concentrations in the hypolimnion.

Algae and Trophic State. Since 2000, the average chlorophyll *a* concentration was about 5.5 to 6.0 µg/L, with a maximum of 15.5 µg/L. There is no clear seasonal pattern for chlorophyll *a*, although most often the highest concentrations occur in the early part of the year (January to May). Chlorophyll *a* concentrations are indicative of a mesotrophic lake.

Recent monitoring in Granby Reservoir includes microcystin toxicity testing along with cell counts of dominant cyanobacteria (blue-green algae) (GCWIN 2007). Microcystin is a hepatotoxin that targets the liver and can be produced by some cyanobacteria. The presence or excessive abundance of toxin-producing algae does not translate into the presence of toxins in the water column. All microcystin results received through July 24, 2007 for Granby Reservoir have been below the detection limit (Clements 2007). Microcystin toxin levels of more than 1 µg/L are of concern for drinking water purposes (WHO 1998). The relationships between the abundance of toxin-producing algae and levels of microcystin are unclear and are the subject of research efforts. Current research indicates that microcystin production is not only controlled by environmental factors (such as light, nutrients, and grazing pressure) but also by genetic composition (Zurawell et al. 2005). There are toxic and non-toxic strains of microcystin producing cyanobacteria. Although cell counts are sometimes used to assess the magnitude of a bloom or when to start testing for toxins, they are not an accurate measure of bloom toxicity. Thus, a water body could have optimum environmental conditions for microcystin production (which are not well understood) and a high microcystin-producing cyanobacteria cell count, and no microcystin production.

Table 3-26. Comparison of key water quality standards for Granby Reservoir under existing conditions.

Use Classification	Parameter Category	Parameter	Unit	Applicable Standard	In-Lake Value	Standard Met?
Aquatic Life	Physical	Dissolved oxygen (elsp)	mg/L	6.0	5.6 (42)	No
		pH (epilimnion)	SU	6.5 - 9.0	7.1 - 8.2	Yes
		pH (hypolimnion)	SU	6.5 - 9.0	6.6 - 7.8	Yes
		Temperature standard (effective December 31, 2008)	°C	9 (ch winter)	1.7 - 2.1	Yes
				13 (ac winter)	2.1 - 2.8	Yes
				18.2 (ch summer)	16.5 - 19.3	No
				23.8 (ac summer)	16.9 - 19.9	Yes
		Temperature (interim)	°C	20.0 (ch)	1.7 - 19.3	Yes
	Inorganic	Ammonia	mg/L as N	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
	Metals	Cadmium, dis	µg/L	ac (varies)	not enough data	
				ac (varies)	varies	Yes
		Copper	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Iron, Trec	µg/L	1,000 (ch)	no data	
		Lead, dis	µg/L	ac (varies)	not enough data	
				ac (varies)	varies	Yes
		Manganese, dis	µg/L	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
		Silver, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
Water Supply	Physical	Dissolved oxygen	mg/L	3.0	5.6 (42)	Yes
		pH	SU	6.5 - 9.0	7.1 - 8.2	Yes
	Inorganic	Nitrate	mg/L	10 (1-day)	max = 0.3 (80)	Yes
	Metals	Cadmium, dis	µg/L	5.0 (1-day)	not enough data	
		Iron, dis	µg/L	300 (30-day)	0 - 80	Yes
		Lead, Trec	µg/L	50 (1-day)	no data	
		Manganese, dis	µg/L	50 (30-day)	0 - 160	No
		Silver, Trec	µg/L	100 (1-day)	no data	
Recreation	Physical	Dissolved oxygen	mg/L	3.0	5.6 (42)	Yes
		pH	SU	6.5 - 9.0	7.1 - 8.2	Yes
Agriculture	Physical	Dissolved oxygen	mg/L	3.0	5.6 (42)	Yes
	Inorganic	Nitrate	mg/L as N	100	max = 0.3 (80)	Yes
	Metals	Cadmium, Trec	µg/L	10 (30-day)	no data	
		Lead, Trec	µg/L	100 (30-day)	no data	
		Manganese, Trec	µg/L	200 (30-day)	no data	

- ac= acute, ch-chronic, dis=dissolved, Trec=total recoverable
- Water quality data for past 5 years (9/02 on) was evaluated against standards applicable to the reservoir according to Colorado water quality regulations.
- Values in parenthesis in “In-Lake Value” column are numbers of samples or daily average values evaluated for the parameter.
- D.O. “In-Lake Values” are 15th percentile of daily average epilimnion profile results (elsp = early life stage present). In addition, per the WQCD, if all measurements in the epilimnion and metalimnion on any one day were below the standard, the reservoir was found to be out of attainment.
- pH range is 15th percentile - 85th percentile value of daily average profile sample results.
- “Large Lake” temperature criteria applied. Temperature “In-Lake Values” are for epilimnion layer min - max of MWAT (ch) (lake equivalent of maximum weekly average temperature) and DM (ac) (daily maximum).
- In 2007, new temperature standards were adopted as defined in Colorado’s Regulation No. 31 (5 CCR 1002-31). Interim standards were established to be applicable until the next Triennial Review process for each basin, at which point it is anticipated the new temperature standards will be adopted.
- Nitrate “In-Lake Value” is the maximum of all discrete Nitrate + Nitrite results.
- Water Supply “In-Lake Value” is min - max range of 30-day averages of hypolimnion samples (insufficient data points to evaluate epilimnion layer).
- For acute computations, evaluated all data. For all other computations, evaluated only if at least 12 data points (per WQCD guidelines).
- ‘no data’ includes instances where there are no hardness data available to evaluate the standard.

Nutrients. Phosphorus and nitrogen concentrations are lower in the epilimnion and higher in the hypolimnion. Inorganic nitrogen concentrations (ammonia, nitrate, and nitrite) that are bioavailable for phytoplankton growth are low and typical of an oligotrophic system (Wetzel 2001). Orthophosphate concentrations (the form available to algae) are also low. Ammonia and nitrate concentrations in Granby Reservoir meet water quality standards (Table 3-26).

There are no standards for phosphorus; however, for lakes or reservoirs, the EPA-recommended total phosphorus concentration to prevent or control eutrophication is 0.025 mg/L (EPA 1986).

Lake analyses sometimes include an investigation to determine which nutrient is limiting the growth of algae. Increases in the limiting nutrient often cause increases in algae growth. Increases of the nonlimiting nutrient will not cause increases in algae growth because there is more available that the algae can take up. Previous bioassays have shown nitrogen limitation (EPA 1970, 1977a) or primarily N limitation (there were a few periods of P limitation and/or the need to increase both P and N) (Morris and Lewis 1988). Lieberman (2007b) concluded that the reservoir is mainly phosphorus limited with periods of co-limitation based on nutrient concentrations.

Water Clarity. The mean Secchi-disk depth value (a measure of clarity) since 2000 is 3.9 meters and the range is 1.6 to 8.0 meters. An analysis of Secchi-disk depth values, indicates a statistically significant increasing trend in clarity between May and October using data from 1989 to 2006.

Dissolved Oxygen. Typical of large deep lakes, DO concentrations are lower in the hypolimnion than the epilimnion because the hypolimnion is essentially cut off from DO additions at the lake's air-water interface. Also, there can be significant demands of DO at the bottom of a lake due to decomposition of organic matter and other reactions. DO at the reservoir bottom in March and October of 2006 was low (<3 mg/L). There was also the development of low DO concentrations at the elevation of the metalimnion in summer 2006. Possible causes for this drop in DO at the metalimnion include 1) decomposition of oxidizable material in the metalimnion, 2) significant concentrations of zooplankton in the metalimnion that respire and drop the DO concentration, and 3) reservoir morphometry or the shape of the reservoir basin (Wetzel 2001). Inflowing water could be entering the reservoir at the metalimnion and supplying organic matter (Lieberman 2007a). DO concentrations do not currently meet standards (Table 3-26).

Temperature. Temperature in the epilimnion ranges from 1.7 to 19.3°C, which meets the current interim water quality standard of 20°C (Table 3-26). However, temperature would exceed the chronic summer standard of 18.2°C, which is expected to go into effect December 31, 2008.

Shadow Mountain Reservoir

Shadow Mountain Reservoir serves to maintain a constant water surface elevation in Grand Lake and is a conduit for flow between Granby Reservoir and Grand Lake. The North Fork of the Colorado River is the major tributary flowing into Shadow Mountain Reservoir. The reservoir also receives and discharges water to Grand Lake and Granby Reservoir depending on C-BT operations. Shadow Mountain Reservoir's physical characteristics and hydrology are described in Table 3-27. This shallow reservoir does not strongly stratify during the summer months due to a high level of mixing (from wind and flow).

Table 3-28 provides a summary comparison of water quality in Shadow Mountain for the years 2000 to 2007 with applicable standards. Following is a brief discussion of the existing water quality in Shadow Mountain Reservoir for key parameters.

Major Ions and Trace Elements. The median concentrations of major ions are typical of nonpolluted watersheds. Together, they make up

Table 3-27. Physical characteristics of Shadow Mountain Reservoir.

Metric	Value
Volume	17,354 AF
Surface Area	1,852 acres
Mean Depth	9.4 feet
Shoreline	8 miles
Hydraulic Residence Time	2.7 to 3.3 weeks

Measures at maximum capacity. Residence time based on annual average content and total annual outflow.
Source: Hydrosphere 2003a; NCWCD 2007b.

Table 3-28. Comparison of key water quality standards for Shadow Mountain Reservoir under existing conditions.

Use Classification	Parameter Category	Parameter	Unit	Applicable Standard	In-Lake Value	Standard Met?
Aquatic Life	Physical	Dissolved oxygen (elsp)	mg/L	6.0	6.7 (40)	Yes
		pH (epilimnion)	SU	6.5 - 9.0	7.0 - 8.3	Yes
		pH (hypolimnion)	SU	6.5 - 9.0	6.9 - 8.2	Yes
		Temperature standard (effective December 31, 2008)	°C	9 (ch winter)	1.7 - 2.2	Yes
				13 (ac winter)	2.1 - 2.4	Yes
				18.2 (ch summer)	14.6 - 19.3	Yes
				23.8 (ac summer)	15.5 - 19.7	Yes
		Temperature (interim)	°C	20.0 (ch)	1.7 - 19.3	Yes
	Inorganic	Ammonia	mg/L as N	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
	Metals	Cadmium, dis	µg/L	ch (varies)	not enough data	
				ac (tr)(varies)	varies	Yes
		Copper	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Iron, Trec	µg/L	1,000 (ch)	no data	
		Lead, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Manganese, dis	µg/L	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
		Silver, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
Water Supply	Physical	Dissolved oxygen	mg/L	3.0	6.7 (40)	Yes
		pH	SU	6.5 - 9.0	7.0 - 8.3	Yes
	Inorganic	Nitrate	mg/L	10 (1-day)	max = 0.1 (61)	Yes
	Metals	Cadmium, dis	µg/L	5.0 (1-day)	not enough data	
		Iron, dis	µg/L	300 (30-day)	13 - 220	Yes
		Lead, Trec	µg/L	50 (1-day)	no data	
		Manganese, dis	µg/L	50 (30-day)	0 - 210	No
		Silver, Trec	µg/L	100 (1-day)	no data	
Recreation	Physical	Dissolved oxygen	mg/L	3.0	6.7 (40)	Yes
		pH	SU	6.5 - 9.0	7.0 - 8.3	Yes
Agriculture	Physical	Dissolved oxygen	mg/L	3.0	6.7 (40)	Yes
	Inorganic	Nitrate	mg/L as N	100	max = 0.1 (61)	Yes
	Metals	Cadmium, Trec	µg/L	10 (30-day)	no data	
		Lead, Trec	µg/L	100 (30-day)	no data	
		Manganese, Trec	µg/L	200 (30-day)	no data	

- ac= acute, ch-chronic, dis=dissolved, Trec=total recoverable
- Water quality data for past 5 years (9/02 on) was evaluated against standards applicable to the reservoir according to Colorado water quality regulations.
- Values in parenthesis in "In-Lake Value" column are numbers of samples or daily average values evaluated for the parameter.
- D.O. "In-Lake Values" are 15th percentile of daily average epilimnion profile results (elsp = early life stage present). In addition, per the WQCD, if all measurements in the epilimnion and metalimnion on any one day were below the standard the reservoir was found to be out of attainment.
- pH range is 15th percentile - 85th percentile value of daily average profile sample results.
- "Large Lake" temperature criteria applied. Temperature "In-Lake Values" are for epilimnion layer min - max of MWAT (ch) (lake equivalent of maximum weekly average temperature) and DM (ac) (daily maximum).
- In 2007, new temperature standards were adopted as defined in Colorado's Regulation No. 31 (5 CCR 1002-31). Interim standards were established to be applicable until the next Triennial Review process for each basin, at which point it is anticipated the new temperature standards will be adopted.
- Nitrate "In-Lake Value" is the maximum of all discrete Nitrate + Nitrite results.
- Water Supply "In-Lake Value" is min - max range of 30-day averages of hypolimnion samples (insufficient data points to evaluate epilimnion layer).
- For acute computations, evaluated all data. For all other computations, evaluated only if at least 12 data points (per WQCD guidelines).
- 'no data' includes instances where there are no hardness data available to evaluate the standard.

most of the TDS concentration, which is closely approximated by specific conductance. Although sufficient data are not available to evaluate if copper standards are being met for Shadow Mountain Reservoir, available data indicate an exceedance of the acute standard on two days. Dissolved iron and dissolved manganese concentrations are higher in the hypolimnion than in the epilimnion. Manganese concentrations currently exceed the water supply standard. Dissolved iron concentrations do not exceed the water supply standard.

Algae and Trophic State. Since 2000, chlorophyll *a* concentrations have averaged 5.1 µg/L and peak chlorophyll *a* concentrations have reached 32.7 µg/L. There is no clear seasonal pattern for chlorophyll *a*, although most often the highest concentrations occur in September. Average summer values of chlorophyll *a* concentrations (2000 to 2007) are indicative of a mesotrophic lake, with higher summer peak concentrations. Recent monitoring in Shadow Mountain Reservoir includes microcystin toxicity testing along with cell counts of dominant cyanobacteria (blue-green algae) (GCWIN 2007).

All microcystin results received through July 24, 2007 for Shadow Mountain Reservoir have been below the detection limit (Clements 2007).

Aquatic Vegetation and Sediment. There are two areas of concern among users of Shadow Mountain Reservoir that do not become evident by analyzing the concentrations of water-quality constituents. Excessive growth of aquatic vegetation in the reservoir has been a problem since the reservoir was filled (Sisneros 2007). Reservoir drawdowns occurred in 1990 and again in 2006 to help mitigate the problem. In addition, sediment has been accumulating where the North Fork enters the reservoir, forming a 15-acre delta. This delta interferes with recreation in that area of the reservoir. Studies have been conducted to assess the delta, identify potential restoration alternatives, and identify strategies for sediment management (e.g., HDR 2003; Barclay 2000).

Nutrients. Total phosphorus and total nitrogen concentrations are similar near the bottom of the reservoir and at the surface. Inorganic nitrogen concentrations (ammonia, nitrate, and nitrite) that are bioavailable for phytoplankton growth are low and typical of an oligotrophic system (Wetzel 2001). Orthophosphate concentrations are also low. Ammonia and nitrate concentrations in Shadow Mountain Reservoir meet water quality standards. Previous bioassays have shown that nitrogen may be the primary limiting factor for algae growth (EPA 1970; EPA 1977a). Although a few periods of P limitation and/or the need to increase both P and N have occurred (Morris and Lewis 1988), no recent bioassays have been conducted to determine if this situation has changed.

Water Clarity. The mean Secchi-disk depth is 2.4 meters with a range between 1 and 4 meters. Based on a statistical analysis of historical data from 1989 to 2006 the lake is clearest during the months of July and August.

Dissolved Oxygen. Although Shadow Mountain Reservoir is considered to be relatively well mixed, low DO concentrations near the bottom have occurred. Low DO concentrations can be a concern because of the potential release of orthophosphate, ammonia, iron, and manganese from the sediments under anoxic conditions. With one possible exception in 2003, water quality standards for DO are currently met in Shadow Mountain Reservoir. Shadow Mountain Reservoir is on the Colorado Water Quality Control Commission's 2008 Monitoring and Evaluation List for dissolved oxygen.

Temperature. Temperature in the epilimnion ranges from 1.7 to 19.7°C, which meets the current interim aquatic life water quality standard of 20°C and standards that will go into effect at the end of 2008.

Grand Lake

Grand Lake is the largest natural lake in Colorado. Its major tributaries are the East Inlet and North Inlet, which emanate from Rocky Mountain National Park. As part of the C-BT Project, Grand Lake also receives flow from Shadow Mountain Reservoir. The majority of the lake's outflow is via the Adams Tunnel, although some water also flows back to Shadow Mountain Reservoir, depending on C-BT operations. The water surface elevation of the lake is maintained within a 1-vertical-foot range as part of the C-BT system operations.

Grand Lake's physical characteristics and hydrology are described in Table 3-29. The lake has a small surface area relative to its depth. The residence time (the average amount of time water spends in the reservoir) is short due to the operation of the C-BT Project and varies according to operations. The lake strongly stratifies during the summer, forming an epilimnion (upper layer), a metalimnion (middle layer), and a hypolimnion (lower layer).

Table 3-29. Physical characteristics of Grand Lake.

Metric	Value
Volume	68,621 AF
Surface Area	507 acres
Mean Depth	135 feet
Maximum Depth	265 feet
Hydraulic Residence Time	2 to 3 months

Measures at maximum capacity. Residence time based on annual average content and total annual outflow.

Table 3-30 provides a summary comparison of water quality at the Grand Lake monitoring site on the west side of the lake for the years 2000 to 2007 with applicable standards. Following is a brief discussion of the existing water quality in Grand Lake for key parameters.

Major Ions and Trace Elements. The median concentrations of major ions are typical of nonpolluted watersheds. Although no sufficient data are available to evaluate if copper standards are being met, available data indicate no exceedances. Likewise, there is insufficient data available to evaluate whether the dissolved manganese standard is being met for Grand Lake, but existing data show values in the hypolimnion above the water supply standard.

Algae and Trophic State. Since 2000, chlorophyll *a* has averaged 7.3 µg/L while peak chlorophyll *a* concentrations have risen to 16.0 µg/L. There is no clear seasonal pattern for chlorophyll *a* although most often, the highest concentrations occur in September. Average chlorophyll *a* concentrations (2000 to 2005) are indicative of a mesotrophic lake.

Recent monitoring in Grand Lake includes microcystin toxicity testing along with cell counts of dominant cyanobacteria (blue-green algae) (GCWIN 2007). All microcystin results received through 2007 for Grand Lake have been below the detection limit except for two August 2007 samples with concentrations of 0.85 µg/l and 0.87 µg/l (Clements 2007).

Nutrients. Orthophosphate concentrations are low. Inorganic nitrogen concentrations (ammonia, nitrate, and nitrite) that are bioavailable for phytoplankton growth are also low and typical of an oligotrophic system (Wetzel 2001). Previous bioassays have shown that nitrogen may be the primary limiting factor for algae growth (EPA 1970, 1977a). Although a few periods of P limitation and/or the need to increase both P and N occurred (Morris and Lewis 1988), no recent bioassays have been conducted to determine if this situation has changed.

Clarity. Secchi-disk depths since 2000 have ranged from 1.8 to 5.6 meters, with a mean of 3.5 meters. Water clarity in Grand Lake is a concern among stakeholders in Grand County. Northwest Colorado Council of Governments (NWCCOG), Grand County, and the Greater Grand Lake Shoreline Association recently proposed a Secchi-disk depth standard for the lake of 4 meters (CWQCC, 2008). In June 2008, the Colorado Water Quality Control Commission established a narrative clarity standard for Grand Lake effective December 31, 2008. This narrative standard is "the highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life". The Colorado Water Quality Control Commission also established a numeric clarity standard of 4 meter Secchi-disk depth for the months of July through September, with an effective date of January 1, 2014. Local communities and other water utilities are evaluating ways to improve water clarity. Reclamation and the NCWCD will experiment with re-operation of the C-BT by altering pumping from Granby Reservoir to Grand Lake during critical periods to determine impacts on Grand Lake clarity.

Dissolved Oxygen. DO concentrations are lowest at the bottom of the lake just before fall turnover. Water quality standards for DO are currently met in Grand Lake.

Table 3-30. Comparison of key water quality standards for Grand Lake under existing conditions.

Use Classification	Parameter Category	Parameter	Unit	Applicable Standard	In-Lake Value	Standard Met?
Aquatic Life	Physical	Dissolved oxygen (elsp)	mg/L	6.0	6.7 (25)	Yes
		pH (epilimnion)	SU	6.5 - 9.0	6.8 - 8.4	Yes
		pH (hypolimnion)	SU	6.5 - 9.0	6.4 - 7.1	No
		Temperature standard (effective December 31, 2008)	°C	9 (ch winter)	1.5 - 2.2	Yes
				13 (ac winter)	2 - 2.3	Yes
				18.2 (ch summer)	15.5 - 16.2	Yes
				23.8 (ac summer)	16.2 - 16.9	Yes
		Temperature (interim)	°C	20.0 (ch)	1.5 - 16.2	Yes
	Inorganic	Ammonia	mg/L as N	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
	Metals	Cadmium, dis	µg/L	ac (varies)	not enough data	
				ac (tr)(varies)	varies	Yes
		Copper	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Iron, Trec	µg/L	1,000 (ch)	no data	
		Lead, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Manganese, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Silver, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	
Water Supply	Physical	Dissolved oxygen	mg/L	3.0	6.7 (25)	Yes
		pH	SU	6.5 - 9.0	6.8 - 8.4	Yes
	Inorganic	Nitrate	mg/L	10 (1-day)	max = 0.2 (50)	Yes
	Metals	Cadmium, dis	µg/L	5.0 (1-day)	not enough data	
		Iron, dis	µg/L	300 (30-day)	not enough data	
		Lead, Trec	µg/L	50 (1-day)	no data	
		Manganese, dis	µg/L	50 (30-day)	not enough data	
		Silver, Trec	µg/L	100 (1-day)	no data	
Recreation	Physical	Dissolved oxygen	mg/L	3.0	6.7 (25)	Yes
		pH	SU	6.5 - 9.0	6.8 - 8.4	Yes
Agriculture	Physical	Dissolved oxygen	mg/L	3.0	6.7 (25)	Yes
	Inorganic	Nitrate	mg/L as N	100	Max = 0.2 (50)	Yes
	Metals	Cadmium, Trec	µg/L	10 (30-day)	no data	
		Lead, Trec	µg/L	100 (30-day)	no data	
		Manganese, Trec	µg/L	200 (30-day)	no data	

- ac= acute, ch-chronic, dis=dissolved, Trec=total recoverable
-Water quality data for past 5 years (9/02 on) was evaluated against standards applicable to the reservoir according to Colorado water quality regulations.
- Values in parenthesis in "In-Lake Value" column are numbers of samples or daily average values evaluated for the parameter.
- D.O. "In-Lake Values" are 15th percentile of daily average epilimnion profile results (elsp = early life stage present). In addition, per the WQCD, if all measurements in the epilimnion and metalimnion on any one day were below the standard the reservoir was found to be out of attainment.
- pH range is 15th percentile - 85th percentile value of daily average profile sample results.
- "Large Lake" temperature criteria applied. Temperature "In-Lake Values" are for epilimnion layer min - max of MWAT (ch) (lake equivalent of maximum weekly average temperature) and DM (ac) (daily maximum).
- In 2007, new temperature standards were adopted as defined in Colorado's Regulation No. 31 (5 CCR 1002-31). Interim standards were established to be applicable until the next Triennial Review process for each basin, at which point it is anticipated the new temperature standards will be adopted.
- Nitrate "In-Lake Value" is the maximum of all discrete Nitrate + Nitrite results.
- Water Supply "In-Lake Value" is min - max range of 30-day averages of hypolimnion samples (insufficient data points to evaluate epilimnion layer).
- For acute computations, evaluated all data. For all other computations, evaluated only if at least 12 data points (per WQCD guidelines).
- 'no data' includes instances where there are no hardness data available to evaluate the standard.

Temperature. Temperature values range from 1.5 to 16.2°C and are within current interim standards and future standards that are effective December 31, 2008.

pH. Values for pH range from 6.4 to 7.1 in the hypolimnion and from 6.8 to 8.4 in the epilimnion. Existing data for the monitoring station on the west side of Grand Lake indicate pH values are below the aquatic life standard of 6.4. pH is a measure of the acidity or alkalinity of water. Values below 7 are more acidic and those above 7 more basic or alkaline.

3.8.1.4 East Slope Affected Environment

Big Thompson River

The water quality of the Big Thompson River in Rocky Mountain National Park is typical of high altitude mountain streams (Figure 3-2). Water quality characteristics for the Big Thompson River at locations below Lake Estes, upstream of the City of Loveland, and downstream near the confluence with the South Platte River are shown in Table 3-31. Iron concentrations are somewhat elevated during higher flows, indicating a natural source within the upper drainage area. Specific conductivity increases downstream near Loveland; and nitrogen, phosphorus, calcium, magnesium, sodium, chloride, and sulfate concentrations also are somewhat higher. As the river flows through Loveland and east to its confluence with the South Platte River, the water quality continues to decline, with specific conductivity indicative of increasing salt concentrations and increased concentrations of nutrients, minerals, and metals. Potential sources of these constituents to the river include natural erosion, runoff from roads and urban development, agricultural return flows, septic systems, WWTP return flows, irrigation return flows, and ground water discharge.

In the upper Big Thompson River, pH values have infrequently been below the pH standard. Below Loveland, the acute and chronic ammonia standard has occasionally been exceeded during winter months. Effluent discharges from the Loveland WWTP and other WWTPs are a likely source of some of the elevated ammonia concentrations.

North St. Vrain Creek and St. Vrain Creek

North St. Vrain Creek and St. Vrain Creek at Lyons are high quality mountain streams that appear to be little affected by human activities within their

Table 3-31. Big Thompson River historical water quality.

Parameter	Below Lake Estes, Above Dille Tunnel[1]		At Loveland[1]		At the Confluence with South Platte River[2]	
	Range	Avg.	Range	Avg.	Range	Avg.
Temperature (°C)	0 - 20	9.3	0.5 - 22.5	12.4	0 - 29	12.5
Specific conductivity (µS/cm)	27 - 151	146	60 - 1,950	857	355 - 3,000	1,813
TDS (mg/L)	26 - 64	43	120 - 1,200	529	NA	NA
Dissolved oxygen (mg/L)	7.5 - 13.9	10.09	6.1 - 14.2	9.6	6.5 - 12.5	9.06
pH	7.1 - 9.1	7.8	7.5 - 8.7	8.1	7.7 - 8.4	8.04
Ammonia (mg/L)	0.001 - 1.77	0.1	<0.002 - 0.75	0.11	0.22 - 4.6	1.66
Nitrate and nitrite (mg/L)	0.015 - 0.62	0.23	<0.05 - 0.72	0.22	0.51 - 5	2.9
Total phosphorus (mg/L)	0.011 - 0.155	0.05	0.004 - 0.19	0.03	0.16 - 0.68	0.44
Sodium (mg/L)	1.6 - 9.27	3.5	5 - 132	37.3	17 - 220	137
Total iron (µg/L)	5 - 130	57.6	20 - 7,100	528	20 - 50	30
Dissolved manganese (µg/L)	0.75 - 10.4	3.7	6.9 - 159	35	10 - 510	144
Dissolved Selenium (µg/L)	0.3 - 0.4	-	0.77 - 1.5	-	NA	NA

[1] Data from 2000 to 2006.
[2] Data from 1980 to 2001.
Source: Earthinfo 2006.

Table 3-32. North St. Vrain and St. Vrain Creek historical water quality.

Parameter	North St. Vrain Creek at Longmont Dam[1]		St. Vrain Creek at Lyons[2]		St. Vrain Creek at the Confluence with Boulder Creek[3]	
	Range	Avg.	Range	Avg.	Range	Avg.
Temperature (°C)	0 - 17.5	7.7	0 - 22	8.9	0.4 - 24	12.3
Specific conductivity (µS/cm)	18 - 73	29	34 - 140	76	261 - 1,900	1,226
Suspended sediment (mg/L)	NA	NA	1 - 48	8.7	15 - 3,370	273
Dissolved oxygen (mg/L)	7.6 - 11.4	9.5	7.3 - 13.5	10	6.4 - 14	9.3
pH	5.4 - 8.3	7.3	6.6 - 7.6	7.1	7.5 - 8.7	8.03
Ammonia (mg/L)	NA	NA	0 - 0.12	0.037	0.05 - 2.5	0.5
Nitrate and nitrite (mg/L)	0 - 0.45	0.07	0.07 - 0.5	0.27	0.52 - 5.4	3.1
Total phosphorus (mg/L)	NA	NA	0.02 - 0.67	0.1	0.22 - 1.5	0.7
Sodium (mg/L)	1 - 4	1.9	1.7 - 5.8	3.6	15 - 160	99.7
Iron, dissolved (µg/L)	30 - 270	104	20 - 200	69	3 - 160	28
Manganese, dissolved (µg/L)	0 - 160	16.6	<10 - 20	10.3	10 - 460	95

[1] Data from 1971 to 1978.
[2] Data from 1980 to 2002.
[3] Data from 1980 to 2001.
Source: Earthinfo 2006.

watersheds. Water quality characteristics for North St. Vrain Creek at Longmont Dam, St. Vrain Creek at Lyons, and St. Vrain Creek at the confluence with Boulder Creek (Figure 3-2) are shown in Table 3-32.

Manganese concentrations exceeded the water supply standard in North St. Vrain Creek one time; likely due to discharge from bedrock ground water. Phosphorus concentrations were occasionally elevated above background concentrations in St. Vrain Creek at Lyons during periods of very low flow; this may be due to discharge from Lyons' WWTP. St. Vrain Creek from Lefthand Creek to I-25 has a Total Maximum Daily Load (TMDL) for ammonia to help attain ammonia standards. East of Longmont, the water quality of St. Vrain Creek declines substantially, with specific conductivity values about 20 times higher and suspended sediment concentrations about 25 times higher than measured at Lyons. Nutrient concentrations also increase downstream, with ammonia concentrations occasionally above the chronic standard below Longmont. Potential sources of these constituents to St. Vrain Creek are natural erosion, runoff from roads and developed areas, WWTP return flows, irrigation return flows, and ground water (especially from bedrock sources, such as the Pierre shale, which outcrops at the west edge of the plains).

Big Dry Creek

Big Dry Creek is primarily a plains stream located in areas of urban and agricultural development (Figure 3-2). Water quality characteristics for Big Dry Creek at locations west of Highway 36, below the Broomfield WWTP, and downstream of Weld County Road 4 near Fort Lupton are shown in Table 3-33. Big Dry Creek water quality is affected by WWTP return flows, runoff from roads and urban areas, and irrigation return flows. Specific conductivity values are high, especially at low flows, and nitrogen and phosphorus concentrations are often elevated. Ammonia chronic and acute standards are occasionally exceeded. Iron concentrations exceed aquatic and recreation standards below the Broomfield WWTP and farther downstream. The manganese agricultural standard is exceeded west of Highway 36.

Coal Creek

Water quality characteristics for Coal Creek near Plainview and Louisville/Lafayette (Figure 3-2) are shown in Table 3-34. Coal Creek at the base of the foothills is fairly pristine, although specific conductivity values and iron concentrations have been elevated at times. Nutrient concentrations in Coal Creek increase downstream with effluent discharges from several WWTPs, plus additional urban and agricultural nonpoint sources. There is an ammonia TMDL on Coal Creek.

Table 3-33. Big Dry Creek historical water quality.

Parameter	West of Highway 36[1]		Below Broomfield WWTP[2]		Below Weld County Road 4[1]	
	Range	Avg.	Range	Avg.	Range	Avg.
Temperature (°C)	0 - 19.9	9	7.3 - 25.3	15	0 - 27.3	13.7
Specific conductivity (µS/cm)	214 - 3,794	1,314	407 - 1,460	1,021	367 - 1,904	1,234
TDS (mg/L)	138 - 2,197	886	346 - 885	660	368 - 1,288	823
Suspended sediment (mg/L)	1 - 170	13	8 - 300	41.2	3.2 - 560	70
Dissolved oxygen (mg/L)	6.2 - 16.5	9.98	7.5 - 11.7	9.46	7.2 - 17	10.5
pH	6.79 - 8.76	7.74	7.11 - 8.31	7.76	7.13 - 9.15	8
Ammonia (mg/L)	<0.01 - 1.4	0.1	0.025 - 8.2	1.05	<0.01 - 12	0.9
Nitrate and nitrite (mg/L)	<0.02 - 3	0.865	2.5 - 20.4	10.85	0.77 - 19.3	8.5
Total phosphorus (mg/L)	<0.01 - 0.22	0.05	0.38 - 3.48	1.98	0.22 - 5.3	1.5
Sodium (mg/L)	16.3 - 539.4	164	62 - 171	120	69 - 240	149
Iron, dissolved (µg/L)	5 - 1,044	337	30 - 10,072	1,090	8.85 - 8,358	1,490
Manganese, dissolved (µg/L)	2 - 1,930	300	8 - 221	80	2 - 168	48.6

[1] Data from 2000 to 2005.
[2] Data from 1994 to 2005.
Source: Earthinfo 2006, BDCWA 2007.

Table 3-34. Coal Creek historical water quality.

Parameter	Near Plainview west of Highway 93[1]		At Louisville and Lafayette[2]	
	Range	Avg.	Range	Avg.
Temperature (°C)	0 - 24	9.1	0 - 24	12.5
Specific conductivity (µS/cm)	95 - 600	233	229 - 2,800	931
Suspended sediment (mg/L)	NA	NA	3 - 4	NA
Dissolved oxygen (mg/L)	5.9 - 12.2	9.1	8.1 - 9.4	NA
pH	6.9 - 8.6	7.5	7.21 - 8.07	7.71
Ammonia (mg/L)	<0.02 - 0.13	0.08	<0.04 - 0.12	0.07
Nitrate and nitrite (mg/L)	0 - 1.8	0.21	<0.06 - 1.9	0.6
Total phosphorus (mg/L)	0 - 0.04	NA	0.016 - 0.018	NA
Sodium (mg/L)	5.6 - 67	20.4	150	NA
Iron, total (µg/L)	34 - 1,200	584	34 - 1,200	490
Manganese, dissolved (µg/L)	<4 - 140	23	10 - 30	16.5

[1] Data from 1980 to 2003.
[2] Data from 1987 to 2003.
Source: Earthinfo 2006.

Table 3-36. Cache la Poudre River historical water quality.

Parameter	Below Fort Collins[1]		Near Greeley[2]	
	Range	Avg.	Range	Avg.
Temperature (°C)	0 - 25	11	1.5 - 25.5	14
Specific conductivity (μS/cm)	49 - 1,330	527	370 - 2,140	1,599
Ammonia (mg/L)	6.5 - 20	11.37	4.3 - 15.8	9.15
Nitrate and nitrite (mg/L)	7.4 - 9.6	8.36	7 - 8.3	7.84
Total phosphorus (mg/L)	0.006 - 2.7	0.2	0.24 - 1.2	0.66
Sodium (mg/L)	0.005 - 4.4	1.24	0.77 - 8.5	4.8
Iron, total (μg/L)	0.01 - 1.5	0.31	0.24 - 1.1	0.6
Manganese, dissolved (μg/L)	2.6 - 62.4	24.6	15 - 150	110

[1] Data from 1980 to 2004.
[2] Data from 1980 to 2001.
Source: Earthinfo 2006.

Cache la Poudre River

The Cache la Poudre River, with headwaters at the Continental Divide, flows through Fort Collins and Greeley to its confluence with the South Platte River near Greeley (Figure 3-2). Water quality characteristics for the Cache la Poudre River downstream of Fort Collins and near Greeley are provided in Table 3-36. Water quality decreases downstream from Fort Collins as a result of urban development, WWTP discharges, agricultural runoff, and natural sources of erosion. Average nutrient, specific conductivity, and mineral concentrations increase between Fort Collins and Greeley. The DO concentration has been below the standard near Greeley on a couple of occasions in the spring, which can affect warm water biota. The chronic ammonia standard also has occasionally been exceeded below Fort Collins and farther downstream.

Chimney Hollow and Dry Creek

No water quality data are available for the intermittent Chimney Hollow and Dry Creek where potential reservoirs would be located. Water quality in these small watersheds would be influenced primarily by natural sources of sediment, organic matter, and inorganic compounds because development is minimal. The llama operation at Dry Creek may introduce nutrients to periodic runoff.

Ralph Price Reservoir

Ralph Price Reservoir is located within the Button Rock Preserve and is the primary water supply for the City of Longmont (Figure 3-7). Ralph Price Reservoir stores water from North St. Vrain Creek, which emanates from the Wild Basin Area of Rocky Mountain National Park. Ralph Price Reservoir's physical characteristics are described in Table 3-35.

No water quality data are available to describe reservoir conditions, although some water quality data were collected downstream of Ralph Price Reservoir (below Longmont Dam) in the 1970s (USGS 2007). These data indicate relatively pristine conditions, which are expected given the nature of the upstream watershed. Ralph Price Reservoir is not impaired nor is it a concern from a water quality standpoint.

Table 3-35. Physical characteristics of Ralph Price Reservoir.

Metric	Value
Volume	16,197 AF
Surface Area	227 acres
Mean Depth	71.3 feet
Average Annual Outflow	48,600 AF/year
Hydraulic Residence Time	1.1 years

Measures at maximum capacity. Residence time based on annual average content and total annual outflow.
Source: Boyle 2006c.

Carter Lake

Carter Lake is a C-BT Project reservoir that supplies water to various Front Range and eastern plains cities and agricultural areas (Figure 3-31). Water for the reservoir comes from Grand Lake and the Big Thompson River through a series of pipelines, conduits, and reservoirs. Reservoir releases are delivered through the St. Vrain Supply Canal and the Southern Water Supply Project. Carter Lake's physical characteristics and hydrology are described in Table 3-37.

Table 3-37. Physical characteristics of Carter Lake.

Metric	Value
Volume	112,230 AF
Surface Area	1,110 acres
Mean Depth	101 feet
Maximum Depth	180 feet
Hydraulic Residence Time	1 year

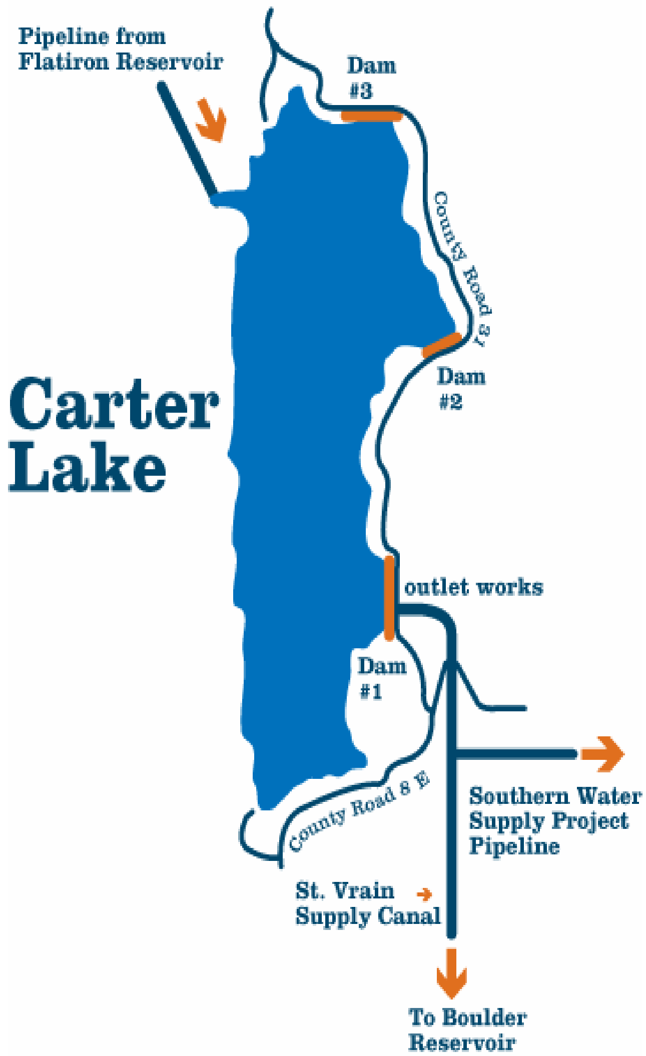
Measures at maximum capacity. Residence time based on annual average content and total annual outflow.
Source: NCWCD 2007c; Jassby and Goldman 1999.

Table 3-38 provides a summary comparison of water quality in Carter Lake for 2000 to 2007 with applicable standards. Following is a brief discussion of the existing water quality in Carter Lake for key parameters.

Major Ions and Trace Metals. The median concentrations of major ions are typical of nonpolluted watersheds. Although no sufficient data are available to evaluate if copper standards are being met, available data indicate an exceedance of the standard on one day. Dissolved iron and dissolved manganese concentrations show higher values in the hypolimnion versus the epilimnion. Manganese concentrations are relatively low with the exception of a spike in September 2006, and currently meet standards.

Algae and Tropic State. Since 2000, the peak chlorophyll *a* concentration was 4.7 µg/L. Peak concentrations tend to occur in the spring and/or fall. The average chlorophyll *a* concentrations translate to a mesotrophic state.

Figure 3-31. Carter Lake.



Nutrients. Orthophosphate concentrations are low. Inorganic nitrogen concentrations (ammonia, nitrate, and nitrite) are low and typical of an oligotrophic system (Wetzel 2001). Ammonia and nitrate concentrations are within water quality standards. No bioassays have been conducted to determine which nutrient is limiting the growth of algae. Estimates based on inorganic nutrient concentrations are uninformative due to the high number of results below the detection limits. Jassby and Goldman (1999) concluded that the reservoir was co-limited by nitrogen and phosphorus.

Water Clarity. Since 2000, the range in Secchi-disk depth has been from 1.6 to 5.1 meters with a mean value of 2.9 meters.

Table 3-38. Comparison of key water quality standards for Carter Lake under existing conditions.

Use Classification	Parameter Category	Parameter	Unit	Applicable Standard	In-Lake Value	Standard Met?
Aquatic Life	Physical	Dissolved oxygen (elsp)	mg/L	6.0	7.2 (26)	Yes
		pH (epilimnion)	standard	6.5 - 9.0	7.6 - 8.5	Yes
		pH (hypolimnion)	standard	6.5 - 9.0	7.0 - 8.4	Yes
		Temperature standard (effective December 31, 2009	°C	9 (ch winter)	no data	
				13 (ac winter)	no data	
				18.2 (ch summer)	20.8 - 22.7	No
				23.8 (ac summer)	21.3 - 22.9	Yes
		Temperature (interim)	°C	20.0 (ch)	20.8 - 22.7	No
	Inorganic	Ammonia	mg/L as N	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
	Metals	Cadmium, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Copper	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Iron, Trec	µg/L	1,000 (ch)	no data	
		Lead, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Manganese, dis	µg/L	ch (varies)	varies	Yes
				ac (varies)	varies	Yes
		Silver, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
Water Supply	Physical	Dissolved oxygen	mg/L	3.0	7.2 (26)	Yes
		pH	standard	6.5 - 9.0	7.6 - 8.5	Yes
	Inorganic	Nitrate	mg/L	10 (1-day)	max = 0.3 (53)	Yes
	Metals	Cadmium, dis	µg/L	5.0 (1-day)	not enough data	
		Iron, dis	µg/L	300 (30-day)	0 - 40	Yes
		Lead, Trec	µg/L	50 (1-day)	no data	
		Manganese, dissolved	µg/L	50 (30-day)	0 - 37.8	Yes
		Silver, Trec	µg/L	100 (1-day)	no data	
Recreation	Physical	Dissolved oxygen	mg/L	3.0	7.2 (26)	Yes
		pH	standard	6.5 - 9.0	7.6 - 8.5	Yes
Agriculture	Physical	Dissolved oxygen	mg/L	3.0	7.2 (26)	Yes
	Inorganic	Nitrate	mg/L as N	100	max = 0.3 (53)	Yes
	Metals	Cadmium, Trec	µg/L	10 (30-day)	no data	
		Lead, Trec	µg/L	100 (30-day)	no data	
		Manganese, Trec	µg/L	200 (30-day)	no data	

- ac= acute, ch-chronic, dis=dissolved, Trec=total recoverable
- Water quality data for past 5 years (9/02 on) was evaluated against standards applicable to the reservoir according to Colorado water quality regulations.
- Values in parenthesis in "In-Lake Value" column are numbers of samples or daily average values evaluated for the parameter.
- D.O. "In-Lake Values" are 15th percentile of daily average epilimnion profile results (elsp = early life stage present). In addition, per the WQCD, if all measurements in the epilimnion and metalimnion on any one day were below the standard the reservoir was found to be out of attainment.
- pH range is 15th percentile - 85th percentile value of daily average profile sample results.
- "Large Lake" temperature criteria applied. Temperature "In-Lake Values" are for epilimnion layer min - max of MWAT (ch) (lake equivalent of maximum weekly average temperature) and DM (ac) (daily maximum).
- In 2007, new temperature standards were adopted as defined in Colorado's Regulation No. 31 (5 CCR 1002-31). Interim standards were established to be applicable until the next Triennial Review process for each basin, at which point it is anticipated the new temperature standards will be adopted.
- Nitrate "In-Lake Value" is the maximum of all discrete Nitrate + Nitrite results.
- Water Supply "In-Lake Value" is min - max range of 30-day averages of hypolimnion samples (insufficient data points to evaluate epilimnion layer).
- For acute computations, evaluated all data. For all other computations, evaluated only if at least 12 data points (per WQCD guidelines).
- 'no data' includes instances where there are no hardness data available to evaluate the standard.

Dissolved Oxygen. DO concentrations in Carter Lake meet water quality standards, although concentrations have been below 4 mg/L near the bottom of the lake in the fall. DO concentrations increase in the spring and early summer at a depth of 5 to 10 meters. This typically occurs because of large algal populations that develop more rapidly than sinking out of this stratum (Wetzel 2001).

Temperature. Surface temperatures in the summer range from 20.8 to 22.7°C, which exceeds the current interim temperature standard and the anticipated December 2008 standard.

Horsetooth Reservoir

Horsetooth Reservoir is a C-BT Project reservoir that supplies water to Fort Collins as well as several rural domestic suppliers, industries, and agricultural lands in the Poudre River basin (Figure 3-32). Water is supplied from Flatiron Reservoir and the Dille Tunnel via the Hansen Feeder Canal. The main outlet is through Horsetooth Dam to the Poudre River via the Hansen Supply Canal. Horsetooth Reservoir's physical characteristics and hydrology are described in Table 3-39.

Table 3-39. Physical characteristics of Horsetooth Reservoir.

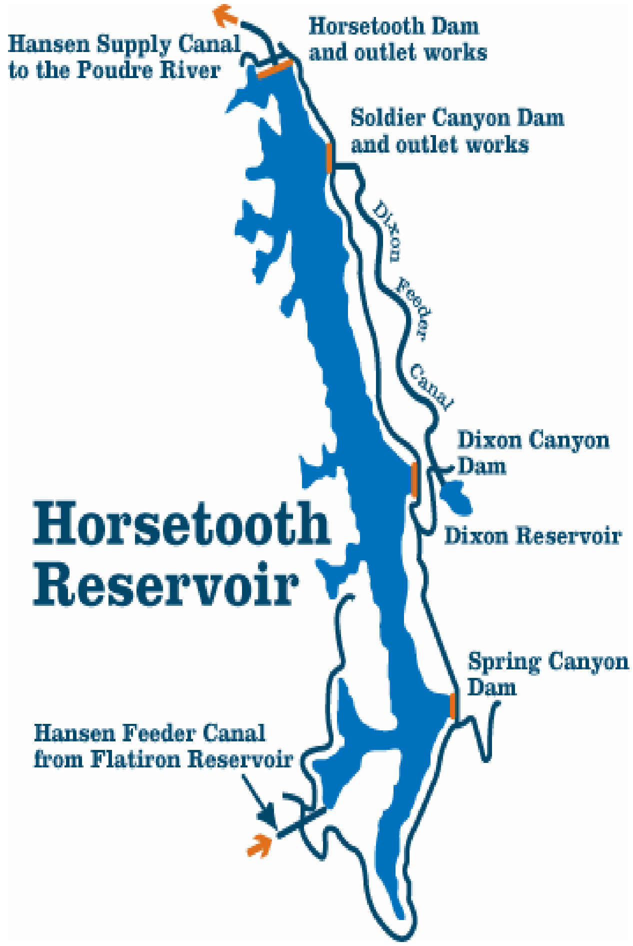
Metric	Value
Volume	156,735 AF
Surface Area	2,143 acres
Mean Depth	73.1 feet
Maximum Depth	188 feet
Hydraulic Residence Time	1 year+

Measures at maximum capacity. Residence time based on annual average content and total annual outflow.
Source: NCWCD 2007d; Jassby and Goldman 1999.

Table 3-40 provides a summary comparison of water quality in Horsetooth Reservoir for the years 2004 to 2007 with applicable standards. Following is a brief discussion of the existing water quality in Horsetooth Reservoir for key parameters at the Soldier Canyon Dam water quality monitoring site.

Major Ions and Trace Elements. The median concentrations of major ions are typical of nonpolluted watersheds. Although no sufficient data is available to evaluate whether copper standards are being met, available data indicate an exceedance of the acute standard on one day. Low dissolved oxygen concentrations in the hypolimnion result in increased dissolved iron and dissolved manganese concentrations. Manganese concentrations currently exceed the water supply standard.

Figure 3-32. Horsetooth Reservoir.



Algae and Trophic State. Since 2004, peak chlorophyll *a* concentrations have been as high as 6.8 µg/L. There is no clear seasonal pattern for chlorophyll *a*, although most often the highest concentrations occur during the summer months. Average chlorophyll *a* concentrations for 2004-2006 are indicative of a mesotrophic state.

Nutrients. More than 70 percent of the orthophosphate concentrations are below the detection limit. Inorganic nitrogen concentrations (ammonia, nitrate, and nitrite) are low and typical of an oligotrophic system (Wetzel 2001). There are not

Table 3-40. Comparison of key water quality standards for Horsetooth Reservoir under existing conditions.

Use Classification	Parameter Category	Parameter	Unit	Applicable Standard	In-Lake Value	Standard Met?
Aquatic Life	Physical	Dissolved oxygen (elsp)	mg/L	6.0	5.5 (28)	No
		pH (epilimnion)	SU	6.5 - 9.0	7.0 - 8.1	Yes
		pH (hypolimnion)	SU	6.5 - 9.0	6.7 - 7.6	Yes
		Temperature standard (effective December 31, 2009)	°C	9 (ch winter)	no data	
				13 (ac winter)	no data	
				18.2 (ch summer)	21.4 - 22.8	No
				23.8 (ac summer)	22.3 - 23.7	Yes
		Temperature (interim)	°C	20.0 (ch)	21.4 - 22.8	No
	Inorganic	Ammonia	mg/L a N	ch (varies)	not enough data	
				ac (varies)	not enough data	
	Metals	Cadmium, dis	µg/L	ch (varies)	no data	
				ac (varies)	no data	
		Copper, dis	µg/L	ch (varies)	no data	
				ac (varies)	no data	
		Iron, Trec	µg/L	1,000 (ch)	not enough data	
		Lead, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
		Manganese, dis	µg/L	ch (varies)	no data	
				ac (varies)	no data	
		Silver, dis	µg/L	ch (varies)	not enough data	
				ac (varies)	varies	Yes
Water Supply	Physical	Dissolved oxygen	mg/L	3.0	5.5 (28)	Yes
		pH	SU	6.5 - 9.0	7.0 - 8.1	Yes
	Inorganic	Nitrate	mg/L	10 (1-day)	max = 0.3 (28)	Yes
	Metals	Cadmium, dissolved	µg/L	5.0 (1-day)	no data	
		Iron, dissolved	µg/L	300 (30-day)	20 - 237.5	Yes
		Lead, Trec	µg/L	50 (1-day)	no data	
		Manganese, dis	µg/L	50 (30-day)	0 - 140	No
		Silver, Trec	µg/L	100 (1-day)	no data	
Recreation	Physical	Dissolved oxygen	mg/L	3.0	5.5 (28)	Yes
		pH	SU	6.5 - 9.0	7.0 - 8.1	Yes
Agriculture	Physical	Dissolved oxygen	mg/L	3.0	5.5 (28)	Yes
	Inorganic	Nitrate	mg/L as N	100	max = 0.3 (28)	Yes
	Metals	Cadmium, Trec	µg/L	10 (30-day)	no data	
		Lead, Trec	µg/L	100 (30-day)	no data	
		Manganese, Trec	µg/L	200 (30-day)	no data	

- ac= acute, ch-chronic, dis=dissolved, Trec=total recoverable
- Water quality data for past 5 years (9/02 on) was evaluated against standards applicable to the reservoir according to Colorado water quality regulations.
- Values in parenthesis in "In-Lake Value" column are numbers of samples or daily average values evaluated for the parameter.
- D.O. "In-Lake Values" are 15th percentile of daily average epilimnion profile results (elsp = early life stage present). In addition, per the WQCD, if all measurements in the epilimnion and metalimnion on any one day were below the standard the reservoir was found to be out of attainment.
- pH range is 15th percentile - 85th percentile value of daily average profile sample results.
- "Large Lake" temperature criteria applied. Temperature "In-Lake Values" are for epilimnion layer min - max of MWAT (ch) (lake equivalent of maximum weekly average temperature) and DM (ac) (daily maximum).
- In 2007, new temperature standards were adopted as defined in Colorado's Regulation No. 31 (5 CCR 1002-31). Interim standards were established to be applicable until the next Triennial Review process for each basin, at which point it is anticipated the new temperature standards will be adopted.
- Nitrate "In-Lake Value" is the maximum of all discrete Nitrate + Nitrite results.
- Water Supply "In-Lake Value" is min - max range of 30-day averages of hypolimnion samples (insufficient data points to evaluate epilimnion layer).
- For acute computations, evaluated all data. For all other computations, evaluated only if at least 12 data points (per WQCD guidelines).
- 'no data' includes instances where there are no hardness data available to evaluate the standard.

enough data to determine if ammonia concentrations are within water quality standards. Nitrate concentrations are within applicable standards. Due to the high nutrient detection limits, it is difficult to determine the limiting nutrient for algae growth.

Jassby and Goldman (1999) concluded that Horsetooth Reservoir was co-limited by nitrogen and phosphorus.

Water Clarity. Since 2004, the mean Secchi-disk depth has ranged from 1.5 to 4.8 meters and has averaged 2.9 meters.

Dissolved Oxygen. Low DO concentrations occur at a depth of about 10 meters during the summer months, similar to Granby Reservoir. Possible causes for this drop in DO in the metalimnion include 1) decomposition of oxidizable material, 2) significant concentrations of zooplankton that respire and drop the DO concentration, and 3) reservoir morphometry (shape) (Wetzel 2001). It is possible that an interflow from the Hansen Feeder Canal results in an increased loading of organic material, causing a reduction in DO concentrations (Lieberman 2007b). Horsetooth Reservoir is currently on the 2006 303(d) List for dissolved oxygen.

Temperature. Summer temperatures, which range from 21.4 to 23.7°C, currently exceed the interim standard and the anticipated December 2008 water quality standards.

Summary of Lake and Reservoir Water Quality Concerns

Regulatory water quality concerns for existing lakes and reservoirs in the study area are summarized in Table 3-41.

Table 3-41. Reservoir status on 2008 303(d) List and 2008 Monitoring and Evaluation List.

Reservoir	Segment	On 2008 303(d) List?	On 2008 M&E List?	Met Standards (using data from this analysis)?
Granby Reservoir	Upper Colorado River Sediment 2 COUCUC02	No	No	No [Dissolved oxygen, Temperature[1], Dissolved Manganese]
Shadow Mountain Reservoir	Upper Colorado River Segment 2 COUCUC02	No	Yes, dissolved oxygen	No [Dissolved Manganese, one exceedances for dissolved oxygen]
Grand Lake	Upper Colorado River Segment 2 COUCUC02	No	No	No [pH, Dissolved Manganese]
Carter Lake	COSPBT11	Yes, Aquatic Life Use (fish consumption advisory due to mercury in fish tissue)	No	No [Temperature[2]]
Horsetooth Reservoir	COSPCP14	Yes, Dissolved oxygen, Aquatic Life Use (fish consumption advisory due to mercury in fish tissue)	No	No [Temperature[2], Dissolved Manganese]
Ralph Price Reservoir	COSPSV02	No	No	—

[1] According to the anticipated December 31, 2008 standard.
[2] According to both the anticipated December 31, 2009 standard and the current interim standard.

3.8.2 Environmental Effects

3.8.2.1 Issues

Several water quality issues were identified during the scoping process. Concern was expressed about potential impacts to Colorado River water quality from nutrient loadings, changes in selenium, salinity, temperature, and sediment. The transport of additional water through the Three Lakes System was a concern because water from the Fraser River, a tributary to the Colorado River above the Windy Gap diversion, includes discharges from several WWTPs that may increase nutrient loading. Nutrient loadings and water quality in existing East Slope reservoirs, as well as new reservoirs, and streams were also an issue of concern.

3.8.2.2 Regulatory Requirements

The Federal Clean Water Act (33 U.S.C. 1251, et seq.) is a set of laws that govern and regulate surface and ground water quality and improve watersheds nationwide. This Act requires states to adopt water quality criteria for waters and develop a plan to implement and enforce the criteria (CDPHE 2002). The Colorado Water Quality Control Commission (WQCC) (the administrative agency) and the Water Quality Control Division (WQCD) (the implementing and enforcing agency) govern water quality in Colorado. This includes 1) assigning use classifications to state water segments, 2) establishing water quality standards for each water segment, and 3) reporting on attainment of water quality standards. The WQCC has adopted water use classifications for streams, lakes, and reservoirs that identify the uses to be protected on a stream segment or in a lake or reservoir and has adopted numerical standards for specific pollutants to protect these uses.

The nonattainment of water quality standards is reported every 2 years via the State's 303(d) List. When segments on the 303(d) List are considered impaired for one or more water quality parameters, a TMDL effort occurs to resolve the impairment. If an impairment is suspected and data are insufficient to draw a conclusion, the water segment is placed on the Monitoring and Evaluation (M&E) List.

The following sections discuss water quality regulations and standards for the West and East Slope rivers, lakes, and reservoirs in the study area.

West Slope

The Colorado River from the outlet of Granby Reservoir to the Roaring Fork River and Willow Creek below Willow Creek Reservoir are designated "reviewable water" by the WQCD. This means these streams must be maintained and protected at their existing quality unless it is determined that poorer water quality is necessary to accommodate important economic or social development. Regulated activities, such as construction of a new West Slope reservoir, would require a 404 Permit from the Corps and 401 Certification from the WQCD. The WQCD would determine the need for an antidegradation review of the selected alternative.

The Colorado River and its tributaries from below Granby Reservoir to the confluence with the Roaring Fork River are classified by the Colorado Department of Public Health and Environment (CDPHE) (2006a) for the following uses:

- Aquatic Life Cold 1 (currently capable of sustaining a wide variety of cold water biota, including sensitive species).
- Recreation 1a (existing primary contact, where the ingestion of small quantities of water is likely to occur, such as swimming or kayaking).
- Water Supply (suitable or intended to become suitable for potable water supplies after receiving standard treatment).
- Agriculture (suitable or intended to become suitable for irrigation of crops and not hazardous for livestock drinking water).

Numeric standards established by the CDPHE (2006a) for the Colorado River mainstem and its tributaries in the study area are provided in Table 3-42. In June 2005, CDPHE adopted new aquatic life acute and chronic criteria for total ammonia (CDPHE 2005). The new ammonia criteria became enforceable standards in all river basins in Colorado on July 1, 2007.

The stream use classifications and the numeric standards do not apply to the mainstem of Church Creek from its headwaters to the confluence with Willow Creek. Due to existing water quality

Table 3-42. Numeric standards for the upper Colorado River and its tributaries, from below Granby Reservoir to the Roaring Fork River.

Parameter	Standard	Parameter	Standard
Physical		**Metals[1] (µg/L)**	
Dissolved oxygen (mg/L)	6.0	Arsenic (acute)	50
Dissolved oxygen, spawning (mg/L)	7.0	Cadmium (acute, dissolved)	1.8
pH	6.5-9.0	Cadmium (chronic, dissolved)	1.3
Temperature[2] (chronic, maximum, ºC) where not gold-medal fishery	20	Chromium III (acute, total rec.)	50
Temperature[2] (chronic, maximum ºC), gold medal fishery (Colorado River from Fraser River to Troublesome Creek), interim standard	18.2	Chromium VI (acute/chronic)	11
Temperature[2] (chronic, maximum, ºC, first, second or third order streams above 7,000 feet) [3]	17	Copper (acute/chronic)	7/5
Inorganic (mg/L)		Iron (chronic, dissolved, water supply)	300
Total ammonia[4] (acute/chronic for early life stages/chronic without early life stages present)	7.02/2.87/3.87	Iron (chronic, total rec., aquatic)	1,000
Chlorine (acute)	0.019	Lead (acute, chronic)	30
Chlorine (chronic)	0.011	Manganese (chronic, water supply)	50
Cyanide	0.005	Manganese (acute/chronic, aquatic)	2,370/1,310
Sulfide as H_2S	0.002	Mercury (chronic, total)	0.01
Boron	0.75	Nickel (acute/chronic)	260/90
Nitrite	0.05	Selenium[5] (acute/chronic)	18.4/4.6
Nitrate	10	Silver (acute/chronic)	0.62/0.1
Chloride	250	Zinc (acute/chronic)	65/66
Sulfate	250		

[1] Most metals standards are hardness dependent; values provided above assume a hardness of 50 mg/L, based on hardness data collected from the Colorado River near the Windy Gap diversion. At distances farther downstream where hardness is greater than 50 mg/L, metal standards would be higher (less stringent).
[2] Temperature standard is the maximum weekly average temperature (MWAT) defined as "the mathematical mean of multiple, evenly spaced, daily temperatures over a 7-day period" (EPA 1977b).
[3] This temperature standard applies to Willow Creek.
[4] The aquatic life ammonia standards are pH and temperature dependent; an average pH of 7.88 and an average stream temperature of 9.9°C was used based on data collected from the Colorado River near the Windy Gap diversion. Ammonia standards are lower when stream temperature and/or pH are higher.
[5] Selenium is a bioaccumulative metal, subject to a range of toxicity values depending on numerous site-specific variables.
Source: CDPHE 2006a.

degradation in Church Creek, the creek is classified as not capable of sustaining a wide variety of cold water biota, not suitable for primary contact recreation use, and not suitable for water supply (CDPHE 2006a). Church Creek is designated as Use-Protected. This means it is not subject to the antidegradation review process. There are numeric standards for Church Creek above the Willow Creek Reservoir Road, except for ammonia, chlorine, chloride, sulfate, or iron. Metal numeric standards are not hardness-based. Below the Willow Creek Reservoir Road to Willow Creek, numeric standards for Church Creek are the same as those shown in Table 3-42, except there is no standard for nitrate.

The WQCD has a Hydrologic Modification Nonpoint Source Management Program with a goal to identify and develop programs to minimize adverse nonpoint source water quality impacts associated with hydrologic modifications (CDPHE 2000). Implementation of Best Management Practices to correct identified nonpoint source water quality problems is voluntary in Colorado. Section

208 of the Clean Water Act requires plans for coordinated regional approaches to water quality management. The Northwest Colorado Council of Governments (NWCCOG) is the designated regional water quality management agency responsible for water quality planning in Grand County and surrounding counties. When a federal 401/404 permit is required for a Hydrologic Modification, such as construction of a new reservoir on the West Slope, NWCCOG is authorized to review and comment on the federal permit.

East Slope

The tributaries to the South Platte River in the study area are the Big Thompson River, Big Dry Creek, Coal Creek, North St. Vrain Creek, St. Vrain Creek, and the Cache la Poudre River. These streams, with the exception of the Big Thompson River upstream of Big Barnes Ditch and North St. Vrain Creek, are classified for the following uses:

- Aquatic Life Warm 2 (currently not capable of sustaining a wide variety of warm water biota, including sensitive species, due to physical habitat, flows, or water quality conditions).
- Recreation 1a or 1b (existing or potential primary contact, where the ingestion of small quantities of water is likely to or might occur, such as swimming or kayaking).
- Agriculture (suitable or intended to become suitable for irrigation of crops and not hazardous for livestock drinking water).
- Water supply (suitable or intended to become suitable for potable water supplies after receiving standard treatment), applies only to Big Dry Creek, St. Vrain Creek above Hygiene Road (west of Longmont), and the Big Thompson River above the Greeley-Loveland Canal.

North St. Vrain Creek and the Big Thompson River from the boundary of Rocky Mountain National Park to Big Barnes Ditch in Loveland are classified for the following uses:

- Aquatic Life Cold 1 (currently capable of sustaining a wide variety of cold water biota, including sensitive species).
- Recreation 1a (existing primary contact, where the ingestion of small quantities of water is likely to occur, such as swimming or kayaking).
- Agriculture (suitable or intended to become suitable for irrigation of crops and not hazardous for livestock drinking water).
- Water Supply (suitable or intended to become suitable for potable water supplies after receiving standard treatment).

The Big Thompson River from the Home Supply Canal near Loveland to its confluence with the South Platte River has different use classifications above and below the Greeley-Loveland Canal diversion. Above the Greeley-Loveland Canal diversion, the Big Thompson River is classified as Aquatic Life Cold 2 (currently not capable of sustaining a wide variety of cold water biota, including sensitive species, due to physical habitat, flows, or water quality conditions), while below the Greeley-Loveland Canal diversion, the Big Thompson River is classified as Aquatic Life Warm 2 (currently not capable of sustaining a wide variety of warm water biota, including sensitive species, due to physical habitat, flows, or water quality conditions). Below the Greeley-Loveland Canal diversion, the Big Thompson River loses its Water Supply classification. Below Big Barnes Ditch in Loveland, the classification of Recreation 1a throughout the year changes to Recreation 2 (not suitable for primary contact uses, but suitable for secondary contact, such as wading or fishing) from mid-October through April 30.

Numeric standards for stream segments on Colorado's East Slope classified for use as Aquatic Life Warm 2, Recreation 1a or 1b, and Agriculture are provided in Table 3-43. Numeric standards for North St. Vrain Creek and the Big Thompson River to Big Barnes Ditch in Loveland are provided in Table 3-44.

Table 3-43. Numeric standards for the East Slope streams (except North St. Vrain Creek and the Big Thompson River above Home Supply Canal).

Parameter	Standard	Parameter	Standard
Physical		**Metals[1] (µg/L)**	
Dissolved oxygen (mg/L)	5.0	Arsenic (acute)	100
pH	6.5-9.0	Cadmium (acute, dissolved)	19.1
Temperature[2] (chronic, maximum, ºC)	30	Cadmium (chronic, dissolved)	6.22
		Chromium III (agriculture)	100
		Chromium VI (acute/chronic)	16/11
Inorganic (mg/L)		Copper (acute/chronic)	49.6/29.3
Total ammonia[3] (acute/chronic Apr 1 to Aug 31/chronic Sep 1 to Mar 31)	5.6/2.43/2.86	Iron (chronic, dissolved, water supply)	-
Chlorine (acute)	0.019	Iron (chronic, total rec., aquatic)	1,000
Chlorine (chronic)	0.011	Lead (acute, chronic)	281/10.9
Cyanide	0.005	Manganese (chronic, water supply)	-
Sulfide as H_2S	0.002	Manganese (agriculture)	200
Boron	0.75	Mercury (chronic, total)	0.01
Nitrite	4.5	Nickel (chronic, aquatic/agriculture)	168/200
Nitrate	10	Selenium[4] (acute/chronic)	18.4/4.6
Chloride	-	Silver (acute/chronic)	22/3.5
Sulfate (water supply)	-	Zinc (acute/chronic)	379/382

[1] Most metals standards are hardness dependent; values provided above assume a hardness of 400 mg/L, based on hardness data collected from affected East Slope streams.
[2] Chronic temperature standard is the maximum weekly average temperature (MWAT) defined as "the mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period" (EPA 1977b).
[3] The aquatic life ammonia standards are pH and temperature dependent; an average pH of 8 and an average stream temperature of 12°C was used based on data collected from affected East Slope streams. Ammonia standards are lower when stream temperature and/or pH are higher.
[4] Selenium is a bioaccumulative metal, subject to a range of toxicity values depending on numerous site-specific variables.
Source: CDPHE 2006b.

Table 3-44. Numeric standards for North St. Vrain Creek and the Big Thompson River above Big Barnes Ditch.

Parameter	Standard	Parameter	Standard
Physical		**Metals[1] (µg/L)**	
Dissolved oxygen (mg/L)	6.0	Arsenic (acute)	50
Dissolved oxygen, spawning (mg/L)	7.0	Cadmium (acute, dissolved)	0.74
pH	6.5-9.0	Cadmium (chronic, dissolved)	0.7
Temperature[2] (chronic, maximum, °C)	20	Chromium III	50
		Chromium VI (acute/chronic)	16/11
Inorganic (mg/L)		Copper (acute/chronic)	2.9/2.3
Total ammonia[3] (acute/chronic for early life stages/chronic without early life stages present)	17.5/5.08/7.73	Iron (chronic, dissolved, water supply)	300
Chlorine (acute)	0.019	Iron (chronic, total rec., aquatic)	1,000
Chlorine (chronic)	0.011	Lead (acute, chronic)	10.8/0.42
Cyanide	0.005	Manganese (water supply)	50
Sulfide as H_2S	0.002	Manganese (agriculture)	200
Boron	0.75	Mercury (chronic, total)	0.01
Nitrite	4.5	Nickel (chronic, aquatic/water supply)	13.3/100
Nitrate	10	Selenium[4] (acute/chronic)	18.4/4.6
Chloride	250	Silver (acute/chronic)	0.13/0.005
Sulfate	250	Zinc (acute/chronic)	30/30.2

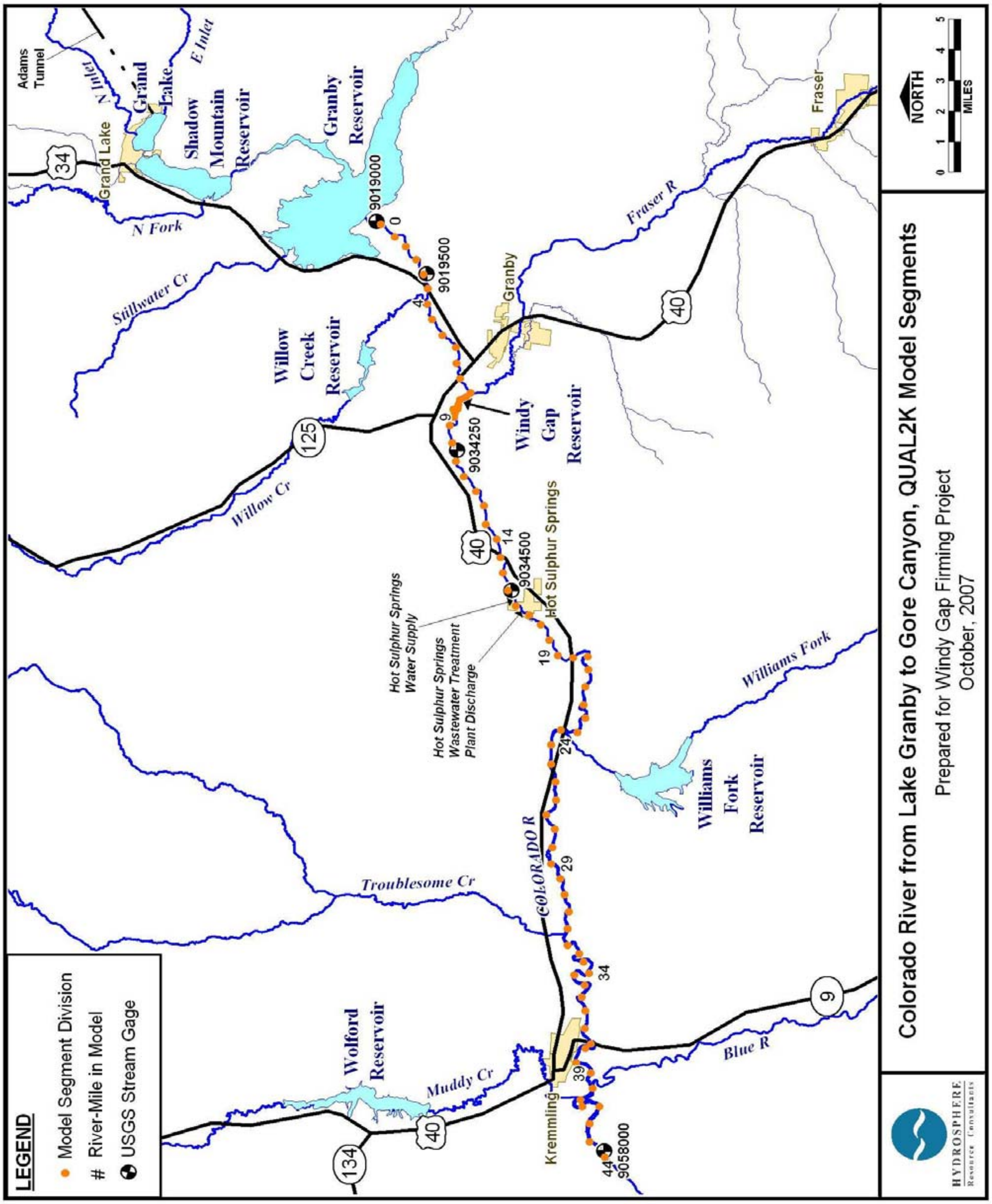
[1] Most metals standards are hardness dependent; values provided above assume a hardness of 20 mg/L, based on hardness data collected from the Big Thompson River and St. Vrain Creek.
[2] Chronic temperature standard is the maximum weekly average temperature (MWAT) defined as "the mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period" (EPA 1977b).
[3] The aquatic life acute ammonia standard is pH and temperature dependent; an average pH of 7.3 was used and an average stream temperature of 8°C was used based on data collected from North St. Vrain Creek and the Big Thompson River. Ammonia standards are lower when stream temperature and/or pH are higher.
[4] Selenium is a bioaccumulative metal, subject to a range of toxicity values depending on numerous site-specific variables.
Source: CDPHE 2006b.

3.8.2.3 Method for Effects Analysis

Rivers and Streams

Colorado River. The simulation of water quality in the Colorado River was performed using the QUAL2K numerical model (Chapra et al. 2006). The QUAL2K model is a one-dimensional, steady state model that simulates flow, temperature, and water quality along a river reach. For the alternatives analysis, the model was used to predict instream flows, water temperature, conductivity and concentrations of DO, nutrients (total ammonia and inorganic phosphorus), pH, and selenium concentrations. Output from the model provides a prediction of the flow and water quality at locations along the river as influenced by upstream quality and quantity, water inflows and diversions, meteorological conditions, and chemical reactions that occur as water flows downstream. This modeling tool effectively simulates the water quality in the Colorado River reach below Granby Reservoir to the top of Gore Canyon. The model considers tributary inflows from Willow Creek, Fraser River, Williams Fork, Troublesome Creek, Muddy Creek, and Blue River, as well as, municipal withdrawals for drinking water and the WWTP outfall at the Town of Hot Sulphur Springs, as well as diversions from the river at Windy Gap Reservoir. The model extent, segment boundaries, and tributaries are shown in Figure 3-33.

Figure 3-33. QUAL2K model segments, Colorado River from Granby Reservoir to Gore Canyon.



The QUAL2K simulations offer a view of the Colorado River during conditions critical for water temperature and other water quality parameters. To determine worst case conditions for aquatic life in the river, July 25 was modeled. This is a time when the Colorado River experiences low flow, when the weather have historically been the hottest, and it is also a time when Windy Gap diversions could occur in some years. The model was run under two hydrologic conditions for July 25. One simulation was based on average stream discharge for July 25. The other simulation assumed that Windy Gap diversions would reduce streamflow to the minimum streamflow requirement of 90 cfs below the Windy Gap diversion. The second analysis demonstrates the potential bounds of river water quality for the lowest allowable flow conditions. Wet and dry hydrologic conditions for the alternatives were not simulated because WGFP dry year diversions would not change from existing conditions and higher flows in wet years would have less impact than the simulated conditions. Complete descriptions of modeling assumptions, model calibration, data used and sensitivity analyses are presented in the Stream Water Quality Technical Report and Modeling Report (ERO and AMEC 2008a and 2008b).

Willow Creek. Effects to water quality on Willow Creek were estimated using two methods. A USGS stream temperature model, called SSTEMP, was used to predict changes in stream temperature due to a decrease in releases to Willow Creek from Willow Creek Reservoir (Bartholow 2002). The maximum average monthly decrease in the flow of Willow Creek would occur during July of an average year under all of the alternatives. Thus, July 15 was chosen to evaluate Willow Creek water quality to determine worst case conditions for aquatic life in the stream. Wet and dry hydrologic conditions for the alternatives were not simulated because decreases in flow would be less in wet years and dry year flows would not change from existing conditions.

A mass balance analysis of ammonia, copper, and iron concentrations in Willow Creek was completed for the month of July to evaluate effects to these water quality parameters. Ammonia, copper, and iron were chosen as indicators of effects to water quality because the Three Lakes WWTP effluent discharge to Church Creek could result in more frequent standard exceedances as a result of reduced flows in Willow Creek.

East Slope Streams. For East Slope streams in which flow would change under one or more of the alternatives, several methods were used to evaluate water quality changes. For the Big Thompson River below Lake Estes to the Hansen Feeder Canal, flow increases would occur during high-flow months as a result of smaller C-BT skim diversions from the river. The Three Lakes model results for water quality for the Adams Tunnel water and existing water quality data for the Big Thompson River above the Dille Tunnel were used as input for mass balance calculations to determine changes in nitrogen and phosphorus concentrations.

For North St. Vrain Creek and St. Vrain Creek at Lyons where both flow increases and decreases under the No Action alternative would occur, historical water quality data for different flow volumes and months were analyzed to predict relative water quality changes.

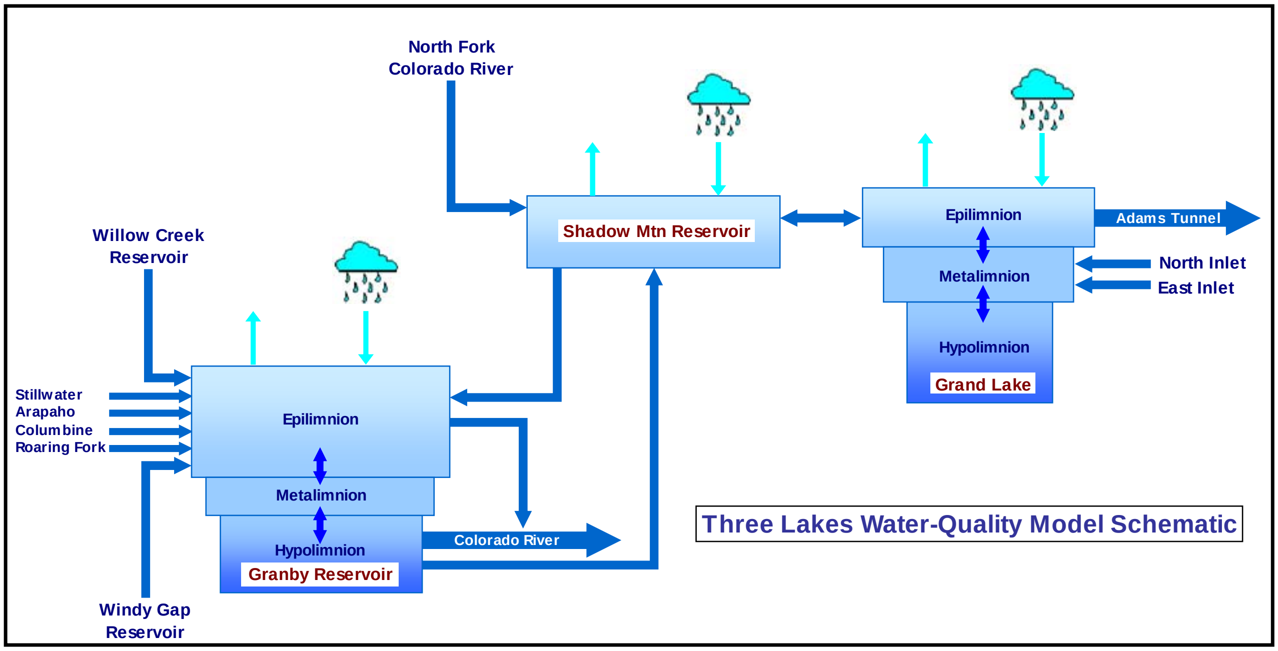
The lower Big Thompson River, Big Dry Creek, Coal Creek, and the Cache la Poudre River would receive increased Participant WWTP return flows under all of the alternatives. For these streams, ammonia, iron, copper, and manganese were chosen as examples of water quality parameters that are measured in WWTP effluent discharge that could have more frequent standard exceedances as a result of additional effluent return flows. A mass balance analysis was completed for the month with the largest increase in WWTP return flow.

Lakes and Reservoirs

Three Lakes. The method used for the prediction of water quality for Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir was based on the Three Lakes Water quality Model (Hydrosphere 2003b). This is a dynamic process-based model that simulates results over time and can be used to predict water quality based on changes in hydrologic conditions and water quality input variables.

The Three Lakes Model characterizes Grand Lake and Granby Reservoir as three-layer lakes. Therefore, both have an epilimnion (upper layer), a metalimnion (middle layer), and a hypolimnion (bottom layer) during the stratified period, and the water quality is assumed to be uniform throughout

Figure 3-34. Three Lakes water quality model schematic.



each layer. The model mixes the three layers during other portions of the year. Shadow Mountain Reservoir is characterized as a single well-mixed layer in the model because it is shallow and does not strongly stratify.

The Three Lakes Model was calibrated using measured data from October 1, 2005 to September 30, 2006. The calibrated model was used to predict future water quality conditions for each alternative using anticipated flow under each alternative. The model simulates the water quality of each layer over time on a daily basis. A schematic of the Three Lakes Water Quality inflows and outflows by segment is illustrated in Figure 3-34. Model runs were based on daily hydrology from the 15-year period (water years 1975 to 1989), which was determined to be representative of the 47-year period used for hydrologic modeling described in Section 3.5. The model is successful at computing average chlorophyll *a* concentrations with changes in hydrology; however, peak annual chlorophyll *a* concentrations may be underestimated if unanticipated nutrient loads occur. The Three Lakes Water Quality Model Documentation Report provides additional detail on model calibration and assumptions (AMEC 2008b).

Model results for each alternative were compared to predictions made for existing conditions. Alternative comparisons were made for total phosphorus (TP) and nitrogen, chlorophyll *a* (a measure of algae), Secchi-disk depth (SD), trophic state, minimum DO, and total suspended solids (TSS). The trophic state index is computed using the Carlson Trophic State Index (TSI) (Table 3-45). The reported TSI is based on the average value from May 1 to November 15 for the Three Lakes and on

Table 3-45. Common chlorophyll *a*, Secchi-disk, and total phosphorus values by trophic state.

Condition	Chloro-phyll *a* (µg/L)	Surrogate Metrics	
		SD (m)	TP (µg/L)
Oligotrophic	<0.95	>8	<6
Oligotrophic-Mesotrophic	0.95-2.6	8-4	6-12
Mesotrophic	2.6-7.3	4-2	12-24
Eutrophic	7.3-20	2-1	24-48
Eutrophic-Hypereutrophic	20-56	0.5-1	48-96
Hypereutrophic	56-155	0.25-0.5	96-192
Extremely Hypereutrophic	>155	<0.25	192-384

Values based on average summer values (June 15-Sept 1). Phosphorus-Limited North American Temperate Lakes www.nalms.org, reproduced with permission from NALMS.

the average annual value for the reservoirs modeled with BATHTUB model (East Slope reservoirs and potential new reservoirs). Trophic state indices were also computed on a monthly basis for the reservoirs modeled using the Three Lakes Water Quality Model. Trophic state indices are based on an average chlorophyll *a* value rather than peak values because there can be significant variations within the averaging period.

The LAKE2K model (Chapra and Martin 2004) was used to simulate temperature in Granby Reservoir for each alternative. Model results showed that there were no discernable changes in the temperature of Granby Reservoir between existing conditions and any of the alternatives.

Carter Lake, Horsetooth Reservoir, Ralph Price Reservoir, and Potential New Reservoirs. Carter Lake, Horsetooth Reservoir, Ralph Price Reservoir, and the four potential new reservoirs were evaluated using a Corps Water Quality Model called BATHTUB. This steady-state model contains several empirical relationships to translate nutrient loading into in-reservoir conditions. Results from the Three Lakes Water Quality Model were used to develop input files for the BATHTUB model runs. The alternatives were evaluated by comparing annual predicted in-reservoir changes from existing conditions using BATHTUB model output for nutrients, chlorophyll *a*, Secchi-disk depth, hypolimnetic oxygen demand (HOD), metalimnetic oxygen demand (MOD), and trophic state.

The BATHTUB model does not provide a direct prediction of DO concentration. However, the relative magnitudes of HOD and MOD predictions were used to compare existing conditions and the alternatives to provide insight on the relative potential impact on the DO concentration in the metalimnion or hypolimnion. Larger HOD or MOD values, as compared to existing conditions, indicate a potential for lower DO in the reservoir. Quantification of the likelihood of the DO concentration to be below the current water quality standards for an alternative is not possible based on the BATHTUB model predictions. Potential changes in manganese concentrations were based on relative HOD. Low DO concentrations in the hypolimnion can result in the conversion of manganese in the reservoir sediments to a soluble form.

The BATHTUB model does not simulate water temperature; therefore, it was assumed that if there was no change in temperature at Granby Reservoir then temperature in East Slope reservoirs would not change.

3.8.2.4 West Slope Effects

Colorado River

The magnitude of influence of tributary inflows on Colorado River water quality varies as a result of the volume of water and tributary concentration compared to the in-river concentration. The largest changes in water quality at tributary inflow points occur where large inflows with different water quality from the Colorado River enter, providing a strong dilution or concentrating effect on the river. The decrease in Colorado River flow under all alternatives enhances the influence of tributary inflows.

Model output indicates the following general influences on Colorado River water quality and the various tributary contributions to those changes. The Fraser River increases water temperatures, whereas the Williams Fork, Blue River, and Muddy Creek decrease temperatures. Specific conductivity is increased most by Willow Creek, the Williams Fork, Blue River, and Muddy Creek. Troublesome Creek offers a dilution effect on specific conductivity. DO concentrations are not influenced greatly by tributary inflows. The Fraser River and Hot Sulphur Springs WWTP provide sources of ammonia and inorganic phosphorus that increase in-river concentrations. The low flow of the natural hot springs near the Town of Hot Sulphur Springs has a very small influence on the water quality of the Colorado River (even if the hot spring flow were nearly 3,000 gpm, which is greater than typical 140 gmp discharges, the discharge would only be 2 percent of the typical July flow of the river and would increase the river temperature immediately below the hot springs by only 1ºC). Downstream of the Hot Sulphur Springs WWTP, when Colorado River concentrations of ammonia and inorganic phosphorus are highest, the Williams Fork offers a dilution effect. To lesser degrees, the Blue River and Muddy Creek increase ammonia concentrations

Figure 3-35. Colorado River average July 25 streamflow.

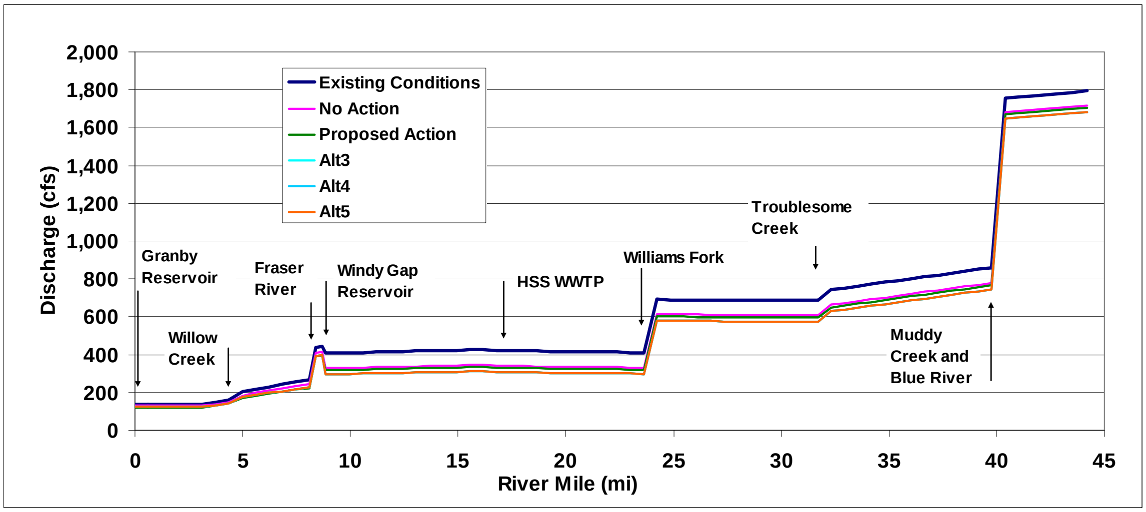
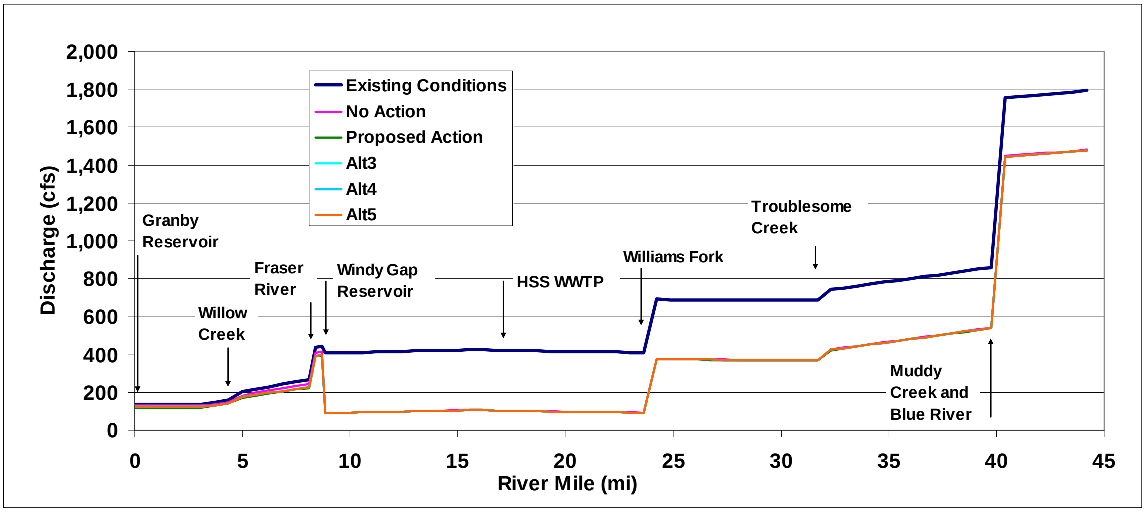


Figure 3-36. Colorado River July 25 streamflow assuming diversion to the minimum instream flow below Windy Gap Reservoir.



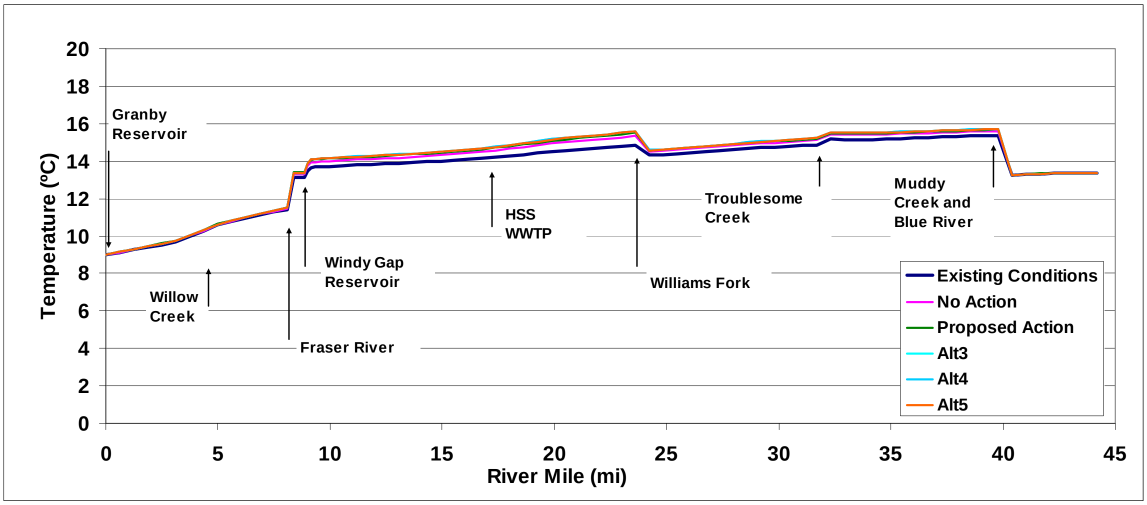
in the Colorado River and Willow Creek is a source of inorganic phosphorus. Muddy Creek provides elevated dissolved selenium concentrations, raising the concentration in the Colorado River slightly.

The following sections provide additional information for flow and several water quality parameters in the Colorado River under each alternative. Water quality effects were evaluated for average condition on July 25 as well as a "worst case" condition, which would occur infrequently, where diversions reduce the flow to near 90 cfs below Windy Gap.

Streamflow. Colorado River flows would decrease below Windy Gap Reservoir as a result of additional diversions under all alternatives. Figure 3-35 indicates the Colorado River streamflow for existing conditions and the alternatives from Granby Reservoir at River Mile 0 to the Kremmling gage at the top of Gore Canyon at about River Mile 45. Alternatives 3 and 4 would have the greatest decrease in streamflow, but all of the action alternatives are similar. The No Action alternative would result in the smallest decrease in streamflow.

Figure 3-36 indicates what Colorado River flows would look like if Windy Gap diversions reduce

Figure 3-37. Colorado River average daily stream temperatures for July 25.



flows for July 25 to the minimum streamflow requirement of 90 cfs. Diversions to 90 cfs could occur under all alternatives; therefore, the flow in Figure 3-36 is the same for all alternatives. Based on daily model results for the 47-year study period, diversions in July to the minimum streamflow would increase by less than one day per year on average compared to existing conditions under the Proposed Action.. Streamflow of 90 cfs or less already occur in the Colorado River when Windy Gap is not diverting as the result of upstream diversions by others and/or low surface runoff or ground water discharge to the river. There would be no change in the current minimum flows available for the Town of Hot Sulphur Springs' potable water treatment plant or dilution flows for its WWTP discharges.

Temperature. Water temperatures would increase with additional diversions at Windy Gap Reservoir. The model used median measured USGS temperatures for July (14.3ºC at the location of greatest temperature change under the alternatives) and mean climatic conditions for both flow simulations. Average daily water temperatures are predicted to increase up to a maximum of 0.8°C under Alternatives 3 and 4 and 0.7°C under Alternative 5 just upstream of the confluence with Williams Fork (Figure 3-37). Temperatures would increase up to 0.5°C under the No Action alternative and up to 0.6°C under the Proposed Action. While the aquatic life maximum weekly average temperature standard (MWAT) for the Colorado River between the Fraser River and Troublesome Creek (18.2°C) is not directly comparable to a daily value, the projected July 25 temperature under any alternative would not exceed 15.6°C in this reach of the river. However, the MWAT standard could be exceeded if the existing conditions temperatures during that week were already near or above the standard. Below the confluence with Troublesome Creek, Colorado River water temperature for July 25 would reach 15.7°C, which is below the weekly standard of 20°C.

When water diversions reduce streamflow below Windy Gap to the 90 cfs minimum streamflow, water temperatures in the Colorado River are predicted to increase up to 4.0°C under all alternatives (Figure 3-38). A maximum temperature of 18.9°C is predicted to occur just upstream of the Williams Fork. Although the model only predicts temperatures for a single day, the MWAT standard of 18.2°C may be exceeded above the Williams Fork if existing temperatures for an entire week are within 4°C of the standard and when Colorado River streamflows are near 90 cfs. The cooler water from Williams Fork inflows reduces Colorado River water temperatures to about 14.8°C, but temperatures would increase gradually downstream until inflow from the Blue River reduces temperatures.

Specific Conductivity. Specific conductivity values for the Colorado River, which are an indicator of the TDS[1] concentration, increases slightly below the Williams Fork (Figure 3-39). Conductivity increases below the Williams Fork because there

[1] Total dissolved solids (mg/L) = 0.6 x conductivity (µS/cm) based on measured data for the Colorado River.

Figure 3-38. Colorado River average daily stream temperatures for July 25 assuming diversion to the minimum instream flow below Windy Gap Reservoir.

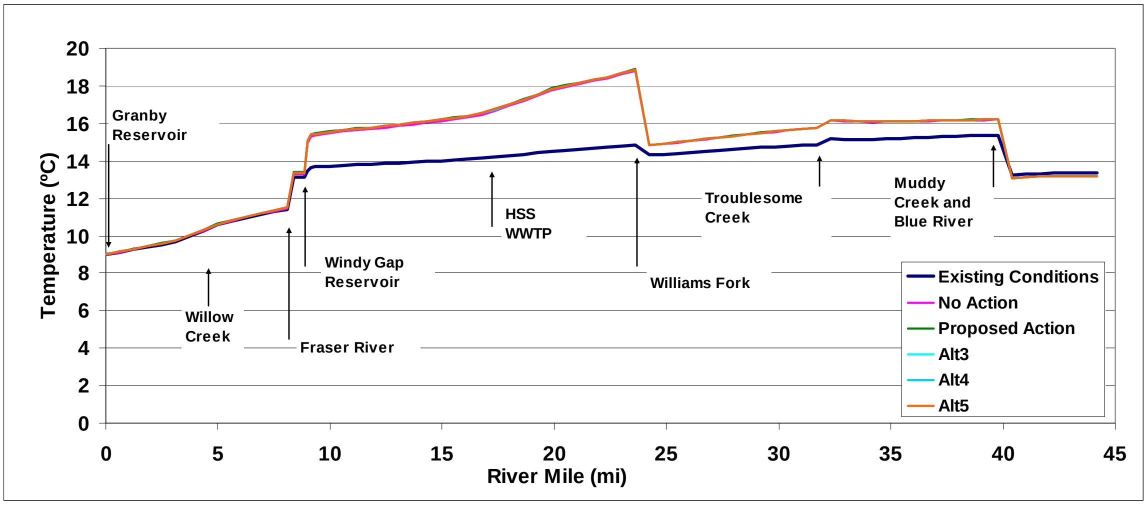
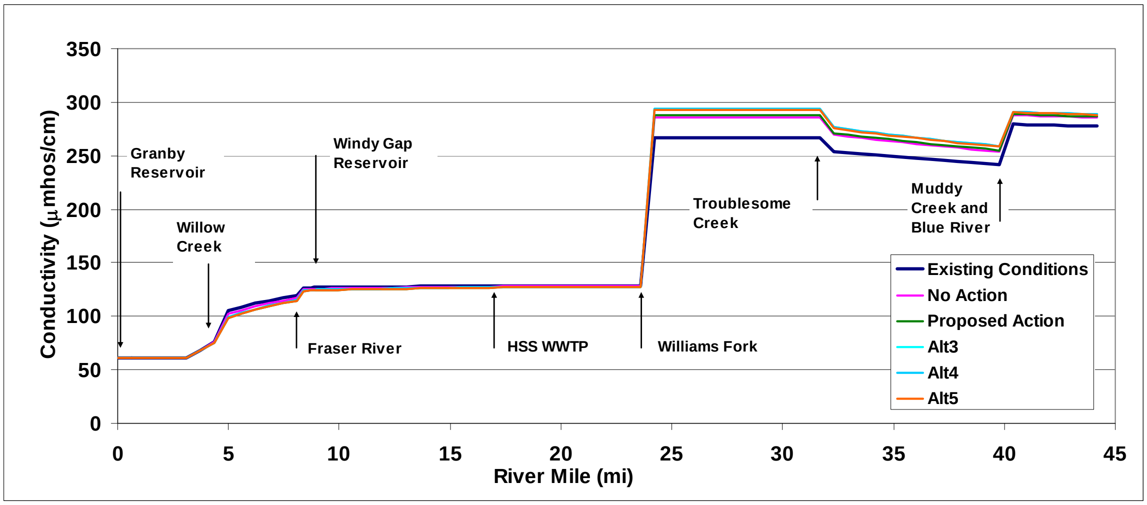


Figure 3-39. Colorado River specific conductivity for July 25.



would be less Colorado River to dilute higher conductivity inflows from the Williams Fork. Alternatives 3, 4, and 5 would increase specific conductivity up to about 10 percent over existing conditions. Conductivity would increase a maximum of about 7 percent under the No Action alternative and about 8 percent under the Proposed Action. Conductivity would increase up to 45 percent under all alternatives with diversions to the 90 cfs minimum streamflow (Figure 3-40).

Dissolved Oxygen. DO concentrations would remain relatively constant as water moves downstream from Granby Reservoir under all alternatives (Figure 3-41). A maximum DO reduction of about 0.1 mg/L below Windy Gap Reservoir is predicted under all alternatives compared to existing conditions. The aquatic life nonspawning standard of 6.0 mg/L of DO and the spawning standard would be met throughout the study reach.

DO concentrations would decrease up to 0.6 mg/L under the Proposed Action and decrease up to 0.5 mg/L for all the other alternatives when flows are at the 90 cfs minimum flow below Windy Gap Reservoir (Figure 3-42). DO concentrations as low as 6.9 mg/L are predicted for a short reach just above the Williams Fork confluence under all alternatives. This is just below the 7.0 spawning standard of 7.0 mg/L. DO would gradually increase below Williams Fork to 7.6 mg/L at the top of Gore Canyon.

Figure 3-40. Colorado River specific conductivity for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir.

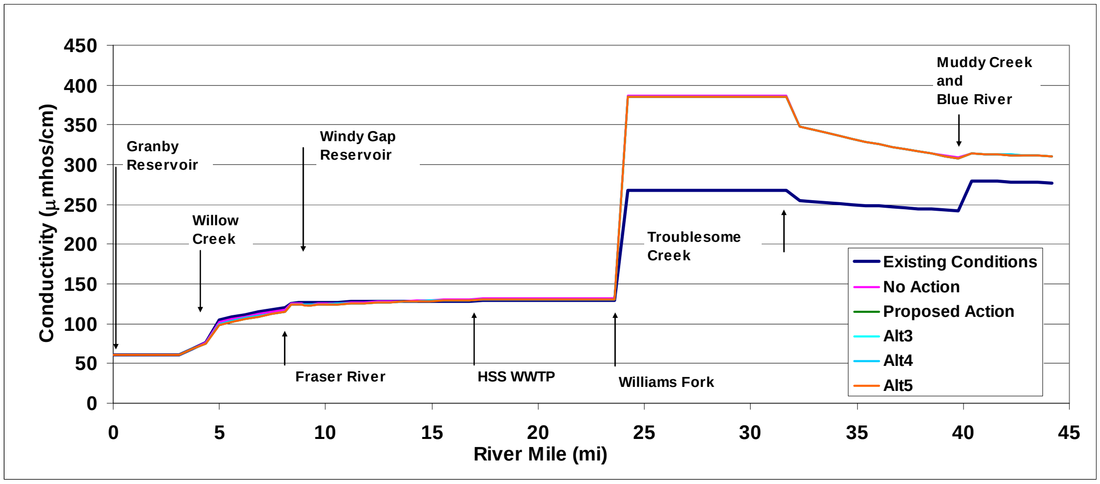


Figure 3-41. Colorado River dissolved oxygen concentrations for July 25.

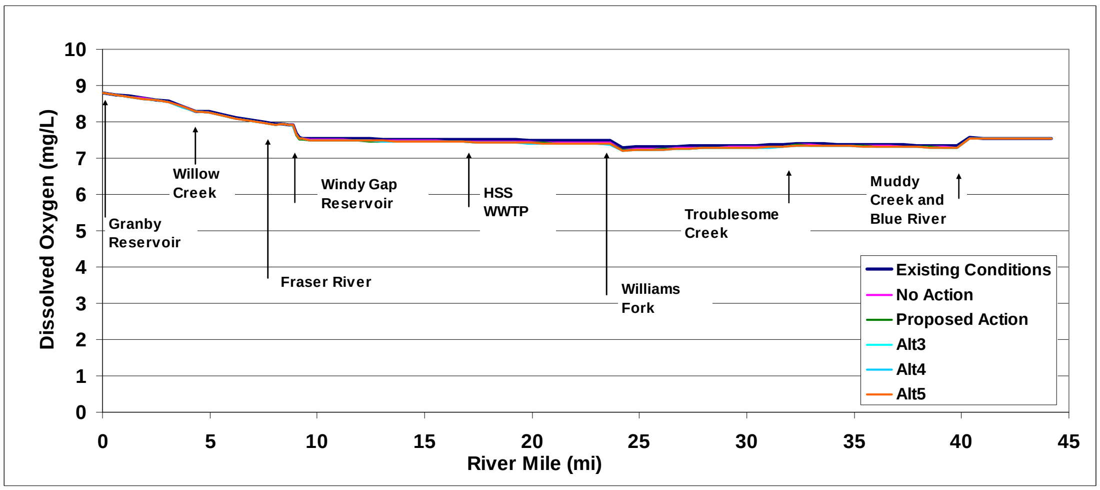


Figure 3-42. Colorado River dissolved oxygen concentrations for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir.

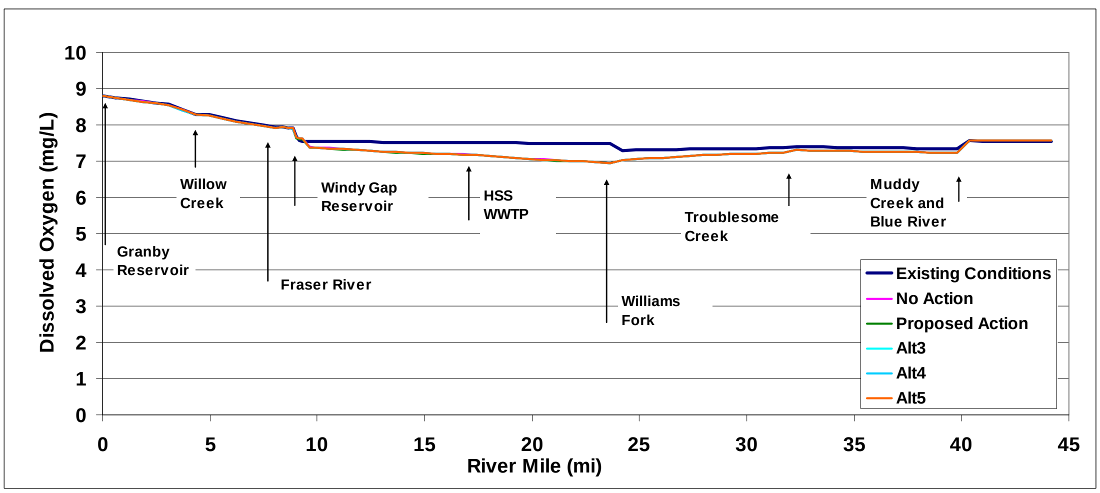
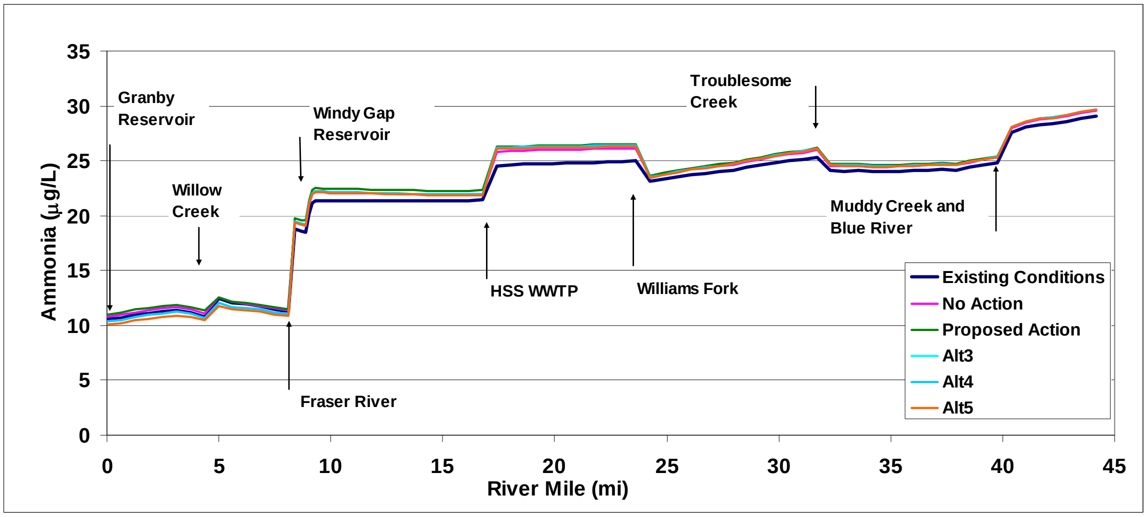


Figure 3-43. Colorado River ammonia concentrations for July 25.



Ammonia. Ammonia concentrations would increase slightly below the Windy Gap diversion (Figure 3-43). The largest increase would occur below the Hot Sulphur Springs WWTP (HSS WWTP) because of less dilution of WWTP effluent discharges. The maximum increase in ammonia concentrations from existing conditions of 1.7 µg/L would occur under the Proposed Action, compared to 1.3 µg/L under No Action, with the other alternatives falling between these values. Ammonia concentrations would be below chronic and acute standards throughout the study reach for all alternatives.

Predicted Colorado River ammonia values for the simulation of minimum streamflow would result in a greater increase in ammonia concentrations (Figure 3-44). The Proposed Action would increase ammonia concentrations up to 9.3 µg/L below the HSS WWTP compared to 9.1 µg/L for the No Action alternative, and slightly less for the other alternatives. Ammonia concentrations would remain below standards for all alternatives at minimum flows.

Figure 3-44. Colorado River ammonia concentrations for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir.

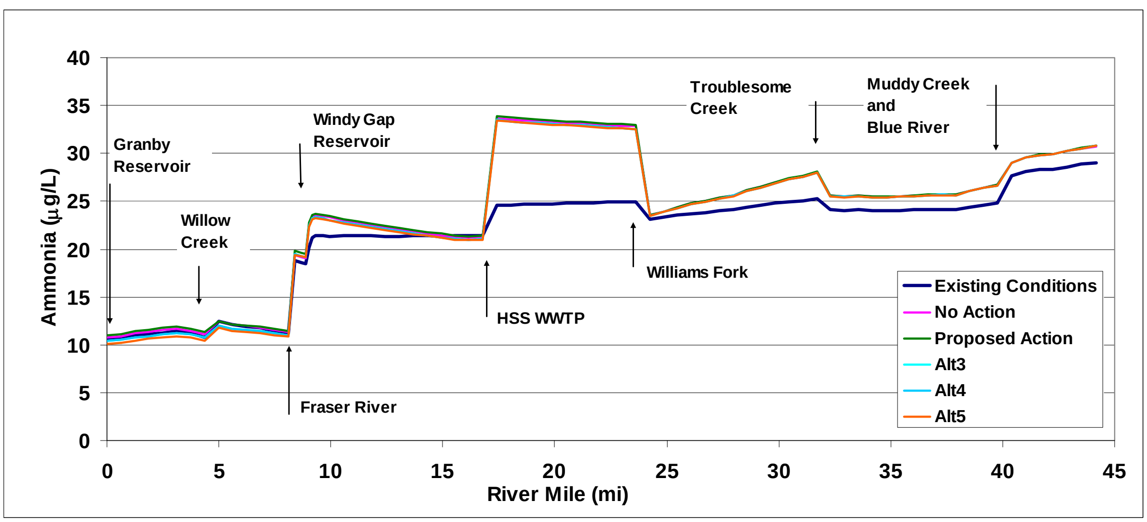
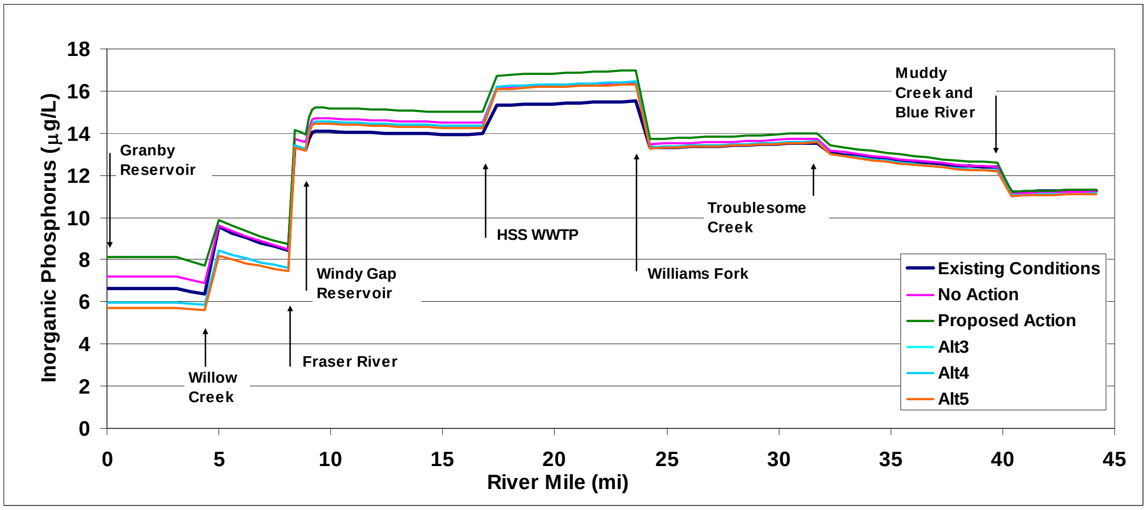


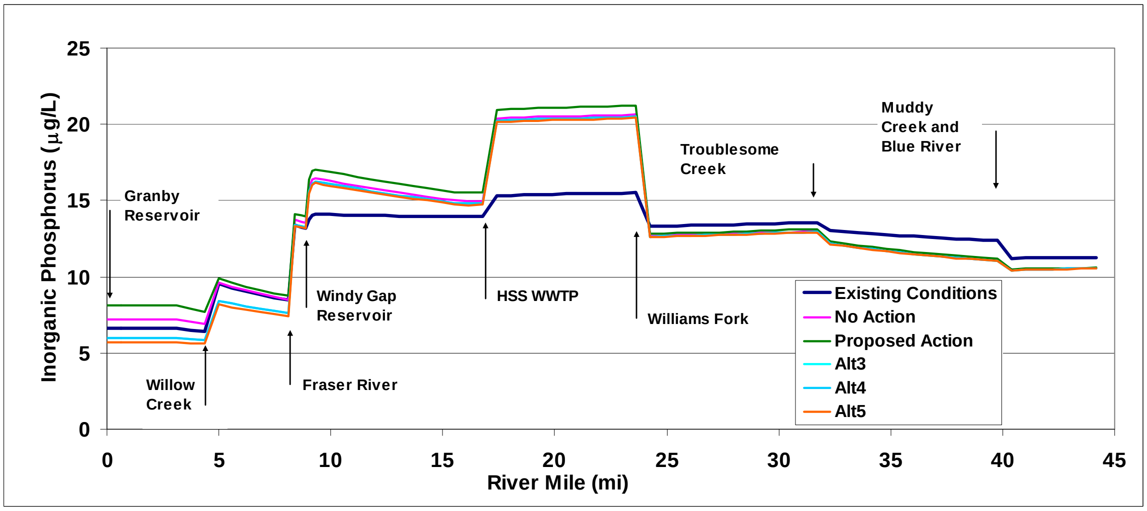
Figure 3-45. Colorado River inorganic phosphorus concentrations for July 25.



Inorganic Phosphorus. Inorganic phosphorus concentrations would vary from existing conditions throughout the study reach (Figure 3-45). Phosphorus concentrations would increase by up to 1.5 µg/L under the Proposed Action below Granby Reservoir and below the HSS WWTP. Other alternatives, including the No Action alternative, would result in an increase of up to 0.9 µg/L in inorganic phosphorus concentrations. Slight reductions in inorganic phosphorus would occur upstream of Willow Creek under Alternatives 4 and 5. There is currently no water quality standard for phosphorus; however, the EPA-recommended concentration for streams is 100 µg/L (EPA 1986).

Inorganic phosphorus concentrations would increase primarily between Windy Gap Reservoir and the Williams Fork at the 90 cfs minimum streamflow (Figure 3-46). The increase in inorganic phosphorus concentrations would be similar among alternatives; however, the Proposed Action would have the greatest increase (5.7 µg/L) and Alternative 5 would have the least (4.9 µg/L). Inorganic phosphorus concentrations would decrease below the Williams Fork for all alternatives because the low phosphorus concentrations in the Williams Fork, would contribute a greater percentage of flow to the Colorado River.

Figure 3-46. Colorado River inorganic phosphorus concentrations for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir.



Selenium. Existing dissolved selenium concentrations in the Colorado River are very low and would increase only slightly near Kremmling under all alternatives. An increase in selenium of up to 0.002 μg/L below Muddy Creek would be the result of the reduction in Colorado River flows relative to naturally higher selenium concentrations in Muddy Creek. Under minimum streamflows of 90 cfs, selenium concentrations would increase up to 0.04 μg/L below Muddy Creek for all alternatives. Selenium concentrations would remain well below the chronic and acute standard for all alternatives for average or minimum flow conditions.

Aquatic Plant Growth. For all alternatives, an increase in aquatic plant growth could occur as a result of an increase in nutrient (ammonia and phosphorus) concentrations. Didymo is an aquatic organism tolerant of a wide range of stream chemical and physical conditions and none of the predicted water quality and flow changes under the alternatives are expected to adversely contribute to the spread or development of didymo populations that are currently present in the river.

Willow Creek

Streamflow would decrease in Willow Creek below Willow Creek Reservoir under all alternatives as discussed in Section 3.5.2.3. Water quality changes are possible due to increases in the relative contribution of ground water and inflow from Church Creek, which carries effluent discharge from the Three Lakes WWTP. The majority of changes in streamflow would occur from June to August; therefore, the evaluation focused on this period.

Under the No Action alternative, model results indicate the change in flow would not measurably affect the water temperature in Willow Creek. For all action alternatives, a decrease in water temperature of 0.2°C or less is predicted. The decrease in water temperature is likely the result of an increase in the influence of cooler ground water discharges to Willow Creek.

Potential changes to ammonia, iron, and copper concentrations in Willow Creek were evaluated because these constituents sometimes have elevated concentrations in Willow Creek and could exceed standards more frequently at lower streamflows. Ammonia concentrations in Willow Creek would increase under all alternatives during the summer (Table 3-46). The greatest increase would occur under the Proposed Action. Acute and chronic aquatic life ammonia standards would not be exceeded under any alternative even at the maximum allowable WWTP discharge rate. Given the lack of algae and chlorophyll data for Willow Creek, it is not known whether the predicted increases in ammonia concentrations would result in algal growth problems in the creek. Dissolved iron concentrations would increase slightly from existing conditions for all alternatives, but would be below the water supply standard. Dissolved copper

Table 3-46. Willow Creek average monthly ammonia, iron, and copper concentrations.

Standard/Alternative	Ammonia (mg/L)			Iron, dis (µg/L)			Copper, dis (µg/L)		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
Standard[1]	2.87	2.87	2.45	300	300	300	10	10	10
WWTP[2]	17			260			21		
EC	0.10	0.10	0.10	92.5	92.5	92.5	3.4	3.4	3.4
Alt 1 – No Action	0.27	0.44	0.88	93.2	95.9	100.2	3.5	3.8	4.2
Alt 2 – Proposed Action	0.29	1.09	2.25	94.37	102.4	113.8	3.6	4.4	5.6
Alt 3	0.28	1.05	2.06	94.3	101.9	119.9	3.6	4.4	5.4
Alt 4	0.28	1.05	2.06	94.3	101.9	119.9	3.6	4.4	5.4
Alt 5	0.29	1.09	2.06	94.3	102.4	111.9	3.5	4.4	5.4

[1] Copper standard based on mean hardness of 112 mg/L (CDPHE 2008).

[2] Effluent concentrations from the Three Lakes WWTP discharge to Church Creek, a tributary to Willow Creek (EPA Envirofacts: http://www.epa.gov/enviro/).

concentrations would increase about the same amount for all alternatives, but would remain below the acute and chronic aquatic life standard.

Jasper East Drainage

The unnamed drainage below the Jasper East Reservoir site would receive seepage or discharge from the new reservoir in Alternative 3. Water quality would be similar to the reservoir, as discussed below. Water quality is predicted to meet standards for all parameters, except manganese. Manganese concentrations may range from 20 to 100 μg/L, occasionally exceeding the water supply standard of 50 μg/L (Hydrosphere 2007c).

Rockwell and Mueller Creeks

Release or seepage to Rockwell and Mueller creeks below the new reservoir under Alternatives 4 and 5 would have water quality similar to the new reservoir, as described below. There would be slight differences in the water quality based on the size of the reservoir. No exceedance of water quality standards is predicted, except possibly for manganese, which could occasionally exceed the water supply standard (Hydrosphere 2007c).

Water Delivery to Three Lakes System

All alternatives would deliver additional water to Granby Reservoir and then to Shadow Mountain Reservoir and Grand Lake via the Farr Pumping Plant. The Proposed Action and No Action alternatives would deliver water to Granby Reservoir directly from Windy Gap Reservoir. Alternative 3 would deliver water from both Windy Gap Reservoir and Jasper East Reservoir. Alternatives 4 and 5 would deliver water from Windy Gap Reservoir and Rockwell Reservoir. The Proposed Action and No Action Alternative would only deliver water to the Three Lakes from April to August, while the other alternatives, with new West Slope storage, would deliver water year round. The annual volume of delivery to Granby Reservoir varies by year. Figure 3-47 shows estimated annual pumping from Windy Gap Reservoir to Granby Reservoir based on the hydrology for the 1975 to 1989 period. The timing and amount of water pumped from Granby Reservoir into Shadow Mountain Reservoir is shown in Figure 3-48.

Figure 3-47. Estimated pumping to Granby Reservoir for each alternative.

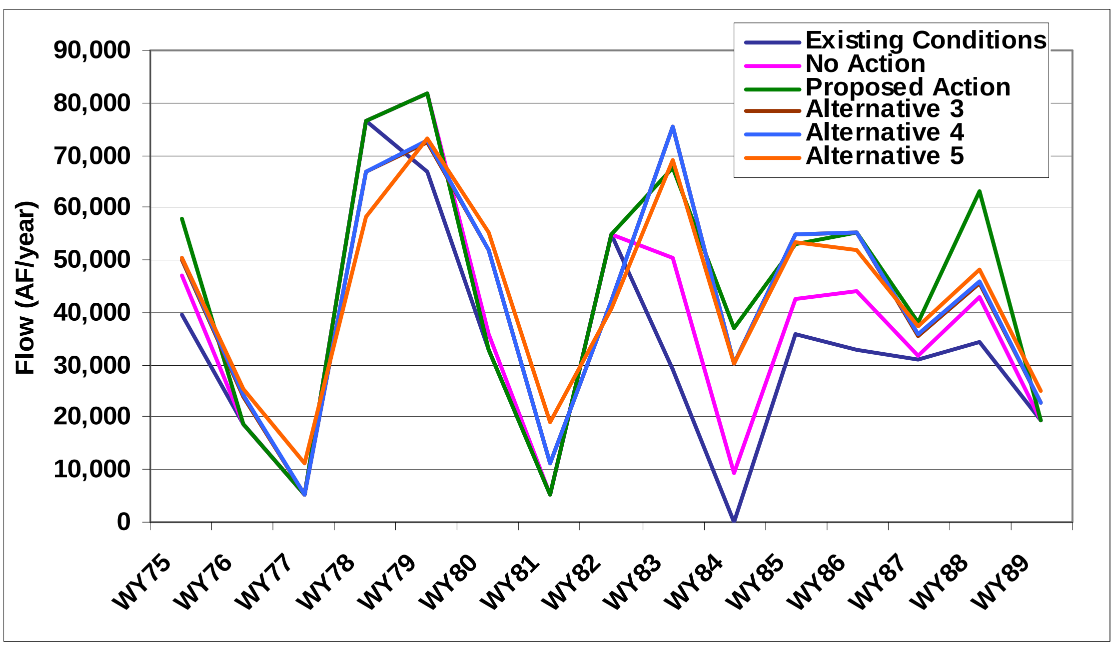
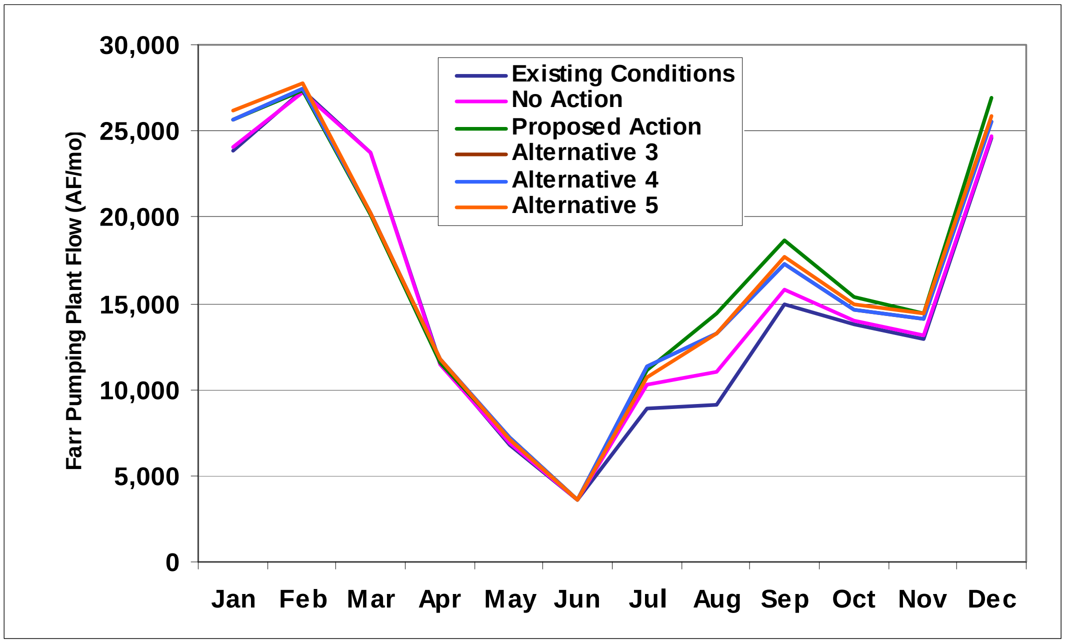


Figure 3-48. Estimated pumping from Granby Reservoir to Shadow Mountain Reservoir.



Nutrient loading into the Three Lakes under existing conditions comes from several sources as shown in Table 3-47. Primary contributors of the phosphorus and nitrogen loading into the Three Lakes are Willow Creek, Windy Gap, and Stillwater Creek. Arapaho Creek is the largest source of nitrogen to the Three Lakes. The change in phosphorus and nitrogen load into the Three Lakes for the alternatives is shown in Table 3-48 and Table 3-49. The Proposed Action has the highest additional nutrient loadings. Alternatives 3, 4, and 5, which include a new West Slope reservoir, would retain a portion of the nutrients in the new reservoir, which would reduce contributions to the Three Lakes System. The following sections focus on the effects to the individual reservoirs in the Three Lakes System.

Table 3-47. Estimated average annual nutrient load into the Three Lakes System for existing conditions (based on 1975 to 1989 hydrology).

Location	Average Total Phosphorus Load (kg/yr)	Percent of Total Phosphorus Load	Average Total Nitrogen Load (kg/yr)	Percent of Total Nitrogen Load
Willow Creek Pumping	1,465	19.3%	15,948	13.8%
Windy Gap Pumping	2,143	28.2%	16,391	14.2%
Arapaho Creek	503	6.6%	20,578	17.9%
Stillwater Creek	1,566	20.6%	7,023	6.1%
North Fork of the Colorado	596	7.8%	7,962	6.9%
North Inlet	355	4.7%	10,717	9.3%
East Inlet	225	3.0%	6,819	5.9%
Roaring Fork	92	1.2%	3,784	3.3%
Columbine Creek	62	0.8%	2,523	2.2%
Precipitation	377	5.0%	13,671	11.9%
Miscellaneous Gains	218	2.9%	9,755	8.5%
Total	7,602	100%	114,049	100%

Table 3-48. Estimated additional total phosphorus load into the Three Lakes System for alternatives over existing conditions (based on 1975 to 1989 hydrology).

Alternative	TP Load from Willow Creek Reservoir (kg/yr)	TP Load from Windy Gap Reservoir (kg/yr)	TP Load from Jasper East Reservoir (kg/yr)	TP Load from Rockwell Creek Reservoir (kg/yr)	Total (kg/yr)
Alt 1 – No Action	+123	+299			+422
Alt 2 – Proposed Action	+143	+730			+873
Alt 3	+142	-436	+557		+263
Alt 4	+142	-435		+525	+232
Alt 5	+143	-654		+613	+102

Table 3-49. Estimated additional total nitrogen load into the Three Lakes System for alternatives over existing conditions (based on 1975 to 1989 hydrology).

Alternative	TN Load from Willow Creek Reservoir (kg/yr)	TN Load from Windy Gap Reservoir (kg/yr)	TN Load from Jasper East Reservoir (kg/yr)	TN Load from Rockwell Creek Reservoir (kg/yr)	Total (kg/yr)
Alt 1 – No Action	+765	+1,455			+2,220
Alt 2 – Proposed Action	+888	+4,625			+5,513
Alt 3	+882	-4,892	+4,560		+550
Alt 4	+882	-4,886		+4,238	+234
Alt 5	+895	-6,287		+5,036	-356

Granby Reservoir

Predicted average annual and the range in daily water quality for Granby Reservoir under existing conditions and all alternatives is summarized in Table 3-50. Table 3-51 shows the percent change in water quality for each alternative compared to existing conditions. There would be no change in the average trophic status or clarity as measured by the Secchi-disk depth under any alternative. Average chlorophyll *a* concentrations would increase about 2.4 percent under the Proposed Action and would not change under the other alternatives. Peak chlorophyll *a* concentrations are difficult to accurately model, but changes are predicted to be minor. Phosphorus concentrations would increase under all alternatives because of the additional Windy Gap water pumped into the reservoir. Nitrogen concentrations would increase slightly under No Action and the Proposed Action, and decrease under the other alternatives. Although more water would be flowing through Granby Reservoir, there would be a decrease in residence time and more flushing of the reservoir content. The reduced residence time offsets some of the additional nitrogen loading. The shorter residence time is not enough to substantially diminish the increased phosphorus loading. Minimum hypolimnetic DO concentrations would remain unchanged for Alternatives 3, 4, and 5, but would decrease slightly for No Action and the Proposed Action. DO concentrations would be lowest during the years when the reservoir contents are lowest. Under these conditions, the volume of the hypolimnion decreases and does not hold as much DO to meet hypolimnetic demands. TSS concentrations would increase slightly for all action alternatives. None of the alternatives would result in a discernable change in the epilimnetic temperature.

Table 3-50. Average predicted water quality for Granby Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period and the Range in Daily Values (min – max)					
	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	12.6 (4.5 - 25.2)	13.4 (4.5 – 26.3)	14.2 (4.5 – 26.5)	13.1 (4.8 – 22.2)	13.0 (4.8 – 22.1)	12.8 (4.9 - 21.7)
Total nitrogen (µg/L)	289 (228 – 375)	290 (229 - 380)	291 (229 -379)	282 (229 – 360)	281 (229 – 359)	279 (229 - 358)
Chlorophyll *a* (µg/L)	4.2 (2.0 – 7.3)	4.2 (2.0 – 7.2)	4.3 (2.0 – 7.2)	4.2 (2.0 – 7.4)	4.2 (2.0 – 7.4)	4.2 (2.0 - 7.3)
Peak chlorophyll *a* (µg/L)	6.6	6.6	6.5	6.6	6.6	6.6
Secchi-disk depth (m)	3.6 (2.1 – 5.3)	3.6 (2.0 – 5.3)	3.6 (2.0 – 5.3)	3.6 (2.1 – 5.2)	3.6 (2.1 – 5.2)	3.6 (2.1 – 5.1)
Trophic state (Index)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)
Minimum DO (mg/L)	4.5	4.4	4.3	4.5	4.5	4.5
TSS (mg/L)	2.3 (1.1 – 5.9)	2.3 (1.1 – 6.2)	2.4 (1.1 – 6.3)	2.4 (1.2 – 5.7)	2.4 (1.2 – 5.7)	2.4 (1.1 – 5.7)

All concentrations are for the epilimnion with the exception of minimum DO, which is for the hypolimnion.

The alternatives were evaluated to determine if water quality standards would be met. Granby Reservoir would continue to meet ammonia and nitrate standards under all alternatives. Manganese concentrations are anticipated to increase because of lower DO concentrations in the hypolimnion under No Action and the Proposed Action; therefore, the manganese water supply standard may continue to be exceeded for all alternatives. DO concentrations would continue to exceed the spawning standard because there is no improvement in DO concentrations for any alternative. The temperature standard would continue to be exceeded under all alternatives, as it is under existing conditions.

Table 3-51. Granby Reservoir predicted water quality changes by alternative compared to existing conditions.

Parameter	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+6.3%	+12.7%	+4.0%	+3.2%	+1.6%
Total nitrogen (µg/L)	+0.3%	+0.7%	-2.1%	-2.8%	-3.5%
Chlorophyll *a* (µg/L)	No Change	+2.4%	No Change	No Change	No Change
Peak chlorophyll *a* (µg/L)	No Change	-1.5%	No Change	No Change	No Change
Secchi-disk depth (m)	No Change	No Change	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	-2.2%	-4.4%	No Change	No Change	No Change
TSS (mg/L)	No Change	+4.3%	+4.3%	+4.3%	+4.3%

Shadow Mountain Reservoir

Predicted average annual and the range in daily water quality for Shadow Mountain Reservoir under existing conditions and all alternatives is summarized in Table 3-52. Table 3-53 shows the percent change in water quality for each alternative compared to existing conditions. Based on annual averages, Shadow Mountain Reservoir would remain in a mesotrophic state for all alternatives, although on a monthly basis, the trophic state would range between oligotrophic–mesotrophic and eutrophic. Seasonal variations in trophic state for existing conditions and the alternatives show that Shadow Mountain borders on eutrophic conditions during summertime. Average chlorophyll *a* concentrations would increase slightly for all alternatives except Alternatives 4 and 5. Total phosphorus and nitrogen concentrations would increase under all alternatives, with the greatest increase under No Action and the Proposed Action. Peak chlorophyll *a* concentrations would increase the most under the Proposed Action. DO would decrease slightly under the Proposed Action, but would not change under other alternatives. TSS concentrations would increase about 5 percent under all alternatives. The maximum summer temperature would not increase

Table 3-52. Average predicted water quality for Shadow Mountain Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period and the Range in Daily Values (min - max)					
	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	12.4 (1.9 -20.3)	13.1 (4.9 – 22.5)	13.8 (4.9 -23.8)	13.4 (5.2 -21.7)	13.0 (5.2 -21.7)	12.8 (5.3 – 20.9)
Total nitrogen (µg/L)	275 (190 – 330)	278 (198 – 332)	280 (197 -333)	276 (197 -316)	273 (197 – 315)	272 (197 - 314)
Chlorophyll *a* (µg/L)	5.7 (1.8 – 10.5)	5.8 (1.7 – 11.2)	5.8 (1.7 – 11.2)	5.8 (1.6 – 11.1)	5.7 (1.6 – 11.0)	5.7 (1.6 – 11.4)
Peak chlorophyll *a* (µg/L)	8.8	9.1	9.4	8.9	8.8	8.7
Secchi-disk depth (m)	2.0 (1.4 – 3.0)	2.0 (1.3 – 3.0)	2.0 (1.3 – 3.1)	2.0 (1.3 - 3.1)	2.0 (1.3 - 3.2)	2.0 (1.3 – 3.2)
Trophic state (Index)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)
Minimum DO (mg/L)	7.1	7.1	7.0	7.1	7.1	7.1
TSS (mg/L)	2.0 (1.1 – 5.3)	2.1 (1.1 – 5.5)	2.1 (1.1 – 5.5)	2.1 (1.1 – 5.5)	2.1 (1.1 – 5.5)	2.1 (1.1 – 5.4)

All concentrations are for the epilimnion with the exception of minimum DO, which is for the hypolimnion.

Table 3-53. Shadow Mountain Reservoir predicted water quality changes by alternative compared to existing conditions.

Parameter	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+5.6%	+11.3%	+8.1%	+4.8%	+3.2%
Total nitrogen (µg/L)	+1.1%	+1.8%	+0.4%	-0.7%	-1.1%
Chlorophyll *a* (µg/L)	+1.8%	+1.8%	+1.8%	No Change	No Change
Peak chlorophyll *a* (µg/L)	+3.4%	+6.8%	+1.1%	No Change	-1.1%
Secchi-disk depth (m)	No Change	No Change	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	No Change	-1.4%	No Change	No Change	No Change
TSS (mg/L)	+5.0%	+5.0%	+5.0%	+5.0%	+5.0%

with any of the action alternatives and may be cooler. Potentially lower temperatures could occur as a result of the additional volume of water flowing through the reservoir. The largest potential decrease in temperature would be in August, the month when exceedance of temperature standards is most likely. The Proposed Action, which has the greatest pumping through the Farr Pumping Plant in August, is most likely to reduce temperatures.

Because the change in nutrient concentrations would be very low for all alternatives, no change in the amount and type of aquatic vegetation (macrophytes) in Shadow Mountain Reservoir is likely. Rooted aquatic plants generally meet their nutrient needs directly from the sediments (Barko et al. 1986). Thus, they can thrive even in oligotrophic systems (Cooke et al. 2005). Therefore, changes in nutrient concentrations cannot be expected to result in changes in macrophyte growth and biomass (Cooke et al. 2005) and although there are anticipated changes in nutrient concentrations associated with the alternatives, it is not anticipated that these changes will aggravate the macrophyte problem.

Shadow Mountain Reservoir would continue to meet DO, ammonia, and nitrate standards. It is anticipated that manganese concentrations would stay about the same for each alternative with the exception of the Proposed Action, which is predicted to result in slightly increased manganese concentrations based on the minimum DO concentrations in the hypolimnion. Thus, the manganese water supply standard may not be met under any alternative, similar to existing conditions. The temperature standard would continue to be met under all alternatives.

Grand Lake

Predicted water quality for Grand Lake under existing conditions and all alternatives is summarized in Table 3-54. Table 3-55 shows the percent change in water quality for each alternative compared to existing conditions. The average trophic state would remain mesotrophic under all alternatives. Secchi-disk depth would decrease about 0.1 meter under all alternatives except Alternative 5, which would not change. Average and peak chlorophyll *a* concentrations would increase under all alternatives, except peak chlorophyll *a* would not change under Alternative 5. The No Action alternative and Proposed Action would result in the highest peak chlorophyll *a* concentrations. Phosphorus concentrations would increase under all alternatives. The Proposed Action would increase the phosphorus concentrations the most, with a 12 percent increase over existing conditions. There would be a slight increase in total nitrogen concentrations under No Action and the Proposed Action, and a slight decrease under Alternatives 3, 4, and 5. The higher flushing rate would offset some of the increased nitrogen loading. Hypolimnetic DO concentrations would decrease under all alternatives, with the greatest change under the No Action alternative. TSS concentrations would increase 5.6 percent for the Proposed Action and Alternatives 3 and 4, and would not change for the other alternatives. None of the alternatives are predicted to increase the temperature of the epilimnion.

Grand Lake would continue to meet DO, ammonia, and nitrate standards. It is anticipated that manganese concentrations would increase over existing conditions due to lower DO concentrations in the hypolimnion. It is predicted that the No Action alternative would result in the highest manganese concentrations and the Proposed Action alternative would result in the second highest concentrations and would likely exceed standards. There is no indication that temperature standards would be exceeded. In addition, there is no evidence to suggest that pH would decrease more under any alternative; therefore, the pH standard is predicted to be exceeded under all alternatives, similar to existing conditions.

Table 3-54. Average predicted water quality for Grand Lake.

Parameter	Average Annual Values Over the 15-Year Model Period and the Range in Daily Values (min - max)					
	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	8.3 (4.3 – 13.7)	8.8 (4.1 – 17.0)	9.3 (4.2 – 19.9)	8.8 (4.2 – 16.7)	8.8 (4.2 – 16.7)	8.7 (4.2 – 15.6)
Total nitrogen (µg/L)	247 (174 – 330)	248 (157 – 348)	251 (156 – 329)	246 (164 – 334)	246 (163 -334)	245 (163 - 333)
Chlorophyll *a* (µg/L)	4.9 (2.1 – 10.2)	5.1 (2.2 – 10.5)	5.2 (2.2 – 9.7)	5.1 (2.2 – 10.2)	5.0 (2.1 – 10.2)	5.0 (2.1 – 10.2)
Peak chlorophyll *a* (µg/L)	7.4	7.7	7.8	7.5	7.5	7.4
Secchi-disk depth (m)	2.6 (1.3 – 4.3)	2.5 (1.3 – 3.9)	2.5 (1.4 – 4.3)	2.5 (1.3 – 4.2)	2.5 (1.3 – 4.2)	2.6 (1.3 – 4.2)
Trophic state (Index)	Mesotrophic (47)	Mesotrophic (47)	Mesotrophic (47)	Mesotrophic (47)	Mesotrophic (47)	Mesotrophic (47)
Minimum DO (mg/L)	5.4	4.8	5.0	5.1	5.1	5.1
TSS (mg/L)	1.8 (1.0 – 4.1)	1.8 (1.1 – 4.3)	1.9 (1.1 – 4.2)	1.9 (1.2 – 4.2)	1.9 (1.2 – 4.2)	1.8 (1.2 – 4.2)

All concentrations are for the epilimnion with the exception of minimum DO, which is for the hypolimnion.

Table 3-55. Grand Lake predicted water quality changes by alternative compared to existing conditions.

Parameter	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+6.0%	+12.0%	+6.0%	+6.0%	+4.8%
Total nitrogen (µg/L)	+0.4%	+1.6%	-0.4%	-0.4%	-0.8%
Chlorophyll *a* (µg/L)	+4.2%	+6.1%	+4.2%	+2.0%	+2.0%
Peak chlorophyll *a* (µg/L)	+4.1%	+5.4%	+1.4%	+1.4%	No Change
Secchi-disk depth (m)	-3.8%	-3.8%	-3.8%	-3.8%	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change
Minimum DO (mg/L)	-11.1%	-7.4%	-5.6%	-5.6%	-5.6%
TSS (mg/L)	No Change	+5.6%	+5.6%	+5.6%	No Change

Jasper East

The water quality for Jasper East Reservoir under Alternative 3 was predicted using the BATHTUB model. The reservoir is predicted to be oligotrophic to mesotrophic (Table 3-56). Jasper East Reservoir would retain some nitrogen and phosphorus; therefore, nutrient deliveries to Granby Reservoir would be reduced. Rapid filling and drawdown could lead to an increase in reservoir erosion, turbidity, and suspended sediment delivery to Granby Reservoir.

Table 3-56. Average predicted water quality for Jasper Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period
Total phosphorus (µg/L)	30
Total nitrogen (µg/L)	246
Chlorophyll *a* (µg/L)	2.3
Secchi-disk depth (m)	3.3
Trophic state (Index)	Oligotrophic - Mesotrophic (39)

Rockwell/Mueller Creek Reservoir

A 20,000 AF Rockwell Reservoir under Alternative 4 and a 30,000 AF reservoir under Alternative 5 would have similar water quality (Table 3-57). The trophic state is predicted to be oligotrophic to mesotrophic for either size of reservoir. Nutrient and chlorophyll *a* concentrations would be slightly lower for Alternative 5 than Alternative 4, primarily due to a higher flushing rate for Alternative 5. Rockwell Reservoir would retain some nitrogen and phosphorus, thereby reducing nutrient deliveries to Granby Reservoir. Rapid filling and drawdown could lead to an increase in reservoir erosion, turbidity, and suspended sediment delivery to Granby Reservoir.

Table 3-57. Average predicted water quality for Rockwell Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period	
	Alternative 4	Alternative 5
Total phosphorus (µg/L)	28	26
Total nitrogen (µg/L)	229	214
Chlorophyll *a* (µg/L)	1.8	1.4
Secchi-disk depth (m)	3.4	3.5
Trophic state (Index)	Oligotrophic-Mesotrophic (36)	Oligotrophic-Mesotrophic (34)

3.8.2.5 East Slope Effects

Big Thompson River

Additional Windy Gap deliveries to the East Slope would increase flows in the Big Thompson River below Lake Estes as described in Section 3.5.2.3. A maximum average monthly flow increase in the Big Thompson River of 9 percent under the Proposed Action would result in an increase in nitrogen and phosphorus concentrations from the Adams Tunnel deliveries (<0.01 mg/L). Other alternatives, including No Action, would import less water and would have slightly lower increases in nitrogen and phosphorus concentrations. The small increases in flow under all alternatives would have minimal effects on stream temperatures.

Big Thompson River flows also would increase farther downstream due to additional discharges from the Loveland WWTP (Figure 3-2). Increases in flow would occur from May to October, with the greatest percent increase in October. Given that ammonia concentrations occasionally exceed the chronic and acute standard under existing low flow, potential changes in ammonia concentrations were calculated for the alternatives. Because data on copper concentrations were available for stream and effluent discharge, changes to copper concentrations were also evaluated. Under all alternatives, ammonia concentrations in the Big Thompson River would decrease slightly from existing conditions because effluent ammonia levels are, on average, lower than in the river. Additional WWTP discharges would have a greater influence on stream concentrations, thus reducing ammonia concentrations (Table 3-58). A slight reduction in the potential for exceeding the ammonia standard is possible under all alternatives. Copper concentrations would increase under all alternatives, but would not exceed water quality standards.

North St. Vrain Creek

Streamflow in North St. Vrain Creek below Ralph Price Reservoir would experience both increases and decreases in average monthly flows under the No Action alternative. As discussed later, water quality in a larger Ralph Price Reservoir is expected to improve and, therefore, releases to the North St.

Table 3-58. Big Thompson River average ammonia and copper concentrations in October below the Loveland WWTP.

Parameter	Standard	Existing Conditions	WWTP Effluent Concentrations[1]	No Action		All Other Alternatives	
		Average	Average	Average	Change	Average	Change
Ammonia (mg/L)	2.86	1.44	1.4	1.06	-0.38	1.21	-0.23
Copper (µg/L)	29.3	2.94	8.06	4.57	1.63	4.87	1.93

[1] Data are from EPA Envirofacts (http://www.epa.gov/enviro).

Vrain Creek would also improve stream water quality. Projected decreases in flow in May and July are estimated to increase stream temperatures in North St. Vrain Creek by up to 1°C from existing July temperatures of about 12°C, which is well below the 20°C standard. Increased North St. Vrain Creek streamflows in September and October would decrease stream temperatures up to 5°C.

DO concentrations in North St. Vrain Creek under the No Action alternative are predicted to decrease by less than 0.5 mg/L during months with reduced flow and increase from 0.5 to 2 mg/L during months with higher flows. A slight reduction in the DO concentration as a result of reduced flow would not reduce the DO concentrations to below the standard of 6 mg/L.

Manganese concentrations in North St. Vrain Creek have exceeded drinking water standards only during very low flows (<15 cfs). The No Action alternative would not reduce flows below 15 cfs during any month. Given that other water quality constituents have low concentrations during all flow levels under existing conditions and that predicted changes in flow are well within the historical range, water quality in North St. Vrain Creek is expected to be similar to historical conditions.

St. Vrain Creek

Under the No Action alternative, the changes in flow in North St. Vrain Creek would affect flow in St. Vrain Creek to the St. Vrain Supply Canal near Lyons (Figure 3-7). Based on the magnitude of these flow changes in relation to existing water quality; temperature, DO, and other water quality parameters would be minimally affected and would not result in any exceedances of water quality standards.

St. Vrain Creek flow would increase from April to October from additional effluent discharges below Longmont's WWTP and the St. Vrain Sanitation District WWTP under all alternatives (Figure 3-2). The largest percent increase above existing flow would occur in October. Impacts to ammonia concentrations in St. Vrain Creek were evaluated for October because the chronic ammonia standard is occasionally exceeded during existing conditions at low flows during that month. Predicted increases in ammonia concentrations for October under all of the alternatives approach, but do not exceed the standard (Table 3-59). The No Action alternative would result in higher ammonia concentrations than the other alternatives because of higher potential maximum WWTP discharges. Under all alternatives, the potential for exceedance of the ammonia standard would increase.

A similar evaluation was conducted for ammonia for St. Vrain Creek below the St. Vrain Sanitation District WWTP (Figure 3-2). Existing ammonia concentrations in the stream are low. Ammonia concentrations would increase under the alternatives, but would not exceed the standard (Table 3-60).

Big Dry Creek

Increased WWTP return flows to Big Dry Creek below Broomfield's WWTP from April to October would occur under all alternatives (Figure 3-2). Changes in ammonia, iron, and manganese concentrations, which already occasionally exceed standards, were calculated for October, the month when the largest percent flow increase would occur. The predicted increase in the ammonia concentrations would not exceed ammonia standards, but the potential for exceedance would increase (Table 3-61).

Iron concentrations would decrease under all alternatives because WWTP discharges have lower concentrations than the stream (Table 3-61). Manganese concentrations would likewise decrease for all alternatives.

Coal Creek

From April to October, streamflow in Coal Creek would increase by a monthly average maximum of about 5 cfs from additional WWTP discharges for Superior, Louisville, Lafayette, and Erie under all alternatives. Currently WWTP discharges provide the majority of Coal Creek flow for this portion of the creek. A quantitative analysis of effects to water quality was not conducted because of a lack of baseline data. Available data indicate low existing ammonia concentrations in Coal Creek (0.07 mg/L), while the ammonia concentrations in the four WWTP effluent discharges range from less than 0.03 mg/L to occasionally greater than 10 mg/L. A higher volume of WWTP discharges would increase ammonia concentrations in Coal Creek and would increase the potential for exceeding the ammonia standard, particularly during low flow.

Table 3-59. St. Vrain Creek average changes in ammonia concentrations in October below the Longmont WWTP under all of the WGFP alternatives.

Parameter	Standard	Existing Conditions	WWTP Effluent Concentrations[1]	No Action		All Other Alternatives	
		Average	Average	Average	Change	Average	Change
Ammonia (mg/L)	2.86	1.3	5.2	2.71	1.41	2.5	1.2

[1] Data are from EPA Envirofacts (http://www.epa.gov/enviro).

Table 3-60. St. Vrain Creek average changes in ammonia concentrations in October below the St. Vrain WWTP under the No Action alternative.

Parameter	Standard	Existing Conditions	WWTP Effluent Concentrations[1]	All Alternatives	
		Average	Average	Average	Change
Ammonia (mg/L)	2.86	0.155	1.05	0.161	0.006

[1] Data are from EPA Envirofacts (http://www.epa.gov/enviro).

Table 3-61. Big Dry Creek average changes in ammonia, iron, and manganese concentrations in October below the Broomfield WWTP under all of the WGFP alternatives.

Parameter	Standard	Existing Conditions	WWTP Effluent Concentrations[1]	All Alternatives	
		Average	Average	Average	Change
Ammonia (mg/L)	2.86	1.05	2	2.41	1.36
Iron (µg/L)	1,000	1,090	161	461	-629
Manganese (µg/L)	200	80	9.74	31.4	-48.6

[1] Data are from EPA Envirofacts (http://www.epa.gov/enviro).

Table 3-62. Cache la Poudre River average changes in ammonia and copper concentrations below Greeley's WWTP under all of the WGFP alternatives.

Parameter	Standard	Existing Conditions	WWTP Effluent Concentrations[1]	No Action (November)		Alternatives 2 to 5 (January)	
		Average	Average	Average	Change	Average	Change
Ammonia (mg/L)	2.86	0.66	4.79	1.4	0.74	1.37	0.71
Copper (µg/L)	29	2	11.1	3.64	1.64	3.56	1.56

[1] Data are from EPA Envirofacts (http://www.epa.gov/enviro).

Cache la Poudre River

The Cache la Poudre River average monthly streamflows would increase up to 8.4 cfs from November to March under the No Action alternative, and up to 7 cfs under the other alternatives from additional discharges below Greeley's WWTP (Figure 3-2). For the No Action alternative, the largest flow increase would occur in November. For the other alternatives, the largest increase would occur in January. Ammonia concentrations would increase about the same amount under all alternatives, but would not exceed standards (Table 3-62). Copper concentrations would increase slightly, but would remain below standards for all alternatives.

Chimney Hollow and Dry Creek

Streamflow in the short reach of Chimney Hollow below the new reservoir would be composed primarily of seepage from the reservoir and would have water quality characteristics similar to the new reservoir, as discussed later. Dry Creek water quality would be similar to that described below for Dry Creek Reservoir. All water quality parameters are predicted to meet standards below both reservoirs (Hydrosphere 2007c).

Ralph Price Reservoir

A summary of estimated water quality changes for the enlargement of Ralph Price Reservoir under the No Action alternative is shown in Table 3-63. Ralph Price Reservoir would remain in an oligotrophic state with a slight improvement in water quality from a larger and deeper reservoir. Nutrient and chlorophyll *a* concentrations would decrease slightly from existing conditions. Metalimnetic and hypolimnetic oxygen demands are expected to decrease; therefore, DO concentrations would likely increase. The larger reservoir would likely have slightly lower temperatures. Ralph Price Reservoir would continue to meet DO, ammonia, nitrate, dissolved manganese, and temperature standards.

Table 3-63. Average predicted water quality for Ralph Price Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period	
	Existing Conditions	No Action
Total phosphorus (µg/L)	5.1	4.9
Total nitrogen (µg/L)	188	177
Chlorophyll *a* (µg/L)	0.6	0.4
Secchi-disk depth (m)	3.8	3.8
Trophic state (Index)	Oligotrophic (26)	Oligotrophic (22)

Water Delivery to East Slope Reservoirs

Changes in Carter Lake, Horsetooth Reservoir, Chimney Hollow, and Dry Creek Reservoir are affected not only by changes in hydrology, but also by changes in loading to the East Slope from Adams Tunnel deliveries. The average annual nutrient loads delivered through the Adams Tunnel, as predicted by the Three Lakes Model are listed in Table 3-64. The highest loading occurs for the Proposed Action and the least for the No Action alternative.

Table 3-64. Average nutrient load through the Adams Tunnel.

Alternative	Average Phosphorus Load (kg/yr)	Average Nitrogen Load (kg/yr)
Existing Conditions	2,480	75,484
Alt 1 – No Action	2,738	78,303
Alt 2 – Proposed Action	3,058	82,328
Alt 3	2,782	79,894
Alt 4	2,773	79,739
Alt 5	2,744	79,627

Carter Lake

Predicted water quality for Carter Lake under existing conditions and all alternatives is summarized in Table 3-65. Table 3-66 shows the percent change in water quality for each alternative compared to existing conditions. No change in the trophic status of Carter Lake is predicted for any alternative. Clarity would decrease by about 0.1 meter in Secchi-disk depth for all alternatives. The No Action alternative, Proposed Action, and Alternative 5 would result in an increase in chlorophyll *a*. Nutrient concentrations would increase under all alternatives. Model predictions indicate that all alternatives may slightly reduce DO concentrations in both the metalimnion and hypolimnion. The oxygen demand predictions indicate that the Proposed Action alternative would likely result in the lowest DO concentrations among the alternatives for both the metalimnion and hypolimnion. No change in temperature is anticipated for any alternative.

Carter Lake would continue to meet DO, ammonia, and nitrate standards. Temperature standards are not predicted to be exceeded compared to existing conditions. Dissolved manganese concentrations may increase due to decreased hypolimnetic DO concentrations, but it is unlikely that the standard would be exceeded for any alternative.

Table 3-65. Average predicted water quality for Carter Lake.

Parameter	Average Annual Values Over the 15-Year Model Period					
	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	9.9	10.4	10.8	10.2	10.2	10.2
Total nitrogen (µg/L)	226	230	235	229	229	230
Chlorophyll *a* (µg/L)	1.8	1.9	2.0	1.8	1.8	1.9
Secchi-disk depth (m)	2.9	2.8	2.8	2.8	2.8	2.8
MOD (mg/[m3-day])	24	25	26	25	25	25
HOD (mg/[m3-day])	22	23	24	23	23	23
Trophic state (Index)	Oligotrophic-Mesotrophic (36)	Oligotrophic-Mesotrophic (37)	Oligotrophic-Mesotrophic (37)	Oligotrophic-Mesotrophic (37)	Oligotrophic-Mesotrophic (37)	Oligotrophic-Mesotrophic (37)

Table 3-66. Carter Lake predicted water quality changes by alternative compared to existing conditions.

Parameter	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+5.1%	+9.1%	+3.0%	+3.0%	+3.0%
Total nitrogen (µg/L)	+1.8%	+4.0%	+1.3%	+1.3%	+1.8%
Chlorophyll *a* (µg/L)	+5.6%	+11.1%	No Change	No Change	+5.6%
Secchi-disk depth (m)	-3.6%	-3.6%	-3.6%	-3.6%	-3.6%
Trophic state (Index)	No Change	No Change	No Change	No Change	No Change

Horsetooth Reservoir

Predicted water quality for Horsetooth Reservoir under existing conditions and all alternatives is summarized in Table 3-67. Table 3-68 shows the percent change in water quality for each alternative compared to existing conditions. Trophic state and Secchi-disk depth would remain unchanged from existing conditions for all alternatives, except for a slight decrease in clarity for the Proposed Action. The Proposed Action also has the highest nutrient loading from the Adams Tunnel and results in the highest nutrient and chlorophyll *a* concentrations. All alternatives may slightly reduce DO concentrations in both the metalimnion and hypolimnion. No change in temperature is predicted for any alternative.

Horsetooth Reservoir would continue to have reduced DO concentrations. The reservoir would continue to meet ammonia, and nitrate standards. Temperature standards are not predicted to be exceeded more than what is occurring under existing conditions. Dissolved manganese concentrations may increase due to decreased hypolimnetic DO concentrations, which could result in continued exceedance of the standard under any of the alternatives.

Chimney Hollow Reservoir

The predicted water quality for Chimney Hollow Reservoir for the Proposed Action and Alternatives 3 and 4 is summarized in Table 3-69. Water quality for both the 70,000 AF and 90,000 AF reservoirs would be similar. The Proposed Action would have slightly higher nutrient and chlorophyll *a* concentrations due to a higher residence time with less flushing. The reservoir would be oligotrophic under all alternatives.

Dry Creek Reservoir

Predicted water quality for Dry Creek Reservoir under Alternative 5 is shown in Table 3-70. The reservoir is expected to be oligotrophic. Reservoir water quality changes would be related to changes in inflow volumes and reservoir storage content.

Table 3-67. Average predicted water quality for Horsetooth Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period					
	Existing Conditions	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	9.9	10.4	11.0	10.3	10.3	10.2
Total nitrogen (µg/L)	274	281	290	285	284	284
Chlorophyll *a* (µg/L)	3.5	3.7	3.9	3.7	3.7	3.7
Secchi-disk depth (m)	2.6	2.6	2.5	2.6	2.6	2.6
Trophic state (Index)	Mesotrophic (43)	Mesotrophic (43)	Mesotrophic (44)	Mesotrophic (43)	Mesotrophic (43)	Mesotrophic (43)

Table 3-68. Horsetooth Reservoir predicted water quality changes by alternative compared to existing conditions.

Parameter	No Action	Proposed Action	Alternative 3	Alternative 4	Alternative 5
Total phosphorus (µg/L)	+5.1%	+11.1%	+4.0%	+4.0%	+3.0%
Total nitrogen (µg/L)	+2.6%	+5.8%	+4.0%	+3.6%	+3.6%
Chlorophyll *a* (µg/L)	+5.7%	+11.4%	+5.7%	+5.7%	+5.7%
Secchi-disk depth (m)	No Change	-3.8%	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change	No Change	No Change

Table 3-69. Average predicted water quality for Chimney Hollow Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period		
	Proposed Action	Alternative 3	Alternative 4
Total phosphorus (µg/L)	8.7	7.2	7.3
Total nitrogen (µg/L)	183	158	158
Chlorophyll *a* (µg/L)	0.7	0.2	0.2
Secchi-disk depth (m)	3.8	3.9	3.9
Trophic state (Index)	Oligotrophic (24)	Oligotrophic (13)	Oligotrophic (13)

Table 3-70. Average predicted water quality for Dry Creek Reservoir.

Parameter	Average Annual Values Over the 15-Year Model Period
Total phosphorus (µg/L)	9.3
Total nitrogen (µg/L)	204
Chlorophyll *a* (µg/L)	1.1
Secchi-disk depth (m)	3.6
Trophic state (Index)	Oligotrophic (26)

3.8.3 Cumulative Effects

The QUAL2K Model also was used for the cumulative effects evaluation of stream water quality based on future hydrologic conditions and nutrient loading. A mass balance model of nutrient load contributions throughout the Fraser River basin was developed for nitrogen and phosphorus concentrations, based on predicted future growth in the basin. Assumptions for future conditions were as follows: lower flow in the Fraser River, a greater population utilizing WWTPs that discharge to the Fraser River, and implementation of advanced wastewater treatment in the Fraser River basin above current levels of treatment. Under these assumptions, the model predicted higher nitrogen concentrations and lower phosphorus concentrations in the Fraser River inflow to the Colorado River (Table 3-71).

As with direct effects, the QUAL2K model runs were conducted for both average July 25 flows and Windy Gap diversions that would reduce river flow to the minimum streamflow of 90 cfs. Because of the similarity in results between Alternatives 3, 4, and 5, only Alternative 5 was used in the model runs to represent the effect of all three alternatives.

For streams other than the Colorado River, mass balance calculations, the SSTEMP model, and other calculations, as discussed in Section 3.8.2.3, were used for the impact assessment.

Lake water quality for the cumulative effects analysis used the same models and methods as described for direct effects based on future hydrologic conditions. In addition, future water quality conditions of each of the inflows into the Three Lakes System were estimated. It was assumed that the water quality of East Inlet, North Inlet, Arapaho Creek, Stillwater Creek, Roaring Fork, the North Fork of the Colorado River, and the water quality of the water pumped from Willow Creek Reservoir would remain unchanged from existing conditions. For pumping from Windy Gap and new West Slope reservoirs, assumptions were made about future water quality in the Fraser River basin due to anticipated growth, including WWTP upgrades with nutrient removal. The resulting anticipated nutrient loads from Windy Gap

Table 3-71. Fraser River nutrient concentration outflow for July 25—cumulative effects.

Alternative	Organic N	Ammonia	Nitrate and Nitrite	Organic P	Inorganic P
	(µg/L)				
Existing Conditions	106	32	87	34	22
All Alternatives	209	63	172	20	13

Table 3-72. Total phosphorus load delivered to Granby Reservoir from Willow Creek Reservoir, Windy Gap Reservoir, and Rockwell Creek Reservoir—cumulative effects.

Alternative	TP Load From Willow Creek Reservoir	TP Load From Windy Gap Reservoir	TP Load From Rockwell Creek Reservoir	Total
	(kg/yr)			
Existing Conditions	1,465	2,143		3,608
Alt 1 – No Action	1,591	1,645		3,236
Alt 2 – Proposed Action	1,633	1,944		3,577
Alt 5	1,608	1,007	387	3,002

Table 3-73. Total nitrogen load delivered to Granby Reservoir from Willow Creek Reservoir, Windy Gap Reservoir, and Rockwell Creek Reservoir—cumulative effects.

Alternative	TN Load from Willow Creek Reservoir	TN Load from Windy Gap Reservoir	TN Load from Rockwell Creek Reservoir	Total
	(kg/yr)			
Existing Conditions	15,948	16,391		32,339
Alt 1 – No Action	16,731	19,911		36,642
Alt 2 – Proposed Action	16,986	22,798		39,784
Alt 5	16,840	10,546	6,533	33,919

Reservoir and Rockwell Creek Reservoir are summarized in Table 3-72 and Table 3-73. Loads from Willow Creek pumping are also included in the model. Alternative 5 was used to represent the results of Alternatives 3 and 4 because of the similarity between these alternatives. Nutrient loads from Jasper East Reservoir under Alternative 3 would be similar to Rockwell Reservoir.

3.8.3.1 West Slope Cumulative Effects

Colorado River

Streamflow. Predicted changes in average Colorado River flow for July 25 are shown in Figure 3-49. Streamflows would be reduced throughout the study reach due to Windy Gap diversions, as well as a reduction in tributary inflows to the Colorado River from reasonably foreseeable future actions. Streamflows calculated for the minimum instream flow simulations would be similar for all of the alternatives and are shown in Figure 3-50. Streamflow changes immediately below Windy Gap Reservoir would be the same as for direct effects, but changes in tributary inflows in the future would reduce flows farther downstream.

Temperature. Water temperatures are predicted to increase by 0.4°C under the No Action alternative, compared to 0.6°C for the Proposed Action and 0.7°C for the other alternatives based on average July 25 flows (Figure 3-51). Using median measured USGS temperatures for July (14.3ºC at the location of greatest temperature change under the alternatives), the predicted July 25 temperature would not exceed 15.6°C in the river (above Troublesome Creek) under Alternative 5, and would be less for other alternatives. The daily average temperature would be below the MWAT of 18.2°C, but the potential for exceedance of the weekly standard would increase.

Figure 3-49. Colorado River average July 25 streamflow—cumulative effects.

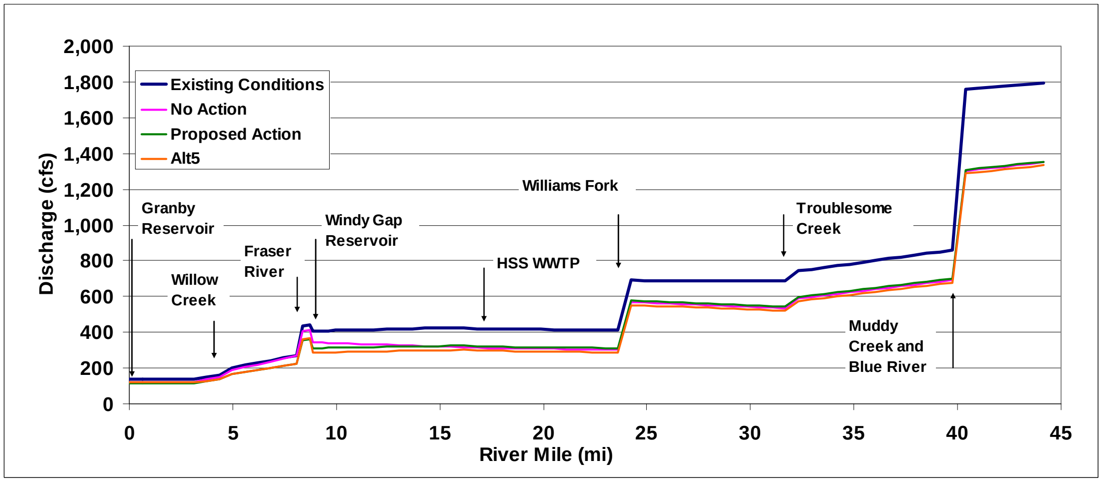


Figure 3-50. Colorado River July 25 streamflow assuming diversion to the minimum instream flow below Windy Gap Reservoir.

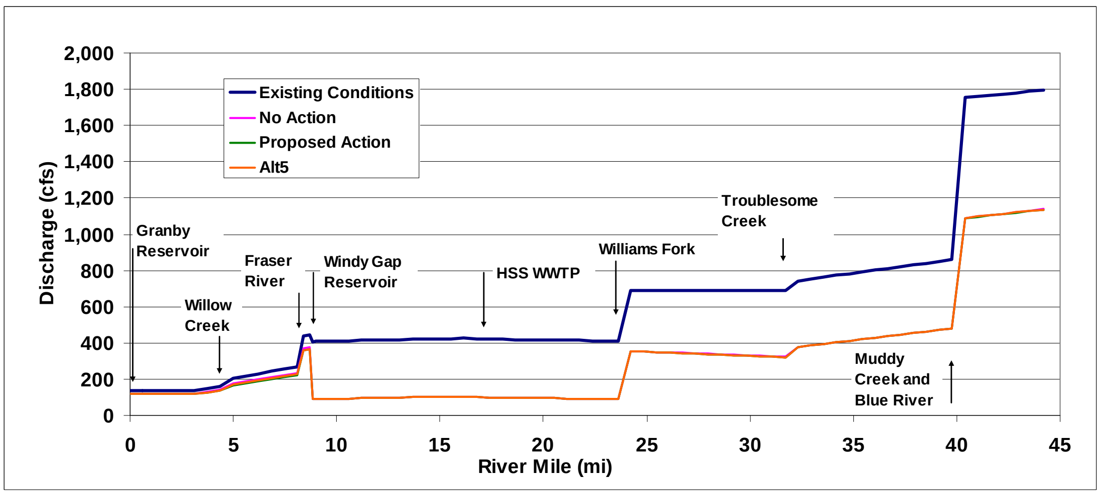


Figure 3-51. Colorado River average daily stream temperatures for July 25—cumulative effects.

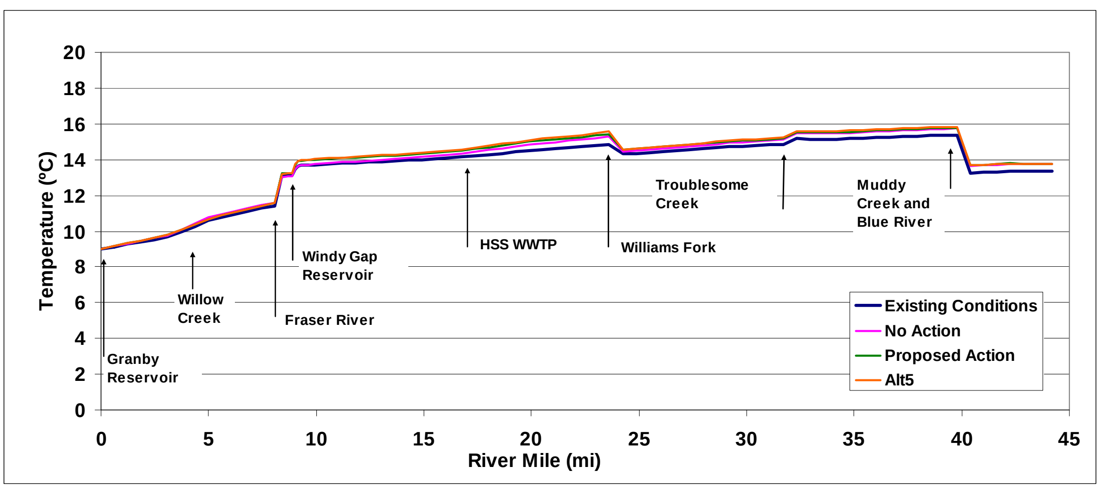
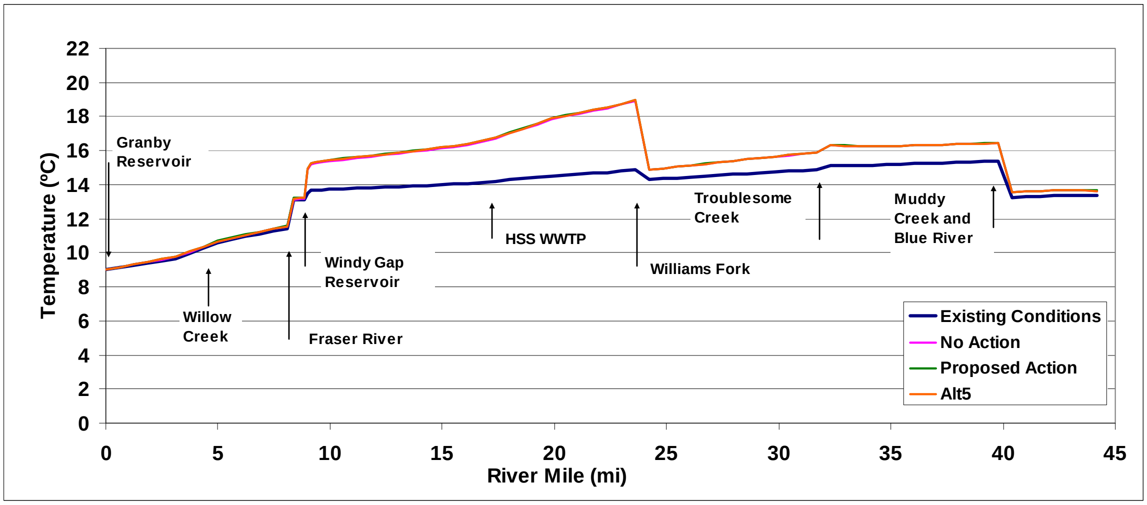


Figure 3-52. Colorado River average daily stream temperatures for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir—cumulative effects.



With Windy Gap diversion to the minimum streamflow of 90 cfs below Windy Gap Reservoir in addition to flow reductions from other reasonably foreseeable actions, July 25 temperatures in the Colorado River would increase up to 4.1°C under all alternatives (Figure 3-52). More frequent exceedances of the MWAT temperature standard in the reach from Windy Gap Reservoir to the Williams Fork and perhaps farther downstream could occur under these conditions.

Specific Conductivity. Specific conductivity in the simulation of cumulative effects would increase slightly less than described for direct effects in Section 3.8.2.4. All alternatives would result in less than a 10 percent increase in conductivity under average July 25 flows below the Williams Fork. At minimum flow rates below Windy Gap Reservoir, the increase in conductivity for all alternatives would be up to a maximum of 44 percent greater between the Williams Fork and Troublesome Creek.

Dissolved Oxygen. DO concentrations would decrease by less than 0.1 mg/L from existing conditions under all alternatives under average July 25 flows. The decrease would not lower the concentration below the standard. DO concentrations would decrease by 0.5 mg/L under the No Action alternative and 0.6 mg/L under the action alternatives at minimum instream flows below Windy Gap. A DO concentration as low as 6.9 mg/L for a short reach above the Williams Fork would be below the aquatic life spawning standard of 7.0 mg/L.

Ammonia. Ammonia concentrations are predicted to increase in the Colorado River below the Fraser River confluence because of projected future increase in ammonia concentrations in the Fraser River from additional WWTP discharges (Figure 3-53). A maximum increase above existing conditions of about 9.5 µg/L would occur under the No Action alternative below the HSS WWTP.

Ammonia would increase up to 11.1 µg/L under the Proposed Action and 10.7 µg/L under Alternative 5 below the Fraser River confluence above Windy Gap Reservoir. Biochemical processes and tributary inflow dilution would reduce these concentration increases to about 2.0 µg/L at the downstream end of the study reach below the Blue River. None of the alternatives would increase the ammonia concentration to above the aquatic life chronic ammonia standard. The maximum predicted ammonia concentration would occur under the Proposed Action (35.3 µg/L).

Diversions to the minimum streamflow below Windy Gap Reservoir would result in similar increases in ammonia concentrations below the HSS WWTP under all alternatives (Figure 3-54). A maximum increase of 16.7 µg/L of ammonia would occur under the Proposed Action, with a slightly smaller increase for the other alternatives. Ammonia concentrations of up to 41.1 µg/L would remain well below standards.

Figure 3-53. Colorado River ammonia concentrations for July 25—cumulative effects.

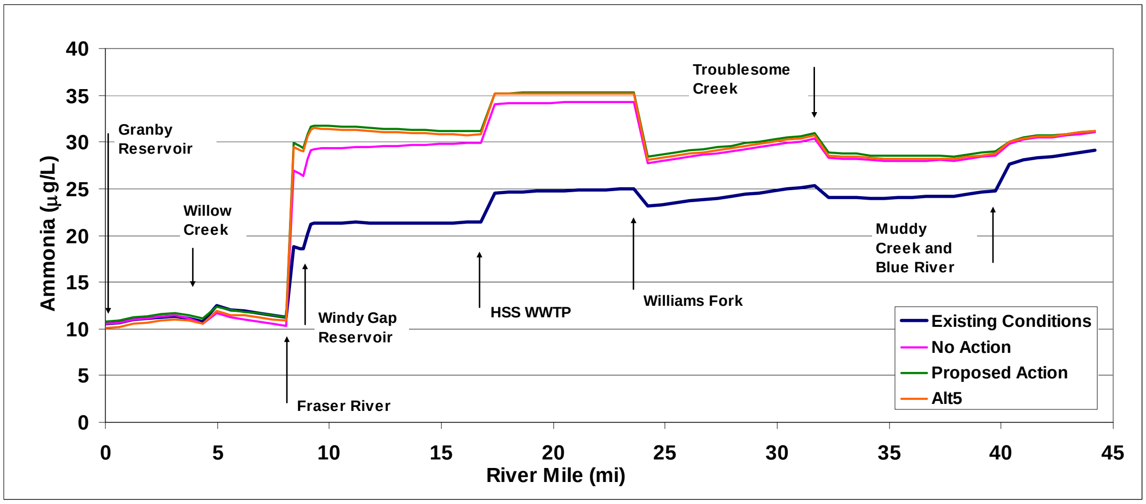
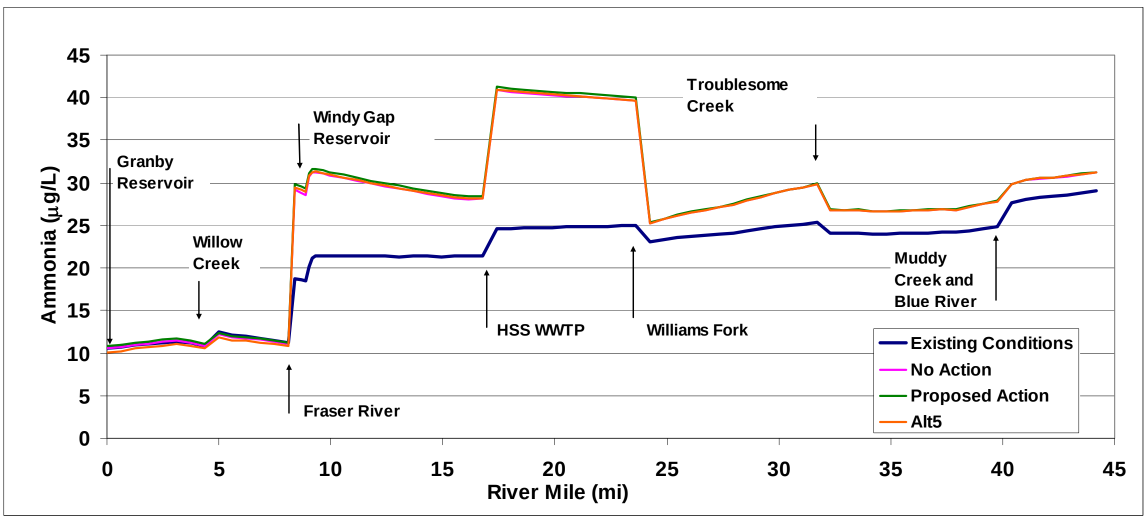


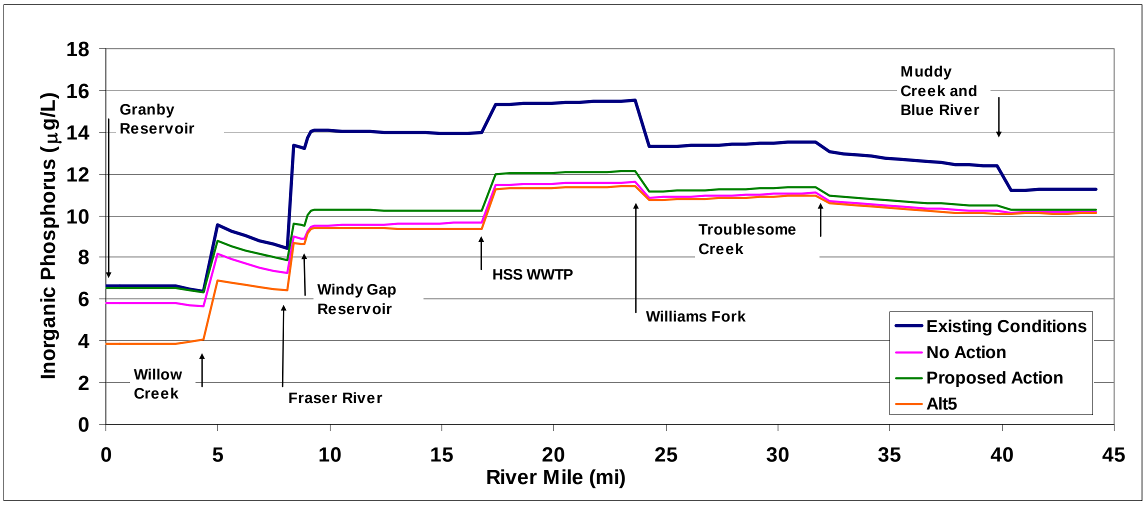
Figure 3-54. Colorado River ammonia concentrations for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir—cumulative effects.



Inorganic Phosphorus. Phosphorus concentrations are predicted to be lower than existing conditions under all alternatives (Figure 3-55). Willow Creek phosphorus concentrations are assumed to remain the same, but lower Willow Creek flows would decrease the load of inorganic phosphorus to the Colorado River. Fraser River phosphorus concentrations are predicted to be lower as a result of advanced wastewater treatment practices that are likely to be required in the future with additional discharges. The reduced phosphorus loading from the Fraser River would result in a decrease in inorganic phosphorus concentrations of about 4.6 µg/L under the No Action alternative, decrease of 4.7µg/L for Alternative 5, and a decrease of about 3.8µg/L under the Proposed Action. Biological uptake and tributary inflows would reduce the decrease in phosphorus concentrations to about 1 µg/L near Kremmling. There are currently no water quality standards for phosphorus; however, the EPA-recommended concentration for streams is 100 µg/L (EPA 1986).

Windy Gap diversions resulting in a minimum streamflow in the Colorado River would reduce dilution of HSS WWTP discharges and increase inorganic phosphorus concentrations between the WWTP and the Williams Fork (Figure 3-56). Under

Figure 3-55. Colorado River inorganic phosphorus concentrations for July 25—cumulative effects.

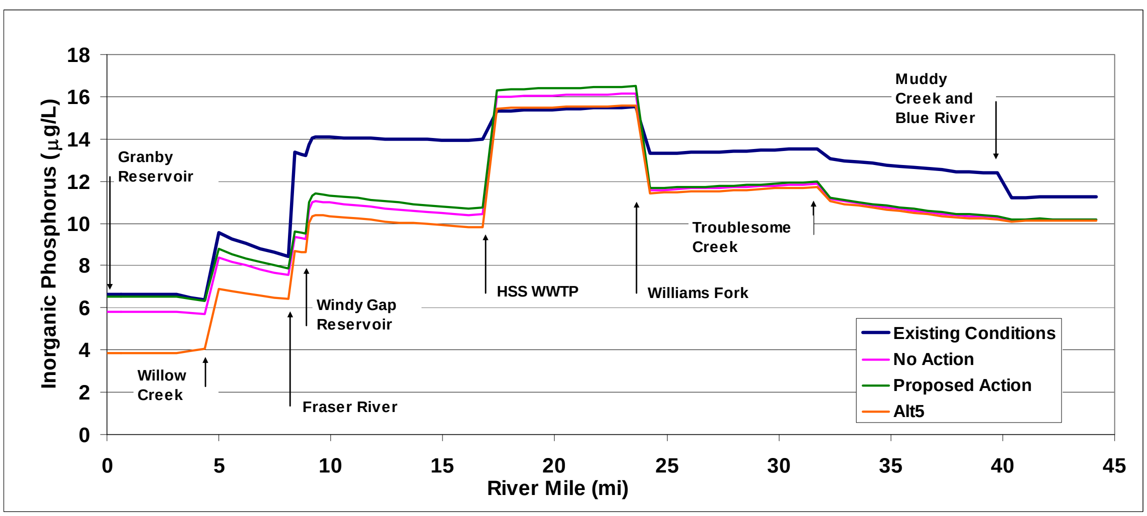


No Action inorganic phosphorus would increase 4.0µg/L and would increase 3.7µg/L under the Proposed Action and 4.7µg/L under other alternatives. Elsewhere in the Colorado River study area, phosphorus concentrations would be lower than existing conditions for all alternatives primarily as a result of a decrease in projected loading from Fraser River WWTPs.

Selenium. Selenium concentrations in the Colorado River are predicted to increase by less than 0.02 µg/L under all alternatives for average July 25 flows. An increase of up to 0.1 µg/L would occur under all alternatives when flows below Windy Gap Reservoir are at the minimum flow. All of the increases in selenium occur below the confluence with Muddy Creek, which has a higher concentration than the Colorado River. Water quality standards for selenium would not be exceeded under any alternative.

Aquatic Plant Growth. For all alternatives, some increase in aquatic plant growth is possible as a result of the increase in nutrient (ammonia and phosphorus) concentrations. None of the projected changes in Colorado River quality would be expected to adversely contribute to the spread or development of didymo populations that are currently present in the river.

Figure 3-56. Colorado River inorganic phosphorus concentrations for July 25 assuming diversion to the minimum streamflow below Windy Gap Reservoir—cumulative effects.



Willow Creek

The Three Lakes WWTP was recently expanded. It is assumed that the expansion was designed with future foreseeable growth in the service area considered. Reduced streamflow in Willow Creek would increase concentrations for ammonia, iron, and copper under all alternatives (Table 3-74). A reduction in available flows for dilution of discharge from the Three Lakes WWTP would not result in an exceedance of water quality standards for the evaluated parameters under the alternative actions even at the maximum permitted WWTP discharge rate. Given the lack of algae and chlorophyll data for Willow Creek, it is not known whether the predicted increases in ammonia concentrations would result in algal growth problems in the creek. Willow Creek temperatures would decrease by less than 0.2°C under all alternatives from the greater contribution of cooler ground water inflows.

Jasper East Drainage and Rockwell/Mueller Creeks

The water quality for the Jasper East drainage and Rockwell/Mueller Creeks below potential new reservoirs would be similar to the quality of the reservoirs as discussed below.

Granby Reservoir

Predicted average annual and the range in daily water quality for Granby Reservoir under existing conditions and the alternatives is summarized in Table 3-75. Table 3-76 shows the percent change in water quality for each alternative compared to existing conditions. Granby Reservoir would remain mesotrophic under all alternatives and there would be no change in Secchi-disk depth. Average chlorophyll *a* concentrations would not change for the No Action alternative or the Proposed Action, and would decrease slightly for the other alternatives. Nitrogen concentrations would be higher than existing conditions for all alternatives. Phosphorus concentrations would be lower under the No Action alternative and Alternative 5 and slightly higher under the Proposed Action. Phosphorus concentrations would be lower than in the direct effects analysis due to anticipated advanced wastewater treatment in the Fraser River basin in the future. Minimum DO concentrations would decrease about 4 percent under the Proposed Action. TSS would increase about 4 percent under the action alternatives. No change in epilimnetic temperature is predicted for any alternative.

Table 3-74. Willow Creek average monthly ammonia, iron, and copper concentrations—cumulative effects.

Std/Alternative	Ammonia (mg/L)			Iron, dis (µg/L)			Copper, dis (µg/L)		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
Standard[1]	2.87	2.87	2.45	300	300	300	10	10	10
WWTP[2]	17			260			21		
Existing Conditions	0.10	0.10	0.10	92.5	92.5	92.5	3.4	3.4	3.4
Alt 1 – No Action	0.27	1.01	2.06	94.2	101.5	120	3.5	4.35	5.7
Alt 2 – Proposed Action	0.29	1.09	2.25	94.4	102.35	113.7	3.6	4.4	5.6
Alt 3 – 5	0.28	1.09	2.25	94.3	102.35	122.7	3.5	4.4	6

[1] Copper standard based on mean hardness of 112 mg/L (CDPHE 2008).

[2] Effluent concentrations from the Three Lakes WWTP discharge to Church Creek, a tributary to Willow Creek (EPA Envirofacts: http://www.epa.gov/enviro/).

Table 3-75. Average predicted water quality for Granby Reservoir—cumulative effects.

Parameter	Average Annual Value Over the 15-Year Model Period and the Range in Daily Values (min - max)			
	Existing Conditions	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	12.6 (4.5 – 25.0)	12.2 (4.5 – 22.1)	12.9 (4.5 – 22.4)	10.9 (4.8 – 17.7)
Total nitrogen (µg/L)	289 (228 – 375)	298 (229 – 396)	300 (229 – 395)	303 (230 - 360)
Chlorophyll *a* (µg/L)	4.2 (2.0 – 7.3)	4.2 (2.0 – 7.3)	4.2 (2.0 – 7.1)	4.1 (2.0 – 6.9)
Peak chlorophyll *a* (µg/L)	6.6	6.5	6.5	6.3
Secchi-disk depth (m)	3.6 (2.1 – 5.3)	3.6 (2.0 – 5.3)	3.6 (2.0 – 5.3)	3.6 (2.1 – 5.1)
Trophic state (Index)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)	Mesotrophic (46)
Minimum DO (mg/L)	4.5	4.5	4.3	4.5
TSS (mg/L)	2.3 (1.1 – 5.9)	2.3 (1.1 – 6.1)	2.4 (1.1 – 6.2)	2.4 (1.1 – 5.1)

All concentrations are for the epilimnion with the exception of minimum DO, which is for the hypolimnion.

Granby Reservoir would continue to meet ammonia and nitrate standards. It is anticipated that manganese concentrations would increase over existing conditions for the Proposed Action due to lower DO concentrations in the hypolimnion. Therefore, the manganese water supply standard may continue to be exceeded for all alternatives. DO concentrations would continue to be below the spawning standard under all alternatives. Minimum DO would not change under the No Action alternative or Alternative 5, and would decrease by 0.2 mg/L under the Proposed Action. Based on the temperature modeling, it is predicted that the temperature standard would continue to be exceeded under all the alternatives in the same manner as under existing conditions.

Table 3-76. Granby Reservoir predicted water quality changes by alternative compared to existing conditions—cumulative effects.

Parameter	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	-3.2%	+2.4%	-13.5%
Total nitrogen (µg/L)	+3.1%	+3.8%	+4.8%
Chlorophyll *a* (µg/L)	No Change	No Change	-2.4%
Peak chlorophyll *a* (µg/L)	-1.5%	-1.5%	-4.5%
Secchi-disk depth (m)	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change
Minimum DO (mg/L)	No Change	-4.4%	No Change
TSS (mg/L)	No Change	+4.3%	+4.3%

Table 3-77. Average predicted water quality for Shadow Mountain—cumulative effects.

Parameter	Average Annual Value Over the 15-Year Model Period and the Range in Daily Values (min - max)			
	Existing Conditions	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	12.4 (4.9 – 20.3)	12.2 (4.9 – 20.3)	12.8 (4.9 – 20.3)	11.2 (4.9 – 20.3)
Total nitrogen (µg/L)	275 (190 – 330)	283 (198 – 338)	285 (196 – 344)	286 (256 – 341)
Chlorophyll *a* (µg/L)	5.7 (1.8 – 10.5)	5.7 (1.6 – 10.9)	5.7 (1.7 – 11.6)	5.4 (1.5 – 10.6)
Peak chlorophyll *a* (µg/L)	8.8	8.8	9.1	8.3
Secchi-disk depth (m)	2.0 (1.4 – 3.1)	2.0 (1.3 – 3.0)	2.0 (1.3 – 3.1)	2.1 (1.3 – 3.2)
Trophic state (Index)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)	Mesotrophic (48)
Minimum DO (mg/L)	7.1	7.1	7.1	7.1
TSS (mg/L)	2.0 (1.1 – 5.3)	2.0 (1.1 – 5.5)	2.1 (1.1 – 5.4)	2.2 (1.1 – 5.4)

Shadow Mountain Reservoir

Predicted average annual and the range in daily water quality for Shadow Mountain Reservoir under existing conditions and the alternatives is summarized in Table 3-77. Table 3-78 shows the percent change in water quality for each alternative compared to existing conditions. The reservoir would remain in a mesotrophic state for all alternatives. Only Alternative 5 indicates a 0.1 meter decrease in Secchi-disk depth. Average chlorophyll *a* concentrations would not change for the No Action alternative or the Proposed Action, but would decrease about 5 percent for Alternative 5. Total phosphorus concentrations would increase for the Proposed Action and decrease for the other alternatives. Total nitrogen would increase less than 4 percent for all alternatives. Minimum DO concentrations would change little for all alternatives. It is expected that the temperature of Shadow Mountain Reservoir would not increase under any action alternative and may be cooler as discussed in Section 3.8.2.4.

Because the change in nutrient concentrations would be very low for all alternatives, no change in the amount and type of aquatic vegetation (macrophytes) in Shadow Mountain Reservoir is expected. Rooted aquatic plants generally meet their nutrient needs directly from the sediments (Barko et

Table 3-78. Shadow Mountain predicted water quality changes by alternative compared to existing conditions—cumulative effects.

Parameter	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	-1.6%	+3.2%	-9.7%
Total nitrogen (µg/L)	+2.9%	+3.6%	+4.0%
Chlorophyll *a* (µg/L)	No Change	No Change	-5.3%
Peak chlorophyll *a* (µg/L)	No Change	+3.7%	-5.7%
Secchi-disk depth (m)	No Change	No Change	+5.0%
Trophic state	No Change	No Change	No Change
Minimum DO (mg/L)	No Change	-1.4%	No Change
TSS (mg/L)	No Change	+5.0%	+10.0%

Table 3-79. Average predicted water quality for Grand Lake—cumulative effects.

Parameter	Average Annual Value Over the 15-Year Model Period and the Range in Daily Values (min - max)			
	Existing Conditions	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	8.3 (4.3 – 13.7)	8.2 (4.1 – 16.0)	8.7 (4.2 – 18.6)	7.7 (4.2 – 13.9)
Total nitrogen (µg/L)	247 (174 – 330)	251 (158 – 386)	255 (157 – 336)	256 (165 – 339)
Chlorophyll *a* (µg/L)	4.9 (2.1 – 10.2)	4.9 (2.1 – 10.7)	5.0 (2.1 – 9.7)	4.6 (2.0 – 10.2)
Peak chlorophyll *a* (µg/L)	7.4	7.4	7.6	6.9
Secchi-disk depth (m)	2.6 (1.3 – 4.3)	2.6 (1.2 – 4.5)	2.5 (1.4 – 4.4)	2.7 (1.3 – 4.4)
Trophic state (Index)	Mesotrophic (47)	Mesotrophic (46)	Mesotrophic (47)	Mesotrophic (46)
Minimum DO (mg/L)	5.4	4.8	5.0	5.1
TSS (mg/L)	1.8 (1.0 – 4.1)	1.8 (1.1 – 3.8)	1.9 (1.1 – 4.2)	1.8 (1.1 – 4.1)

All concentrations are for the epilimnion with the exception of minimum DO, which is for the hypolimnion.

al. 1986). Thus, they can thrive even in oligotrophic systems (Cooke et al. 2005). Therefore, changes in nutrient concentrations cannot be expected to result in changes in macrophyte growth and biomass (Cooke et al. 2005) and although there are anticipated changes in nutrient concentrations associated with the alternatives, it is not anticipated that these changes will aggravate the macrophyte problem.

Shadow Mountain Reservoir would continue to meet DO, ammonia, and nitrate standards. It is anticipated that manganese concentrations would stay about the same for all alternatives based on the minimum DO concentrations in the hypolimnion. Therefore, the manganese water supply standard may continue to be exceeded for all alternatives.

Grand Lake

Predicted average annual and the range in daily water quality for Grand Lake under existing conditions and all of the alternatives is summarized in Table 3-79. Table 3-80 shows the percent change in water quality for each alternative compared to existing conditions. The reservoir would remain mesotrophic for all alternatives. Clarity would decrease slightly with a decrease of 0.1 meter in Secchi-disk depth under the Proposed Action, and would increase about 0.1 meter under Alternative 5. A small increase in chlorophyll *a* is predicted for the Proposed Action and a small decrease in chlorophyll

Table 3-80. Grand Lake predicted water quality changes by alternative compared to existing conditions—cumulative effects.

Parameter	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	-1.2%	+4.8%	-7.2%
Total nitrogen (µg/L)	+1.6%	+3.2%	+3.6%
Chlorophyll *a* (µg/L)	No Change	+2.0%	-6.1%
Peak chlorophyll *a* (µg/L)	No Change	+2.7%	-6.8%
Secchi-disk depth (m)	No Change	-3.8%	+3.8%
Trophic state	No Change	No Change	No Change
Minimum DO (mg/L)	-11.1%	-7.4%	-5.6%
TSS (mg/L)	No Change	+5.6%	No Change

a is predicted for Alternative 5. Nitrogen concentrations are slightly higher than existing conditions for all alternatives. Phosphorus concentrations are lower than existing conditions for the No Action alternative and Alternative 5. The Proposed Action would increase phosphorus concentrations about 5 percent. DO concentrations would decrease for all alternatives.

Grand Lake would continue to meet DO, ammonia, and nitrate standards. It is anticipated that manganese concentrations would increase over existing conditions due to lower DO concentrations in the hypolimnion. It is predicted that the No Action alternative would result in the highest manganese concentrations and the Proposed Action alternative would result in the second highest manganese concentration. There is no indication that temperature standards would be exceeded because no increase in temperature is predicted. In addition, there is no evidence to suggest that pH would decrease more under any alternative; therefore, the pH standard would continue to be exceeded under all alternatives, similar to existing conditions.

Jasper East Reservoir

Water quality for Jasper East Reservoir was not modeled for the cumulative effects analysis, but is expected to be similar to Rockwell Reservoir.

Rockwell/Mueller Creek Reservoir

Predicted water quality for Rockwell Reservoir is summarized in Table 3-81. The reservoir is predicted to be mesotrophic. Rockwell Reservoir would retain some nitrogen and phosphorus, thereby reducing nutrient deliveries to Granby Reservoir. Rapid filling and drawdown could lead to an increase in reservoir erosion turbidity and suspended sediment delivery to Granby Reservoir.

Table 3-81. Average predicted water quality for Rockwell/Mueller Creek Reservoir—cumulative effects.

Parameter	Average Annual Values Over the 15-Year Model Period
Total phosphorus (µg/L)	15.1
Total nitrogen (µg/L)	286
Chlorophyll *a* (µg/L)	3.0
Secchi-disk depth (m)	3.1
Trophic state (Index)	Mesotrophic (41)

3.8.3.2 East Slope Cumulative Effects

Big Thompson River

Nitrogen and phosphorus concentrations in the Big Thompson River below Lake Estes are projected to increase by less than 0.02 mg/L under all alternatives in the months of May and July. Small projected increases in flow would have minimal effects on stream temperatures.

Big Thompson River flows also would increase as a result of additional discharges from the Loveland WWTP in the future. Predicted changes for ammonia and copper concentrations in the cumulative effects analysis would be similar to those described for direct effects, as shown in Table 3-58. Under all alternatives, ammonia concentrations in the Big Thompson River would decrease slightly from existing conditions because effluent ammonia levels are lower than in the river. A slight reduction in the potential for exceeding the ammonia standard is possible under all alternatives. Copper concentrations would increase under all alternatives, but would not exceed water quality standards.

North St. Vrain Creek

The changes in flow and water quality in North St. Vrain Creek under the No Action alternative in the future would be essentially the same as discussed for direct effects (Section 3.8.2.5). The predicted flow changes would result in monthly increases and decreases in stream temperature, DO, and other parameters. No exceedance of water quality standards are predicted under cumulative effects.

St. Vrain Creek

The small changes in flow in St. Vrain Creek upstream of the St. Vrain Supply Canal under the No Action alternative would have minimal effects on physical or chemical qualities of the stream, and would not result in exceedance of water quality standards.

St. Vrain Creek streamflow increases below Longmont's WWTP would result in an increase in the concentration of ammonia similar to that shown for direct effects in Table 3-59. Predicted increases in ammonia concentrations could result in occasional exceedances of the standard under all alternatives. The No Action alternative would have the greatest potential to result in exceedances of the standard because of the higher maximum Windy Gap deliveries that could occur. None of the alternatives are predicted to result in exceedances of iron or manganese standards.

Assessment of St. Vrain Creek water quality below the St. Vrain Sanitation District WWTP for cumulative effects resulted in similar water quality changes as shown in Table 3-60. None of the alternatives would substantially increase the potential for exceedance of water quality standards in this reach of the creek.

Big Dry Creek

Increased flows from additional effluent discharges in Big Dry Creek below the Broomfield WWTP would increase the concentration of ammonia to about 2.4 mg/L under the No Action alternative and about 2.6 mg/L under the action alternatives. The higher ammonia concentrations would increase the potential for exceeding the chronic ammonia standard. Iron concentrations, which currently exceed the standard, would decrease to below the standard under all alternatives. Manganese concentrations would decrease under all alternatives and remain below the standard.

Coal Creek

Higher streamflow in Coal Creek from additional WWTP discharges for Superior, Louisville, Lafayette, and Erie are expected to increase ammonia concentrations in Coal Creek based on the currently quality of WWTP discharges. All alternatives could result in ammonia concentrations that would exceed the standard, particularly during low flows.

Cache la Poudre River

Additional WWTP discharges to the Cache la Poudre River below Greeley's WWTP would increase ammonia and copper concentrations similar to those shown in Table 3-62. All alternatives would have a similar increase in ammonia and copper concentrations. No exceedance of water quality standards for these parameters was predicted.

Chimney Hollow and Dry Creek

Water quality in the short reach of Chimney Hollow below the new reservoir and in Dry Creek would be similar to the water quality characteristics of the reservoirs as described later. All water quality parameters are predicted to meet standards below both reservoirs.

Ralph Price Reservoir

A summary of estimated water quality changes for the enlargement of Ralph Price Reservoir under the No Action alternative is shown in Table 3-82. Ralph Price Reservoir would remain in an oligotrophic state with no change in clarity. Water quality would improve slightly with a larger and deeper reservoir. Nutrient and chlorophyll *a* concentrations would decrease slightly from existing conditions. DO concentrations would likely increase. The larger reservoir would likely have slightly lower temperatures than existing conditions. Ralph Price Reservoir would continue to meet DO, ammonia, nitrate, dissolved manganese, and temperature standards.

Table 3-82. Average predicted water quality for Ralph Price Reservoir—cumulative effects.

Parameter	Average Annual Values Over the 15-Year Model Period	
	Existing Conditions	No Action
Total phosphorus (µg/L)	5.1	4.9
Total nitrogen (µg/L)	188	177
Chlorophyll *a* (µg/L)	0.6	0.4
Secchi-disk depth (m)	3.8	3.8
Trophic state (Index)	Oligotrophic (26)	Oligotrophic (22)

Water Delivery to East Slope Reservoirs

Water delivery to East Slope Reservoirs and nutrient loadings from the Adams Tunnel affects reservoir water quality. The average annual nutrient loads delivered through the Adams Tunnel, as predicted by the Three Lakes Model, are listed in Table 3-83. The highest loading occurs for the Proposed Action and the least for the No Action alternative.

Table 3-83. Average nutrient load through the Adams Tunnel—cumulative effects.

Alternative	Average Phosphorus Load	Average Nitrogen Load
	(kg/yr)	
Existing Conditions	2,480	75,484
Alternative 1 – No Action	2,501	78,942
Alternative 2 – Proposed Action	2,774	82,947
Alternative 3 – 5	2,369	82,516

Carter Lake

Predicted water quality for Carter Lake under existing conditions and all alternatives is summarized in Table 3-84. Table 3-85 shows the percent change in water quality for each alternative compared to existing conditions. The trophic state would remain oligotrophic-mesotrophic and clarity would not change from existing conditions under all alternatives. Chlorophyll *a* would increase slightly under the action alternatives. Nutrient concentrations would increase the most under the Proposed Action. Model predictions indicate that all alternatives may slightly reduce DO concentrations in both the metalimnion and hypolimnion. The Proposed Action would likely result in the lowest DO concentrations.

Carter Lake would continue to meet DO, ammonia, and nitrate standards. Temperature standards are not predicted to exceed existing conditions. Dissolved manganese concentrations may increase due to decreased hypolimnetic DO concentrations, but it is unlikely that the standard would be exceeded for the alternatives.

Table 3-84. Average predicted water quality for Carter Lake—cumulative effects

Parameter	Average Annual Values Over the 15-Year Model Period			
	Existing Conditions	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	9.9	9.9	10.4	9.7
Total nitrogen (µg/L)	226	231	237	236
Chlorophyll *a* (µg/L)	1.8	1.8	2.0	1.9
Secchi-disk depth (m)	2.8	2.8	2.8	2.8
Trophic state (Index)	Oligotrophic - Mesotrophic (36)	Oligotrophic - Mesotrophic (37)	Oligotrophic - Mesotrophic (37)	Oligotrophic - Mesotrophic (37)

Table 3-85. Carter Lake predicted water quality changes by alternative compared to existing conditions—cumulative effects.

Parameter	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	No Change	+5.1%	-2.0%
Total nitrogen (µg/L)	+2.2%	+4.9%	+4.4%
Chlorophyll *a* (µg/L)	No Change	+11.1%	+5.6%
Secchi-disk depth (m)	No Change	No Change	No Change
Trophic state	No Change	No Change	No Change

Table 3-86. Average predicted water quality for Horsetooth Reservoir—cumulative effects.

Parameter	Average Annual Values Over the 15-Year Model Period			
	Existing Conditions	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	9.9	9.9	10.5	9.6
Total nitrogen (µg/L)	274	283	292	291
Chlorophyll *a* (µg/L)	3.5	3.6	3.8	3.6
Secchi-disk depth (m)	2.6	2.6	2.5	2.6
Trophic state (Index)	Mesotrophic (43)	Mesotrophic (43)	Mesotrophic (44)	Mesotrophic (43)

Table 3-87. Horsetooth Reservoir predicted water quality changes by alternative compared to existing conditions—cumulative effects.

Parameter	No Action	Proposed Action	Alternative 5
Total phosphorus (µg/L)	No Change	+6.1%	-3.0%
Total nitrogen (µg/L)	+3.3%	+6.6%	+6.2%
Chlorophyll *a* (µg/L)	+2.9%	+8.6%	+2.9%
Secchi-disk depth (m)	No Change	-3.8%	No Change
Trophic state	No Change	No Change	No Change

Horsetooth Reservoir

Predicted water quality for Horsetooth Reservoir under existing conditions and all alternatives is summarized in Table 3-86. Table 3-87 shows the percent change in water quality for each alternative compared to existing conditions. The trophic state would remain unchanged for all alternatives. Clarity, as measured by Secchi-disk depth, would decrease by 0.1 meter for the Proposed Action. The Proposed Action also has the highest nutrient loading from the Adams Tunnel and would result in the highest reservoir nutrient and chlorophyll *a* concentrations. Dry Creek Reservoir under Alternative 5 would retain phosphorus, thereby reducing the phosphorus load to Horsetooth Reservoir. All alternatives may slightly reduce DO concentrations in both the metalimnion and hypolimnion.

Horsetooth Reservoir would continue to meet ammonia and nitrate standards. Temperature standards are not predicted to exceed existing conditions. Dissolved manganese concentrations may increase slightly due to decreased hypolimnetic DO concentrations, which may result in continued exceedance in the DO and manganese water supply standards under all alternatives.

Chimney Hollow Reservoir

The predicted water quality for Chimney Hollow Reservoir for the Proposed Action is summarized in Table 3-88. Water quality for a 70,000 AF Chimney Hollow Reservoir under Alternatives 3 and 4 would be similar. The reservoir is predicted to be oligotrophic with low nutrient and chlorophyll *a* concentrations.

Table 3-88. Average predicted water quality for Chimney Hollow Reservoir—cumulative effects.

Parameter	Average Annual Values Over the 15-Year Model Period
Total phosphorus (µg/L)	8.5
Total nitrogen (µg/L)	185
Chlorophyll *a* (µg/L)	0.7
Secchi-disk depth (m)	3.7
Trophic state (Index)	Oligotrophic (25)

Dry Creek Reservoir

Predicted water quality for Dry Creek Reservoir under Alternative 5 is shown in Table 3-89. The reservoir is predicted to be oligotrophic. Water quality would be slightly lower than Chimney Hollow Reservoir.

Table 3-89. Average predicted water quality for Dry Creek Reservoir—cumulative effects.

Parameter	Average Annual Values Over the 15-Year Model Period
Total phosphorus (µg/L)	9.7
Total nitrogen (µg/L)	222
Chlorophyll *a* (µg/L)	1.3
Secchi-disk depth (m)	3.6
Trophic state (Index)	Oligotrophic (28)

3.8.4 Proposed Mitigation

The following mitigation measures are proposed for water quality effects:

- A construction stormwater management plan will be developed and implemented for new facility construction under all alternatives to reduce erosion and sediment delivery to nearby streams and water bodies.
- The Subdistrict will commit to continued participation and funding of the ongoing Nutrient Studies, with participation and collaboration by Reclamation, NCWCD and Grand County, to better understand water quality issues in the Three Lakes system and provide guidance for future management decisions
- The Subdistrict will work with Grand County, CDOW, and others to determine if increasing bypass flows in the Colorado River from the existing minimum flow of 90 cfs to 135 cfs while Windy Gap is pumping during July and August would result in temperature reductions downstream of Windy Gap that would measurably benefit the trout fishery. If studies indicate that increased bypass flows would be effective, Subdistrict would consider increasing required bypass flows under certain water supply conditions.

3.8.5 Unavoidable Adverse Effects

Windy Gap diversions from the Colorado River under all alternatives would result in an increase in stream temperatures and an increase in the concentration of ammonia, inorganic phosphorus, and total dissolved solids. Cumulative effects would be slightly greater than direct effects, although phosphorus concentrations would be lower. The only parameter likely to result in periodic exceedances of the state standard is stream temperature. In addition, dissolved oxygen concentrations may be lower than the state numeric standard for a short reach above the Williams Fork confluence.

Predicted lower dissolved oxygen concentrations in the Three Lakes may continue to result in manganese concentrations that would exceed the numeric standard. Dissolved oxygen concentrations in Granby Reservoir would remain below the spawning standard. In general, nutrient concentrations would increase in the Three Lakes; however, Alternatives 3, 4, and 5 with new West Slope storage reservoirs would reduce nutrient concentrations. Clarity in Grand Lake would decrease slightly (0.1 meter) under all alternatives except Alternative 5.

Additional WWTP return flows could increase the potential for exceedance of the ammonia standard in Big Dry Creek and Coal Creek. Lower dissolved oxygen concentrations in Horsetooth Reservoir could increase the potential for additional exceedances of the manganese water supply standard. Nutrient concentrations would increase slightly in Carter Lake and Horsetooth Reservoir.

3.9 Aquatic Resources

3.9.1 Affected Environment

3.9.1.1 Regulatory Framework

Fish are protected by a variety of laws and regulations including the Endangered Species Act (ESA) and Fish and Wildlife Coordination Act.

Federally listed threatened and endangered fish species protected under the ESA are discussed in Section 3.13.

The Fish and Wildlife Coordination Act (16 U.S.C. §§ 661-667e) allows for coordination between the federal action agency and the FWS and CDOW. The goal of consultation under the Coordination Act is conservation of wildlife by preventing loss of, and damage to, wildlife resources and providing for the development and improvement of these resources in connection with water resource development.

CDOW has the authority to manage and conserve wildlife resources within the state for hunted, fished, and nongame wildlife. CDOW enforces various fishing regulations, including regulations concerning the illegal take or use of threatened or endangered species.

Executive Order (EO) 12962 relates to recreational fisheries. The intent of this EO is to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide.

3.9.1.2 Area of Potential Effect

The area of potential effect for assessing impacts to aquatic resources encompasses the various West and East Slope streams and reservoirs that would experience hydrologic or water quality changes as a result of the alternative actions. On the West Slope this is the Colorado River from Granby Reservoir to below the confluence with the Blue River and Willow Creek below Willow Creek Reservoir. Three Lakes Reservoirs also are in the study area, as well as potential new reservoir sites at Jasper East and Rockwell. Study area streams on the East Slope are North St. Vrain Creek below Ralph Price Reservoir, St. Vrain Creek, Big Thompson River, Big Dry Creek, and Coal Creek. East Slope reservoirs in the study area are Carter Lake, Horsetooth Reservoir, and Ralph Price Reservoir, as well as potential new reservoirs at Chimney Hollow and Dry Creek.

3.9.1.3 Data Sources

Information on fish and macroinvertebrates in the study area was collected from existing data sources and field studies. Fish population and fish community data were compiled from CDOW surveys and stocking records, and historical data collected from other sources. Fish habitat analysis on the Colorado River was based on the River2D instream flow model using data gathered on channel topography, water surface elevation, velocity profile, and fish for two sites on the Colorado River above and below the Williams Fork River confluence. Macroinvertebrate sampling was conducted on the Colorado River as part of the analysis for the EIS. Additional information on aquatic resources is found in the Aquatic Resources Technical Report (Miller 2008).

3.9.1.4 West Slope Rivers, Streams, and Reservoirs

Colorado River

The Colorado River between Windy Gap Reservoir and Kremmling, Colorado is managed by CDOW as a sport fishery for brown trout and rainbow trout. Special regulations include a two-fish bag and possession limit from Granby Dam downstream to the lower boundary of Byers Canyon, and from the Troublesome Creek confluence downstream to Rifle, Colorado. The section between the lower boundary of Byers Canyon and the Troublesome Creek confluence is a catch and release Gold Medal designated fishing with artificial flies and lures only. A fish survey in the Colorado River from Windy Gap Reservoir downstream to Kremmling indicated that brown trout and rainbow trout, both introduced species, were two of the dominant fish species at each sampling location (CDOW 2002 unpublished data). Brown trout populations (>6 inches in length) in the Colorado River between Parshall and Sunset from 2001 to 2007 ranged from about 4,100 fish per mile to over 11,000 fish per mile (Ewert 2008). Two nonnative sucker species, the white sucker and longnose sucker, also were consistently reported throughout this reach. One nonnative minnow, the longnose dace, was found throughout the reach, while other small fish occasionally collected included the Johnny darter, creek chub, and mottled sculpin. Prior to European settlement, Colorado River cutthroat trout was the only native trout species in the Colorado River. The existing habitat conditions are generally favorable for all the fish species collected. The trout populations are very high and comparable to the best fisheries in the western United States.

Quantitative macroinvertebrate (aquatic insects) sampling was conducted at two sites (Lone Buck and Breeze) on the Colorado River (Figure 3-57) to characterize the composition and health of the benthic community. Ecological parameters such as diversity, evenness, biotic indices, taxa richness, biomass, and functional feeding groups were used to evaluate the existing condition of macroinvertebrate populations. Results of these evaluations indicated that aquatic conditions were excellent at both study areas, with the best metric values occurring at the Breeze site. More than 40 identifiable taxa were collected at each site with more than half of the taxa represented by species that are sensitive to disturbance (Plafkin et al. 1989). Sampling data indicated high biomass values at both sites, with the highest at the Lone Buck site. The Breeze site had the highest density values. Collector-gather functional feeding groups were most common at both sites, as is typical of most western streams; however, other groups also were well represented at each location.

Willow Creek

Fish population data were available for three locations on Willow Creek between Willow Creek Reservoir and the Colorado River (Miller 1997). Fish abundance was typical of small streams. Brown trout was the dominant species at all three locations with a relative abundance ranging from 63 to 97 percent. All life stages of brown trout were present and population estimates ranged from about 1,650 fish per acre to 2,670 fish per acre. The habitat conditions in Willow Creek support a reproducing brown trout population. Also present were longnose sucker, white sucker, Piute sculpin, and very few rainbow trout.

Macroinvertebrate sampling on Willow Creek was conducted at the same sites and time as fish collection (Miller 1997). Index values used to assess aquatic health indicated some stress to the macroinvertebrate communities; however, the high number of individuals and taxa collected, and the presence of several pollution intolerant species suggests that pollution was not the cause of stress. It is likely that the effects of the Willow Creek Reservoir dam (i.e., less temperature fluctuation and rapid changes in discharge), or local land use created the disturbance necessary to have a slight negative effect on the index values. Typically, streams below dams support larger, but less diverse, macroinvertebrate communities.

Rockwell/Muller Creeks and Unnamed Drainage at Jasper East Reservoir Site

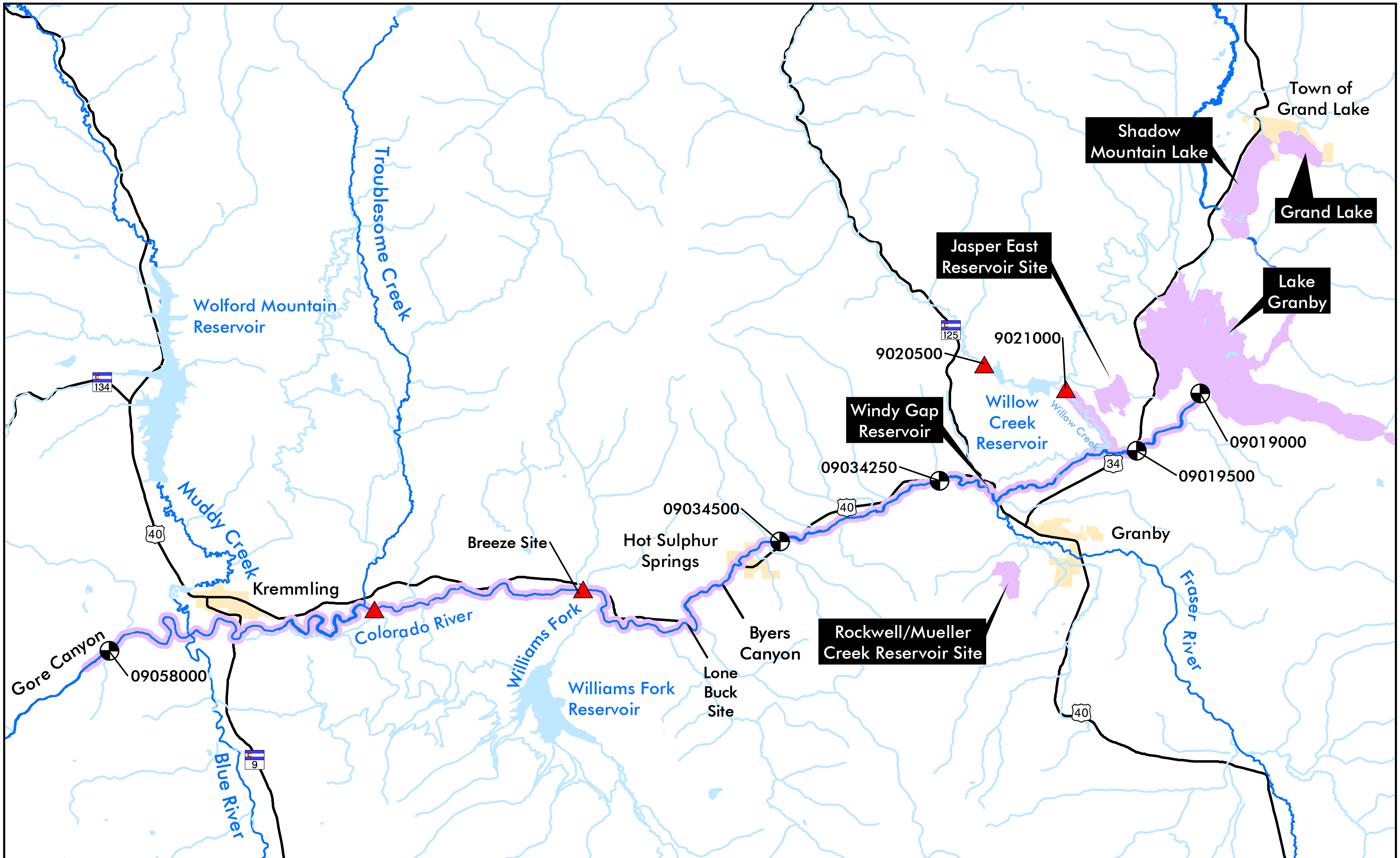
CDOW does not have fish data for Rockwell and Mueller creeks or the unnamed drainage at the Jasper East Reservoir site. No fish were observed in the unnamed Jasper East drainage during a site visit. Short lived invertebrates, typical of intermittent streams were observed, but intermittent flows are unlikely to support a fishery. Access to Rockwell and Mueller Creeks was not available to access fish presence, but conditions are likely similar to the drainage at Jasper East.

Grand Lake

Grand Lake provides recreational fishing for rainbow trout, brown trout, kokanee, and lake trout. Natural reproduction of lake trout is self-sustaining at a level to support a reasonable fishery. Lake trout were stocked on two occasions in the 1990s and additionally in 2004 and 2007 to investigate growth rates. No extensive stocking of lake trout is anticipated in the foreseeable future (Velarde, pers. comm. 2008). Populations of brown trout are at least partially maintained by natural reproduction in streams feeding into the lake. Other game fish populations are augmented through a stocking program conducted by CDOW. Rainbow trout and kokanee are stocked annually, while lake trout are stocked semiannually. In a July 2001 survey, rainbow trout and kokanee were not collected, but brown trout and lake trout were well represented (CDOW 2001 unpublished). The only other species present in collections was the longnose sucker.

Shadow Mountain Reservoir

Shadow Mountain Reservoir is managed by the CDOW as a recreational fishery that provides angling opportunities for rainbow trout, brown trout, cutthroat trout, kokanee, and lake trout. Natural reproduction for game fish is inadequate to support the existing level of angling recreation; therefore, populations are augmented through a stocking program. Rainbow trout, brown trout, and kokanee are stocked annually, and cutthroat trout are stocked occasionally. Nonnative sucker species present are the longnose sucker and white sucker (CDOW 2001 unpublished). The white sucker was the dominant



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

USGS Gaging Station
NCWCD Gaging Station
Lake or Reservoir
Study Area Reservoir
City
Highway
Major Streams
Minor Streams
Study Area Stream

0 2 4 Miles
1 Inch = 4 Miles
N

Figure 3-57
West Slope Aquatic Resource Study Area

Prepared for: Windy Gap Firming Project
File: 2390 WestSlopeAquatics.mxd (JP)
January 2008

fish species collected in July 2001 (CDOW 2001 unpublished data).

Granby Reservoir

Granby Reservoir is a recreational fishery that provides angling opportunities for lake trout, kokanee, rainbow trout, and brown trout. Fish populations are maintained through natural reproduction and a strategic stocking program that provides angling opportunities while supporting a balanced fish community. Lake trout and brown trout are maintained through natural reproduction. Rainbow trout are capable of limited natural reproduction, but populations are augmented through frequent stocking. Kokanee exhibit little or no natural reproduction; therefore, populations are dependent on stocking. However, Granby Reservoir is a critical source for kokanee eggs used in the hatchery program for kokanee stocking. An unpublished CDOW fish survey (2004) indicated that nonnative, nongame fish (longnose sucker and white sucker) were the most abundant, representing more than 85 percent of the total (CDOW 2004 unpublished data).

Balance between lake trout populations and kokanee is dependent on the water surface elevation of Granby Reservoir. During periods of low reservoir levels, the two species are thermally separated because the kokanee are more tolerant of warmer surface water than lake trout. Young lake trout survival is lower at low reservoir levels, which ultimately results in fewer lake trout, but a better balance between fish populations. During periods of high reservoir elevations, survival of young lake trout is greater than survival at low reservoir levels and less thermal separation occurs between lake trout and kokanee. The conditions that exist during high water elevations result in an overabundance of lake trout, with greater accessibility to and predation on kokanee. This, in turn, results in fewer kokanee, which eventually has negative effects on lake trout numbers because there is not a sufficient prey base to support the lake trout. Through stocking management, and specific angling regulations, CDOW strives to keep an appropriate balance between the predatory lake trout and the kokanee upon which lake trout prey.

Windy Gap Reservoir

Windy Gap Reservoir is a private reservoir that is not stocked or managed by CDOW; however, fish stocked in the Fraser or Colorado rivers upstream of Windy Gap are expected to be found in the reservoir. A 2004 CDOW fish survey at Windy Gap Reservoir indicated the presence of rainbow trout, brown trout, kokanee, longnose sucker, and white sucker. The white sucker was the dominant species comprising more than 85 percent of the captured fish (CDOW 2004 unpublished).

Whirling disease (WD), which has been shown to decrease the survival of juvenile trout, is found in most West and East Slope streams, including Windy Gap Reservoir. WD is caused by a parasite (*Myxobolus cerebralis*) with a complex life cycle that requires two aquatic host organisms (Nehring 2004). The earliest detection of *M. cerebralis* in the upper Colorado River basin occurred in 1988. Since that time, recruitment of wild rainbow trout has severely declined (Nehring et al. 2000). The two host organisms required for completion of the *M. cerebralis* life cycle are aquatic tubificid worm (*Tubifex tubifex*) and a salmonid fish (trout). Spores released by one species of host organism infect the other host organism. The spore of *M. cerebralis* that is produced and released from *T. tubifex* worms is referred to as a triactinomyxon or TAM.

CDOW identified Windy Gap Reservoir as some of the most suitable habitat (low-velocity water and silt or mud substrate) for *T. tubifex*, especially those lineages that are most susceptible to infection by *M. cerebralis* (Beauchamp et al. 2002). Therefore, Windy Gap Reservoir has historically been considered a major source for TAM production in this drainage (Nehring and Thompson 2003). However, CDOW sampling in Windy Gap Reservoir in 2004 and 2005 indicated a dramatic decrease in the worm population structure in the lake in the last 5 to 6 years (Nehring, pers. comm. 2006). TAM production in Windy Gap Reservoir is now similar to that produced in the Fraser and Colorado rivers above the lake. Windy Gap is no longer considered a major source of TAM in the upper Colorado River.

3.9.1.5 East Slope Rivers, Streams, and Reservoirs

Big Thompson River, North St. Vrain Creek, St. Vrain Creek, Big Dry Creek, and Coal Creek

East Slope streams in the study area contain both game and nongame species. Fish abundance varies by location, with cool water game species such as brown trout and rainbow trout found closer to the foothills. Warm water game and nongame species found farther east include smallmouth bass, walleye, black crappie, common carp, and a variety of minnow-type species.

Several of the warm water nongame species are state species of concern. These species are Iowa darter, plains topminnow, common shiner, brassy minnow, northern red-belly dace, stonecat, and Johnny darter. Although their presence varies by location, all of these species are present in the Big Thompson and St. Vrain drainages, Big Dry Creek, and Coal Creek.

Carter Lake and Horsetooth Reservoir

Carter Lake and Horsetooth Reservoir are managed by CDOW for recreational fishing. Fish species present include walleye, smallmouth bass, wiper, and trout species. Salmonid populations within both lakes are managed by stocking. Warmwater species, such as smallmouth bass populations are maintained by natural reproduction.

Ralph Price Reservoir

Ralph Price Reservoir is managed for fishing by CDOW and is stocked with trout. Access is limited to walk-in recreation use with no fishing from a boat allowed.

Chimney Hollow and Dry Creek

Chimney Hollow is an intermittent stream that is often dry and does not support a fishery. Dry Creek is an intermittent drainage that is dry in the upper reaches, but the lower reach supports fathead minnows and invertebrates common to intermittent streams.

3.9.2 Environmental Effects

3.9.2.1 Issues

Key aquatic resource concerns identified during scoping were potential impacts to fish and other aquatic life from changes in streamflow, water quality, and temperature in the Colorado River and lakes and reservoirs. Also of concern was the potential for the spread or increase of WD.

3.9.2.2 Method for Effects Analysis

The assessment of effects to fish habitat along the Colorado River and Willow Creek was conducted using the River2D Model. Fish habitat in Willow Creek was assessed using Physical Habitat Simulation (PHABSIM). Data from a previous study (Miller 1997) was used to develop the habitat flow relationships. This approach follows the concepts of the Instream Flow Incremental Methodology (IFIM) (Bovee 1982, Bovee et al. 1998). IFIM is an analysis framework that combines stream hydraulics, habitat use criteria, and hydrology to predict fish habitat as a function of streamflow. Existing unpublished CDOW habitat suitability data was used for the target fish species. The analysis focused on juvenile and adult life stages of rainbow trout and brown trout in consultation with CDOW during selection of the study areas. The two selected study areas are below the Windy Gap Reservoir diversion at Lone Buck, a State Wildlife Area upstream of the Williams Fork River (Figure 3-58), and at the Breeze State Wildlife Area downstream of the Williams Fork River (Figure 3-59). These areas are representative of the Colorado River from Windy Gap to the Blue River.

Fish community and fish populations were assessed qualitatively based on changes in physical habitat, as well as projected water quality changes within those systems. The change was compared to the existing conditions in rivers and reservoirs to determine if there would be factors that affect fish populations at the acute or chronic level. Other factors such as fishing pressure, management and stocking can change fish populations and community structure more than physical habitat. Specific long term field data for species occurrence by habitat type and population data by species and size are required to develop cause and affect relationships between habitat change and population levels. There are basic assumptions in IFM regarding population response to habitat. In general, more habitat is assumed to result in larger populations, but the relationship may not be linear. Since detailed population data was not available (and is not available for most rivers), the qualitative approach was used for this analysis.

Figure 3-58. Lone Buck aquatic study area.

Figure 3-59. Breeze aquatic study area.

Hydrologic conditions at seven locations from Windy Gap downstream to the Kremmling Gage (downstream of the Blue River) were combined with the habitat data to determine changes in fish habitat for the alternative actions (Figure 3-57). Daily flows for average, dry, and wet year flow conditions were modeled under the various WGFP alternatives. Because of the similarity in Colorado River diversions among the action alternatives, the effects to fish habitat are likewise similar and, therefore, the discussion of alternative effects is consolidated. Water diversions under the No Action alternative would be less than the action alternatives; thus impacts to fish habitat under No Action typically would be less than for other alternatives as noted in the analysis.

Water quality changes, as discussed in Section 3.8, also were used to evaluate effects to aquatic life. DO and water temperature were the principal stream water quality parameters used to evaluate effects to fish habitat and populations. For reservoirs, the trophic state, DO, water temperature, and changes in reservoir depth and area were used to determine potential effects to fish.

Effects to fish habitat in East Slope reservoirs and streams were based on hydrologic and water quality changes and the likely potential for a change in habitat.

Macroinvertebrates were evaluated using the results of the baseline data collection and inferences made based on changes in streamflow and water quality. The time between low water and high water and flow changes during the summer were used as a qualitative indicator of effects to macroinvertebrate health.

3.9.2.3 West Slope Effects

Colorado River

The results of fish habitat modeling for the Colorado River provided information on the changes in fish habitat and the frequency at which those changes would occur. Examples of the habitat area versus discharge relationship for juvenile and adult rainbow and brown trout at the Breeze study area is shown in Figure 3-60 and Figure 3-61. As these figures indicate, habitat availability for adult rainbow and brown trout peaks at streamflow of about 500 cfs. Habitat for juvenile rainbow and brown trout is best at about 400 to 500 cfs. Typically, a reduction in streamflow reduces available fish habitat; however, during periods of high flow, such as spring runoff, a reduction in flow can increase available fish habitat. This occurs occasionally under all alternatives from Windy Gap diversions during peak flows.

Figure 3-60. Habitat area versus discharge – Breeze site for rainbow trout.

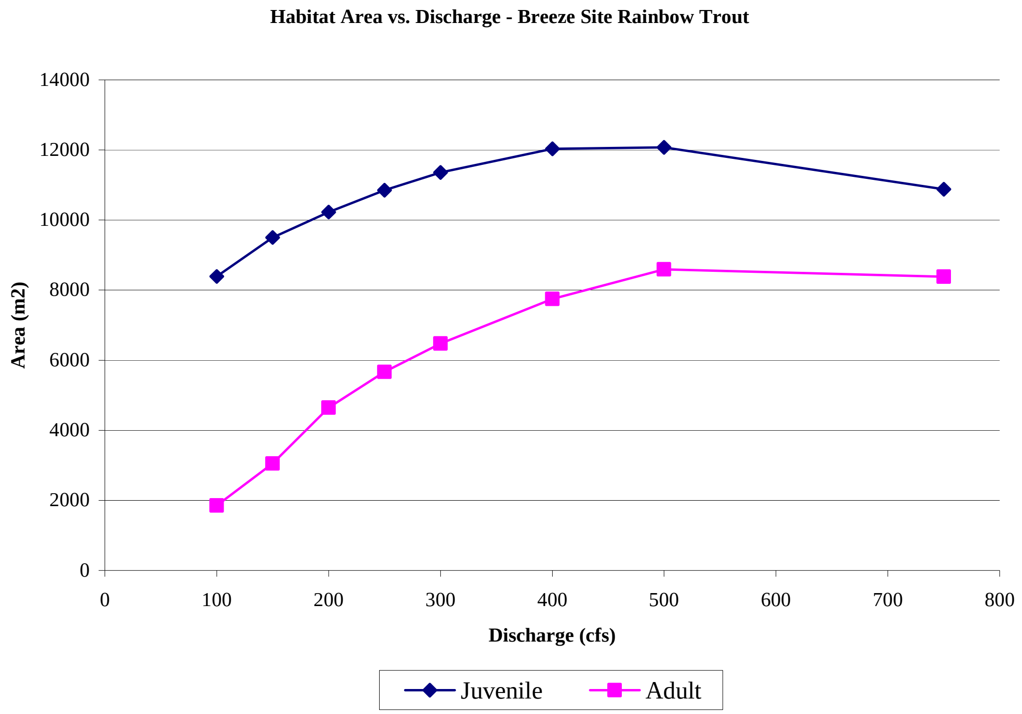


Figure 3-61. Habitat area versus discharge – Breeze site for brown trout.

Habitat model output generates information on the amount of habitat available over time. Figure 3-62 shows the changes in habitat for adult rainbow trout on the Colorado River below Windy Gap Reservoir during average flow conditions. On this graph, the left axis indicates the percent change in habitat from existing conditions, where the 0 line is existing conditions. Values below the 0 line indicate a decrease in habitat and values above the 0 line indicate an increase in habitat. The bottom axis indicates the percent of time that habitat changes. Thus, in Figure 3-62, about 20 percent of the time (bottom axis), habitat (left axis) under the No Action alternative decreases about 10 percent from existing conditions. For the action alternatives, about 20 percent of the time, habitat decreases about 20 percent from existing conditions. About 50 percent of the time, there is little difference between the alternatives and existing conditions at this location for this species. A similar example farther downstream for rainbow trout on the Colorado River above the confluence with the Blue River is shown in Figure 3-63. At this location, adult rainbow trout habitat decreases about 10 percent around 10 percent of the time, with small differences between the alternatives.

Results of the habitat modeling for locations on the Colorado River and Willow Creek for average years are summarized in Table 3-90. This data indicates the maximum change in habitat and the frequency of change. The results are representative of all action alternatives and indicate both the maximum change from existing conditions and the maximum change when compared to the No Action alternative. During times when there is a decrease in habitat, the frequency of decrease ranges from 1 year in 20 years to approximately 4 out of 10 years. The greatest decrease in existing habitat would occur from Windy Gap Reservoir downstream to the Williams Forks, where adult rainbow trout habitat would decrease up to 24 percent in 4 out of 10 years for the action alternatives. Below the Williams Fork, maximum decreases in habitat would be less and would occur less frequently. Maximum decreases in juvenile rainbow trout habitat would be less than 15 percent for less than 1 out of 10 years. A maximum decrease in adult brown trout habitat of 19 percent occurs above the Williams Fork confluence in 2 out of 10 years.

Under the No Action alternative for average conditions, adult rainbow trout habitat would decrease up to 9 percent in 3 out of 10 years above the Williams Fork. Juvenile rainbow trout habitat would decrease up to 3 percent in 1 out of 10 years. Juvenile brown trout habitat would decrease up to 9 percent in 1 out of 10 years above the Blue River. Adult brown trout habitat in Willow Creek would decrease up to 9 percent in 2 out of 10 years and juvenile trout up to 6 percent in 2 out of 10 years.

A summary of habitat modeling output under wet year hydrologic conditions is shown in Table 3-91. The Colorado River below Windy Gap and above the Williams Fork confluence showed the greatest maximum decreases (20 to 30 percent) in fish habitat availability for both juvenile and adult rainbow and brown trout during wet year flow conditions. These decreases would occur from 1 out of 20 to 3 out of 10 wet years for all alternatives. However, because high runoff wet years only occur about 10 percent of the time, the actual long-term recurrence interval for these effects would be less than 3 percent of the time. Trout habitat availability during dry year flow conditions would not change from existing conditions for any alternative because Windy Gap diversions would not change from existing conditions.

Overall, the modeled changes in fish habitat in the Colorado River for all alternatives indicate the greatest changes in habitat would occur between Windy Gap Reservoir and the confluence with the Williams Fork River in both average and wet years. For most of the Colorado River the reduction in habitat would occur in 2 years out of 10 or less. For the Colorado River above the Williams Fork, the habitat would be reduced in 4 out of 10 and 3 out of 10 years in average and wet years, respectively.

The greatest reductions in fish habitat occur during the period of higher runoff for a few months in the early spring and summer when Windy Gap diversions occur. The remainder of the year, flow is lower and available habitat is lower. The lower habitat that exists for most of the year is a more controlling factor that influences the size of the fish population than the short duration that more abundant habitat is present in spring runoff. Therefore, even though the percent reduction in habitat is large from Windy Gap diversions in the

Figure 3-62. Below Windy Gap – percent change in habitat over time from existing conditions under average streamflow for adult rainbow trout.

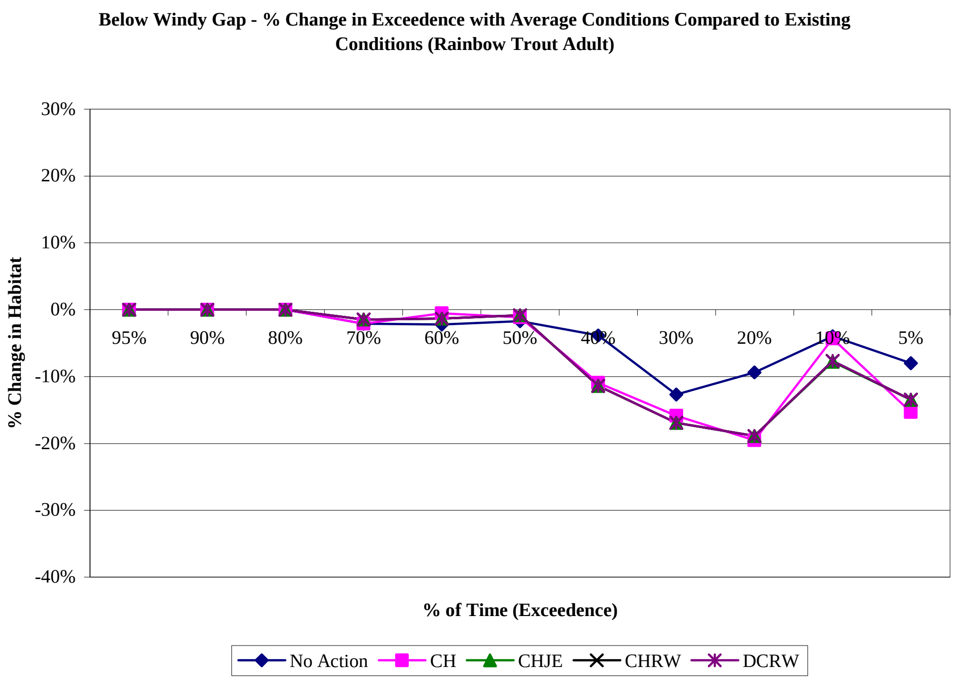


Figure 3-63. Above Blue River – percent change in habitat over time from existing conditions under average streamflow for adult rainbow trout.

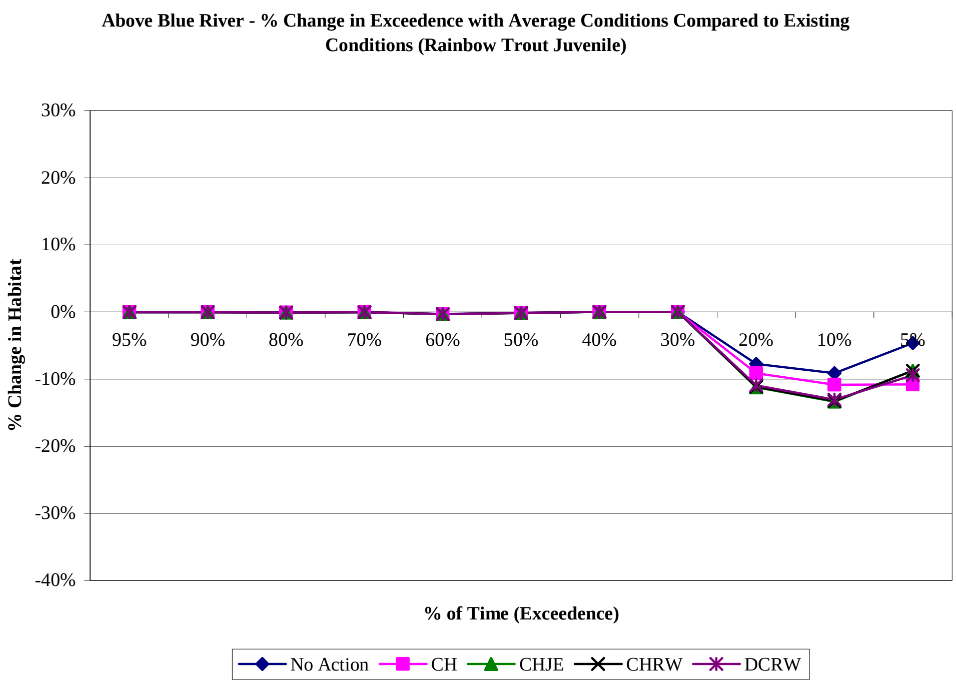


Table 3-90. Summary of fish habitat changes in the Colorado River and Willow Creek in average water years for rainbow and brown trout.

Location	Rainbow Trout								Brown Trout							
	Juvenile				Adult				Juvenile				Adult			
	Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
Below Windy Gap	-6	2/10	-5	2/10	-19	2/10	-10	2/10	-8	0.5/10	-3	0.5/10	-6	2/10	-1	2/10
Hot Sulphur Springs	-6	2/10	-5	2/10	-18	2/10	-10	2/10	-7	0.5/10	-2	0.5/10	-4	2/10	-1	2/10
Above Williams Fork	-7	2/10	-5	2/10	-24	4/10	-18	4/10	-19	0.5/10	-11	0.5/10	-19	2/10	-11	2/10
Below Williams Fork	-15	1/10	-9	1/10	-15	0.5/10	-8	0.5/10	-15	0.5/10	-8	0.5/10	-15	0.5/10	-8	0.5/10
Above Troublesome	-15	0.5/10	-9	0.5/10	-15	0.5/10	-9	0.5/10	-15	0.5/10	-9	0.5/10	-15	0.5/10	-9	0.5/10
Above Blue River	-13	1/10	-4	1/10	-13	1/10	-4	1/10	-13	1/10	-4	1/10	-13	1/10	-4	1/10
Below Blue River	-4	1/10	-4	0.5/10	-6	1/10	-4	0.5/10	-7	0.5/10	-4	0.5/10	-7	0.5/10	-4	0.5/10
Willow Creek	-9	2/10	-5	2/10	-19	2/10	-11	2/10	-13	2/10	-7	2/10	-21	2/10	-12	2/10

Table 3-91. Summary of fish habitat changes in the Colorado River and Willow Creek in wet water years for rainbow and brown trout.

Location	Rainbow Trout								Brown Trout							
	Juvenile				Adult				Juvenile				Adult			
	Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
Below Windy Gap	-24	1/10	-24	1/10	-30	3/10	-30	3/10	-28	0.5/10	-28	0.5/10	-32	2/10	-32	2/10
Hot Sulphur Springs	-24	1/10	-3	1/10	-24	1/10	-3	1/10	-24	1/10	-3	1/10	-24	1/10	-3	1/10
Above Williams Fork	-25	1/10	-3	1/10	-30	3/10	-11	3/10	-29	1/10	-4	1/10	-25	1/10	-4	1/10
Below Williams Fork	-9	1/10	-6	1/10	-11	2/10	-9	2/10	-10	2/10	-8	2/10	-10	2/10	-8	2/10
Above Troublesome	-13	2/10	-11	2/10	-14	2/10	-12	2/10	-13	2/10	-11	2/10	-13	2/10	-11	2/10
Above Blue River	-9	2/10	-8	2/10	-9	2/10	-8	2/10	-9	2/10	-8	2/10	-9	2/10	-8	2/10
Below Blue River	-10	1/10	-6	2/10	-10	1/10	-6	2/10	-10	1/10	-6	2/10	-10	1/10	-6	2/10
Willow Creek	-6	3/10	0	-	-16	3/10	-16	3/10	-12	.5/10	0	-	-13	2/10	-10	2/10

spring, diversions occur when flow/habitat is greater than during the majority of the year. These decreases in fish habitat would affect both trout species at the adult and juvenile life stages. Because fish habitat can be lower at high flows, diversions that reduce high flow can result in increased available habitat during runoff. Habitat time series output indicates Windy Gap diversions from the Colorado River, primarily in wet years, would result in an increase in habitat at times. At the Below Windy Gap site, there would be up to a 10 percent increase in available fish habitat 90 percent of the time in wet years.

Trout in the study area have a maximum age of approximately 6 or 7 years; therefore, impacts to trout habitat that occur often during their life span (i.e., 4 out of 10 years) may affect populations. Impacts to trout habitat that occur less frequently (i.e., 2 out of 10 years or less) are less likely to affect populations. Trout populations would have multiple years of spawning and recruitment between the less frequent events, which is the reason these events would have less effect on the populations. The predicted maximum periodic decreases in fish habitat are unlikely to substantially impact fish populations at most locations. The more frequent habitat reductions above the Williams Fork confluence could result in a slight decrease in rainbow trout population. Reductions in brown trout habitat and the frequency of those changes are unlikely to impact current populations.

In general, CDOW research on Colorado rivers (Nehring and Anderson 1993) has demonstrated the greatest impact to trout populations occurs during high flows when small juvenile fish are present (especially during wet hydrologic years). The previous research demonstrated that the strongest year classes for juvenile fish were present when peak flows were lower than normal. This response to lower peak flows had a positive influence on the year classes in subsequent years. The WGFP would reduce Colorado River peak flows, which could be beneficial to fish, particularly in wet years.

Fall spawning brown trout would not be affected by Windy Gap diversions. Rainbow trout spawning occurs from mid-April through May, with hatching in June and July. Rainbow fry emerge from the gravel in July into the first of August (Nehring and Anderson 1993). With rainbow trout spawning occurring on the lower portion of the ascending limb of the hydrograph, the redds would be covered by water through egg hatch and emergence. Since the eggs and fry would not be dewatered, an impact to these life stages is not likely for any of the alternatives.

Peak flows are an important component for creating and maintaining stream habitat for aquatic life. Biological component of riverine systems include instream biota such as primary and secondary producers (e.g. algae, periphyton, benthic invertebrates) and consumers (e.g. invertebrates, fish). Aquatic biota has evolved to survive within the range of flows that occur under natural conditions. For example, benthic invertebrates with annual life cycles are in life stages that avoid high flows impacts. These include adult free flying life stages and egg life stages. Fish species also have evolved to minimize impacts from detrimental flows. Timing of spawning, hatching and emergence for salmonids is timed to maximize success under natural flow regimes. The natural flow regimes create habitat that can be used by juvenile and adult fish to avoid detrimental effects of high flows and refuge habitat during low flows.

Overall stream productivity on average in natural systems is determined by the baseflow conditions that provide for primary and secondary productivity and feeding as well as refuge habitats. Peak flows temper those populations and can influence the year class strength of salmonids if very high discharges occur when the young fish are susceptible to the peak flows. In general, the peak flow time period is the lowest amount of optimal habitat for fish species but that peak flow provides the work in the channel that shapes, creates and maintains habitat for the majority of the year for those species.

The hydrology data for the action alternatives for the Colorado River shows little change in peak flow magnitude and recurrence intervals (ERO and Boyle 2007). These small changes in peak flow characteristics are not expected to result in substantial changes to the existing habitats that are created and maintained by the existing flow regime. Therefore, the current channel type, and habitat characteristics are expected to be maintained with all alternatives.

Table 3-92. Summary of stream water quality changes relevant to potential fish impacts.

Location	Greatest Change in Dissolved Oxygen (mg/L) from Existing Conditions for all Alternatives	Greatest Change in Water Temperature (°C) from Existing Conditions for all Alternatives
Colorado River in the study reach	-0.1 to -0.6	0.8 to 4.0
Willow Creek	No change	-0.2
St. Vrain Creek	No change	No change
North St. Vrain Creek	Decrease less than 0.5	No change
Big Thompson	No change	No change

Source: ERO and AMEC 2008a.

Table 3-93. Thermal tolerance of rainbow trout, brown trout, and longnose dace.

Species	TEMPERATURE (C)																															Authors
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Rainbow Trout																																
Egg																																DeCola 1970, Danie et al 1984,
Larval												O	O	O,F	O	O	O	O	O							C						Houston 1982
Juvenile															O	O	O	O	O								C					Brown 1974,
Adult																													C			Lee and Rinne 1980
Brown Trout																																
Egg																																Brown 1974, Cherry et al 1977,
Larval																							C									Coutant 1977a, Spotila et al 1979,
Juvenile												O	O																	C		Lee and Rinne 1980, Jobling 1981,
Adult												O	O	O	O	O	O	O	O											C		Raleigh et al 1986, Carline 2001
Longnose Dace																																
Egg														O	O																	Spotila et al 1979, Brazo et al 1978
Larval																																Edwards et al. 1983
Juvenile																															C	
Adult																				O	O										C	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

KEY:

Suitable Range	O Optimum	C Critical Maximum Temperature	F Preferred Temperature

Results of water quality modeling also were used to evaluate potential effects to aquatic life. Modeling of water quality parameters for the Colorado River predicted a slight decrease of 0.1 mg/L in DO and a slight increase in water temperature of less than 1°C (Table 3-92) for all alternatives based on average July 25 flows[2]. Changes in stream temperature and DO levels would be less during May and June when the majority of Windy Gap diversions would occur because the water temperature in spring runoff and the air temperature is cooler than mid-summer.

Additional analysis of potential changes in temperature and DO was conducted for times when Windy Gap diversions for July 25 reduce Colorado River flows below Windy Gap to the minimum flow of about 90 cfs. Under these conditions, the Colorado River showed an increase in water temperature up to 4°C. This results in an estimated water temperature of about 19°C just upstream of the Williams Fork, which is within the historical range of water temperatures for that reach. The temperature of about 19°C is well below lethal and chronic levels for rainbow, cutthroat, and especially brown trout (Table 3-93). Lower flows could increase the potential for exceeding the weekly maximum average temperature standard for aquatic life, but increased temperatures are unlikely to measurably impact fish populations. This conclusion is based on the observed water temperatures, which occasionally exceed 19°C under current conditions, and the healthy fish population that exist in this reach of the river, as well as

[2] July 25 was used for modeling water quality impacts, as discussed in Section 3.8, and is representative of low flow conditions when temperatures are high and WGFP diversions could occur in some years.

infrequent diversions to the minimum streamflow when air temperature is high. DO levels could decrease up to 0.6 mg/L during diversions to minimum streamflow. DO levels in the Colorado River under all modeled conditions would be well above the 5.0 mg/L required for lethal effects to trout and would not impact trout in this section of the river.

Willow Creek

The changes to Willow Creek habitat would be similar to those modeled for the Colorado River, with most decreases in habitat expected to be less than 15 percent (Table 3-90 and Table 3-91). The greatest change in habitat for adult brown trout during an average water year would be a 21 percent reduction in habitat 2 out of 10 years. The frequency of maximum habitat changes would be 3 out of 10 years or less and the majority would occur 2 out of 10 years. Changes of this magnitude are unlikely to be measurable at the population level for fish in Willow Creek. In addition to physical habitat, the estimated change in water quality shows that there would be a slight decrease in water temperature, which may benefit the fishery, although this water temperature would not be measurable at the population level. Overall, the fish community in Willow Creek is not expected to change with any alternative.

Macroinvertebrates

Habitat needs of the macroinvertebrates present in the Colorado River and Willow Creek are similar to those of the trout species. The species, abundance, and distribution of macroinvertebrates should remain similar to existing conditions under all alternatives based on the anticipated changes in flow and minor changes in water quality.

Grand Lake, Shadow Mountain Reservoir, Granby Reservoir, and Willow Creek Reservoir

There would be no change in reservoir elevation in Grand Lake, Shadow Mountain Reservoir, or Willow Creek Reservoir under any alternative; thus there would be no effect to available fish habitat. Predicted decreases in Granby Reservoir water levels of up to 10 feet in wet years are not expected to change the dynamics of the fish population. Sequential dry years that result in substantially lower reservoir elevations would reduce available fish habitat and could affect the dynamic balance between lake trout and kokanee. The Proposed Action has the greatest potential for drawdown in consecutive dry years at Granby Reservoir.

Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir would remain mesotrophic under all alternatives; thus, lake productivity would not change. The minimum DO concentrations in the hypolimnion for Grand Lake would decrease up to 0.6 mg/L for the No Action alternative and less under the action alternatives. Granby Reservoir and Shadow Mountain minimum DO levels would decrease less than 0.2 mg/L for all alternatives. None of the alternatives would affect Three Lakes surface temperature. Because the trophic state is expected to remain the same, the DO levels would remain within the range observed under existing conditions, and temperature changes would be minor, no change in fish population dynamics are expected from changes in the physical environment at the Three Lakes for any alternative.

Windy Gap Reservoir

None of the alternatives are expected to increase the development conditions for the spread of WD in Windy Gap Reservoir or elsewhere in the Colorado River, Three Lakes, or East Slope streams and reservoirs.

Jasper East Reservoir and Rockwell Reservoir

Jasper East and Rockwell reservoirs are predicted to be oligotrophic-mesotrophic (low to medium productivity). These reservoirs are likely to support a fishery with appropriate management, although the large fluctuations in reservoir storage may reduce productivity.

3.9.2.4 East Slope Effects

Big Thompson River, North St. Vrain Creek, St. Vrain Creek, Big Dry Creek, and Coal Creek

All alternatives would result in an increase (1 to 9 percent) in Big Thompson River flows below Lake Estes from April to October from additional Windy Gap deliveries. These slight flow changes could increase fish habitat, but are unlikely to measurably affect fish populations. Increased return flow below the Participant's WWTPs on the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek, which occurs year-round, could slightly enhance fish habitat in these streams under all alternatives.

The No Action alternative would result in both increases and decreases in flows at North St. Vrain Creek below Ralph Price Reservoir and St. Vrain Creek to Lyons. A slight reduction in fish habitat would occur with lower May and July flows; however, increased flows in the fall and winter when flows are typically lowest would benefit fish habitat.

Overall, the small changes in streamflow and water quality parameters are not expected to impact the current fish or macroinvertebrate populations in East Slope streams.

Carter Lake and Horsetooth Reservoir

Estimated lower average water levels in Carter Lake and Horsetooth Reservoir, under the action alternatives, would slightly reduce available fish habitat; however, these changes would not measurably impact fish survival, reproduction, or fishing success. Under all alternatives, there would be no change in the trophic state or other water quality parameters that would adversely impact fish of Carter Lake or Horsetooth Reservoir. Therefore, the habitat in these reservoirs would continue to support fish under current management by CDOW.

Ralph Price Reservoir

The enlargement of the dam at Ralph Price Reservoir under the No Action alternative may require a substantial drawdown of the reservoir, which could adversely impact existing fish populations. Following construction, the fishery would be restored and maintained with conditions similar to the current reservoir. Water quality is predicted to be oligotrophic, which means productivity would be relatively low and growth for fish stocked in the lake may be slow, as is currently the case.

Chimney Hollow and Dry Creek Reservoirs

There would be no adverse impact to aquatic habitat in Chimney Hollow because this intermittent stream is often dry and does not support a fishery. Dam construction and inundation of Dry Creek at Dry Creek Reservoir under Alternative 5 would impact intermittent aquatic habitat that supports minnows and aquatic invertebrates.

Chimney Hollow and Dry Creek reservoirs would require development of a fisheries management plan. The fishery would then be established based on reservoir characteristics and expected outcomes for anglers. It is likely these reservoirs would support a fishery similar to other Front Range reservoirs, with a combination of cool water and cold water species. Both reservoirs likely would be similar in species composition to Carter Lake or Horsetooth Reservoir; however, Chimney Hollow and Dry Creek reservoirs may be less productive because they are predicted to be oligotrophic, which is less productive than the trophic state of Carter Lake and Horsetooth Reservoir.

3.9.3 Cumulative Effects

The evaluation of aquatic resource cumulative effects was based on fish habitat model runs using the hydrologic conditions with reasonably foreseeable water-based projects in place.

3.9.3.1 West Slope Effects

Cumulative impacts to fish habitat on the Colorado River and Willow Creek would be very similar to the impacts discussed for direct effects. The maximum decrease in fish habitat would be slightly more than under direct effects, but the frequency that the habitat decreases would be slightly less (Table 3-94 and Table 3-95). Average year and wet year impacts would be similar, with most effects occurring as described for direct effects. For the action alternatives, adult rainbow trout habitat in the Colorado River below Windy Gap Reservoir in average years would decrease up to 24 percent in 4 out of 10 years. Juvenile rainbow trout habitat would decrease up to 15 percent below Williams Fork in 1 out of 10 years. Adult and juvenile brown trout habitat would decrease less than 19 percent in 2 out of 10 years. Predicted maximum periodic decreases in fish habitat are unlikely to impact fish populations at most locations, with the greatest impact occurring above the Williams Fork. Predicted increases in Colorado River stream temperature are unlikely to measurably impact fish populations. Willow Creek brown trout habitat, the principle species, would decrease up to 21 percent in 2 out of 10 years. Fish habitat downstream of the Blue River would decrease in the future because

Table 3-94. Summary of cumulative effects to fish habitat in the Colorado River and Willow Creek in average water years for rainbow and brown trout.

Location	Rainbow Trout								Brown Trout							
	Juvenile				Adult				Juvenile				Adult			
	Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
Below Windy Gap	-7	2/10	-2	2/10	-28	2/10	-12	2/10	-8	0.5/10	-0	0.5/10	-6	2/10	-0	2/10
Hot Sulphur Springs	-6	2/10	-10	2/10	-26	2/10	-12	2/10	-8	0.5/10	-1	0.5/10	-5	3/10	-0	2/10
Above Williams Fork	-6	2/10	-0	2/10	-30	4/10	-11	4/10	-7	3/10	-2	3/10	-6	4/10	-4	4/10
Below Williams Fork	-19	0.5/10	-10	1/10	-19	0.5/10	-10	0.5/10	-19	0.5/10	-10	0.5/10	-19	0.5/10	-10	0.5/10
Above Troublesome Creek	-22	0.5/10	-10	0.5/10	-22	0.5/10	-10	0.5/10	-22	0.5/10	-10	0.5/10	-22	0.5/10	-10	0.5/10
Above Blue River	-20	1/10	-2	1/10	-20	1/10	-2	1/10	-20	1/10	-2	1/10	-20	1/10	-2	1/10
Below Blue River	-20	1/10	-1	1/10	-24	1/10	-1	1/10	-24	1/10	-1	1/10	-24	1/10	-1	1/10
Willow Creek	-9	2/10	-2	2/10	-20	2/10	-4	2/10	-13	2/10	-2	2/10	-21	2/10	-12	2/10

Table 3-95. Summary of cumulative effects to fish habitat in the Colorado River and Willow Creek in wet water years for rainbow and brown trout.

Location	Rainbow Trout								Brown Trout							
	Juvenile				Adult				Juvenile				Adult			
	Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
Below Windy Gap	-29	1/10	-3	1/10	-20	2/10	0	2/10	-29	1/10	-3	1/10	-29	1/10	-3	1/10
Hot Sulphur Springs	-29	1/10	-3	1/10	-29	1/10	-3	1/10	-29	1/10	-3	1/10	-30	1/10	-4	1/10
Above Williams Fork	-30	1/10	-4	1/10	-30	1/10	-4	1/10	-30	1/10	-4	1/10	-30	1/10	-4	1/10
Below Williams Fork	-22	1/10	-3	1/10	-22	1/10	-3	1/10	-22	1/10	-3	1/10	-22	1/10	-3	1/10
Above Troublesome Creek	-22	1/10	-2	1/10	-23	1/10	-3	1/10	-23	1/10	-3	1/10	-23	1/10	-3	1/10
Above Blue River	-18	1/10	-2	1/10	-18	1/10	-2	1/10	-18	1/10	-2	1/10	-18	1/10	-2	1/10
Below Blue River	-18	1/10	-1	1/10	-18	1/10	-1	1/10	-18	1/10	-1	1/10	-18	1/10	-1	1/10
Willow Creek	-9	3/10	-2	3/10	-15	3/10	-11	3/10	-11	0.5/10	0	-	-11	2/10	-6	2/10

reasonably foreseeable actions reduce Blue River flows. The impact to fish habitat is relatively small and would occur in about 1 in 10 years. Projected water quality changes in the future would be similar to direct effects and are not expected to significantly impact fish populations in the Colorado River or Willow Creek.

Under the No Action alternative for average years, adult rainbow trout habitat would decrease up to 29 percent in 4 out of 10 years above Williams Fork. Juvenile rainbow trout habitat would decrease up to 6 percent in 2 out of 10 years. Juvenile and adult brown trout habitat would decrease up to 18 percent in 1 out of 10 years above the Blue River. Adult brown trout habitat in Willow Creek would decrease up to 17 percent in 2 out of 10 years and juvenile trout up to 11 percent in 2 out of 10 years.

Dry year impacts to fish habitat for cumulative conditions would be greater than direct effects (Table 3-96); however, since there is no effect from WGFP in dry years, all the dry year effects are due to reasonably foreseeable actions.

Cumulative impacts to the Three Lakes fishery would be about the same as those described in the direct effects evaluation. Small reductions in DO concentrations are expected, but no change in trophic state for any of the lakes or reservoirs is expected. Because no change in trophic state is predicted, no measurable change in fish populations is likely. There would be no change in Three Lakes Reservoir temperature under any alternative.

3.9.3.2 East Slope Effects

No reasonably foreseeable water-based actions on the East Slope were identified that would add to the impacts of the Windy Gap Project. The changes in hydrology on the East Slope would be primarily related to less Windy Gap deliveries to the East Slope with reasonably foreseeable West Slope water-based projects online. The pattern of flows is expected to be similar to the direct effects. Small increases in streamflow predicted for East Slope streams would generally be less than 10 percent and any change in aquatic life is likely not measurable.

Hydrologic changes in Horsetooth and Carter reservoirs with reasonably foreseeable actions are unlikely to measurably affect fish populations in those reservoirs. Hydrologic and water quality changes at Ralph Price Reservoir with reasonably foreseeable actions in place would result in effects similar to direct effects, with slightly improved habitat following reservoir enlargement.

3.9.4 Proposed Mitigation

The Subdistrict will coordinate with the CDOW to establish a sport fishery in Chimney Hollow Reservoir. CDOW would be responsible for the establishment and management of the fishery. Chimney Hollow Reservoir would be accessible as part of the open space managed by Larimer County.

3.9.5 Unavoidable Adverse Effects

The additional diversions under all alternatives would result in a decrease in available fish habitat in the Colorado River below Windy Gap Reservoir and Willow Creek below Willow Creek Reservoir. The greatest effect to fish habitat would occur in the reach between Windy Gap Reservoir and the Williams Fork River; however, no significant impacts to fish populations are likely. Additional Windy Gap diversions from the Colorado River are likely to result in more exceedances of the aquatic life temperature standard, primarily when diversions occur in July and August. Predicted changes in North St. Vrain Creek and St. Vrain Creek flows under the No Action alternative could result in minor adverse effects to fish habitat in several months when flows decrease in the summer. Changes in Grand Lake, Shadow Mountain Reservoir, Granby Reservoir, Carter Lake, and Horsetooth Reservoir storage and water quality could result in minor unquantifiable adverse effects to fish.

Table 3-96. Summary of cumulative effects to fish habitat in the Colorado River and Willow Creek in dry water years for rainbow and brown trout.

Location	Rainbow Trout								Brown Trout							
	Juvenile				Adult				Juvenile				Adult			
	Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action		Maximum Change from Existing Conditions		Maximum Change from No Action	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
Below Windy Gap	-4	9/10	5	9/10	-16	9/10	20	9/10	-4		5	9/10	-19	9/10	23	9/10
Hot Sulphur Springs	-5	8/10	5	9/10	-16	9/10	19	9/10	-5	8/10	5	8/10	-18	9/10	22	9/10
Above Williams Fork	-7	9/10	7	9/10	-27	4/10	37	9/10	-7	9/10	7	9/10	-31	9/10	45	9/10
Below Williams Fork	-3	0.5/10	3	8/10	12	8/10	-10	8/10	-3	0.5/10	3	0.5/10	-3	0.5/10	3	0.5/10
Above Troublesome Creek	-5	9/10	6	9/10	-20	9/10	23	9/10	-5	0.5/10	-5	9/10	-13	9/10	15	9/10
Above Blue River	3	9/10	-3	9/10	9	9/10	-8	9/10	3	9/10	-3	9/10	2	9/10	-2	9/10
Below Blue River	-6	1/10	7	0.5/10	-10	2/10	14	9/10	-6	1/10	7	1/10	-6	1/10	8	2/10
Willow Creek	3	6/10	3	6/10	4	6/10	4	6/10	3	6/10	-2	2/10	4	6/10	6	2/10

3.10 Vegetation

3.10.1 Affected Environment

3.10.1.1 Regulatory Framework

Vegetation resources in general are not regulated by state and federal agencies. Wetlands, which are regulated under the Clean Water Act, are discussed in Section 3.11. Federally listed plant species protected under the Endangered Species Act are discussed in Section 3.13. Plant species and communities of concern in the state are monitored by the Colorado Natural Heritage Program (CNHP). CNHP monitored plants are discussed in this section, but there is no formal regulatory protection.

Noxious weeds are regulated under the Colorado Noxious Weed Act (C.R.S. 35-5.5), which states that all landowners must manage noxious weeds that may be damaging to adjacent landowners. Noxious weeds are classified as A, B, or C list species targeted for eradication or control.

3.10.1.2 Area of Potential Effect

The area of potential effect for vegetation resources is the potential reservoir sites and related pipelines, roads, and infrastructure that would be disturbed during construction or inundated by a new or larger reservoir. In addition, the area of potential effect includes riparian vegetation bordering the Colorado River, Willow Creek, Granby Reservoir, Horsetooth Reservoir, Carter Lake, and East Slope streams that would experience changes in hydrology.

3.10.1.3 Data Sources

Information on existing vegetation resources in the area of potential effect was collected from on-site field investigations and aerial photography at the Chimney Hollow, Dry Creek, and Jasper East reservoir sites and Ralph Price Reservoir. Information for the Rockwell Reservoir site was taken primarily from aerial photography because of lack of access to private property. Reconnaissance field investigations and aerial photography also were used to characterize riparian vegetation adjacent to streams and existing reservoirs. Dominant species in each vegetation community was grouped to produce a map of vegetation cover types for each of the reservoir sites. Noxious weeds were noted during field investigations. Site surveys at Chimney Hollow, Dry Creek, and Jasper East were used to determine the presence of CNHP-tracked plant communities or species in addition to a search of the CNHP database for nearby records of occurrence. Additional information on vegetation resources is included in the Vegetation Resources Technical Report (ERO 2007a).

3.10.1.4 Ralph Price Reservoir

Vegetation Cover Types

The Ralph Price Reservoir study area supports three vegetation cover types: upland native forest, upland native grassland, and upland shrubland.

Upland Native Forest. Upland native forest dominates most of the lands bordering the reservoir. Ponderosa pine forests are found primarily on south-facing slopes with an understory of junegrass, needle-and-threadgrass, and western wheatgrass. Cheatgrass—a C List noxious weed—is present in portions of the low density ponderosa pine stands. North-facing slopes consist of dense stands of Douglas-fir with scattered ponderosa pine and blue spruce.

Upland Native Grasslands. Upland native grasslands occur primarily near potential borrow areas for dam construction. Species in this vegetation type include western wheatgrass, blue grama, smooth brome, and various needle grasses.

Upland Shrubland. Small areas of upland shrubland are present on the eastern and northern side of the reservoir. Dominant plants in the upland shrubland cover type include mountain mahogany, bitterbrush, blue grama, western wheatgrass, and fringed sage.

CNHP Plant Communities and Species

The CNHP database indicates that suitable habitat for five imperiled or vulnerable plants species is present at Ralph Price Reservoir. Larimer aletes, rattlesnake fern, broad-leaved twayblade, Rocky Mountain cinquefoil, and prairie violet could potentially be present. Field surveys for these species would need to be completed if this alternative is selected.

3.10.1.5 Chimney Hollow and Dry Creek Reservoirs

Vegetation Cover Types

The Chimney Hollow and Dry Creek Reservoir sites are located in adjacent watersheds between a hogback ridge and the foothills (Figure 2-3). At an elevation of about 5,500 feet, both reservoir sites support similar vegetation cover types with slight differences in species composition. Primary vegetation cover types at these reservoir sites are described below.

Upland Native Forest. The upland native forest consists of ponderosa pine forests cover the foothills on the west side of the Chimney Hollow and Dry Creek drainages. The ponderosa pine forest vegetation cover type ranges from dense stands with little understory vegetation to open stands with mountain mahogany and grasslands of western wheatgrass, prairie dropseed, blue grama, and mountain muhly. Little bluestem and big bluestem are common in moist locations, particularly in the northwestern portion of Dry Creek and western portion of Chimney Hollow. The density and distribution of the noxious weed cheatgrass varies annually, but is a common component of the understory at Chimney Hollow and less so at Dry Creek.

Mesic Native Woodland. The mesic native woodlands vegetation cover type occurs in moist areas along the Chimney Hollow and Dry Creek drainages and in scattered locations along some of the west side drainages. Along Chimney Hollow, plains cottonwood and peachleaf willow are common with an understory of sandbar willow or smooth brome, western wheatgrass, redtop and snowberry. Small drainages in Chimney Hollow also support narrowleaf cottonwood and lanceleaf cottonwood with an understory of chokecherry and wild plum. Along Dry Creek, narrowleaf and plains cottonwood, along with box elder are common. The understory includes sandbar willow, chokecherry and grasses such as Canada wildrye, smooth brome, and Canada bluegrass.

Upland Native Shrubland. The upland native shrubland cover types is found along the low ridges and slopes west of Chimney Hollow and Dry Creek, as well as the west-facing hogback ridge. Mountain mahogany is the dominant species with skunkbush common on lower slopes. Ponderosa pine is scattered within the shrubland at some locations. The understory contains a variety of grasses and forbs including blue grama, needlegrasses, fringed sage, prickly pear cactus and cheatgrass. On dry rocky ridges, the understory is sparse with grasses such as Indian rice grass and mixed forbs.

Mesic Native Shrubland. The mesic native shrubland vegetation cover type occurs primarily in the moist to wet drainages on the west side of reservoir valleys. Dense thickets of chokecherry and wild plum are found along ephemeral drainages in the study areas. Other shrubs include skunkbush, sandbar willow, snowberry, and currents.

Upland Native Grasslands. Upland native grasslands are present on the upper slopes of the Chimney Hollow and Dry Creek valleys and in pockets with the forest and shrublands of the foothills and hogback. Blue grama is dominant on dry slopes with sideoats grama and needle-and-thread grass common in other areas. On moist slopes, western wheatgrass and big bluestem is present. Mountain mahogany, yucca, fringed sage, and other small shrubs are also found in this grassland.

Mesic Mixed Grasslands. Native grasses such as western wheatgrass, various needlegrasses, and dropseed are found in the mesic mixed grassland vegetation cover type. Nonnative species include smooth brome and crested wheatgrass. Weeds include cheatgrass, musk thistle, mullein, and kochia. At both Chimney Hollow and Dry Creek, mesic mixed grasslands are found on valley

Dry Creek reservoir valley

sideslopes where previous livestock grazing occurred.

Upland Introduced Grasslands. Upland introduced grasslands are located along the valley floor of both reservoir sites where historical livestock grazing has been intense. Smooth brome, crested wheatgrass, and weedy species such as cheatgrass and kochia are common. Canada thistle and musk thistle also are present, especially on the Dry Creek Reservoir site.

CNHP Plant Communities and Species

The Chimney Hollow and Dry Creek Reservoir sites contain several vegetation communities classified as vulnerable or imperiled by the CNHP. These plant communities are present in the study area, but typically in scattered pockets or in combination with other more dominant species. CNHP plant communities and species found within the Chimney Hollow and Dry Creek study areas are discussed below.

Ponderosa Pine/Mountain Mahogany/Big Bluestem. The upland native forest vegetation cover type at both reservoir sites contains components of this vegetation community.

Mountain Mahogany/New Mexico Needlegrass. Patches of mountain mahogany/New Mexico needlegrass shrublands occur along the hogback on the east site of Chimney Hollow in the upland native shrublands vegetation cover type. This community was not observed in Dry Creek.

Skunkbush Riparian Community. Patches of this community were found in the dry narrow drainages on both the reservoir sites in the mesic native shrubland cover type.

Narrowleaf Cottonwood/Chokecherry Riparian Community. This community is found in scattered areas in northern drainages at Chimney Hollow in the mesic native woodland cover type.

Suitable habitat for 12 CNHP-tracked plant species is present in the Chimney Hollow and Dry Creek Reservoir sites. Although three species—Bell's twinpod, Larimer aletes, and strap-style gayfeather—have been recorded nearby, no occurrence is recorded for these species in the area of potential effect and field surveys of both reservoirs did not locate any of the 12 CNHP species (ERO 2007a).

3.10.1.6 Jasper East and Rockwell/ Mueller Creek Reservoirs

Vegetation Cover Types

Upland Native Forest. Lodgepole pine forests—an upland native forest vegetation type—are found at both potential reservoir sites. At Jasper East, lodgepole pine is found on scattered north-facing slopes and at Rockwell on the upper western slopes. Dominant understory species include grouse whortleberry, kinnikinnick, common juniper buffaloberry, heartleaf arnica, Nelson needlegrass, bluegrass, and elk sedge. Aspen upland native forest stands is present at Rockwell and less common at Jasper East. Understory species in aspen forests contain bitterbrush, shrubby cinquefoil, Woods' rose, bluebunch, wheatgrass and various forbs.

Upland Native Shrubland. Upland native shrubland with a sagebrush-dominant cover type is found on hillsides at both reservoir sites. Other shrubs present include snakeweed, bitterbrush, and snowberry. Common grasses and forbs include western wheatgrass, prairie junegrass, fringed sage, Sulphur flower, Indian paintbrush, and yarrow.

Mesic Native Shrubland. The mesic native shrubland vegetation cover type includes riparian species such as planeleaf, stapleaf, and Geyer's willow. Understory species in dry areas include currant, shrubby cinquefoil, bluejoint reedgrass, bluebells, and Baltic rush. At Jasper East, this vegetation cover type is found near the Willow Creek pump station and drainages. At the Rockwell Reservoir site, mesic native shrublands are found along the drainages.

Upland Mixed Grassland. The upland mixed grassland vegetation cover type is dominated by mountain brome, smooth brome, slender wheatgrass, timothy, yarrow, clustered field sedge, Baltic rush, and slender wheatgrass. Canada thistle, a noxious weed, is found in some locations on the Jasper East Reservoir site.

Mesic Mixed Grassland. The Jasper Reservoir site contains irrigated hayfields of mesic mixed grasses that are mowed several times per year. Common species in this grassland include meadow foxtail, Kentucky bluegrass, smooth brome, timothy, and clover.

CNHP Plant Communities and Species

No CNHP-tracked vegetation communities were identified during field studies in the area of potential effect at Jasper East Reservoir. No surveys were conducted of the Rockwell Reservoir site because access was denied.

Suitable habitat for nine CNHP species is present at the Jasper East and Rockwell reservoir sites and historical records indicate Bodin milkvetch, Nagoon berry, and bitterroot have occurred nearby, but there are no known occurrences in the area of potential effect. The only CNHP species documented during field surveys of the Jasper East Reservoir site in 2004 (ERO 2007a) was Middle Park penstemon. This species is considered vulnerable to secure in Colorado and was found low to moderate densities in upland native shrubland. The Rockwell Reservoir site would need to be surveyed to determine the presence of Middle Park Penstemon and other CNHP species.

3.10.1.7 Riparian Vegetation

Colorado River and Willow Creek

Riparian vegetation along the Colorado River is influenced by stream channel morphology, topography, ground water, streamflow, and agricultural irrigation. Topography along the Colorado River includes broad open valleys and narrow canyons. Where the floodplain is wide vegetation communities include stands of narrow-leaved cottonwoods, willows, sedges, and grasses. Irrigated meadows adjacent to portions of the river support meadow foxtail, smooth brome, and Kentucky bluegrass. Irrigation return flow is likely to help support riparian vegetation down gradient of the meadows. Byers Canon and Gore Canyon, riparian vegetation, when present, is often limited to narrow bands adjacent to the channel.

An examination of historical aerial photographs of the Colorado River from the 1970s and 2005 indicate minimal changes in the overall distribution and composition of riparian vegetation (ERO 2007a). Shrub and tree size and density has increased in some locations and decreased in others, but changes appear within the natural variability expected over 30 years.

Riparian habitat along Willow Creek below Willow Creek Reservoir includes narrowleaf cottonwood, willows, and herbaceous vegetation. The upper portions of the area of potential effect include extensive irrigated hay meadows dominated by species such as meadow foxtail, smooth brome, timothy, and redtop. Downstream of irrigated meadows, the channel and riparian vegetation narrows before broadening out again near the confluence with the Colorado River.

East Slope Streams

Riparian habitat along East Slope streams within the area of potential effect is described below.

North St. Vrain and St. Vrain Creeks. North St. Vrain Creek below Ralph Price Reservoir flows through a narrow forested valley dominated by Douglas-fir and ponderosa pine. Riparian vegetation is limited to narrow scattered bands along the incised stream channel. Streambank vegetation includes willows, alder, cottonwood, chokecherry, and shrubby cinquefoil. Where the creek parallels Highway 36, riparian vegetation becomes narrows as the stream is constricted by the road. Cottonwood trees dominate both North St. Vrain Creek and St. Vrain Creek once the streams reach the plains near the town of Lyons.

Big Thompson River. Riparian vegetation along the Big Thompson River below Lake Estes is characterized primarily by a narrow band of streambank vegetation through Big Thompson Canyon. Common species include blue spruce, cottonwood, willow, alder, hawthorn, sedges, and forbs in small wet areas. Cottonwoods become more common as the stream exits the mountains.

Coal Creek and Big Dry Creek. Riparian vegetation along these small perennial streams is dominated by willows, cottonwoods, mixed shrubs, and herbaceous vegetation.

3.10.2 Environmental Effects

3.10.2.1 Issues

Vegetation was identified as a resource of concern because of the potential effect to native vegetation communities or sensitive plant species. Potential effects to riparian vegetation associated with changes in streamflow or reservoir operation were also identified as an issue of concern.

3.10.2.2 Method for Effects Analysis

Direct effects to vegetation resources were assessed quantitatively by overlaying project features for each alternative on vegetation mapping from field surveys or aerial photos. Permanent effects to vegetation resources would occur in areas that would be inundated by a reservoir or located within the footprint of dams, roads, relocated transmission line, or other facilities. Temporary effects would occur in areas that would be revegetated following construction, such as pipeline routes and staging areas. Impacts to wetland vegetation were evaluated separately in Section 3.11.

Potential effects to CNHP-tracked vegetation communities are discussed, although the area of effect was not quantified because these communities are typically interspersed with other plant communities, making them difficult delineate. Potential effects to CNHP-tracked plant species were evaluated based on the species' present in the area of potential effect.

The assessment of potential indirect effects to riparian vegetation, including wetlands, was based primarily on changing hydrologic conditions associated with each alternative. Key considerations were potential changes in stream morphology, changes in stream stage or reservoir elevation, and changes in ground water elevation. Water resource data discussed in Sections 3.5 to 3.7 and in more detail in the Water Resources Technical Report (ERO and Boyle 2007) provided information on changing hydrologic conditions for the assessment of riparian vegetation effects. Aerial photography also provided information on the distribution and the stability of riparian vegetation over time.

Vegetation effects common to all alternatives are discussed first, followed by direct effects to vegetation types, and CNHP plant communities and species for each alternative. Indirect effects to riparian vegetation from changing hydrologic conditions are discussed in Section 0.

3.10.2.3 Vegetation Effects Common to All Alternatives

Temporary Vegetation Disturbance

All alternatives would result in construction-related disturbances for staging areas, pipelines, and other facilities that would remove existing vegetation and require reclamation and revegetation following construction. As discussed in *Mitigation* (Section 3.10.4), a revegetation plan would be developed for temporarily disturbed areas. Revegetated areas are likely to take several years to recover and species composition may differ from current conditions, particularly where forested or upland shrub vegetation is removed. Temporary effects to vegetation are quantified in the discussion for each alternative.

Noxious Weeds

Construction activities at the reservoir sites would result in disturbed soils that are susceptible to the invasion and spread of noxious weeds. Most of the reservoir sites contain existing noxious weed populations that are likely to spread to newly disturbed areas, and additional weeds could be introduced from construction equipment and other sources. To control the establishment and spread of noxious weeds, a noxious weed plan would be developed as discussed in *Mitigation* (Section 3.10.4).

3.10.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Enlargement of Ralph Price Reservoir would result in a long-term loss of about 77 acres of vegetation from additional reservoir inundation and dam construction (Table 3-97). The majority of the effect would occur to upland native forests bordering the existing reservoir.

Table 3-97. Alternative 1—Direct effects to vegetation cover types at Ralph Price Reservoir.

Vegetation Cover Type	Permanent Effects (acres)
Upland native shrublands	3
Upland native grasslands	1
Upland native forest	73
Total	**77**

Potential habitat for five CNHP plant species—Larimer aletes, rattlesnake fern, broad-leaved twayblade, Rocky Mountain cinquefoil, and prairie violet—would be affected. These species may be adversely affected if present.

3.10.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Construction of Chimney Hollow Reservoir and related facilities would permanently affect about 788 acres of vegetation and temporarily disturb about 123 acres of vegetation (Table 3-98). The largest permanent effect would occur to upland native shrubs, mixed grasslands, and upland native forests.

Table 3-98. Alternative 2—Direct effects to vegetation cover types at Chimney Hollow Reservoir.

Vegetation Cover Type	Permanent Effects (acres)	Temporary Effects (acres)
Upland native shrublands	261	21
Upland native grasslands	119	39
Upland native forest	135	4
Upland introduced grasslands	32	10
Mesic mixed grasslands	193	24
Mesic native woodlands	40	6
Mesic native shrublands	8	19
Total	**788**	**123**

Relocation of the existing Western transmission line would result in small additional areas of vegetation loss associated with placement of the tower foundations as well as removal of the existing line. Removal of the existing poles and line would result in temporary vegetation disturbances, many of which would be located within the footprint of the reservoir that would be impacted by material excavation and eventually inundation in the new reservoir. Western would remove trees that could negatively impact the reliable operation of the relocated transmission line (e.g. trees that could grow tall enough to cause arcing between the tree and the conductors or could fall into the conductors or structures). Western would promote the growth of low-growing native plants on the ROW. There would be a long-term change in vegetation cover under the transmission line. Relocation of the transmission line also would result in vegetation disturbance during installation and from access and maintenance roads. The extent of these effects depends on the final transmission line alignment. Additional unquantified effects to vegetation would occur from construction of a parking area, picnic area, marina, and other recreation facilities on the west side of the reservoir near the dam. Upland native grasslands and native shrublands would be the primary vegetation types affected by these facilities. Trail construction for linkage with Larimer County Open Space on the west side of the reservoir also would result in a loss of vegetation. The specific placement of recreation facilities would not be determined until final design.

Four vulnerable to imperiled plant communities tracked by the CNHP are found in scattered locations and in varying conditions in the area of potential effect. These communities are ponderosa pine/mountain mahogany/big bluestem forest, mountain mahogany/New Mexico needlegrass shrublands, skunkbush riparian, and narrowleaf cottonwood/chokecherry riparian. It is difficult to quantify the area of these vegetation communities because they are often found in small pockets, they are mixed with other more dominant species, or they have been degraded by the presence of noxious weeds.

Potential habitat for several CNHP species is present in the area of potential effect, but none were found during field surveys; thus, there would be no effect.

3.10.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Construction of a 70,000 AF Chimney Hollow Reservoir would result in the permanent loss of about 669 acres of vegetation and a temporary disturbance to about 131 acres of vegetation (Table 3-99). The largest effect would occur to upland native shrubland and mesic mixed grasslands. Permanent impacts to vegetation at the Jasper East Reservoir site would be about 436 acres and temporary effects would be about 114 acres. The mesic mixed grasslands (irrigated meadows) would have the largest area of impact followed upland native shrubland. The combined total permanent

Table 3-99. Alternative 3—Direct effects to vegetation cover types at Chimney Hollow Reservoir (70,000) and Jasper East Reservoir.

Vegetation Cover Type	Chimney Hollow		Jasper East		Total	
	Permanent Effects (acres)	Temporary Effects (acres)	Permanent Effects (acres)	Temporary Effects (acres)	Permanent Effects (acres)	Temporary Effects (acres)
Upland native shrublands	204	30	107	58	311	88
Upland native grasslands	100	52	0	0	100	52
Upland native forest	117	12	13	1	130	13
Upland introduced /mixed grasslands	31	11	23	0	54	11
Mesic mixed grasslands	169	20	290	47	458	67
Mesic native shrublands	8	<1	3	8	11	8
Mesic native forest	40	6	0	0	40	6
Total	**669**	**131**	**436**	**114**	**1104**	**245**

effect to vegetation from construction of both reservoirs would be 1,104 acres. About 245 acres of temporarily disturbed lands would need to be reclaimed following construction of both reservoirs.

The loss of CNHP plant communities at the Chimney Hollow Reservoir site would be similar to that described for Alternative 2. There would be no effect to individual CNHP plant species because none were found in the area of effect.

No CNHP plant communities would be affected at Jasper East Reservoir, but there would be a loss of a population of Middle Park penstemon. This CNHP-tracked species would be adversely affected by the permanent loss of about 107 acres of native shrublands and the temporary disturbance of about 58 acres. Given the abundance of sagebrush habitat and the apparent widespread distribution of Middle Park penstemon, it is unlikely this loss of habitat would affect the long-term viability of this species in the region.

3.10.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

The effect to vegetation and CNHP plant communities and species at Chimney Hollow Reservoir under Alterative 4 would be the same as described for Alterative 3.

Construction of a 20,000 AF Rockwell Reservoir would permanently affect about 304 acres of vegetation and temporarily disturb about 151 acres of vegetation (Table 3-100). The majority of the impact would occur to upland native shrub habitat. The combined permanent effect to vegetation for Chimney Hollow and Rockwell reservoirs would be about 973 acres. Temporary disturbances that require revegetation would total 281 acres.

No field surveys were done at the Rockwell Reservoir site so the presence of CNHP species is not known. The area of potential effect includes about 364 acres of upland native shrubland that would be permanently and temporarily affected. Middle Park penstemon, which was found at the Jasper East Reservoir site, could be present at Rockwell Reservoir.

3.10.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Construction of Dry Creek Reservoir would permanently disturb about 647 acres of vegetation and temporarily disturb about 149 acres of vegetation (Table 3-101). The largest effect would occur to upland native forest, mesic mixed grassland, and upland native shrubland. The construction of a 30,000 AF Rockwell Reservoir would permanently disturb about 378 acres of vegetation and temporarily disturb 156 acres of vegetation (Table 3-101). Most of the impact would

Table 3-100. Alternative 4—Direct effects to vegetation cover types at Chimney Hollow Reservoir (70,000) and Rockwell/Mueller Creek Reservoir.

Vegetation Cover Type	Rockwell/Mueller Creek		Total (Including Chimney Hollow)	
	Permanent Effects (acres)	Temporary Effects (acres)	Permanent Effects (acres)	Temporary Effects (acres)
Upland native shrublands	261	103	466	132
Upland native grassland	0	0	100	52
Upland native forest	5	14	122	26
Upland introduced/mixed grasslands	24	14	55	25
Mesic mixed grasslands	<1	15	169	35
Mesic native shrubland	14	5	21	5
Mesic native forest	0	0	40	6
Total	**304**	**151**	**973**	**281**

Table 3-101. Alternative 5–Direct effects to vegetation cover types at Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir (30,000 AF).

Vegetation Cover Type	Dry Creek Reservoir		Rockwell/Mueller Creek Reservoir (30,000 AF)		Permanent Effects (acres)	Temporary Effects (acres)
	Permanent Effects (acres)	Temporary Effects (acres)	Permanent Effects (acres)	Temporary Effects (acres)		
Upland native shrublands	149	31	323	108	475	139
Upland native grasslands	90	25	0	0	90	25
Upland native forest	201	36	9	14	209	50
Upland introduced/mixed grasslands	11	5	30	14	40	19
Mesic mixed grasslands	160	42	<1	15	160	57
Mesic native shrublands	12	2	16	5	27	7
Mesic native woodlands	24	8	0	0	24	8
Total	**647**	**149**	**378**	**156**	**1025**	**305**

occur to upland native shrubland vegetation. The combined effect to vegetation under Alternative 5 would be a permanently loss of about 1,025 acres and temporary disturbance to 305 acres.

Two CNHP plant communities would be adversely affected by construction of Dry Creek Reservoir. Ponderosa pine/mountain mahogany/big bluestem forest found in scattered patches on the northwest side of the reservoir would be adversely affected. The skunkbush riparian plant community found in narrow tributaries to Dry Creek also would be adversely affected. There would be no effect CNHP-tracked plant species at the Dry Creek Reservoir site because none were found during field surveys. The Rockwell Reservoir site would need to be surveyed to determine species of concern.

3.10.2.9 Comparison of Vegetation Effects by Alternative

The estimated permanent and temporary effects to vegetation for each alternative is summarized in Table 3-102. The No Action alternative would have the least effect on vegetation resource because it only includes enlarging Ralph Price Reservoir. The Proposed Action would have the least effect to vegetation of the action alternatives because only one reservoir would be constructed.

Table 3-102. Summary of direct effects to vegetation.

Alternative	Permanent Effects (acres)	Temporary Effects (acres)	Total (acres)
Alt 1 – No Action	77	NA	77
Alt 2 – Proposed Action	788	123	911
Alt 3	1,104	245	1,349
Alt 4	973	281	1,254
Alt 5	1,025	305	1,330

3.10.2.10 Effects to Riparian Vegetation

Existing Reservoirs

Each alternative would result in changes in reservoir storage at several existing C-BT reservoirs—Granby Reservoir, Carter Lake, and Horsetooth Reservoir. In general, all alternatives, including No Action, would result in lower water surface levels in Granby Reservoir throughout the year and during the growing season. On average, Granby Reservoir would be about 2.1 feet lower than existing conditions from May to September under the No Action alternative, and the Proposed Action would be about 5.4 feet lower (Section 3.5.2). For the other alternatives, the change in water levels would fall in between these values.

The range of change in water level in Horsetooth Reservoir would be similar to Granby Reservoir. Changes in reservoir level in Carter Lake would be less than 2 feet for all alternatives under wet, dry, and average conditions. Decreases in water levels in all three reservoirs would be slightly more in dry years and less in wet years for all alternatives and would fluctuate within the levels maintained as part of existing reservoir operations.

Historically, Horsetooth Reservoir has fluctuated up to 45 feet, and Granby Reservoir water levels have fluctuated by nearly 90 feet. The vegetation types bordering Granby Reservoir, Carter Lake, and Horsetooth Reservoir primarily include upland species not dependent on lake levels, with limited riparian development. Lower water levels in Granby Reservoir, Carter Lake, and Horsetooth Reservoir are unlikely to substantially affect vegetation for any alternative because reservoir fluctuations would fall within the historical operations of the reservoir.

None of the alternatives would affect reservoir water levels in Shadow Mountain Reservoir, Grand Lake, Willow Creek Reservoir, or other smaller C-BT reservoirs. Thus, there would be no effect on riparian vegetation at these reservoirs.

New Reservoirs

Development of riparian vegetation bordering any of the potential new reservoirs is possible. The steep topography bordering Ralph Price Reservoir is unlikely to result in substantial riparian development except perhaps at tributary inlets. Chimney Hollow Reservoir and Dry Creek Reservoir would be maintained near full most of the time; therefore, riparian development is possible in flat shoreline areas and tributary inlets. The projected wide range in reservoir elevations at Jasper East and Rockwell is unlikely to provide conditions suitable for substantial riparian development.

Streams

Potential effects to streamside riparian vegetation were assessed based on an analysis of predicted changes in stream morphology, ground water, and stream stage. All alternatives would have somewhat similar effects because each alternative would increase diversions from the Colorado River.

Channel maintenance flows are composed of a range of flows that maintain the physical characteristics of the stream channel. Potential changes in channel maintenance flows and the affect on riparian vegetation were evaluated. The magnitude, duration, timing, and frequency of streamflow can affect riparian vegetation and channel conditions (Schmidt and Potyondy 2004). A reduction in channel maintenance flows can allow riparian vegetation to encroach into the channel. An increase in flows can increase streambank erosion and reduce riparian vegetation in areas where streamflow velocities are high.

Colorado River. Potential effects to riparian vegetation along the Colorado River below Granby Reservoir from changes in streamflow were examined. At the Hot Sulphur Springs gage on the Colorado below the Windy Gap diversion, there would be a 2- to 4-day reduction in the average number of days per year that streamflow equals or exceeds the low range of channel maintenance flows (80 percent of 1.5-year peak flow to the 2-year peak flow) for all alternatives. The potential for reaching the upper range of channel maintenance flows (25-year peak flow) would be reduced by less than 10 percent under all alternatives. The effect to channel maintenance flows would diminish downstream with tributary inflows.

Projected changes in bankfull discharge streamflow volumes also were reviewed to evaluate potential changes in channel morphology that may affect riparian vegetation. Many of the morphologic characteristics of a stream are formed when a stream flows at its bankfull discharge (1.5- to 2-year peak flow) (Rosgen 1996). Under existing conditions, bankfull discharge at Hot Sulphur Springs would be exceeded about 4 percent of the time. Under all alternatives, bankfull discharge at Hot Sulphur Springs would be exceeded about 3 percent of time, or 1 percent less than existing conditions. Bankfull discharge under existing conditions is exceeded about 3 percent of the time at the Kremmling gage on the Colorado River. Under all the alternative actions, there would be a less than 1 percent decrease in bankfull discharge at the Kremmling gage.

The magnitude, timing and frequency of channel maintenance flows in the Colorado River below Granby Reservoir would change as a result of changes in spills. When spills are not occurring, the flow of the river below Granby Reservoir is controlled by instream flows. Changes in the magnitude, frequency, timing and duration of spills under the alternatives would be minor and are not expected to alter channel morphology.

The projected changes in channel maintenance flows and the slight reduction in the percentage of time that flows exceed bankfull discharge for all alternatives compared to existing conditions are not expected to alter channel morphology or sediment movement on the Colorado River. As a result, the conditions for growth, establishment, maintenance, and periodic scouring of riparian vegetation below Granby Reservoir or the Windy Gap diversion are not expected to change significantly as a result of the No Action alternative or any of the WGFP action alternatives.

Stream stage changes and potential effects on alluvial ground water for the Colorado River were examined to determine if the timing and amount of change in the surface elevation of the river might affect hydrologic conditions for riparian vegetation. Monthly stream stage under existing conditions was compared to each alternative at the Hot Sulphur Springs (Figure 3-64) and near Kremmling gages (Figure 3-65) on the Colorado River. At the Hot Sulphur Springs gage, average monthly stream stage under the No Action alternative would range from 0.03 feet to 0.16 feet lower than existing conditions from May to August. Alternatives 2 to 5 would range from 0.06 to 0.23 feet lower than existing conditions. Under all alternatives, the greatest percent change in stream stage would occur in July. The No Action alternative would reduce average stream stage in July by about 12 percent compared to 14 percent by the Proposed Action and about 17 percent for the other alternatives. In wet years, stream stage under No Action would range from 0.02 feet to 0.35 lower than existing conditions. Under Alternatives 2 to 5, wet year average monthly stream stage would be about 0.01 feet to 0.41 feet lower than existing conditions. There would be no change from existing conditions in dry years for any alternative.

Average monthly stream stage on the Colorado River near Kremmling under the No Action alternative would range from 0.02 feet to 0.17 feet lower than existing conditions from May to August. Alternatives 2 to 5 would range from 0.02 to 0.28 feet lower than existing conditions. The No Action alternative would reduce average stream stage in July by about 2 percent compared to about 3 percent by the Proposed Action and other alternatives. In wet years, stream stage under No Action would range from 0.03 feet to 0.39 lower than existing conditions. Under Alternatives 2 to 5, wet year average monthly stream stage would be about 0.11 feet to 0.45 feet lower than existing conditions.

Figure 3-64. Colorado River stream stage at Hot Sulphur Springs.

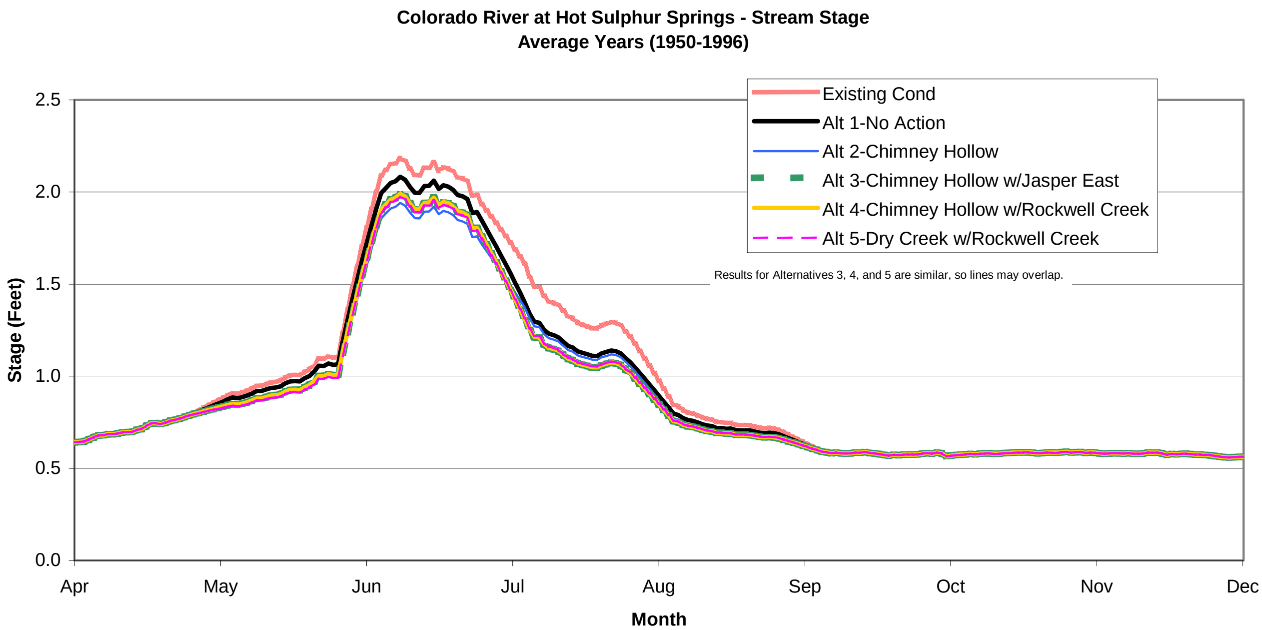
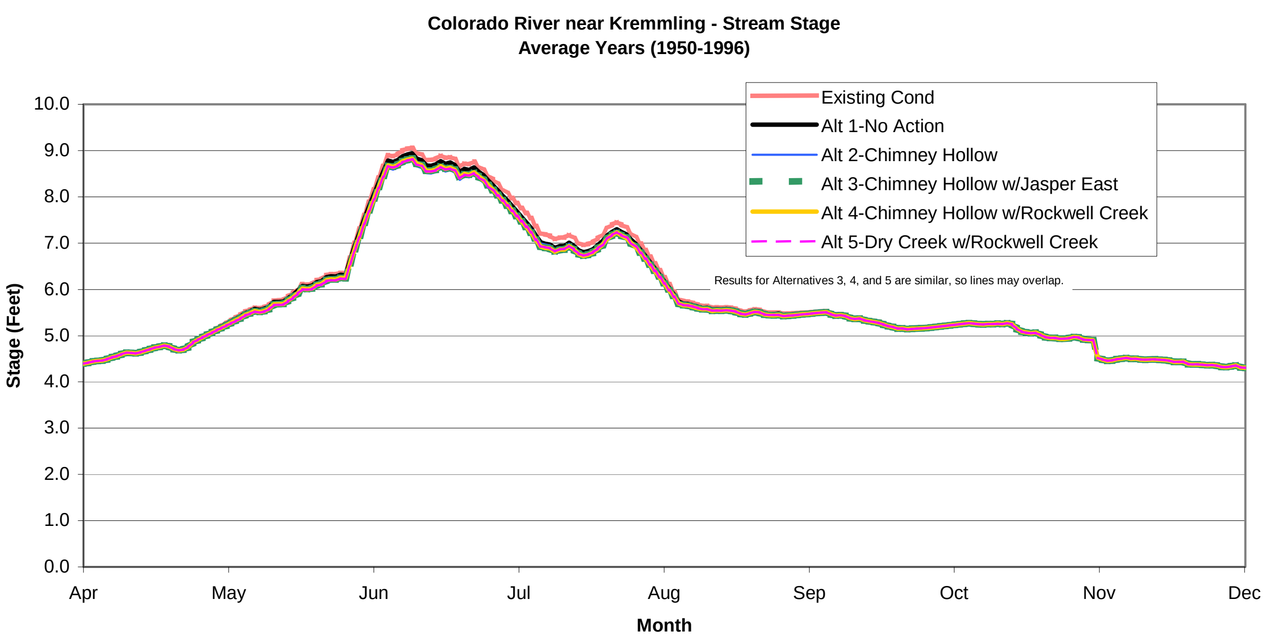


Figure 3-65. Colorado River stream stage near Kremmling.



The projected changes in stream stage would be minor with respect to potential effects to adjacent alluvial ground water levels. There would be no change in average monthly stream stage for any alternative during dry years when riparian and wetland vegetation is more susceptible to drought. In wet years, the stage of the Colorado River would be nearly twice as high as during average years for existing conditions as well as all alternatives during the growing season. Thus, supporting hydrology for riparian wetland vegetation would not be a limiting factor in wet years.

The projected magnitude of changes in stream stage is unlikely to adversely affect riparian and wetland vegetation along the Colorado River for any alternative. In the study area, most of the Colorado River is a gaining stream; thus, contributions from adjacent lands likely play an important role in supporting riparian vegetation. Riparian vegetation adjacent to the river would continue to be supported by streamflow, ground water discharge, and irrigation return flows under each alternative. Existing instream flow requirements below Granby Reservoir and below the Windy Gap diversion that contribute to supporting riparian vegetation would not change under any alternative.

Willow Creek. Examination of bankfull discharge indicates that the 2-year peak discharge would decrease by less than 1 percent between existing conditions and all alternatives. It is unlikely that there would be a significant effect to stream morphology or change in sediment transport or deposition for any alternative that would affect maintenance of riparian vegetation. Stream stage data are not available for Willow Creek, but average monthly streamflow during the growing season would decrease from 0 to 19 percent under No Action compared to existing conditions and from about 0 to 36 percent for the Proposed Action and other alternatives. These changes are not expected to substantially affect alluvial ground water levels for any alternative. It is unlikely that riparian vegetation along Willow Creek would be adversely affected by the projected changes in streamflow given the natural contribution from ground water discharge, irrigation return flows, and continued Willow Creek Reservoir minimum releases of at least 7 cfs.

North St. Vrain and St. Vrain Creeks. Under the No Action alternative, there would be a change in streamflow on North St. Vrain Creek below Ralph Price Reservoir and on St. Vrain Creek to the St. Vrain Supply Canal near Lyons. The greatest decrease in flow in North St. Vrain Creek would be a 25 percent decrease in average July flows below Longmont Reservoir and a 13 percent decrease in St. Vrain Creek at Lyons (Table 3-9). Other months would have smaller decreases or increases in flow. The projected magnitude of the changes in streamflow is unlikely to adversely affect the shrub and tree riparian vegetation along these creeks, which would continue to be supported by ground water discharge and streamflow, including existing bypass flows on North St. Vrain Creek below Ralph Price Reservoir.

Big Thompson River. Stream stage on the Big Thompson River below Lake Estes would increase less than 0.04 feet under No Action compared to existing conditions. Under the Proposed Action and other alternatives, stream stage would increase less than 0.02 feet compared to existing conditions. These projected minor increases in streamflow are unlikely to adversely affect channel morphology or hydrologic conditions supporting riparian vegetation.

Big Dry Creek and Coal Creek. Projected increases in streamflow in these drainages from additional Windy Gap return flows under all alternatives are unlikely to substantially alter channel morphology or hydrologic conditions for riparian vegetation. The increases in flows as discussed in Section 3.5.2 would be a small additional increment to the range of flows currently occurring in these drainages.

3.10.3 Cumulative Effects

Land-based reasonably foreseeable actions potentially occurring in the basins where alternative reservoir facilities would be located were used to estimate cumulative direct effects to vegetation. The development of Larimer County Open Space adjacent to the Chimney Hollow Reservoir site and a residential development near Jasper East were the only reasonably foreseeable land-based actions identified with potential cumulative effects. Reasonably foreseeable water-based actions that may affect hydrologic resources were evaluated for potential indirect cumulative effects to riparian and wetland vegetation as per the methods discussed in Section 3.10.2.2.

3.10.3.1 Alternative 1—Ralph Price Reservoir (No Action)

Ponderosa pine, Douglas-fir forests, and riparian areas along North St. Vrain Creek have been affected by the original construction of Ralph Price Reservoir. Reservoir operations and recreation activities have had a limited effect on existing vegetation resources. No reasonably foreseeable land development activities near the reservoir have been identified; thus, there would be no cumulative effects to vegetation from enlarging Ralph Price Reservoir.

3.10.3.2 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Vegetation resources at the Chimney Hollow Reservoir site and surrounding lands have been influenced by historical livestock operations. The future planned management of the Chimney Hollow Reservoir site as part of Larimer County's adjacent Chimney Hollow Open Space includes trail development and public access. There would be a cumulative loss of vegetation from construction of about 10 miles of trail in addition to the vegetation disturbance and loss from construction of Chimney Hollow Reservoir and related facilities. Potential cumulative impact to CNHP-tracked plant communities or species from trail construction is possible; however, trails can typically be located to avoid sensitive areas. Open space designation and management by Larimer County would protect the area from future development, which would be beneficial to vegetation communities.

3.10.3.3 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow

Cumulative effects to vegetation for a 70,000 AF Chimney Hollow Reservoir would be similar to Alternative 2.

Jasper East

Existing vegetation at the Jasper East Reservoir site has been influenced by irrigation, hay production, grazing, and construction of the Willow Creek Canal, pump station, forebay, and roads. Reasonably foreseeable future development in the Jasper East basin includes about 980 acres of planned residential development at the C-Lazy-U Preserve located north of the reservoir site. A total cumulative effect to vegetation of up to 1,465 acres from the 485-acre Jasper East Reservoir and the C-Lazy-U development is possible. However, future land developments at C-Lazy-U would impact a relatively small portion of the site based on planned low-density housing and designation of common open space. Much of C-Lazy-U land is currently used for hay production and pasture. The loss of sagebrush habitat at C-Lazy-U could result in a cumulative impact to habitat for Middle Park penstemon, a CNHP species considered vulnerable.

3.10.3.4 Alternative 4—Chimney Hollow Reservoir and Rockwell Reservoir

Chimney Hollow

The cumulative effect to vegetation and plant species of concern at Chimney Hollow Reservoir under this alternative would be the same as Alternative 3.

Rockwell/Mueller Creek

Vegetation at the Rockwell Reservoir site has been affected by low density residential housing roads, and livestock grazing. No reasonably foreseeable land development activities in the reservoir basin have been identified; thus, there would be no incremental cumulative effects to vegetation.

3.10.3.5 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek

The Dry Creek Reservoir site is mostly undeveloped land with a few scattered homes. Planned trail construction on adjacent Larimer County Open Space could result in a minor incremental cumulative effect to vegetation resources.

Rockwell/Mueller Creek

There would be no cumulative effect to vegetation from construction of a 30,000 AF Rockwell Reservoir.

3.10.3.6 Riparian Areas

Hydrology model output, which included reasonably foreseeable water-based actions, was used to evaluate potential indirect cumulative effects to riparian and wetland areas along streams and bordering reservoirs. Hydrologic output for Alternative 5 was used in the cumulative effects assessment as representative of Alternative 3, 4, and 5 because of the similarity in the effects of these alternatives.

Granby Reservoir, Carter Lake, and Horsetooth Reservoir

Projected changes in water levels at these reservoirs, as discussed in Section 3.5, would result in lower average water levels during the growing season for all alternatives. No measurable effect to riparian vegetation is expected for any alternative because reservoir fluctuations would fall within the historical operations of the reservoir and the vegetation bordering the reservoirs is not dependent on lake levels.

Colorado River

Projected future actions along with WGFP diversions would change the timing and amount of flow in the Colorado River. For all alternatives, the frequency of flows exceeding the 2-year peak discharge would decrease by no more than 2 percent from existing conditions at Hot Sulphur Springs and near Kremmling. Modeled Colorado River flows below Granby Reservoir and at Hot Sulphur Springs for all alternatives indicate changes in the magnitude, timing and frequency of channel maintenance flows from existing conditions (ERO and Boyle 2007), but none of the changes are of a magnitude sufficient to measurably alter channel morphology or sediment movement. Therefore, riparian and wetland resources are unlikely to be adversely affected because there would be no substantial change in channel capacity, scouring flows, and other channel-forming processes that maintain a suitable substrate for vegetation.

Changes in stream stage and alluvial ground water levels also were examined along the Colorado River. At Hot Sulphur Springs below the Windy Gap diversion, average monthly stream stage would decrease by less than 0.35 feet for all alternatives. There would be negligible changes in dry years and up to 0.5 feet decrease in stage during wet years. Average monthly stream stage on the Colorado River below the Blue River confluence would decrease up to about 1 foot for the Proposed Action and Alternative 5 and about 0.85 foot under No Action. The larger changes in stream stage (a decrease of up to 1 foot in average years in June and July) near the top of Gore Canyon would occur where the channel deepens and riparian vegetation begins to narrow; thus, potential effects to riparian and wetland vegetation are unlikely. Projected changes in stream stage would not substantially alter alluvial ground water levels (ERO and Boyle 2007) and are unlikely to measurably affect the distribution and composition of riparian and wetland vegetation along the Colorado River. Riparian vegetation would continue to be supported by various hydrologic sources, including streamflow, ground water, and irrigation return flows.

Willow Creek

Projected changes in Willow Creek streamflow indicate a 1 percent decrease in the frequency of 2-year peak discharges for all alternatives (ERO and Boyle 2007), which is unlikely to affect stream morphology and conditions for riparian and wetland growth and establishment. Stream stage for Willow Creek is not available, but projected changes in streamflow would not measurably affect ground water levels adjacent to the creek. Therefore, it is unlikely that riparian and wetland vegetation on Willow Creek, which is supported by irrigation return flows, ground water, and streamflow, would be affected by changes flow.

East Slope Streams

The change in East Slope streamflow, including increased flows in the Big Thompson River between Lake Estes and the Charles Hansen Feeder Canal, and below WWTP discharge points for WGFP Participants on the Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek, would be less than or equal to the amounts discussed for direct effects for all alternatives. With reasonably foreseeable actions in place, Windy Gap deliveries to the East Slope would be less than under direct effects. The same is true for the No Action alternative, which would result in less water exchanged to Ralph Price Reservoir and less or equal changes in North St. Vrain Creek and St. Vrain Creek streamflow than the direct effects assessment. As discussed in Section 0, these changes in streamflow are unlikely to measurably affect stream morphology, ground water levels adjacent to streams, or hydrologic support for riparian and wetland vegetation.

3.10.4 Proposed Mitigation

Mitigation measures and best management practices would be used to minimize impacts to vegetation, control noxious weeds, and reduce erosion during reservoir and facility construction for all alternatives. These measures include preparation of a detailed revegetation management plan, which would be integrated with the Stormwater Management Plan required for erosion prevention and control under Colorado NPDES permitting requirements for construction sites. Key components of the revegetation plan would include:

- Establishing well-defined construction limits to minimize vegetation disturbance.
- Minimizing the length of time that soils are exposed.
- Salvaging topsoil from weed free disturbed areas to aid in revegetation.
- Applying soil amendments, mulches, organic matter, and other measures as needed to facilitate revegetation.
- Using native seed and planting shrubs and trees according to site-specific conditions and vegetation communities. Species selection would be coordinated with local agencies such as Larimer County Open Space and the CDOW.
- Monitoring revegetation until native vegetation cover is at least 70 percent of the original vegetation cover in accordance with Colorado NPDES stormwater permitting requirements. Corrective actions would be implemented as needed to ensure that adequate vegetation cover of native species is established.

A weed management plan would be prepared in accordance with the Colorado Noxious Weed Control Act and in cooperation with Larimer, Boulder, and Grand County weed programs. Key components of the plan would include:

- Requiring that equipment be washed and inspected prior to entering the project area to prevent importing weeds on vehicle tires and mud.
- Limiting the use of fertilizers that may favor weeds over native species.
- Using periodic inspections and spot controls to prevent weed establishment. If weeds invade an area, an integrated weed management process to selectively combine management techniques (biological, chemical, mechanical, and cultural) to control the particular weed species would be used.

3.10.5 Unavoidable Adverse Effects

There would be an unavoidable permanent loss of existing vegetation resources associated with construction of Chimney Hollow Reservoir under the Proposed Action as well as reservoirs under Alternatives 3 to 5 and the enlargement of Ralph Price Reservoir under the No Action alternative. CNHP plant communities at the Chimney Hollow Reservoir site would be adversely affected under the Proposed Action and Alternatives 3 and 4. CNHP plant communities at the Dry Creek Reservoir site would be adversely affected under Alternative 5. There would be an adverse effect to existing populations of Middle Park penstemon, a CNHP-tracked plant species at Jasper East under Alternative 3, and possibly Alternative 5. Temporary disturbances to vegetation communities during construction would be unavoidable. Although reclamation of these areas would restore native vegetation, there would be long-term changes in the composition of shrub or forested vegetation communities. Exposure of soil during construction would increase the potential for noxious weed establishment; however, mitigation measures would prevent long-term establishment and spread.

3.11 Wetlands and Other Waters

3.11.1 Affected Environment

3.11.1.1 Regulatory Framework

All alternatives, including No Action, would involve the discharge of dredged or fill material into wetlands or other waters of the U.S. to construct dams or other facilities. The Corps regulates the placement of dredged or fill material into waters of the U.S. under Section 404 of the Clean Water Act. Federal agencies also have responsibilities to avoid, minimize, and mitigate unavoidable impacts on wetlands under EO 11990. The Corps defines wetlands (33 CFR 323.2 [c]) as:

> "…those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Other waters of the U.S. include streams (perennial, intermittent, and ephemeral), ponds, and lakes (33 CFR 328.3[a]). Waters tributary to navigable and interstate waters are considered waters of the U.S. and are subject to the Corps' jurisdiction. Wetlands subject to the Corps' jurisdiction (jurisdictional wetlands) meet the Corps' definition of wetlands and are adjacent, neighboring, or have a surface tributary connection to interstate or navigable waters of the U.S. For purposes of this EIS, all wetlands found in the study area are included; although, the determination of the jurisdictional status of these wetlands has not been made by the Corps. Effects to jurisdictional wetlands and waters will be determined as part of the Section 404 permit application process between the draft and final EIS.

As described in the Alternative Selection Process in Section 2.1, Section 404(b)(1) Guidelines (40 CFR, Part 230), were used in the screening of alternatives to identify the least damaging practicable alternatives to the aquatic environment. The discussion in the EIS includes a comparison of the potential effect to wetlands and waters for each alternative.

3.11.1.2 Area of Potential Effect

The area of potential effect for wetland resources and other waters includes the reservoir sites and related pipelines, roads, and infrastructure that would result in the placement of dredge or fill material into waters of the U.S. Wetlands and waters that would be affected by inundation from construction or enlargement of a reservoir are included in the area of potential effect. Wetlands that could be indirectly affected by changing hydrologic conditions along streams and surrounding reservoirs are discussed in *Effects to Riparian Vegetation* in Section 0.

3.11.1.3 Data Sources

Wetlands at the Chimney Hollow, Dry Creek, and Jasper East Reservoir sites were identified and mapped in the field using methods outlined in the 1987 Corps of Engineers Wetland Delineation Manual (Corps 1987). Wetlands were determined based on the presence of three wetland indicators: hydrophytic vegetation, hydric soils, and wetland hydrology. Results of the wetland delineation were documented in wetland delineation reports for each of these three study areas (ERO 2003b, 2004a, 2004b). Small portions of the Dry Creek Reservoir study area were not delineated because landowner access was not secured. In this portion of Dry Creek Reservoir, wetlands were mapped using aerial photographs.

Wetlands were not delineated at the Rockwell Reservoir study area because access was denied. Wetlands at this site were mapped using aerial photographs, National Wetland Inventory (NWI) maps from the U.S. Fish and Wildlife Service, and a review of the site conducted from nearby public roads.

Wetlands at Ralph Price Reservoir were mapped using aerial photography, NWI maps, and field observations of wetlands around the existing reservoir shoreline and below the dam.

Wetlands along channel at the mainstem of Chimney Hollow

Wetlands at Chimney Hollow, Dry Creek, and Jasper East were rated for functions and values according using a modified Montana Method (Burgland 1999). This method provides a rating of low, moderate, high, or not applicable based on observations of wetland characteristics for representative wetland types.

Other waters were identified by field observations, USGS quadrangle maps, and aerial photography.

3.11.1.4 Ralph Price Reservoir

Wetlands

No wetlands in the area of potential reservoir enlargement or the potential borrow areas are indicated on NWI maps; however, field observations indicate small areas of shoreline wetlands and wetland vegetation bordering the North St. Vrain Creek inlet. Dominant species in the wetland areas include Nebraska sedge, Baltic rush, soft-stem bulrush, and redtop.

Other Waters

Ralph Price Reservoir is an existing water body with a surface area of about 227 acres when full. Other waters potentially affected by enlargement of Ralph Price Reservoir are upstream and downstream portions of North St. Vrain Creek and possibly ephemeral tributaries to the reservoir including Rattlesnake Gulch, Long Gulch, and other unnamed drainages.

3.11.1.5 Chimney Hollow Reservoir

Wetlands

Wetlands are present primarily in narrow bands along the Chimney Hollow drainages. Vegetation along Chimney Hollow includes plains cottonwood, crack willow, wild plum, sandbar willow, redtop, and sedges. Small ephemeral tributary drainages to Chimney Hollow support wetlands in scattered isolated pockets. These wetlands include sandbar willow-dominated patches with occasional narrowleaf cottonwoods, and herbaceous wetlands dominated by redtop, Nebraska sedge, or cattails.

Wetland functions for the Chimney Hollow drainage were rated high for:

- Habitat for rare or imperiled CNHP tracked wildlife species
- Ground water discharge/recharge

Wetlands functions were rated as moderate for general wildlife habitat, and low to moderate for sediment/shoreline stabilization, and production export/food chain support. Wetlands functions and values were rated low for fish and aquatic habitat, flood attenuation and storage, sediment/nutrient/ toxicant retention and removal, uniqueness, and recreation/education potential.

Other Waters

Waters include reaches of the Chimney Hollow drainage, which flows into Flatiron Reservoir. Below Flatiron Reservoir the drainage becomes Dry Creek, a tributary to the Big Thompson River. Several small unnamed ephemeral drainages are found on the west side of the Chimney Hollow valley. Generally, waters are those drainages characterized by either flowing water or unvegetated drainages with evidence of flowing water.

3.11.1.6 Dry Creek Reservoir

Wetlands

Wetlands are primarily found in 1- to 20-foot-wide bands bordering Dry Creek and small ponds in the channel. The wetlands along Dry Creek support cottonwoods, especially around the ponds. Patches of sandbar willow wetlands are interspersed with herbaceous wetlands dominated by redtop, cattails, mixed grasses and sedges. Wetlands are also found on ephemeral tributary drainages and seeps particularly near rock outcrops. Along the

Dry Creek Wetlands

tributaries, wetlands generally consist of patches of herbaceous species interspersed with sandbar willow. The small seeps on the western hillsides tend to be dominated by herbaceous species such as Nebraska sedge and cattails.

Wetland functions for Dry Creek were rated high for:

- Habitat for rare or imperiled CNHP-tracked wildlife species
- General wildlife habitat (moderate to high)
- Ground water discharge/recharge
- Sediment/shoreline stabilization
- Production export/food chain support (low to high)

Wetlands functions were rated as moderate for flood attenuation and storage, and sediment/nutrient/ toxicant retention/removal. Wetlands were rated low for recreation/education potential, fish and aquatic habitat, and uniqueness.

Other Waters

Waters include reaches of Dry Creek and its tributaries. Dry Creek is a tributary to the Little Thompson River. Generally, waters of the U.S. in the study area are characterized by either flowing water or unvegetated areas with evidence of flowing water. Several small ponds also are present along Dry Creek.

3.11.1.7 Jasper East Reservoir

Wetlands

Wetlands occur along several ephemeral drainages and within irrigated meadows. Most of the wetland areas support herbaceous plant species dominated by beaked sedge, small-winged sedge, water sedge, short-beaked sedge, and tufted hairgrass. Other common species include Baltic rush and Jacob's ladder. Planeleaf willow and Geyer's willow occur in some wetlands.

Wetlands found in irrigated meadows contain meadow foxtail, Kentucky bluegrass, smooth brome, timothy, and clover. It is likely that many of the wetlands found within irrigated meadows are supported entirely by irrigation waters and are not naturally occurring. Additional studies would be necessary to determine the extent of wetlands supported by irrigation.

For two representative wetlands, wetland functions were rated high for:

- Ground water discharge/recharge
- Sediment/shoreline stabilization

Wetlands functions were rated moderate to high for production export/food chain support and dynamic surface water storage. General wildlife habitat and uniqueness were rated as moderate. Other wetland functions including flood attenuation and storage, sediment/nutrient/toxicant retention and removal, uniqueness, and recreation/education potential were rated low to moderate.

Other Waters

Waters at Jasper East include an unnamed tributary to Church Creek, which is tributary to Willow Creek. The Willow Creek Canal and pump station forebay are located in the area of potential effect. Irrigation ditches that distribute water to the irrigated hay meadows also are present.

3.11.1.8 Rockwell/Mueller Creek Reservoir

Wetlands

Wetlands at Rockwell Reservoir based on secondary sources nearby observations are expected to occur within the mesic native shrubland vegetation type present along Rockwell and Mueller creeks. The species composition is likely to include planeleaf, stapleaf, and Geyer's willow, with understory species of shrubby cinquefoil, bluejoint reedgrass, bluebells, and Baltic rush. Additional wetlands are found along the pipeline route to Windy Gap Reservoir including those along the Colorado River.

Other Waters

Waters located on the reservoir site include Rockwell and Mueller Creek, which are tributary to the Fraser River. A small stock pond also is located within the reservoir area. In addition, the pipeline to Windy Gap Reservoir would cross the Colorado River.

3.11.2 Environmental Effects

3.11.2.1 Issues

Wetlands were identified as a resource of concern because of the potential loss or impact to wetland communities and the associated functions and values. Effects to waters also were of concern because of the value associated with streams, ponds, and other open water. As discussed previously in the *Regulatory Framework* section, effects to wetlands are of concern because of the requirements under the Clean Water Act and Executive Order 11990 to avoid and minimize wetland impacts.

3.11.2.2 Method for Effects Analysis

Direct effects to wetlands were evaluated by overlaying maps of project facilities with wetland mapping from field delineations or other data sources. Potential effects were quantified as either a permanent effect from inundation, dam construction, other infrastructure, or a temporary affect associated with pipeline crossings and other short-term disturbances. Due to lack of access at the Rockwell Reservoir study area, effects to wetlands were based on secondary data sources. Estimates of wetland effects at Ralph Price Reservoir were based on field observations. Indirect effects to wetlands from hydrologic changes were evaluated in the *Effects to Riparian Vegetation* in Section 0.

Potential effects to waters of the U.S. were determined from field investigations of waters and the expected loss or disturbance from reservoir and facility construction. The potential area of effect was calculated from GIS mapping of the drainage and estimates of average widths of the drainages at Chimney Hollow, Jasper East, and Dry Creek. For the Rockwell Reservoir site and Ralph Price Reservoir, waters of the U.S. were estimated from USGS 1:24,000 topographic quadrangles and aerial photographs.

3.11.2.3 Alternative 1—Ralph Price Reservoir (No Action)

The enlargement of Ralph Price Reservoir is estimated to inundate about 0.3 acre of wetlands around the existing shoreline and at stream inlets (Table 3-103). New shoreline wetlands would likely develop along stream inlets and shoreline areas of the expanded reservoir, similar to those currently present depending on the topography. Likewise, lost wetland functions would likely be replaced with redevelopment of similar communities around the expanded reservoir. No temporary effects to wetlands have been identified, but disturbances could occur when final project disturbance limits are identified.

Table 3-103. Summary of wetland effects.

Alternative	Perm. Effects	Temp. Effects	Total
	acres		
Alternative 1			
No Action[1]	0.3	–	0.3
Alternative 2			
Proposed Action	1.6	0.1	1.7
Alternative 3			
Chimney Hollow	1.5	0.1	1.6
Jasper East	21.2	4.8	26.0
TOTAL	**22.7**	**4.9**	**27.6**
Alternative 4			
Chimney Hollow	1.5	0.1	1.6
Rockwell	3.0-13.6	2.0-5.0	5.0-18.6
TOTAL	**4.5- 15.1**	**2.1-5.1**	**6.6-20.2**
Alternative 5			
Dry Creek	6.2	0.3	6.5
Rockwell	3.0-15.6	2.0-5.0	5.0-20.6
TOTAL	**9.2-21.8**	**2.3-5.3**	**11.5-27.1**

[1] Additional permanent or temporary wetland effects are possible below the dam or in borrow areas.

Additional permanent or temporary wetland effects are possible in borrow areas once the specific location is known; however, any wetlands present could probably be avoided.

Enlargement of the reservoir would inundate about 500 feet, or 0.1 acre, of the North St. Vrain Creek at the upstream end of the reservoir (Table 3-104). It is uncertain if raising the existing dam by 50 feet would require additional fill in North St. Vrain below the dam. Small tributaries to Ralph Price Reservoir, such as Rattlesnake Gulch, Long Gulch, and other unnamed drainages, also may have waters that would be inundated. The enlarged reservoir would create about 77 acres of additional open water.

3.11.2.4 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

About 1.6 acres of wetlands would be permanently impacted and about 0.1 acre of wetlands would be temporarily disturbed from construction of a 90,000 AF Chimney Hollow Reservoir and facilities (Table 3-103). Wetlands along Chimney Hollow have been disturbed somewhat by grazing, although the wetlands in the tributaries are relatively undisturbed. Impacted wetlands are rated with a high function for rare or imperiled CNHP-tracked wildlife species habitat and ground water discharge. Wetland and riparian vegetation communities could develop around portions of the lake margin because the reservoir would remain near capacity throughout the growing season and the rest of year. Stable water levels would help support shoreline wetlands and riparian species, although steep banks would prevent substantial riparian development around much of the reservoir. Seepage below the dam also could increase the potential for wetland or riparian vegetation establishment on Chimney Hollow.

Construction of Chimney Hollow Reservoir would permanently affect 1.3 acre of waters along Chimney Hollow and several small ephemeral drainages (Table 3-104). Temporary effects to waters would be about 0.1 acre. The new reservoir would create about 742 acres of open water when full.

Table 3-104. Summary of effects to other waters.

Alternative	Perm. Effects	Temp. Effects	Total
	acres		
Alternative 1			
No Action[1]	0.1	–	0.1
Alternative 2			
Proposed Action	1.3	0.1	1.4
Alternative 3			
Chimney Hollow	1.3	0.1	1.4
Jasper East[2]	6.3	0.2	6.5
TOTAL	**7.6**	**0.3**	**7.9**
Alternative 4			
Chimney Hollow	1.3	0.1	1.4
Rockwell	3.6	1.7	5.3
TOTAL	**4.9**	**1.8**	**6.7**
Alternative 5			
Dry Creek	2.8	0.3	3.1
Rockwell	3.7	1.7	5.4
TOTAL	**6.5**	**2.0**	**8.5**

[1]Additional temporary effects to waters below the dam are possible and at borrow areas.
[2]In addition, the existing 6-acre Willow Creek Pump Canal forebay would be relocated.

3.11.2.5 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow Reservoir (70,000 AF)

Permanent effects to wetlands from construction of a 70,000 AF Chimney Hollow Reservoir would be slightly less than the 90,000 AF Chimney Hollow Reservoir in the Proposed Action. About 1.5 acres of wetlands would be permanently affected and about 0.1 acre of wetlands would be temporarily affected (Table 3-103). Effects to wetland functions would be the same as the Proposed Action.

On average, Chimney Hollow Reservoir levels would remain fairly stable throughout the year, but generally below capacity. The establishment of wetland and riparian vegetation tolerant of periodic inundation on the reservoir perimeter where the shoreline is less steep is possible.

The effect to waters would be the same as the Proposed Action (Table 3-104). A 70,000 AF

Chimney Hollow Reservoir would create about 674 acres of open water.

Jasper East Reservoir

About 21.2 acres of wetlands would be permanently impacted in the footprint of the dam, pump station, access road, and reservoir (Table 3-103). About 4.8 acres of wetlands would be temporarily disturbed during construction of pipelines and other facilities. Some of the wetlands (an estimated 8 acres, or 38 percent of the permanently impacted wetlands) are likely created as a result of flood irrigation and have been affected by grazing and hay harvesting. The development of shoreline wetlands and riparian vegetation communities around the reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations. Seepage below the dam also could increase the potential for wetland or riparian vegetation establishment.

About 0.3 acre of waters in the unnamed ephemeral drainage located within the reservoir and dam footprint would be permanently impacted (Table 3-104). Temporary effects to waters in the same drainage would affect about 0.2 acre. The existing, approximate 6-acre forebay and the Willow Creek Pump Canal would be relocated to the north. The new reservoir would create about 434 acres of open water.

Total Effects to Wetland and Waters

The combined permanent effect to wetlands for both reservoirs is 22.7 acres and the total temporary effect would be 4.9 acres (Table 3-103). The total permanent impact to other waters would be about 7.9 acre with a temporary effect of less than 0.3 acre (Table 3-104). About 1,108 acres of waters would be created with construction of both reservoirs when they are full.

3.11.2.6 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Chimney Hollow Reservoir (70,000 AF)

Effects to wetlands and waters would be the same as described for Alternative 3.

Rockwell/Mueller Creek Reservoir (20,000 AF)

The permanent affect to wetlands from construction of Rockwell Reservoir is estimated to range from 3.0 acres to 13.6 acres (Table 3-103). The-3.0-acre value is based on NWI mapping and the 13.6-acre value is based on the assumption that wetlands are located with the mesic native shrubland community mapped from aerial photography. Using the same data sources, temporary wetland effects are estimated to range from 2 to 5 acres.

Permanent wetland effects would occur primarily from dam construction and inundation from the reservoir. Temporary wetland effects would result from installation of the pipeline connection to Windy Gap Reservoir, which would involve crossing the Colorado River floodplain. Wetland functions and values were not investigated in the Rockwell Reservoir study area, but are likely similar to those in the Jasper East study area.

The development of shoreline wetlands and riparian vegetation communities around the Rockwell Reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations that would limit wetland development. Seepage below the dam could increase the potential for wetland or riparian vegetation establishment.

Although not field verified, it is assumed that Rockwell and Mueller creeks possess the characteristics of a water of the U.S. Construction of the 30,000 AF Rockwell Reservoir dam is estimated to inundate or permanently fill about 0.6 acre of stream channel (Table 3-104) in addition to an approximate 3-acre stock pond that would be inundated. In addition, about 1.7 acres of waters would be temporarily impacted during placement of the raw water pipeline across the Colorado River. A 20,000 AF Rockwell Reservoir would create about 294 acres of open water.

Total Effects to Wetland and Waters

The combined permanent effect to wetlands for both reservoirs would range from about 4.5 to 15.1 acres and the total temporary effect would range from about 2.1 to 5.1 acres (Table 3-103). The total permanent impact to other waters would be about 4.9 acres with a temporary effect of 1.8 acres (Table 3-104). About 968 acres of waters would be created with construction of both reservoirs when they are full.

3.11.2.7 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek Reservoir

About 6.2 acres of wetlands would be permanently impacted and about 0.3 acre of wetlands would be temporarily impacted from construction of Dry Creek Reservoir and facilities (Table 3-103). Along Dry Creek, wetlands that would be permanently impacted have been somewhat disturbed by grazing; however, wetlands in the tributaries are relatively undisturbed. This alternative would affect wetlands rated with a high function for rare or imperiled CNHP-listed wildlife species habitat, general wildlife habitat, ground water discharge/recharge, sediment/shoreline stabilization, and production export/food chain support.

Construction of the reservoir may result in the development of new vegetation communities around the lake margin because the reservoir would remain near capacity throughout the growing season and the rest of year. Stable water levels would help support shoreline wetlands and riparian species, although steep banks would prevent substantial riparian development. Seepage below the dam also could increase the potential for wetland or riparian vegetation establishment along Dry Creek.

Construction of Dry Creek Reservoir would permanently affect about 2.8 acres of waters (Table 3-104) including Dry Creek and several tributaries, either from inundation, fill from dam construction, or spillway. Temporary effects to waters would be about 0.3 acre. The new reservoir would create about 589 acres of open water.

Rockwell/Mueller Creek Reservoir (30,000 AF)

Construction of a 30,000 AF Rockwell Reservoir would permanently affect about 3 to 15.6 acres of wetlands based on NWI mapping and aerial photography (Table 3-103). Temporary wetland effects would range from about 2 to 5 acres. Wetland functions and values were not investigated, but are likely similar to those at Jasper East Reservoir.

The development of shoreline wetlands and riparian vegetation communities around the Rockwell Reservoir margin is unlikely because of projected large annual fluctuations in reservoir elevations, but seepage below the dam could support downstream wetlands.

Rockwell Reservoir is estimated to inundate or permanently fill from dam construction about 0.7 acre of stream channel and a 3 acres stock pond (Table 3-104). In addition, about 1.7 acres of waters would be temporarily impacted during placement of the raw water pipeline across the Colorado River. A 30,000 AF Rockwell Reservoir would create about 348 acres of open water.

Total Effects to Wetland and Waters

The combined permanent effect to wetlands for both reservoirs would range from 9.2 to 21.8 acres and the total temporary effect would range from 2.3 to 5.3 acres (Table 3-103). The total permanent impact to other waters would be 6.5 acres with a temporary effect of 2.0 acres (Table 3-104). About 937 acres of waters would be created with construction of both reservoirs when they are full.

3.11.3 Cumulative Effects

Potential direct cumulative effects to wetlands from land-based reasonably foreseeable actions in addition to the wetland impacts identified at the reservoir sites are possible. Reasonably foreseeable land-based developments potentially occurring in the basins where alternative reservoir facilities are located include Larimer County Open Space adjacent to Chimney Reservoir site and a residential development near Jasper East. Potential indirect effects to riparian areas and wetlands along streams and bordering reservoirs are discussed in Section 0.

No reasonable foreseeable future actions that would result in a direct cumulative effect to wetlands were identified in the Ralph Price Reservoir or Rockwell Reservoir basins. Planned future recreation development of Larimer County open space adjacent to Chimney Hollow and part of Dry Creek could potentially impact wetlands from trail construction. Specific trail locations have not been determined, but typically trails can be located to avoid wetlands. Development of the C-Lazy-U Preserve residential development north of the Jasper East Reservoir site could result in a cumulative impact to wetlands in the basin. Impacts to wetlands from development of C-Lazy-U Preserve are not known at this time. Any future losses to wetlands associated with future development may require permitting and mitigation.

3.11.4 Proposed Mitigation

Mitigation for potential impacts to wetlands and waters began with the alternative selection process by using wetlands and perennial streams as key screening criteria. All of the potential action alternatives are located on small ephemeral drainages with limited natural wetlands present. Because complete avoidance of wetlands and waters is difficult with water storage projects, all alternatives would require mitigation for wetland impacts.

A wetland mitigation plan has been prepared to address permanent and temporary impacts to wetlands and has been submitted to the Corps as part of the 404 Permit application for the Proposed Action. Proposed mitigation for permanent effects to jurisdictional wetlands includes purchase of wetland credits in a wetland bank as preferred by the Corps. In addition, on-site wetland restoration or creation around Chimney Hollow Reservoir would be used to mitigate for nonjurisdictional wetlands impacted by reservoir construction. Regardless of the alternative, to the greatest degree possible, impacts on wetlands would be avoided or minimized by shifting project features during final design.

Temporary wetland impacts from actions such as pipeline construction would be addressed by the use of best management practices (BMPs). BMPs would include limiting the area of disturbance, establishing erosion control, salvaging existing wetland plants, restoring natural hydrology, controlling weeds, and monitoring revegetation success.

Mitigation for lost waters would occur from the creation of additional open water aquatic habitat from reservoir construction.

3.11.5 Unavoidable Adverse Effects

All alternatives would result in unavoidable temporary and permanent effects to existing wetlands and waters. Complete avoidance of wetlands is not feasible, but additional modifications during final design could slightly reduce wetland effects associated with project facilities. Unavoidable permanent wetland impacts for the action alternatives range from 1.6 acres for the Proposed Action to 22.7 acres for Alternative 3 with other alternatives following within this range. The No Action alternative would permanently impact about 0.3 acres of wetlands. Unavoidable permanent effects to existing waters would range from 1.3 acre for the Proposed Action to 7.6 acres for Alternative 3 compared to 0.1 acre for the No Action alternative.

Following proposed mitigation, all of the temporary disturbed wetlands would be restored to near existing conditions, although complete restoration of wetland functions could take several years. All permanently affected wetlands and associated functions would be replaced by creation or restoration of new wetlands. Lost waters are proposed to be replaced by reservoir creation.

3.12 Wildlife

3.12.1 Affected Environment

3.12.1.1 Regulatory Framework

As directed by Colorado State Statute 33 (Colo. Rev. Stat. Ann. §§ 33-1-101-124) for wildlife species not federally listed as threatened or endangered, the Colorado Wildlife Commission issues regulations and develops management programs, which are implemented by CDOW. This includes maintaining a list of state threatened and endangered species. CDOW also maintains a list of species of concern, but these are not protected under Statute 33. Take of game species, such as deer, elk, pheasant, quail, and some species of waterfowl, is permitted through a hunting license. Take of nongame species, such as small mammals, birds, and reptiles, is permitted for specific activities such as scientific collecting.

Migratory birds, including raptors and active nests, are protected under the Migratory Bird Treaty Act (MBTA). The MBTA prohibits activities that may harm or harass migratory birds during the nesting and breeding season. Removal of active nests that results in the loss of eggs or young is also prohibited under the MBTA. In Colorado, most birds except for European starling, house sparrow, and rock dove (pigeon) are protected under the MBTA (§§ 703-712). Additionally, Executive Order 13186 directs federal agencies to take certain actions to implement the MBTA (86 FR 3853). The Bald Eagle Protection Act includes several prohibitions not found in the MBTA, such as molestation or disturbance; in 1962, the Act was amended to include the golden eagle.

The Fish and Wildlife Coordination Act requires the federal action agency to consult with the U.S. Fish and Wildlife Service (FWS) and the CDOW on issues related to conservation of wildlife resources for federal projects resulting in modifications to waters or channels of a body of water (16 U.S.C. §§ 661-667c).

The Colorado Natural Heritage Program (CNHP) maintains a list and ranking of rare and imperiled wildlife and plant species in Colorado. CNHP-tracked species generally include federal and state listed endangered species, as well as other species of concern. CNHP-listed species have no formal regulatory status or protection.

Federally listed threatened and endangered species protected under the Endangered Species Act are discussed in Section 3.13.

3.12.1.2 Area of Potential Effect

The study area for evaluating potential effect to wildlife includes the reservoir sites and related pipelines, roads, and infrastructure that would be directly affected. Because many wildlife species use a variety of habitats and have a wide range of movement, the study area includes a 3-mile buffer around reservoir sites and project facilities.

3.12.1.3 Data Sources

Wildlife resource data were collected from field observations at all of the reservoir sites except Rockwell Reservoir, where access to the privately owned property was denied. Other data sources for species occurrence and potentially suitable habitat included aerial photography, published reports, database searches of the Colorado Natural Diversity Information Source (CNDIS) and CNHP. Consultation with the FWS and CDOW also provided information. Draft Wildlife Technical Report provides additional information on wildlife resources (ERO 2007b).

The affected environment describes wildlife in four categories: 1) state endangered, threatened, and species of concern; 2) CNHP-listed species; 3) migratory birds and raptors; and 4) large game and other wildlife.

3.12.1.4 State Endangered, Threatened, and Species of Concern

State endangered, threatened, and species of concern with potentially suitable habitat in the study area are listed in Table 3-105 and described below.

Boreal Toad

The boreal toad inhabits wetland areas such as beaver ponds, wet meadows, and slow moving streams at elevations above 7,800 feet (Hammerson 1999). The species was removed as a candidate for federal listing (FWS 2005).

West Slope Study Area. The boreal toad is known to occur along Willow Creek in Grand County (USFS 2005). Wetland and aquatic habitat at the Jasper East Reservoir site does not contain preferred foraging and breeding habitat suitable for the boreal toad and none were discovered during field surveys. No records of boreal toad near Rockwell Reservoir are known. The small pond and two drainages provide limited suitable habitat for boreal toad.

East Slope Study Areas. The Chimney Hollow, Dry Creek, and Ralph Price Reservoir study areas are below the boreal toad's known elevation range and therefore do not contain any habitat for this species.

Northern Leopard Frog

The northern leopard frog occupies much of Colorado with the exception of the southeastern part of the state. Typical habitat includes irrigation ditches, streams, wet meadows, marshes, ponds, and lakes (Hammerson 1999). The CDOW lists the northern leopard frog as uncommon in Boulder and Larimer counties and rare in Grand County (CNDIS 2006).

West Slope Study Areas. Historically the northern leopard frog was recorded along all of the major drainages in Grand County. Potentially suitable habitat exists within wetland areas in the Jasper East study area; however, none were discovered during field surveys. Potentially suitable habitat exists in and near wetland areas associated with the pond and tributary on the Rockwell Reservoir site. The nearest capture site is along the Colorado River approximately 3 miles northwest of the Rockwell Reservoir site (CDOW 2005).

Table 3-105. State endangered, threatened, and species of concern potentially occurring in the study areas.

Common Name	State Status	Ralph Price	Chimney Hollow	Dry Creek	Jasper East	Rockwell/ Mueller
Amphibians						
Boreal toad	SE	0	0	0	1	1
Northern leopard frog	SOC	1	3	3	1	1
Wood frog	SOC	0	0	0	1	1
Reptiles						
Common gartersnake	SOC	0	3	3	0	0
Birds						
Ferruginous hawk	SOC	0	1	1	1	1
Greater sandhill crane	SOC	0	0	0	1	01?
Peregrine falcon	SOC	1	3	3	1	10?
Greater sage grouse	SOC	0	0	0	1	3
Mammals						
Townsend's big-eared bat	SOC	1	1	1	0	0
River otter	ST	1	0	0	0	0

0– No habitat
1 – Limited habitat present, species unlikely to occur
2 – Potential foraging habitat
3 – Potential breeding and foraging habitat
SE = State Endangered ST = State Threatened SOC = State Species of Concern

Source: CDOW 2006.

East Slope Study Areas. Suitable habitat for northern leopard frog exists in wetland areas within the Chimney Hollow and Dry Creek drainages. One adult leopard frog was observed in July 2005 along Dry Creek. It is likely that small breeding populations exist along wetter areas of Dry Creek. No leopard frogs were observed during field surveys at Chimney Hollow, but they could be present. Dry Creek contains more riparian wetlands and several small ponds that provide more suitable leopard frog habitat than Chimney Hollow.

The steep rocky areas along the Ralph Price Reservoir shoreline do not provide quality habitat for northern leopard frog; however, this species may be present upstream and downstream of the reservoir along shallow areas of North St. Vrain Creek.

Wood Frog

This species typically inhabits high mountain marshes, bogs, beaver ponds, willow thickets and stream borders (Hammerson 1999). In Colorado this species is only known in Larimer, Jackson, and Grand counties. The CDOW lists the wood frog as common in Grand County (CNDIS 2006).

West Slope Study Areas. The nearest known population of the wood frog occurs along the Colorado River near Grand Lake (CDOW 2005b). Potentially suitable habitat for the wood frog exists within wetland areas of the Jasper East study area; however, none were found during field surveys. The pond and wetlands present at Rockwell Reservoir do not provide the type of habitat favored by the wood frog.

East Slope Study Areas. No potential habitat exists for the wood frog in the Chimney Hollow, Dry Creek, or Ralph Price study areas. All three sites are located below the elevation range for this species in Colorado.

Common Gartersnake

The common gartersnake is distributed in northeastern Colorado and is associated with the

South Platte River and its tributaries at elevations below 6,000 feet (Hammerson 1999). It is found in aquatic and riparian habitats within floodplains and inhabits marshes, ponds, and stream edges. The CDOW lists the common gartersnake as sparsely common in Boulder County and uncommon in Larimer County (CNDIS 2006).

West Slope Study Areas. Both the Jasper East and Rockwell study areas are located outside the known range of the common gartersnake in Colorado.

East Slope Study Areas. The Chimney Hollow and Dry Creek study areas contain suitable habitat for the common gartersnake and it was observed at Chimney Hollow during field studies. It is likely that this species inhabits the wetland and riparian areas at both East Slope reservoir sites.

Ralph Price Reservoir is above the upper elevation limit for this species and, therefore, the common gartersnake is unlikely to be present. It may occur downstream of the reservoir along North St. Vrain Creek.

Ferruginous Hawk

The ferruginous hawk inhabits open prairie and desert habitats and is strongly associated with primary prey species such as ground squirrels and jackrabbits. Ferruginous hawks are relatively common winter residents in eastern Colorado, particularly in association with the black-tailed prairie dog (Kingery 1998). The CDOW lists the ferruginous hawk as an uncommon to rare breeder in Boulder, Larimer, and Grand counties (CNDIS 2006).

West Slope Study Areas. Breeding bird surveys did not document any nesting of this species in the county (Kingery 1998); however, the Colorado River basin within Grand County is considered winter and migration habitat (Andrews and Righter 1992). Ferruginous hawks were observed in low numbers near Jasper East and Rockwell during field studies. Wintering ferruginous hawks could possibly roost within or near West Slope study areas.

East Slope Study Areas. No records of ferruginous hawks nesting in central or western Larimer or Boulder counties are known (Kingery 1998). This species is a common migrant along the Front Range. Although it may occasionally occur at the Chimney Hollow, Dry Creek, and Ralph Price study areas, it is unlikely to nest at any of these study areas because more suitable habitat is available to the east.

Greater Sandhill Crane

In Colorado, the greater sandhill crane nests west of the Continental Divide, typically near flooded wetlands, beaver ponds, and wet meadows. The CDOW lists the northern sandhill crane as an unknown breeder in Boulder and Larimer counties and uncommon in Grand County (CNDIS 2006).

West Slope Study Areas. The greater sandhill crane has been recorded nesting in the northwestern portion of Grand County, but no breeding populations have been noted within or near the Jasper East or Rockwell (Kingery 1998; Sumerlin, pers. comm. 2005). The Jasper East study area contains irrigated wet meadows that could be used for foraging, but is unlikely to provide nesting habitat because the area is mowed regularly. The Rockwell Reservoir site contains narrow riparian wetlands and a small pond that does not provide suitable for foraging or nesting habitat.

East Slope Study Areas. No suitable nesting or foraging habitat for this species exists within the Chimney Hollow, Dry Creek, or Ralph Price study areas.

Peregrine Falcon

The peregrine falcon has been removed from both the CDOW and federal endangered species lists, but it remains a state species of concern. Peregrines nest on high steep cliffs generally along stream courses. The peregrine falcon migrates through eastern Colorado and nests in canyons and cliffs along the Front Range (Craig and Enderson 2004).

West Slope Study Areas. Peregrine nesting has never been documented in Grand County, but breeding populations have been noted in nearby Jackson County (Kingery 1998). The Jasper East study area does not contain suitable nesting habitat for the peregrine falcon. Rocky outcrops to the northeast provide potential habitat for the peregrine, but the U.S. Forest Service has no records of occurrence in the area (Sumerlin, pers. comm. 2005). No rocky cliffs or canyon habitat that peregrines typically favor occur at or near the Rockwell Reservoir study area.

East Slope Study Areas. Although no nests or individuals have been recorded in the East Slope study areas, rocky outcrops and cliffs on the hogback east of Chimney Hollow and Dry Creek and rocky outcrops near Ralph Price have potentially suitable habitat. The hogbacks near Chimney Hollow and Dry Creek are relatively small and provide habitat more suitable for prairie falcons. No peregrine falcon was observed at Chimney Hollow or Dry Creek during field surveys and there are no records of occurrence at Ralph Price (CNHP 2006).

Greater Sage Grouse

Greater sage grouse populations in North and Middle Parks typically occur in sagebrush habitat between 7,000 and 9,500 feet (Kingery 1998). Habitat requirements shift from sage-dominated habitat in winter to more variable mountain-shrub habitat in summer (GSGCP 2001). In the spring, male grouse congregate in courtship displays in flat open areas dominated by sagebrush. Nesting usually occurs near production areas (leks) and 80 percent of sage grouse forage within 4 miles of a lek. Sage grouse does not occur in Boulder or Larimer counties and is uncommon in Grand County (CNDIS 2006). This species was removed as a candidate for federal listing in January 2005.

West Slope Study Areas. Vegetation mapping and site reconnaissance indicate that habitat preferred by sage grouse is present in the Jasper East study area. Sage grouse are common in west Grand County and uncommon in east Grand County, with only two leks remaining (CNDIS 2006). CDOW recorded breeding activity in drier habitat west of the Jasper East site in 2004 (CDOW 2005a). The Horn lek, above the intersection of Highways 34 and 40 and south of Jasper East, was active with five males on the lek in 2005 and 2006, and only one male in 2007 (Cowardin 2006, 2007).

The eastern side of the Rockwell study area includes a designated sage grouse lek (CDOW 2001b; CNDIS 2006). A sage grouse brooding area also has been identified north and east of Rockwell. Sagebrush at Rockwell provide nesting and year-round grouse habitat. Sage grouse have experienced population declines in eastern Grand County and recent residential development in the Granby area has reduced available habitat. The highest number of males counted on the Linke lek, east of Rockwell, was 26 in 1990. The decline has been significant over the last few years from 20 males in 2004 to five in 2005, three in 2006, and then one in 2007 (Cowardin 2006, 2007).

East Slope Study Areas. The Chimney Hollow, Dry Creek, and Ralph Price study areas do not contain suitable sage-dominated habitat for sage grouse.

Townsend's Big-eared Bat

The Townsend's big-eared bat is a year-round resident in the western ⅔ of Colorado (Fitzgerald et al. 1994). This species inhabits woodland areas with rocky outcrops, vacant buildings, caves and old mine shafts (Fitzgerald et al. 1994). The CDOW lists the Townsend's big-eared bat as uncommon in Boulder and Larimer counties and has no records of occurrence for Grand County (CNDIS 2006).

West Slope Study Areas. Due to the lack of large rocky outcrops and vacant mines or buildings on both West Slope study areas, it is unlikely that the species occurs at Jasper East or Rockwell. However, it may intermittently forage in these study areas.

East Slope Study Areas. The Chimney Hollow, Dry Creek, and Ralph Price study areas contain potentially suitable habitat for the Townsend's big-eared bat. The species could potentially roost or hibernate in rocky areas along the hogbacks and foothill areas, as well as in old buildings or small caves.

River Otter

The river otter inhabits riparian habitats across a variety of ecosystems ranging from semi-desert shrublands to montane and subalpine forests. River otter requires clear, permanent water with an abundant food base of fish and crustaceans. Other habitat requirements include ice-free water in winter, water depth, stream width, and suitable access to shoreline (Fitzgerald et al. 1994).

West Slope Study Area. River otter occur in all the larger streams of eastern Grand County, including the Colorado and Fraser rivers and Willow Creek, both above and below Willow Creek Reservoir. Otter may occasionally visit the Jasper East or Rockwell area, but the sites lack suitable habitat, including permanent water of relatively high quality and an abundant food base.

East Slope Study Area. No known populations of otter occur near any of the three East Slope study areas. Although tracks and other sign of otter have been found in the Poudre and Laramie drainages in Larimer County the nearest location to Chimney Hollow and Dry Creek is more than 15 miles east, near Windsor (CNDIS 2007). The Chimney Hollow and Dry Creek study areas also lack suitable habitat for river otter including permanent water of relatively high quality and an abundant food base.

3.12.1.5 CNHP Species

Colorado Natural Heritage Program species considered imperiled, rare, or vulnerable in the state with potentially suitable habitat in the study area are listed in Table 3-106 and described below.

Sage Sparrow

The sage sparrow is a local and irregular summer resident in western Colorado (CNDIS 2006). This sparrow has a narrow habitat requirement for nesting, but tends to be associated with sagebrush. Most of the confirmed nests for sage sparrow in Colorado are in Moffat County (Kingery 1998). The CDOW lists the sage sparrow as unknown in Boulder, Larimer, and Grand counties (CNDIS 2006).

West Slope Study Areas. Jasper East and Rockwell study areas contain potentially suitable nesting habitat for the sage sparrow. However, based on museum records and statewide breeding bird surveys, no documented nesting has been recorded in Grand County (Andrews and Righter 1992; Kingery 1998). This species may occasionally visit these sites during migration.

East Slope Study Areas. The Chimney Hollow and Dry Creek study areas do not contain sage habitat that this species typically favors. Sage sparrow has not been documented nesting in Boulder or Larimer counties (Kingery 1998).

Butterflies—Argos Skipper, Ottoe Skipper, Dusted Skipper, Cross-line Skipper, Mottled Duskywing, Moss' Elfin, Rhesus Skipper, and Simius Roadside Skipper

Habitat for several species of butterfly is present along the East Slope of the Front Range within the study areas primarily for Chimney Hollow and Dry Creek. There is no suitable habitat for these butterfly species in the West Slope study areas.

Argos skipper and ottoe skipper prefer habitat dominated by big bluestem grasslands. Big bluestem is not abundant at Chimney Hollow or Dry Creek, but Argos skipper has been found in the grasslands and foothills near the reservoir sites (CNHP 2005).

Dusted skipper occurs in abandoned agricultural fields, open woodlands, and mid- to tallgrass prairies; cross-line skipper favors prairie grasslands. Both skippers inhabit areas with little bluestem and dusted skipper also prefers big bluestem. Chimney Hollow and Dry Creek provide patches of potential habitat for these species.

Mottled duskywing occurs in hilly open woodlands preferring buckbrush shrubs. It has been found in central Larimer County (CNHP 2005). Mountain mahogany shrublands with scattered buckbrush at Chimney Hollow and Dry Creek provide potential habitat.

Moss' elfin is found in moist north-facing slopes and steep canyons. The caterpillar stage of this species feeds on yellow stonecrop. Areas of potential habitat could be present at Chimney Hollow, Dry Creek, and Ralph Price if stonecrop is present.

Rhesus skipper and simius roadside skipper prefer shortgrass prairie habitat dominated by blue grama grass. A population of simius roadside skipper was recorded in the foothills near Chimney Hollow and Dry Creek (CNHP 2005). Potential habitat for both species is present at Chimney Hollow and Dry Creek.

3.12.1.6 Migratory Birds

Nearly all bird species potentially present in the East and West Slope study areas are protected under the Migratory Bird Treaty Act. Bald eagles, which were downlisted from a federally threatened species in August 2007, are still protected under the MBTA and Bald Eagle Protection Act. Known and potential species for each reservoir site are discussed below.

Table 3-106. CNHP-tracked species potentially occurring in the West and East Slope study areas.

Common Name	CNHP Ranking	Ralph Price	Chimney Hollow	Dry Creek	Jasper East	Rockwell/ Mueller
Birds						
Sage sparrow	G5, S3	0	0	0	3	3
Butterflies						
Arogos skipper	G3/G4, S2	0	3	3	0	0
Ottoe skipper	G3/G4, S2	0	3	3	0	0
Dusted skipper	G4/G5, S2	0	3	3	0	0
Cross-line Skipper	G5, S3	0	3	3	0	0
Mottled duskywing	G3/G4, S2/S3	0	3	3	0	0
Moss' elfin	G3/G4/T3, S2/S3	3	3	3	0	0
Rhesus skipper	G4, S2/S3	0	3	3	0	0
Simius roadside skipper	G4, S3	0	3	3	0	0

0– No habitat
1 – Limited habitat present, species unlikely to occur
2 – Potential foraging habitat
3 – Potential breeding and foraging habitat

Source: CNHP 2005

CNHP Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range.)

G2 = Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range.)

G3 = Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range.)

G4 = Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

G5 = Secure – Common; widespread and abundant.

GU = Unable to assign rank due to lack of available information.

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state.)

S2 = Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or threatened in state.)

S3 = Vulnerable in state (21 to 100 occurrences).

S4 = Apparently secure in the state, though it might be quite rare in parts of its range, especially at the periphery.

B = Breeding season imperilment, not permanent residents

T(1-5) = Trinomial Rank – Used for subspecies. These species are ranked on the same criteria as G1 to G5.

Ralph Price Study Area

The mixed ponderosa pine and Douglas-fir forest and open water at Ralph Price Reservoir provides habitat for migratory upland birds and waterfowl. Species observed by reservoir management staff and during an August 2005 site visit included osprey, great blue heron, cormorant, and gadwall. Northern goshawks also have been observed in the area (Jones 2006). No bald eagle active nest sites, winter range, winter roost site, or winter concentration area or associated buffers are known at Ralph Price Reservoir (CNDIS 2006), although bald eagle have been observed (Jones 2006). The St. Vrain River east of Lyons about 6 miles from Ralph Price Reservoir supports known bald eagle nesting, winter roosting, and summer foraging areas. Habitat for waterfowl, including various ducks, and white pelican is available at Ralph Price Reservoir. Forests bordering the reservoir likely support pygmy nuthatch, Steller's jay, mountain blue-bird, hairy woodpecker, dark-eyed junco, and other woodland species.

Chimney Hollow and Dry Creek Study Areas

Several migratory bird species were observed foraging within the Chimney Hollow and Dry Creek study area during field surveys. Ground-nesting species observed within the study areas included spotted towhee, savannah sparrow, western meadowlark, and mourning dove. Species observed in riparian and wetland habitat included Bullock's oriole, American goldfinch, and yellow warbler. Additional species observed were barn swallow, eastern kingbird, American robin, American kestrel, and chipping sparrow. Riparian and ridge areas, combined with ponderosa pine forests in the higher elevations of the site, contained potentially suitable nesting habitat for several bird species such as dark-eyed junco, pygmy nuthatch, western tanager, American crow, and red-tailed hawk.

Bald eagle winter range is present east of the Chimney Hollow Reservoir site, which incorporates Carter Lake and the east side of the Dry Creek Reservoir site (CNDIS 2006). Bald eagle winter concentration areas are present along the Little Thompson River south of the Dry Creek Reservoir dam site. Bald eagle use of the Chimney Hollow or Dry Creek Reservoir sites for winter roosting or nesting is unlikely because no perennial streams or large bodies of water are present; however, they may occasionally forage in the area.

Several small nests were observed in riparian areas along Chimney Hollow, Dry Creek, and adjacent tributaries. Many of the nests were identified as oriole and magpie nests. Three large nests were present on rocky outcrops and cliffs on the ridgeline east of Chimney Hollow. Two of these large nests appeared to be inactive during the July 2003 site visit. Adult and fledgling golden eagles were observed in a third nest. All large nests on the ridgeline are likely used as alternative nests for golden eagles in the area.

A red-tailed hawk nest was observed in a stand of cottonwood trees in the southern portion of Dry Creek. A large golden eagle nest also was seen along the eastern ridgeline on the northern end of the Dry Creek study area. Both nests showed evidence of activity in 2005.

Jasper East Study Area

Raptors and migratory birds likely forage throughout the Jasper East study area. Ground-nesting birds observed, such as green-tailed towhee, savannah sparrow, and killdeer, are likely to inhabit pasture or meadow habitat. Species such as golden eagle and cliff swallow, common raven, American kestrel, and red-tailed hawk are likely to nest along the rocky ridges of the hogbacks northeast of the reservoir site. Wetland and riparian species such as red-winged blackbird, yellow-headed blackbird, and song sparrow are likely to nest in cattail stands or along the edge of wet areas. Several generalist species such as American robin, violet-green swallow, and American crow may nest in forested or wetland areas. Waterfowl, herons, and an occasional migrant sandhill crane have been observed in wetlands and open water habitats in the Jasper East study area (Sumerlin 2005). Nearby Willow Creek Reservoir and Granby Reservoir support breeding Canada geese, mallards, and common mergansers (Kingery 1998).

Bald eagle winter concentration and winter foraging areas are present along the Colorado River and Willow Creek west and south of the Jasper East Reservoir study area and north of the Rockwell Reservoir site (CNDIS 2006). Two active nests are near Granby Reservoir. There is no habitat suitable for winter roosting, nesting, important foraging areas, or essential eagle habitat at the Jasper East or Rockwell Reservoir sites, but bald eagles could occasionally forage in the area.

No potentially suitable raptor nests were identified directly within the Jasper East study area during the 2004 and 2005 site visits. A series of three alternate golden eagle nests are located on Table Mountain, northeast of the reservoir site. One of these nests was active in 2007 (Sumerlin pers. com. 2007). An osprey nest is located on a platform approximately 1,000 feet east of the potential reservoir. Foraging osprey were observed during the 2004 site visit along the Willow Creek Pump Canal within the potential reservoir footprint.

Rockwell Study Area

The Rockwell study area contains habitat similar to Jasper East, although somewhat drier without irrigated meadows. Bald eagle habitat in the region is described previously under Jasper East Reservoir. The pipeline connection to Windy Gap Reservoir for Rockwell Reservoir would cross bald eagle winter range along the Colorado River. The stock pond and drainages provide habitat for wetland bird species.

Various waterfowl such as gadwall, American wigeon, and mallard may use the stock pond during different times of the year. Dry meadow and sagebrush habitat may support shrubland and ground-nesting species such as killdeer, Brewer's sparrow, and vesper sparrow.

3.12.1.7 Large Game and Other Wildlife

Large game wildlife such as deer, elk, pronghorn, bighorn sheep, mountain lion, and black bear are economically important species in Colorado. The Colorado Wildlife Commission through the CDOW is responsible for regulations and policies regarding game management and hunting.

No major large game migration routes exist within the East and West Slope study areas (CNDIS 2006 and SREP 2005), although ridgelines and drainages often serve as smaller movement corridors for game species as well as other wildlife species. The CDOW has identified and mapped the overall range of large game throughout Colorado. The CDOW has further identified seasonally important areas, including winter range, winter concentration areas, and severe winter range for several large game species within the study areas (CNDIS 2006). Winter range is defined as an area of land necessary for winter survival of large game species. Severe winter range is defined as, "winter range where 90 percent of the individuals are located when the annual snow pack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten." Winter concentration area is defined as "that part of the winter range where densities are at least 200 percent greater than the surrounding winter range density" (CNDIS 2006). Big game and other wildlife habitat in the study areas are described below.

Elk

Elk are an important big game species in Colorado. This species primarily inhabits the western two-thirds of the state, but is occasionally found east of the Front Range foothills (Fitzgerald et al. 1994). Elk are generally associated with forested areas adjacent to meadows, open parks, and tundra in the warmer months.

West Slope Study Areas. The Jasper East and Rockwell study areas contain the scattered meadow/forest habitat that provides elk overall range. Elk winter range and concentration areas occur on the south side of Jasper East. Nearby lands bordering the reservoir site also provide winter range and winter concentration areas for elk. No elk migration routes are present at the Jasper East site, but elk move across a broad area in the Willow Creek drainage, with seasonal movement and numerous road kills along U.S. Highway 34 to the east (Oldham, pers. comm. 2007). The Rockwell study area provides summer elk range and winter range on the west and northwest side of the reservoir site.

East Slope Study Areas. The Chimney Hollow and Dry Creek study areas contain overall range and winter range for elk. Elk winter concentration areas are located northeast of the Chimney Hollow Reservoir site. Elk in this region use a variety of habitat in the foothills, plains, and agricultural and residential areas. No summer concentration ranges occur near either study area.

The Ralph Price study area is located within elk overall winter and severe winter range. The north side of the reservoir provides winter concentration area. No important summer concentration or summer range is present.

Mule Deer

Mule deer is an important big game species in Colorado that occupies all ecosystems in Colorado from grasslands to alpine tundra (Fitzgerald et al. 1994). This species reaches it greatest densities in shrublands that provide abundant forage and cover.

West Slope Study Areas. The Jasper East and Rockwell study areas are located in mule deer summer range, although, mule deer likely visit these areas during all seasons. Mule deer winter range occurs southeast of the Jasper East Reservoir site and a small area of severe winter range overlaps the southern portion of the reservoir. Winter mule deer range is located east and west of the Rockwell study area.

East Slope Study Area. The Chimney Hollow and Dry Creek study areas are located in mule deer overall and summer range. Additionally, both study areas are located within winter concentration areas and overall winter range for mule deer. The Ralph Rice study area provides overall summer and winter range for mule deer.

White-tailed Deer

White-tailed deer are less widespread and more secretive than mule deer. The white-tailed deer occupies shrublands that provide plentiful forage and cover. White-tailed deer are often seen in riparian areas bordering larger streams and rivers. This species does not migrate in large numbers, but does move seasonally up and down river corridors in small numbers.

West Slope Study Areas. No white-tailed deer concentration areas occur within the Jasper East or Rockwell study areas. White-tailed deer are found along the Colorado River approximately 1 mile south of the Jasper East and along the Fraser River approximately ½ mile north of Rockwell. White-tailed deer occasionally may forage on both sites.

East Slope Study Area. The Chimney Hollow and Dry Creek study areas fall within the overall range for the white-tailed deer. No white-tailed deer concentration areas, winter, or summer ranges occur at either site. The Ralph Price Reservoir study area does not fall within the overall range for white-tailed deer.

Pronghorn

The pronghorn is a big game species in Colorado that inhabits grasslands and semi-desert shrublands on rolling topography that provides good visibility (Fitzgerald et al. 1994). Pronghorn tend to favor vast expanses of open areas and are typically sensitive to human presence.

West Slope Study Areas. The Jasper East and Rockwell study areas fall within the overall range for pronghorn. However, no identified seasonal ranges, migration corridors or seasonal concentration areas occur in either study area.

East Slope Study Areas. Both the Chimney Hollow and Dry Creek study areas fall within the overall range for pronghorn. No seasonal ranges, migration corridors or seasonal concentration areas have been identified in either study area. No large open meadow areas or seasonal ranges for pronghorn occur at Ralph Price Reservoir.

Bighorn Sheep

Bighorn sheep inhabit steep, rocky areas in the mountains of Colorado (Fitzgerald et al. 1994). Once thought to have ranged throughout the Colorado foothills and mountains, the sheep currently have sporadic distribution in locations throughout the higher mountains.

West Slope Study Areas. The nearest sheep population is north of the proposed Jasper East and Rockwell Reservoir sites near the Grand County boundary with Jackson and Larimer counties. It is unlikely that bighorn sheep migrate onto either study area because of a lack of suitable habitat.

East Slope Study Area. The nearest sheep population is located south and west of the Chimney Hollow and Dry Creek within Big Thompson Canyon and the western Larimer County boundary with Jackson County. It is unlikely that bighorn sheep migrate onto either study area because of the distance to the nearest population and a lack of suitable habitat.

Bighorn sheep have been observed approximately 5 miles west of the Ralph Price Reservoir (CNDIS 2006). Winter range is located on the west and southeast of the reservoir.

Black Bear

The black bear is Colorado's largest carnivore and inhabits montane shrublands and forests. It also is found in subalpine forests at moderate elevations, and even ranges from the edge of the alpine tundra to canyon country and lower foothills (Fitzgerald et al. 1994).

West Slope Study Areas. The Jasper East and Rockwell study areas are located within the overall range for black bear. A portion of the Jasper East reservoir footprint overlaps a black bear summer concentration area.

East Slope Study Area. The Chimney Hollow and Dry Creek study areas are located within the overall range for black bear. Both study areas also are located within a black bear fall concentration area. Black bear may occasionally forage on both of the sites at all times of the year. Because of the number of human residences and recreation areas, the CDOW has identified Carter Lake, located to the east and northeast of both study areas, as a black bear/human conflict area.

The Ralph Price Reservoir study area provides overall range for black bear. No human conflict areas or seasonal concentration areas occur immediately adjacent to the reservoir.

Mountain Lion

This species typically inhabits rocky outcroppings and ridges near the foothill and mountain areas of the state. Mountain lions prey mainly on deer, as well as elk and other ungulates in North America and their distribution and movements correspond to their ungulate prey (Fitzgerald et al. 1994).

West Slope Study Areas. The Jasper East and Rockwell study areas occur within the overall range for mountain lion; however, this species typically favors rocky outcroppings, not the open meadow and sage habitat located in the study areas.

East Slope Study Area. The Chimney Hollow and Dry Creek study areas occur within the overall range for the mountain lion and tracks of a female lion with two cubs were observed during field studies at Chimney Hollow. Mountain lion typically favor rocky outcroppings, such as the hogbacks west and east of the reservoir sites. It is likely that lions prey on mule deer and other animals near and in the Chimney Hollow and Dry Creek study area. Because of the density of human residences and recreation areas, human conflict areas occur around Carter Lake and Flatiron Reservoir north and east of the Chimney Hollow study area. Human conflict areas also occur south of the Dry Creek study area.

Ralph Price Reservoir is located within the mountain lion overall range. No concentration areas or human conflict areas are located nearby.

Moose

Moose were introduced to the state in 1978. This species inhabits high elevation meadows and boreal forest edges in northern and central Colorado (Fitzgerald et al. 1994).

West Slope Study Areas. Moose overall range includes the Jasper East and Rockwell study areas. Moose winter range and winter concentration areas occur north of the Jasper East Reservoir site.

No seasonal ranges or concentration areas within 5 miles of Rockwell are present. Winter range and winter concentration areas are located about 8 miles southwest of the Rockwell site.

East Slope Study Areas. The Chimney Hollow, Dry Creek, and Ralph Price study areas are located outside of the overall range for moose in Colorado.

Other Wildlife

West Slope Study Areas. Both the Jasper East and Rockwell study areas provide habitat for a variety of other mammals. Larger mammals likely to use habitat in either study area include coyote, red fox, badger, raccoon, porcupine, and bobcat. Smaller mammals such as deer mouse, mountain cottontail, montane vole, and northern pocket gopher are likely to be present in the study areas.

East Slope Study Area. The Chimney Hollow Dry Creek, and Ralph Price study areas provide habitat for species similar to those mentioned for the West Slope study area. Coyote, red fox, raccoon, bobcat and porcupine all likely occur on these sites. Smaller mammals, such as cottontail rabbit, deer mouse, northern pocket gopher and amphibians and reptiles, including Woodhouse toad, and bullsnake potentially use habitat within these study areas. Wildlife endemic to ponderosa pine or Front Range canyon habitats include long-eared myotis, rock squirrel, northern rock mouse, and Mexican woodrat.

3.12.2 Environmental Effects

3.12.2.1 Issues

Wildlife issues of concern included the potential loss and fragmentation of habitat and potential effects to big game species, raptors and other birds, and sensitive species.

3.12.2.2 Method for Effects Analysis

The potential effect on wildlife resources was evaluated for each alternative. Effects were assessed using information on known populations or suitable habitat. Colorado NDIS habitat ranges and distribution were overlain on maps showing project features to determine the potential loss of habitat. Permanent impacts to wildlife habitat could occur in areas that are inundated or permanently filled by project features such as the dam, access roads, and pump stations. Temporary impacts to habitat could occur in areas that would be reclaimed following construction, such as pipeline routes and staging areas. Effects to waterbirds and aquatic and riverine mammals from changes in hydrology were based on potential effects to riparian vegetation as discussed in Section 0. The following effects discussion focuses on wildlife species or habitat most likely to be affected by potential alternatives.

3.12.2.3 Potential Wildlife Effects Common to All Alternatives

Changes in Stream and Reservoir Hydrology

Each alternative would result in changes in C-BT and Windy Gap storage and release from the primary C-BT reservoirs—Granby Reservoir, Carter Lake, and Horsetooth Reservoir. In addition, the action alternatives would create one to two new reservoirs and the No Action alternative would enlarge an existing reservoir. All alternatives would result in changes in streamflow in the Colorado River below Granby Reservoir and small changes in streamflow to East Slope streams. Potential effects to wildlife for West Slope and East Slope streams and for existing and new reservoirs are discussed below. The *Aquatic Resource* section discusses effects to aquatic species.

West Slope Streams. Each alternative would result in increased stream diversions from the Colorado River and changes in releases from Granby Reservoir. Changes in streamflow would have no direct effect on terrestrial wildlife habitat. Potential indirect effects are possible if changes in streamflow result in a change in vegetation composition or characteristics in the riparian areas bordering the Colorado River or Willow Creek that are used by wildlife. Based on the analysis of changes in streamflow and stream geomorphology, measurable changes in vegetation composition are unlikely for any alternative (Section 0). As a result, a change in streamflow in the Colorado River and Willow Creek under any alternative is unlikely to affect terrestrial wildlife resources because there would be no adverse effect to habitat.

East Slope Streams. Minor increases in streamflow would occur in several East Slope streams as Participants use Windy Gap water and increase their WWTP discharges. Changes in streamflow for the Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek would fall well within the range of historical flows under all alternatives and are unlikely to substantially change stream channel characteristics, or vegetation composition; hence, changes in streamflow are unlikely to affect wildlife habitat.

Existing Colorado-Big Thompson Reservoirs. The availability of additional storage for Windy Gap water under all alternatives would reduce the use of storage by Windy Gap and C-BT (under the Proposed Action) in Granby Reservoir, Carter Lake, and Horsetooth Reservoir by varying amounts. The largest change in storage would occur under the Proposed Action, because prepositioning would allow storage of C-BT water in Chimney Hollow Reservoir. The smallest change would occur under the No Action alternative, which has the smallest increase in Windy Gap firming storage with the enlargement of Ralph Price Reservoir. Existing reservoirs would continue to operate within the historical range of seasonal and annual variability depending on precipitation, evaporation, and water demand. Terrestrial wildlife are not dependent on reservoir levels and would not be directly affected by fluctuations in reservoir elevations. Lower reservoir levels would reduce available habitat for waterfowl, but it is unlikely that lower reservoir levels would adversely affect breeding or foraging habitat.

New Reservoirs. Enlargement of Ralph Price Reservoir or the construction of Chimney Hollow Reservoir, Dry Creek Reservoir, Jasper East Reservoir, or Rockwell Reservoir would increase open water habitat for waterfowl, bald eagles, and osprey. Chimney Hollow Reservoir and Dry Creek Reservoir would have the most stable lake levels, which would most benefit these species. West Slope reservoirs would fluctuate more on a seasonal and annual basis, but would still provide habitat beneficial to waterfowl and raptors that forage on fish or waterfowl. Improved waterfowl habitat could increase the production of nuisance species, such as Canada geese. Conversely, waterfowl populations could indirectly provide improved waterfowl hunting opportunities at locations other than the reservoir sites. The lack of hunting waterfowl at a new reservoir would create a refugia that could further increase conflicts with nuisance geese.

Construction Disturbance

All alternatives involve earthmoving, heavy equipment, noise, and other disturbances during construction of dams and other facilities, which would displace wildlife. These disturbances would have a direct impact to burrows, dens, and possible mortality of small less mobile mammals, reptiles, and amphibians. More mobile mammals and birds would be displaced from disturbed habitat. Construction activity would indirectly affect wildlife behavior in the vicinity. Tolerance to disturbance varies by species and individuals, but behavioral responses range from habituation to activity, to complete avoidance of undisturbed habitat near the construction site, or increased movement and expenditure of energy reserves. The indirect displacement of wildlife during construction would be a temporary effect, but would last about 3 years depending on the alternative.

3.12.2.4 Alternative 1—Ralph Price Reservoir (No Action)

State Threatened, Endangered and Species of Concern

Reservoir enlargement would inundate about 0.1 acre of riparian vegetation on North St. Vrain Creek that could provide habitat for northern leopard frog and common gartersnake. Projected minor changes in streamflow below the reservoir would not measurably affect riparian vegetation or habitat for leopard frog or gartersnake. No peregrine falcon habitat would be affected. Potential Townsend's big-eared bat habitat could be impacted if rocky areas bordering the reservoir are inundated.

CNHP Species

Yellow stonecrop, the host plant for the butterfly Moss' elfin, could potentially occur within the area of inundation, although habitat for the stonecrop is marginal.

Migratory Birds and Raptors

Reservoir expansion would inundate potential foraging and nesting habitat for some migratory birds, primarily tree-nesting birds. No known raptor nests would be affected, but suitable habitat is present for northern goshawk, Cooper's hawk, flammulated owl, and red-tailed hawk. There would be no impact to any existing bald eagle nesting or roosting sites. Reservoir drawdown during construction would temporarily reduce bald eagle foraging opportunities. Bald eagle, osprey and waterfowl would benefit slightly from a larger reservoir.

Large Game and Other Wildlife

Ralph Price Reservoir expansion would result in a permanent loss of about 77 acres of elk winter range, including 4 acres of elk winter concentration area. The same amount of mule deer summer and winter range and overall range for white-tailed deer, black bear, and mountain lion would also be lost. No areas of severe winter range, which is the most critical to large game would be affected. Winter range for elk and mule deer is widespread throughout Boulder County; thus, populations of these big game species are unlikely to be adversely affected by the habitat loss. No seasonal ranges for back bear or mountain lion would be affected. Additional temporary effects to big game habitat are possible if borrow areas outside the reservoir footprint are needed. The expansion of the existing reservoir would not substantially affect wildlife movement or fragment habitat.

Other wildlife species potentially displaced with reservoir expansion include coyote, red fox, cottontail rabbit and species common in ponderosa pine and Douglas-fir habitat such as long-eared myotis, porcupine, rock squirrel, northern rock mouse, southern red-backed vole, and Mexican woodrat.

3.12.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

State Threatened, Endangered and Species of Concern

The loss of about 2.5 acres of wetland and creek habitat from reservoir construction would affect potential northern leopard frog habitat. A leopard frog was observed along Dry Creek and similar, but lower quality habitat is present at Chimney Hollow. Common gartersnake, which also uses wetland habitat as well as mesic woodlands and shrublands, also could be affected by the loss of about 50 acres of suitable habitat. Replacement of lost wetland habitat and natural riparian development around the new reservoir could potentially offset some of the lost habitat for leopard frog and gartersnake.

The loss of grassland and shrubland habitat would reduce habitat for potential prey species of ferruginous hawk and peregrine falcon that may occasionally forage or migrate over this area. This alternative is unlikely to adversely affect these species because of the lack of documented breeding activity in the area and the availability of alternative prey nearby. Potential nest habitat for peregrines on the hogback east of Chimney Hollow would not be affected. The Chimney Hollow site contains limited potential habitat at the periphery of the Townsend's big-eared bat's range and there are no records of occurrence.

CNHP Species

Suitable habitat for several butterfly species would be affected by construction of Chimney Hollow Reservoir and facilities. There would be a loss of about 390 acres of native grassland and shrubland habitat that contains areas of blue grama grass used by simius road skipper and rhesus skipper. Argos skipper, dusted skipper, ottoe skipper, and cross-line skipper use big bluestem and little bluestem grassland habitat. There would be a loss of ponderosa pine and native grassland habitat where scattered patches of these grasses are present. The loss of about 270 acres of shrublands would affect potential habitat used by mottled duskywing.

Migratory Birds and Raptors

Construction of Chimney Hollow Reservoir would affect nesting and foraging habitat for several migratory birds and raptors. There would be a permanent loss of about 400 acres of upland forest and shrub habitat, in which raptors such as Swainson's hawk and red-tailed hawk and other species such as black-billed magpie and American crow could nest. The loss of 40 acres of mesic native woodland habitat and riparian areas along Chimney Hollow would reduce potential foraging and breeding habitat for migratory bird species such as American robin, red-winged and yellow-headed blackbirds, and Bullock's oriole. Inundation or disturbance of about 340 acres of upland and mesic grassland habitat would reduce habitat for ground-nesting species such as killdeer, mourning dove, and western meadowlark. The loss of habitat would displace species that have historically nested in these habitats.

The disturbance of about 150 acres of various habitats from pipeline construction, staging areas, and other temporary activities would have a short-term effect on potential bird habitat until sites are revegetated. Clearing of about 43 acres of forest under the transmission line would reduce available habitat for tree- and cavity-nesting birds. Western would design the transmission line in conformance with Suggested Practices for Protection of Raptors on Power lines (APLIC 1994) and Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006 (APLIC 2006).

Approximately 7 acres of bald eagle winter range would be disturbed from construction of a southern access road. This road would be located within an existing transmission line maintenance road and may be partially reclaimed following construction. The new reservoir would result in a beneficial long-term effect to bald eagles by creating open water foraging habitat once a fish population is established. The loss of winter range would have a minor effect on bald eagles, while the construction of new open water habitat would have a long-term beneficial effect.

There would be no direct effect on golden eagle nest sites located on the hogback ridge to the east, although foraging habitat would be reduced with the loss of terrestrial habitat that supports small mammal prey species. Noise and visual disturbance during construction could affect normal behavior of golden eagles during the breeding season; however, all construction would be outside CDOW's recommended ¼-mile buffer. No known raptor nests would be affected, but the loss of riparian woodlands along the Chimney Hollow drainage would eliminate potential nest and roost sites for raptors and other birds.

Osprey, and waterfowl, such as mallard, double-crested cormorant, and gadwall, would benefit from additional open water habitat.

Large Game and Other Wildlife

There would be a permanent loss of about 810 acres of elk winter range, mule deer winter range and concentration areas and mule deer summer range from reservoir construction. Loss of winter range would reduce the availability of forage and increase competition for limited forage resources during winter. The loss of elk and mule deer winter range represents about a 0.2 percent loss of available winter range within CDOW Game Management Unit 20, which encompasses Larimer County and northern Boulder County. The Chimney Hollow study area occurs within the overall range of white-tailed deer, but there would be no effect to winter or summer ranges.

There would be a loss of about 810 acres of black bear fall concentration area, which would reduce foraging opportunities. The loss of foraging would be offset partially by increased opportunities to forage on fish and waterfowl attracted to reservoirs. There would be no effect to mountain lion seasonal ranges. Expansion of existing mountain lion/human conflict areas north of the reservoir site and black bear/human conflict areas area Carter Lake is possible with planned recreation activity in the area.

A new reservoir in the Chimney Hollow valley would fragment existing habitat for some mammals. Elk winter range and black bear fall concentration areas on the east side of Chimney Hollow may be more difficult to access due to the new reservoir and topographic constraints. Although no designated migration corridors for big game would be disrupted, Chimney Hollow Reservoir would alter local movement patterns by deer, elk, and other wildlife.

Other common mammals that would be displaced include coyote, red fox, cottontail rabbit, long-eared myotis, rock squirrel, northern rock mouse, Mexican woodrat, and other small mammals.

3.12.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Construction of a 70,000 AF Chimney Hollow Reservoir would have effects to wildlife similar to those described for Alternative 2; however, the permanent loss of terrestrial habitat would decrease to about 670 acres and the temporary effect would be about 145 acres. Specific differences include a slight reduction in the loss of wetland and water habitat potentially used by northern leopard frog and common gartersnake. There would be a loss of about 675 acres of elk winter range, mule deer summer, winter, winter concentration areas, and black bear fall concentration areas. Impacts to bald eagles and golden eagles during construction would be the same as Alternative 2.

The following discussion pertains to the effect from construction of Jasper East Reservoir.

State Threatened, Endangered and Species of Concern

The Jasper East Reservoir site does not contain quality habitat for boreal toad, wood frog, and northern leopard frog and none were found in field surveys, but there would be a loss of about 22 acres of potential habitat in wetlands and waters. There would be no effect to potential breeding habitat for ferruginous hawks, which may migrate through the area in the winter, or to peregrine falcons that are not known to nest in Grand County. The loss of hayfields and wetlands is unlikely to adversely affect sandhill crane, which prefers grain fields with better forage and nesting habitat that is not mowed. There would be a loss of about 125 acres of native sagebrush shrublands and a temporary impact on 35 acres that could provide habitat for greater sage grouse. There would be no effect to any known sage grouse populations, but the loss of potentially suitable habitat could affect eastward expansion of a sage grouse population located west of Jasper East.

CNHP Species

The loss of sagebrush habitat would reduce suitable foraging habitat for the sage sparrow, which may migrate through the area.

Migratory Birds and Raptors

The loss of about 190 acres of grasslands and 129 acres of shrublands would reduce available foraging and nesting habitat for birds such as spotted towhee, savannah sparrow, and other ground-nesting birds. The loss of about 14 acres of upland forest would reduce habitat for tree- and cavity-nesting species. The disturbance to about 128 acres from pipelines and construction staging would temporarily displace birds from potential foraging and nesting sites.

Road construction would affect about 3 acres of bald eagle winter range, and pipeline construction would temporarily affect about 5 acres of bald eagle winter range. The temporary disturbance of winter range would have a short-term minor effect on bald eagles. Construction of new open water habitat would have a long-term beneficial effect by increasing bald eagle foraging habitat.

There would be no effect to the golden eagle nest site located on a bluff to the east of the Jasper East reservoir site. This alternate nest site was active in 2007, but is more than 1 mile from the reservoir site. No other known raptor nest would be affected.

Jasper East Reservoir would provide additional foraging habitat for osprey and waterfowl.

Large Game and Other Wildlife

There would be a loss of about 480 acres of moose and mule deer summer range from construction of Jasper Reservoir. Summer range is not a limiting factor for either of these species, and the loss of a very small portion of summer range would not have any measurable effect on mule deer or moose populations. Relocation of the Willow Creek pump station and canal would affect about 16 acres of moose winter range and winter concentration area. The reservoir would impact about 24 acres of elk winter range. The very small loss of these winter ranges would not have any measurable effect on populations. Additional temporary impacts include disturbance of 85 acres of moose and mule deer summer range and 17 acres of elk winter range and concentration area. Overall range for white-tailed deer would be lost.

There would be a loss of about 93 acres and a temporary impact to 19 acres of black bear summer concentration area. No mountain lion seasonal range or concentration areas would be affected.

Construction of Jasper East Reservoir would displace some widely dispersed and common wildlife species.

3.12.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Effects to wildlife for Chimney Hollow Reservoir under Alternative 4 would be the same as Alternative 3. The effects below pertain to Rockwell Reservoir.

State Threatened, Endangered and Species of Concern

Construction of Rockwell Reservoir would result in the loss of about 17 acres of wetland and riparian habitat that potentially could provide habitat for boreal toad, wood frog, and northern leopard frog. The site is geographically separated from other boreal toad populations; therefore, effects are unlikely. Wood frogs are unlikely to be affected because they typically prefer higher elevation marshes that provide better quality habitat than at Rockwell. There would be no effect to potential breeding habitat for ferruginous hawk, which may migrate through the area in the winter, or peregrine falcon, which is not known to nest in Grand County. Sandhill cranes are unlikely to be affected because of a lack of suitable habitat. The loss of about 290 acres of sagebrush habitat within a sage grouse production and brood rearing area would adversely affect a declining sage grouse population.

CNHP Species

The loss of sagebrush habitat would reduce suitable foraging habitat for sage sparrow that may migrate through the area.

Migratory Birds and Raptors

The loss of about 297 acres of shrubland habitat would reduce foraging and nesting habitat for species such as Brewer's sparrow and vesper sparrow. Removal of about 14 acres of lodgepole pine forest would reduce habitat for cavity-nesting species. The loss of about 17 acres of riparian habitat along Rockwell and Mueller Creek would reduce habitat for species such as, pine siskin, white-crowned sparrow, and western wood pewee. Pipeline construction and staging areas would temporarily disturb about 105 acres of potential habitat used by various bird species.

The Rockwell Reservoir pipeline connection to Windy Gap Reservoir in Alternatives 4 and 5 would cross bald eagle winter range and winter concentration areas along the Colorado River. Construction of new open water habitat at Rockwell Reservoir would have a long-term beneficial effect by increasing bald eagle foraging habitat.

No known raptor nests would be affected, but suitable foraging habitat is present and forested areas provide roost and perch sites. A new reservoir would provide breeding foraging habitat for waterfowl and other waterbirds.

Large Game and Other Wildlife

There would be a permanent loss of about 312 acres of summer range for moose and mule deer. Summer range is not a limiting factor for either of these species, and the loss of a very small portion of summer range would not have any measurable effect on mule deer or moose populations. The reservoir would permanently impact about 73 acres of elk winter range and 82 acres of summer range. The loss of elk winter range represents a loss of less than

0.1 percent of available winter range within CDOW Game management Unit 18 in Grand County. Temporary disturbance to 56 acres of elk summer range and 9 acres of elk winter range would occur at borrow areas and along the pipeline route. Overall range for white-tailed deer would be lost. There would be no impact to black bear or mountain lion seasonal ranges, although these species may use habitat in the area.

Reservoir construction would displace widely dispersed wildlife species such as coyote, gray fox, and black-tailed jack rabbit, and striped skunk.

3.12.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

The effect to wildlife resources from construction of a 30,000 AF Rockwell Reservoir would be similar, but slightly greater than those described for the smaller reservoir in Alternative 4. There would be a permanent loss of wildlife habitat of about 390 acres and a temporary loss of about 69 acres of wildlife habitat. Key differences include a permanent impact to 334 acres of sage grouse breeding and brood rearing habitat, which would affect the existing population. The loss of moose and mule deer summer range would increase to about 393 acres and about 97 acres of elk winter range would be lost. The loss of elk winter range represents about 0.15 percent of the available winter range in CDOW Game Management Unit 18 in Grand County.

The remainder of this section discusses effects to wildlife from construction of Dry Creek Reservoir.

State Threatened, Endangered and Species of Concern

The loss of about 8.5 acres or wetland and water habitat from Dry Creek Reservoir construction would affect known northern leopard frog habitat. Common gartersnake, which also uses wetland habitat as well as mesic woodlands and shrublands, also could be affected by the loss of about 30 acres of suitable habitat. Replacement of lost wetland habitat and riparian development around the new reservoir could potentially offset some of the lost habitat for leopard frog and gartersnake.

The loss of grassland and shrubland habitat would reduce potential foraging habitat for ferruginous hawk and peregrine falcon. Potential nesting, migration, and roosting habitat for peregrines on the hogback east of Dry Creek would not be affected. The loss of potential foraging habitat is unlikely to adversely affect these species because of the lack of documented activity in the area. The Dry Creek site contains limited potential habitat at the periphery of the Townsend's big-eared bat's range, but there are no records of this species' occurrence in the study area.

CNHP Species

Suitable habitat for several butterfly species would be affected by construction of Dry Creek Reservoir and facilities. There would be loss of about 239 acres of native grassland and shrubland habitat that contains areas of blue grama grass used by simius road skipper and rhesus skipper. Argos skipper, dusted skipper, ottoe skipper, and cross-line skipper habitat would be affected by the loss of ponderosa pine and native grasslands that contain areas of big bluestem and little bluestem grasses. The loss of about 162 acres of shrublands would affect potential habitat used by mottled duskywing.

Migratory Birds and Raptors

Construction of Dry Creek Reservoir would affect nesting and foraging habitat for several migratory birds and raptors. A permanent loss of about 200 acres of ponderosa pine forest would reduce available habitat for American crow, pygmy nuthatch, Steller's jay, and other forest-nesting species. The loss of about 400 acres of shrubland and grassland would affect habitat used by western meadowlark, morning dove, savannah sparrow, and other ground-nesting birds. The loss of about 30 acres of woodlands and wetlands along Dry Creek would affect potential habitat for raptors, magpies, robins, goldfinch, and a variety of small birds. A red-tailed hawk nest located along Dry Creek would be lost. There would be no affect to a golden eagle nest located more than 3 miles away on the hogback to the east, although there would be loss of foraging habitat.

There would be a permanent impact to about 165 acres of bald eagle winter range and temporary disturbance of 40 acres of winter range. Construction of the spillway would affect less than 1 acre of bald eagle winter concentration area. The loss of winter range would reduce terrestrial habitat for bald eagle foraging while the construction of a new reservoir would have a long-term beneficial effect by creating open water foraging habitat.

The disturbance of about 158 acres of various habitats from pipeline construction, staging areas, and other temporary activities would have a short-term effect on potential bird habitat until sites are revegetated.

Osprey, and waterfowl, such as mallard, double-crested cormorant, and gadwall, would benefit from additional open water habitat.

Large Game and Other Wildlife

About 650 acres of elk winter range, mule deer summer range, and mule deer winter range and winter concentration areas would be lost permanently. The loss of this small portion of the overall available winter range would not have any measurable effect on elk or mule deer populations. The loss of elk and mule deer winter range represents a loss of less than 0.2 percent of available winter range within CDOW Game Management Unit 20, which encompasses southern Larimer County and portions of northern Boulder County. Pipeline construction and construction staging would temporarily impact approximately 158 acres of elk winter range, mule deer summer range, and mule deer winter range and winter concentration areas. White-tailed deer overall range would be impacted, but no seasonal ranges would be affected.

There would be a permanent impact to 619 acres of black bear fall concentration area and overall mountain lion range. The loss of this small portion of the overall available range would not have a measurable effect on bear populations. Temporary impacts would occur to about 69 acres of black bear fall concentration area. Human conflict areas for black bear and mountain lions are possible if recreation use is developed at Dry Creek Reservoir.

Other common mammals that would be displaced include coyote, red fox and cottontail rabbit, as well as species endemic to ponderosa pine habitats, such as long-eared myotis, rock squirrel, northern rock mouse, Mexican woodrat, and other small mammals.

3.12.3 Cumulative Effects

Cumulative effects to wildlife focused on the loss or change in habitat associated with reasonably foreseeable land-based developments within 5 miles of each of the alternative reservoir locations (Figures 2-15 and 2-16). A 5-mile analysis area was used because many species of wildlife use a range of habitats over a wide area. Use of a broad study area provides an indication of the cumulative regional impact to wildlife within about an 80 square mile area surrounding each alternative reservoir site. Indirect effects to terrestrial wildlife from water-based reasonably foreseeable actions are not expected to measurably affect riparian vegetation that provides habitat for some wildlife species as discussed in Section 3.12.2.3. Potential cumulative effects to wildlife are discussed for each alternative.

Alternative 1—Ralph Price Reservoir (No Action)

Wildlife habitat near Ralph Price Reservoir has been affected by the original reservoir construction, which inundated about 1.5 miles of North St. Vrain Creek and adjacent upland habitat and created about 220 acres of open water habitat. No reasonably foreseeable actions were identified within 5 miles of the reservoir that would result in a cumulative effect to wildlife.

Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Wildlife resources and habitat near the Chimney Hollow Reservoir have been affected by historical livestock operations and nearby land development such as construction of Carter Lake, Flatiron Reservoir, and other C-BT facilities, Bureau of Reclamation offices, rural residential development, and roads. Reasonably foreseeable future development includes about 1,440 acres of primarily residential development and other surface disturbances within about 5 miles of the Chimney Hollow Reservoir site (Figure 2-16). In addition to construction of Chimney Hollow Reservoir, these developments would result in a cumulative effect to about 2,240 acres of terrestrial wildlife habitat. Reasonably foreseeable future land developments are unlikely to completely eliminate existing wildlife habitat, but a reduction in wildlife value for some species is likely.

A cumulative loss of potentially suitable habitat for state species of concern—northern leopard frog and common gartersnake—is possible if riparian habitat is affected at future developments. The loss of grasslands at future developments could reduce potential foraging habitat for ferruginous hawk. A cumulative effect to other state species is unlikely because no suitable habitat to support these species is present in the region or there would be no effect on these specific species from construction of Chimney Hollow Reservoir.

Reasonably foreseeable land developments near Chimney Hollow Reservoir would affect about 66 acres of elk winter range. The loss of about 800 acres of elk winter range with construction of Chimney Hollow Reservoir would result in a cumulative regional loss of about 866 acres of winter foraging habitat for elk. The loss of elk winter range represents about a 0.2 percent impact on available winter range within CDOW Game Management Unit 20. Cumulative effects to mule deer winter range and winter concentration areas would include a loss of 800 acres from construction of Chimney Hollow Reservoir and an impact of about 1,290 acres from reasonably foreseeable land developments for total cumulative effect of about 2,090 acres. This represents a cumulative effect to about 0.6 percent of available mule deer winter range within CDOW Game Management Unit 20.

Reasonably foreseeable future developments within about 5 miles of Chimney Hollow Reservoir could affect about 1,375 acres of bald eagle winter range. This, in addition to the loss of 7 acres of winter range from construction of Chimney Hollow Reservoir and facilities under the Proposed Action, would result in a cumulative impact to about 1,382 acres of bald eagle winter range.

The cumulative loss of undeveloped upland areas would reduce available habitat for migratory birds, particularly ground- nesting species. There would be a cumulative loss of terrestrial nongame wildlife habitat for small and medium sized mammals. The cumulative loss and change in wildlife habitat would fragment wildlife habitat, which could disrupt animal travel corridors, reduce available foraging and breeding habitat, and displace some wildlife species.

Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow. Construction of a 70,000 AF Chimney Hollow Reservoir would result in a cumulative loss of terrestrial wildlife habitat of about 2,115 acres. This includes the loss of about 675 acres from construction of the reservoir, dam, and spillway and 1,440 acres of reasonably foreseeable land development within 5 miles of the reservoir site. The potential effects to wildlife would be similar to Alternative 2. The cumulative loss of elk winter range would be about 741 acres of elk winter range including the loss of 675 acres with construction of Chimney Hollow Reservoir and 66 acres from reasonably foreseeable developments. Cumulative effects to mule deer winter range and winter concentration areas would include a loss of 675 acres from construction of Chimney Hollow Reservoir and an impact of about 1,290 acres from reasonably foreseeable land developments in the region for a total cumulative effect of about 1,965 acres.

A 70,000 AF Chimney Hollow Reservoir would result in a loss of bald eagle winter range similar to Alternative 2 and a cumulative increase in open water foraging habitat of about 625 acres.

Jasper East. Wildlife habitat at the Jasper East Reservoir site has been influenced by irrigation and mowing of pasture lands, construction of the Willow Creek Canal, pump station, and forebay, and the presence of County Road 40, which bisects the property. Reasonably foreseeable future development within about 5 miles of the Jasper East Reservoir site includes about 1,590 acres of land development southwest of the Town of Granby and 980 acres of planned residential development at the C-Lazy-U Preserves located just north of the reservoir site. The cumulative effect to terrestrial wildlife habitat from construction of an approximately 485-acre Jasper East Reservoir and future land development would total about 3,005 acres. However, some developments such as the C-Lazy-U Preserve include areas of undisturbed open space that would continue to provide habitat value for wildlife.

A cumulative loss of potentially suitable habitat for sage grouse is possible from the loss of about 125 acres of sagebrush habitat at Jasper East in addition to an unknown loss of sagebrush from future development at C-Lazy-U Preserve.

Cumulative impacts to elk winter range include the loss of about 24 acres from reservoir construction and 1,230 acres from future land development. This represents a cumulative impact to about 1.5 percent of available elk winter range in Game Management Unit 18. The cumulative effect to moose winter range would be about 327 acres—16 acres from construction of Jasper East Reservoir and 311 acres from nearby future land developments. The cumulative effect to moose winter range would be about 1.2 percent of available range in Game Management Unit 18.

Reasonably foreseeable future land development south of Jasper East Reservoir could affect about 222 acres of bald eagle winter range including 55 acres of winter concentration area. Construction of Jasper East Reservoir would add about 3 acres to the cumulative effect on bald eagle winter range.

There would be a cumulative loss of terrestrial nongame wildlife habitat including potential fragmentation of wildlife habitat, which could disrupt animal travel corridors, reduce available foraging and breeding habitat, and displace some wildlife species

Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Chimney Hollow. The cumulative effect to wildlife resources at Chimney Hollow Reservoir under this alternative would be the same as described for Alternative 3.

Rockwell. Wildlife habitat in the 20,000 AF Rockwell Reservoir site has been affected in the past by low density residential housing, roads, and livestock grazing. Reasonably foreseeable future development within about 5 miles of the Rockwell Reservoir site includes residential, commercial, and mixed development at Grand Elk and Granby Ranch. Future development encompasses areas of existing development, but further infill of these lands is expected. The total cumulative regional effect on terrestrial wildlife habitat including reasonably foreseeable land development and construction of Rockwell Reservoir would be about 5,105 acres. This includes the loss of about 335 acres from construction of the reservoir, dam, and spillway and 4,770 acres of reasonably foreseeable land development.

There would be a cumulative impact to about 740 acres of sage grouse production area consisting of the loss of about 290 acres from construction of Rockwell Reservoir and 450 acres from other reasonably foreseeable actions. The cumulative loss of sage grouse habitat could result in the complete loss of this declining population. A cumulative effect to other state species is unlikely because no suitable habitat is present in the region or there would be no effect from construction of Rockwell Reservoir.

A cumulative loss in elk winter range of about 3,173 acres would occur from the loss of about 73 acres from construction of Rockwell Reservoir and 3,100 acres from development on nearby lands. The cumulative impact to elk winter range would affect about 4.1 percent of the available winter range in Game Management Unit 18.

The Rockwell Reservoir pipeline to Windy Gap Reservoir would temporarily affect a bald eagle winter concentration area, but would not add to any permanent cumulative effects from other land developments in the region.

Much of the land within areas of reasonably foreseeable future development has already been disturbed, although additional development would further reduce these lands' suitability for wildlife use. Construction of Rockwell Reservoir site would contribute to the loss of upland terrestrial habitat, but would provide open water habitat for waterfowl and foraging habitat for bald eagles and osprey.

Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek. The Dry Creek Reservoir site is mostly undeveloped land and currently supports a few scattered homes, unpaved roads, and a small llama ranch. Historically, livestock grazing also influenced the condition of the area. Reasonably foreseeable actions within about 5 miles of Dry Creek Reservoir would be about 1,460 acres of land that is under county development review for subdivision, dispersed residential development, commercial development, and/or special review for a proposed change in land use.

The total cumulative impact to terrestrial wildlife habitat would be about 2,091 acres. This consists of the loss of about 630 acres from construction of the Dry Creek Reservoir, dam, and spillway and 1,460 acres of reasonably foreseeable land development. Dry Creek Reservoir would provide about 590 acres of open water habitat for waterfowl, shore birds, bald eagles, and aquatic species. Future land developments are unlikely to completely eliminate existing wildlife habitat, but a reduction in wildlife value for some species is likely.

A cumulative loss of habitat for two state species of concern—northern leopard frog and common gartersnake—is possible if riparian habitat is affected at future developments. The loss of grasslands at future developments could reduce potential foraging habitat for ferruginous hawk. A cumulative effect to other state species is unlikely because no suitable habitat is present in the region or there would be no effect from construction of Dry Creek Reservoir.

The cumulative loss of undeveloped upland areas would reduce available habitat for migratory birds and in particular ground-nesting species because most of the reasonably foreseeable land development would be in open grasslands.

Cumulative effects to elk winter range would be 630 acres from construction of Dry Creek Reservoir and 52 acres from reasonably foreseeable land development for a total impact of about 682 acres. The loss of elk winter range represents less than a 0.2 percent impact on available winter range within CDOW Game Management Unit 20. The cumulative effect on mule deer winter range and concentration areas would be about 1,934 acres consisting of impacts of 630 acres from reservoir construction and 1,304 acres from future development. This represents a cumulative effect to about 0.5 percent of available mule deer winter range within CDOW Game Management Unit 20.

Reasonably foreseeable land developments near Dry Creek Reservoir could affect about 1,409 acres of bald eagle winter range. Construction of Dry Creek Reservoir would add 165 acres of impact to bald eagle winter range for a cumulative effect of 1,574 acres.

The cumulative loss of terrestrial habitat for wildlife in the region would reduce available foraging and breeding habitat for upland species, as well as fragmenting existing areas of available wildlife habitat.

Rockwell. Construction of a 30,000 AF Rockwell Reservoir would result in a cumulative impact to about 5,196 acres of terrestrial wildlife habitat from about 4,770 acres of reasonably foreseeable land development and the 425-acre Rockwell Reservoir.

There would be a cumulative impact to about 784 acres of sage grouse production area from the 334 acres lost from reservoir construction and 450 acres potentially disturbed by other reasonably foreseeable actions. The cumulative loss of sage grouse habitat could result in the complete loss of this declining population.

A cumulative loss in elk winter range of about 3,197 acres would occur from the loss of about 97 acres at Rockwell Reservoir and from development of 3,100 acres on nearby lands. The cumulative loss in elk winter range would affect about 4.5 percent of the available winter range in Game Management Unit 18.

The Rockwell Reservoir pipeline to Windy Gap Reservoir would temporarily affect a bald eagle winter concentration area, but would not add to any permanent cumulative effects from other land developments in the region.

3.12.4 Proposed Mitigation

Several mitigation measures would be used for all alternatives to reduce potential effects to wildlife resources, including:

- The area of disturbance would be minimized and all temporary disturbances would revegetated.
- Areas of sensitive wildlife habitat (i.e., wetlands and sage grouse habitat at Rockwell) outside of project disturbance limits would be protected.
- Habitat-disturbing activities (such as tree removal, grading, scraping, and grubbing) would be conducted outside of the nesting season for migratory birds (August through February) to avoid disturbing (or take) of a migratory bird nest if possible. Surveys for nesting species would be conducted prior to disturbance during the nesting season.
- Recreation facilities at new reservoirs would have a plan for disposing trash to avoid attracting wildlife or creating conflicts with human use.

- Opportunities for wildlife enhancement at reservoir sites will be coordinated with CDOW.
- Pipeline construction across the Colorado River for Rockwell Reservoir under Alternatives 4 and 5 would be coordinated with the Corps, CDOW and FWS to minimize effects to wintering bald eagles. A late summer-early fall crossing would minimize water quality effects and effects to the eagles.
- If Rockwell Reservoir is built, disturbance to sage grouse habitat and activity near leks in the spring and summer would be minimized to the extent possible.

3.12.5 Unavoidable Adverse Effects

All alternatives would result in the unavoidable loss of terrestrial wildlife habitat from dam construction, inundation, and other surface facilities. There would be a loss in habitat for state threatened, endangered, and species of concern, CNHP species, migratory birds, raptors, big game, and other wildlife. Temporary disturbances would reduce the quality of vegetation and wildlife habitat until restoration is complete. Construction-related activity would temporarily displace some wildlife from adjacent lands. Creation of new or additional open water habitat would benefit waterfowl, some raptors, amphibians, and would create opportunities for enhancement and protection of habitat.

3.13 Threatened and Endangered Species

3.13.1 Affected Environment

3.13.1.1 Regulatory Framework

Federally threatened and endangered species are protected under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). A potential effect to a federally listed species or its designated critical habitat resulting from a project with a federal action requires consultation with the FWS under Section 7 of the ESA. Consultations are not required for effects to candidate species; however, if a species were to become listed during project planning or construction, consultation with the FWS would be required for the newly listed species.

3.13.1.2 Area of Potential Effect

The study area for evaluating potential direct effects to threatened and endangered plants and wildlife includes the reservoir sites and related pipelines, roads, and infrastructure. In addition, because some wildlife species use a variety of habitats and have a wide range of movement, the study areas include lands surrounding reservoir sites and project facilities, or downstream areas that could be directly or indirectly affected by changes in hydrology or water quality.

3.13.1.3 Data Sources

Information on threatened or endangered species potentially occurring in the study areas was taken from the Boulder, Larimer, and Grand counties lists of endangered species maintained by the FWS (2006). Other data sources for evaluating the occurrence of species and potentially suitable habitat included published reports, database searches of the Colorado Natural Diversity Information Source and CNHP. Information was also obtained through consultations with the FWS and CDOW. Field investigations were conducted to evaluate habitat suitability, and for some species field surveys were conducted to determine if a species was present. No field investigation was conducted at Rockwell Reservoir because access to the privately owned property was denied. Additional information on threatened and endangered species is found in the Wildlife Resources Technical Report (ERO 2007b), the Aquatic Resources Technical Report (Miller 2008), and the Vegetation Resources Technical Report (ERO 2007a).

3.13.1.4 Federally Threatened and Endangered Species

Federally listed threatened and endangered species identified by the FWS as potentially occurring in Boulder, Larimer, and Grand counties are shown in Table 3-107. Habitat suitability, survey, and other sources of data were used to determine whether any of these species are located within the area of potential effect for each alternative. Potential Canada lynx habitat is found near the Rockwell

Table 3-107. Federally listed threatened and endangered species in Boulder, Larimer, and Grand counties potentially occurring in the study areas.

Common Name	Federal Status	Suitable Habitat in the Area of Potential Effect				
		Ralph Price	Chimney Hollow	Dry Creek	Jasper East	Rockwell
BIRDS						
Interior least tern	Endangered	N	N	N	N	N
Piping plover	Threatened	N	N	N	N	N
Whooping crane	Endangered	N	N	N	N	N
Mexican spotted owl	Threatened	N	N	N	N	N
MAMMALS						
Black-footed ferret	Endangered	N	N	N	N	N
Canada lynx	Threatened	N	N	N	N	Y
Preble's meadow jumping mouse	Threatened	N	N	N	N	N
FISH						
Bonytail chub	Endangered	N	N	N	N	N
Colorado pikeminnow	Endangered	N	N	N	N	N
Humpback chub	Endangered	N	N	N	N	N
Razorback sucker	Endangered	N	N	N	N	N
Greenback cutthroat	Threatened	N	N	N	N	N
PLANTS						
Ute ladies'- tresses orchid	Threatened	N	N	N	N	N
Colorado butterfly plant	Threatened	Y	Y	Y	Y	Y
Osterhout milkvetch	Endangered	N	N	N	N	N
Penland beardtongue	Endangered	N	N	N	N	N

Reservoir site and potential habitat for the Colorado butterfly plant is found at Chimney Hollow and Dry Creek reservoirs. Osterhout milkvetch and Penland beardtongue are endangered plant species with potential habitat on the West Slope. Threatened and endangered fish species in the Colorado River are located downstream near Rifle. The following sections provide a brief description for each of the species and potential presence in the study areas.

Interior Least Tern, Piping Plover, and Whooping Crane

The interior least tern, piping plover, and whooping crane seasonally use habitat along the Platte River in Nebraska. These species are potentially affected by water depletions in the South Platte River basin. All of the WGFP alternatives import water from the West Slope to the East Slope, which would result in a negligible increase in flows in the Platte River; thus, there would be no effect to these species.

Mexican Spotted Owl

Mexican spotted owl typically inhabits areas with steep, exposed cliffs and canyons that are characterized by piñon-juniper and old-growth forests interspersed with Douglas-fir, ponderosa pine, and white fir (Andrews and Righter 1992). No critical habitat has been designated in Boulder, Larimer, or Grand County (66 FR 8530).

No suitable habitat or documented observations of Mexican spotted owl are reported for Ralph Price, Chimney Hollow, or Dry Creek Reservoir study area. Chimney Hollow and Dry Creek reservoir sites do not contain old growth coniferous forests typically favored by this species. Although mixed Douglas-fir and ponderosa pine forests surround Ralph Price Reservoir, the only recorded occurrence of a Mexican spotted owl was 8 miles south of Ralph Price Reservoir (BCAS 2005).

The Jasper East and Rockwell Reservoir study areas do not contain suitable old growth Douglas-fir and ponderosa pine forests or rocky cliffs that this species typically inhabits. Mexican spotted owl has never been recorded in this portion of the state (Andrews and Righter 1992).

Black-footed Ferret

The black-footed ferret is associated with prairie dog colonies because it depends on prairie dogs for food and shelter. No prairie dog colonies are present within the study areas for any alternative.

Canada Lynx

Canada lynx (lynx) in Colorado typically forage in spruce/fir forests surrounded by lodgepole pine, with uneven-aged stands, open canopies, and mature understories at higher elevations. The lynx's foraging and denning habitat closely follows that of the snowshoe hare—the primary food source in Colorado, although alternative prey including grouse, voles, and squirrels will be taken (Fitzgerald et al. 1994; Ruggiero et al. 2000; NatureServe 2006). Lynx rarely venture into open nonforested areas wider than 300 feet (Ruggiero et al. 2000).

The Chimney Hollow, Dry Creek, and Ralph Price Reservoir study areas are located below the known lower elevation limits for lynx.

The western side of the Rockwell Reservoir study area and adjacent lands to the west have been identified by the CNDIS (2006) as potential lynx habitat. Lynx could occasionally visit the site, but the area contains limited coniferous forest habitat that lynx typically favors. The study area does not contain habitat for the snowshoe hare, the lynx's primary prey. No designated lynx habitat is present at Jasper East Reservoir, but nearby lands to the north and west provide potential habitat. Lynx could occasionally travel through the Jasper East Reservoir study area; however, suitable foraging and denning habitat is not present, the area lacks suitable habitat for snowshoe hare, and contains large open meadows that lynx typically avoid.

Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse (Preble's) is typically found in riparian corridors with trees or tall shrubs and low undergrowth, or in wet meadows. Along Colorado's Front Range, Preble's is generally found between 5,000 and 7,600 feet in elevation, generally in lowlands with medium to high moisture along permanent or intermittent streams and irrigation canals (FWS 1999a; Meaney et al. 1997). There is no designated critical habitat within or downstream of any of the study areas (68 FR 37276).

Ralph Price Reservoir does not contain the shrub and riparian habitat that Preble's typically inhabits and, therefore, is not likely to occur in the area. Preble's have been captured approximately 5 miles downstream of the reservoir near Lyons (FWS 1999a).

Field trapping surveys for Preble's conducted in 1997 (CNHP) and 2000 (ERO) at the Chimney Hollow Reservoir study area did not locate Preble's. Following the 2000 survey, the FWS concluded that a population of Preble's was not likely to be present within the Chimney Hollow Reservoir study area and that development or other actions on the site would not directly affect Preble's. A subsequent habitat evaluation on an additional portion of the Chimney Hollow site determined that no suitable habitat was present in previously surveyed areas or the expanded area (ERO 2003c). The FWS (2003) concurred with the habitat assessment, but requested an additional habitat assessment prior to construction.

Trapping surveys at Dry Creek Reservoir did not locate Preble's (ERO 2004c). The FWS (2004) concurred with the negative findings, but requested that the area be surveyed again prior to construction of the reservoir.

The Jasper East Reservoir and Rockwell Reservoir study areas are located out of the known geographic range for Preble's.

Fish

No threatened or endangered fish species are present within the West Slope study areas. In the downstream reaches of the Colorado below Rifle there is critical habitat and presence of four endangered fish species—bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker.

On the East Slope, one threatened species is present in Larimer County and Boulder County, the greenback cutthroat trout. Greenbacks do not occur within the study area, but are generally present in small headwater areas with isolation from other cutthroat species.

Ute Ladies'-Tresses Orchid

Habitat for Ute ladies'-tresses orchid (orchid) typically includes subirrigated alluvial soils along streams, and in open meadows and floodplains (Spackman et al. 1997) at elevations from 4,500 to 6,800 feet.

The Ralph Price Reservoir study area is above the typical elevation range for the orchid.

Although the Chimney Hollow and Dry Creek Reservoir study areas do not meet the FWS orchid survey protocol for Larimer County (areas with suitable habitat along perennial streams (FWS 1992)), field surveys were conducted along these two drainages. The orchid was not found at either reservoir site (ERO 2006b).

The Jasper East and Rockwell Reservoir study areas are outside the elevation range for the orchid.

Colorado Butterfly Plant

The Colorado butterfly plant (CBP) is a short-lived perennial herb found in moist areas of floodplains occurring on sub-irrigated, alluvial soils on level or slightly sloping floodplains and drainage bottoms at elevations 5,000 to 6,000 feet (Spackman et al. 1997).

Ralph Price Reservoir is above the elevation range for the CBP.

The riparian areas along Chimney Hollow and Dry Creek provide marginal habitat for the CBP because of grazing, weed infestation, and lack of an active floodplain. No CBP were found during field surveys at the Chimney Hollow or Dry Creek Reservoir (ERO 2007a).

Jasper East and Rockwell reservoirs are outside the elevation range for the CBP.

Osterhout Milkvetch

Osterhout milkvetch occurs in highly seleniferous, grayish brown clay soils derived from shales of the Niobrara, Pierre, and Troublesome formations, often in sagebrush shrublands (Spackman et al. 1997). Osterhout milkvetch was recorded near Jasper East Reservoir in 1961 (CNHP 2004), but field surveys in 2004 did not locate this species. No field surveys were conducted at Rockwell Reservoir because the landowner denied access.

There is no suitable habitat for this species at Ralph Price, Chimney Hollow, or Dry Creek Reservoir.

Penland Beardtongue

Penland beardtongue occurs in strongly seleniferous clay-shales of the Troublesome Formation, in areas with sparse plant cover, often in sagebrush (Spackman et al. 1997). Field surveys at Jasper East Reservoir did not locate this species. No field surveys were conducted at Rockwell Reservoir because the landowner denied access.

There is no suitable habitat for this species at Ralph Price, Chimney Hollow, or Dry Creek Reservoir.

3.13.2 Environmental Effects

3.13.2.1 Issues

Public scoping identified concerns about the potential impact to Preble's meadow jumping mouse, Colorado River endangered fish species from flow changes, and other threatened and endangered species.

3.13.2.2 Methods for Effects Analysis

Potential direct and indirect effects to threatened or endangered species were evaluated for each alternative. Effects were based on potential effects to known populations or from a loss of suitable habitat. Permanent impacts could occur in areas that are inundated or permanently disturbed by project features such as the dam, access roads, and pump stations. Temporary impacts to habitat could occur in areas that would be reclaimed following construction, such as pipeline routes and staging areas. The following effects discussion focuses on threatened and endangered species with suitable habitat or known presence in the study area for each alternative. Because none of the alternatives would result in a water depletion to the Platte River basin, there would be no effect to downstream threatened and endangered species, such as interior least tern, piping plover, and whooping crane. A determination of effect for all species is given in Table 3-108, but only species potentially affected are discussed in greater detail below.

Canada Lynx

There would be no effect to lynx from the enlargement of Ralph Price Reservoir under the No Action alternative because no suitable habitat is present. The same is true for construction of Chimney Hollow Reservoir in the Proposed Action and Alternatives 3 and 4, and for Dry Creek Reservoir in Alternative 5.

Construction of Jasper East Reservoir in Alternative 3 would not affect potentially suitable lynx habitat. There would be a loss of about 13 acres of native coniferous forest. The areas of impacted forest consist of small, isolated stands that do not provide foraging or denning habitat for lynx; therefore, Jasper East Reservoir would have no effect on the Canada lynx.

Construction of the 20,000 AF Rockwell Reservoir in Alternative 4 and associated facilities would permanently impact about 5 acres of native forest and temporarily disturb about 14 acres of native forest within potential lynx habitat. Construction of a 30,000 AF Rockwell Reservoir in Alternative 5 would have similar temporary impacts and about 9 acres of permanent impacts to potential lynx habitat. Much of the forested area adjacent to the Rockwell Reservoir study area has been previously fragmented by road construction and residential development. The loss of forest may affect, but is not likely to adversely affect lynx because this forest habitat is on the edge of potential lynx habitat, is discontinuous and fragmented, and most of the reservoir site is nonforested.

Preble's Meadow Jumping Mouse

Enlargement of Ralph Price Reservoir under the No Action Alternative would not impact populations of Preble's because no suitable habitat is present. As discussed in *Vegetation Resources* (Section 3.10), projected changes in streamflow below the reservoir on North St. Vrain Creek and St. Vrain Creek would not adversely affect riparian vegetation and, therefore, would not indirectly affect potential Preble's habitat downstream. There would be no change in flow in St. Vrain Creek from Windy Gap exchanges to Ralph Price Reservoir below the St. Vrain Supply Canal or at the closest recorded population of Preble's near Lyons.

Construction of Chimney Hollow Reservoir under the Proposed Action and Alternatives 3 and 4 would have no affect on Preble's populations based on trapping surveys. The FWS concurred that a population of Preble's does not likely occur within the Chimney Hollow study area. There would be no changes in streamflow below Chimney Hollow Reservoir that would affect potential downstream Preble's habitat. Based on negative survey findings, lack of potentially suitable habitat, and past FWS concurrence, construction of Chimney Hollow Reservoir would have no effect on Preble's. The FWS recommends a habitat evaluation prior to construction in case conditions change (FWS 2003).

Based on the negative trapping results at Dry Creek Reservoir in Alternative 5, there would be no direct impact to Preble's populations from construction of the reservoir and facilities. There would be no change in streamflow below the reservoir site that would affect potential Preble's habitat downstream. The FWS (2004) has requested an additional survey prior to construction to confirm the absence of Preble's. Thus, the interim determination of effects for the Preble's is no effect unless additional surveys locate Preble's.

There is no suitable habitat for Preble's at Jasper East or Rockwell Reservoir. Thus, there would be no effect to Preble's from construction of these facilities.

Table 3-108. Summary of effects determination for federally listed threatened and endangered species by alternative.

Species	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4	Alternative 5
	Determination of Potential Effects[1]				
BIRDS					
Interior least tern	No effect	No effect	No effect	No effect	No effect
Mexican spotted owl	No effect	No effect	No effect	No effect	No effect
Piping plover	No effect	No effect	No effect	No effect	No effect
Whooping crane	No effect	No effect	No effect	No effect	No effect
MAMMALS					
Black-footed ferret	No effect	No effect	No effect	No effect	No effect
Canada lynx	No effect	No effect	No effect	May affect	May affect
Preble's meadow jumping mouse[2]	No effect	No effect	No effect	No effect	No effect
FISH					
Bonytail chub	No effect	No effect	No effect	No effect	No effect
Colorado pikeminnow	No effect	No effect	No effect	No effect	No effect
Greenback cutthroat trout	No effect	No effect	No effect	No effect	No effect
Humpback chub	No effect	No effect	No effect	No effect	No effect
Razorback sucker	No effect	No effect	No effect	No effect	No effect
PLANTS					
Colorado butterfly plant	No effect	No effect	No effect	No effect	No effect
Ute ladies'- tresses orchid	No effect	No effect	No effect	No effect	No effect
Osterhout milkvetch	No effect	No effect	No effect	May affect[3]	May affect[3]
Penland beardtongue	No effect	No effect	No effect	May affect[3]	May affect[3]

[1] A **no effect** determination indicates there would be no impact on the species. A **may affect** determination is not likely to adversely affect the species. The effect could be discountable, insignificant, or completely beneficial.

[2] The FWS has requested another habitat evaluation for Chimney Hollow Reservoir and a second survey for Dry Creek Reservoir prior to construction.

[3] Field survey of the Rockwell Reservoir site is needed to determine species presence.

Fish

Impacts to the endangered species in the Colorado River were originally addressed in the 1991 FWS Biological Opinion for the original Windy Gap Reservoir. More recently, the future Windy Gap depletions were incorporated in the Recovery Plan for the Upper Colorado River. No effect to the endangered fish species are expected if the steps outlined in the Recovery Plan and Programmatic Biological Opinion (PBO) are followed. The proposed WGFP meets the criteria of the PBO (FWS 1999b) and the Recovery Implementation Program Recovery Action Plan (FWS 1993). These criteria include:

- The Firming Project is located within the geographic area covered by the PBO
- The project proponent must sign a Recovery Agreement and the Subdistrict has previously signed a Recovery Agreement in January 2000.
- If the depletions are greater than 100 AF, a one-time fee for recovery actions would need to be paid for the additional depletions above the average depletion of 18,779 AF

included in the PBO. The depletion fee in fiscal year 2005 was $16.30. The fee is adjusted annually for inflation according to the CPI.

- Reclamation must retain federal discretionary authority for any future consultations.

Reclamation will reinitiate consultation with the FWS for the preferred WGFP alternative.

There would be no effect to greenback cutthroat trout on the East Slope because they are not present in streams or reservoirs affected by alternative actions.

Ute Ladies'-Tresses Orchid and Colorado Butterfly Plant

Negative survey results for the orchid and CBP and a lack of suitable orchid habitat at Chimney Hollow and Dry Creek reservoirs indicate no effect to either species. Thus the Proposed Action and Alternatives 3, 4, and 5 would have no effect on the orchid or CBP. There would be no effect to these species from Jasper East or Rockwell Reservoir because no suitable habitat is present.

Osterhout Milkvetch and Penland Beardtongue

There would be no effect to Osterhout milkvetch or Penland beardtongue from construction of Jasper East Reservoir under Alternative 3 based on negative survey results. Rockwell Reservoir, a component of Alternatives 4 and 5, has potential habitat for Osterhout milkvetch and Penland beardtongue, but no field surveys were conducted because the landowners denied access. Thus, construction of Rockwell Reservoir and related facilities may affect, but are not likely to adversely affect, these plant species pending field surveys. There would be no effect to these species from Chimney Hollow or Dry Creek Reservoir because no suitable habitat is present.

3.13.3 Cumulative Effects

Cumulative effects to threatened and endangered species considered the potential incremental impact from reasonably foreseeable land-based developments within 5 miles of each of the alternative reservoir locations for terrestrial wildlife and plant species. Hydrologic data under cumulative effect conditions was used to quantify impacts to aquatic species. Potential cumulative effects to threatened and endangered species are discussed for each of the species where possible direct effects were identified.

Canada Lynx

Reasonably foreseeable land developments within 5 miles of Rockwell Reservoir could affect about 1,432 acres of potential lynx habitat. Construction of Rockwell Reservoir in Alternatives 4 and 5 would affect less than 20 acres of forest within potential lynx habitat. The incremental effect to potential lynx habitat under Alternatives 4 and 5, in addition to possible effects from future nearby land development, would be small, but may contribute to the loss or disturbance of potential lynx habitat. Because much of the land in the area is of marginal value for lynx and areas of future development include areas with existing disturbance, the cumulative impact to lynx habitat may affect, but is unlikely to adversely affect, the lynx.

Preble's Meadow Jumping Mouse

There would be no cumulative effect to Preble's from construction of Chimney Hollow or Dry Creek Reservoir because no Preble's is present at either location.

Fish

Cumulative effects to Colorado River endangered fish would be similar to what was described for direct effects and would be fall under the Recovery Plan and PBO. Colorado River depletions would be lower under cumulative effects for all alternatives. Greenback cutthroat trout would not be impacted under any alternative.

Ute Ladies'-Tresses Orchid and Colorado Butterfly Plant

There would be no cumulative effect to the orchid or CBP from construction of Chimney Hollow or Dry Creek reservoirs because these plants are not present at either location.

Osterhout Milkvetch and Penland Beardtongue

There would be no cumulative effect to Osterhout milkvetch or Penland beardtongue from construction of Jasper East Reservoir because neither species is present. Construction of Rockwell Reservoir could potentially impact these species. A cumulative effect to these endangered plants is possible if these species are present and if other future land disturbance impacts suitable habitat.

3.13.4 Proposed Mitigation

Colorado River depletions associated with any of the alternatives would require participation in the Recovery Plan and Programmatic Biological Opinion, including payment of a one-time fee to the recovery program for endangered fish species. Surveys for Osterhaut milkvetch and Penland beardtongue would be conducted if the Rockwell Reservoir site is selected to determine their presence and if mitigation is needed. Mitigation for the loss of a small amount of potential lynx habitat at Rockwell Reservoir would be determined in consultation with the FWS. An additional Preble's jumping mouse survey would be conducted if Dry Creek Reservoir is developed to confirm their absence; if present, a mitigation plan would be developed. A Preble's jumping mouse habitat evaluation would be conducted at Chimney Hollow Reservoir prior to construction.

3.13.5 Unavoidable Adverse Effects

Construction of Rockwell Reservoir under Alternatives 4 and 5 would result in a small unavoidable adverse effect to potential lynx habitat and possibly suitable habitat for Osterhaut milkvetch and Penland beardtongue. Construction of Dry Creek Reservoir could result in the loss of Preble's mouse habitat, although none were found during field surveys.

3.14 Geology

3.14.1 Affected Environment

3.14.1.1 Area of Potential Effect

The area of potential effect for geologic resources includes the reservoir sites, projected areas of disturbance for dam construction, borrow areas, and other facilities.

3.14.1.2 Data Sources

Information on geologic resources was gathered from geologic maps, reports, and limited field investigation (Boyle Engineering 2005b). Information on potential paleontological resources was based on literature review and geology.

3.14.1.3 Ralph Price Reservoir

The Ralph Price Reservoir site is located in the Front Range foothills. The geology of the area is composed of Precambrian-aged granitic rocks that typically weather to sand and gravel, with some silts and clays (Braddock 1988). No geologic hazards or faults were identified in previous geologic studies for raising Button Rock Dam (Woodward-Clyde 1987). Suitable rock and earthfill material sources for use in enlarging the dam have been identified in the reservoir footprint and surrounding lands. The Ralph Price area is not currently recognized as a source of mineral or energy resources, although the granite could be used as coarse aggregate (Cappa et al. 2000). Paleontological resources are unlikely in the area because the geology is composed primarily of igneous rock.

3.14.1.4 Chimney Hollow Reservoir

The Chimney Hollow area is located in the foothills of the Colorado Front Range. The western side of Chimney Hollow is characterized by a complex series of sedimentary and volcanic rocks intruded by igneous dikes and sills (Braddock et al. 1988). The hogback to the east of Chimney Hollow is part of a series of north to south trending ridges. The ridges consist of tilted sandstone and limestone. The lower slopes and valleys consist of siltstone and shale covered with alluvium and loose rock. Several faults are located about ½ to 3 miles west and northwest of Chimney Hollow. A pair of northwest-southwest trending faults is located within a few hundred feet of the proposed right dam abutment. Faults in the area are not considered active or potentially active (Widmann et al. 2002). No landslides or other geologic hazards have been documented in past or recent field investigations (Braddock et al. 1988; Crosby 1978; Boyle 2005b). Slickensides were observed along bedding planes in the finer grain portion of the bedrock in drill core samples and test pits and during construction of the nearby Flatiron Powerplant. Slickensides may indicate potentially weakened slip surfaces that can result in slides or wall failures into open excavation for which a contractor would need adequate temporary slope stabilization (Boyle 2005b).

Borrow areas for dam construction would be located within the Chimney Hollow Reservoir footprint.

Granite along the north-central portion of the reservoir would provide rockfill for the dam and fine-grained deposits in the valley and lower slopes would be used to construct the core of the dam if a central core rockfill dam is selected. The Chimney Hollow area is not recognized for potential oil and gas deposits, metallic mineral resources, coal-bearing rocks, or sand and gravel deposits (Streufert and Cappa 1994; Cappa et al. 2001). Several sandstone quarries are located on the hogback to the east (Keller et al. 2002).

The eastern side of Chimney Hollow includes sandstone rocks of the Fountain and Lykins Formations. Trace fossils of plants and invertebrates have been found in these formations at locations near Denver and Castle Rock, but none have been identified near Chimney Hollow.

3.14.1.5 Dry Creek Reservoir

The regional and local geology of the Dry Creek Reservoir site is similar to Chimney Hollow. The west side of the Dry Creek valley includes volcanic and sedimentary rock and the east side of the Dry Creek valley includes sedimentary rock. The Blue Mountain Fault parallels the Little Thompson drainage to the south and several faults are located about 5 miles to the northwest. All of these faults are considered nonactive (Widmann et al. 2002). No landslides, debris flows, or other geologic hazards are believed to be present in the Dry Creek area (Braddock et al. 1988).

Published geologic mapping (Braddock et al. 1998) indicates granite bedrock in the Dry Creek area could provide a possible aggregate source for dam construction. Field exploration would be needed to confirm the presence and quantity of local material sources. The Dry Creek area is not recognized for potential oil and gas deposits, metallic mineral resources, coal-bearing rocks, or sand and gravel deposits (Streufert and Cappa 1994; Cappa et al. 2001). Several sandstone quarries located on the hogback to the east extract decorative building material (Keller et al. 2002).

Sandstone rocks from the Fountain Formation and Lyons Formation on the east side of Dry Creek are not known to contain paleontological resources.

3.14.1.6 Jasper Reservoir

The landform at the Jasper East Reservoir site is the result of faulting, uplift, glaciation, and erosion. Predominant surface rock from the Troublesome Formation consists of mudstone and sandstone interlayered with basalt flows and granite and volcanic material. Alluvial deposits of sand and gravel are also present. A series of northwest trending inferred faults are located near the proposed east dam embankment trending along the toe of Table Mountain (Izett 1974; Kirkham and Rogers 1981). A northwest trending fault is located north of the existing Willow Creek Pump Canal forebay dam. Two other faults parallel Willow Creek to the west of the Jasper Reservoir site. None of these faults are considered active or potentially active (Widmann et al. 2002). A landslide area is present on the south end of Table Mountain northeast of the reservoir site (Izett 1974). No evidence of other landslides or instability was observed or mapped in the study area.

Material from overburden deposits and weathered fine grain bedrock within the reservoir footprint may provide suitable material for dam construction (Boyle 2005e). Basalt bedrock located near the reservoir site contains potential riprap and bedding material. An existing sand and gravel quarry near the left dam abutment also may provide suitable material for dam construction. Field exploration would be needed to confirm the presence and quantity of local material sources. The Jasper East study area is not known for potential oil, gas, metallic minerals, or coal (Streufert and Cappa 1994; Cappa et al. 2001). An existing sand and gravel quarry is located on the west side of the reservoir site.

Portions of Jasper East dam and reservoir are located in the Tertiary-age Troublesome Formation, which is known to contain fossil mammals (Lewis 1969).

3.14.1.7 Rockwell/Mueller Creek Reservoir

The Rockwell site is underlain by the Troublesome Formation, except for the alluvial deposits in the narrow Rockwell Creek drainage. Rocks in the Troublesome Formation include interbedded siltstone, mudstone or shale with less abundant amounts of sandstone, conglomerate, limestone, ash, tuff and granitic cobbles (Shroeder 1995). A north-south trending fault is located about ½ mile west of the proposed reservoir. Another fault is located about 800 feet east of the proposed north dam abutment. These faults are not considered active or potentially active (Widmann et al. 2002), nor is seismic activity considered to be a hazard based on studies for existing dams in the area (Unruh et al. 1996). Landslide material is present downstream of the reservoir site. No other geologic hazards were identified in the proposed reservoir area.

Fine grained material for dam construction may be available onsite from overburden deposits and weathered bedrock. If this material is not suitable, a potential borrow area about 1 mile south may provide material. Riprap and filter/drain material does not appear to be present at the reservoir site, so import from off-site sources may be necessary. Field exploration would be needed to confirm the presence and quantity of local material sources. The Rockwell area is not recognized for potential oil and gas deposits, metallic minerals, coal-bearing rocks, or sand and gravel deposits (Streufert and Cappa 1994; Cappa et al. 2001). The proposed pipeline across the Colorado River could transect sand and gravel deposits.

Rockwell is located in the Tertiary-age Troublesome Formation, which is known to contain fossil mammals (Lewis 1969).

3.14.2 Environmental Effects

3.14.2.1 Issues

Geologic issues of concern were the presence of geologic hazards that may affect dam and facility construction, safety, and possible effects to paleontological resources.

3.14.2.2 Method for Effects Analysis

Potential effects to geologic resources included an evaluation of the presence of geologic hazards that might affect the stability of the dam or other structures, such as faults, slope failures, or landslides. The potential loss of known mineral resources, such as oil, natural gas, metallic and nonmetallic minerals, also was evaluated. The potential for fossil-bearing formations was evaluated based on the types of rock present and available published data.

3.14.2.3 Effects Common to All Alternatives

All of the new reservoirs and enlargement of Ralph Price Reservoir would result in wetting of the reservoir slopes as the reservoirs fill. Wave action and wetting and draining of soils on reservoir slopes resulting from raising and lowering water levels could result in creep movement or sloughing of near surface materials into the reservoir. Such occurrences are considered normal and acceptable in the operation of reservoirs and in the terrain and environments such as these reservoirs. There are no indications of potential slides, slope failures, or debris flows that would adversely affect the integrity or safety of any of the potential dam sites based on available information. The perimeter soil erosion and sloughing of shallow, near surface materials would contribute sediment to the reservoir.

3.14.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Enlarging Ralph Price Reservoir would require excavation of geologic material from borrow areas to raise the existing dam approximately 50 feet in elevation. Potential borrow areas include areas within the footprint of the existing reservoir as well as several nearby sites. No known geologic hazards are known within the study area; however, the faults within the project limits and study area would need further investigation to determine their characteristics and impact on facility design. There are no known oil and/or natural gas production areas, metallic mineral resources, coal-bearing formations, or other industrial mineral deposits in the area that would be affected. The Silver Plume granite present in the area may have some use as a coarse aggregate. No known geologic formations containing potential paleontological resources would be affected by enlarging Ralph Price Reservoir.

3.14.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

None of the faults present near Chimney Hollow are active or potentially active; thus, there is little to no hazard from seismic activity from known fault zones. However, the faults would need additional investigation during final design to determine their characteristics and effect on the facility construction.

There are no known oil and/or natural gas production areas, metallic mineral resources, coal-bearing formations, or sand, gravel or other industrial mineral deposits in the area that would be affected by construction. The construction road access corridor through the hogback on the southeast side of the reservoir would cross a sandstone quarry, which could affect quarry operation. No currently known geologic formations containing potential paleontological resources would be affected by construction of Chimney Hollow Reservoir and facilities; however, plant and invertebrate fossils could be present in some sandstone formations.

3.14.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

The effect to geologic resources for a 70,000 AF Chimney Hollow Reservoir would be similar to those described for Alternative 2.

A landslide area on the south end of Table Mountain is unlikely to affect Jasper East Reservoir construction because of its distance from the reservoir. There would be little to no potential hazard to the dam or facilities from faulting. However, the faults within the project limits and study area would need investigation to determine their characteristics and potential impact to structures and facilities during final design. There would be no effect to known oil and/or natural gas production areas, metallic mineral resources, or coal-bearing formations in the area. The existing aggregate source near Jasper East Reservoir would be used for reservoir construction. Excavations in the Troublesome Formation could expose mammal fossils, which would require monitoring possible salvage during construction.

3.14.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Potential effects to geologic resources at Chimney Hollow Reservoir would be the same as described for Alternative 2.

If the sideslope landslide downstream of the Rockwell Reservoir site is active in the future, it could impact drainage on Rockwell Creek. Future studies would be required to evaluate this potential hazard. There is no indication of potential slides, slope failures, or debris flows that would adversely affect the integrity or safety of the dam based on available information. There is little to no hazard from faulting; however, the faults in the area would need further investigation to determine their characteristics and impact on facility design. There would be no effect to known oil and/or natural gas production areas, metallic mineral resources, coal-bearing formations, or other industrial mineral deposits in the area. The pipeline across the Colorado River would include excavation in potential sand and gravel deposits that are often found in alluvial floodplain. Excavations in the Troublesome Formation could expose mammal fossils, which would require monitoring and salvaging during construction.

3.14.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Potential effects to geologic resources for a 30,000 AF Rockwell Reservoir would be similar to Alternative 4.

There would be minimal hazard to Dry Creek Reservoir from faulting and seismic activity. However, the faults within the project limits and study area would need further investigation to determine their characteristics and impact on facilities or structures. There would be no effect to known oil and/or natural gas production areas, metallic mineral resources, coal-bearing formations, sand, gravel or other industrial mineral deposits in the area. The pipeline to Carter Lake would cross a sandstone quarry, which could affect quarry operations. No known geologic formations containing potential paleontological resources would be affected by reservoir and facility construction.

3.14.3 Cumulative Effects

No reasonably foreseeable actions that would incrementally add to the disturbance to geologic resources were identified at the potential reservoir sites. No cumulative effects are expected from water-based reasonably foreseeable actions.

3.14.4 Proposed Mitigation

Further evaluation is needed at all of the reservoir sites to determine if potential geologic hazards need to be addressed during final design. Construction of either Jasper East or Rockwell reservoirs could expose fossil mammals from the Troublesome Formation. Excavation in the sandstone formations at Chimney Hollow could uncover plant and invertebrate fossils. If significant fossils are found during construction of any reservoir site or facilities, paleontologists with the Denver Museum of Science and History would be notified.

3.14.5 Unavoidable Adverse Effects

Reservoir and dam construction would result in an unavoidable disturbance to geologic resources from excavation and earthmoving activities. There would be a potential loss of fossil mammals from excavations at Jasper East and Rockwell reservoirs and possibly plant and invertebrate fossils at Chimney Hollow.

3.15 Soils

3.15.1 Affected Environment

3.15.1.1 Area of Potential Effect

The area of potential effect for evaluating soil resources includes the alternative reservoir sites and related pipelines, roads, and infrastructure that would permanently or temporarily affect soils.

3.15.1.2 Data Sources

Information on soils was collected from published data sources including Natural Resources Conservation Service (NRCS) soil survey reports for Larimer, Boulder, and Grand counties, and the NRCS Web Soil Survey (2006).

Potential water quality effects associated with erosion and sedimentation at reservoir sites are addressed in *Surface Water Quality* (Section 3.8). Fugitive dust is discussed in *Air Quality* (Section 3.16). Revegetation of disturbed soils is discussed in *Vegetation* (Section 3.10). Additional information on soils is included in the Geology and Soils Technical Report (ERO and Boyle 2006).

3.15.1.3 Ralph Price Reservoir

The NRCS has not surveyed soils at Ralph Price Reservoir. Information from the Boulder County Soil Survey (NRCS 1975) for lands with similar parent material and geographic position was used to estimate likely soil types at the reservoir. Based on this information, it is likely the Juget-Rock outcrop soil complex is present on the mountain slopes surrounding Ralph Price Reservoir. The Juget soil series consists of shallow, somewhat excessively drained soils derived from weathered granite on slopes of 9 to 55 percent. Surface and subsurface soils are very gravely sandy loams over granite bedrock. Runoff is rapid and the erosion hazard is high for this soil.

3.15.1.4 Chimney Hollow and Dry Creek Reservoirs

The soil types (NRCS 1980) present in the Chimney Hollow and Dry Creek study areas are similar. The characteristics for common soils present at these reservoir sites are listed below.

Kirtley-Purner complex, 5 to 20 percent slopes. This complex occurs on upland and valley sides on the west side of the reservoirs. The Kirtley series is a moderately deep, well drained soil formed from weathered sandstone and shale. The surface is loam textured and the subsurface is a heavy loam. The Purner series is a shallow, well drained soil formed from weathered sandstone. The surface horizon and subsoil is composed of a fine sand loam. Runoff is rapid and the erosion hazard is severe.

Purner-Rock outcrop complex, 10 to 50 percent slopes. This soil complex is found at the toe of the hogback ridge along the east shoreline of the reservoirs. The rock outcrop in this unit is primarily in the steep ridges of the hogback above the reservoirs. Runoff is rapid and the erosion hazard is severe.

Ratake-Rock outcrop complex, 25 to 55 percent slopes. This complex consists of steep soils on the northwest portion of Chimney Hollow, the pipeline route to the Bald Mountain surge tank and near the Dry Creek Reservoir dam. The Ratake series consists of shallow, well drained to somewhat excessively drained soils that formed from weathered granite, schist, or phyllite. The surface soil is a channery loam with increasing rock content with depth. Runoff is rapid and the erosion hazard is severe.

Wetmore-Boyle-Moen complex, 5 to 40 percent slopes. This soil complex is found in the area of the western shoreline sideslopes of both the reservoirs. The Wetmore series consists of shallow, well drained soils derived from weathered granite. The surface horizon is a sandy loam and subsurface horizons have a gravely loamy sand texture. The Boyle series is a shallow, well drained soil formed from weathered sandstone. The surface soil is a stony sandy loam with increasing rock content with depth. The Moen series is a moderately deep, well drained soil formed from weathered granite and schist with a loam surface texture and clay loam subsurface texture. Runoff is rapid and the erosion hazard is severe.

Connerton-Barnum complex, 3 to 9 percent slopes. This soil complex is located along the Chimney Hollow drainage in a few scattered locations at Dry Creek. The Connerton series consists of deep, well drained soils that formed in mixed alluvial material with a fine sandy loam surface and loam subsurface. The Barnum series consists of deep, well drained soils formed in alluvium valleys. These soils have a loam textured surface and subsurface. Runoff is medium and the erosion hazard is moderate to severe.

The Dry Creek Reservoir site has several additional soil types not common or present at Chimney Hollow. These include:

Haplustolls-Rock outcrop, complex steep. This complex consists of soils on slopes ranging in steepness from 5 to 50 percent and rock outcrop located on the southeast shoreline of the reservoir. Haplustolls are present along the east side of the hogback ridge where the pipeline connection to Carter Lake would be located. Haplustolls are shallow to deep and have surface and subsurface layers of loam or clay loam with varying amounts of cobbles and rock. Runoff is rapid and the erosion hazard is moderate to severe.

Nunn clay loam, 3 to 5 percent. This gently sloping soil is located along a portion of the pipeline route to Carter Lake. These soils are deep, well drained, and have a light clay loam surface and clay loam subsurface. Runoff is medium and the water erosion hazard is moderate.

Satanta loam, 3 to 5 percent. This soil is located on upland side slopes along the pipeline route to Carter Lake. The Satanta soil is deep, and well drained with a loam surface and heavy loam to clay loam subsurface. Runoff is medium and the erosion hazard is moderate.

Both reservoir sites contain several other less common soil map units. These map units consist of different complexes with the same soils series previously described and other soil types with similar parent material, soil textures, depths, and slopes as described for the dominant soil types.

3.15.1.5 Jasper Reservoir

The Jasper Reservoir site, access roads, pipeline route, and relocated Willow Creek Canal overlay 20 different soil map units (NRCS 1983). Principle soil types in the study area include:

Cimarron loam, 2 to 35 percent. This deep, well drained soil is found within the reservoir footprint and along portions of the Willow Creek Pump Canal. These soils formed from shale and alluvium. The surface layer is loam and the subsurface is clay. Surface runoff is slow and the erosion hazard is slight on slopes less than 6 percent. Runoff is rapid and the erosion hazard is severe on slopes steeper than 15 percent.

Youga loam, 2 to 45 percent. This deep well drained soil is found in the reservoir footprint, on the northern and western dam abutment, and in the filter borrow area and a portion of the access road. This soil has a surface horizon of loam with a subsoil of loam and clay loam. Surface runoff is medium and the erosion hazard is moderate.

Leavitt loam, 6 to 50 percent slopes. This deep well drained soil is found within the reservoir footprint, in the rock borrow area, and portions of the Willow Creek Pump Canal. This soil is formed in local alluvium from sedimentary rock. The surface layer is loam and the subsurface is clay loam. Surface runoff is slow on slopes less than 15 percent and the erosion hazard is moderate. On steeper slopes the surface runoff is medium and the erosion hazard is high.

Mayoworth clay loam, 6 to 50 percent slopes. This is a moderately deep, well drained soil found within the reservoir footprint and along the Willow Creek Pump Canal route. The surface is a clay loam and the subsurface is clay above shale bedrock. Surface runoff is rapid and the erosion hazard ranges from moderate to high depending on slope.

Waybe clay loam, 10 to 55 percent slopes (Map Unit 90). This shallow, well drained soil is found within the reservoir and dam footprint and access roads. The surface layer is a clay loam and the subsoil is clay over weathered shale. Surface runoff is rapid and the erosion hazard is high.

Remaining soil types are found in lesser amounts in the study area and mostly have loam and clay loam surface horizons with slopes below 30 percent. Several small areas of rock outcrop are found in scattered locations. Cumulic Cryaquolls are dark wet soils along the drainage that supports wetlands.

3.15.1.6 Rockwell/Mueller Creek Reservoir

The Rockwell Reservoir, dam, pipeline to Windy Gap Reservoir, and relocated county road would cross 18 different soil map units (NRCS 1983). Several of the same soil map units previously described for the Jasper East study area are also present in the Rockwell Reservoir study area. Cimarron loam, is the dominant soil type in the reservoir and dam footprint. Mayoworth clay loam is present within the reservoir footprint, the rock borrow area, and along the pipeline. Waybe clay loam is found in the reservoir, dam, and construction staging area. Additional dominant soil map units in the Rockwell Reservoir study area not previously described include:

Aaberg clay loam, 15 to 30 percent slopes. This moderately deep, well drained soil is found on mountainsides within the reservoir footprint. The surface soil is a clay loam and the subsoil is clay over soft shale. Surface runoff is rapid and the erosion hazard is high.

Gateway loam, 15 to 50 percent slopes. This soil is moderately deep, well drained, and is found on the west side of the reservoir and in the borrow area south of the reservoir. The surface texture is loam and the subsoil is clay over mudstone. Surface runoff is rapid and the erosion hazard is high.

Quander stony loam, 15 to 55 percent slopes. This deep, well drained soil is the dominant soil in the borrow area. It has a surface layer of stony loam over very stony sandy clay loam. Surface runoff is rapid and the erosion hazard is high.

The pipeline from Rockwell Reservoir to Windy Gap Reservoir crosses several soil map units in addition to those previously described. The pipeline route through the Colorado River floodplain crosses Cumulic-Cryaquolls soils, which are formed in alluvium. Tine gravelly sandy loam, 0 to 3 percent is present in the gently sloping terrace along the pipeline route. This is a deep, well drained soil with a loam surface horizon and very cobbly loam subsoil. Surface runoff is slow and the erosion hazard slight on these gentle slopes.

Other soils in the study area occur in smaller amounts and are primarily loams and sandy loams of widely varying slope ranges.

3.15.2 Environmental Effects

3.15.2.1 Issues

Soil resources of concern were the potential affect on revegetation of disturbed areas and the potential for increased erosion and impacts to water quality.

3.15.2.2 Method for Effects Analysis

Potential effects to soil resource were evaluated for the loss of soil resources or reduced productivity, potential for erosion during construction, shoreline erosion or sedimentation at new reservoirs, and soil suitability for revegetation of disturbed areas. Project features were overlain on soil maps to determine the acreage and soil types affected by permanent and temporary disturbances.

Susceptibility to wind and water erosion is primarily a function of soil texture, vegetation cover, and slope. The evaluation of susceptibility to wind erosion was based on the wind erodibility group for the soil map unit as designated by the NRCS soil survey. The potential for water erosion was based on the erosion hazard classification for each map unit and the individual soil physical properties that determine the soils erosion factor. Successful revegetation depends in part on the quality of the soils salvaged and replaced. The NRCS established ratings for topsoil suitability for each map unit were used to evaluate revegetation potential for temporarily disturbed soils.

3.15.2.3 Effects Common to All Alternatives

For all temporary soil disturbances associated with construction activities at any of the potential reservoir sites, a revegetation and erosion control plan would be developed. The revegetation plan would include site-specific details on the removal, handling, storage, and replacement of soil for revegetation, but there would be a loss in productivity from soils that are stripped, stored, and reapplied. Revegetation of areas with poor topsoil quality may require additional soil amendments and would take longer to establish vegetation.

3.15.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Soil Loss and Disturbance

The enlargement of Ralph Price Reservoir would result in a permanent loss of about 77 acres of soil resources from inundation and possible other losses from enlarging the dam and spillway construction. If borrow areas are located within the reservoir footprint, there would be no additional loss of soil from extraction of material for dam construction. It is assumed that the majority of the soil loss would occur in the Juget-Rock outcrop complex.

Additional temporary soil disturbance is likely from construction staging and if a borrow site outside of the reservoir footprint is used. The area of temporary disturbance is not known, but is assumed that the Juget-Rock outcrop complex would be a component of the disturbed soils.

Shoreline Erosion

Existing shoreline erosion around Ralph Price Reservoir is minimal because the shoreline is fairly stable and has weathered to bedrock. Enlarging the reservoir would inundate soils and increase the potential for shoreline erosion until a new equilibrium is reached. Seasonal fluctuations in water levels of about 14 feet on average and up to 33 feet in wet years also would contribute to shoreline erosion. Based on the condition of the existing shoreline, the granitic bedrock underlying the shallow soils would create a stable nonerosive shoreline over the long term if the reservoir is enlarged.

Sedimentation

Sedimentation in Ralph Price Reservoir from local sources in the North St. Vrain Creek basin is possible, but would likely be minimal because the majority of the upstream watershed is within National Forest and National Park Service ownership. However, the reservoir would continue to accumulate sediment from stream inflows. Shoreline erosion and areas of soil disturbance from construction also would contribute sediment to the reservoir.

Temporary Erosion

Temporary wind and water erosion of soils is possible during dam and spillway construction and if a borrow area outside the reservoir footprint is used. The Juget-Rock outcrop soil complex has a very low susceptibility to wind erosion when vegetation is removed; thus, wind erosion is expected to be minor. The water erosion hazard is severe because of the steep slopes, although the Juget soil has a low erosion factor based on soil texture and the high amount of rock.

Revegetation Potential

The amount of area that would require revegetation is unknown, but would likely include construction staging areas near the dam and spillway and possible borrow areas. The Juget-Rock outcrop complex has poor topsoil suitability because of the depth to bedrock, rock fragments, and steep slopes. Revegetation of disturbed lands may be difficult because of these limitations.

3.15.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Soil Loss and Disturbance

Construction of Chimney Hollow Reservoir and facilities would result in a permanent loss of about 794 acres of soil resources. Affected soils would either be inundated by the new reservoir or buried or removed for dam, spillway and road construction. Proposed borrow areas are located within the reservoir footprint so there would be no additional loss of soil from extraction of material for dam construction. There also would be a small loss of soil resources associated with construction of the foundation for new transmission line towers. The majority of the lost soil resources would be to the Kirtley-Purner soil complex (48 percent) and the Purner-Rock outcrop complex (19 percent).

Construction of the pipeline connection to the Bald Mountain surge tank, as well as inlet/outlet pipelines below the dam, and construction staging areas would temporally affect soil resources on about 130 acres.

Shoreline Erosion

Shoreline erosion on Chimney Hollow Reservoir is possible from wave action. Chimney Hollow Reservoir would remain close to full throughout the year under most conditions with fluctuations in reservoir elevation of less than 2 feet. Erosion of shoreline soils, particularly during the first several years following reservoir construction, is likely until the shoreline stabilizes. The Purner-Rock outcrop soil complex dominates the east side of the reservoir site. The Purner soil has a moderate erosion potential, but steep slopes increase the potential for erosion on the shoreline and prevailing winds would generate wave action on the east side of the reservoir. Soil map units on the west side of the reservoir have a lower erosion factor, but areas with steeper slopes have increased susceptibility to erosion. The fine textured soils of the Kirtley-Purner complex at the north end of the reservoir have a moderate erosion factor, and gentle slopes. This portion of the reservoir may develop beach areas with areas of sand or mudflats, as well as wetland or riparian vegetation.

Sedimentation

Sedimentation in Chimney Hollow Reservoir from local sources within the basin is expected to be minimal. The relatively undisturbed Chimney Hollow watershed is about 3,000 acres. All of the Chimney Hollow drainage would be inundated by the new reservoir; therefore, the only local source of inflow would be from ephemeral tributary drainages to the east and west. Shoreline erosion and areas of soil disturbance from construction also would contribute sediment to the reservoir. Development of recreation facilities by Larimer County Parks and Open Lands Department would generate minor sources of sedimentation from a parking area and trails.

Temporary Erosion

Temporary wind and water erosion of soils is possible during excavation of material for dam construction, installation of pipelines, road construction, relocation of the transmission line, and other facilities until disturbed areas can be revegetated. The Kirtley, Purner, and Ratake soils have moderate susceptibility to wind erosion when vegetation is removed. These same soils are subject to severe water erosion hazard, particularly where the slopes are steep due to rapid runoff and the texture of the surface soil. An increase in soil erosion is likely during construction, but implementation of an erosion control plan and revegetation would reduce soil loss.

Revegetation Potential

Reclamation of about 130 acres of temporarily disturbed soils to facilitate vegetation establishment would be needed. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate that about 67 acres of soils have fair suitability for use as topsoil and 62 acres have poor suitability. Less than 1 acre of soils has good suitability for topsoil. The Kirtley-Purney complex, which makes up most of the disturbed soils, has fair topsoil suitability and is limited because the soil material is less than 20 inches thick over bedrock. The poorly rated soils are composed primarily of the Ratake-Rock outcrop complex and are limited because of steep slope, shallow soils, and the amount of rock in the soil.

3.15.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow Reservoir

Soil Loss and Disturbance. Construction of a 70,000 AF Chimney Hollow Reservoir and facilities would result in a permanent loss of about 671 acres of soil resources. The majority of the lost soil resources would be to the Kirtley-Purner soil complex (54 percent) and the Purner-Rock outcrop complex (15 percent).

Construction of the pipeline connection to the Bald Mountain surge tank, as well as inlet/outlet pipelines below the dam, construction staging areas, and 23 acres of borrow area outside of the reservoir footprint, would temporally affect soil resources on about 149 acres.

Shoreline Erosion. Shoreline erosion at Chimney Hollow Reservoir from wave action and fluctuating water levels would be similar to the 90,000 AF reservoir in the Proposed Action. However, a wider range in reservoir water surface fluctuations of about 15 feet on average and up to 28 feet in wet years could increase the potential for shoreline erosion.

Sedimentation. The potential for sedimentation in Chimney Hollow Reservoir from local sources within the basin would be similar to the Proposed Action, although there would be a slightly larger area of temporary soils disturbance from a borrow area outside the reservoir footprint that could contribute additional sediment until revegetated.

Temporary Erosion. The potential for temporary wind and water erosion of soils would be the same as discussed for the Proposed Action because similar soil types would be disturbed.

Revegetation Potential. Approximately 149 acres of soils would be temporarily disturbed during construction. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate about 76 acres with fair suitability for topsoil and 73 acres with poor suitability. The soils rated with fair topsoil suitability are limited because the soil material is less than 20 inches thick over bedrock and the poorly rated soils are limited because of steep slope, shallow soils, and the amount of rock in the soil.

Jasper East Reservoir

Soil Loss and Disturbance. Construction of Jasper East Reservoir and facilities would result in a permanent loss of about 491 acres of soil resources. Affected soils include those inundated by the new reservoir or buried or removed for dam, spillway and road construction and soils affected by relocation of the Willow Creek Canal, pump station, and forebay. Soil loss would be spread over 20 different map units. The larger map units affected include Cimarron loam (34 percent), Leavitt loam (13 percent), Youga loam (10 percent), and Mayoworth clay loam (9 percent).

Temporary disturbance from construction staging areas, borrow sites, and the relocation the Willow Creek pipeline would affect soil resources on about 125 acres.

Shoreline Erosion. Wave action and wide fluctuations in Jasper Reservoir water levels would result in shoreline erosion. Water levels in Jasper East Reservoir would fluctuate about 59 feet on average and as much as 72 feet during wet years. Shoreline soils are primarily clay loam and clays that would contribute fine textured suspended sediment. Weathered shale parent material below the soil also would be subject to shoreline erosion.

Sedimentation. Potential local sources of sedimentation to Jasper East Reservoir in addition to shoreline erosion are limited within the 957-acre watershed within which the reservoir would be located. Surrounding lands are undeveloped rangeland with near natural levels of erosion. Relocation of County Road 40 below the reservoir dams would eliminate road-generated erosion and sediment. Minor sources of sedimentation could be generated if recreation facilities are developed.

Temporary Erosion. Disturbance of soils during construction would result in a temporary increase in wind and water erosion. Dominant soil types representing about 55 percent of the area expected to be disturbed, include Cimarron loam, Youga loam, and Mayoworth clay loam, which have a low potential for wind erosion. Remaining soils have a moderate potential for wind erosion when exposed. The potential for water erosion is high for most of the areas of expected disturbance, although areas with gentle slopes including Youga loam and Mayoworth loam have moderate ratings for water erosion.

Revegetation Potential. Reclamation of about 125 acres of temporarily disturbed soils would be needed for construction staging areas, along the Willow Creek pipeline and pipeline connection to the existing Windy Gap pipeline, and roadside disturbance associated with relocation of County Road 40. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate that the majority of soils (93 acres) have a poor suitability for topsoil and 32 acres have fair topsoil suitability. None of the temporarily disturbed areas have good topsoil suitability. Temporarily disturbed soils including Cimarron, Mayoworth, and Waybe soils series have poor topsoil properties because of a high clay content. Steep slopes for some soils and the amount of rock fragments also reduce topsoil suitability. The Youga loam soils series has fair topsoil suitability, with limitations because of the amount of rock fragments or the steepness of the slope.

3.15.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Chimney Hollow Reservoir

Potential effects to soil resources at Chimney Hollow Reservoir would be the same as described for Alternative 3.

Rockwell/Mueller Creek Reservoir

Soil Loss and Disturbance. Construction of Rockwell Reservoir and facilities would result in a permanent loss of about 315 acres of soil resources. Primary soil types affected include Cimarron loam (54 percent), Mayoworth clay loam (18 percent) and Aaberg clay loam (16 percent).

Temporary disturbance from construction staging areas, an offsite borrow area, and the pipeline to Windy Gap Reservoir would affect soil resources on about 155 acres.

Shoreline Erosion. Wave action and fluctuations in reservoir levels would result in erosion of the shoreline. Water levels in Rockwell Reservoir could fluctuate 80 feet on average and as much as 102 feet during wet years. Shoreline soils are primarily clay loam and clays that would contribute fine textured suspended sediment. Weathered shale parent material below the soil also would be subject to shoreline erosion.

Sedimentation. Potential local sources of sedimentation to Rockwell Reservoir in addition to shoreline erosion in the 1,358-acre watershed include undeveloped forest, scattered homes, and gravel roads. Erosion from upstream land development is likely to be minor because of the buffer areas of native forest vegetation. Minor sources of sedimentation could be generated if recreation facilities are developed.

Temporary Erosion. Wind erosion susceptibility varies from low to high for the various soils that would be exposed during construction. Low to moderate wind erodibility would occur from exposure of Gateway loam, Quander cobbly loam, and Cimarron loam. Exposures of Rogert gravelly sandy loam, Tine gravelly sandy loam, and Waybe clay loam have a higher potential for wind erosion. The potential for water erosion is high for most of the areas of expected disturbance because of steep slopes. The water erosion hazard is slight on gentle slopes where the pipeline to Windy Gap crosses the Tine and the Cumulic Cryaquolls soil map units near the Colorado River. The Youga loam soil type along the pipeline route has a moderate water erosion hazard.

Revegetation Potential. Reclamation of about 155 acres of temporarily disturbed soils would be needed for construction staging areas, along the pipeline to Windy Gap Reservoir, and for the offsite borrow area. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate that 142 acres of soil have poor suitability for topsoil. Poor topsoil suitability is due to the amount of clay in the Cimarron, Mayoworth, and Gateway loam soil series, and a combination of shallow depth and/or rock fragment limitations in most of the other soils. About 13 acres of the Clayburn loam and Youga loam along the pipeline route have fair topsoil suitability, but with limitations because of the amount of rock fragments.

3.15.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek Reservoir

Soil Loss and Disturbance. Construction of Dry Creek Reservoir and facilities would result in a permanent loss of about 633 acres of soil resources. Affected soils include those inundated by the new reservoir or buried or removed for dam, spillway and access roads along the pipeline from the north and from the east over the hogback. The majority of the lost soil resources would be to the Kirtley-Purner soil complex (31 percent), the Wetmore-Boyle-Moen complex (20 percent), and the Ratake-Rock outcrop complex (19 percent).

Temporary disturbance from construction staging areas, along access roads, and the pipeline connection to the Bald Mountain surge tank, and from the dam to Carter Lake would affect soil resources on about 158 acres.

Shoreline Erosion. Dry Creek Reservoir would fluctuate about 9 feet on average, but as much as 17 feet in wet years. Shoreline soils subject to erosion from wave action and fluctuating reservoir levels include principally the Purner-Rock outcrop complex on the west side of the reservoir and the Wetmore-Boyle-Moen complex on the west side of the reservoir. Both these soils have severe erosion hazard because of slope, but both have low erosion factors, which indicates low susceptibility to sheet and rill erosion on gentle slopes. The shallow Purner soils overlay sandstone, which would result in a fairly stable shoreline. The granitic bedrock underlying the Wetmore-Boyle-Moen complex would result in a weather resistant shoreline following erosion of surface soil. The finer textured soils of the Kirtley-Purner complex at the north end of the reservoir have a moderate erosion factor, and gentle slopes. This portion of the reservoir may develop beach areas with areas of sand or mudflats.

Sedimentation. Sedimentation in Dry Creek Reservoir from local sources within the basin other than shoreline erosion is expected to be minimal. The relatively undisturbed Dry Creek watershed is about 2,500 acres. All of the Dry Creek drainage above the dam would be inundated by the new reservoir; therefore, the only local source of inflow would be from ephemeral tributary drainages to the east and west. Sediment input from these tributaries would be at natural erosion rates. Minor sources of sedimentation could be generated if recreation facilities are developed.

Temporary Erosion. The majority of soils subject to wind erosion from temporary disturbances have a moderate susceptibility for erosion along the pipeline to Carter Lake, the pipeline to the Bald Mountain surge tank, and construction staging areas. The Paoli fine sandy loam, Pinata-Rock outcrop, and Connerton -Barnum complex found along pipeline routes and staging areas are more susceptible to wind erosion when disturbed. The potential for water erosion is generally severe because of the steep slopes, although erosion hazard is moderate on gentle slopes in the Connerton-Barnum and Nunn clay loam soils found along pipeline routes.

Revegetation Potential. Reclamation of about 158 acres of temporarily disturbed soils to facilitate vegetation establishment would be needed for construction staging areas, along pipelines, and other areas of construction disturbance. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate that 74 acres of soils have poor suitability for use as topsoil, 71 acres have fair suitability, and 13 acres have good suitability. The Connerton-Barnum soils along the pipeline route to the north have good topsoil characteristics for revegetation. The Kirtley-Purney complex, which makes up a majority of the soils rated as fair topsoil suitability, are limited because the soil material is less than 20 inches thick over bedrock. The Ratake-Rock outcrop complex is poorly rated for topsoil use because of steep slopes, shallow soils, and the amount of rock in the soil. The Nunn clay loam and Pinata-Rock Outcrop are too clayey for topsoil use.

Rockwell/Mueller Creek Reservoir

Soil Loss and Disturbance. Construction of a 30,000 AF Rockwell Reservoir and facilities would result in a permanent loss of about 393 acres of soil resources from inundation and dam, spillway, and road construction. The same soil types would be affected as the 20,000 AF reservoir in Alternative 4. Temporary soil disturbances would affect 161 acres.

Shoreline Erosion. The potential for shoreline erosion from wave action and fluctuating water levels would be similar to Alternative 4. The reservoir would fluctuate about 70 feet on average and up to 100 feet in wet years. Large fluctuations in water levels expose more of the reservoir to wind action and increase the potential for erosion.

Sedimentation. The potential for sedimentation in Rockwell Reservoir from local sources within the basin would be similar to Alternative 4.

Temporary Erosion. The potential for temporary wind and water erosion of soils would be the same as discussed for Alternative 4 because similar soil types would be disturbed.

Revegetation Potential. Reclamation of about 161 acres of temporarily disturbed soils to facilitate vegetation establishment would be needed. NRCS topsoil suitability ratings for temporarily disturbed soils in the study area indicate about 148 acres have poor suitability for topsoil, 13 acres are rated fair, and none are rated good. The soils rated as fair topsoil suitability are limited because of the amount of rock fragments and the poorly rated soils are limited because of clay content, shallow soils, and the amount of rock.

3.15.3 Cumulative Effects

No reasonably foreseeable actions that would incrementally add to the disturbance to soil resources and increase the potential for localized erosion were identified at the potential reservoir sites. No cumulative effects are expected from water-based reasonably foreseeable actions.

3.15.4 Proposed Mitigation

A number of mitigation measures would be implemented prior to and during construction for any alternative to minimize effects to soil resources. Measures include:

- Clearly defining construction limits to minimize soil disturbance.
- Developing an erosion control plan as part of the required Stormwater NPDES permit to reduce the potential for erosion from disturbed areas or capture sediments on-site.
- Integrating the erosion control plan with the revegetation plan.
- Salvaging of suitable topsoil from areas of temporary disturbance, where possible, to aid in revegetation following construction.
- Using soil amendments or additional site preparation techniques to revegetate disturbed areas with poor topsoil suitability.

3.15.5 Unavoidable Adverse Effects

There would be an unavoidable long-term loss of soils in areas affected by dam construction, inundation by the reservoir, and other permanent facilities. Temporarily disturbed soils would be subject to wind and water erosion that could lead to reduced soil productivity and effects to water quality. Implementation of erosion control measures including revegetation would reduce erosion from temporary disturbances to natural erosion rates over the long-term. Shoreline erosion from wave action would result in sediment contributions to new reservoirs.

3.16 Air Quality

3.16.1 Affected Environment

3.16.1.1 Regulatory Framework

The Clean Air Act (CAA) of 1970, 42 U.S.C. 7401 et seq., was enacted to protect and enhance air quality and to assist state and local governments with air pollution prevention programs. The CAA requires the EPA to identify and publish a list of common air pollutants that could endanger public health or welfare. The EPA has delegated enforcement of the CAA to the Air Pollution Control Division (APCD) of the Colorado Department of Public Health and Environment (CDPHE). All state programs regarding the provisions and enforcement of the CAA are subject to oversight and approval by the EPA.

The EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants—carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, particulate matter fewer than 10 microns in diameter (PM_{10}), and lead—to protect the public from health hazards associated with air pollution. These pollutants are called “criteria air pollutants” because the EPA has regulated them by first developing health-based criteria as the basis for setting permissible levels. One set of limits (primary standard) protects health; another set of limits (secondary standard) is intended to prevent environmental and property damage. A geographic area that has air quality equal to or better than a primary standard is called an attainment area; an area that does not meet a primary standard is a nonattainment area.

Emission sources of pollutants are categorized as either stationary or mobile. Stationary sources of pollutants include activities such as combustion of fossil fuels for power, emissions from industrial or commercial processes, and burning from natural fires. Mobile sources of pollutants include on-road (cars and trucks) and off-road vehicles (farm and construction equipment), and fugitive dust from unpaved roads and construction activities. Fugitive dust can be generated by either earth disturbing activities or by wind.

Colorado’s air quality laws contain requirements for controlling fugitive dust emissions during construction activities. These requirements vary depending on the amount of land disturbed and the duration of the disturbance.

3.16.1.2 Area of Potential Effect

The area of potential effect for air quality includes the area of projected disturbance for each alternative where sources of emissions would be generated, as well as surrounding lands where emissions would disperse.

3.16.1.3 Data Sources

Regional air quality is described based on available information from the EPA and CDPHE. Additional information is included in the Air Quality and Noise Technical Report (ERO 2006).

3.16.1.4 Existing Air Quality

The existing air quality for all of the study areas on both the East and West Slope is good. The reservoir sites and associated facilities are primarily located in rural areas with emissions occurring mostly from on-road and off-road vehicles and from fugitive dust. Nearby urban areas such as Loveland and Lyons on the East Slope and Granby on the West Slope may have slightly lower air quality from vehicle emissions and stationary pollution sources. Particulate concentrations are higher near unpaved roads, disturbed lands, and fallow agricultural fields compared to vegetated rangeland.

The existing air quality in the East and West Slope study areas does not exceed NAAQS. All Colorado communities are currently in attainment of all NAAQS (CDPHE 2006c).

3.16.2 Environmental Effects

3.16.2.1 Issues

Potential effects to air quality identified during scoping were air pollution from vehicle emissions and dust during and after construction.

3.16.2.2 Methods for Effects Analysis

Potential effects to air quality were evaluated based on source of air quality emissions and the duration of the effects. Adverse impacts to air quality are possible if NAAQS are exceeded.

3.16.2.3 Effects Common to all Alternatives

For the No Action and action alternatives, air quality impacts during construction would primarily include exhaust emissions from construction equipment, employee and delivery vehicles, and from fugitive dust. With the exception of lead, all of the criteria pollutants would be emitted or created due to construction activities. Fugitive dust would be generated from activities associated with soil disturbance and from equipment and vehicular traffic moving over the disturbed site. These emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The amount of emissions of both fugitive dust and vehicle exhaust would depend on the number of vehicles used at specific sites and the disturbed area.

Because the project area for all alternatives exceeds 25 contiguous acres, one or more land development permits would be required from the APCD. As part of the land development permit application, a Fugitive Particulate Emission Control Plan that outlines the specific steps that would be taken to minimize fugitive dust generation would be prepared.

3.16.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Enlarging Button Rock Dam and spillway at Ralph Price Reservoir is estimated to require about 30 months. Vehicle emissions and fugitive dust generated during construction would result in minor localized and temporary effects to air quality. It is unlikely that the increased pollutants during construction would exceed NAAQS for any criteria pollutants because of the relatively small disturbance area in comparison to regional emission sources throughout the Boulder-Longmont area. Increased emissions would cease after construction; therefore, there would be no long-term effect to air quality.

3.16.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Construction of Chimney Hollow dam and the associated pipeline, roads, and facilities would take about 3 to 5 years. Construction equipment, traffic from a workforce ranging from 200 to 500 workers and truck deliveries of about 5 to 10 vehicles per day would result in a temporary increase in vehicle exhaust emissions. Dust from surface disturbances at rock borrow areas, the dam site, along pipeline routes, and construction access roads would increase during construction. Removal and relocation of Western's transmission line would result in short term, minor air quality impacts from emissions from diesel-fueled equipment and dust related to construction activities.

The Proposed Action would result in negligible to minor impacts on existing air quality during construction at the reservoir site. Regional impacts to northeast Colorado air quality from construction are unlikely to exceed NAAQS for any criteria pollutants because of the relatively localized nature of construction and emission sources in comparison to regional emissions present in Larimer County. Emissions would decrease following completion of construction.

Following construction, Chimney Hollow Reservoir and adjacent Larimer County Open Space would be opened for recreational use. Recreation traffic to the reservoir would result in a negligible long-term increase in vehicle emissions that would not adversely affect local air quality or exceed applicable standards.

3.16.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Construction of a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2. The smaller dam would not substantially change the size of the work force, construction traffic or vehicle and dust emissions. Impacts to air quality would be similar to that described for Alternative 2.

Construction of Jasper East Reservoir is estimated to take 2.5 to 5 years and would include relocation of the Willow Creek Pumping Station, relocation of County Road 40, followed by development of borrow areas, dam construction, spillways, and pipeline and booster pump installation. Construction equipment, traffic from a workforce of up to 160 workers, and truck deliveries of about 5 to 10 vehicles per day would result in a temporary increase in vehicle exhaust emissions. Dust would be generated from surface disturbance at the reservoir site and construction traffic along the existing and relocated County Road 40. Regional impacts to Grand County air quality from construction are unlikely to exceed NAAQS for any criteria pollutants because of the relatively small localized sources of emission during construction. Increased emissions would cease after construction, although if recreation facilities were developed at the reservoir, there would be negligible long-term increase in vehicle exhaust and dust along County Road 40 from visitor traffic.

3.16.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Air quality effects associated with construction a 70,000 AF Chimney Hollow Reservoir would be similar to that described for Alternative 2.

Construction of Rockwell Reservoir is estimated to take 2.5 to 4.5 years and would include the development of borrow and staging areas, dam construction, spillways, and pipeline and booster pump installation. The average truck traffic to the site would be about 18 vehicles per day, peaking at as many as 45 vehicles per day during dam construction. About 26 trucks per day would access the project area during pipeline construction. Construction activities and associated traffic would increase emissions from vehicle exhaust and fugitive dust along County Roads 56 and 57. Regional impacts to Grand County air quality from construction are unlikely to exceed NAAQS for any criteria pollutants because of the relatively small localized sources of emission during construction. Increased emissions would cease after construction, although if recreation facilities were developed at the reservoir, there would be negligible long-term increase in vehicle exhaust and dust along county access roads from visitor traffic.

3.16.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Potential air quality effects from construction of a 30,000 AF Rockwell Reservoir would be similar to that described for Alternative 4.

Construction of the Dry Creek Reservoir dam and appurtenances is estimated to take 2.5 to 4.5 years and includes the establishment of staging areas, development of borrow areas, and construction of the dam, spillways, and pipelines including the outlet boring to Carter Lake. The average truck traffic during dam construction is estimated at about five vehicles per day with peak deliveries of 10 vehicles per day. Construction equipment, truck deliveries, and traffic from a workforce of up to 460 workers would increase vehicle emissions. Traffic along dirt access roads and from surface disturbances would increase dust. Regional impacts to northeast Colorado air quality from construction are unlikely to exceed NAAQS for any criteria pollutants because of the relatively small localized emission sources in comparison to regional emissions present in Larimer County. Increased emissions due to construction activities would cease after completion. If recreation facilities were developed, there could be negligible increase in vehicle emissions from visitor traffic and possibly dust depending on the location and surface of an access road.

3.16.3 Cumulative Effects

No reasonably foreseeable actions were identified in the vicinity of the reservoir sites for the No Action or action alternatives that would result in a cumulative long-term effect to air quality.

3.16.4 Proposed Mitigation

Several mitigation measures would be used to reduce air emissions:

- Preparing a Fugitive Particulate Emission Control Plan according to applicable local and state management practices to minimize particulate and dust emissions. Inclusion of dust palliative application and/or dust abatement as bid items if they are considered among the management practices.
- Ensuring construction equipment (especially diesel equipment) meets opacity standards for operating emissions.
- Revegetating or stabilizing disturbed areas as soon as possible to reduce dust sources.

3.16.5 Unavoidable Adverse Effects

There would be an unavoidable temporary increase in air pollutants primarily near the reservoir sites for each alternative during construction. There would be no long-term adverse impact to air quality after reservoir and facility construction.

3.17 Noise

3.17.1 Affected Environment

3.17.1.1 Regulatory Framework

Colorado Revised Statutes (CRS) 30-15-401 (m)(I) authorizes counties to enact ordinances that regulate noise on public and private property. Maximum permissible noise levels in Colorado are stated in CRS 25-12-103 and have been adopted into Larimer and Boulder counties' ordinances (Table 3-109). Grand County does not have a noise ordinance (Campbell 2006).

Table 3-109. Maximum noise levels by sound source for Boulder and Larimer counties.

Sound Source	Maximum Noise (dB(A)) 7 AM to 7 PM	Maximum Noise (dB(A)) 7 PM to 7 AM
Residential Zones	55	50
Construction/ Demolition	80	75

Source: Boulder County 2006; Larimer County 2006.

3.17.1.2 Area of Potential Effect

The area of potential effect for evaluating noise is the reservoir and facility construction areas and potential receptors bordering the construction sites that may experience increased noise.

3.17.1.3 Data Sources

Ambient noise levels were based on comparative information for conditions similar to the reservoir sites. Information on construction-related noise was obtained from published sources. Additional information is included in the Air Quality and Noise Technical Report (ERO 2006).

3.17.1.4 Existing Noise Levels

Noise, usually defined as unwanted or unacceptable sound, is measured in terms of decibels (dB) scaled to approximate the hearing capability of the human ear dB(A). A decibel is a unit of measurement that quantifies the sound pressure differences in the air that perceived as sound (or noise) on a scale ranging from zero decibels on up. Zero decibels is the threshold of human hearing, 40 to 50 dB(A) is normal for a peaceful neighborhood, 70 to 80 dB(A) is the level adjacent to a busy urban street or 50 feet from a major freeway, and 120 to 140 dB(A) is a typical level at which sound is painful.

The study areas for alternative reservoir sites, pipelines, and other facilities currently have negligible vibration and low ambient noise levels (35 to 45 dB(A)) typical of rural locations. Existing noise levels at Ralph Price Reservoir are very low because no private vehicles are allowed at the reservoir and no motorized boating is allowed. Sources of noise at Chimney Hollow are limited primarily to activities at nearby Bureau of Reclamation facilities. Rural public and private roads and a few residents are the primary sources of noise near the Dry Creek Reservoir site. Noise sources at Jasper East include traffic along the existing County Road 40 that bisects the reservoir site, excavation at a nearby aggregate quarry, and tractors and equipment from ranching activities. Noise sources near the Rockwell Reservoir site include traffic on county roads and nearby residential and commercial development.

3.17.2 Environmental Effects

3.17.2.1 Issues

Potential short- and long-term increases in noise levels near reservoir sites were identified as an issue during scoping.

3.17.2.2 Methods for Effects Analysis

Potential impacts from increased noise were evaluated based on anticipated noise levels, the duration of the effects, and the location of nearby receptors. Noise-evaluation criteria are based on land use compatibility and on the direction and magnitude of noise level changes. Annoyance effects are typically the primary consideration. Often, the magnitude of a noise level change is as important as the resulting overall noise level. A noticeable increase in noise levels often is considered a substantive effect by local residents, even if the overall noise level remains within land use compatibility guidelines or complies with local ordinances. Conversely, sometimes noise levels that are somewhat above land use compatibility guidelines or ordinance-specified levels are not noticeable to people.

Noise levels are loudest near the point of generation and decrease with increased distance from the source. Sound intensity decreases in proportion with the square of the distance from the source. Generally, sound levels for a point source will decrease by 6 dB(A) for each doubling of distance (Table 3-110).

Table 3-110. Distance attenuation for construction noise.

Receptor Distance (feet)	Noise Level at Receptor (decibels)
50	95
100	89
200	83
400	77
800	71
1,600	65
3,200	59

Notes: Reference noise level is 95 dB(A) for construction equipment. Basic sound level decrease is 6 dB(A) for each doubling of distance. Sound level decrease does not include atmospheric absorption or terrain and vegetative barriers.
Source: FHWA 1995.

3.17.2.3 Effects Common to All Alternatives

Construction activities would be similar for all alternatives. Direct and indirect effects would include noise from construction equipment, increased traffic noise from project-vicinity roadways, and noise from operation of pump stations. Construction activities would generate noise from diesel-powered earth moving equipment such as dump trucks and bulldozers, back-up alarms on certain equipment, compressors, and pile drivers, if necessary. Construction noise at off-site receptor locations is usually dependent on the loudest one or two pieces of equipment operating at the moment. Noise levels from diesel-powered equipment range from 80 to 95 dB(A) at a distance of 50 feet. Impact equipment such as rock drills and pile drivers can generate louder noise levels (FTA 1995).

It is difficult to predict reliable levels of construction noise at a particular receptor or group of receptors. Heavy machinery, the major source of noise in construction, is constantly moving in unpredictable patterns. Construction normally occurs during daylight hours when occasional loud noises are more tolerable. No one receptor is expected to be exposed to construction noise of long duration; therefore, extended disruption of normal activities is not anticipated. However, provisions will be included in the plans and specifications requiring the contractor to comply with local and state noise ordinances for construction noise.

Blasting would be necessary at all of the reservoir sites for all the action alternatives and possibly for the No Action alternative. Blasting is needed to: 1) obtain a suitable foundation for the dam prior to placement of the embankment materials; 2) produce suitable rock for the upstream and downstream slopes of the dam from the borrow areas; and 3) construct water conveyance facilities, temporary or permanent access roads, and other project features. Blasting activities could take place throughout the construction period depending on the contractor's plans for producing and stockpiling rock for use in the dam. Blasting would be below the ground and occur for short periods of time during daylight hours. The vibration and sound from blasting can produce a startle effect, although below ground blasts are somewhat muffled and dissipate with distance depending on the geology and meteorological conditions.

Construction of project components would be phased depending on need; however, once all components are constructed, construction noise would cease. Noise levels during operations would be negligible.

3.17.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Raising Button Rock Dam would result in a temporary increase in noise and vibration during construction. Noise from construction would be heard at residences that are about 200 feet from the reservoir. These noise levels could be as much as much as 83 dB(A), which would exceed Larimer County's maximum permissible noise levels (Larimer County 2006).

3.17.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Noise and vibration would result from construction of Chimney Hollow dam and the associated pipeline, roads, and related facilities. Nearby residents located on the hogback about 1,000 feet east of the proposed reservoir would experience temporary increased noise levels during construction. These noise levels could reach about 71 dB(A). This temporary noise level would conform to the maximum noise level for construction activity permitted by Larimer County (Table 3-109) (Larimer County 2006). Removal and relocation of Western's transmission line would result in short term, noise impacts from construction activity.

Power supply to the reservoir and conveyance facilities would come from the existing facilities associated with the Flatiron Power Plant. A substation may be needed to step down voltage; however, the noise generated would not exceed 50 dB(A) at the property boundary, which is the nighttime noise allowance for residential areas in Larimer County (Larimer County 2006).

After project completion, recreational access would be allowed at Chimney Hollow Reservoir and adjacent Larimer County Open Space. Visitors to the site would increase noise from existing levels, but because recreation would be limited to day use and nonmotorized boating, residents on the hogback ridge east of the Chimney Hollow Reservoir site would be unlikely to experience substantial changes in sound levels.

3.17.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Noise-related impacts for Chimney Hollow Reservoir would be similar to that described for Alternative 2.

Residents located on private lands north and south of County Road 40 and along Highway 34 near the Jasper East Reservoir site may experience temporary increased noise levels during construction. The closest residences are about 1,600 feet from the reservoir site and would experience noise levels of up to about 65 dB(A). Visitors to Willow Creek Reservoir may experience occasional increased noise levels during construction; however, the intensity of the impact would vary according to the activity in progress, and would likely be minor. If recreation facilities were developed, there could be minor levels of noise from visitor traffic and recreation activity.

The booster pump station would contribute to long-term intermittent exterior noise levels; however, the noise generated would not exceed 50 dB(A) at the property boundary.

3.17.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Noise-related impacts for Chimney Hollow Reservoir would be similar to that described for Alternative 2.

Residents near Rockwell Reservoir would experience temporary increased noise levels during construction. Residences are at least 800 feet from the proposed reservoir and at that distance would experience noise levels of up to 71 dB(A). The booster pump station, which would assist in the delivery to Granby Reservoir, would contribute to exterior noise levels; however, the noise generated would not exceed 50 dB(A) at the property boundary. If recreation facilities were developed, there could be minor levels of noise from visitor traffic and recreation activity.

3.17.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Noise-related impacts for Rockwell Reservoir would be similar to that described for Alternative 4.

Residents near Dry Creek Reservoir would experience temporary increased noise levels during construction. Residences are at least 800 feet from the proposed reservoir and at that distance would experience construction noise levels of up to 71 dB(A). Residences located about 200 feet from the outlet boring to Carter Lake may experience temporary noise levels of up to about 83 dB(A), which would exceed Larimer County's maximum permissible noise levels (Larimer County 2006). If recreation facilities were developed, there could be minor levels of noise from visitor traffic and recreation activity.

3.17.3 Cumulative Effects

In the vicinity of the alternative reservoir sites, no reasonably foreseeable actions were identified that would result in a cumulative long-term change in noise levels. However, as discussed for Alternative 2, future recreation activities on Larimer County Open Space adjacent to the Chimney Hollow Reservoir site would result in a minor long-term increase in noise.

3.17.4 Proposed Mitigation

Potential effects from noise and vibration would be mitigated by:

- Ensuring construction equipment functions as designed and conforms to applicable noise emission standards.
- Requiring the contractor to adhere to project work hour restrictions.
- Restricting access to construction areas so that the public could not be in close proximity to loud equipment or blasting.
- Developing a blasting schedule and notification process for nearby residents when blasting is anticipated to occur. Proceeding blasting with a warning alarm. Blasting plans would include the implementation of seismographs for

vibration measurements and air blast recordings for noise.

- Locating operating equipment (e.g., pump stations) in structures designed to minimize radiated noise outside the structure, and designing structures to meet local noise ordinance requirements.
- Developing a noise monitoring and noise mitigation plan if activities are expected to exceed maximum permissible noise levels.

3.17.5 Unavoidable Adverse Effects

All alternatives would result in an unavoidable temporary increase in noise levels during construction. Recreation development at Chimney Hollow Reservoir in Alternatives 2, 3, and 4 would result in a minor long-term increase in noise levels.

3.18 Land Use

3.18.1 Affected Environment

3.18.1.1 Regulatory Framework

County land use regulations for water resource developments vary for each of the counties where project facilities would be located. The enlargement of Ralph Price Reservoir in Boulder County would be subject to special use review, location and extent review, and 1041 Review of Areas and Activities of State Interest (Boulder 2004). The Larimer County Comprehensive Plan and Larimer County Zoning Code regulate land use activities in the county. Construction of Chimney Hollow or Dry Creek reservoirs would be subject to the Location and Extent Review Process prior to county approval (Larimer County 2004). Water projects, such as construction of Jasper East or Rockwell reservoirs in Grand County are subject to a Special Use Review (Grand County 2004a, 2004b). In addition, Grand County 1041 Regulations include permit requirements for municipal and industrial water projects.

3.18.1.2 Area of Potential Effect

The area of potential effect for evaluating land use includes the alternative reservoir sites and related pipelines, roads, and infrastructure that would be permanently or temporarily affected. In addition, lands surrounding the reservoir sites that could be indirectly affected are included in the study area. Project facilities for the alternatives are located in three counties. Chimney Hollow and Dry Creek reservoirs would be located in Larimer County, Jasper East and Rockwell Reservoir would be located in Grand County, and Ralph Price Reservoir is located in Boulder County.

3.18.1.3 Data Sources

Information on existing land ownership and use was collected from local, state, federal sources, as well as on-site verification of land use. Colorado Department of Transportation (CDOT) and county data were used to estimate existing traffic volumes near potential reservoir sites. Additional information is included in the Land Use Technical Report (ERO 2008a).

3.18.1.4 Regional Overview

State and federal lands comprise 72 percent of the land in Grand County, 52 percent of the land in Larimer County, and 36 percent of Boulder County (CDOA 2005). Predominant land uses in Grand, Larimer, and Boulder counties near potential project facilities include agriculture, recreation, small town urban areas, and low-density residential homes.

Agricultural activities occur on about 18.5 percent of the land in Grand County, 20 percent in Larimer County, and 22 percent of Boulder County (USDA 2002). Recreation is an important component of land use in all three of the counties. National Forest lands in Grand County, including the Arapaho National Recreation Area (ANRA) that encompasses Granby Reservoir, Shadow Mountain Lake, Grand Lake, and Willow Creek reservoirs, provide popular recreation opportunities. Rocky Mountain National Park is located in Grand and Larimer counties. National Forest land and county open space support a variety of recreation activities in Larimer County. Municipal and county open space, along with National Forest lands provide public recreation opportunities in Boulder County.

Urban and residential areas in Grand County are located along the Colorado River and Fraser River. The Town of Granby is located south of the Jasper East Reservoir site and north of the Rockwell

Reservoir site. Much of the residential development in Grand County is dispersed as low-density rural areas, but many new developments include low to moderate densities of homes. Residential land use near Chimney Hollow and Dry Creek reservoirs in Larimer County is primarily low-density rural homes. Loveland and Berthoud are the closest communities to these reservoir sites. Lyons is the closest community to Ralph Price Reservoir and residences near the reservoir are few and scattered.

3.18.1.5 Ralph Price Reservoir

Land Ownership

Ralph Price Reservoir, including the area of potential enlargement, is located on land owned by the City of Longmont (Figure 3-66). Potential borrow sites are located on city, National Forest, and private lands.

Land Use

Ralph Price Reservoir is an existing reservoir in unincorporated Boulder County. The reservoir and surrounding lands are designated in the Boulder County Comprehensive Plan as a *Municipal Watershed* and zoned as *Forestry* (Boulder County 2004). Recreation and water storage are permitted uses. The City of Longmont manages the reservoir and surrounding land for resource preservation and water storage as part of the Button Rock Preserve. Two private residences are located on the north side of the reservoir. City of Longmont property includes a ranger residence. Angling opportunities are available at Ralph Price Reservoir and the surrounding lands offer opportunities for hiking and wildlife viewing.

Transportation

Access to the Ralph Price Reservoir is provided via Boulder County Road 80 off U.S. 36, although visitor parking is located about 2 miles from the reservoir. Existing average daily traffic on County Road 80 is 320 vehicles (Boulder County 2005).

3.18.1.6 Chimney Hollow Reservoir

Land Ownership

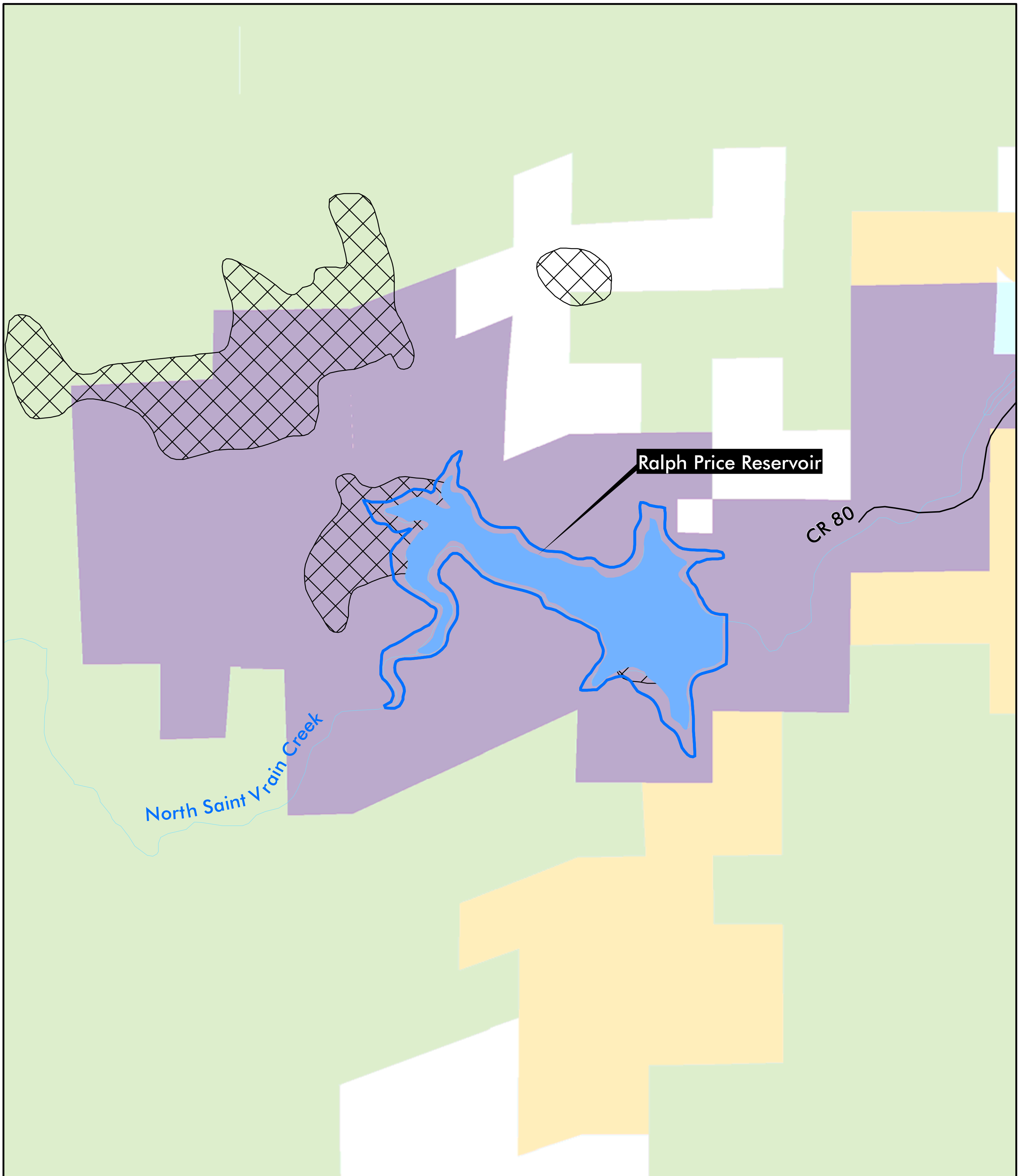
Chimney Hollow Reservoir would be located primarily on land owned by the Subdistrict (Figure 3-67). A portion of the reservoir and project facilities would be located on private lands, Larimer County Open Space, and Reclamation property.

Land Use

The Chimney Hollow Reservoir site is currently undeveloped land zoned as *Open Lands (low density rural residential 1/10 acres) and Estate-1* lands (Larimer County 2004). Historically the land was used for livestock grazing and as a private recreation area. The proposed reservoir footprint includes 63 acres of two soil types classified as farmland of local importance and farmland of statewide importance (NRCS 2005a). Areas having this soil complex with slopes less than 6 percent would qualify as prime farmland if irrigated with an adequate supply of water (SCS 1982). None of the affected lands are currently farmed or irrigated.

No occupied homes are present at the site. Several homes are located on the hogback ridge east of the reservoir site. A 115-kV electric transmission line operated by the Western Area Power Administration runs the length of the site. Flatiron Reservoir, a hydropower generation facility, Reclamation offices, and other C-BT facilities are located just north of the Chimney Hollow Reservoir site.

No active land use or management activities are presently occurring in the Chimney Hollow area. The 1998 Larimer County Open Lands Plan identified lands at Chimney Hollow as part of the Blue Mountain Project and a potential high priority open space. The goals of the Blue Mountain Project are to protect natural resources and open space (including ridgelines) and provide ecosystem connectivity between Blue Mountain Ranch and Carter Lake (Larimer County 1998). Lands at the Blue Mountain Ranch were recently protected from further development through a Larimer County conservation easement. Larimer County has purchased over 1,700 acres of land adjacent to Subdistrict lands; these lands would become part of the planned Chimney Hollow Open Space area. Larimer County and the Subdistrict entered into an intergovernmental agreement that includes a recreational lease by the county of about 1,600 acres of the Subdistrict property at no fee (Larimer County-Municipal Subdistrict 2004). The recreational lease is contingent on construction of Chimney Hollow Reservoir.



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Ralph Price Reservoir Enlargement
Potential Borrow Areas

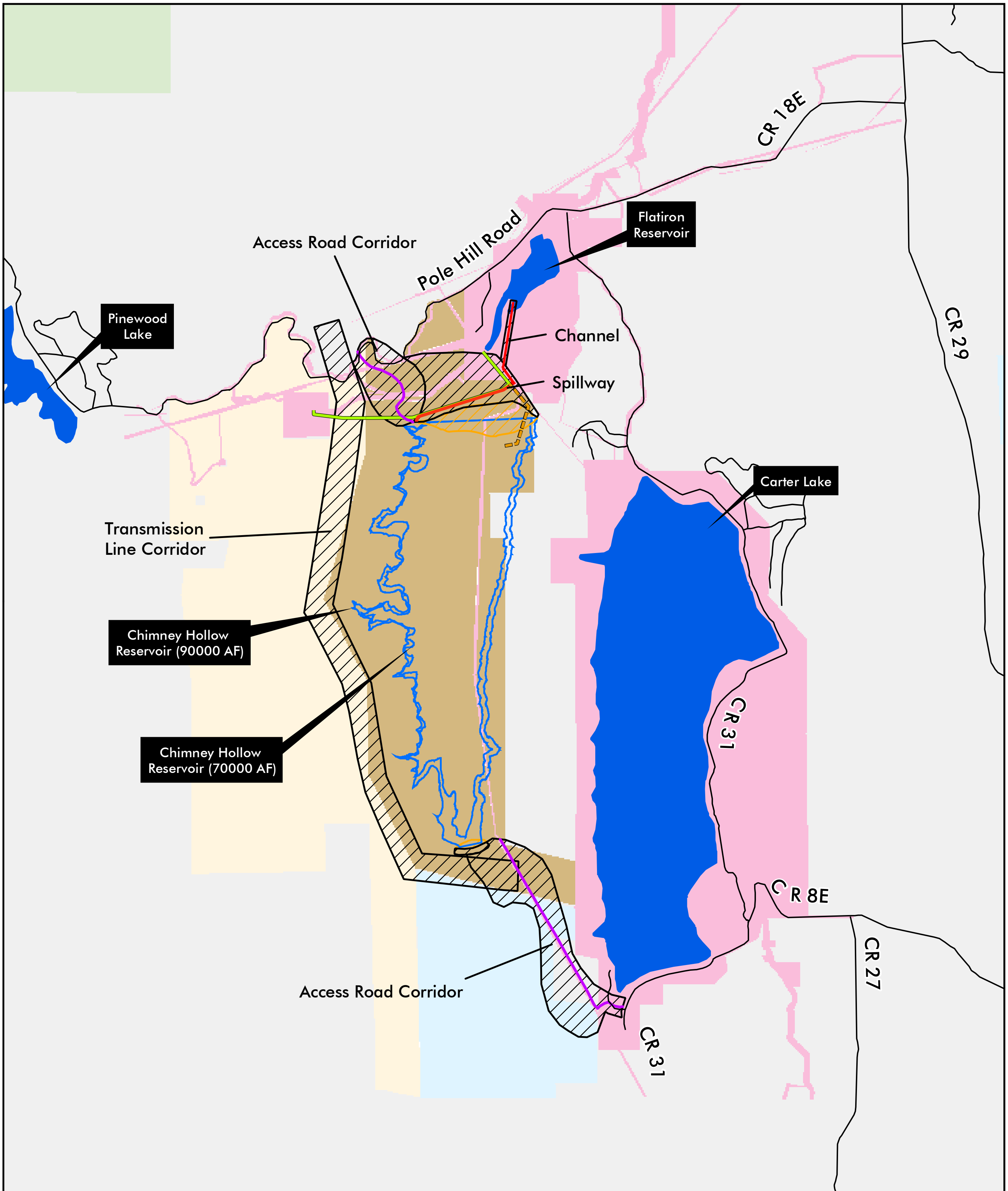
Land Owner

City of Longmont
Boulder County Open Space
State of Colorado
U.S. Forest Service
Private

0 1,300 2,600 Feet
1 Inch = 2,600 Feet
N

Figure 3-66
Ralph Price Reservoir Land Ownership

Prepared for: Windy Gap Firming Project
File: Ralph_Price_Reservoir_Land_Ownership.mxd
January 7, 2008



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Land Owner
- State of Colorado
- U.S. Forest Service
- Reclamation Lands
- Subdistrict
- Larimer County Open Space
- Private

- New or Improved Road Access
- Inlet - Outlet
- Spillway/Channel
- Pipeline
- Potential Disturbance Area

0 2,000 4,000 Feet
1 Inch = 4,000 Feet
N

Figure 3-67
Chimney Hollow Land Ownership

Prepared for: Windy Gap Firming Project
File: Chimney_Hollow_Land_Ownership_All.mxd
January 7, 2008

Transportation

An existing private dirt road and several spur roads extending from County Road 18E and County Road 31 provide access to the reservoir site. Other nearby county roads that provide linkage to the reservoir site are shown in Figure 3-67 and the existing traffic volumes are shown in Table 3-111.

Table 3-111. Existing traffic and capacity near Chimney Hollow and Dry Creek reservoirs.

Access Road	Average Daily Traffic	Vehicle Per Day Capacity
CR 18E	1,300	3,200
CR 31	800	5,400
CR 8E	1,200	5,400
CR 29	1,800	5,800

Source: Larimer County 2000.

3.18.1.7 Dry Creek Reservoir

Land Ownership

Dry Creek Reservoir is located primarily on private property and Colorado State Land Board property (Figure 3-68). A small portion of the reservoir footprint is located on Larimer County Open Space. Pipeline connections would cross Subdistrict, private, and Reclamation property.

Land Use

The Dry Creek area is mostly undeveloped and provides habitat for a variety of wildlife species. The reservoir site is located on lands zoned primarily as *Open Lands (low density rural residential 1/10 acres) and Estate-1* lands (Larimer County 2004). Like Chimney Hollow, Larimer County has identified the Dry Creek site as part of the Blue Mountain Project and as high priority open space (Larimer County 1998). Included on the site are three private residences, one of which is a llama operation. This small business specializes in breeding, showing, and packing llamas, and in 2005 had about 13 animals. The State Land Board currently has a mining lease with a party who is selling moss rock from the site (Routen pers. comm. 2006). State Land Board property at Dry Creek has historically been leased for grazing and is currently closed to public use.

Dry Creek Reservoir includes 10 acres of soils classified as farmland of local importance (NRCS 2005b). Areas having this soil complex with slopes less than 6 percent would qualify as prime farmland if irrigated with an adequate supply of water (SCS 1982). None of this land is currently farmed or irrigated.

Transportation

Access to the site is via U.S. 36, unpaved County Road 71, and other private roads northwest of Lyons. An unimproved road extends through the center of the site in addition to several private dirt roads that provide access to homes.

3.18.1.8 Jasper East

Land Ownership

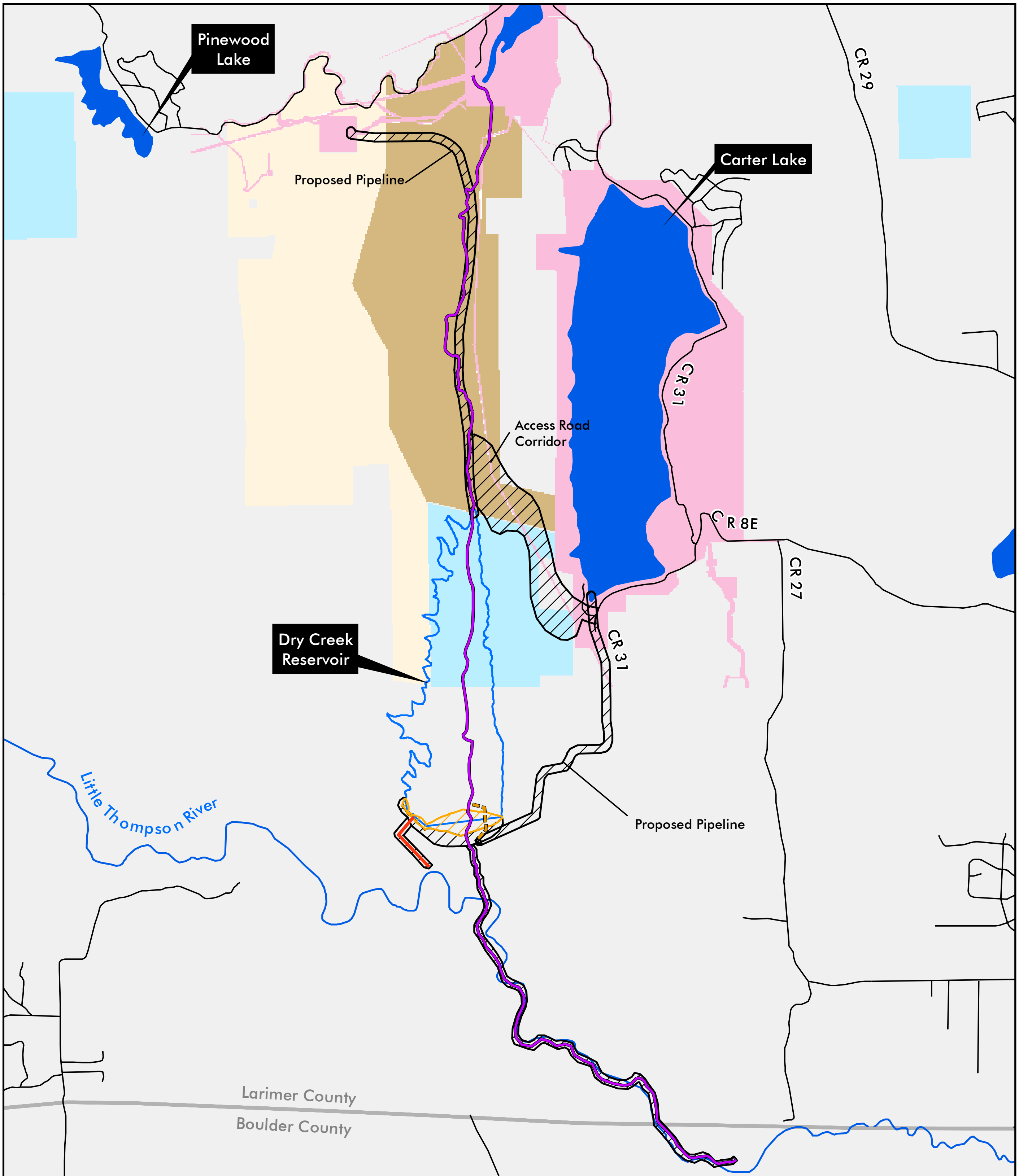
Land ownership at the Jasper East Reservoir site includes NCWCD and Reclamation property (Figure 3-69).

Land Use

Agriculture is the primary land use at the Jasper East Reservoir site. Lands are zoned by Grand County as *Forestry/Open* lands (Grand County 2004a, 2004b). Approximately 313 acres are flood irrigated for cultivation of hay and cattle grazing; however, no prime farmland is present (SCS 1982). The Willow Creek Pump Station, forebay, and portions of the Willow Creek pump canal, which are features of the C-BT Project used to carry water from Willow Creek Reservoir to Granby Reservoir, are located at the site. The remainder of the site is undeveloped and provides wildlife habitat. No homes are present at Jasper East.

Transportation

County Road 40 provides access from Highway 34 to the reservoir site as well as to Willow Creek Reservoir, private land, and residences. Existing average daily traffic on Highway 34 is 4,400 vehicles (CDOT 2004).



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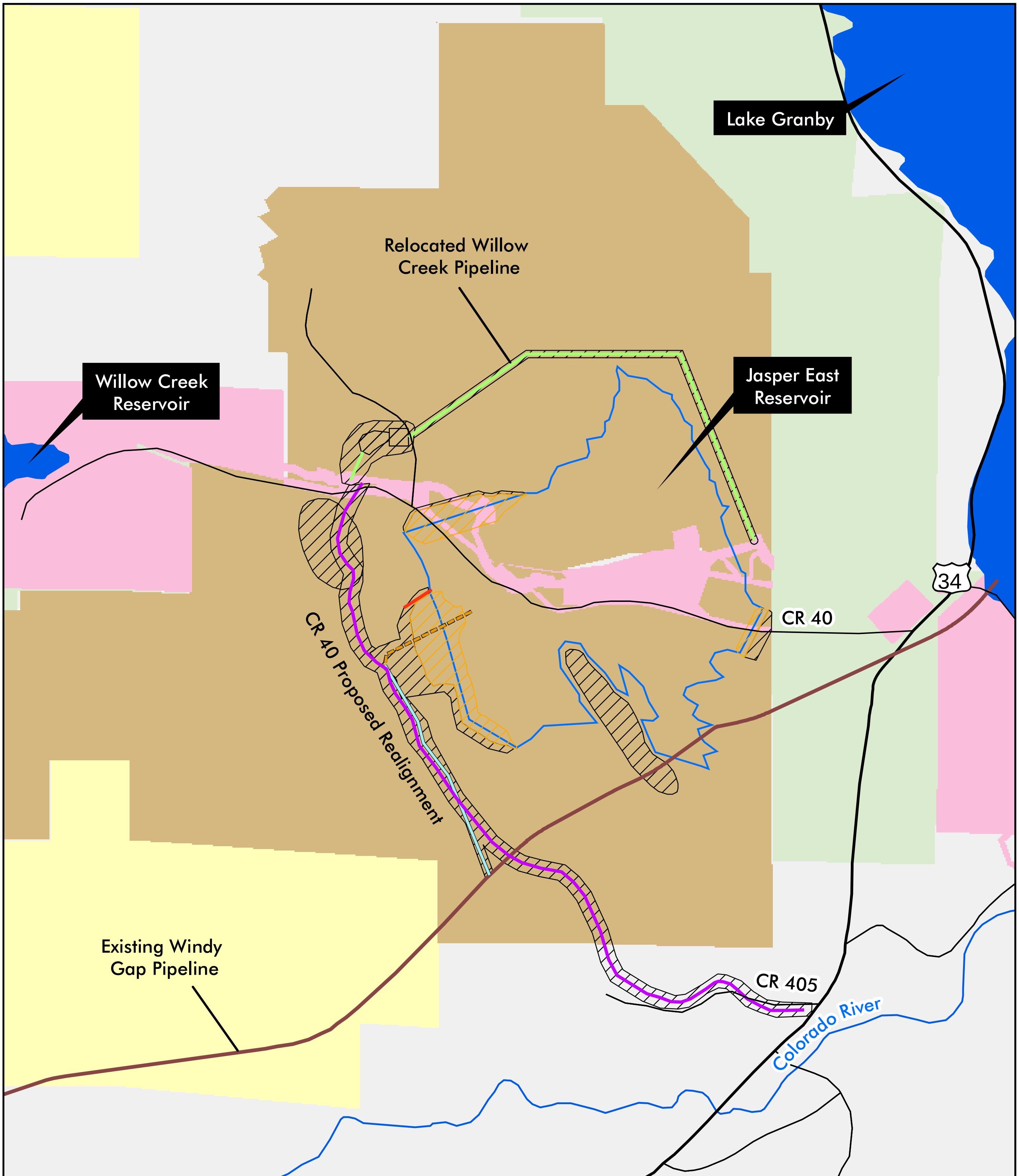
Land Owner
- State of Colorado
- U.S. Forest Service
- Reclamation Lands
- Subdistrict
- Larimer County Open Space
- Private

- New or Improved Access Road
- Spillway
- Inlet - Outlet
- Potential Disturbance Area
- Dam

0 2,500 5,000 Feet
1 Inch = 5,000 Feet
N

Figure 3-68
Dry Creek
Land Ownership

Prepared for: Windy Gap Firming Project
File: Dry_Creek_Land_Ownership_All.mxd
January 7, 2008



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Land Owner

- Bureau of Land Management
- U.S. Forest Service
- Reclamation Lands
- Subdistrict
- Private
- New or Improved Access Road
- New Pipeline
- Inlet - Outlet
- Spillway
- Dam
- Potential Disturbance Area

0 1,100 2,200 Feet
1 Inch = 2,200 Feet
N

Figure 3-69
Jasper East Land Ownership

Prepared for: Windy Gap Firming Project
File: Jasper_East_Land_Ownership_All.mxd
January 7, 2008

3.18.1.9 Rockwell Reservoir

Land Ownership

The Rockwell Reservoir site is located on private and BLM property (Figure 3-70).

Land Use

The Rockwell Reservoir site supports irrigated and nonirrigated meadows used as pastureland, a small stock pond, and four private residences. No prime farmland is present at the site (SCS 1982). The undeveloped portions of this site provide wildlife habitat. Lands are zoned by Grand County as *Forestry/Open* lands (Grand County 2004a, 2004b).

Transportation

Access to the site is via unpaved county roads. County Road 57 off U.S. 40 provides access from the north and County Road 56 off U.S. 40 provides access from the east. Existing average daily traffic on U.S. 40 near County Road 56 is 9,100 vehicles per day and existing average daily traffic near County Road 57 is 6,400 vehicles per day (CDOT 2004).

3.18.2 Environmental Effects

3.18.2.1 Issues

Potential effects to private and public land ownership and existing land uses were identified as issues of concern during scoping. Also of concern were effects to local transportation near new reservoir sites during construction and with any new recreation development.

3.18.2.2 Methods for Effects Analysis

Potential effects to existing land ownership were evaluated by overlaying proposed project facilities for each alternative on land ownership maps. Similarly, effects to existing land uses were evaluated based on anticipated changes at reservoir sites. Potential conflicts with local land use regulations were also evaluated for each of the alternative reservoir sites. Predicted construction traffic volumes and visitor estimates were used to evaluate short and long-term effects to local traffic.

3.18.2.3 Land Use Effects Common to All Alternatives

All alternatives include the diversion of water from the Colorado River at the existing Windy Gap Reservoir west of the Town of Granby. The Subdistrict would continue to operate the Windy Gap diversion and reservoir on property it owns. No new facilities would be constructed along the Colorado River that would affect existing land ownership and land uses. Water rights for existing agriculture, municipal, and other uses would be protected under Colorado water law. Municipal and agricultural diversions downstream from Windy Gap Reservoir, per Colorado water law (C.R.S. § 37-92-102(2)(b)), would remain responsible for developing a reasonable means of diversion for their water.

None of the alternatives would directly affect land use at locations outside of those needed to support project facilities. Future land development in Boulder, Grand, and Larimer counties is determined by local land use plans and zoning.

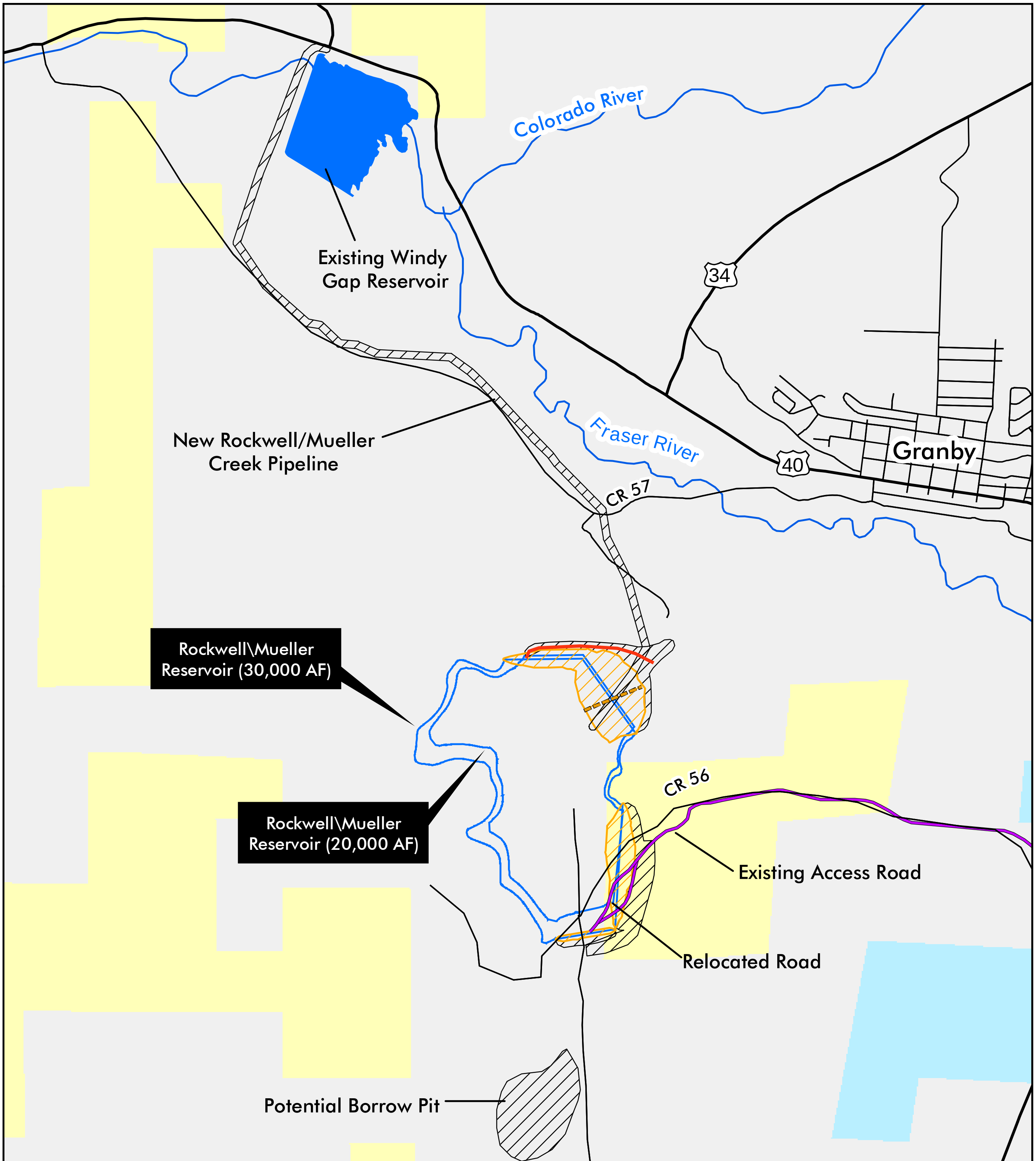
3.18.2.4 Alternative 1—Ralph Price Reservoir (No Action)

Land Ownership

The enlargement of Ralph Price Reservoir would occur entirely on about 77 acres of City of Longmont property (Table 3-112). Borrow areas likely would be located on city land, but could potentially be located on private or National Forest lands. No land acquisition is required to enlarge Ralph Price Reservoir.

Land Use

Existing recreation activities and public access at Ralph Price Reservoir and Button Rock Preserve would be temporarily suspended during construction; however, access and amenities would be restored following reservoir enlargement. There would be no direct effect to private residences near the reservoir, but Longmont's ranger residence could be affected. No elements of the expansion of Ralph Price Reservoir were identified that would directly conflict with the Boulder County Comprehensive Plan or other regulations. The county review process would further evaluate the effects of the action and any conditions for approval.



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New or Improved Access Road
Inlet - Outlet
Spillway
Dam
Potential Disturbance Area
Reservoir

Land Owner

Bureau of Land Management
State of Colorado
Private

0 1,400 2,800 Feet
1 Inch = 2,800 Feet

N

Figure 3-70
Rockwell Land Ownership

Prepared for: Windy Gap Firming Project
File: Rockwell_Land_Ownership_All.mxd
January 7, 2008

Table 3-112. Current land ownership at potential reservoir sites.

Alternative	Private	Subdistrict	Reclamation	BLM	State Land Board	County/ Municipal
	acres					
Alternative 1 Ralph Price	-	-	-	-	-	77
Alternative 2 Chimney Hollow	36	858	70	-	2	54
Alternative 3 Chimney Hollow	26	750	66	-	2	54
Jasper East	10	536[1]	70	-	-	-
Total	**36**	**1,286**	**136**		**2**	**54**
Alternative 4 Chimney Hollow	26	750	66	-	2	54
Rockwell	443	-	-	29	-	-
Total	**469**	**750**	**66**	29	**2**	**54**
Alternative 5 Dry Creek	459	74	18	-	233	7
Rockwell	504	-	-	51	-	-
Total	**963**	**74**	**18**	51	**233**	**7**

[1]The Subdistrict would need to acquire these lands from the NCWCD.

Transportation

During the estimated 30-month construction period, traffic on U.S. 36 and County Road 80 would increase. In addition to supply and equipment deliveries, the construction workforce of up to 100 workers would increase current average daily traffic levels on County Road 80 by about 63 percent. Following construction, traffic levels would be expected to return to existing levels.

3.18.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Land Ownership

The Subdistrict currently owns about 84 percent of the land needed to construct and operate the proposed Chimney Hollow Reservoir (Table 3-112). Portions of several small, private parcels near the northeast corner of the proposed reservoir would need to be acquired in addition to several easements. No private homes would need to be acquired. Western would need to acquire easements on Larimer County, Subdistrict, Reclamation, and possibly State Land Board property depending on the final design and alignment for relocation of 3.8 miles of transmission line. The pipeline connection to the Bald Mountain Tunnel Surge Tank and the Flatiron Penstock Valve house would require a 1,640-foot construction and permanent easement from Larimer County and a 1,035-foot easement from Reclamation. The 1.3-mile construction access road at the south dam would require acquisition of an approximately 0.3-mile easement across State Land Board property, as well as 0.4 mile of easement on private land, and 0.2 mile of easement on Reclamation land (Boyle Engineering 2005b).

Land Use

None of the property is used for agriculture, but there would be a loss of 63 acres of land classified as farmland of local and state-wide importance including land that would be considered prime farmland if irrigated (NRCS 2005a). Because none of the property potentially affected by construction of Chimney Hollow Reservoir is irrigated, there would be no loss of prime farmland associated with construction of Chimney Hollow Reservoir.

Subdistrict land, including the reservoir, would be managed for recreation use by Larimer County in an agreement with the Subdistrict as part of the larger Chimney Hollow Open Space area (Larimer County–Municipal Subdistrict 2004). Subdistrict and county lands would be protected from future development and would be open to a variety of nonmotorized recreational opportunities including hiking, biking, and horseback riding. Water-based recreation opportunities would be angling and nonmotorized boating. Anticipated recreation features that would be developed in a recreation management plan would include a parking area, trails, boat dock and ramp, picnic facilities, and vault toilets. It is estimated that 10 miles of trail would be constructed on both county and Subdistrict land (Larimer County-Municipal Subdistrict 2004). Larimer County Parks and Open Land would prepare a recreation master plan prior to completion of the reservoir.

There would be no impact to existing or planned residential or commercial property. No elements associated with the construction of Chimney Hollow Reservoir and facilities were identified that would directly conflict with Larimer County land use plans or other regulations. The county review process would further evaluate the effects of the action and any conditions for approval.

Transportation

With an estimated peak workforce of up to 500 workers and 5 to 10 truck deliveries per day, construction traffic, would increase traffic volume on County Road 18E (Figure 3-67) about 79 percent during the estimated 38-month construction period. Although the traffic increase would remain below the capacity of 3,200 vehicles per day, traffic delays and congestion at intersections during the morning and afternoon commuting periods would be likely. A portion of the traffic would access the south end of the reservoir off County Road 31 for construction of the saddle dam; however, traffic volumes would be well below the capacity of 5,400 vehicles per day.

No existing public recreation use of the property would be affected. Following construction, access to the reservoir and Chimney Hollow Open Space would be limited to a new road extending off County Road 18E to the west side of the reservoir above the dam. A long-term increase in traffic on County Road 18E would occur from projected recreation of 50,000 visitors annually. Recreation traffic likely would be greatest on weekends during the summer.

3.18.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow Reservoir

Land Ownership. Construction of a 70,000 AF Chimney Hollow Reservoir would affect land ownership on 10 fewer acres of private land, 4 acres less of Reclamation land, and 108 acres less of Subdistrict land than the Proposed Action (Table 3-112). Other easement requirements would be similar to the Proposed Action.

Land Use and Transportation. Land use and transportation effects would be the same as described for the Proposed Action.

Jasper East Reservoir

Land Ownership. The majority of Jasper East Reservoir, dam, and facilities would be located on land owned by the NCWCD and that would need to purchased by the Subdistrict (Table 3-112). About 70 acres would be located on Reclamation property. Reclamation and the Subdistrict would develop an appropriate agreement to permit construction of the reservoir. This could involve either a land exchange or a contract between Reclamation and the Subdistrict. The relocation of about 1.6 miles of County Road 40 would require purchase of about 4.4 acres of private land and 6.9 acres of NCWCD property. Road relocation could affect existing private lands uses, which currently appear to support livestock. The relocated road would need to be constructed to Grand County road and drainage standards, although maintenance would remain with Grand County. Relocation of 1.7 miles of the Willow Creek Pump Canal and the 1.1-mile Jasper East-Windy Gap pipeline connection would require acquisition of NCWCD property by the Subdistrict.

Land Use. Construction of Jasper East Reservoir and associated facilities would permanently remove about 313 acres of irrigated hay meadows from use for grazing and hay production. This would be less than a 1 percent reduction in Grand County total farmland. There would be a loss in lease and agricultural production revenue associated with the change in land use. No prime farmland would be affected (SCS 1982).

There would be no impact to existing or planned residential or commercial property. Construction of large reservoirs, dams, and other water management structures are permitted by special review. The zoning regulations contain specific regulations for special use permits to "construct or operate facilities for a trans-basin diversion" (Grand County 2006). Jasper East Reservoir would be located outside of the Three Lakes Design Review Area. No elements associated with the construction of Jasper East Reservoir and facilities were identified that would directly conflict with Grand County land use plans or other regulations. The county review process would further evaluate the effects of the action and any conditions for approval through its Special Use Review and 1041 Regulations to ensure that the project complies with county planning and zoning policies and regulations.

No existing public recreation use of the property would be affected. Recreation development at the new reservoir is possible if a managing entity is identified. Forest Service management of the property would likely require a transfer of land (Mathew pers. comm. 2005). If an entity is found to manage recreation facilities, a management plan would be prepared to determine what types of activities to allow and how the facility would operate. Development of recreation facilities would contribute to changes in land use from the additional public access and associated traffic. Construction of Jasper East Reservoir would not affect conceptual trail corridors being evaluated in the county (Headwaters Trails Alliance 2008, Elicker, pers. comm. 2008).

Transportation. County Road 40 would be relocated to maintain access to Willow Creek Reservoir and private residences and property. Construction traffic, composed of an estimated peak workforce of up to 160 workers and 5 to 10 truck deliveries per day, would increase traffic volume on U.S. 34 and County Road 40 (Figure 3-69) during the estimated 38-month construction period. The construction workforce would likely commute from Grand Lake, Granby, Hot Sulphur Springs, and other nearby communities. The estimated increase in traffic volume of 340 vehicles per day would be an 8 percent increase from existing traffic volumes on U.S. 34. No existing traffic count data are available for County Road 40, but relocation of County Road 40 would assist in separating construction traffic from local traffic. Traffic to the reservoir following construction for operation and maintenance would be minimal. If recreation facilities are developed, an increase in traffic, particularly during the summer season, would occur.

3.18.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Chimney Hollow Reservoir

Land use effects for Chimney Hollow Reservoir under Alternative 4 would be the same as Alternative 3.

Rockwell/Mueller Creek Reservoir

Land Ownership. Rockwell Reservoir and associated facilities would require Subdistrict acquisition of about 443 acres of private land owned by several landowners and about 29 acres of BLM land (Table 3-112). The Subdistrict would need to obtain a BLM special use permit prior to using 56 acres of BLM property for a potential borrow pit (Cassel pers. comm. 2005a). Realignment of 2,200 feet of County Road 56 would require acquisition of an easement along undeveloped BLM property. Construction of the 3.2-mile pipeline to Windy Gap Reservoir and placement of a booster station would require acquisition of a 100-foot wide construction easement, as well as a 50-foot wide permanent easement directly adjacent to County Road 57 from private landowners (Boyle Engineering 2005b).

Four private homes would need to be purchased and residents would be displaced with reservoir construction. There would be no effect to commercial or urban property.

Land Use. Reservoir construction would eliminate about 53 acres of pastureland land and displace existing livestock grazing, and landowners. Construction of large reservoirs, dams, and other water management structures are permitted by special review. The zoning regulations contain specific regulations for special use permits to "construct or operate facilities for a trans-basin diversion" (Grand County 2006). Rockwell Reservoir would be located outside of the Three Lakes Design Review Area. No elements associated with the construction of Rockwell Reservoir and facilities were identified that would directly conflict with Grand County land use plans or other regulations. The county review process would further evaluate the effects of the action and any conditions for approval through its Special Use Review and 1041 Regulations to ensure that the project complies with county planning and zoning policies and regulations.

No existing public recreation use of the property would be affected. Recreation development at the new reservoir is possible if a managing entity is identified. If an entity is found to manage recreation facilities, a management plan would be prepared to determine what types of activities to allow and how the facility would be operated. Development of recreation facilities would contribute to changes in land use from the additional public access and associated traffic.

Transportation. Access to Rockwell Reservoir would occur via County Road 57 from the north and County Road 56 to the east. Both of these roads may need to be improved to handle construction traffic. County Road 56 would need to be realigned south of the dam prior to construction to maintain private property access. The realignment of county roads would need to be constructed to Grand County road and drainage standards. Maintenance would remain with Grand County if road construction were approved.

Construction traffic, including a peak workforce of up to 152 workers and 5 to 10 truck deliveries per day would increase traffic volume on U.S. 40 and County Roads 56 and 57 (Figure 3-70) during the estimated 38-month construction period. Assuming that construction traffic is evenly split between County Road 56 and County Road 57, the additional 324 vehicles per day would result in a 4 percent increase in average daily traffic on U.S. 40 near the intersection of County Road 56, and a 5 percent increase in average daily traffic on U.S. 40 near the intersection of County Road 57. The additional traffic may result in periodic vehicle delays and congestion at intersections.

Following construction, traffic to the reservoir for operation and maintenance would be minimal. If recreation facilities are developed, an increase in traffic, particularly during the summer season would occur.

3.18.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek Reservoir

Land Ownership. The Subdistrict would need to acquire about 459 acres of private land and about 230 acres of State Land Board property to construct Dry Creek Reservoir (Table 3-112). About 18 acres of Reclamation lands would be disturbed by new or improved access roads and pipeline connections. A potential construction access route from the south via Meadow Hollow would require acquisition of an easement from private landowners for access and road improvements. The pipeline connection to C-BT facilities would extend across about 317 feet of Reclamation property and 3 miles of Subdistrict land. Construction of a 2-mile long pipeline between Dry Creek and Carter Lake would require acquisition of a 100-foot wide construction and 50-foot wide permanent easement from private landowners and Reclamation (Boyle Engineering 2005b).

Construction of Dry Creek Reservoir would require acquisition of three private homes and would permanently displace residents.

Land Use. Reservoir construction would permanently displace the existing llama operation. None of the property is used for agriculture, but there would be a loss of about 10 acres of land classified as farmland of local and state-wide importance including land that would be considered prime farmland if irrigated (NRCS 2005a). There would be no loss of prime farmland associated with construction of Dry Creek Reservoir because none of the land is irrigated.

No existing public recreation use of the property would be affected. Recreation development at the new reservoir is possible if a managing entity is identified. If an entity is found to manage recreation facilities, a management plan would be prepared to determine what types of activities to allow and how the facility would be operated. Development of recreation facilities would contribute to changes in land use from the additional public access and associated traffic. Construction of Rockwell Reservoir would not affect conceptual trail corridors being evaluated in the county (Headwaters Trails Alliance 2008, Elicker, pers. comm. 2008).

No elements associated with the construction of Dry Creek Reservoir and facilities were identified that would directly conflict with Larimer County land use plans or other regulations. The county review process would further evaluate the effects of the action and any conditions for approval.

Transportation. It is assumed that construction access would be primarily via County Road 18E and an improved access road built from the north through Chimney Hollow (Figure 3-68). Construction traffic, with an estimated peak workforce of up to 460 workers and 5 to 10 truck deliveries per day, would increase average daily traffic volume on County Road 18E about 72 percent during the estimated 38-month construction period. The additional traffic is likely to reduce vehicle speeds and increase congestion at intersections. The traffic increase would remain within Larimer County's capacity of 3,200 vehicles per day. Access from the south or east off of County Road 31 is also possible, which would disperse traffic over a greater area.

Following construction, traffic to the reservoir for operation and maintenance would be minimal. If recreation facilities are developed, an increase in traffic, particularly during the summer season, would occur.

Rockwell/Mueller Creek Reservoir

Land Ownership. Effects to land ownership and land use associated with construction of a 30,000 AF Rockwell Reservoir would be similar to those described for Alternative 4. The Subdistrict would need to acquire about 530 acres of private land and about 52 acres of BLM property (Table 3-112). Similar easements would be required including an additional 0.1 mile for relocation of County Road 56.

Land Use and Transportation. Land use and transportation effects would be the same as described for Alternative 4.

3.18.3 Cumulative Effects

No reasonably foreseeable future land developments were identified near Ralph Price Reservoir that would contribute to a cumulative effect on local land use.

Reasonably foreseeable future residential development on 1,440 acres of land within 5 miles of Chimney Hollow Reservoir would contribute to a cumulative loss in undeveloped land in the area under the Proposed Action and Alternatives 4 and 5. Larimer County Open Space development on lands adjacent to Chimney Hollow Reservoir would add to a cumulative increase in recreation opportunities.

Future residential and commercial land developments within 5 miles of the Jasper East Reservoir site in Alternative 3 would contribute about 1,590 acres of additional land use change to the local area, including a potential loss in additional agricultural land and undeveloped land.

Planned future residential, commercial, and mixed land use developments near Rockwell Reservoir in Alternatives 4 and 5 would contribute about 4,770 acres of additional land use change to the area. This could include a cumulative loss of land used for agriculture and undeveloped land.

Reasonably foreseeable future residential land developments near Dry Creek Reservoir in Alternative 5 would add about 1,460 acres of land use change to the area. This would contribute to the cumulative loss of undeveloped land near the reservoir site.

Reasonably foreseeable water-based actions on the West Slope would affect streamflows in the Colorado River, but would not have any direct incremental effect on land ownership or use that overlap the effects of the WGFP. The expiration of Denver Water's contract with Big Lake Ditch in 2013 would reduce the amount of irrigated agriculture in the Reeder Creek drainage and add to the cumulative loss of agricultural production in Grand County with construction of Jasper East Reservoir under Alternative 3. No other cumulative effects were identified for water-based reasonably foreseeable actions.

3.18.4 Proposed Mitigation

No specific mitigation was identified other than what may be needed for land acquisitions or county land use requirements, including special use review, location and extent review, and 1041 permitting. The Subdistrict would compensate landowners for acquisition of property or homes impacted by project facilities.

3.18.5 Unavoidable Adverse Effects

There would be a long-term change in land use and for some reservoir sites, in land ownership, associated with construction and operation of the alternative reservoirs and facilities.

3.19 Recreation

3.19.1 Affected Environment

3.19.1.1 Area of Potential Effect

The study area for assessing potential effects to recreation resources includes portions of Grand, Larimer, and Boulder counties where project facilities would be located, and existing streams, lakes, and reservoirs that would be affected by changes in flow or storage. C-BT reservoirs that would experience a change in operations—Granby Reservoir on the West Slope and Carter Lake and Horsetooth Reservoir on the East Slope are also in the study area. Water levels in Grand Lake and Shadow Mountain Reservoir would not change, but potential changes in water quality that could affect recreation are discussed. Willow Creek Reservoir is not in the study area because there would be no change in water surface elevation or water quality under any alternative, and consequently no impact to recreation. Streams with potential recreation-related effects are the Colorado River from Granby Reservoir to State Bridge and Willow Creek below Willow Creek Reservoir on the West Slope. East Slope streams in the recreation study area are North St. Vrain Creek, St. Vrain Creek, Big Thompson River, Big Dry Creek, and Coal Creek.

3.19.1.2 Data Sources

Information on recreation activities and facilities in the study area was gathered from the BLM, Forest Service, CDOW, and Larimer County Parks and Open Lands. Information was also obtained from reports, communication with river guides, and field visits. Emphasis was given to water-based recreation because the greatest potential for recreation impacts would occur to activities such as boating and fishing. Additional information on recreation is found in the Recreation Resources Technical Report (ERO 2008b).

3.19.1.3 West Slope Reservoir Recreation

Grand Lake, Shadow Mountain, and Granby Reservoir

Recreation at Three Lakes—Grand Lake, Shadow Mountain, and Grand Lake—primarily consists of boating and fishing during the summer season. Winter recreation includes cross-country skiing, snowmobiling, and ice fishing. Power and sail boating are popular, along with canoeing and kayaking. Boating facilities include boat ramps and marinas at all Three Lakes (Table 3-113). An estimated 500 to 3,000 anglers visit the Three Lakes on busy summer weekends (Oldham, pers. comm. 2005). Camping and hiking are also popular near the Three Lakes.

Table 3-113. Three Lakes boating facilities.

Recreation Activities and Uses	Surface Acres	Boat Ramps	Marinas
Grand Lake	507	1 (public)	2
Shadow Mountain Reservoir	1,852	2	1
Granby Reservoir	7,250	3	4

Windy Gap Reservoir

Windy Gap Reservoir, located on the Colorado River west of the Town of Granby, provides wildlife viewing and picnicking.

Rockwell Reservoir

Rockwell Reservoir is located mostly on private lands not available for public use. About 50 acres of the site is on BLM land and receives occasional dispersed recreation use (Cassel, pers. comm. 2005b).

Jasper East Reservoir

The Jasper East Reservoir site is located on NCWCD and Reclamation land not open for public use, although Reclamation leases land for a model airplane park. County Road (CR) 40 crosses the reservoir site and provides access to Willow Creek Reservoir, which provides camping, boating, and fishing opportunities as part of the Arapaho National Recreation Area.

3.19.1.4 West Slope River Recreation

Fishing and boating are popular recreation activities at several locations along the Colorado River and campsites are found at some state wildlife areas (SWAs) and on BLM land. Recreation activities vary by reach between Granby Reservoir and State Bridge (Figure 3-71). Recreation resources along the Colorado River are described for five river reaches.

Colorado River: Granby Reservoir to Windy Gap Reservoir

The 7-mile reach of the Colorado River between Granby Reservoir and Windy Gap Reservoir is mostly private land with no designated recreation sites. Fishing opportunities are present primarily on private land, some of which, such as the Orvis property west of the Town of Granby, are currently being developed. This reach of the river is not known for boating use.

Colorado River: Windy Gap Reservoir to Williams Fork

Recreation in this 14-mile reach supports boating, fishing, and camping. Byers Canyon downstream of Hot Sulphur Springs is a 2.6-mile reach that provides Class IV to V whitewater boating. Class IV- rapids are present at flows between 400 and 1,000 cfs, Class IV+ between 1,000 and 2,000 cfs, an Class V rapids over 2,000 cfs (Banks and Eckhardt 1999). Byers Canyon is not used for commercial boating (Farr, pers. comm. 2006), but receives occasional use, estimated at 15 boaters per year by private kayakers (Crosby, pers. comm. 2008). This reach of the Colorado River is designated as a Gold Medal stream for outstanding fishing opportunities. Public access is available at Beaver Creek, Lone Buck, and Paul Gilbert Fishing Area Units of the Hot Sulphur Springs SWA for about 2 miles.

Colorado River: Williams Fork to Kremmling

This 16-mile reach of the Colorado River has no developed recreation facilities and is not known as a popular boating destination. Gold Medal waters for fishing are present upstream of Troublesome Creek. Public fishing access is available within the Kemp-Breeze SWA and BLM's Sunset Bridge, Powers, and Highway 9 sites. Private lands adjacent to the river, such as Elktrout Lodge property, also provide opportunities for fishing access and guided fishing.

Colorado River: Kremmling to Pumphouse

The Colorado River from the confluence with the Blue River to the Pumphouse Recreation Area is known as Big Gore Canyon. This reach of the river supports 9.2 miles of difficult Class V to VI rapids. This area attracts advanced boaters and is used by commercial and private rafters and kayakers. Commercial rafting companies run the river at flows between 850 cfs and 1,250 cfs (Sommerhoff, pers. comm. 2006). Flows within this range typically occur in early May and in August and September. Commercial trips are usually only run in the later season when temperatures are warmer. Private boaters run the river at flows above 1,250 cfs, but safety becomes a concern at higher flows. Table 3-114 provides rafting and kayaking flows for various conditions. High flows and lack of public shoreline access preclude most fishing in this reach. The Gore Race, a popular whitewater rafting race, is held annually on this reach of the river. August is the primary month for boating in Big Gore Canyon and the Gore Race is typically held the third week of the month. No formal data are available for boating use in Gore Canyon; however, total annual boating

Table 3-114. Colorado River boating flows for Gore Canyon and Pumphouse.

Boating Type	Big Gore Canyon	Pumphouse to State Bridge
	cfs	
Preferred minimum rafting flows	850	400 to 800
Preferred rafting flows	1,000	2,000 to 3,000
Preferred minimum kayaking flows	400 - 800	400 to 800
Preferred kayaking flows	Class V- 800 to 1,300 Class V 1,300 to 2,200 Class V+ >2,200	1,100
Commercial rafting	850 to 1,250	No restrictions

Source: Sommerhoff, pers. comm. 2006; Hydrosphere 2003; Banks and Eckhardt 1999.

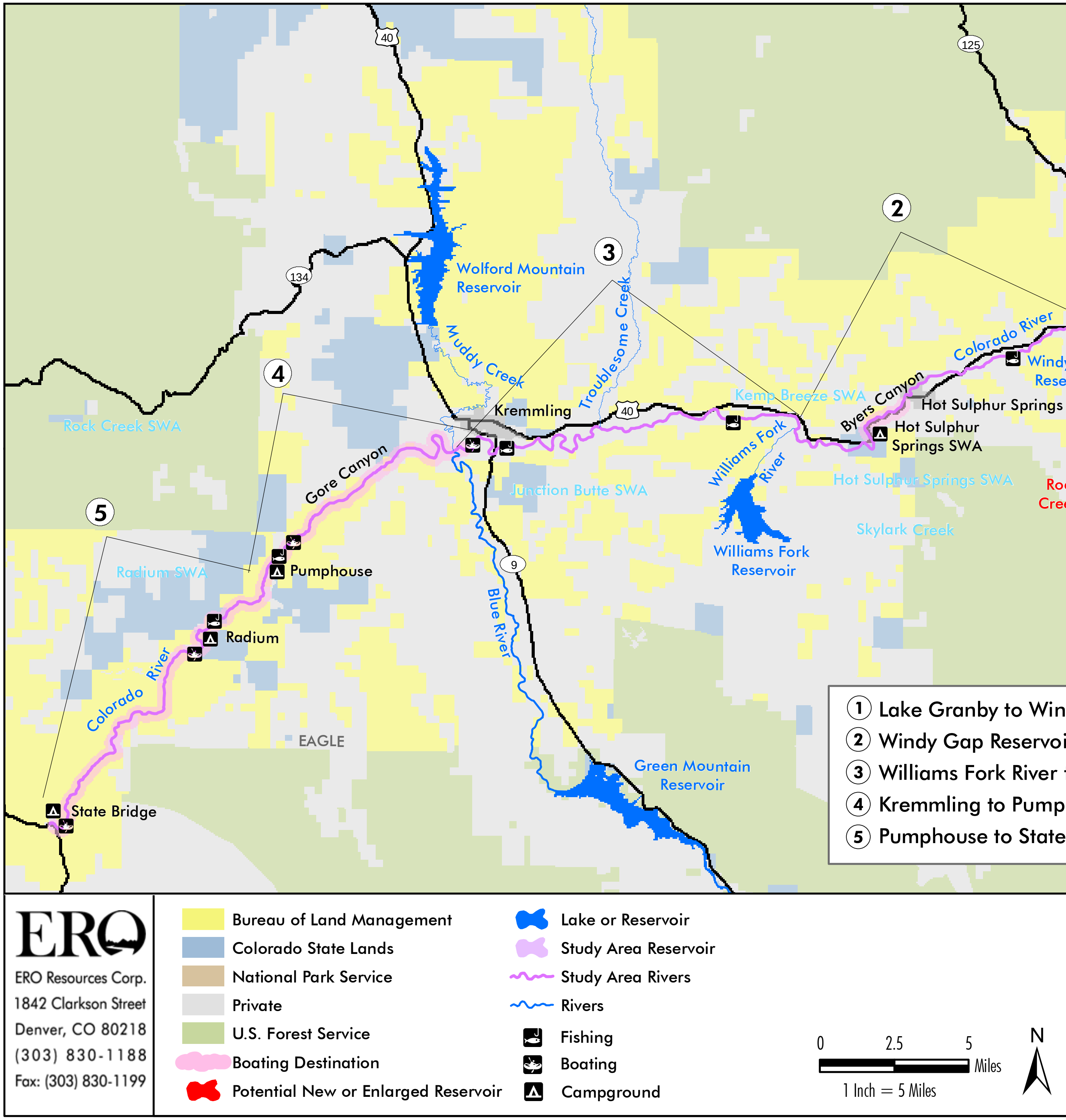


Figure 3-71
Colorado River Recreation

Prepared for: Windy Gap Firming Project
File: 2390 Rec_Fig4_colorado_River Recreation.mxd(JP)
January 2008

use is estimated at 1,200 users, of which about 500 are commercial user days, 500 are private, and about 200 are participants in the Gore Race (Windsor, pers. comm. 2008).

Colorado River: Pumphouse to State Bridge

The Colorado River in this reach provides most of the river-based recreation in the study area. This 11.6-mile reach of the Colorado River includes Class II and III water for intermediate level commercial and private boaters. Preferred flows for rafting in this reach are between 2,000 and 3,000 cfs, with acceptable low flows between 400 and 800 cfs (Sommerhoff, pers. comm. 2006). Kayakers prefer flows between 400 and 1,100 cfs (Table 3-114).

The Pumphouse run is one of the state's most heavily used day-use sites (Arkins, pers. comm. 2004). The boating season is during the summer months of June to August. Although detailed information is not available, the distribution of boating use by month is estimated to be 18 percent in June, 42 percent in July, and 32 percent in August (Windsor, pers. comm. 2008). The remaining 8 percent of use occurs in May, September, and October. The BLM Kremmling Field Office reports total visitation for 2004 and 2005 of 44,566 and 42,247, respectively. These totals reflect the use of the Pumphouse and Radium Recreation Areas for boating, fishing, camping, and day uses. A breakdown of total commercial boating and fishing use numbers from 1999 to 2005 is provided in Table 3-115. Commercial numbers only reflect boating and fishing user days at Pumphouse and Radium on the Colorado River. Commercial boating user days in the upper Colorado River were estimated to be about 31,000 in 2006 and 32,000 in 2007 (CROA 2008).

River shore and floatfishing are popular activities in the designated Wild Trout water found in this reach. In 2005, 15 companies offered guided fishing trips (Sterin, pers. comm. 2006). The BLM estimates that there were about 30,000 to 40,000 annual user days for fisherman in 2004 (Arkins, pers. comm. 2004). Camping, hiking, mountain biking, and off-highway vehicle use are available on nearby lands.

Wild and Scenic Rivers Study

The BLM completed the eligibility phase of a wild and scenic river evaluation for various reaches of the Colorado River within the study area to identify river segments for possible designation under the National Wild and Scenic Rivers Act (BLM 2007a). This inventory and eligibility review was conducted as part of the BLM's Resource Management Plan (RMP) revision process. Eligibility criteria included free-flowing streams with outstanding remarkable values for scenic, recreational, geologic, fish, wildlife, historic, cultural, and other similar values. Five segments of the Colorado River were identified as eligible in the BLM study. These segments and the outstanding remarkable values for each segment are:

- Windy Gap to Hot Sulphur Springs — recreational (fish), wildlife, and historic
- Byers Canyon — recreational (fishing and floatfishing, scenic driving, and other recreation), scenic, wildlife, geological, and historic
- Below Byers Canyon to the mouth of Gore Canyon — recreational (fishing, scenic driving, and other recreation), wildlife, and historic
- Gore Canyon — recreation (fishing, floatfishing, scenic driving, and other recreation), scenic, geological, wildlife, historic, and cultural
- Pumphouse to State Bridge — recreation (fishing, floatfishing, scenic driving, and other recreation), scenic, geological, paleontological, wildlife, historic, and cultural

Table 3-115. Total annual commercial boating and fishing visitor days (1999-2005) in the Pumphouse and Gore Canyon section of the Colorado River.

Year	1999	2000	2001	2002	2003	2004	2005
Commercial Boating	38,803	42,933	34,381	37,801	32,188	29,681	27,211
Commercial Fishing	1,560	1,671	1,537	1,992	1,745	3,552	2,225
Total Annual Commercial Visitors	40,363	44,604	35,918	39,793	33,933	33,233	29,436
Annual Percent Change		+9%	-19%	+10%	-14%	-2%	-11%

Source: BLM 2007b.

There are three classes for river designation under the Wild and Scenic Rivers Act—Wild, Scenic, and Recreational. All of these river reaches were preliminarily classified by BLM as Recreational.

The next phase of evaluation is to determine whether eligible river segments are suitable for inclusion in the Wild and Scenic Rivers System. BLM will complete the suitability evaluation as part of its RMP revision process with recommendations given in a Draft EIS scheduled for 2008. BLM's policy is to manage and protect eligible river segments so as not to adversely constrain the suitability assessment or any subsequent recommendations to Congress. River or stream segments must be found eligible and suitable to be considered for designation in the National Wild and Scenic Rivers System and only Congress or the Secretary of Interior can designate segments.

Willow Creek

Willow Creek below Willow Creek Reservoir is located mostly on private land with limited opportunities for public recreation access. Fishing may occur on private land, but no boating occurs.

3.19.1.5 East Slope Reservoir Recreation

Carter Lake, Horsetooth Reservoir, and Ralph Price Reservoir provide a variety of recreation opportunities along the Front Range. Constructed as part of the C-BT Project, Carter Lake and Horsetooth Reservoir are Reclamation reservoirs that are leased and managed by Larimer County Parks and Open Lands Department for public recreation.

Carter Lake

Carter Lake has a marina, three boat ramps, two campgrounds, trails, and other recreation facilities. Fishing is allowed year-round from shore or boat. Primary recreation use occurs from May to September, with peak weekend boating use of 140 to 190 boats depending on reservoir levels (Fleming, pers. comm. 2003).

Horsetooth Reservoir

Recreation facilities include four campgrounds, five boat ramps, a marina, and swim beach. Use of the reservoir varies during the year, with the greatest activity on weekends and holidays from May to September. While formal visitation records are not maintained, it is estimated that there were about 700,000 visitor days in 2004 (Coffman, pers. comm. 2005). The reservoir can reach the carrying capacity for boats during busy summer days, which ranges from 90 to 380 boats, depending upon the reservoir level (Coffman, pers. comm. 2005.).

Ralph Price Reservoir

This reservoir is located along North St. Vrain Creek about 7 miles west of Lyons. The reservoir is within the Button Rock Preserve, which provides fishing, hiking, and wildlife viewing. No boating is allowed and fishing requires a permit from the City of Longmont. Visitor days in 2004 were estimated to be about 17,000 (Huson, pers. comm. 2005).

Chimney Hollow Reservoir

This reservoir site is owned by the Subdistrict and is currently closed to public use. Larimer County Parks and Open Lands own about 1,800 acres of adjacent land to the west. Recreation use on Larimer County lands is currently limited, but trail development, nonmotorized boating, and fishing are planned for the future. If Chimney Hollow Reservoir is built, Larimer County would manage recreation use at the reservoir and adjacent county lands.

Dry Creek Reservoir

There is no public recreation use on the private or state lands at the Dry Creek Reservoir site.

3.19.1.6 East Slope River Recreation

Big Thompson River

The Big Thompson River Canyon downstream of Drake offers about 6.2 miles of Class IV rapids when the river is above 400 cfs (Banks and Eckhardt 1999). This is not a popular kayak destination and is not used by commercial or private rafters. Opportunities for fishing occur on public and private land.

North St. Vrain Creek and St. Vrain Creek

Three reaches of North St. Vrain Creek below Longmont Reservoir are used by kayakers at flows between 150 and 500 cfs. A 2-mile reach of the creek between Longmont Reservoir and CR 80 provides Class V rapids. From CR 80 to Apple Valley there are 2.4 miles of Class III rapids, and below this reach to Lyons there are 4.2 miles of Class III water. Under average flow conditions, June and July are historically the only months North St. Vrain Creek is boatable. A whitewater park for kayakers on St. Vrain Creek in Lyons is typically used in late May through early July at flows from 60 to 200+ cfs (Boulder Outdoor Center 2006). No commercial boating occurs on these stream segments. Fishing occurs on private and public land along both streams.

Other East Slope Streams

Other streams in the study area are lower portions of the Big Thompson River, St. Vrain Creek to the South Platte River, Coal Creek from Superior to Boulder Creek, and Dry Creek from Boulder to the South Platte River. These streams have limited recreation use. Most of these reaches occur in or near urban areas and experience occasional uses such as fishing, wildlife viewing, and tubing.

3.19.2 Environmental Effects

3.19.2.1 Issues

Recreation issues of concern identified during scoping were the potential effect to recreation use at existing reservoirs from changes in water levels and the types of recreation that might be available at new reservoirs. Also of concern was the potential effect to streamflows supporting rafting and kayaking on the Colorado River.

3.19.2.2 Methods for Effects Analysis

Potential recreation effects were based primarily on changes in hydrologic conditions at reservoirs and streams in the study area. Hydrologic data for average, wet, and dry years was used in the evaluation. Effects to reservoir recreation were evaluated by comparing changes in surface area and water levels under the alternatives to existing conditions. Because of the similarity in effects between Alternatives 3, 4, and 5, values for Alternative 5 are representative of all three alternatives and are shown in figures and tables comparing alternatives. In general, a decrease in water surface area would be considered a negative effect, although it is difficult to quantify any change in visitor use. The analysis considered how changes in water level may affect access to boat ramps.

Changes in streamflow were used to evaluate effects to river-based recreation. The effects analysis focused on the primary recreation season—May to September—which also coincides with most of the hydrologic changes. For the Colorado River, potential effects to rafting and kayaking were determined by evaluating changes in average monthly streamflow and changes in daily flow. Flow changes were evaluated at the three segments of the Colorado River where boating occurs: Byers Canyon near the Hot Sulphur Springs gage, and in the Big Gore Canyon and Pumphouse reaches of the river represented by the Kremmling gage. Average monthly flow data provide a graphical representation of the changes in streamflow in relation to boating preferences. Daily hydrologic data was used to estimate the change in the number of days when preferred rafting and kayaking flows would occur. This involved an analysis of the number of days during the boating season when flows would be within preferred ranges for rafting or kayaking. Daily data from the 47-year hydrologic period of record (1950-1996) indicated the number of days when flow fell within a preferred boating range and the range of change in the number of days per year that preferred flows for boating would occur compared to existing conditions. The analysis of daily data also indicated the frequency of flow changes based on the number of years in the period of record that there would be a change in the number of days with preferred boating flows for each of the alternatives. The potential effects to angling were based on the results of the aquatic resource evaluation discussed in Section 3.9.

To facilitate the comparison of recreation impacts among the alternatives, this section is organized by reservoir and stream locations on the West and East Slopes. In general, the action alternatives result in similar hydrologic and recreation effects on streams because similar amounts of water are diverted.

Potential effects to recreation for Colorado River reaches eligible for designation under the Wild and Scenic Rivers Act are discussed, but no determination is made on whether the alternatives would affect the suitability of these reaches for designation. The BLM is currently evaluating suitability as part of the RMP revisions.

3.19.2.3 Effects Common to All Alternatives

Effects to water-based recreation from the action alternatives would have limited direct impacts on land-based recreation activities such as camping, picnicking, and hiking. Effects to recreational boating under any alternative, as described below, are not expected to measurably impact recreation use of campgrounds and other facilities near lakes and streams affected by the action alternatives. The recreational experience for these activities such as camping, hiking, mountain biking, hunting, scenic driving, and OHV riding is unlikely to be affected, although some visitors may discern a reduction in aesthetic value of the Colorado River from periodic lower flows or lower reservoir levels in Granby Reservoir or Horsetooth Reservoir. There could be a decrease in camping in upper Colorado River campgrounds during periods when streamflow is less than preferred for boating.

Potential effects to aquatic resources from changes in streamflow and reservoir storage on the West Slope and East Slope as discussed in Section 3.9 are unlikely to adversely impact sport fishing under any alternative based on estimated effects to fish habitat and communities.

3.19.2.4 West Slope Reservoir Recreation

Grand Lake and Shadow Mountain Reservoir

There would be no change in surface water elevation at Grand Lake or Shadow Mountain Lake for any alternative because the C-BT Project limits reservoir fluctuations to no more than 1 foot from the top of the conservation pool. Thus, none of the alternatives would result in hydrologic changes that would affect recreation activities or opportunities. As indicated in *Surface Water Quality* (Section 3.8), predicted changes in water quality would not impact water quality standards for recreation use. Reduced water clarity and algal growth has been a concern in Grand Lake and Shadow Mountain Reservoir that may contribute to a diminished recreation experience (Stahl and Crabtree 2005). Predicted small reductions in water clarity would continue or slightly increase the potential for a diminished recreation experience under all of the alternatives. The assessment of aquatic resources in Section 3.9 determined that the predicted water quality changes in Grand Lake and Shadow Mountain Lake would not adversely impact fish and, therefore, there would be no effect on fishing opportunities in these lakes.

Granby Reservoir

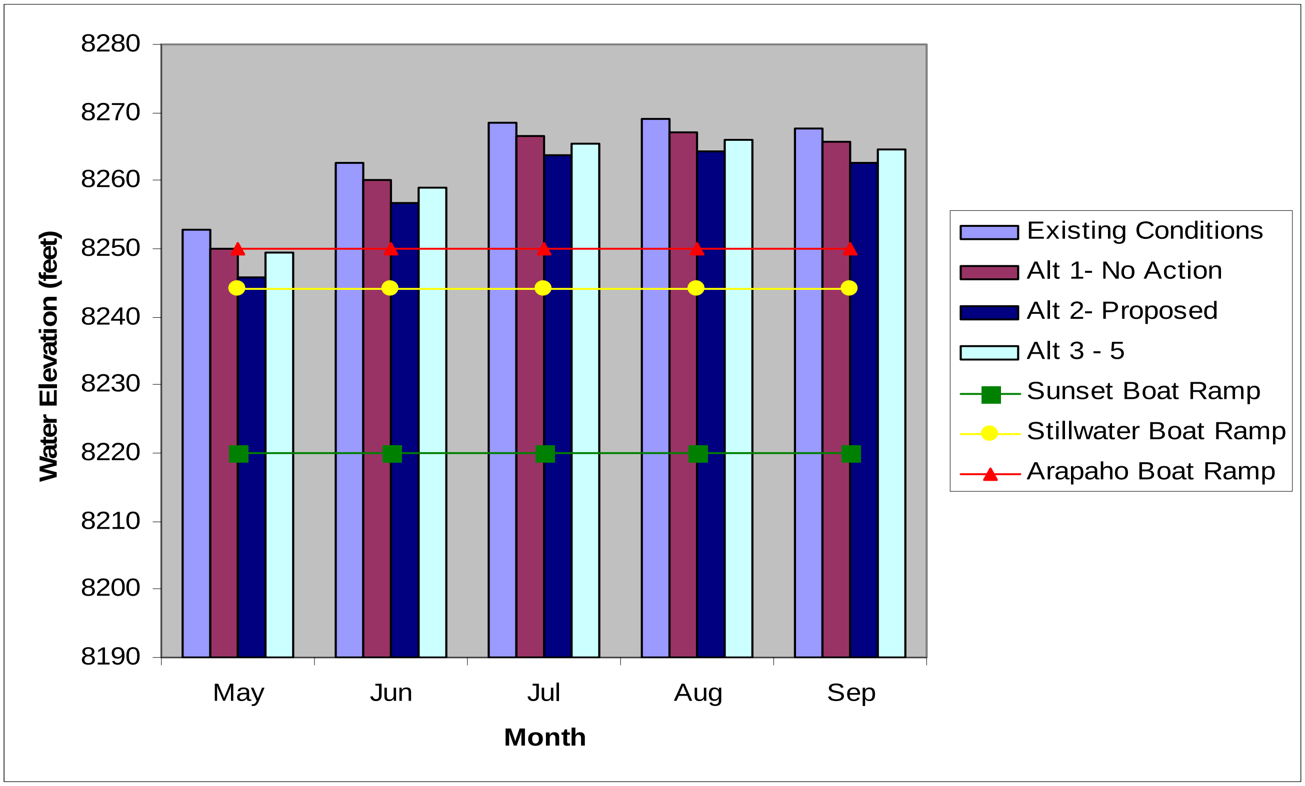
Water levels in Granby Reservoir would be lower during the summer months under all alternatives. The No Action alternative would reduce water surface area by less than 140 acres or about 2 percent compared to existing conditions during the summer in average years (Table 3-116). The Proposed Action would reduce summer water surface area less than 351 acres or about 6 percent on average, with smaller changes under Alternatives 3 to 5. Wet year surface area changes would be slightly greater for all alternatives in early summer and less in late summer. Dry year reductions in lake surface area would be similar to average years, although decreases of up to 18 feet could occur in consecutive dry years under the No Action alternative and up to 23 feet under the Proposed Action, with smaller changes for other action alternatives.

In average years, all boat ramps would remain accessible in the summer under the action alternatives, except for Arapaho Bay in May (Figure 3-72). In dry years, all alternatives would lower Granby Reservoir below the Arapaho Bay boat ramp

Table 3-116. Average monthly changes in Granby Reservoir surface area.

Alternative	May	June	July	August	September
	Surface Area (ac)				
Existing Conditions	**5,970**	**6,440**	**6,722**	**6,750**	**6,691**
	Changes in Lake Surface Area from Existing Conditions (ac)				
Alt 1 – No Action	-140	-113	-90	-88	-96
Alt 2 – Proposed Action	-351	-281	-225	-226	-251
Alt 3 – 5	-167	-174	-147	-143	-150

Figure 3-72. Average monthly water levels at Granby Reservoir boat ramps.



in August. The Proposed Action also would result in lake levels below the Arapaho Bay boat ramp in May, and possibly below the Stillwater and Sunset boat ramps in successive dry years.

The relatively small percent reduction in boatable area on this large reservoir in most years is unlikely to noticeably affect recreation use or the quality of the recreation experience under any alternative. Additional exposed shoreline at lower water levels could reduce the aesthetic value. Lower water levels under all alternatives would not substantially affect accessibility for shoreline fishing, but in periods of successive dry years, the lower water levels would affect boat ramp access, which may reduce the quality of the reaction experience. Camping, hiking, and shoreline activities could decrease during periods of low water levels. Visitor user days have historically declined during dry or drought years, although this may be due to factors other than water levels, including campfire restrictions or weather (Orr, pers. comm. 2008).

Windy Gap Reservoir

There would be no substantial changes in the operation of Windy Gap Reservoir under any alternative that impact existing recreation use.

Jasper East Reservoir

Construction of Jasper East Reservoir in Alternative 3 would displace a model airplane facility and require rerouting CR 40, which provides access to Willow Creek Reservoir. No other public accessible recreation would be affected. Jasper East Reservoir could provide a recreation opportunity if a managing entity is found. Wide fluctuations in reservoir water levels would reduce suitability for recreation and maintaining a fishery.

Rockwell Reservoir

No existing recreation resource facilities would be affected with construction of either size of Rockwell Reservoir in Alternative 4 or 5. Recreation facilities could be developed if a managing entity is found. Seasonal water level fluctuations and low water levels during the winter months could affect the establishment of a viable fishery and recreation activities.

3.19.2.5 West Slope River Recreation

Potential effects to recreation activities were evaluated for the Colorado River and Willow Creek. No other West Slope streams would be affected by the alternatives. Colorado River streamflow was evaluated for five reaches between Granby Reservoir and State Bridge. Daily data for all years in the 47-year study period were used to evaluate the effect on preferred boating flows. There would be no change from existing conditions for any alternative in dry years during the recreation season. Changes in wet year flows are generally not a concern because streamflow is about 2 to 3 times greater than average, so sufficient water is typically available to meet recreation needs.

Colorado River: Granby Reservoir to Windy Gap Reservoir

Changes in flow below Granby Reservoir are primarily a function of changes in spills. In average conditions, the No Action alternative would reduce average monthly Colorado River streamflow above Windy Gap 0 to 6 percent from existing conditions from May to September. The Proposed Action and Alternatives 3, 4, and 5 would result in an average monthly flow reduction of 0 to 11 percent in Colorado River between May and September. Because this reach of the river is not a popular boating destination, there would be negligible impact to boating activities.

Colorado River: Windy Gap Reservoir to Williams Fork

Under existing conditions, average flows in Byers Canyon exceed the 400 cfs needed for kayaking in June and July. Average monthly streamflow data indicates that flows in Byers Canyon under all alternatives would remain above 400 cfs in June, but would drop below 400 cfs in July (Figure 3-73). Estimated daily flow data indicate that in 29 years of the 47-year period of record there would be no change in the number of days that flow exceeds 400 cfs for any of the alternatives (Table 3-117). In the remaining 18 years, there would be an estimated average decrease of 8 days per year with flows less than the preferred kayaking minimum of 400 cfs under No Action and an estimated average of 12 fewer days per year for the action alternatives. In those years when there is a change in the number of days with flows greater than 400 cfs, the estimated change varies from 1 more day to up to 49 fewer days. Although Byers Canyon does not support commercial boating and is infrequently used for kayaking, these changes would affect boating opportunities in this reach of the river primarily in July.

Colorado River: Williams Fork to Kremmling

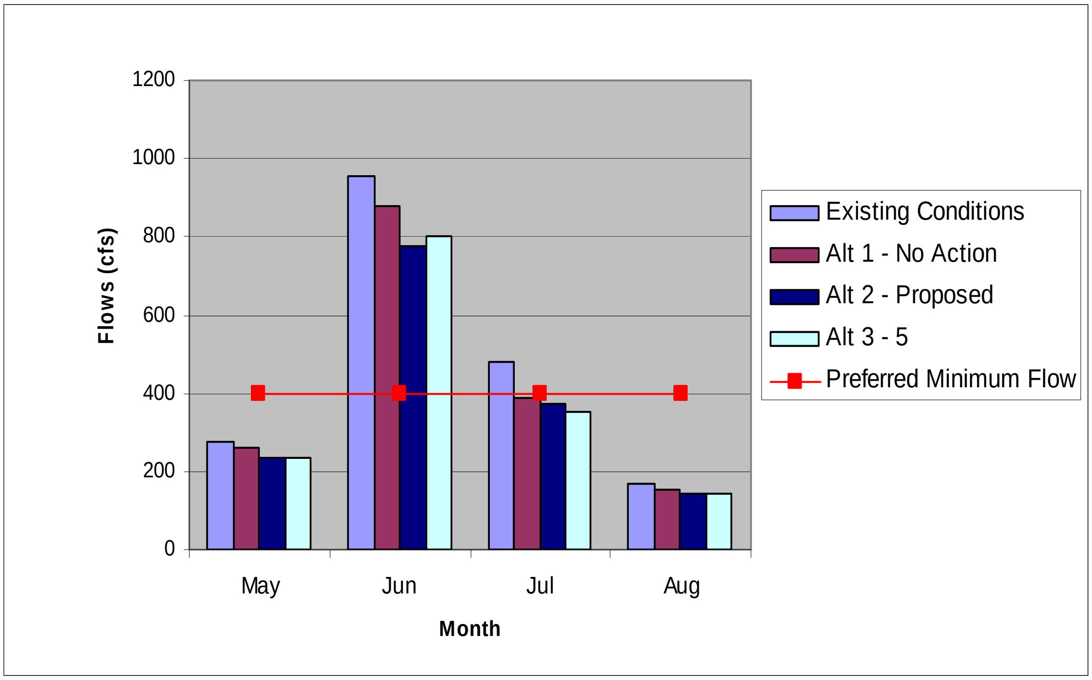
Average monthly streamflow would decrease a maximum of 13 percent under the No Action alternative in July compared to a maximum decrease of 15 percent under the Proposed Action in June, and

Table 3-117. Comparison of preferred boating flow days (flows above 400 cfs) in Byers Canyon (June 1 through July 26) between existing conditions and the alternatives.

Alternative	Total days in 47-year period flows are >400 cfs	Average change in preferred flow days per year from EC during the 18 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 18 years when flow changes occur
Existing Conditions (EC)	1,012		
Alt 1 – No Action	870	8.0	-34 to 0
Alt 2 – Proposed Action	792	12.0	-49 to +1
Alt 3	793	11.0	-49 to +1
Alt 4	778	12.3	-49 to +1
Alt 5	789	12.4	-49 to 0

*There would be no change in the number of days when flows exceed 400 cfs between EC and any of the alternatives in 29 of the 47 years.

Figure 3-73. Average monthly streamflow on the Colorado River in the Byers Canyon kayak reach below Hot Sulphur Springs.



a maximum decrease of 18 percent in July for the other action alternatives. Because of the limited existing boating in this reach of the Colorado River, none of the alternatives would substantially effect recreational boating.

Colorado River: Kremmling to Pumphouse

The Big Gore Canyon of the Colorado River from the Blue River confluence near Kremmling to Pumphouse provides advanced whitewater boating. Average monthly May to September flow reductions in this reach of the Colorado River range from 1 to 5 percent under the No Action alternative (Table 3-118). Under the Proposed Action and other action alternatives, average monthly streamflow would decrease up to 7 percent. None of the alternatives would reduce May to September flow below 850 cfs, which is the commercial low flow rate for rafting or 800 cfs for kayaking (Figure 3-74 and Figure 3-75).

Estimated daily flow data indicates that in 37 years of the 47-year period of record, there would be no change from existing conditions in the number of days preferred rafting flows of 850 to 1,250 cfs occur in Big Gore Canyon for any of the alternatives (Table 3-119). Preferred rafting flows in Gore Canyon would occur about 24 days less under the No Action alternative compared to existing conditions over the 47-year study period. Under the Proposed Action, preferred rafting flows would occur about 23 days less than existing conditions over the 47 years. On average, this would be about 2.3 days per year with fewer preferred rafting flows during the 10 years when flows fall outside of the

Table 3-118. Average monthly changes to Colorado River flows in Gore Canyon to State Bridge.

Alternative	May		June		July		August		September	
	cfs	%[1]	cfs	%[1]	cfs	%[1]	cfs	%[1]	cfs	%[1]
Existing Conditions	**1,145**	—	**2,619**	—	**1,745**	—	**1,026**	—	**909**	—
Alt 1 – No Action	1,129	-1%	2,542	-3%	1,660	-5%	1,010	-2%	901	-1%
Alt 2 – Proposed Action	1,104	-4%	2,442	-7%	1,647	-6%	1,002	-2%	899	-1%
Alt 3 – 5	1,101	-4%	2,466	-6%	1,624	-7%	999	-3%	901	-1%

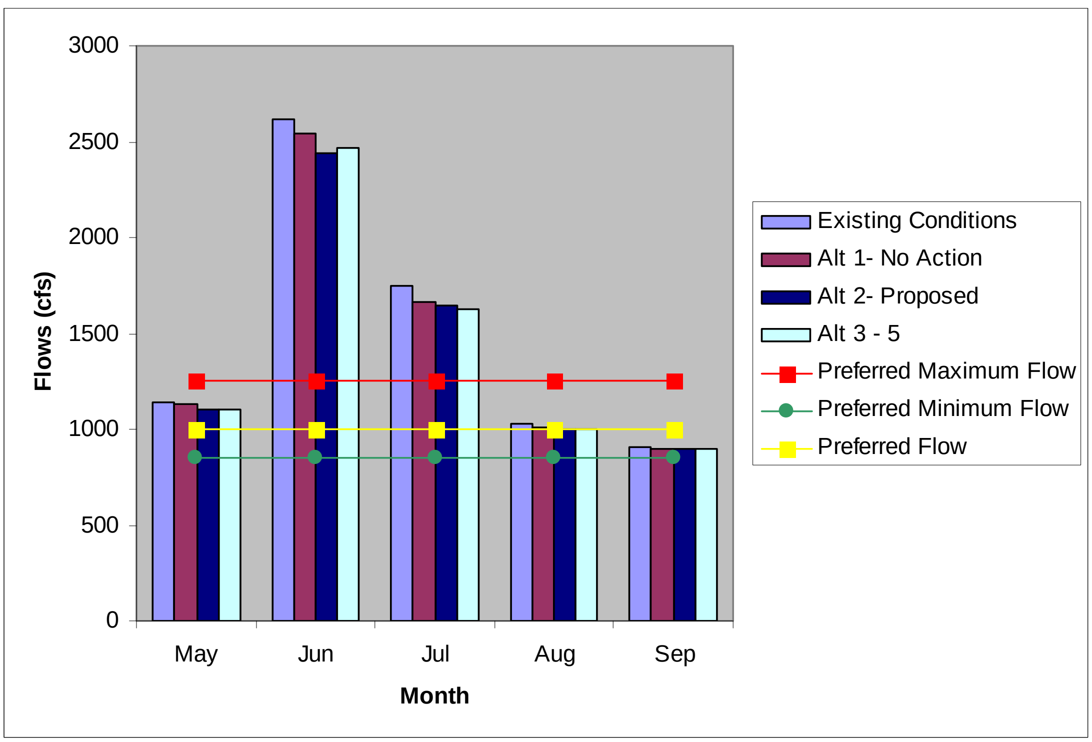
[1] Percent change in streamflow from existing conditions.

Table 3-119. Comparison of preferred rafting flow days (850 to 1,250 cfs) in Big Gore Canyon between existing conditions and the alternatives in August.

Alternative	Total days in 47-year period flows were between 850 and 1,250 cfs	Average change in preferred flow days per year from EC during the 10 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 10 years when flow changes occur
Existing Conditions (EC)	848		
Alt 1 – No Action	824	-2.4	-11 to 0
Alt 2 – Proposed Action	825	-2.3	-11 to +1
Alt 3	825	-2.3	-11 to +1
Alt 4	829	-1.9	-11 to +1
Alt 5	821	-2.7	-11 to +1

*There would be no change in the number of days when flows are between 850 and 1,250 cfs in 37 of 47 years.

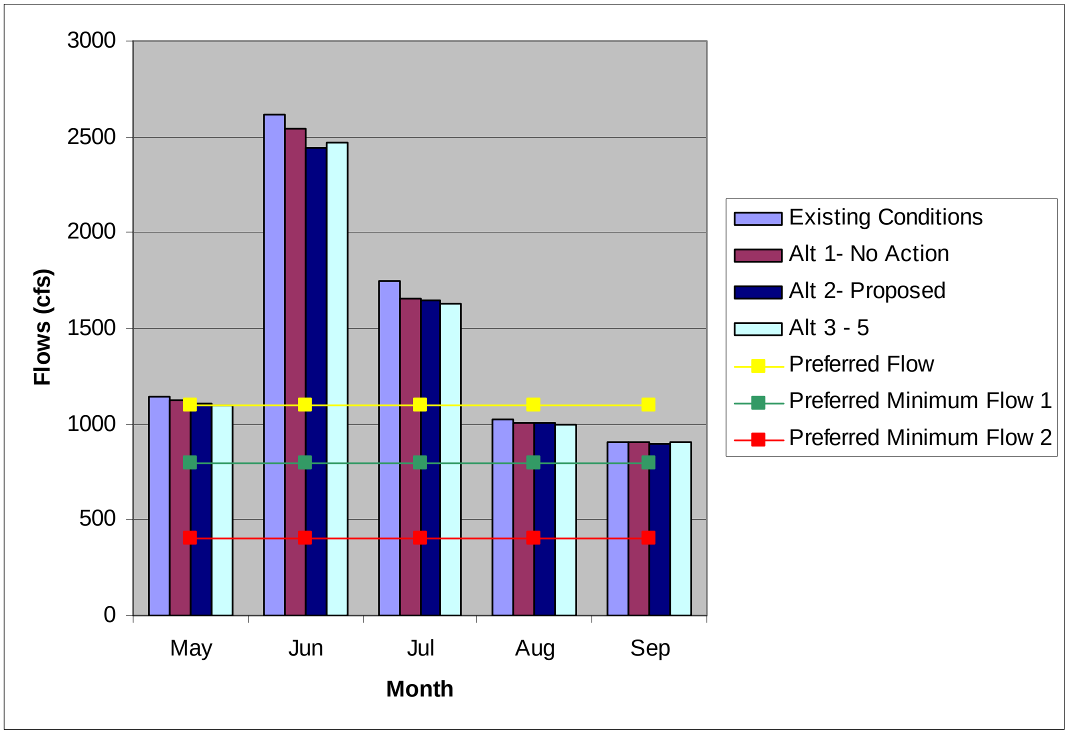
Figure 3-74. Average monthly streamflow on the Colorado River through Big Gore Canyon for rafting.



preferred range. The greatest decrease in preferred flows for rafting in a single year would be 11 days under all of the alternatives (year 1961), with an increase of 1 day in some years for the action alternatives. Projected flows for all of the alternatives would allow commercial outfitters to continue to run trips through Big Gore Canyon in August most of the time. Reduced flow in about 10 out of 47 years would decrease opportunities for commercial rafting by several days.

There would be no change in the number of days that flows fall within the preferred range of 400 to 2,200 cfs for kayaking in 45 years out of the 47-year study period in Big Gore Canyon and in the

Figure 3-75. Average monthly streamflow on the Colorado River from Kremmling to State Bridge for kayaking.



Pumphouse to State Bridge reach under any of the alternatives (Table 3-120). During the 2 years when flow changes fall outside the preferred range, there would be an average of 2 additional days of preferred flow. The greatest change in the number of preferred flow days in a single year would range from an increase of 3 days to a decrease of 1 day under all of the alternatives. There would be no substantial change in kayaking opportunities in Big Gore Canyon or Pumphouse to State Bridge under any of the alternatives.

A change in the number of days that preferred kayaking flows would be between 1,100 and 2,200

Table 3-120. Comparison of preferred kayaking flow days (400 to 2,200 cfs) in Big Gore Canyon and Pumphouse to State Bridge between existing conditions and the alternatives in August.

Alternative	Total days in 47-year period flows were between 400 and 2,200 cfs	Average change in preferred flow days per year from EC during the 2 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 2 years when flow changes occur
Existing Conditions (EC)	1,421		
Alt 1 – No Action	1,425	+2	-1 to +3
Alt 2 – Proposed Action	1,425	+2	-1 to +3
Alt 3	1,425	+2	-1 to +3
Alt 4	1,425	+2	-1 to +3
Alt 5	1,425	+2	-1 to +3

*There would be no change in the number of days when flows for kayaking are between 400 and 2,200 cfs in 45 of the 47 years.

cfs in Big Gore Canyon and Pumphouse also was evaluated because some kayakers prefer the higher flow range (Table 3-121). Estimated daily flow data indicates that in 32 years of the 47-year study period, there would be no change in the number of days in this flow range for any of the alternatives. Results also indicate that over the 47-year study period, there would be about 1 more day of preferred kayaking flows under the No Action alternative compared to existing conditions. Under the Proposed Action, there would be about 4 fewer days, which would average 1 day less per year of preferred kayaking flows during the 15 years when flow changes occur. The greatest change in preferred flows for kayaking in a single year would be 15 days fewer under all of the alternatives, with an increase of up to 7 days with preferred kayaking flows under the No Action alternative and 6 days under the Proposed Action. Results of the analysis indicate the potential for impacts to the annual Gore Race, usually held the third week in August, is unlikely in most years and the Subdistrict would curtail diversions during the race if flows fall below 2,200 cfs at Kremmling as a mitigation measure (Section 3.19.4); therefore, the WGFP would have no effect on the Gore Race.

Colorado River: Pumphouse to State Bridge

The reach of the Colorado River between Pumphouse and State Bridge is generally flat water with some Class II and III rapids. The flows for this reach are measured by the same gage as for Big Gore Canyon (Table 3-118) Rafting companies prefer flows between 2,000 and 3,000 cfs, and typically curtail operations at flows less than 400 to 800 cfs (Figure 3-76). Kayakers have the same preferences for flows (1,100 cfs) on this reach as they do for Big Gore Canyon (Figure 3-75).

In the Pumphouse reach of the Colorado River, there would be no change in the number of days that preferred rafting and kayaking flows between 400 and 3,000 cfs occur in 34 years out of the 47-year study period (Table 3-122). Over the 47-year period, there would be 22 additional days under the No Action alternative compared to existing conditions when flows are in the preferred flow range. Under the Proposed Action, there would be a total of about 38 additional days in the preferred flow range. The number of days in the preferred flow range increases for other alternatives as well, as a result of diversions that reduce flow below 3,000 cfs. On average, this would be an increase of about 3 days per year during the 13 years when flow changes occur for the action alternatives and 2 days for the No Action alternative. In those years when there is a change in the number of days with flows in the preferred range, the estimated change varies from 12 days fewer (year 1961) to 14 additional days under all of the alternatives.

Table 3-121. Comparison of preferred kayaking flow days (1,100 to 2,200 cfs) in Big Gore Canyon and Pumphouse to State Bridge between existing conditions and the alternatives from June to August.

Alternative	Total days in 47-year period flows were between 1,100 and 2,200 cfs	Average change in preferred flow days per year from EC during the 15 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 15 years when flow changes occur
Existing Conditions (EC)	1,034		
Alt 1 – No Action	1,035	+<1	-15 to +7
Alt 2 – Proposed Action	1,030	-<1	-15 to +6
Alt 3	1,030	-<1	-15 to +6
Alt 4	1,037	+<1	-15 to +10
Alt 5	1,033	-<1	-15 to +10

*There would be no change in the number of days when preferred flows for kayaking are between 1,100 and 2,200 cfs in 32 of the 47 years.

Figure 3-76. Average monthly streamflow on the Colorado River from Pumphouse to State Bridge for rafting.

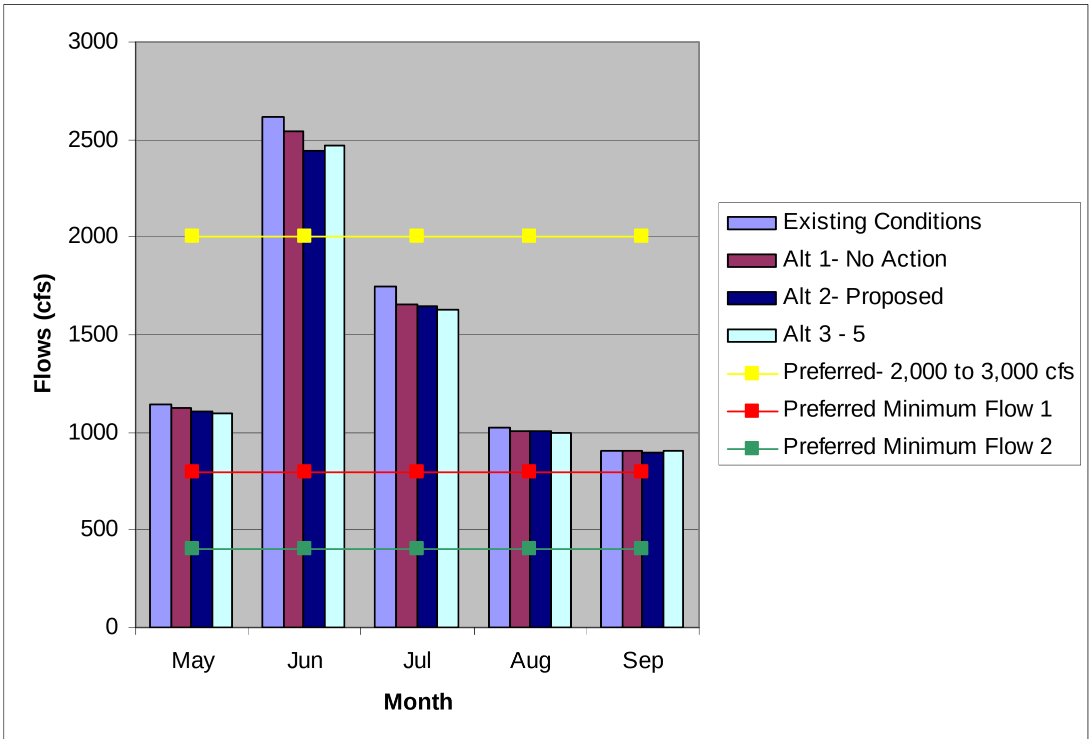


Table 3-122. Comparison of preferred rafting and kayaking flow days (400 to 3,000 cfs) from Pumphouse to State Bridge between existing conditions and the alternatives for June through August.

Alternative	Total days in 47-year period flows were between 400 and 3,000 cfs	Average change in preferred flow days per year from EC during the 13 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 13 years when flow changes occur
Existing Conditions (EC)	3,498		
Alt 1 – No Action	3,520	+1.7	-12 to +14
Alt 2 – Proposed Action	3,536	+2.9	-12 to +14
Alt 3	3,535	+2.8	-12 to +14
Alt 4	3,534	+2.8	-12 to +14
Alt 5	3,536	+2.9	-12 to +14

*There would be no change in the number of days when flows are between 400 and 3,000 cfs in 34 of the 47 years.

There would be no change from existing conditions in the number of days when preferred rafting and kayaking flows in the Pumphouse reach are in the higher flow range of 2,000 to 3,000 cfs in 28 years of the 47-year study period under the alternatives (Table 3-123). Over the 47-year period, there would be 6 more days of preferred flows under the No Action alternative and 20 fewer days under the Proposed Action. On average during the 19 years where flow changes occur, there would be about 1 less day in the preferred rafting flow range under all of the alternatives. The greatest decrease in the preferred flow range in a single year (year 1952) would be 17 days fewer under all of the action alternatives except Alternative 5, which would have 5 fewer days. The greatest increase in the number of days of preferred flows in a year would be 11 days under the No Action alternative and 8 days under Alternative 5. Although overall there would be more preferred flow days available between 400 and 3,000 cfs as shown in Table 3-122, there would be fewer days in the preferred higher flow range. This could reduce the number of boaters or diminish the boating experience when flows drop below 2,000 cfs. A reduction in preferred kayaking flows of 1,100 to 2,200 cfs would be the same as discussed for the Big Gore reach and shown in Table 3-121.

Willow Creek

Willow Creek is not used for recreational boating and hence there would be no effect under any alternative.

3.19.2.6 East Slope Reservoir Recreation

Ralph Price Reservoir

Enlargement of Button Rock Dam at Ralph Price Reservoir would require temporary suspension of recreation access during the estimated 2-year construction period. During this time, no fishing, hiking, wildlife viewing, or other activities would be allowed. Upon completion of the dam, recreation access and activities would resume, similar to current conditions. Fishing opportunities may be diminished for several years following construction until the reservoir refills, but a larger reservoir would improve habitat for fish. Portions of the existing trail around the reservoir also would need to be reconstructed. Recreation use would likely be similar to existing conditions once the reservoir refills.

Carter Lake

Carter Lake surface area would decrease less than 1 percent and the surface elevation would decrease less than 1 foot from existing conditions during the peak recreation season under all alternatives in average conditions. In wet years, average monthly reservoir levels would be less than 2 feet lower than existing conditions for all alternatives in the peak recreation season, and dry year water levels would typically not change from existing conditions. Boat ramps would remain accessible in average, wet, and dry years for all alternatives. The projected minor decrease in surface area under all alternatives is

Table 3-123. Comparison of preferred rafting flow days (2,000 to 3,000 cfs) from Pumphouse to State Bridge between existing conditions and the alternatives for June through August.

Alternative	Total days in 47-year period flows were between 2,000 and 3,000 cfs	Average change in preferred flow days per year from EC during the 19 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 19 years when flow changes occur
Existing Conditions (EC)	441		
Alt 1 – No Action	447	+0.3	-4 to +11
Alt 2 – Proposed Action	421	-1.1	-17 to +3
Alt 3	420	-1.0	-17 to +4
Alt 4	414	-1.4	-17 to +4
Alt 5	436	-0.3	-5 to +8

*There would be no change in the number of days when flows for rafting are between 2,000 and 3,000 cfs in 28 of 47 years.

unlikely to adversely affect visitor numbers or recreation activities. In periods of consecutive dry years, Carter Lake could experience reductions in lake levels up to 7 feet under No Action, and as much as 27 feet under the Proposed Action. Other alternatives would have declines of up to 2 feet. A large decline in surface area after several consecutive dry years, primarily under the Proposed Action, could diminish the overall quality of the user experience by increasing the distance between land-based facilities and the water surface, and potentially reducing the overall aesthetics of the experience.

Horsetooth Reservoir

Monthly water levels would not change from existing conditions under the No Action alternative in the primary recreation season from May to September in average, wet, and dry years. The Proposed Action would reduce average monthly reservoir water surface area up to about 5 percent or 80 acres in May. Other alternatives would reduce reservoir surface area less than 30 acres. Wet year changes would be similar to average years, and in dry years the Proposed Action would reduce Horsetooth Reservoir surface water area up to 9 percent (109 acres) during the recreation season. Other alternatives would experience less than a 66 acre decrease in water surface area in dry years. A series of consecutive dry years could result in a decline in lake levels of 35 to 40 feet during the recreation season under the Proposed Action.

Boat ramp access at Horsetooth Reservoir would not be affected by any alternative in average years during the primary recreation season except for the possible use of the South Bay-South boat ramp in September under the Proposed Action. In dry years, all alternatives would lower lake levels to an elevation below one boat ramp in August and two of the five boat ramps in September. Boating opportunities are unlikely to be adversely affected in average years for any alternative. A slight reduction in the carrying capacity for boats is possible in dry years under the Proposed Action, particularly consecutive dry years. This could diminish the overall quality of the user experience. Recreational experiences may change to the extent that changes in lake levels affect the aesthetic quality of the experience.

Chimney Hollow Reservoir

The Chimney Hollow Reservoir site does not currently support recreation use. If either size of reservoir is constructed in Alternatives 2, 3, and 4, Larimer County Parks and Open Lands would manage recreation use of the reservoir in concert with adjacent Larimer County Open Space land to the west. Recreation at Chimney Hollow would be limited to day-use activities such as hiking, picnicking, fishing, and nonmotorized boating. Because reservoir water levels would remain relatively high with moderate fluctuations, it should provide good fishing opportunities. It is estimated that Chimney Hollow Reservoir would receive about 50,000 annual visitors under the Proposed Action and Alternatives 3 and 4 compared to about 300,000 annual visitors at Carter Lake (Flenniken, pers. comm. 2006; Rieves, pers. comm. 2005).

Dry Creek Reservoir

No existing recreation resource facilities would be affected with construction of Dry Creek Reservoir. Recreation activities and development similar to those anticipated at Chimney Hollow are possible if a managing entity is found. Public access to the reservoir site would need to be developed.

3.19.2.7 East Slope River Recreation

Big Thompson River

All alternatives would maintain or increase Big Thompson River flow below Lake Estes during the May to September recreation season in average years. There would be less than a 1 percent increase in flows under No Action and up to a 7 percent increase in average flows in May and July under the Proposed Action. Average monthly flows would increase between 0 and 4 percent for other alternatives. In wet years, the No Action alternative would reduce Big Thompson River flows less than 1 percent and the Proposed Action would increase flows less than 3 percent, with no change in flow for other alternatives. In dry years, there would be no change in flow for any alternative.

The lower portion of Big Thompson Canyon provides Class IV kayaking at flows above 400 cfs. None of the alternatives would reduce the frequency of flows greater than 400 cfs during average, wet, or dry years and thus, kayaking would not be adversely affected.

North St. Vrain Creek and St. Vrain Creek

Only the No Action alternative would affect streamflow in North St. Vrain Creek below Longmont Reservoir and St. Vrain Creek above the St. Vrain Supply Canal near Lyons. Average monthly streamflow in North St. Vrain Creek would decrease about 11 percent in May, decrease 27 percent in July, and increase 19 percent in September. Flow changes in other summer months would be minimal. The kayak runs between Longmont Reservoir and Lyons are generally boatable in June and part of July under existing conditions at flows from 150 to 500 cfs. The No Action alternative would not affect boating during June, but average flows in July would drop below preferred low flows for kayaking. This would likely reduce kayaking opportunities during the later part of July, although under existing conditions average flows are just below the minimum preferred level in July. Less than a 13 percent decrease in average monthly streamflow on St. Vrain Creek near Lyons would not reduce preferred flows for kayaking (>200 cfs) from May to July.

Other East Slope Streams

The Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek would receive increased return flow below Participant WWTP facilities under all alternatives. East Slope streamflows would increase from about 0.5 to 11 cfs. Project flow increases and water quality changes are not expected to adversely affect fish or fishing opportunities. Other limited recreation use of these drainages also would unlikely be affected by minor increases in flow.

3.19.3 Cumulative Effects

Cumulative effects to recreation considered the reasonably foreseeable future water-based actions described in Chapter 2. The future development of Chimney Hollow Open Space by Larimer County also was considered.

The evaluation of cumulative recreation effects used the same methods as direct effects. Because of the similarity in effects for Alternatives 3, 4, and 5, the cumulative effects analysis used the results of Alternative 5 as representative of all three alternatives.

3.19.3.1 Effects Common to All Alternatives

None of the alternatives are expected to adversely affect land-based recreation activities such as camping, picnicking, and hiking. Potential effects to aquatic resources from changes in streamflow and reservoir storage on the West Slope and East Slope as discussed in Section 3.9 are unlikely to adversely impact sport fishing under any alternative based on accessed impacts to fish habitat.

3.19.3.2 West Slope Reservoir Recreation

Grand Lake, Shadow Mountain Lake, and Willow Creek Reservoir

There would be no change in surface water elevation at these lakes for any alternative. Projected changes in water quality in Grand Lake and Shadow Mountain Lake would not impact designated water quality standards for recreation uses. Predicted small reductions in water clarity would continue or slightly increase the potential for a diminished recreation experience under all of the alternatives.

Granby Reservoir

In average hydrologic conditions during the recreation season, Granby Reservoir surface area would decrease up to about 190 acres or 3 percent under the No Action alternative compared to existing conditions. The Proposed Action would result in a decrease in lake surface area of up to 431 acres, or about 7 percent, while Alternatives 3 to 5 would result in less than a 4 percent decrease in surface area. In a wet year, decreases in water surface area represent less than a 5 percent change from existing conditions for the No Action alternative and Alternatives 3, 4, and 5, and less than 8 percent for the Proposed Action. In a dry year, water surface area would decrease up to 9 percent under the Proposed Action, up to 7 percent for the No Action alternative, and up to 4 percent under Alternatives 3, 4, and 5.

All alternatives would result in lake levels below the Arapaho Bay boat ramp in May of average years and most of the summer months in dry years. The Proposed Action would also result in lake levels below the Stillwater boat ramp in May. Boatable surface area at Granby Reservoir would decrease less than 3 percent under No Action, less than 7 percent under the Proposed Action, and less than 4 percent for other alternatives in average years.

Because of the often wide fluctuations in Granby Reservoir water levels, the projected changes in surface area and boat ramp access in the early season are unlikely to adversely affect recreation activity in average years for any alternative. Lower water levels and reduced surface area in dry years could reduce the quality of the recreation experience or displace some visitor use from Granby Reservoir to Grand Lake, Shadow Mountain Lake, or other locations.

Jasper East and Rockwell Reservoirs

No reasonably foreseeable actions were identified that would result in cumulative recreation effects at these reservoirs.

3.19.3.3 West Slope River Recreation

Predicted changes in average monthly streamflow and daily flows were used to evaluate the cumulative effects for recreational boating in the Colorado River. Dry year effects on recreation would be primarily related to changes in flow from reasonably foreseeable actions because WGFP diversions would be the same as existing conditions in dry years. Changes in wet year flows are generally not a concern because streamflow is substantially greater than average, so sufficient water is typically available to meet recreation needs.

Colorado River: Granby Reservoir to Windy Gap Reservoir

Average monthly May to September streamflow in the Colorado River above Windy Gap Reservoir would decrease from 6 to 15 percent under the No Action alternative. Under the Proposed Action, the decrease would range from 7 to 21 percent, with up to a 18 percent decrease for Alternatives 3, 4, and 5. Because this reach of the river is not a popular boating destination, there would be negligible impacts to boating activities.

Colorado River: Windy Gap Reservoir to Williams Fork

Streamflow in Byers Canyon under all alternatives would remain above suitable kayaking flows of 400 cfs in June, but would drop below 400 cfs in July, reducing kayaking opportunities. Estimated daily flow data indicates that in 22 years of the 47-year period of record, there would be no change in the number of days that flow exceeds 400 cfs for any of the alternatives. In the remaining 25 years, there would be an estimated average decrease of 11 days with flows less than the preferred kayaking minimum of 400 cfs under the No Action alternative and an estimated 12 to 13 fewer days for the action alternatives (Table 3-124). In those years when there is a change in the number of days with flows greater than 400 cfs, the estimated change varies from 1 more day to up to 56 fewer days.

Although Byers Canyon does not support commercial boating and is infrequently used for kayaking, these changes would reduce the

Table 3-124. Comparison of preferred kayaking flow days (flows above 400 cfs) in Byers Canyon (June 1 through July 26) between existing conditions and the alternatives—cumulative effects.

Alternative	Total days in 47-year period flows are >400 cfs	Average change in preferred flow days per year from EC during the 25 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 25 years when flow changes occur
Existing Conditions (EC)	1,012		
Alt 1 – No Action	768	-11.0	-56 to 0
Alt 2 – Proposed Action	725	-11.6	-56 to +1
Alt 3 – 5	703	-12.7	-56 to +1

*There would be no change in the number of days when kayaking flows exceed 400 cfs between EC and any of the alternatives in 22 of the 47 years.

availability of whitewater flows in Byers Canyon primarily during July. If Byers Canyon is not boatable due to low water, kayakers would likely be displaced to lower stretches of the Upper Colorado River, such as Gore Canyon, for the Class IV to V experience.

Colorado River: Williams Fork to Kremmling

Average monthly streamflow would decrease up to 19 percent under the No Action alternative in July compared to a maximum decrease of 20 percent under the Proposed Action in May, and a maximum decrease of 21 percent in May and July for other alternatives. Because of the limited existing boating in this reach of the Colorado River, none of the alternatives would substantially affect recreational boating.

Colorado River: Kremmling to Pumphouse

Average monthly May to September flow in this reach of the Colorado River would decrease up to 25 percent under the No Action and Proposed Action alternatives (Table 3-125). Alternatives 3, 4, and 5 would reduce flow up to 26 percent in July. Dry year flow decreases of about 3 to 25 percent would be similar for all alternatives, including No Action. Streamflow through Big Gore Canyon, with reasonably foreseeable future water developments in place, indicates fewer days with preferred rafting flows between 850 cfs and 1,250 cfs in average conditions (Figure 3-77).

Estimated daily flow data indicate that in 13 years of the 47-year period of record, there would be no change in the number of days that preferred rafting flows of 850 to 1,250 cfs occur for any of the alternatives. Preferred rafting flows in Gore Canyon would occur about 40 days less under the No Action alternative compared to existing conditions over the 47-year study period (Table 3-126). Under the Proposed Action, preferred rafting flows would occur about 56 days less than existing conditions over the 47 years. On average, this would be about 1 to 2 days fewer with preferred rafting flows during the 34 years when flows fall outside of the preferred range. The greatest decrease in the number of days with preferred rafting flows in a single year would be 23 days under the No Action alternative and up to 31 days for the Proposed Action and other alternatives. There would also be years when the number of rafting days increases. The No Action alternative would increase the number of days with preferred rafting flows by up 17 days in a single year and the action alternatives up to 22 days. Projected flows for all of the alternatives would allow commercial outfitters to continue to run trips through Big Gore Canyon in August most of the time. In some years, there would be more days with preferred rafting flows than currently occur and in other years there could be fewer.

Estimated daily flow data indicates there would be no change in the in the number of days that flows fall within the preferred range of 400 to 2,200 cfs for kayaking in 43 years out of the 47-year study period in Big Gore Canyon and Pumphouse (Table 3-127). During the 4 years when flow changes fall outside this range, there would be an average of about 1 less day of preferred flow for the No Action alternative and about 2 fewer days for the action alternatives. In those years when there is a change in the number of days when flows are between 400 and 2,200 cfs, the estimated change varies from 3 more days to 11 fewer days. There would be no substantial change in kayaking opportunities in Big Gore Canyon under any of the alternatives, with an overall net change of 5 fewer days of kayaking over the 47-year study period.

A change in the number of days of preferred kayaking flows between 1,100 and 2,200 cfs in Big Gore Canyon and Pumphouse to State Bridge was also evaluated (Table 3-128). There would be no

Table 3-125. Average monthly changes to Colorado River Flow for Big Gore Canyon—cumulative effects.

Alternative	May		June		July		August		September	
	cfs	%[1]	cfs	%[1]	cfs	%[1]	cfs	%[1]	cfs	%[1]
Existing Conditions	**1,145**	—	**2,619**	—	**1,745**	—	**1,026**	—	**909**	—
Alt 1 – No Action	975	-15%	2,114	-19%	1,303	-25%	953	-7%	864	-5%
Alt 2 – Proposed Action	948	-17%	2,002	-24%	1,313	-25%	953	-7%	859	-5%
Alt 3 – 5	945	-17%	2,030	-22%	1,286	-26%	948	-8%	862	-5%

[1] Percent change in streamflow from existing conditions.

Figure 3-77. Colorado River average year flows for rafting in Gore Canyon and Pumphouse – cumulative effects.

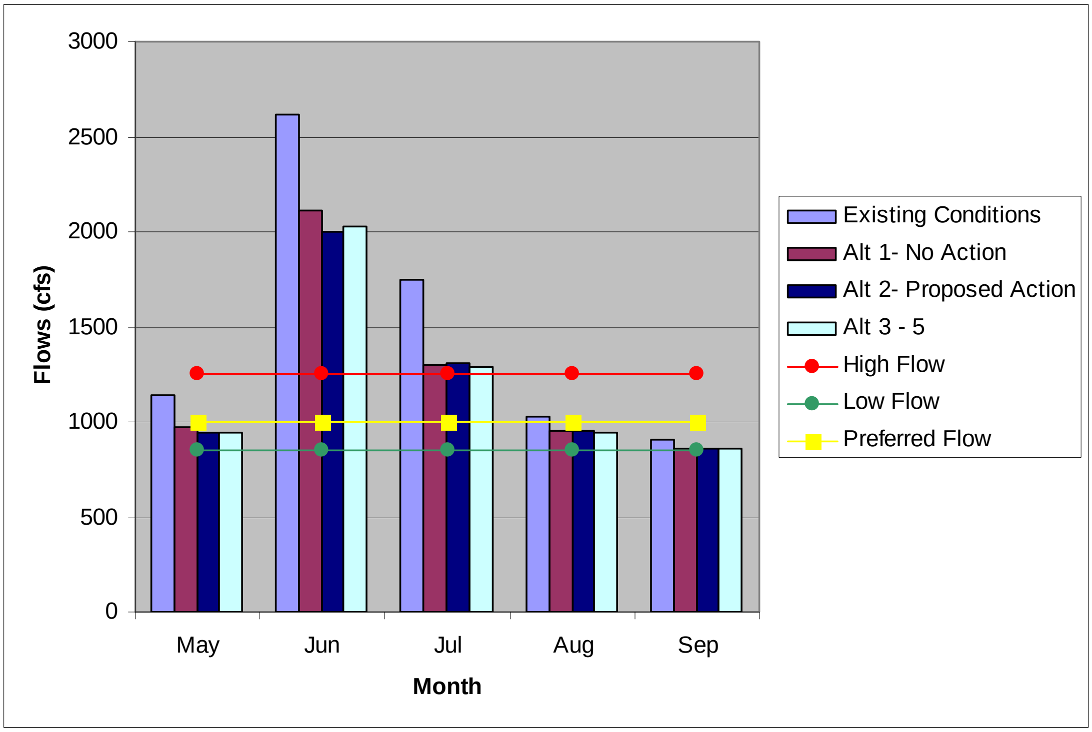


Table 3-126. Comparison of preferred rafting flow days (850 to 1,250 cfs) in Big Gore Canyon between existing conditions and the alternatives in August—cumulative effects.

Alternative	Total days in 47-year period were between 850 and 1,250 cfs	Average change in preferred flow days per year from EC during the 34 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 34 years when flow changes occur
Existing Conditions (EC)	848		
Alt 1 – No Action	808	-1.2	-23 to +17
Alt 2 – Proposed Action	792	-1.7	-31 to +22
Alt 3 – 5	786	-1.8	-31 to +22

*There would be no change in the number of days when preferred flows for rafting are between 850 and 1,250 cfs in 13 of 47 years.

Table 3-127. Comparison of preferred kayaking flow days (400 to 2,200 cfs) in Big Gore Canyon and Pumphouse to State Bridge between existing conditions and the alternatives in August—cumulative effects.

Alternative	Total days in 47-year period flows were between 400 and 2,200 cfs	Average change in preferred flow days per year from EC during the 4 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 4 years when flow changes occur
Existing Conditions (EC)	1,421		
Alt 1 – No Action	1,416	-1.3	-11 to +3
Alt 2 – Proposed Action	1,416	-1.3	-11 to +3
Alt 3 – 5	1,416	-1.3	-11 to +3

*There would be no change in the number of days when preferred flows for kayaking are between 400 and 2,200 cfs in 43 of the 47 years.

Table 3-128. Comparison of preferred kayaking flow days (1,100 to 2,200 cfs) in Big Gore Canyon and Pumphouse to State Bridge between existing conditions and the alternatives from June to August—cumulative effects.

Alternative	Total days in 47-year period flows were between 1,100 and 2,200 cfs	Average change in preferred flow days per year from EC during the 40 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 40 years when flow changes occur
Existing Conditions (EC)	1,034		
Alt 1 – No Action	844	-4.3	-56 to +31
Alt 2 – Proposed Action	827	-4.5	-56 to +31
Alt 3 – 5	834	-4.5	-56 to +29

*There would be no change in the number of boating days when flows are between 1,100 and 2,200 cfs in 7 of the 47 years.

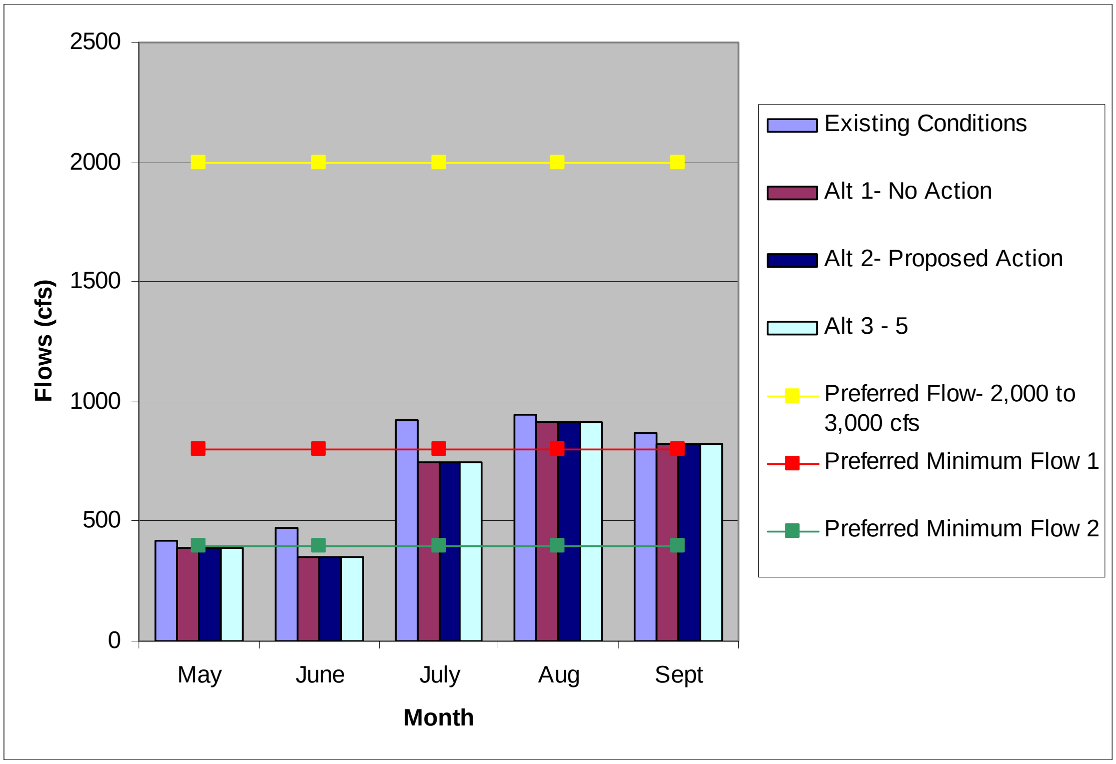
change in the number of days in this flow range in 7 years out of the 47-year study period. Results also indicate that over the 47-year study period, there would be about 190 fewer days of preferred kayaking flows under the No Action alternative compared to existing conditions, and about 207 fewer days under the Proposed Action. On average, this would be about 5 less days per year of preferred kayaking flows during the 40 years where flow changes occur. In those years when there is a change in the number of days with flows between 1,100 and 2,200 cfs, the estimated change varies from 31 more days to 56 fewer days. Based on the information in Table 3-127 and Table 3-128, flows may be below the preferred levels for the annual Gore Race in late August in some years. The WGFP under all of the alternatives would curtail diversions during the Gore Race, thus there would be no impact from the proposed project. Reduced flows from other reasonably foreseeable alternatives, including future reductions in Blue River flows to the Colorado River, would have the greatest impact on Colorado River flows in August.

Colorado River: Pumphouse to State Bridge

In average years, the flows on the Colorado River between the Pumphouse and State Bridge would remain above the acceptable low flow for rafting of 400 to 800 cfs during the prime summer season under all alternatives (Figure 3-77).

Dry year streamflow in the Pumphouse reach would be substantially lower under all alternatives (Figure 3-78). Reasonably foreseeable future actions would be responsible for the majority of changes in flow in

Figure 3-78. Dry year monthly streamflow on the Colorado River and preferred rafting flows, Pumphouse to State Bridge – cumulative effects.



dry years because dry year flows would not change from existing conditions under the WGFP. Streamflow under existing conditions is below acceptable rafting conditions during dry years in May and June. Flows of 400 cfs, which is acceptable for kayakers, would be met July through September for all alternatives. The rafting season would be reduced in July for all the alternatives in dry years.

Estimated daily flow data indicate that in 15 years out of the 47-year period of record. There would be no change in the number of days that flows in the Pumphouse reach of the Colorado River are between 400 and 3,000 cfs for any of the alternatives (Table 3-129). Over the 47-year study period, there would be 65 more days with flows in this range under the No Action alternative compared to existing conditions. Under the Proposed Action and other

Table 3-129. Comparison of preferred rafting and kayaking flow days (400 to 3,000 cfs) from Pumphouse to State Bridge between existing conditions and the alternatives for June through August—cumulative effects.

Alternative	Total days in 47-year period flows were between 400 and 3,000 cfs	Average change in preferred flow days per year from EC during the 32 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 32 years when flow changes occur
Existing Conditions (EC)	3,498		
Alt 1 – No Action	3,563	+2.0	-19 to +30
Alt 2 – Proposed Action	3,579	+2.8	-19 to +30
Alt 3 – 5	3,580	+2.6	-19 to +30

*There would be no change in the number of boating days when flows are between 400 and 3,000 cfs in 15 of the 47 years.

alternatives, there would be a total of about 81 more days in the preferred flow range as a result of diversions that reduce flow below 3,000 cfs. On average, this would be an increase of about 2 to 3 days per year during the 32 years when flow changes occur. In those years when there is a change in the number of days with flows greater than 400 cfs, the estimated change varies from 30 more days to 19 fewer days under all the alternatives.

There would be no change from existing conditions in the number of days when rafting flows in the Pumphouse reach are between 2,000 and 3,000 cfs in 21 years out the 47-year study period under the alternatives (Table 3-130). Over the 47-year study period, there would be 206 fewer days of preferred flows under the No Action alternative and 190 fewer days under the Proposed Action. On average during the 26 years where flow changes occur, there would be about 9 less days per year in the preferred rafting flow range. The greatest decrease in the number of days in the preferred flow range in a single year would be 17 days under all of the action alternatives except Alternative 5, which would have 15 fewer days. The greatest increase in the number of days in the preferred flow range in a year would be 31 days under the No Action and Proposed Action alternatives. Although overall there would be more rafting days available between 400 and 3,000 cfs as shown in Table 3-129, there would be fewer days in the preferred higher flow range of 2,000 to 3,000 cfs. This could reduce the number boaters or diminish the boating experience in years when flows drop below 2,000 cfs.

Willow Creek

Willow Creek is not used for recreational boating and there would be no effects to recreation.

3.19.3.4 East Slope Reservoir Recreation

Ralph Price Reservoir

No reasonably foreseeable actions were identified that would result in cumulative recreation effects if Ralph Price Reservoir is enlarged.

Carter Lake

Water levels at Carter Lake would not be noticeably affected under any alternative. During average conditions or a dry year, average monthly surface area would decrease less than 5 acres under any alternative. In wet years under all alternatives, the average monthly lake surface area would decrease less than 11 acres. In dry years, fluctuations would be within 1 foot of existing conditions for all alternatives. These changes would not impact access to boat ramps or noticeably change boating opportunities.

Horsetooth Reservoir

The No Action alternative would not affect water levels in Horsetooth Reservoir during the peak recreation season from May to September in average, wet, or dry years. The Proposed Action would reduce average monthly water surface area less than 72 acres during the recreation season compared to about a 25 acre decrease for the other action alternatives.

Boat ramps would remain accessible throughout the primary recreation season for all alternatives in

Table 3-130. Comparison of preferred rafting flow days (2,000 to 3,000 cfs) from Pumphouse to State Bridge between existing conditions and the alternatives for June through August—cumulative effects.

Alternative	Total days in 47-year period flows were between 2,000 and 3,000 cfs	Average change in preferred flow days per year from EC during the 26 years when flow changes occur*	Greatest change in the number of preferred flow days in a single year compared to EC during the 26 years when flow changes occur
Existing Conditions (EC)	441		
Alt 1 – No Action	235	-8.8	-15 to +31
Alt 2 – Proposed Action	251	-9.0	-14 to +31
Alt 3 – 5	232	-8.3	-14 to +27

*There would be no change in the number of boating days when flows are between 2,000 and 3,000 cfs in 21 of 47 years.

average years, although use of the South Bay-South boat ramp may not be accessible under the Proposed Action in September. The South Bay-South boat ramp would be inaccessible in August and September of dry years under all alternatives. The Satanka Cove boat ramp could also be unusable in September under existing conditions and unusable in dry years under all alternatives.

The loss of use of one or two of the five boat ramps at Horsetooth Reservoir could increase crowding at usable boat ramps. Loss of boat ramp access would occur primarily during the late season and would most likely occur under the Proposed Action. Projected changes in lake levels may reduce the carrying capacity for boating when water levels are low. Recreational experiences may change to the extent that changes in lake levels affect the aesthetic quality of the experience.

Chimney Hollow Reservoir

Recreational development at Chimney Hollow Reservoir, along with those planned by Larimer County Parks and Open Lands on adjacent property would enhance regional recreation opportunities.

Dry Creek Reservoir

Recreation activities and development similar to those anticipated at Chimney Hollow are possible if a managing entity is found. Public access to the reservoir site would need to be developed.

3.19.3.5 East Slope River Recreation

Big Thompson River

All alternatives would increase average year flows on the Big Thompson River during the May to September recreation season below Lake Estes. Streamflow increases of up to 7 percent under the Proposed Action in July and similar flow increases in other months, and for the other alternatives, would not substantially change kayaking opportunities on the Big Thompson River during average, wet, or dry years.

North St. Vrain Creek and St. Vrain Creek

Changes in streamflow in these streams would only occur under the No Action alternative. There would be no change in average monthly June flows when most kayaking occurs, but a 25 percent decrease in July flows would reduce flows below 150 cfs, the lower limit of acceptable flows for kayaking. Less than a 13 percent decrease in average monthly streamflow on St. Vrain Creek near Lyons would not reduce preferred flows for kayaking (>200 cfs) from May to July.

Other East Slope Streams

Increased flows from greater WWTP discharges below Participant outfalls on the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek would occur under all alternatives. Flow increases between 0 and 7.6 cfs and water quality changes may slightly improve fish habitat and are not expected to affect infrequent water-based recreation.

3.19.4 Proposed Mitigation

The Subdistrict would curtail Colorado River diversions during the annual Big Gore Race typically held the third week in August if flows at the Kremmling gage are below 2,200 cfs.

3.19.5 Unavoidable Adverse Effects

Reductions in Colorado River flows under all alternatives in the popular boating reaches below Kremmling to State Bridge could experience a reduction in preferred boating flows in some years. Colorado River flows in Byers Canyon would be lower in July under all alternatives, resulting in reduced kayaking opportunities in this low use reach of the river. Water storage, primarily in Granby Reservoir, and to a lesser extent in Carter Lake and Horsetooth Reservoir would be lower on average under all alternatives, which could affect recreation use. The greatest impact would occur during infrequent periods of consecutive dry years when reservoir storage drops and access to some boat ramps could be impacted. Under the No Action Alternative, recreation activities at Ralph Price Reservoir would be suspended for about 2 years until the dam enlargement is complete. Also under No Action, lower July flows in the North St. Vrain River would reduce kayaking opportunities.

Adverse cumulative effects to recreation would be similar to direct effects. Lower Colorado River flows, primarily below the Blue River with reasonably foreseeable actions in place would result in fewer dates when preferred flows for rafting and kayaking in Big Gore Canyon and Pumphouse are available.

3.20 Cultural Resources

3.20.1 Affected Environment

3.20.1.1 Regulatory Framework

Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended (16 U.S.C. 470, et seq.) and its implementing regulations under 36 CFR 800 require all federal agencies to consider effects of federal actions on cultural resources eligible for or listed in the National Register of Historic Places (NRHP). Both listed and eligible properties must be considered during Section 106 review.

Traditional Cultural Properties (TCPs) are protected under Section 106 of the NHPA; the American Indian Religious Freedom Act of 1978 (AIRFA); and, the Native American Grave Protection and Repatriation Act of 1990 (NAGPRA). A TCP may be eligible for listing in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in the history of the community or tribe, and, (b) are important in maintaining the continuing cultural identity of the community or tribe.

3.20.1.2 Area of Potential Effect

The NHPA and 36 CFR Part 800 requires Reclamation to consider effects to historic properties 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 (36 CFR Part 800.16)." The WGFP APE has been defined by Reclamation to include the five reservoir study areas (i.e., the project footprint) and an approximate 2-mile buffer surrounding each. The Colorado State Historic Preservation Officer (SHPO) has concurred with this definition (Contiguglia, pers. comm. 2007). The APE for Chimney Hollow has a 1-mile buffer because an intensive Class III pedestrian survey was conducted for the reservoir footprint (WCRM 2004a and 2004b). The APE includes areas of possible direct, indirect, and cumulative effects. The study area for each of the alternative reservoir sites includes areas that could be directly affected by reservoir construction, including the footprint of the reservoir pool, dam, spillway, pipelines, access roads, rerouted transmission lines, staging areas, borrow areas, and other facilities. Areas that would be indirectly affected include planned open space recreation associated with Chimney Hollow Reservoir and possibly recreation at other reservoir sites. Reasonably foreseeable future land development in the APE could also contribute to cumulative effects.

3.20.1.3 Data Sources

Class I file searches and literature reviews of the APE including the study areas where project facilities for the five potential reservoir sites are located were conducted at the Colorado Office of Archaeology and Historic Preservation (OAHP) to determine the presence of previously recorded and/or documented cultural resources (WCRM 2005, 2007) In addition to this file search data, Reclamation provided information on two additional studies that are not officially on file with the OAHP (WCRM 2007).

Reclamation contacted Native American tribes to request information on whether TCPs are located within the APE; the tribes contacted included: Apache Tribe of Oklahoma, Cheyenne and Arapaho Tribes of Oklahoma, Cheyenne River Sioux Tribe, Comanche Nation of Oklahoma, Crow Creek Sioux Tribe, Fort Sill Apache Tribe, Jicarilla Apache Tribe, Kiowa Tribe of Oklahoma, Mescalero Apache Tribe, Northern Arapaho Tribe, Northern Cheyenne Tribe, Northern Ute Tribe, Oglala Sioux Tribe, Pawnee Nation of Oklahoma, Rosebud Sioux Tribe, Eastern Shoshone Tribe, Southern Ute Indian Tribe, Standing Rock Sioux Tribe, Ute Mountain Ute Tribe, Comanche Nation of Oklahoma, and the Crow Creek Sioux Tribe.

Five tribes responded to the invitation to consult with Reclamation. The Southern Ute Tribe had no interest in the area. The Pawnee of Oklahoma indicated no historic properties would be affected. The Cheyenne River Sioux, Southern Arapahoe, and the Eastern Shoshone requested continued consultation as the project progresses.

Potential historic properties may include districts, sites, buildings, structures, and objects that possess historical integrity and are more than 50 years old. Cultural resource types found within the APE for all reservoir study areas include prehistoric and historic archaeological sites, historic buildings, structures, and features, and isolated finds. Examples of prehistoric archaeological sites include camps where short-term occupation took place by hunter-gatherers, lithic scatters that represent the remains of temporary work areas, and hunting sites and blinds, among others. Historic period cultural resources include the archaeological remains of various site types as well as ranches, water diversion features, roads and trails, and features related to the Colorado-Big Thompson (C-BT) Project Historic District, among others.

The current NRHP status of known resources determined to be within the APE of the proposed federal undertaking was documented. Resources recorded as a result of the Class III survey of the Chimney Hollow Reservoir footprint (i.e., no associated facilities were surveyed) were fully documented and NRHP significance evaluated (WCRM 2004a and 2004b). Evaluation of cultural resources is codified under 36 CFR 60.4, and summarized below (NRHP, National Register Bulletin, revised 1998):

> The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> b) that are associated with the lives of persons significant in the past; or
>
> c) that embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction; or
>
> d) that have yielded, or are likely to yield, information important in prehistory or history.

Regardless of their level of significance, properties listed in or eligible for listing in the NRHP must be important in American history, architecture, archaeology, engineering, or culture. In addition, to be significant, a property also must have physical integrity to be listed in or be eligible for listing in the NRHP. In some cases, additional information must be gathered to evaluate a cultural resource with regard to the NRHP criteria. This information may be gathered by means of limited excavation and/or testing to determine the presence and extent of significant buried cultural material or, in the case of historic sites, archival research to better evaluate these sites under criteria a-c, as summarized above. Cultural resource sites recommended not eligible for the NRHP either do not meet any of the criteria outlined under 36 CFR 60.4 or lack physical integrity (i.e., have been significantly altered or destroyed by previous human activity or natural processes). Sites with field evaluations (i.e., field eligible, field not eligible, field needs data), those that have not been assessed with regard to NRHP eligibility, or that cannot be relocated by means of file search data alone are considered potentially eligible for inclusion in the NRHP.

3.20.1.4 Cultural History Overview

Summarizing the culture history of the APE requires an evaluation of human history on both sides of the Continental Divide. Much of the story is the same—humans have inhabited Colorado for at least 12,000 years. A succinct summary of this history is provided below, subdivided into chronologically sequential stages defined primarily by changes in subsistence strategies and material culture. These stages are Paleoindian, Archaic, Late Prehistoric, and Historic. The cultural overview provided below is taken entirely from the synthetic overviews published by the Colorado Council of Professional Archaeologists (CCPA) (Gilmore et al. 1999; Reed and Metcalf 1999). Although the project APE includes two distinct geographical areas, the close proximity of the western portion is considered in this document to be most similar to the Front Range/Plains ecotone and, as such, the chronological sequence adopted for the South Platte basin is used here (Gilmore et al. 1999).

The Paleoindian stage is further subdivided into three periods: Clovis, Folsom, and Plano. Each of these periods is characterized by highly stylized projectile points—a reflection on the emphasis these people placed on hunting now-extinct mammoth and bison and later modern but smaller species of bison. Sites common to the periods include camps and kill sites. Archaeological sites of this general period are relatively rare, but some of the better known sites are found in Middle Park, including Grand County and the Denver Basin along the Front Range.

The Archaic stage is subdivided into Early, Middle, and Late period designations, based partially on changes in projectile point form and changes in settlement and subsistence strategies. Changes in climate led to adaptive human subsistence strategies geared more toward generalized hunting and gathering where each was an equally important food source. It is during this stage that hunter-gatherers likely began to form into bands reminiscent of those tribes encountered during the 19th century. Common sites include camps, hunting sites, and limited-activity lithic scatters.

The Late Prehistoric stage again comprises three periods: Early Ceramic, Middle Ceramic, and Protohistoric. The Early Ceramic period witnessed the adoption of ceramic technology and the bow and arrow. Horticulture was practiced in the Denver Basin during the Early Ceramic period, but not in Middle Park. A change in climate initiated the transition to the Middle Ceramic period, when much of the Front Range may have been abandoned, due to drought which forced an emigration into the mountains. The Protohistoric sub-period begins in A.D. 1540 with the arrival of the Spanish in the Southwest; however, it took nearly 200 years for Euroamerican goods, including horses, to affect a change in Native American culture.

The advent of the horse radically changed the disposition of Native American tribes, turning semi-nomadic hunter-gatherers into highly nomadic, horse-mounted cultures. A succession of tribes occupied the Denver Basin and Front Range, including the Apache, Comanche, Kiowa, Cheyenne, and Arapaho. The Ute arrived in the Southern Rocky Mountains by at least A.D. 1400, but made only excursions into the Plains. The arrival of Euroamericans in the Denver Basin beginning around 1860 permanently impacted Native American culture. By the 1880s, Native Americans had been forcibly removed to reservations in Wyoming and Oklahoma (Clark 1999).

The discovery of gold at the confluence of Cherry Creek and the South Platte River began the Historic period in earnest. Thousands of prospectors and commercial opportunists swarmed to the Denver Basin lured by the incentive of easy wealth. Once the furor of gold abated, many who failed at prospecting tried their luck at ranching and farming. Inexpensive land and ranching opportunities were incentives for Euroamericans to settle in the mountains. Ranching and farming were and continue to be the primary commercial enterprises within the project APE. Common historic archaeological sites include: active and/or abandoned farms and ranches and associated facilities; early commercial endeavors such as water reclamation projects; and, early transportation features such as the railroad and roads.

3.20.1.5 Ralph Price Reservoir

A total of 21 sites and 33 isolated finds were identified within the Ralph Price APE (WCRM 2005, 2007). Twenty sites (Table 3-131) are either eligible or potentially eligible for inclusion in the NRHP. There are no known sites within the study area, but three cultural resources (5BL1, 5BL16, and 5BL24) identified during the file search have not been assessed and their location is unclear.

Table 3-131. Eligible or potentially eligible cultural sites within the Ralph Price/Button Rock Reservoir APE.

Site Number	Site Type	NRHP Status
5BL1	Open Camp	No Assessment – exact location unknown
5BL16	Open Camp	No Assessment – exact location unknown
5BL24	Open Camp	No Assessment – exact location unknown
5BL26	Open Camp	Field Not Eligible
5BL27	Open Camp	Field Needs Data
5BL483	Longmont Power Plant and	Officially Listed

Site Number	Site Type	NRHP Status
	Hydroelectric Plant	
5BL518	Stage Stop	No Assessment
5BL4838	Open Camp	Officially Eligible
5BL5661	Prehistoric Hunting Blinds	Field Eligible
5BL5662	Rock Shelter and Hunting Blind	Field Eligible
5BL6449	Homestead	Field Not Eligible
5BL6450	Homestead	Field Eligible
5BL6453	Nelson Ranch/Clarke Homestead	Field Not Eligible
5BL6454	Open Lithic	Field Not Eligible
5BL6460	Historic Trash Scatter	Field Not Eligible
5BL6461	Homestead	Field Not Eligible
5BL6466	Multi-Component	Field Not Eligible
5BL6467	Open Camp	Field Needs Data
5BL6469	Open Camp	Field Not Eligible
5BL6471	Open Lithic	Field Not Eligible

3.20.1.6 Chimney Hollow Reservoir

A total of 27 sites and 28 isolated finds were identified within the Chimney Hollow APE (WCRM 2005, 2007). Nineteen sites (Table 3-132) are either eligible or potentially eligible for inclusion in the NRHP; 12 are located within the reservoir study area.

Table 3-132. Eligible or potentially eligible cultural sites within the Chimney Hollow Reservoir APE.

Site Number[1]	Site Type	NRHP Status
5LR42[2]	Open Camp/Burial	Officially Eligible
5LR55	Open Architectural	Not Assessed
5LR57	Open Lithic	Not Assessed
5LR343	Open Camp	Not Assessed
5LR390	Open Architectural	Not Assessed
5LR1363[1]	Carter Lake Historic Area	Contributing to Historic District
5LR1734	Historic Water Control	Field Eligible
5LR1735	Historic Water Control	Field Not Eligible
5LR3984*	Flatiron Dam and Reservoir	Field Not Eligible
5LR4002[1]	Carter Lake Pressure Conduit and Tunnel	Field Not Eligible
5LR4006[1]	Dispatch Building, Flatiron Service Area	Contributing to Historic District
5LR4007[1]	Flatiron Service Yard and Buildings	Contributing to Historic District
5LR9388[1]	Flatiron-Pole Hill Transmission Line	Field Not Eligible
5LR9389[1]	Flatiron Valley to Greeley Transmission Line	Field Not Eligible
5LR9454.1[1]	Segment of Estes to Lyons Tap Transmission Line	Field Not Eligible
5LR10410[1]	Open Lithic	Field Needs Data
5LR10731[1]	Historic Ranch	Field Not Eligible
5LR10732[1]	Prospecting Pits	Field Not Eligible
5LR10733[1]	Stock Ponds	Field Not Eligible

[1] Resources within reservoir study area (i.e., footprint).
[2] The buffers for Chimney Hollow and Dry Creek reservoirs overlap, so 5LR42 falls within the APE for both.

The Carter Lake Historic Area (5LR1363) incorporates the C-BT facilities surrounding Carter Lake and has been recommended as contributing to the C-BT Historic District. The boundaries of the district extend into a small portion of the proposed Chimney Hollow Reservoir study area. The Flatiron Dam and Reservoir (5LR3984) and Carter Lake Pressure Conduit and Tunnel (5LR4002) are recommended field not eligible. Like the Carter Lake Historic Area, two sites, the Dispatch Building and Flatiron Service Area (5LR4006) and the

Flatiron Service Yard and Buildings (5LR4007) also have been designated as contributing to the C-BT Historic District. Three historic transmission lines are located within the APE and reservoir study area. An unnamed transmission line (5LR9388) and the Flatiron Valley to Greeley transmission line (5LR9389) are located in the northern portion of the APE. A segment of the Estes to Lyons TAP transmission line (5LR9454.1) would be relocated as part of the Proposed Action (WCRM 2004b). A lithic scatter (5LR10410) is located within the pool of the reservoir study area; it is recommended that further information be obtained to evaluate this site. Sites 5LR10731, 5LR10732, and 5LR10733 were documented during the Class III inventory of the proposed reservoir pool and are recommended field not eligible (WCRM 2004a); all three sites are related to historic use of the area.

3.20.1.7 Dry Creek Reservoir

A total of 10 sites and ten isolated finds were identified within the Dry Creek Reservoir APE (WCRM 2005, 2007). Six sites (Table 3-133) are either eligible or potentially eligible for inclusion in the NRHP; two are located within the reservoir study area.

Table 3-133. Eligible or potentially eligible cultural sites within the Dry Creek Reservoir APE.

Site Number[1]	Site Type	NRHP Status
5LR42[2]	Open Camp/Burial	Officially Eligible
5LR59	Open Lithic	No Assessment
5LR435	Historic Dugout/Rock Art	Field Needs Data
5LR653 Resources[1]	Historic Quarry	Field Eligible
5LR1363[1]	Carter Lake Historic Area	Contributing to Historic District
5LR2114	Multi-Component	Field Eligible

[1] Resources within reservoir study area (i.e., footprint).
[2] The buffers for Chimney Hollow and Dry Creek reservoirs overlap, so 5LR42 falls within the APE for both.

Site 5LR653 is a historic quarry listed as field eligible. The Carter Lake Historic Area (5LR1363), previously discussed under the Chimney Hollow Reservoir, overlaps a portion of proposed disturbance area associated with the Dry Creek Reservoir site.

3.20.1.8 Jasper East Reservoir

A total of 65 sites and 20 isolated finds were identified within the Jasper East APE (WCRM 2005, 2007). Forty-five sites located within the APE (Table 3-134) are either eligible or potentially eligible for inclusion in the NRHP; eight are located within the reservoir study area.

Table 3-134. Eligible or potentially eligible cultural sites within the Jasper East Reservoir APE.

Site Number[1]	Site Type	NRHP Status
5GA118	Open Camp	Field Needs Data
5GA119[1]	Prehistoric Quarry	Field Needs Data
5GA128	Open Architectural	Officially Eligible
5GA149	Open Lithic	Field Needs Data
5GA150[1]	Open Lithic	Field Not Eligible
5GA151[1]	Prehistoric Quarry	Officially Eligible
5GA152	Open Lithic	Field Not Eligible
5GA163	Open Lithic	Field Not Eligible
5GA164	Open Lithic	Field Not Eligible
5GA165	Multi-Component	Field Eligible
5GA240	Open Lithic	Field Not Eligible
5GA245	Open Lithic	Field Not Eligible
5GA247	Open Lithic	Field Not Eligible
5GA248	Open Lithic	Field Eligible
5GA666	Open Lithic	Field Needs Data
5GA668	Open Lithic	Field Not Eligible
5GA671	Open Lithic	No Assessment
5GA1685	Historic Mine	Field Not Eligible
5GA1697	Homestead	Field Not Eligible
5GA1700	Historic Mine	Field Not Eligible
5GA2266	Open Camp	Officially Needs Data
5GA2277	Willow Creek Dam	Within Potential District- Field Not Eligible
5GA2278[1]	Willow Creek	Within Potential

Site Number[1]	Site Type	NRHP Status
	Feeder Canal	District- Field Not Eligible
5GA2279[1]	Willow Creek Pumping Plant	Within Potential District- Field Not Eligible
5GA2312	Open Camp	Officially Needs Data
5GA2397[1]	Willow Creek Switchyard-Pumphouse	Field Not Eligible
5GA2400[1]	Willow Creek to Willow Creek Dam Transmission Line	Field Not Eligible
5GA2401[1]	Transmission Line	Field Eligible
5GA2773.2	Ditch Segment	Field Not Eligible
5GA2946	Open Lithic	Officially Eligible
5GA3006	Open Lithic	Field Not Eligible
5GA3070	Open Camp	Field Eligible
5GA3071	Open Lithic	Field Not Eligible
5GA3072	Open Lithic	Field Not Eligible
5GA3073	Open Lithic	Field Not Eligible
5GA3074	Open Lithic	Field Not Eligible
5GA3075	Open Lithic	Field Not Eligible
5GA3076	Open Lithic	Field Not Eligible
5GA3077	Open Lithic	Field Not Eligible
5GA3078	Open Lithic	Field Not Eligible
5GA3079	Multi-Component	Field Not Eligible
5GA3080	Open Lithic	Field Not Eligible
5GA3081	Open Lithic	Field Not Eligible
5GA3082	Open Lithic	Field Not Eligible
5GA3083	Homestead/Ranch	Field Eligible

[1] Resources within reservoir study area (i.e., footprint).

A prehistoric quarry (5GA119) and two prehistoric lithic scatters (5GA150 and 5GA3006) are recommended field not eligible. 5GA151, a second prehistoric quarry, has been determined to be officially eligible. Sites 5GA2278, 5GA2279, 5GA2397 and 5LR2400 are associated with the Willow Creek Canal, which transports water from Willow Creek Reservoir to Granby Reservoir. The Willow Creek Feeder Canal (5GA2278) and the Willow Creek Pumping Plant (5GA2279) are recommended potentially eligible for inclusion in the NRHP as part of a district. The Willow Creek Switchyard (5GA2397), Willow Creek to Willow Creek Dam Transmission Line (5GA2400), and a transmission line (5GA2401) are recommended as field not eligible. The Willow Creek to Willow Creek Dam Transmission Line (5GA2400) and site 5GA2401, a transmission line, are potentially eligible.

3.20.1.9 Rockwell/Mueller Creek Reservoir

A total of 46 sites and 54 isolated finds were identified within the Rockwell Reservoir APE (WCRM 2005, 2007). Eighteen sites (Table 3-135) are either eligible or potentially eligible for inclusion in the NRHP; one is located within the reservoir study area

Table 3-135. Eligible or potentially eligible cultural sites within the Rockwell/Mueller Creek Reservoir APE.

Site Number[1]	Site Type	NRHP Status
5GA122	Multi-Component	Officially Eligible
5GA123	Open Lithic	Officially Needs Data
5GA157	Open Camp	Field Needs Data
5GA159	Open Lithic	Field Needs Data
5GA160	Open Camp	Field Needs Data
5GA238	Stone Quarry; Open Lithic	Field Not Eligible
5GA241	Open Lithic	Field Not Eligible
5GA606	Open Lithic	Officially Eligible
5GA669	Open Lithic	Officially Eligible
5GA670	Open Architectural	Officially Eligible
5GA680	Stone Quarry	Officially Eligible
5GA686	Historic Road and Trash Dump	No Assessment
5GA686.1	Historic Road Segment	Officially Eligible
5GA687	Open Lithic	Officially Eligible
5GA869	Open Camp	Officially Eligible
5GA1684	Open Lithic	No Assessment
5GA2281[1]	Granby Warehouse	Field Not Eligible

Site Number[1]	Site Type	NRHP Status
5GA2811	Open Lithic	Officially Needs Data

[1]Resources within reservoir study area (i.e., footprint).

The Granby Warehouse (5GA2281) has been recommended field not eligible; a re-evaluation and official NRHP determination is required. The pipeline connection to Windy Gap Reservoir would cross the existing Denver and Rio Grande Railroad (D&RG) and a possible water diversion ditch. Elsewhere in Colorado, the D&RG (5GA3564) is considered an officially eligible historic resource; the segment within the reservoir study area has not been formally recorded. It is presently unknown whether the diversion ditch is historic; if so, it would require formal documentation.

3.20.2 Environmental Effects

3.20.2.1 Issues

Impacts to important cultural resources from reservoir construction were identified as an issue of concern during scoping.

3.20.2.2 Methods for Effects Analysis

The NRHP eligibility of each cultural resource previously documented and/or recorded within the APE was reviewed. Prehistoric, historic, and traditional cultural properties are considered significant under 36 CFR 60.4 if they are eligible for listing in the NRHP.

For purposes of the Section 106 process, consultation regarding resources located within the APE must occur between Reclamation, the Colorado SHPO, and other consulting parties. NRHP evaluation of the resources and determinations of effect would be carried out by Reclamation in consultation with the SHPO. In general, the SHPO recommends that sites be re-recorded when the previous recording occurred five or more years in the past. A site should be re-evaluated whenever its eligibility is being considered or integrity challenged. The SHPO can be consulted to determine when a site needs to be rerecorded or re-evaluated. Reclamation would consult with the SHPO regarding any historic properties that may be affected by the WGFP and assess any adverse effects. After consultation, the SHPO provides a determination of eligibility (DOE) for each cultural resource within the APE. Some cultural resources recorded within the proposed reservoir study areas already have an official DOE.

If SHPO or other consulting parties do not concur with the recommendations provided by Reclamation, continued consultation can occur or the Advisory Council on Historic Preservation (ACHP) can be asked to review the findings. Cultural resources that remain eligible for listing in the NRHP and cannot be avoided during project implementation would be adversely affected. To address these adverse effects, Reclamation would consult with the SHPO and other consulting parties to resolve the adverse effects and develop a Memorandum of Agreement (MOA). The MOA can specify the mitigation or alternatives agreed to by the consulting parties, identify who is responsible for carrying out the specified measures, and serve as evidence that Reclamation has complied with Section 106.

3.20.2.3 Effects Common to All Alternatives

Construction of new reservoirs or the enlargement of an existing reservoir has the potential to adversely affect cultural resources. Direct effects include construction of access roads, borrow pits, transmission lines, pipelines, and dam facilities. The inundation of cultural resources is an indirect effect that can be either adverse or beneficial. Adverse effects can occur to sites located in the area of oscillating shoreline during the cyclical period of drawdown and filling. Beneficial effects of inundation occur to sites that are not subject to shoreline erosion and are preserved from the silting of the reservoir bottom. Indirect adverse effects to cultural resource sites also are possible as a result of increased visitation to reservoirs or parks by the public. Increased exposure of sites contributes to the illicit collection of artifacts, unauthorized excavation of archaeological material, and potential erosion from facility development.

With regard to cumulative effects, a variety of new land developments are anticipated in the vicinity (within 5 miles) of potential WGFP reservoir sites in Larimer and Grand counties.

Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected by project construction; it is likely that some previously recorded sites would need to be re-evaluated.

3.20.2.4 Alternative 1—Ralph Price Reservoir (No Action)

It is uncertain as to whether the enlargement of Ralph Price Reservoir would have a direct or indirect effect on known cultural resources. Twenty previously recorded sites were identified within the reservoir APE. There are no known cultural resources that would be directly impacted by the project. The exact location of three sites (5BL1, 5BL16, and 5BL24) is unknown; they may be located within the reservoir study area. Intensive (Class III) cultural resource investigations would need to be conducted in areas of direct, indirect and cumulative effects to identify known and unknown potentially eligible sites if the No Action alternative is implemented. All previously recorded sites would need to either be rerecorded or re-evaluated.

3.20.2.5 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Twenty-five cultural resource sites eligible or potentially eligible for listing in the NRHP were identified within the Chimney Hollow Reservoir APE, while 12 are located within the reservoir study area and could be directly affected. The 12 cultural resources include the Carter Lake Historic Area (5LR1363), the Flatiron Dam and Reservoir (5LR3984), a pressure conduit and tunnel associated with Carter Lake (5LR4002), two sites associated with the Flatiron Dam (5LR4006 and 5LR4007), three area transmission line segments (5LR9388, 5LR9389, and 5LR9454.1), a prehistoric lithic scatter (5LR10410), one historic ranch (5LR10731), one site consisting of prospecting pits (5LR10732), and one of stock ponds (5LR10733).

Three sites (5LR1363, 5LR4006, and 5LR4007) have been determined to be contributing elements to the Colorado-Big Thompson Historic District. Current project design indicates that a portion of the southern construction access road would overlap part of Carter Lake Historic Area (5LR1363) resulting in direct effects. At this time, it is not known precisely what features within the area would be directly impacted, but comparison with the District documentation (WCRM 1989) indicates that Area 17 (sandstone quarries) and Area 18 (South Shore recreational facilities) could be directly affected by construction. After appropriate survey measures and re-evaluation of previously recorded sites, consultation between Reclamation and the SHPO would determine whether reservoir construction would affect the District's historical integrity. Appropriate mitigation measures with regard to all three resources would be determined in consultation with the SHPO.

NRHP assessments for 5LR3984, 5LR4002, 5LR9388, 5LR9389, 5LR9454.1, 5LR10731, 5LR10732 must be determined in consultation with SHPO. All previously recorded sites would need to be re-evaluated and, where necessary as per the SHPO, re-recorded. After eligibility determinations have been made by Reclamation in consultation with the SHPO, possible mitigation measures can be developed. If there is concurrence with the field recommendations, no further work would be necessary. A segment of the Estes to Lyons TAP transmission line (5LR9454.1) is located within the reservoir footprint. If Reclamation and the SHPO concur recommending this segment eligible, then possible mitigation measures may include Level 1 Historic American Engineering Record (HAER) documentation prior to removal and relocation. Depending on the outcome regarding NRHP eligibility of each site, similar mitigation measures may need to be taken with regard to the Flatiron-Pole Hill Transmission Line (5LR9388) and the Flatiron Valley to Greeley Transmission Line (5LR9389).

One cultural resource (5LR10410) previously recorded by Metropolitan State College is recommended field eligible. Following significant surface collection of the site during recordation, Reclamation recommended that further information is necessary in order to determine its status with regard to the NRHP. If, following further data collection, it is determined in consultation with the SHPO that the site is not eligible for inclusion in the NRHP, no mitigation would be required.

Indirect effects to unknown cultural resources from public visitation could result in the collection of artifacts and potential unauthorized excavation or disturbance of cultural deposits.

3.20.2.6 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Chimney Hollow Reservoir

The effects associated with construction of a 70,000 AF Chimney Hollow would be the same as described for the Proposed Action.

Jasper East Reservoir

Forty-five cultural resources eligible or potentially eligible for inclusion in the NRHP were identified within the Jasper East Reservoir APE. Eight sites are located within the proposed Jasper East Reservoir study area and could be directly affected. The resources include: two prehistoric quarries (5GA119 and 5GA151), one prehistoric lithic scatter (5GA150), and five sites associated with the Willow Creek Reservoir (5GA2278, 5GA2279, 5GA2397, 5GA2400, 5GA2401).

Site 5GA151 is a prehistoric quarry that has been officially determined to be eligible for inclusion in the NRHP. After re-evaluation of the site, Reclamation, in consultation with the SHPO, would develop a data recovery plan to mitigate any adverse effects.

NRHP assessments for 5GA119, 5GA150, 5GA2278, 5GA2279, 5GA2397, 5GA2400, and 5GA2401 must be made by Reclamation in consultation with the SHPO. These sites would need to be re-evaluated before assessments can be made. If Reclamation and the SHPO concur with the field recommendations, no further work would be necessary with regard to sites 5GA150, 5GA2278, 5GA2279, 5GA2397, and 5GA2400. It has been recommended that further data be collected at sites 5GA119 and 5GA2313 in order to determine their eligibility. After eligibility determinations have been made, if appropriate, mitigation measures could be developed.

Indirect effects to unknown cultural resources from public visitation could result in the collection of artifacts and potential unauthorized excavation or disturbance of cultural deposits if recreation development occurs.

3.20.2.7 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Chimney Hollow Reservoir

The effect associated with construction of a 70,000 AF Chimney Hollow would be the same as the Proposed Action.

Rockwell/Mueller Creek Reservoir

Eighteen previously recorded cultural resources eligible or potentially eligible for inclusion in the NRHP were identified within the Rockwell Reservoir APE. One site, the Granby Warehouse (5GA2281), is located within the proposed Rockwell/Muller Reservoir study area. This site, recommended field not eligible, would need to be reevaluated and an official determination assessed. As mentioned previously, the pipeline connection to Windy Gap Reservoir would cross the existing D&RG (5GA3564) and a possible water diversion ditch. Both resources should be formally recorded and evaluated for their eligibility with regard to the NRHP.

Indirect effects to unknown cultural resources from public visitation could result in the collection of artifacts and potential unauthorized excavation or disturbance of cultural deposits if recreation development occurs.

3.20.2.8 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek Reservoir

Seven cultural resources eligible or potentially eligible for inclusion in the NRHP were identified within the Dry Creek Reservoir APE. Two sites are located within the proposed Dry Creek Reservoir study area and could be directly affected. These resources are a historic quarry (5LR653) and the Carter Lake Historic Area (5LR1363). This historic area is mentioned previously in the discussion under the proposed Chimney Hollow Reservoir.

Site 5LR653, a historic quarry, has been recommended field eligible for inclusion in the NRHP. If after re-evaluation, Reclamation in consultation with the SHPO, agrees with the field determination, appropriate mitigation measures would be developed.

With regard to the Carter Lake Historic Area (5LR1363), as previously mentioned under the proposed Chimney Hollow Reservoir, after appropriate survey measures and re-evaluation of this site have occurred, consultation between Reclamation and the SHPO would determine whether reservoir construction would affect the historical integrity of the C-BT Historic District; if the district would be adversely affected, appropriate mitigation measures will be determined. Effects to the Carter Lake Historic Area would be similar to Alternative 2 with disturbance related to a construction access road and the pipeline to Carter Lake. At this time, is not known precisely what features would be impacted, but comparison with the District documentation (WCRM 1989) indicates that Area 17 (sandstone quarries) and Area 18 (South Shore recreational facilities) could be affected by construction.

Indirect effects to unknown cultural resources from public visitation could result in the collection of artifacts and potential unauthorized excavation or disturbance of cultural deposits if recreation development occurs.

Rockwell/Mueller Creek Reservoir

The effect associated with construction of a 30,000 AF Rockwell Reservoir would be the same as Alternative 4.

3.20.2.9 Traditional Cultural Properties

To date TCPs have not been identified within the APE of the proposed alternatives.

3.20.3 Cumulative Effects

No reasonably foreseeable actions were identified within the APE for expansion of Ralph Price Reservoir under the No Action Alternative. Land developments near the Jasper East, Rockwell, Chimney Hollow, and Dry Creek reservoir sites could affect cultural resources and result in cumulative effect to cultural resources in the APE.

3.20.4 Proposed Mitigation

Mitigation Common to All Alternatives

The potential exists for presently unknown cultural resources to be uncovered during project construction. To develop a course of action to mitigate adverse effects to cultural resources discovered during construction, a Discovery Plan would be prepared that includes a pre-construction meeting with Reclamation and the construction contractor. A cultural resource consultant would be available to respond to discovered cultural resources in a timely fashion. All cultural resources located as a result of discovery would be documented and evaluated for eligibility to the NRHP. Reclamation would make determinations of eligibility in consultation with the SHPO and, if necessary, develop a mitigation plan.

In the event that human remains are uncovered, activity in the immediate area would be halted, the area secured, and the county sheriff and coroner contacted. Once the coroner determines the remains to be prehistoric or historic in nature, the SHPO would be contacted and a qualified archaeologist would exhume them. Reclamation would then contact Native American tribes to begin consultation under NAGPRA.

Reclamation, in consultation with the SHPO, would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be reevaluated.

Additional mitigation for specific reservoir sites is discussed below. A Memorandum of Agreement (MOA) or Programmatic Agreement (PA) with the county may be necessary that stipulates for the cultural resource inventory of the planned open space to mitigate potential adverse cumulative effects. A MOA would be drafted that stipulates compliance under Section 106 for the selected alternative. Included would be provisions for the mitigation of adversely effected cultural resources. All participating agencies and consulting parties would be invited as signatories.

Ralph Price Reservoir

No mitigation efforts are currently identified for the No Action alternative other than continued Native American and public consultation. Three resources (5BL1, 5BL16, and 5BL24) may be present within the proposed reservoir study area. Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected by project construction. If these sites are relocated during a Class III cultural resource survey, they would be re-evaluated and/or rerecorded and evaluated.

Chimney Hollow Reservoir

The Carter Lake Historic District (5LR1363) would need to be re-evaluated, and consultation between Reclamation and the SHPO would develop mitigation measures. Sites 5LR4006 and 5LR4007, also contributing elements to the C-BT Historic District would be re-evaluated and a mitigation plan would need to be developed. Preliminary assessment indicates that Area 17 and Area 18, included as part of the District, could be affected by reservoir construction.

NRHP assessments for 5LR3984, 5LR4002, 5LR9388, 5LR9389, 5LR9454.1, 5LR10731, 5LR10732 must be determined in consultation with SHPO. All previously recorded sites would need to be re-evaluated and, where necessary as per the SHPO, re-recorded. After eligibility determinations have been made by Reclamation in consultation with the SHPO, possible mitigation measures can be developed. If there is concurrence with the field recommendations, no further work would be necessary.

Further data would need to be collected from 5LR10410, a prehistoric lithic scatter, in order to determine eligibility. Subsequently, should the site be determined not eligible, no further work would be required.

Western will implement mitigation during construction that will require construction to stop in the area of suspected cultural resources that are discovered during construction. A field investigation, and if need be, consultation with the SHPO will be undertaken prior to reinitiating construction in the area of the resource.

Dry Creek

Site 5LR653 is recommended field eligible and, pending an official determination of eligibility, may require the development of a mitigation plan. Mitigation for 5LR1363 would be the same as described under the Chimney Hollow alternative and would involve consultation between Reclamation and the SHPO. Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

Jasper East

Consultation between Reclamation and the SHPO is required for all 10 previously recorded cultural resources eligible for or potentially eligible for inclusion in the NRHP. These sites would need to be re-evaluated and, in some cases, possibly rerecorded. Sites determined not eligible would require no further work.

Further data collection has been recommended at sites 5GA119 and 5GA2313; if these sites are determined eligible, appropriate mitigation measures should be developed. Following re-evaluation of site 5GA151, a site recommended officially eligible, a mitigation plan should be developed through consultation.

Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

Rockwell/Mueller Creek Reservoir

A re-evaluation and official determination of eligibility would need to be obtained for the Granby Warehouse (5GA2281). If determined eligible, mitigation measures would need to be developed through consultation.

Reclamation, in consultation with the SHPO, would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

3.20.5 Unavoidable Adverse Effects

Unavoidable adverse effects include inundation of cultural resources within the reservoir pool and destruction of cultural resources located in areas of ground disturbance for the different alternative sites. Cultural resources determined officially eligible, and that would be adversely affected by project development, would be mitigated in consultation between Reclamation and the SHPO. Mitigation serves to recover all reasonably available data through further documentation and/or excavation.

3.21 Visual Quality

3.21.1 Affected Environment

3.21.1.1 Area of Potential Effect

The study areas for the visual quality assessment includes the alternative reservoir sites and surrounding areas up to 2.5 miles away with potential views of the reservoir and dam as determined by digital viewshed analysis. Potential effects to visual quality from changes in hydrology also are considered at existing reservoirs and streams.

3.21.1.2 Data Sources

The visual quality in the area of potential effect was based on field observations, aerial photography, maps, and digital elevation topography data. Additional information is included in the Visual Assessment Technical Report (ERO 2008b).

3.21.1.3 Existing Visual Quality

The existing visual quality of all of the alternative reservoir sites is generally high because the sites are in areas with limited development.

Ralph Price Reservoir

The Ralph Price Reservoir site is located in a scenic valley along the North Fork of St. Vrain Creek. The existing reservoir is surrounded by dense coniferous forest on low mountains. The reservoir is visible to recreation visitors who hike to the lake and a few nearby private homes. The reservoir is not visible from any public roads.

Chimney Hollow Reservoir

The Chimney Hollow Reservoir site is located in a valley bordered by the steep ridge and cliffs of a hogback formation to the east and moderately sloped and forested foothill mountains to the west. The majority of the valley is open grass and shrublands with scattered ponderosa pine forest on the western foothills and cottonwoods along the valley bottom. The existing visual character of the Chimney Hollow valley includes several artificial linear forms including a transmission line that extends throughout the length of the valley, several small power lines, and a large above ground pipeline. The Chimney Hollow valley is currently visible from several homes on the eastern hogback ridge and small portions of County Road 18E, but is otherwise secluded.

Dry Creek Reservoir

The Dry Creek Reservoir site is in a hogback framed valley similar to Chimney Hollow. Shrubland and sandstone rock outcrops are found along the steep hogback east of Dry Creek Reservoir and rolling foothill mountains are present on forested slopes to the west. Dry Creek Reservoir supports mixed woodlands and small ponds. A few single-family residences, rural roads, and wire fences are the only artificial forms in the area. The Dry Creek Reservoir site is visible only from private residences and public roads to the residences.

Jasper East Reservoir

The Jasper East Reservoir site is characterized by a large open valley with rolling hills and mountain ranges in the distance. The area supports a mix of irrigated meadows, sagebrush hills, and isolated stands of lodgepole pine. CR 40, a gravel road bisects the property, as well as smaller private roads. Other artificial landforms include the Willow Creek Pump Canal, forebay, and pump station, and an asphalt runway for model airplanes. The Jasper East Reservoir site is primarily visible from the county road and from some private residences to the west.

Rockwell/Mueller Creek Reservoir

The Rockwell Reservoir site is located in an open hillside drainage above the Fraser River valley. Sagebrush and grasslands encompass most of the site with shrubby riparian vegetation along two small drainages, and coniferous and aspen forest along the western perimeter. Existing visual quality is influenced by scattered low-density housing on and near the site, adjacent county roads, and private roads. Although portions of the site are visible from the Town of Granby, Highway 40, man-made obstructions are common in the foreground. Residential and commercial areas in the Fraser River valley also have some visibility of the reservoir site.

3.21.2 Environmental Effects

3.21.2.1 Issues

Issues of concern identified during scoping were the potential effect to existing visual quality near the reservoir sites, the visual impact of relocating the transmission line at Chimney Hollow, and the impact to scenic resources from hydrological changes.

3.21.2.2 Methods for Effects Analysis

Potential effects to visual quality considered changes in the visual quality due to reservoir and facility construction, both temporary and permanent, and the impact to the scenery from nearby observation points where the reservoir and dam would be visible. The visual quality assessment for the reservoir sites consisted of two separate assessments:

- A line-of-sight/viewshed analysis, called a visibility study, identified areas with views of the alternative dams and reservoirs. Using digital terrain modeling, a polygon of points was set at the top of the dam elevation in the shape of the reservoir. If any point could see the surrounding terrain within a 2.5-mile radius of the reservoir's edge, a shaded area was created. The shaded areas away from the reservoir, therefore, identified locations from which the reservoir would be visible. At distances beyond 2.5 miles, visibility would diminish, as would impacts to scenic quality.
- A scenic quality assessment evaluated the existing scenic quality in the study areas. This portion of the assessment is a field measurement of the physical characteristics, or elements, of scenic quality. These elements include landform types, rock form types and sizes, water form types, artificial form types and quantity, the size of the field of view (referred to as containment), and the color and texture variations.

Potential visual quality effects at reservoirs and streams were evaluated based on changes in reservoir water surface area and streamflow.

3.21.2.3 Effects Common to All Alternatives

Scenic quality at all of the reservoir sites would be temporarily impacted during dam and facility construction. This would include removal of vegetation and exposure of soil and geologic material from material source sites, preparation of the dam foundation, and pipeline installation. Exposed soil material would contrast with adjacent vegetated areas and would generate dust. Construction equipment, vehicles, temporary buildings, and supplies would affect the visual quality of the area for the 4- to 5-year construction period for Alternatives 2, 3, 4, and 5 and about 30 months for the No Action alternative. Temporarily disturbed areas would be revegetated following construction, but new vegetation would contrast with undisturbed vegetations for several years.

Once reservoir construction is completed and the reservoirs are filled, the scenic character at the new reservoir sites would shift from a mostly natural landform to a flat water feature. The presence of water would provide a visual complement or contrast to the surrounding landscape. Reduced scenic quality is expected where the dam face or other above ground artificial features would be visible.

3.21.2.4 Visual Quality Effects at Alternative Reservoir Sites

This section includes a discussion of the effects to visual quality for each of the new reservoir sites.

Ralph Price Reservoir

The visual quality at Ralph Price Reservoir would not change substantially if the existing reservoir is enlarged by about 77 surface acres. Visual quality would temporarily diminish if the reservoir is drained during construction; however, public access to the reservoir would be restricted during construction. The scenic quality from the two private residences and for visitors when the reservoir is completed and filled would remain about the same because the larger dam and greater area of inundation would not increase the visibility from surrounding areas.

Ralph Price Reservoir water elevations would fluctuate slightly more than existing conditions from the exchange of Windy Gap water to the reservoir. During the summer months, the reservoir would operate at about 72 to 80 percent of capacity; therefore, portions of the shoreline would be visible. Although the reservoir would be larger than existing conditions at capacity, the visual quality of the reservoir would be similar to existing condition.

Chimney Hollow Reservoir

Changes in the scenic quality of Chimney Hollow Reservoir would be similar for both the 90,000 AF reservoir in the Proposed Action and the 70,000 AF reservoir in Alternatives 3 and 4. The dam for the larger reservoir size would be about 30 feet higher and a larger reservoir pool would make the reservoir and dam more visible. Chimney Hollow Reservoir would be visible primarily from homes along the hogback to the east and from lands to the west where the reservoir is not screened by trees. There are no key observation points west of the reservoir, although trail development on Larimer County Open Space is likely to provide views of the reservoir as would recreation facilities at the reservoir. The Chimney Hollow dam face would be visible from observation points to the north up to about 2.5 miles away. The dam also would be visible from Reclamation offices, Flatiron Reservoir, scattered residences, and County Road 18E.

The transmission line to be relocated to the west of Chimney Hollow Reservoir would be visible from several locations including the reservoir surface and shoreline and possibly from new trails on Larimer County Open Space. The transmission line would be most prominent where linear forest clearings are required. A visibility simulation was conducted with Larimer County Open Space and Western to reduce the visual impact of the relocated line.

A 90,000 AF Chimney Hollow Reservoir would be operated to remain at about 95 percent of capacity throughout the year. Because water levels would remain fairly stable, shoreline exposure would be limited, which would reduce the visual contrast between water and vegetated areas. Effects to visual quality, due to water level fluctuations would be unnoticeable to most viewers. A 70,000 AF Chimney Hollow Reservoir under Alternatives 3 and 4 would have a relatively stable water surface elevation on average, remaining at about 70 to 80 percent of capacity throughout the year. A portion of the reservoir shoreline would remain exposed throughout the year except during very wet years when storage is higher.

Dry Creek Reservoir

Construction of Dry Creek Reservoir under Alternative 5 would change the visual character of the existing valley by introducing a large body of water and dam enclosing the southern portion of the valley. The new reservoir would be visible from scattered locations to the west and east of the reservoir and from higher elevations up to 2 miles south. There are few observation points for the reservoir because most of the area is undeveloped and has limited access. The dam face would be visible from portions of a gravel road along Little Thompson Creek. Scattered rural residences also may have views of the dam and reservoir.

Dry Creek Reservoir content would fluctuate seasonally but would operate between about 75 and 80 percent of capacity on average. Lower water levels would expose a contrasting shoreline that would remain visible much of the year.

Jasper East Reservoir

Construction of Jasper East Reservoir under Alternative 3 would introduce another water feature to the region between the Willow Creek Reservoir and Granby Reservoir. Jasper Reservoir would be visible from surrounding lands at higher elevations, although observation points are limited. Because the reservoir includes three dams, the dam faces would be visible from lands to the north, west, and south. The majority of the lands that would have a view of the dams are unoccupied, but residences to the west, and portions of the Arapaho National Recreation Area could have views of a dam. The Jasper East Reservoir would require relocation of County Road 40 to the south, which would have views of two of the dams.

Water storage in Jasper East Reservoir would vary seasonally from 20 to 80 percent of capacity. The fluctuations in water levels would expose large areas of unvegetated shoreline when the reservoir is low, which would reduce the scenic quality of the reservoir. However, the lowest water levels would occur during the winter and early spring when visitor use would be low and snow cover is possible. Higher water levels would be present during the summer months when more visitors could be present.

Rockwell Reservoir

The surface of Rockwell Reservoir would be visible primarily from higher topographic positions to the west and south. Because most of this area is forested, views of the reservoir would be limited. Rockwell Reservoir's north dam face would be visible over a large area including the Town of Granby. However, views of the dam would be over 1 mile away and would be screened by urban development and trees along Highway 40. The east-facing dam would be visible from portions of the Grand Elk development, Granby Ranch, and Highway 40. Homes closest to the dam site would have the greatest reduction in scenic quality.

Rockwell Reservoir would operate similar to Jasper East Reservoir with wide fluctuations in reservoir content and reduced scenic quality from exposure of the shoreline during winter and spring.

3.21.2.5 Visual Quality at Existing Reservoirs and Streams

Windy Gap Reservoir

Windy Gap Reservoir would continue to function as a regulating reservoir for pumping water into Granby Reservoir under all the alternatives. Additional pumping would not necessarily cause lower reservoir levels. Water level in Windy Gap Reservoir would fluctuate by 1 to 2 feet during pumping, but typically would not cause noticeable changes in exposed lake shoreline. Algae are visible in the reservoir under existing conditions and this would continue in the future under all the alternatives. Increased nutrient loadings from upstream sources could cause an increase in algal growth and therefore reduce the visual quality of the reservoir.

Grand Lake and Shadow Mountain Reservoir

None of the WGFP alternatives would result in changes in the water levels of Grand Lake or Shadow Mountain Reservoir; therefore there would be no change in the amount of exposed shoreline. Predicted small reductions in water clarity and increased algal growth in Grand Lake may contribute to diminished visual quality at times of the year under all of the alternatives. The decrease in water clarity of about 0.1 meters would be the same for Alternatives 1 to 4 and there would be no change for Alternative 5.

There would be no change in clarity in Shadow Mountain Reservoir for any of the alternatives. Predicted minor water quality changes in Shadow Mountain Reservoir are unlikely to noticeably affect the visual quality. Aquatic vegetation will continue to be visible, but none of the alternatives would substantially contribute to the growth of rooted plants.

Granby Reservoir

A change in water storage at Granby Reservoir under all alternatives would affect visual quality by reducing water levels, thereby increasing the amount of visible shoreline, and diminishing the amount of visible surface water. Under existing summer conditions (May to August) in average years, about 290 acres of exposed shoreline are visible. Under the No Action alternative, lower summer water levels in Granby Reservoir would increase the amount of visible shoreline about 108 acres. The Proposed Action would increase the amount of exposed shoreline by about 270 acres more than existing conditions during the summer. Alternatives 3, 4, and 5 would increase visible shoreline by about 155 acres.

During successive drought years, Granby Reservoir water levels would drop up to 23 feet under the Proposed Action and up to 15 feet under Alternatives 3, 4, and 5, which would increase the amount of shoreline visible. Granby Reservoir water levels currently fluctuate as much as 90 feet, but the lower water levels in average and drought years would reduce the visual quality of the reservoir for some viewers compared to existing conditions.

Carter Lake

A decrease in water levels of about 1-foot on average in Carter Lake would result in a negligible change to visible shoreline visibility that is unlikely to be noticeable under any of the alternatives. Dry year changes in Carter Lake water levels would also be less than 1-foot under all of the alternatives with negligible effect on the visual quality of the reservoir. During wet years, water levels would be as much as 2-feet lower than existing conditions in the summer months, but water levels would remain above average and would have little, or no noticeable affect on visual quality.

For all alternatives, the decrease in reservoir surface area would be less than 6 percent during the summer in average, wet, and dry years. This relatively small change in a 6,500 acre reservoir would have a minor effect on visual quality from the increased exposure of shoreline.

Horsetooth Reservoir

At Horsetooth Reservoir, under existing conditions in the summer (May to August) of average years, about 82 acres of exposed shoreline are visible. Under the No Action alternative exposed shoreline would increase less than 6 acres in the summer, which would not noticeably increase shoreline visibility. Under the Proposed Action, the exposed shoreline would increase about 73 acres on average in the summer.. For Alternatives 3, 4, and 5 the additional shoreline exposure would average less than 24 acres. In dry years, the additional visible shoreline under the No Action alternative in the summer would be less than 6 acres compared to a maximum of 109 acres for the Proposed Action. Alternatives 3, 4, and 5 would increase the visible shoreline from 6 to 66 acres during the summer months of dry years. The effect to visual quality, due to water level fluctuations would be unnoticeable to most viewers because of current water level fluctuations and relatively small changes in surface area in a reservoir that is typically about 1,800 acres in size during the summer.

West Slope Streams

All of the alternatives would result in a change in streamflow on the West Slope from increased diversions on the Colorado River and operational changes that reduce flows on Willow Creek. The majority of these streamflow reductions occur in May and June, but they could occur from April to October. Average monthly stream stage below Windy Gap Reservoir would decrease up to 0.1 feet under the No Action alternative, 0.22 foot under the Proposed Action, and about 0.19 foot for other alternatives. There would be no change in Colorado River flows from existing conditions in dry years and the change in wet years would be greater, but streamflows would be substantially higher than average years. Reductions in Colorado River average monthly stream stage downstream of Kremmling would range from about 0.12 foot for the No Action alternative to 0.28 foot under the Proposed Action, and about 0.24 foot for other alternatives. Lower streamflows could potentially reduce the visual quality of the Colorado River, but for most viewers these changes would not be discernible. The scenic character of these streams would remain similar to existing conditions.

Average annual streamflow in Willow Creek below Willow Creek Reservoir would decrease about 7 percent under No Action compared to about 14 percent for the Proposed Action and 12 percent for other alternatives. The projected lower flows would occur from May to November and would reduce the visual quality of the stream for some viewers, although public access to this section of the stream is limited.

East Slope Streams

The additional import of water to the East Slope through the Adams Tunnel would result in slightly increased flows to several streams. The Big Thompson River below Estes Park to the canyon mouth would experience an increase in average monthly flow of up to 1 percent under No Action, 9 percent under the Proposed Action, and less than 5 percent for other alternatives. Streams below Participant WWTPs also would have an increase in flow following use of Windy Gap water. Streams that would experience an increase inflow below WWTPs include St. Vrain Creek, Big Thompson Creek, Big Dry Creek, and Coal Creek. The relatively small increases in flow would most likely be unnoticeable to most viewers. Under the No Action alternative, there would be both increases and decreases in streamflow below Ralph Price Reservoir in the North Forth of the St. Vrain and the St. Vrain River above Lyons from exchanges and releases to storage. Visual quality would potentially decrease in May and July, and increase in other months.

3.21.3 Cumulative Effects

Cumulative effects to visual quality were assessed by looking at reasonably foreseeable land developments likely to occur in the future near the alternative reservoir sites. The study area for cumulative visual effects includes the 2.5-mile buffer surrounding the reservoir sites used in the visibility analysis. Identified reasonably foreseeable changes to visual quality in the study area were primarily planned future residential and commercial land developments. Thus, the cumulative effect to local visual quality would include the changes to the landscape from alternative reservoirs and facilities plus other new land developments. These cumulative effects are discussed for each of the reservoir sites in the alternatives. Reasonably foreseeable water-based actions on the West Slope would affect streamflows in the Colorado River, but would not result in any new direct disturbance that would affect visual quality. The hydrologic changes to streams and reservoirs associated with implementation of future water and the WGFP were evaluated for potential affects to visual quality.

3.21.3.1 Water-Based Reasonably Foreseeable Actions

New or Enlarged Reservoirs

Construction of Chimney Hollow Reservoir, Dry Creek Reservoir, Jasper East Reservoir, Rockwell/Mueller Creek Reservoir, or the enlargement of Ralph Price Reservoir would all operate in a manner similar to that without reasonably foreseeable actions in place, thus the visual quality of these reservoirs would be similar to that described previously for direct effects.

Grand Lake and Shadow Mountain Reservoir

Water levels in these reservoirs would not change from existing conditions; therefore, there would be no change in visible shoreline. Predicted water quality changes potentially affecting the visual quality of Grand Lake include a decrease in clarity of about 0.1 meters for the Proposed Action, no change for the No Action alternative, and an improvement in clarity of about 0.1 meters for the other alternatives. The predicted small reductions in water clarity and increased algal growth in Grand Lake may contribute to diminished visual quality at times of the year.

Water clarity in Shadow Mountain Reservoir would not change under No Action or the Proposed Action. Under Alternatives 3, 4, and 5, clarity would improve about 0.1 meters. Thus, there would be no change in the visual quality of Shadow Mountain Reservoir under the No Action and Proposed Action alternatives and a slight improvement under other alternatives.

Granby Reservoir

Under existing conditions in average years during the summer (May to August), about 290 acres of exposed shoreline are visible. Under the No Action alternative, exposed shoreline would increase about 160 acres during the summer and the Proposed Action would increase the average summer shoreline exposure about 348 acres. Alternatives 3 to 5 would increase the amount of exposed shoreline about 166 acres. Changes in shoreline exposure would decrease the visual quality of the reservoir under all alternatives for some viewers.

In wet years, under the No Action alternative, exposed shoreline would increase about 171 acres in the summer and under the Proposed Action, the exposed shoreline would increase about 288 acres. Under Alternatives 3 to 5, the exposed shoreline would increase about 232 acres. In the summer of dry years under existing conditions, the reservoir water surface area is about 6,020 acres with an exposed shoreline of about 735 acres. Under the No Action alternative, exposed shoreline would increase about 172 acres and under the Proposed Action, the exposed shoreline would increase about 288 acres. Under Alternatives 3, 4, and 5, the exposed shoreline would increase about 152 acres. The increases in exposed shoreline would diminish visual quality for some viewers, during dry year conditions.

Windy Gap Reservoir

Effects to visual quality in Windy Gap Reservoir would be similar to that described for direct effects.

Carter Lake

Water levels changes at Carter Lake would not be noticeably affected under any of the alternatives. During average or dry years, average monthly surface area would decrease less than 5 acres and lake levels would not decrease more than 1 foot under any of the alternatives. In wet years, under all alternatives, the average monthly lake surface area would decrease less than 11 acres and lake levels would decrease less than 2 feet for all alternatives. In dry years, fluctuations would be within 1 foot of existing conditions for all alternatives. Therefore changes to exposed shoreline areas and the visual quality of the reservoir would be negligible or unnoticeable.

Horsetooth Reservoir

At Horsetooth Reservoir, under existing conditions in the summer (May to August) of average years, about 82 acres of exposed shoreline are visible. The No Action alternative would not affect water levels in Horsetooth Reservoir during summer, the peak recreation season, under average conditions, wet years, or dry years. The Proposed Action would increase exposed shoreline area less than 72 acres during the same period under average conditions. Alternative 5 would increase exposed shoreline area less than 25 acres during summer average conditions. There would be less than a 2 acre change in exposed shoreline in wet years under the No Action alternative. During wet years, the Proposed Action would increase exposed shoreline area less than 70 acres and Alternatives 3, 4, and 5 would increase exposed shoreline area less than 15 acres. The Proposed Action would increase exposed shoreline area up to 89 acres during dry years, compared to 53 acres for Alternatives 3, 4, and 5 and less than 3 acres for the No Action alternative. Therefore changes to exposed shoreline areas and the visual quality of the reservoir would be negligible or unnoticeable.

West Slope Streams

Cumulative effects to Colorado River streamflow would occur with reasonably foreseeable future water-based actions implemented along with one of the WGFP alternatives. The average monthly change in stream stage below Windy Gap Reservoir would decrease up to 0.19 foot under the No Action alternative, 0.33 foot under the Proposed Action, and about 0.29 foot for other alternatives. Dry year changes in river stage of less than 0.3 feet would occur as the result of reasonably foreseeable actions. The change river stage in wet years would be greater, but streamflows would be substantially higher than average years. Reductions in Colorado River average monthly stream stage downstream of Kremmling would range from about 0.85 foot for the No Action alternative to 1.04 feet under the Proposed Action, and about 1.00 foot for other alternatives. The stream channel at this gage near the mouth of Gore Canyon is much narrower and deeper than upstream portions of the Colorado River. Lower streamflows flows could potentially reduce the scenic quality of the Colorado River, but for many viewers these changes may not be discernible.

Average annual streamflow in Willow Creek below Willow Creek Reservoir would decrease about 9 percent under No Action compared to about 15 percent for the Proposed Action and 13 percent for other alternatives. The projected lower flows would occur from May to November and may reduce the visual quality of the stream.

East Slope Streams

The additional import of water to the East Slope through the Adams Tunnel would result in a slight increase flows to several streams similar to described that described for direct effects. The relatively small increases in flow are unlikely to be discernable, and therefore no change the visual quality of these streams from the existing condition is expected.

3.21.3.2 Land-Based Reasonably Foreseeable Actions

Ralph Price Reservoir

No reasonably foreseeable actions were identified near Ralph Price Reservoir that would add to the cumulative visual effects for the area.

Chimney Hollow Reservoir

The only reasonably foreseeable land developments with 2.5 mile of Chimney Hollow Reservoir are a residential developments northeast and east of Carter Lake and planned future trail development on Larimer County Open Space on the west side of Chimney Hollow. The planned residential development near Carter Lake would add an artificial form to the landscape. Trails on Larimer County Open Space would add linear features to the landscape, but many of the trails would be screened by forest vegetation.

Dry Creek Reservoir

No reasonably foreseeable developments would occur within 2.5 miles of the Dry Creek Reservoir site that would add to cumulative visual impacts.

Jasper East Reservoir

The planned C-Lazy-U Preservers is located about 1 mile northwest of the reservoir site. The low-density housing planned for C-Lazy-U Preservers and residential development on other properties in the study area would contribute to a cumulative change in the visual quality of the area.

Western is planning on rebuilding the transmission line between the Granby Pumping Plant on the north side of Granby Reservoir and the Windy Gap Substation near Windy Gap Reservoir. The use of new poles in the existing alignment or a possible new alignment would result in an additional change the landscape east of the Jasper Reservoir site.

Rockwell Reservoir

Planned future residential and commercial developments within 2.5 miles of the Rockwell Reservoir site in addition to the reservoir would result in a cumulative change to the visual quality of the landscape.

3.21.4 Proposed Mitigation

Mitigation measures for all alternatives include measures to minimize the amount of ground clearing, reclamation, and restoration of areas disturbed during construction. As described in *Vegetation* (Section 3.10.4), all temporarily disturbed lands, such as staging areas, pipelines, and other surfaces disturbances, would be revegetated with species similar to existing conditions. Aboveground structures would be constructed with materials that complement the adjacent existing landscape. As discussed in *Air Quality* (Section 3.16.4), dust-control measures would be used during construction to reduce visual emissions.

The proposed relocation of the transmission line at Chimney Hollow Reservoir for the Proposed Action and Alternatives 3 and 4 included a visual simulation to minimize the visual effect. Western, which is responsible for relocating the transmission line, would work with Larimer County Open Space and the Subdistrict on the final alignment within the proposed corridor to further reduce visual impacts. The relocated transmission line would be constructed using nonspecular wire, nonreflective insulators, and monopoles finished to complement the sky background or forest background. The finish and color of the monopoles is yet to be determined. Maintenance roads would be located and aligned to minimize earthwork for the road construction, and avoid or minimize the removal of trees.

3.21.5 Unavoidable Adverse Effects

All of the action alternatives would result in an unavoidable change in the character of the visual landscape from the introduction of a new large water body and dam structure. The visual quality of the landscape would change less under the No Action Alternative because only the existing Ralph Price Reservoir would be enlarged. The visual quality of affected streams and reservoirs would also change with increased water diversions on the West Slope, increased deliveries and return flows on the East Slope and a change in water levels for several reservoirs.

3.22 Socioeconomics

3.22.1 Affected Environment

3.22.1.1 Area of Potential Effect

The study area includes areas that could experience socioeconomic effects from implementation of the alternatives. The primary study area is the counties and nearby communities where potential reservoirs and associated facilities would be located (Grand, Larimer, and Boulder counties). Also discussed are the service areas of the WGFP Participants, which encompass portions of Boulder, Larimer, Weld, and Broomfield counties on the East Slope and the MPWCD, which serves Grand and Summit counties on the West Slope.

3.22.1.2 Data Sources

Information from local, state, and federal sources was used to characterize the overall baseline and future economic and demographic conditions in the study area. Data was collected for population, employment, earnings by sector, labor force, unemployment rate, household income, wage rates, and other economic and demographic variables. Socioeconomic information was obtained through personal interviews with key individuals in the study area, such as city and county planners, local business leaders, recreation specialists, and utility planners. Data for specific economic sectors and activities that might be particularly affected, such as recreation, was taken from the Recreation Resources Technical Report (ERO 2008b). Information on Participant population growth, water supply and projected demands, water rates, and rate structures are taken from the WGFP Purpose and Need Report (ERO and Harvey Economics 2005). Additional information is included in the Socioeconomic Resources Technical Report (ERO 2008c).

The following sections provide an overview of the population, employment, income, community services, and land use values for the study area.

3.22.1.3 Population

The populations of Grand, Larimer, and Boulder counties have all grown sharply over the last decade and are expected to continue to increase in the future (Table 3-136). The population in the service areas for WGFP Participants is also expected to continue to grow.

Grand County's 2003 permanent population of 13,732 is expected to reach almost 29,000 by 2030 (DOLA 2004d). During the winter, seasonal residents increase the population up to 18,000 and summer residents increase the population about 5,000 (Grand County 1998). In addition, Grand County receives more than 1 million ski visitors per year and many of the almost 3 million tourists visit Rocky Mountain National Park each year. Key trends influencing the seasonal population are more tourists and second home residents that visit during the off-season. About 55 percent of the population in Grand County resides in unincorporated areas. Granby and Kremmling are the most populated towns in the county along the Colorado River corridor with populations of about 1,700 each in 2003. Hot Sulphur Springs had a population of about 570, and the town of Grand Lake had about 480 in 2003 (DOLA 2004b). According to census data, the population of Grand County is about 95.2 percent white, and Hispanics account for about 4.4 percent of the population (Census 2000a).

The Larimer County population has increased over 40 percent between 1990 and 2003 to 266,610 residents and is expected to reach over 440,000 by 2030 (DOLA 2004b). Much of this growth is expected to occur within existing urban growth areas near the cities of Fort Collins, Loveland, and Berthoud. Fort Collins is the largest community in Larimer County with a 2003 population of about 125,500 (DOLA 2004b). Loveland is the next largest municipality with a population of about 56,000 in 2003 (DOLA 2004b). Race statistics (Census 2000a) indicate about 91.4 percent of Larimer County is white, and Hispanics are the largest minority group at 8.3 percent.

Boulder County's population increased about 29 percent between 1990 and 2000 and was about 277,467 residents by 2003 (DOLA 2004d). The Boulder County population is projected to reach almost 384,000 by 2030 (DOLA 2004d). Most residents in the county reside in the town of Boulder with a 2003 population of about 98,000. Hispanics are the largest minority group in the county at 10.5 percent and the white population is about 89.5 percent (Census 2000a).

Much like county trends, the population of each WGFP Participant's jurisdiction or service area has increased substantially in recent years (ERO and Harvey Economics 2005). Participants are planning for and expecting future population growth from 25 to 334 percent in the next 20 to 25 years. While many of these Participants are expected to reach build-out by 2020 to 2030, several (such as Evans, Fort Lupton, and Greeley) will continue to experience population increases beyond these dates. Chapter 2 provides additional detail on population growth for each of the Participants.

3.22.1.4 Employment

Total employment in Grand County was about 6,462 in 2002 with an unemployment rate of about 4 percent (DOLA 2004c). Almost half of Grand County's labor force resides in Granby, Kremmling, Grand Lake, or Hot Sulphur Springs. Wage and

Table 3-136. Historical population trends by county.

	Grand County				Larimer County				Boulder County			
	1990	2000	2003	2030	1990	2000	2003	2030	1990	2000	2003[1]	2030
Total Population	7,966	12,442	13,732	28,800	186,136	251,494	266,610	440,675	225,339	291,288	277,467	383,634
Change	-	4,476	1,290	15,068	-	65,358	15,116	174,065	-	65,949	-13,821	106,167
Percent Change	-	56.2%	10.4%	109%	-	35.1%	6.0%	65%	-	29.3%	-4.7%	38%

[1] Boulder County population decrease between 2000 and 2003 is attributed to the City and County of Broomfield seceding from Boulder County.

Source: DOLA 2004a.

salary employment accounted for 69 percent of the jobs and the remainder was from self employment. Top industries that provide about 42 percent of the employment in Grand County include the categories of arts, entertainment, recreation, accommodation, food services, construction, and retail trade (BEA 2002a). Many of these jobs support skiing, rafting, outfitters, and other outdoor recreation activities. Jobs directly related to visitors accounted for about 39 percent of Grand County jobs in 2003 (Coley Forrest 2007). State and local government is also a large employer in Grand County and provides about 10 percent of the employment.

Larimer County employment in 2002 was about 148,500 with an unemployment rate of about 5 percent (DOLA 2004c). The City of Loveland accounted for about 19 percent of the county employment. Wage and salary employment accounted for 77 percent of the jobs and the remainder was from self employment. Top employers in Larimer County include the categories of state and local government, retail trade, and manufacturing, which provide about 35 percent of the jobs (BEA 2002a).

Boulder County employment was about 156,000 in 2002 with an unemployment rate of 5 percent (DOLA 2004c). Wage and salary employment accounted for 78 percent of the jobs and the remainder was from self employment. A wide variety of employers are present in Boulder County, but retail trade, manufacturing, and educational services provide about 23 percent of the employment (BEA 2002a).

3.22.1.5 Income

Per capita income in Grand, Larimer, and Boulder counties ranged from 88 to 119 percent of the state average in 2002 (BEA 2002b). Grand County per capita income of $29,560 ranked 19th in the state. In Larimer County, per capita income was $31,400 in 2002 and ranked 14th in the state. Boulder County's per capita personal income of $34,228 ranked 5th in the state in 2002. Individual poverty levels in 2000 were 5.4 percent in Grand County, 9.2 percent in Larimer County, and 9.5 percent in Boulder County. The statewide individual poverty level was 9.3 percent (Census 2000a).

3.22.1.6 Community Services

Each of the counties where reservoir storage sites would be located and construction activities would occur have developed school, medical, fire, and police services supporting local communities. Schools and community services in the portion of the counties near project facilities are briefly outlined below.

Grand County has three elementary schools, one middle school, one high school, and one private school with a combined enrollment of about 1,370 students. Emergency services nearest the potential West Slope reservoir sites include the St. Anthony Granby Medical Center and the Kremmling Memorial Hospital. Fire services near these sites base out of Granby, Hot Sulphur Springs, and Grand Lake. The Colorado State Patrol has a base office in Granby.

Larimer County's Thompson School District encompasses schools in Berthoud and Loveland. The District includes 18 elementary schools, five middle schools, and five high schools. District-wide enrollment in 2003-2004 was over 14,600 students. Emergency medical services are available at Poudre Valley Hospital, Longmont United Hospital, and Boulder Community Hospital. Fire and police services nearest the potential reservoir sites are located in Loveland and Berthoud.

Boulder County's St. Vrain School District encompasses schools in Lyons, Longmont, and Erie. District-wide enrollment in 2003-2004 was 22,180 students. Emergency medical services are available at Longmont United Hospital and Boulder Community Hospital. Fire and police services are located in Lyons, Longmont, and Erie.

3.22.1.7 Land Use Values

Land uses at potential reservoir sites with socioeconomic values primarily include agriculture, recreation, and residences. Existing reservoirs and streams with projected hydrologic effects primarily have land use values associated with recreation. The following section discusses land use values in the study area. More information on land use is included in Section 3.18.

Ralph Price Reservoir

Ralph Price Reservoir is located in unincorporated Boulder County on land owned and managed by the City of Longmont for water supply storage and recreation. Recreation access for hiking and sightseeing is free to the public, but a permit is required for fishing. Two private residences are located on the northern side of the reservoir. The City of Longmont's caretaker for the site has a home near the reservoir. There is no agricultural use of the land.

Chimney Hollow Reservoir Site

The land on which the Chimney Hollow Reservoir would be located is owned by the Subdistrict and currently does not support agricultural or recreational activities or private residences.

Dry Creek Reservoir Site

The Dry Creek Reservoir site supports a small llama breeding operation in addition to three private residences. The state owns a portion of the site that currently has a mining lease for selling moss rock (Routen, pers. comm. 2006) and that in the past has included livestock grazing. No public recreation activities occur at the site.

Jasper East Reservoir Site

Livestock production is the primary land use at the Jasper East Reservoir site. Approximately 313 acres are flood irrigated for cultivation of hay and cattle grazing. Income generated from agricultural production is primarily associated with an annual sale of calves. Cattle grazed on the Jasper East Reservoir site produce about 45 calves annually, contributing to about $27,000 in annual income (Alexander, pers. comm. 2005).

The Willow Creek Pump Station, forebay, and portions of the Willow Creek pump canal, which is used to carry water from Willow Creek Reservoir to Granby Reservoir, are located at the site. No homes are present and the only recreation is a model airplane facility.

Rockwell/Mueller Creek Reservoir Site

The Rockwell Reservoir site includes meadows used as pastureland for horses and four private residences. No public recreation is available.

Three Lakes and Colorado River

Tourism is an important component of the Grand County economy. In 2003, about 12.5 percent of Grand County's jobs were attributed to recreation, arts, and entertainment, which include recreation activities such as rafting, skiing, and other activities related to tourism (BEA 2002a). Winter visitation associated with downhill skiing is the largest contributor to the Grand County recreation and tourism industry, contributing about 27 percent ($162.3 million) of countywide sales in 2002 (Lloyd Levy Consulting 2004). The direct impact of spending by visitors in Grand County in 2003 was estimated at about $170 million (Coley/Forrest 2007). Expenditures included travel, lodging, food and beverages, recreation, and other visitor-related commodities, but did not include the secondary economic benefits. Boating and fishing are popular summer attractions at Shadow Mountain Reservoir, Grand Lake, Granby Reservoir, and along the Colorado River. The CDOW has rated the Colorado River between Windy Gap Reservoir and Troublesome Creek as a Gold Medal fishery because of the outstanding fishing opportunities. No complete statistics are available on the amount of angling use on the Colorado River; however, BLM records permits for commercial fishing use in the Pumphouse reach of the Colorado River. These records indicate an average of 2,040 user days per year between 1999 and 2004 (BLM 2007b). The average annual economic value of this angling activity is estimated to be about $108,000 based on outdoor recreation use values for fishing in the Intermountain region of $53.04 per user day (indexed to 2007 dollars) (Loomis 2005). Additional angling activity occurs on publicly accessible lands at State Wildlife Areas, BLM land, as well as fishing from privately held property and resorts along the Colorado River.

Boating is most popular on the Colorado River below Kremmling. In 2007, commercial boating on the Upper Colorado River generated the sixth highest level of direct economic impact (about $3.4 million) and total economic impact (about $8.7 million) when compared to all other Colorado rivers (CROA 2008). There were about 32,000 commercial user boating days in 2007 (CROA 2008).

Carter Lake and Horsetooth Reservoir

Carter Lake and Horsetooth Reservoir in Larimer County provide year-round water- and land-based recreation opportunities including boating, angling, camping, and other land-based recreation. Recreation, arts, and entertainment accounted for about 2.4 percent of Larimer County's employment in 2003 (BEA 2003).

3.22.2 Environmental Effects

3.22.2.1 Issues

Identified socioeconomic issues of concern were the loss of private property or homes and the potential for vandalism or trespass if recreation activities are allowed at reservoir sites. Potential impacts to tourism and recreation, particularly related to effects on Colorado River boating, was a concern on the West Slope. The economic impact to West Slope communities and real estate values were also mentioned as a concern during scoping.

3.22.2.2 Method for Effects Analysis

Regional Input-output Modeling System (RIMS II) multipliers were used to estimate secondary effects to regional earnings and employment as a result of construction, operation, and maintenance of the alternatives. RIMS II multipliers are commonly used to estimate the total regional effects on industrial output, earnings, and employment for any county or group of contiguous counties resulting from any industry activity.[3] Expected employment needs and direct employment costs were based on preliminary project design and cost estimates (Boyle 2005b).

Calculations of regional economic effects including output, earnings, and employment assume that certain percentages of construction, operation, and maintenance spending would occur within the region that each reservoir site is located. The three RIMS II data regions relevant to the study area include the "Scenic and Resort Region" (Jasper East Reservoir and Rockwell Reservoir sites in Grand County), "Larimer and Weld Region" (Chimney Hollow and Dry Creek reservoir sites), and the "Denver Metro Region" (Ralph Price Reservoir). For Jasper East Reservoir and Rockwell Reservoir, it is assumed that 25 percent of the total project cost would be spent locally in the Scenic and Resort Region. This is consistent with the anticipated percentage of the work force that would be hired locally (Bandy pers. comm. 2005) and the fact that the regional economy is not highly diversified and is unlikely to include all of the necessary construction inputs necessary to construct a reservoir. For Chimney Hollow Reservoir and Dry Creek Reservoir, it is assumed that 50 percent of the total project cost would be spent in the local region. It is expected that a substantial portion of the construction inputs would need to be brought in from the Denver Metro Region or other surrounding regions. For expansion of Ralph Price Reservoir, it was assumed that 100 percent of the project spending would occur within the Denver Metro Region. Economic output from construction-related spending outside of the local study areas also would generate economic benefits to those locations. Construction costs are in 2003 dollars.

Potential economic effects to recreation associated with changes in rafting and kayaking opportunities as a result of different hydrologic conditions on the Colorado River were based on the estimated changes in the number of days preferred flows would occur, as described in the Recreation Section 3.19. Available data on commercial boating use and user permits from the BLM provided estimates of annual boating and recreation use in the Big Gore Canyon and Pumphouse reaches of the Colorado River downstream from Kremmling. No detailed records on visitor use are available, but the BLM provided estimates on the location and season of use.

The analysis of effects to boating was based on changes in the number of days that streamflow fell within preferred flow ranges for rafting and kayaking in the Colorado River. The following flow ranges for the three river segments evaluated were:

- Byers Canyon: >400cfs

[3] Industrial output is a measure of the economic activity created by spending associated with a project. Earnings (sometimes referred to as wages and salaries) are a subset of total economic output. More specifically, earnings refer to a measure, expressed in millions of dollars, of the change in the value of earnings that are received by households from the production of regional goods and services. Employment is expressed as full-time person years of employment.

- Big Gore Canyon: 850 to 1,250 cfs for kayaking and rafting
- Pumphouse: 1,200 to 2,200 cfs for kayaking and 2,000 to 3,000 cfs for rafting

These flow ranges represent preferred flows; however, boaters currently use the river at flows as low as 400 cfs, with the exception of commercial rafting in Big Gore Canyon, which only occurs at flows between 850 and 1,250 cfs. The economic analysis provides somewhat of a worst-case scenario because all changes in the number of days outside of the preferred range were considered a loss in visitor days and the associated recreation value. Boating would likely continue, as it currently does, outside of the preferred flow ranges as long as minimum boating flows are available, but there could be a decrease in the quality of the experience for some boaters.

Daily hydrology data for the 47-year hydrologic period of record (1950 to 1996) were used for the evaluation of changes in the number of days with preferred boating and kayaking flows during the summer boating season from June to August. Daily data indicated the number of days when flows fell within a preferred boating range, the frequency of changes in preferred boating flows, and the maximum range of change in the number of days in a year that preferred flows for boating would occur compared to existing conditions.

Recreation economic impacts were based on the unit-day approximation of willingness to pay. This valuation is common for this type of analysis and can be applied to the limited existing data. Under this approach, the value of the recreation impact is the unit-day value, expressed in terms of dollars per visitor day, multiplied by the estimated gain or loss in visitors. Baseline unit-day values used in the analysis were derived from Loomis (2005). The Loomis unit-day value for nonmotorized boating was escalated to 2007 dollars using the Consumer Price Index and rounded up to $73. The dollars per visitor day are assumed to apply equally to all boating locations and for both private and commercial boating. The unit-day value of $37 for camping from the Loomis study was escalated to 2007 dollars and used to estimate impacts from potential changes in camping. All of the direct recreational value would not accrue to Grand County because not all of the expenditures would occur there.

There may be other indirect costs or benefits associated with recreation that accrue to Grand County or other locations. Indirect economic impacts associated with commercial rafting have been estimated by the Colorado River Outfitters Association to be about 1.56 times direct expenditures for all commercial boating in the state (CROA 2008). The secondary impacts associated with changes in recreation expenditures were not explicitly quantified for this analysis because accurate estimates of the percentage of those expenditures in the study area were not available. For simplicity, this analysis assumes that using the full direct economic impact as accruing to the study area encompasses both the direct and indirect impacts that might occur within the study area. Also, because the analysis conservatively assumes a total loss of boating user days when preferred flows are not met, no additional estimates of indirect economic impacts were made.

Environmental justice was based on the potential for disproportionate impacts to minority or low-income populations from implementation of any alternative.

The water delivered from Grand Lake through Reclamation hydropower facilities from increased Windy Gap diversions would generate additional power under all of the alternatives. Estimates of the net change in power generation were based on hydrologic data and estimates of what similar amounts of energy would cost.

3.22.2.3 Socioeconomic Effects Common to All Alternatives

Community Services

Construction of reservoirs and associated facilities for any alternative would result in a slight increase in the demand for community services during the construction period. Communities near the reservoir sites are unlikely to experience a substantial increase in the need for police, fire, medical, education, or other community services. Existing community services in Loveland, Berthoud, and Larimer County should be sufficient to serve the temporary increase in workforce associated with construction of Chimney Hollow Reservoir or Dry Creek Reservoir. Granby and other surrounding Grand County communities should also have the capacity to meet community service needs during construction of Jasper East or Rockwell reservoirs.

Property Values

Construction of alternative reservoirs is unlikely to adversely affect adjacent property values over the long term and may increase values if recreation is developed. A temporary reduction in property values is possible where residents near the reservoir sites are affected by noise, traffic, and disturbances during construction.

Colorado River Water Use and Quality

The WGFP would be subject to downstream senior water rights that have the ability to place a call on the river if flows are not sufficient; therefore, there would be no economic effect to senior water right holders. The WGFP would not reduce Colorado River streamflow downstream of Windy Gap Reservoir below the 90 cfs minimum instream flow and would have no effect on flows when natural conditions or actions by others reduce flows below 90 cfs. Municipal and agricultural diversions downstream from Windy Gap Reservoir, per Colorado water law (C.R.S. § 37-92-102(2)(b)), would remain responsible for developing a reasonable means of diversion for their water. Streamflows below Windy Gap Reservoir, at or below the minimum flow, have occurred historically without Windy Gap diversions; however, the WGFP would slightly increase the frequency of flows at 90 cfs. The Municipal Subdistrict paid $500,000 to upgrade diversion structures for ranches on the Colorado River below Windy Gap Reservoir as part of the original construction of Windy Gap Reservoir.

None of the WGFP alternatives are projected to result in the exceedance of water quality standards that would affect municipal water diversions or discharges. The Municipal Subdistrict paid the Town of Hot Sulphur Springs $150,000 for assistance in improving its water treatment facility and $270,000 for improving its WWTP as mitigation for the original Windy Gap Project, which was intended to divert more water than the proposed WGFP.

Environmental Justice

Executive Order 12898 established a goal of environmental justice to ensure that minority and low-income populations are not disproportionately affected by adverse human health or environmental impacts of a federal action. Environmental justice embraces two principles: (1) fair treatment of all people regardless of race, color, nation of origin, or income and (2) meaningful involvement of people in communities potentially affected by program actions.

None of the alternatives would disproportionately affect minority or low-income populations. Reservoir sites are located primarily in rural areas with low population density and although small numbers of minority or low-income populations are present within broader Census Tract and Block Groups in the respective counties (Census 2000b), reservoir construction would not disproportionately affect local minority or low-income residents. Temporary construction jobs may provide employment opportunities for minority and low-income populations within the local regions. These employment opportunities would provide wages that are higher than many local service jobs.

Hydropower Energy Production

The additional water delivered from Grand Lake through Reclamation C-BT hydropower facilities would generate additional power under all alternatives as discussed in Section 3.5.1.6. Table 3-137 indicates the net increase in energy that would be generated considering the additional power generated at Marys Lake, Estes, Pole Hill, Flatiron, and the Big Thompson Power Plants less the additional energy costs for pumping water at the Willow Creek Pump Canal, Granby Pump Canal, and Flatiron No. 3. The estimated value of the additional energy generation was based on the power production costs for an equivalent amount of energy generated from a coal power plant in 2015 adjusted to 2005 dollars, which would be about $56 per megawatt hour or $56,000 per gigawatt hour (GWH) (Energy Information Administration 2007). The retail value of generated energy would have a higher value.

Table 3-137. Net increase in energy generation and production value over existing conditions.

Alternative	Energy Generation (GWH)	Production Value
Alt 1 – No Action	18.95	$1,062,500
Alt 2 – Proposed Action	26.03	$1,459,500
Alt 3	25.79	$1,446,000
Alt 4	25.83	$1,448,300
Alt 5	29.57	$1,658,000

Western anticipated greater hydropower generation following construction of the Windy Gap Project based on the original diversion projections. Western entered into agreements to provide energy based on those original projections; however, because diversions were less than anticipated and hydropower generation was less than projected, Western has had to purchase replacement power to meet commitments. The replacement power that Western purchased is generally from coal fired power plants. If Windy Gap diversions increase as a result of the WGFP, Western would be able to reduce its purchase of replacement power from coal fired power plants.

The Municipal Subdistrict would be responsible for the power costs associated with pumping additional water from Windy Gap Reservoir to Granby Reservoir. These costs vary with the amount of pumping and other factors, but average about $25 per AF. Based on average year diversions of 43,573 AF under the No Action alternative, energy costs for pumping to Granby Reservoir would be about $1.09 million. Energy costs for the action alternatives would range from about $1.15 million for the Proposed Action to $1.21 million for Alternative 5. The Municipal Subdistrict is also responsible for paying Reclamation for the pumping costs associated with the delivery of Windy Gap water from Granby Reservoir to Shadow Mountain Reservoir/Grand Lake and from Flatiron Reservoir to Carter Lake. The repayment is only for water delivered through the Adams Tunnel and is based on the pump energy charges for the Farr Pumping Plant and Flatiron Pumping Plant.

Project Financing and Water Rates

Municipal and water district water rates and water rate structures are established to recover expenses such as annual operating and maintenance expenditures associated with water delivery and treatment, projected debt service, and capital improvements. Most WGFP Participants use inclining block rate pricing, where water rates increase as consumption increases. Other Participants have found that a uniform water rate adequately covers the expenses of providing water to their customers and use other measures and programs to encourage water conservation.

Each Participant has planned for the purchase of WGFP storage. Some Participants, such as Longmont, Greeley, Lafayette, and Louisville, have already set aside funding for the purchase of WGFP storage. Other Participants, such as Broomfield, have set aside at least a portion of the necessary funding for the project and plan to acquire any additional needed funds through development fees or bonding measures. Still others, such as Erie, Fort Lupton, and Evans, are financing the purchase of the Windy Gap water rights and/or storage through a combination of development fees including tap fees and bonding measures. A breakdown of the anticipated funding mechanisms and cost allocation for each Participant in the WGFP is shown in Table 3-138 based on the cost of the Proposed Action. The percent allocation would be the same for any of the action alternatives. Longmont would solely fund the enlargement of Ralph Price Reservoir under the No Action Alternative. All Participants would continue to monitor and adjust water rates as necessary to meet the ongoing costs associated with the development, treatment, and delivery of water to their respective service areas.

3.22.2.4 Economic Effects to Recreation that are Similar for all Alternatives

All of the alternatives would result in similar types of effects to recreation on the Colorado River and at Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir from changes in hydrologic conditions. Potential effects to the recreation economy include changes in recreational boating, fishing opportunities, and other related land-based activities such as camping and sightseeing.

Table 3-138. Participant funding and financial contribution to the WGFP.

Participant	Expected Contribution to WGFP[1]	Percent of Total Cost	Cash Financing	Cash and Debt Financing	All Debt Financing
Broomfield	$61,000,000	28%		X	
Erie	$15,000,000	7%			X
Evans	$4,000,000	2%			X
Fort Lupton	$2,000,000	1%			X
Greeley	$18,000,000	8%	X		
Lafayette	$4,000,000	2%	X		
Longmont	$32,000,000	15%	X		
Louisville	$7,000,000	3%	X		
Loveland	$15,000,000	7%	X		
Superior	$11,000,000	5%		X	
LTWD	$11,000,000	5%			X
CWCWD	$1,000,000	<1%	X		
Platte River	$32,000,000	14%	X		
MPWCD1	$7,000,000	3%	n/a	n/a	n/a

[1]Cost allocation based on percent of total requested storage volume for Proposed Action (Chimney Hollow Reservoir) rounded to the nearest million.

Colorado River Boating

The potential effects to rafting and kayaking on the Colorado River for three sections of the Colorado River — Byers Canyon downstream of Hot Sulphur Springs, Big Gore Canyon, and the Pumphouse downstream of Big Gore Canyon discussed in the Recreation (Section 3.19), were evaluated to determine potential effects to the recreation economy.

Byers Canyon. Byers Canyon provides Class IV to V whitewater kayaking at streamflows above 400 cfs. This reach of the river is not a popular boating destination and is used infrequently by private boaters. No commercial boating occurs in this reach. No statistics are available on boater use, but currently about 15 boaters per year are estimated to use this reach of the river (Crosby, pers. comm. 2008). Flows sufficient for kayaking under existing conditions are available primarily in June and July.

Daily flow data indicate that in June and July there would be no change in the number of days that flow exceeds 400 cfs in 29 years of the 47-year period of record. In years when there is a change in flow, there would be an average decrease of 8 kayaking days per year under the No Action alternative and about 12 fewer kayaking days per year for the action alternatives. The greatest decrease in boating days in a single year would be 34 days under the No Action alternative and 49 days under the Proposed Action and other alternatives. Assuming the maximum loss of 49 boating days would eliminate all kayaking activity in the year with the lowest available flow, this would represent a loss of about 15 user days with a per unit day value of about $73 or about $1,095.

Gore Canyon. Big Gore Canyon provides Class V whitewater used by commercial rafting companies at flows from 850 to 1,250 cfs and for kayakers at flows from 400 cfs to about 2,200 cfs. Preferred kayaking flows are around 1,100 to 2,200 cfs. August is the primary month for boating in Big Gore Canyon and the Gore Race is typically held the third week of the month.

The net economic effect from the estimated loss of about 3 boating days on average per year during 10 years out of the 47-year study period under the No Action alternative would be a loss of about 117 visitor days with an annual value of about $8,541. For the Proposed Action and other alternatives, there would be a loss of about 4 boating days per year during 15 years out of the 47-year study period on average, or a loss of 156 visitor days with a value of $11,388. A maximum loss of 11 boating days in a single year under each alternative would result in a loss of 429 visitor days with a value of $31,317. A beneficial effect from 1 additional day in some years would provide 39 additional visitor days with a value of $2,847 under the action alternatives. There would be no economic effect to the annual Gore Race in August because the WGFP would curtail diversions during the race if flows at the Kremmling gage fall below 2,200 cfs.

Pumphouse. The reach of the Colorado River between the Pumphouse and State Bridge provides generally flat water with Class II and III rapids. Rafters in this reach of the river prefer flows from 2,000 to 3,000 cfs, but will boat at flows from 400 to 3,000 cfs. Kayakers prefer flows of around 1,100 cfs, but will also boat at flows to 400 cfs.

The net economic effect from the loss of 1 day per year of preferred kayaking flows during 15 years out the 47-year study period when flow changes affect kayaking under all of the alternatives would be a loss of about 225 visitor days with an annual value of about $16,425. A maximum loss of 15 kayaking days in a single year under all of the alternatives would result in a loss of 3,375 visitor days with a value of $246,375. Beneficial effects from 6 to 10 additional days in some years for the alternatives would provide 1,350 to 2,250 additional visitor days with a value of $98,550 to $164,250. The net increase of 1 kayaking day over the 47-year study period under the No Action alternative, and a net decrease of 4 kayaking days over 47 years for the Proposed Action would result in a minor long-term economic effect. Similar small changes in the total number of preferred kayaking days would occur for Alternatives 3, 4, and 5.

The net economic effect from the loss of 1 rafting day on average per year during the 19 years out of the 47-year study period when flow changes affect rafting under all of the alternatives would be a loss of about 225 visitor days with an annual value of about $16,425. A maximum loss of 17 rafting days in a single year under the Proposed Action and Alternatives 3 and 4 would result in a loss of 3,825 visitor days with a value of $279,225. Beneficial effects from 3 to 11 additional days in some years for the alternatives would provide 675 to 2,475 additional visitor days with a value of $49,275 to $180,675.

Comparison of Effects to Boating. To provide a common basis for comparing the economic effects to boating on the Colorado River, the change in the number of boating days over the 47-year study period were used to annualize gains or losses in boating recreational values (Table 3-139). The average cost per year for reduced boating opportunities in Byers Canyon would be $416 for each of the alternatives. A reduction in the number of rafting and kayaking days in Big Gore Canyon would result in an average annual loss in recreation value ranging from $1,151 for Alternative 4 to $1,651 for Alternative 5. In the Pumphouse reach, the No Action alternative would result in a slight increase in average annual recreation value for kayaking and rafting, while other alternatives would result in an average annual loss in value of about $2,100 for Alternative 5 to about $10,500 for Alternative 4. As previously stated, this analysis assumes a complete loss of boating days when flows fall outside of preferred ranges; however, the range of flows acceptable for boating would not change

Table 3-139. Annualized cost or benefit to recreational boating on the Colorado River by alternative.

Alternative	Byers Canyon (kayaking)	Big Gore Canyon (rafting and kayaking)	Pumphouse	
			Kayaking	Rafting
No Action	-$416	-$1,458	+$349	+$2,097
Proposed Action	-$416	-$1,393	-$1,397	-$6,989
Alt 3	-$416	-$1,393	-$1,397	-$7,339
Alt 4	-$416	-$1,151	-$1,048	-$9,437
Alt 5	-$416	-$1,635	-$349	-$1,747

substantially from existing conditions, and actual economic effects are likely to be less.

Colorado River Camping

It is possible that camping, sightseeing, and other recreation use in the Pumphouse and Radium areas would also change as a result of changes in streamflow. Assuming that nonboating recreation changes in a pattern similar to that of rafting, then an average decrease of 1 day of rafting would result in the loss of about 10 nonboating visitor days with an economic value of about $370. This loss would occur in 28 years of the 47-year study period. A maximum annual loss of nonboating recreation from 17 fewer rafting days under the Proposed Action and Alternatives 3 and 4 would translate to a loss of 170 nonboating user days with a value of $6,290. The estimated increase in nonboating recreation would range from 30 to 110 visitor days with a value of $1,100 to $4,070 when streamflow changes increase rafting opportunities.

Colorado River Angling

Angling opportunities along the Colorado River are an important component of the local economy. Fishing occurs on BLM lands, State Wildlife Areas, and on private lands and resorts. Projected changes in streamflow on the Colorado River below Granby Reservoir under all of the alternatives would result in a loss of fish habitat (Miller 2008). An increase in water temperature also would occur below the Windy Gap Reservoir diversion under some conditions. The anticipated reduced flows, which are greatest during the high runoff period, are not expected to adversely impact fish populations or fishing opportunities. High stream flushing flows sufficient for channel and fish habitat maintenance and sediment transport would still occur (ERO and Boyle 2007). No Windy Gap diversions would occur when flows reach the minimum streamflow requirement under all of the alternatives. Projected effects to fish habitat are not predicted to translate to loss in angling opportunities or fishing success. No flow preferences for angling are available for the Colorado River, but fly fisherman typically like lower to moderate flows for wading (Smith and Hill 2000). Windy Gap diversions during high flow periods could increase the suitability for wading. Lower flows in some months could diminish the aesthetic value of the river for some visitors and possibly affect the quality of the recreation experience. The WGFP would not increase the potential for production or distribution of whirling disease, which affects rainbow trout populations throughout the Colorado River and numerous locations throughout the State (Miller 2008). No measurable effect to angler user days on the Colorado River or associated economic effects were identified for any of the alternatives.

Three Lakes Recreation

No changes in surface water elevation at Grand Lake and Shadow Mountain Reservoir would occur under any of the alternatives because, as part of the C-BT Project, Reclamation limits reservoir fluctuations to no more than 1 foot from the top of the conservation pool. No change in water quality parameters that exceed water quality standards for recreation use would occur. Reduced water clarity and algal growth has been an issue of concern in Grand Lake and Shadow Mountain Reservoir, which may contribute to a diminished recreation experience. Predicted small reductions in water clarity would continue or slightly increase the potential for a diminished recreation experience under all of the alternatives. It is unknown whether these water clarity issues would translate to a loss in visitors and associated economic effects. Aquatic weeds in Shadow Mountain Reservoir are also an issue that Reclamation, the NCWCD, and numerous entities from Grand County are cooperating in an attempt to address. None of the alternatives are anticipated to result in changes to the conditions that contribute to the aquatic weed problem and, therefore, the WGFP is unlikely to exacerbate the problem (AMEC 2008a).

There also have been concerns related to algal toxins in Grand Lake including an advisory issued in the summer of 2007 related to use of the lake for drinking water. Microtoxin levels did not exceed concern levels, but ongoing monitoring and accurate analysis would help determine if production of toxins is a problem. Chronic toxin levels could have an economic effect, but there is currently not enough information to determine that this would occur.

Projected relatively small reductions in boatable area for Granby Reservoir in most years are unlikely to noticeably affect recreation use of the reservoir or the quality of the recreation experience under any of the alternatives. Additional exposed shoreline at lower water levels could reduce the aesthetic value and affect the quality of the visitor experience. During a sequence of dry years, there would be reduced access to boat ramps under all of the alternatives, which may reduce the number of visitors and quality of the recreation experience at Granby Reservoir. Camping, hiking, and shoreline activities could decrease during periods of low water levels, when boat ramp access declines, or from a perceived decrease in aesthetic values. Visitor user days have historically declined during dry or drought years, although this may be due to factors other than water levels, including campfire restrictions or weather (Orr 2008). Sufficient information is unavailable to determine if lower Granby Reservoir water levels would directly affect visitor use.

Predicted minor changes in the physical and water quality conditions for aquatic life in Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir is unlikely to affect the fish communities in Grand Lake and Shadow Mountain Reservoir (AMEC 2008a; Miller 2008). Thus, there would be no effect to recreational fishing opportunities at the Three Lakes for any of the alternatives.

Carter Lake and Horsetooth Reservoir Recreation

The small projected changes in Carter Lake water surface area under all of the alternatives would unlikely adversely affect visitor numbers or recreation activities. Larger reductions in surface area after several consecutive dry years, particularly under the Proposed Action, could diminish the overall quality of the user experience by potentially reducing the overall aesthetics of the experience. No measurable economic impact to local economies is likely from predicted changes in reservoir storage.

Projected changes in Horsetooth Reservoir water elevations are unlikely to substantially affect recreation activities under any of the alternatives. A reduction in lake surface area, particularly under the Proposed Action, could diminish the overall quality of the user experience by potentially reducing the overall aesthetics of the experience. A larger decline in lake levels after several consecutive dry years, primarily under the Proposed Action, would impact access to boat ramps, reduce boating capacity, and diminish the quality of the recreation experience. A decrease in recreation value is possible during periods when Horsetooth Reservoir water levels are substantially lower, such as sequential dry years.

3.22.2.5 Alternative 1—Ralph Price Reservoir (No Action)

Construction Employment and Spending

The average workforce anticipated during the estimated 2 years of construction would be 50 employees with a peak employment of 100 (Boyle 2005d). A temporary localized population increase may occur during construction in nearby towns such as Lyons. Of the estimated $31 million in construction cost, about $8 million would be for direct labor (Table 3-140). Indirect labor would contribute an additional $8.7 million to regional earnings and create 69 temporary jobs. If all of the construction-related costs are expended in the Denver Metro Region, then the project would generate about $73 million in total economic output including local government (e.g., sales tax revenue) and secondary effects from spending in the region (Colorado Division of Local Government 2005). To the extent that construction spending takes place outside of the region, such as materials purchased elsewhere, these direct and secondary benefits would accrue to other regions. All population-, employment-, and income-related effects would be temporary for the construction period. Reservoir

Table 3-140. Project, direct labor, and operation and maintenance cost by alternative.

Alternative	Total Project Cost	Direct Labor	Annual O &M Cost[1]
	Millions of dollars		
Alt 1 – No Action	$31	$8	No change
Alt 2 – Proposed Action	$223	$47	$0.79
Alt 3	$240	$49	$1.37
Alt 4	$252	$52	$1.73
Alt 5	$288	$60	$2.24

[1]A detailed cost breakdown by Alternative is found in Chapter 2, Table 2-4.

operation and maintenance costs would be similar to existing conditions.

Land Use Values

There would be no direct impact to private residences or acquisition of private property needed to expand Ralph Price Reservoir. Recreation activities would be suspended during construction and there would be a loss in revenue to the City of Longmont from the sale of fishing permits for several years. Following completion of the reservoir enlargement, recreation activities would be restored.

3.22.2.6 Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Construction Employment and Spending

Construction of Chimney Hollow Reservoir would require an average workforce of about 235 during the 3- to 5-year construction period. The workforce could reach about 500 at peak construction. It is estimated that about 50 percent of the workers would commute from existing residences near Loveland, Berthoud, and other northern Front Range communities (Bandy, pers. comm. 2005). The remaining 50 percent would likely come from the Denver Metro Region. Some workers could relocate to communities near the reservoir site, but the temporary population increase would be relatively small compared with the overall population, and local housing would likely be sufficient.

Total construction costs would be about $223 million of which about $47 million would be for direct labor (Table 3-140). A portion of construction dollars would create secondary income and jobs in the region. If 50 percent of the project costs were spent in the local Larimer and Weld Region, the project would generate an estimated $292 million in total economic output and secondary economic effects from spending and about 127 additional jobs. Indirect labor would contribute an additional $20 million to local earnings in the Larimer and Weld Region. Similar direct and secondary economic output would occur in the Denver Metro Region or other locations from employment and spending.

Annual operation and maintenance of the reservoir and conveyance facilities would cost about $795,000 annually and would require four employees. Ongoing operations would produce a small positive economic effect over the life of the project.

Land Use Values

The Subdistrict owns the majority of the Chimney Hollow Reservoir site, but would need to purchase small areas of private land and/or acquire easements or leases. There would be no loss in agricultural production or impact to private residences from construction of Chimney Hollow Reservoir.

Larimer County anticipates expenditures of about $1 million for the development of recreation facilities at the Chimney Hollow Reservoir and adjacent county open space. Annual management costs for staff, facility and trail maintenance, weed control, patrol, vehicles, and administration are estimated to be about $265,000 (Flenniken pers. comm. 2006). Projected annual visitation of 50,000 could result in an increase in revenues to local businesses associated with recreational visitor expenditures.

3.22.2.7 Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Construction Employment and Spending

Construction of two reservoirs under Alternative 3 would require an average workforce of about 190 at Chimney Hollow Reservoir and about 65 for Jasper East Reservoir during the 2.5- to 5-year construction period. The combined peak labor needs for both reservoirs could reach about 570. Construction activities would have a temporary beneficial effect to local employment and income in nearby towns including Loveland and Berthoud for Chimney Hollow Reservoir and Granby, Hot Sulphur Springs, Kremmling, Fraser, and Grand Lake for Jasper East Reservoir. Similar to Alternative 2, about half the workers for Chimney Hollow Reservoir would come from local communities and the rest from other locations including the Denver Metro Region. At the Jasper East Reservoir, it is estimated that about 25 percent of the workers would be drawn from local Grand County communities and another 25 percent from the Denver Metro Region. The remainder of workers would likely come from other locations in the state. Housing needs on the West Slope for construction workers could likely be met with the existing supply, particularly during the nonwinter season when rental and hotel occupancy is lower. Sufficient local housing and community services should be available to meet the need during construction of Chimney Hollow Reservoir.

Construction of Chimney Hollow Reservoir is estimated to cost about $180 million and Jasper East Reservoir about $60 million for a combined cost of $240 million (Table 3-140). Direct labor costs for both reservoirs would be about $49 million. Indirect labor would create about 102 additional jobs and contribute about $16 million in addition to direct earnings to the Larimer and Weld Region and would create about 30 additional jobs and generate about $2 million to the Grand County area. Total economic output, earnings, and expenditures from construction of Chimney Hollow Reservoir would generate $236 million locally in the Larimer and Weld Region with a similar amount possible in the Denver Metro Region or other locations. Construction of Jasper East Reservoir would generate a total economic output of about $35 million in the Grand County area.

Annual operation and maintenance costs for Chimney Hollow Reservoir would be about $795,000 annually and require four employees. Jasper East Reservoir would cost $417,000 annually to maintain and operate plus $162,000 in energy costs to pump water to Granby Reservoir. Two employees would be needed to operate and maintain Jasper East Reservoir.

Land Use Values

Effects to land use values for a 70,000 AF Chimney Hollow Reservoir would be the same as described for Alternative 2.

Construction of Jasper East Reservoir would result in a loss of grazing land and a decrease in agricultural output. The value of lost income for livestock production would be about $27,000 in gross profit per year. NCWCD would forego lease revenue associated with the site and state and local governments would experience a small loss in tax revenue associated with reduced agricultural activity. A beneficial effect to nearby private property is possible if recreation is developed at Jasper East Reservoir.

3.22.2.8 Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Construction Employment and Spending

Construction employment, income, and spending for Chimney Hollow Reservoir would be the same as described for Alternative 3.

Construction of Rockwell Reservoir would require an average workforce of about 76 and a peak workforce of about 150. Similar to the discussion on Jasper East Reservoir, about 25 percent of the employment is expected to come from the Grand County area, 25 percent from the Denver Metro Region, and the remainder from other regional locations. A slight increase in local population in Grand County is likely during construction, but would be relatively small and within the capacity of local lodging.

Construction related spending for Rockwell Reservoir would generate about $41 million in total direct and indirect local economic output for Grand County. Direct labor costs of $4 million in Grand County would generate an additional $3 million in indirect earnings and create about 30 new jobs. Total economic output, earnings, and expenditures from construction of Rockwell Reservoir would generate $41 million locally in Grand County. Construction-related employment and spending would last from 2.5 to 5 years.

Annual Rockwell Reservoir operation and maintenance costs would be about $728,000 and require two employees. An additional power generation cost of $207,000 annually would be needed for pumping water to Granby Reservoir.

Land Use Values

Effects to land use values for a 70,000 AF Chimney Hollow Reservoir would be the same as described for Alternative 2.

Construction of Rockwell Reservoir would require the purchase of four private residences and the land for the reservoir. Additional easements would be needed for the pipeline to Windy Gap Reservoir. The Subdistrict would have to pay just compensation for these properties. Property owners near the new reservoir could benefit if recreational amenities are developed. Local communities and businesses could also benefit from recreation-related expenditures at a new reservoir.

3.22.2.9 Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Construction Employment and Spending

The construction of Dry Creek and Rockwell reservoirs would require an average workforce of about 210 at Dry Creek Reservoir and 92 at Rockwell Reservoir over the 2.5- to 4.5-year construction period. During peak construction, the combined workforce could reach 657. It is estimated that about 50 percent of the construction workforce for Dry Creek Reservoir would come from nearby local communities near Loveland and Berthoud and that the remaining 50 percent would come from other areas, including the Denver Metro Region. The workforce for Rockwell Reservoir is expected to come from local communities in Grand County (25 percent), the Denver Metro Region (25 percent), and the rest from other locations. Some workers could move into the communities for the duration of construction.

Construction costs for Dry Creek Reservoir are estimated at $180 million including $42 million in direct labor cost. Indirect labor would generate about $17 million in earnings to the Larimer and Weld Region and 112 secondary jobs. Total economic output for the Larimer and Weld Region would be about $236 million, with a similar amount generated for locations outside of the local region.

Construction of a 30,000 AF Rockwell Reservoir would cost $88 million (2003 dollars). This would generate about $18 million in direct labor costs with about $5 million in the Grand County area. Indirect labor would contribute another $3 million to the Grand County area and 42 jobs. Total economic output related to the construction of Rockwell Reservoir would be in the order of $51 million in the Grand County area.

Land Use Values

Effects to land use values for a 30,000 AF Rockwell Reservoir would be the same as described for Alternative 4.

Construction of Dry Creek Reservoir would displace the Rancho Lobo y Mariposa Llama Ranch and the associated economic value of this business. The loss of this relatively small operation would not have a substantial effect on the overall agricultural activity in Larimer County, but would adversely impact a small business. In addition, reservoir construction would require acquisition of three private residences and purchase of private land and a section of state land. The revenues associated with lease of the state land for a moss rock collection and the economic value for a landscape rock business would be lost. The Subdistrict would have to negotiate just compensation for acquisition of these properties.

3.22.3 Cumulative Effects

Cumulative socioeconomic effects were evaluated for both water-based and land-based reasonably foreseeable actions. Water-based reasonably foreseeable actions are located on the West Slope and land-based reasonably foreseeable actions occur near potential reservoir sites on both the East Slope and West Slope. Potential cumulative socioeconomic effects include the overlapping effects that might occur to population, employment, income, land use values, and community services from the combination of the WGFP alternative actions with reasonably foreseeable future actions. The additional net hydropower production and value was calculated the same as direct effects using cumulative effects hydrology.

3.22.3.1 Hydropower Energy Production

The additional net energy production and estimated value compared to existing conditions for each alternative is shown in Table 3-141. Energy production would be lower than under direct effects because less water Windy Gap water would be delivered to the East Slope.

Western’s plan to rebuild the transmission line from the Granby Pumping Plant to the Windy Gap Substation would improve the reliability and quality of electric service to the region. The existing transmission line and associated infrastructure currently serving the Windy Gap pumping plant is adequate to meet current and future needs if the WGFP is implemented. The rebuilt transmission line could improve reliability for Windy Gap pumping, but is not necessary for continued operation of the existing pumps. The Municipal Subdistrict would pay a portion of the costs

Table 3-141. Net increase in energy generation and production value over existing conditions—cumulative effects.

Alternative	Energy Generation (GWH)	Production Value
Alt 1 – No Action	15.16	$850,000
Alt 2 – Proposed Action	21.42	$1,201,000
Alt 3	20.94	$1,174,100
Alt 4	20.99	$1,176,900
Alt 5	24.69	$1,384,400

associated with the line upgrade per existing agreements with Western and Reclamation. Implementation of the WGFP would not result in additional costs to Grand County for transmission line improvements.

3.22.3.2 Water-Based Reasonably Foreseeable Actions

The Moffat Collection System Project (MCSP), future population growth and increased water use in Grand and Summit counties, and other expected changes in water use would result in additional water diversions out of the Fraser River and Colorado River or changes in flow. None of the reasonably foreseeable future changes in water use on the West Slope involve new infrastructure that would add to the potential employment or expenditures if a West Slope reservoir is built under Alternative 3, 4, or 5. Construction of MCSP water storage facilities on the East Slope would contribute additional short-term employment and income effects and add to the total economic output from implementation of any of the WGFP alternatives. Both projects would have a positive short-term employment and income effects that would occur in the Denver Metro Region.

The exercise of water rights by Denver Water for the MCSP, Grand and Summit counties water providers, and those for the WGFP are subject to the state's priority system for allocation of water rights. Additional water diversions are subject to any senior agricultural water rights in the Colorado River basin and thus the exercise of these rights would have no cumulative effect to existing agricultural production or farm income in Grand County. The expiration of the Big Lake Ditch contract in 2013 would reduce irrigated agriculture in the Reeder Creek drainage. The loss of irrigated lands with construction of Jasper East Reservoir in Alternative 3 would result in a small adverse cumulative impact to the agriculture economy in Grand County.

Reasonably foreseeable water-based actions in addition to diversions for the WGFP would reduce or change flows in the Colorado River. As discussed in the *Aquatic Resource* and *Recreation* sections (Sections 3.9 and 3.19), no adverse impact to boating or fishing in the Colorado River that would impact the tourism-related expenditures is likely for any alternative. Reasonably foreseeable water-based actions would not directly impact water storage or recreation at Granby Reservoir, Grand Lake, Shadow Mountain Reservoir, and Willow Creek Reservoir.

3.22.3.3 Land-Based Reasonably Foreseeable Actions

Potential future land-based developments near alternative reservoir sites primarily include new residential and commercial developments. Larimer County is planning for future management of open space lands adjacent to Chimney Hollow Reservoir. In addition, a general trend in population growth and development in the northern Front Range counties where WGFP Participants are located is expected.

New residential developments near alternative reservoir sites would result in an increased population, along with temporary increases in employment and income during home construction. New commercial developments would result in a long-term increase in employment and income. The relatively short-term economic effects associated with construction of any of the alternative reservoirs in addition to the effects associated with new land developments would have minimal cumulative effects to population, employment, and income in the counties where alternatives are located. Property values near new reservoirs may be enhanced if recreation is developed.

The planned future development of open space facilities by Larimer County adjacent to Chimney Hollow Reservoir would provide employment during construction of recreation facilities and long-term employment for Larimer County Parks and Open Lands staff. There would also be a cumulative increase in recreation opportunities in Larimer County under Alternatives 2, 3, and 4. Open space lands would not directly generate revenue because there would no entrance fee; however, local business could benefit from recreation user expenditures.

Construction of Jasper East Reservoir would result in loss of hay production, and some grazing land would be lost at the Rockwell Reservoir site. Planned future development of the C-Lazy-U Preserve near Jasper East Reservoir and other residential or commercial developments would result in an incremental cumulative loss in agricultural production and farm income in Grand County under Alternatives 3, 4, and 5. This would be a relatively minor component of county-wide farm income.

Like many other Front Range counties where WGFP Participants are located, Boulder, Broomfield, Larimer, and Weld counties have experienced significant population growth during the last decade. The populations of these counties are expected to continue to grow through 2030 with or without construction of any one of the alternatives. Implementation of any of the WGFP alternatives would allow Participants to meet anticipated water needs that support local economies.

3.22.3.4 Economic Effects to Recreation that are Similar for all Alternatives

All of the alternatives would result in similar effects to recreation on the Colorado River and at Grand Lake, Shadow Mountain Reservoir, Granby Reservoir, Carter Lake, and Horsetooth Reservoir from changes in hydrologic conditions and water quality. Potential economic effects to changes in recreation from implementation of water-based reasonably foreseeable actions along with the WGFP are described below.

Colorado River Boating

Byers Canyon. An estimated maximum loss of 56 boating days would eliminate all kayaking activity in the year with the lowest flow, which would represent a loss of about 15 user days (based on the existing level of use) with a value of about $1,095. The loss would be similar for all alternatives.

Gore Canyon. The economic effect from the loss of about 2 boating days on average per year during 34 years of the 47-year study period, under each of the alternatives, would be about 78 visitor days with an annual value of about $5,694. A maximum loss of 23 boating days in a single year under the No Action alternative would result in a loss of 897 visitor days with a value of $65,481. Under the Proposed Action and other alternatives, a maximum loss of 31 days would result the loss of all 1,200 boating visitors with an impact of $87,600. If flow levels are insufficient to support the Big Gore Race in late August, there would be additional direct and secondary economic effects associated with impacts to this event. The WGFP under all of the alternatives would rarely divert water in August except in wet years and would curtail diversions during the Big Gore Race if flows at the Kremmling gage are less than 2,200 cfs, thus, there would be no effect on the Gore Race. Beneficial effects from the additional days within the preferred flow range in some years would range from 663 additional visitor days with a value of $48,399 for the No Action alternative to 858 additional visitor days under the other alternatives with a value of $62,634.

Pumphouse. The net economic effect from an average reduction in 5 days per year with preferred flows for kayaking, which occurs in 40 years out of the 47-year study period, would be a loss of about 1,125 visitor days with an annual value of about $82,125. A maximum decrease of 56 days with preferred kayaking flows in a single year under all of the alternatives would result in a loss of 12,600 visitor days with a value of $919,800. Beneficial effects from up to 31 additional days with preferred flows in some years for the No Action and Proposed Action alternatives would provide 6,975 additional visitor days with a value of $509,175.

The net economic effect from the loss of about 9 rafting days on average per year in the 26 years out of the 47 years when flow changes occur would be a loss of about 2,025 visitor days with an annual value of about $147,825. A maximum decrease of 15 days within the preferred flow range for rafting in a single year under the No Action alternative would result in a loss of 3,375 visitor days with a value of $246,375. A maximum decrease of 14 days within the preferred flow range for rafting under the action alternatives would result in the loss of 3,150 user days with a value of $229,950. Beneficial effects from up to 31 additional days within the preferred flow range for rafting days for the No Action and the

Proposed Action alternatives would provide 6,975 additional visitor days with a value of $509,175. A gain of up to 27 days with preferred rafting flows would provide a recreational value of $443,475 for Alternatives 3, 4, and 5.

Comparison of Effects to Boating. To provide a common basis for comparing the economic effects to boating on the Colorado River, the change in the number of boating days over the 47-year study period was used to annualize gains or losses in boating recreational values. The average cost per year for reduced boating opportunities in Byers Canyon would be $416 for each of the alternatives (Table 3-142). A reduction in the number of rafting and kayaking days in Big Gore Canyon would result in an average annual loss in recreation value ranging from $2,423 for the No Action alternative to $3,756 for Alternatives 3, 4, and 5. In the Pumphouse reach, all of the alternatives would result in a decrease in average annual recreation value for kayaking and rafting of about $70,000. As previously stated, this analysis assumes a complete loss of boating days when flows fall outside of preferred ranges; however, the range of acceptable boating flows would be similar to existing conditions; therefore, the actual economic effects would likely be less.

Camping and Sightseeing

It is possible that camping, sightseeing, and other recreation use in the Pumphouse and Radium areas would also change as a result of changes in streamflow. Assuming that nonboating recreation changes in a pattern similar to that of rafting, then an average decrease of 9 days of rafting would result in the loss of about 90 nonboating visitor days with an economic value of about $3,330. This loss would occur in about 21 years out of the 47-year study period. A maximum annual loss of nonboating recreation from 15 fewer rafting days under the No Action alternative would be $5,550. The camping value of the loss of 14 days for other alternatives would be $5,180. The estimated increase in nonboating recreation would range from an additional 270 visitor days under Alternatives 3, 4, and 5, to 310 visitor days under the No Action and the Proposed Action alternatives. The recreational value of these additional camping days would range from $9,990 to $11,470.

Colorado River Angling

When reasonably foreseeable water-based actions are in place, WGFP diversions would decrease, although Colorado River flows would be lower than with just the WGFP operating. Projected changes in streamflow on the Colorado River below Granby Reservoir in the future under all of the alternatives would result in a loss of fish habitat (Miller 2008). An increase in water temperature also would occur under some conditions below Windy Gap Reservoir. The anticipated reduced flows, which are greatest during the high runoff period, are not expected to adversely impact fish populations or fishing opportunities. High stream flushing flows sufficient for channel and fish habitat maintenance and sediment transport would still occur (ERO and Boyle 2007). No Windy Gap diversions would occur when flows reach minimum streamflow requirements under all of the alternatives. Projected effects to fish habitat are not predicted to translate to a loss in angling opportunities or fishing success. Lower flows in some months could diminish the aesthetic value of the river for some visitors and possibly affect the quality of the recreation experience. No measurable effect to angler user days on the Colorado River or associated economic effects were identified for any of the alternatives.

Three Lakes Recreation

The surface water elevation at Grand Lake and Shadow Mountain Reservoir would not change from existing conditions under any of the alternatives. No change in water quality parameters that exceed water

Table 3-142. Annualized cost or benefit to recreational boating on the Colorado River by alternative.

Alternative	Byers Canyon (Kayaking)	Big Gore Canyon (Rafting and Kayaking)	Pumphouse	
			Kayaking	Rafting
No Action	-$416	-$2,423	-$66,399	-$71,990
Proposed Action	-$416	-$3,392	-$72,340	-$66,399
Alt 3 – 5	-$416	-$3,756	-$69,894	-$73,039

quality standards for recreation use would occur. Predicted small reductions in water clarity would continue or slightly increase the potential for a diminished recreation experience under all of the alternatives. It is unknown whether the water clarity issues would translate to a loss in visitors and associated economic effects. Predicted minor changes in water quality and aquatic habitat in the Three Lakes would not adversely impact recreational fishing opportunities for any of the alternatives (Miller 2008).

Average monthly Granby Reservoir water surface area would be lower under all of the alternatives during the summer months. The decrease in boatable surface area is unlikely to measurably affect recreation activity in a reservoir of this size under any of the alternatives. Additional exposed shoreline at lower water levels could reduce the aesthetic value and affect the quality of the visitor experience. During a sequence of dry years, access to boat ramps would be reduced under all of the alternatives, which may reduce the number of visitors and quality of the recreational experience at Granby Reservoir. Camping, hiking, and shoreline activities could decrease during periods of low water levels, when boat ramp access declines, or from a decrease in aesthetic value. Visitor user days have historically declined during dry or drought years, although this may be due to factors other than water levels, including campfire restrictions or weather (Orr 2008). There is insufficient information to determine if lower Granby Reservoir water levels would directly affect visitor use.

Carter Lake and Horsetooth Reservoir Recreation

The small projected changes in Carter Lake water surface area under all of the alternatives is unlikely to adversely affect visitor numbers or recreation activities. Larger reductions in surface area after several consecutive dry years, particularly under the Proposed Action, could diminish the overall quality of the user experience by potentially reducing the overall aesthetics of the experience. No measurable economic impact to local economies is likely from the small predicted changes in reservoir storage.

Projected changes in Horsetooth Reservoir water elevations are unlikely to substantially affect recreation activities under any of the alternatives. A reduction in lake surface area, particularly under the Proposed Action, could diminish the overall quality of the user experience by potentially reducing the overall aesthetics of the recreation experience. A large decline in lake levels after several consecutive dry years under the Proposed Action would impact access to boat ramps, reduce boating capacity, and diminish the quality of the recreation experience. An unquantified decrease in recreation value is possible during periods when Horsetooth Reservoir water levels are low.

3.22.4 Proposed Mitigation

The Subdistrict would negotiate a fair market value for acquisition of any property or homes that would be impacted by implementation of any alternative.

The Subdistrict would curtail Colorado River diversions during the annual Big Gore Race typically held the third week in August if flows at the Kremmling gage are below 2,200 cfs to avoid any economic effects to this event.

3.22.5 Unavoidable Adverse Effects

Construction of Jasper East Reservoir under Alternative 3 would result in the loss of agricultural revenues from the current livestock operation. Construction of Rockwell Reservoir would result in the loss of four homes under Alternatives 4 and 5. If Dry Creek Reservoir is built in Alternative 5, there would be an unavoidable loss of three homes and the revenues from the llama ranch.

Reduced Colorado River streamflow could result in a loss or diminished recreation value for boating in some years under all of the alternatives. Indirect effects to recreation use or activities are possible from lower water levels at the Three Lakes Reservoirs and primarily Horsetooth Reservoir.

3.23 Relationship between Short-Term Uses of the Environment and Long-Term Productivity

Potential effects to the environment can be either short-term or long-term. Effects can be either beneficial or negative and often there is a trade-off between short-term uses and long term productivity. As described earlier in this chapter short-term effects for this project are defined as those that occur from the beginning of construction through completion of reclamation or about 5 years. Long-term effects would occur for the life of the project. The following discussion summarizes the relationship between short-term uses and long-term productivity for the proposed project.

All alternatives would result in similar types of impacts, although the location of disturbance and amount of impact would vary. All alternatives, including No Action would result in the long-term diversion of water from the Colorado River and reduced flow in Willow Creek. This would result in long-term effects to stream hydrology, morphology, water quality, aquatic habitat, and recreation as described previously for each of the resources. Additional water deliveries to the East Slope would result in a long-term increase in streamflow and water quality changes for the Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek. The No Action alternative would also result in a long-term change in flows in North St. Vrain Creek. Changes in water deliveries, storage, and water quality would have long-term consequences to the Three Lakes, Carter Lake, and Horsetooth Reservoir.

Construction of one or more new reservoirs would result in both short and long-term effects. Short-term effects during construction would be soil disturbance, vegetation clearing, wildlife habitat disturbance, as well as the noise, dust, and traffic generated by construction activities. Construction spending, employment, and socioeconomic effects would primarily be short-term effects for communities near the new reservoirs. There would be a long-term change in land use at new reservoir sites for the action alternatives. Construction of Rockwell and/or Dry Creek Reservoir would result in the long-term displacement of several residents. New land use at the Chimney Hollow Reservoir site would include recreation activities and establishment of a fishery. Other reservoir sites could have similar recreation opportunities. Enlargement of Ralph Price Reservoir under the No Action alternative would not substantially change land use, but would trade natural vegetation and wildlife habitat for additional open water. All alternatives would result in disturbance of plant and wildlife habitats that could result in the long-term reduction in biological productivity. Construction activities would result in a short-term impact to visual resources, as well as long-term effects to visual quality from vantage points near the reservoir sites. Additional water to WGFP Participant's under the Proposed Action, and to a lesser degree under the other alternatives, would provide a long-term reliable water supply to support regional communities and businesses.

3.24 Irreversible or Irretrievable Commitment of Resources

This section describes irreversible and irretrievable commitments of resources associated with implementation of the alternatives. An irreversible commitment of resources means that nonrenewable resources are consumed or destroyed; these resources are permanently lost due to project implementation. For example, fossil fuel resources used during construction would represent an irreversible commitment of resources because their use is lost for future generations.

In contrast, an irretrievable commitment of resources is the loss of resources or resource production, or use of renewable resources during project construction and during the period of time that the project is in place. Irretrievable commitments are not permanent; but are lost for a period of time. An irretrievable commitment of resources would apply to the loss of production or use of natural resources, such as plant communities disturbed during construction and not restored until construction activities are complete.

The construction or operation of the action alternatives would involve irreversible and irretrievable commitments of various resources that are either consumed, committed, or lost during the life of the project. The irreversible and irretrievable commitment of resources includes:

- Water Resources: Water diverted and evaporated or consumed under the proposed project would be irretrievably lost.
- Geology: Material excavated for use in construction of the reservoir dam would be irretrievably lost.
- Soils: Soils within the area of reservoir inundation would be irreversibly lost, while those temporarily disturbed during construction would be irretrievably committed for period of time, but

productivity would be restored following construction.

- Construction materials: Use of aggregate, steel, concrete, and fossil fuels for facilities construction would be irreversibly lost.
- Cultural Resources: Construction may cause the incidental impact to cultural resources and nonrenewable resources could be lost.
- Vegetation, Wildlife Habitat, and Wetlands: Biotic resources would be irretrievably lost from construction of dams, inundation within the reservoir. Construction of the pipelines and other temporary disturbances would be a temporary irretrievable loss of vegetation, wildlife habitat, and wetlands that would be restored following construction.
- Visual: The substantial earthwork associated with reservoir construction would result in irreversible change to the scenic character of the landscape, while shorter term disturbances that are revegetated would be an irretrievable commitment of scenic resources for the period of disturbance.

3.25 Mitigation Summary

The environmental screening criteria described in the alternative selection process in Chapter 2 were used to avoid and minimize the impacts of the proposed project. The Subdistrict has identified mitigation measures to further reduce the effects identified for the various resources evaluated in the DEIS as summarized in this section. The inclusion of these mitigation measures does not imply that all measures listed will be implemented. Several mitigation measures under consideration will require additional hydrologic and water quality modeling, as well as coordination with cooperating agencies and other entities to accurately evaluate their value and effectiveness. These additional evaluations will be conducted between release of the DEIS and preparation of the Final EIS. In addition, it is anticipated that other mitigation strategies may be identified from the comments received on the DEIS. Final mitigation measures will be included in the Final EIS and would become part of the selected alternative.

3.25.1 Water Resources

To reduce potential drawdowns in Granby Reservoir under the Proposed Action, it may be possible to modify prepositioning operations to deliver less C-BT or Windy Gap water to Chimney Hollow Reservoir during dry years. Additional hydrologic evaluations would be conducted to determine if changes in the timing of water deliveries to the East Slope can reduce impacts to Granby Reservoir while still meeting the purpose and need for the project.

3.25.2 Ground Water

Because no significant effects to ground water hydrology or quality for any alternative are expected; no mitigation is proposed for ground water aquifers in the project area.

3.25.3 Stream Morphology and Floodplains

Because no significant effects to stream morphology or floodplains for any alternative are expected; no mitigation is proposed.

3.25.4 Water Quality

A construction stormwater management plan would be developed and implemented for new facility construction under all alternatives to reduce erosion and sediment delivery to nearby streams and water bodies.

The Subdistrict will commit to continued participation and funding of the ongoing Nutrient Studies, with participation and collaboration by Reclamation, NCWCD and Grand County, to better understand water quality issues in the Three Lakes system and provide guidance for future management decisions

The Subdistrict will work with Grand County, CDOW, and others to determine if increasing bypass flows in the Colorado River from the existing minimum flow of 90 cfs to 135 cfs while Windy Gap is pumping during July and August would result in temperature reductions downstream of Windy Gap that would measurably benefit the trout fishery. If studies indicate that increased bypass flows would be effective, the Subdistrict would consider increasing required bypass flows under certain water supply conditions.

3.25.5 Aquatic Resources

The Subdistrict would coordinate with the CDOW to establish a sport fishery in Chimney Hollow Reservoir. CDOW would be responsible for the establishment and management of the fishery. Chimney Hollow Reservoir would be accessible as part of the open space managed by Larimer County.

3.25.6 Wildlife

Several mitigation measures would be used for all alternatives to reduce potential effects to wildlife resources, including:

- The area of disturbance would be minimized and all temporary disturbances would revegetated.
- Areas of sensitive wildlife habitat (i.e., wetlands and sage grouse habitat at Rockwell) outside of project disturbance limits would be protected.
- Habitat-disturbing activities (such as tree removal, grading, scraping, and grubbing) would be conducted outside of the nesting season for migratory birds (August through February) to avoid disturbing (or take) of a migratory bird nest if possible. Surveys for nesting species would be conducted prior to disturbance during the nesting season.
- Recreation facilities at new reservoirs would have a plan for disposing trash to avoid attracting wildlife or creating conflicts with human use.
- Opportunities for wildlife enhancement at reservoir sites will be coordinated with CDOW.
- Pipeline construction across the Colorado River for Rockwell Reservoir under Alternatives 4 and 5 would be coordinated with the Corps, CDOW, and FWS to minimize effects to wintering bald eagles. A late summer-early fall crossing would minimize water quality effects and effects to the eagles.
- If Rockwell Reservoir is built, disturbance to sage grouse habitat and activity near leks in the spring and summer would be minimized to the extent possible.

3.25.7 Threatened and Endangered Species

Colorado River depletions associated with any of the alternatives would require Section 7 consultation with the Fish and Wildlife Service to assure that participation in the Recovery Plan and Programmatic Biological Opinion, including payment of a one-time depletion fee to the recovery program will address depletion effect to Colorado River endangered fish species. Surveys for Osterhaut milkvetch and Penland beardtongue would be conducted if the Rockwell Reservoir site is selected to determine their presence and if mitigation is needed. Mitigation for the loss of a small amount of potential lynx habitat at Rockwell Reservoir would be determined in consultation with the FWS. An additional Preble's mouse survey would be conducted if Dry Creek Reservoir is developed to confirm their absence; if present, a mitigation plan would be developed. A Preble's meadow jumping mouse habitat evaluation would be conducted at Chimney Hollow Reservoir prior to construction.

3.25.8 Geology

Further evaluation is needed at all of the reservoir sites to determine if potential geologic hazards need to be addressed during final design. Construction of either Jasper East or Rockwell reservoirs could expose fossil mammals from the Troublesome Formation. Excavation in the sandstone formations at Chimney Hollow could uncover plant and invertebrate fossils. If significant fossils are found during construction of any reservoir site or facilities, paleontologists with the Denver Museum of Science and History would be notified.

3.25.9 Soils

A number of mitigation measures would be implemented prior to and during construction for any alternative to minimize effects to soil resources. Measures include:

- Clearly defining construction limits to minimize soil disturbance.
- Developing an erosion control plan as part of the required Stormwater NPDES permit to reduce the potential for erosion from disturbed areas or capture sediments on-site.

- Integrating the erosion control plan with the revegetation plan.
- Salvaging of suitable topsoil from areas of temporary disturbance, where possible, to aid in revegetation following construction.
- Using soil amendments or additional site preparation techniques to revegetate disturbed areas with poor topsoil suitability.

3.25.10 Air Quality

Several mitigation measures would be used to reduce air quality emissions:

- Preparing a Fugitive Particulate Emission Control Plan according to applicable local and state management practices to minimize particulate and dust emissions. Inclusion of dust palliative application and/or dust abatement as bid items if they are considered among the management practices.
- Ensuring construction equipment (especially diesel equipment) meets opacity standards for operating emissions.
- Revegetating or stabilizing disturbed areas as soon as possible to reduce dust sources.

3.25.11 Noise

Potential effects from noise and vibration would be mitigated by:

- Ensuring construction equipment functions as designed and conforms to applicable noise emission standards.
- Requiring the contractor to adhere to project work hour restrictions.
- Restricting access to construction areas so that the public could not be in close proximity to loud equipment or blasting.
- Developing a blasting schedule and notification process for nearby residents when blasting is anticipated to occur. Proceeding blasting with a warning alarm. Blasting plans would include the implementation of seismographs for vibration measurements and air blast recordings for noise.
- Locating operating equipment (e.g., pump stations) in structures designed to minimize radiated noise outside the structure, and designing structures to meet local noise ordinance requirements.
- Developing a noise monitoring and noise mitigation plan if activities are expected to exceed maximum permissible noise levels.

3.25.12 Land Use

No specific mitigation was identified other than what may be needed for land acquisitions or county land use requirements, including special use review, location and extent review, and 1041 permitting. The Subdistrict would compensate landowners for acquisition of property or homes impacted by project facilities.

3.25.13 Recreation

The Subdistrict would curtail Colorado River diversions during the annual Big Gore Race typically held the third week in August if flows at the Kremmling gage are below 2,200 cfs.

3.25.14 Cultural Resources

Mitigation Common to All Alternatives

The potential exists for presently unknown cultural resources to be uncovered during project construction. To develop a course of action to mitigate adverse effects to cultural resources discovered during construction, a Discovery Plan would be prepared that includes a pre-construction meeting with Reclamation and the construction contractor. A cultural resource consultant would be available to respond to discovered cultural resources in a timely fashion. All cultural resources located as a result of discovery would be documented and evaluated for eligibility to the NRHP. Reclamation would make determinations of eligibility in consultation with the SHPO and, if necessary, develop a mitigation plan.

In the event that human remains are uncovered, activity in the immediate area would be halted, the area secured, and the county sheriff and coroner contacted. Once the coroner determines the remains to be prehistoric or historic in nature, the SHPO would be contacted and a qualified archaeologist would exhume them. Reclamation would then contact Native American tribes to begin consultation under NAGPRA.

Reclamation, in consultation with the SHPO, would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be reevaluated.

Additional mitigation for specific reservoir sites is discussed below. A Memorandum of Agreement (MOA) or Programmatic Agreement (PA) with the county may be necessary that stipulates for the cultural resource inventory of the planned open space to mitigate potential adverse cumulative effects. A MOA would be drafted that stipulates compliance under Section 106 for the selected alternative. Included would be provisions for the mitigation of adversely effected cultural resources. All participating agencies and consulting parties would be invited as signatories.

Ralph Price Reservoir

No mitigation efforts are currently identified for the No Action alternative other than continued Native American and public consultation. Three resources (5BL1, 5BL16, and 5BL24) may be present within the proposed reservoir study area. Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected by project construction. If these sites are relocated during a Class III cultural resource survey, they would be re-evaluated and/or rerecorded and evaluated.

Chimney Hollow Reservoir

The Carter Lake Historic District (5LR1363) would need to be re-evaluated, and consultation between Reclamation and the SHPO would develop mitigation measures. Sites 5LR4006 and 5LR4007, also contributing elements to the C-BT Historic District would be re-evaluated and a mitigation plan would need to be developed. Preliminary assessment indicates that Area 17 and Area 18, included as part of the District, could be affected by reservoir construction.

NRHP assessments for 5LR3984, 5LR4002, 5LR9388, 5LR9389, 5LR9454.1, 5LR10731, 5LR10732 must be determined in consultation with SHPO. All previously recorded sites would need to be re-evaluated and, where necessary as per the SHPO, re-recorded. After eligibility determinations have been made by Reclamation in consultation with the SHPO, possible mitigation measures can be developed. If there is concurrence with the field recommendations, no further work would be necessary.

Further data would need to be collected from 5LR10410, a prehistoric lithic scatter, in order to determine eligibility. Subsequently, should the site be determined not eligible, no further work would be required.

Western will implement mitigation during construction that will require construction to stop in the area of suspected cultural resources that are discovered during construction. A field investigation, and if need be, consultation with the SHPO will be undertaken prior to reinitiating construction in the area of the resource.

Dry Creek

Site 5LR653 is recommended field eligible and, pending an official determination of eligibility, may require the development of a mitigation plan. Mitigation for 5LR1363 would be the same as described under the Chimney Hollow alternative and would involve consultation between Reclamation and the SHPO. Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

Jasper East

Consultation between Reclamation and the SHPO is required for all 10 previously recorded cultural resources eligible for or potentially eligible for inclusion in the NRHP. These sites would need to be re-evaluated and, in some cases, possibly rerecorded. Sites determined not eligible would require no further work.

Further data collection has been recommended at sites 5GA119 and 5GA2313; if these sites are determined eligible, appropriate mitigation measures should be developed. Following re-evaluation of site 5GA151, a site recommended officially eligible, a mitigation plan should be developed through consultation.

Reclamation in consultation with the SHPO would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

Rockwell/Mueller Creek Reservoir

A re-evaluation and official determination of eligibility would need to be obtained for the Granby Warehouse (5GA2281). If determined eligible, mitigation measures would need to be developed through consultation.

Reclamation, in consultation with the SHPO, would determine the level of survey needed for those areas that would be affected (directly, indirectly, or cumulatively) by project construction; it is likely that previously recorded sites would need to be re-evaluated.

3.25.15 Socioeconomics

The Subdistrict would negotiate a fair market value for acquisition of any property or homes that would be impacted by implementation of any alternative.

The Subdistrict would curtail Colorado River diversions during the annual Big Gore Race typically held the third week in August if flows at the Kremmling gage are below 2,200 cfs to avoid any economic effects to this event.

Chapter 4. Consultation and Coordination

Public Scoping Meeting

4.1 Public Scoping

As required by NEPA, Reclamation provided for an early and open process to determine the scope of significant issues to be addressed in the EIS. Scoping is not a single isolated action, but an ongoing process. The scoping process helps to:

- Inform the public and the affected agencies about the background, purpose, and features of the proposed project;
- Objectively identify public issues and concerns about the project;
- Gather additional information about the issues; and
- Identify a reasonable range of alternatives and potential impacts to be addressed.

To identify the issues and concerns related to the WGFP, agency and public scoping was undertaken by the Reclamation as follows.

4.1.1 Public Scoping Outreach Activities

Public scoping began with informal meetings with interested members of the public held on July 22, 2003 in Granby, Colorado, and on July 23 in Loveland, Colorado. Notice of the meetings was given via press releases and ads in local newspapers as well as a mailing list of about 375 people. These meetings were used to inform the public about the proposed Project and to initiate public involvement.

The formal scoping period began with publication of a Notice of Intent (NOI) in the Federal Register on September 8, 2003. The NOI as well as other paid advertisements announcing public scoping meetings, a scoping announcement, and publication of project information on the District's website and the

Reclamation's website were used to solicit comments on the proposed project and announce plans for additional public meetings. Notification of the formal scoping meeting was announced via press releases to 26 local and regional news media organizations (newspapers, radio, and TV), and paid advertisements in 14 newspapers. Reclamation also distributed announcements of the scoping meetings to 415 individuals.

Reclamation held three public scoping meetings to solicit ideas, issues, and concerns about the proposed project. One meeting was held in Granby on September 30, 2003; one was held in Loveland on October 1, 2003; and one was held in Lyons on October 2, 2003.

Reclamation conducted the scoping meetings in both an open house and formal presentation format. The meetings provided an opportunity for the public to review possible alternatives, view exhibits and maps, and ask questions. About 250 people attended the three scoping meetings. Comment sheets to encourage written comments were provided at each public meeting. Reclamation requested submission of comments by November 7, 2003.

4.1.2 Agency Scoping Meeting

On September 17, 2003, Reclamation hosted an agency scoping meeting for representatives from various local, state, and federal agencies interested in the WGFP. Of the 28 agencies or individuals that were invited, seven persons attended. Represented agencies included the Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Colorado Department of Public Health and Environment, and Grand County.

Three agencies requested participation in the WGFP EIS as cooperating agencies:

U.S. Army Corps of Engineers — because of potential effects to water and wetland resources.

Western Area Power Administration — because of the need to relocate a Western transmission line if Chimney Hollow Reservoir is built.

Grand County — because of potential effects to the West Slope environment, water, recreation, and other resources in the county, as well as regulatory issues for some alternatives.

Results of the public and agency scoping process were summarized in the WGFP Scoping Report (ERO 2003a). The report contained a summary of the outreach activities, public and agency scoping meetings, and a summary of comments received from the public and agencies.

4.1.3 Agency Consultation

Reclamation initiated preliminary consultation with the U.S. Fish and Wildlife Service during the preparation of the DEIS. Potential effects to threatened and endangered species from the proposed project appear to be limited to the effects on endangered fish species from depletions to the Colorado River. These depletions are covered by the Upper Colorado River Recovery Plan and Programmatic Biological Opinion. Reclamation will consult with the FWS between the Draft and Final EIS on the preferred alternative.

4.1.4 Future Planned Outreach Activities and Commenting on the DEIS

Public hearings will be held after release of the Draft EIS. The time, date, and location of future opportunities for comments will be mailed to those on the Reclamation's mailing list and posted on Reclamation's website. Public notice on the availability of the EIS also will be posted in local newspapers and copies of the EIS will be placed in local libraries. Reclamation welcomes all comments during the 60-day comment period. Comments on the Draft EIS can be sent by:

Mail: Will Tully, Bureau of Reclamation
11056 West County Rd. 18E
Loveland, CO 80537

Fax: Will Tully, 970-663-3212

E-mail: wtully@gp.usbr.gov (with *Windy Gap Draft EIS Comment* as the subject line)

Written and oral comments may also be made at the public hearings.

Before including your name, address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment, including your personal identifying information, may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Copies of the Draft EIS and related documents are available online from Reclamation's website at:

http://www.usbr.gov/gp/nepa/quarterly.cfm#ecao

Paper copies of the Draft EIS may be obtained by calling Kara Lamb at 970-962- 4326.

A copy of the draft EIS can be reviewed at the following locations:

- Eastern Colorado Area Office, 11056 W. County Rd. 18E, Loveland, CO 80537, 970 962-4410.
- Corps of Engineers, Chatfield Reservoir Office, 9307 South Wadsworth Blvd., Littleton, CO 80128
- Morgan Library, Colorado State University, 501 University Avenue, Fort Collins, CO 80523-1019
- Berthoud, Berthoud Public Library, 236 Welch Avenue
- Broomfield, Mamie Eisenhower Public Library, 3 Community Park Road
- Fort Collins, Fort Collins Public Library, 201 Peterson Street
- Ft. Lupton, Ft. Lupton Public Library, 425 South Denver Avenue
- Granby, Granby Branch Library, 13 East Jasper Avenue
- Grand Lake, Juniper Library, 316 Garfield Street
- Greeley, Centennial Park Branch, Weld Library District, 2227 23rd Avenue
- Greeley, Farr Branch, Weld Library District, 1939 61st Avenue
- Greeley, Lincoln Park Branch, Weld Library District, 919 7th Street
- Hot Sulphur Springs, Hot Sulphur Springs Branch Library, 105 Moffat
- Kremmling, Kremmling Branch Library, 300 South 8th Street
- Longmont, Longmont Public Library, 409 4th Avenue
- Louisville, Louisville Public Library, 950 Spruce Street
- Loveland, Loveland Public Library, 300 North Adams Avenue
- Lyons, Lyons Depot Library, 5th and Broadway

4.2 Consultation

Government agencies, businesses, organizations, and Native American Tribes contacted or consulted during the preparation of the Draft EIS are listed in Table 4-1.

Table 4-1. List of agencies and organizations contacted for the Draft EIS.

Cooperating Agencies
• U.S. Army Corps of Engineers (Corps) • Western Area Power Administration (Western) • Grand County Government
Federal Agencies
• Bureau of Land Management (BLM) • Environmental Protection Agency (EPA) • Rocky Mountain National Park • U.S. Fish and Wildlife Service (USFWS) • U.S. Forest Service
State Agencies
• Colorado Department of Public Health and Environment (CDPHE)/Water Quality Control Division (WQCD) • Colorado Department of Transportation, Environmental Programs Branch • Colorado Division of Wildlife (CDOW) • Colorado State Engineer • Colorado State Historic Preservation Officer (SHPO), Colorado Office of Archaeology and Historic Preservation (OAHP) • Colorado State Land Board
Local Agencies and Special Districts
• Boulder County • Central Weld County Water District • City of Boulder • City of Broomfield • City of Denver • City of Fort Collins • City of Fort Lupton • City of Greeley • City of Lafayette • City of Longmont • City of Louisville • City of Loveland • Colorado River Water Conservation District • Grand County Commissioners and County Manager • Grand County Historical Association • Grand County Planning Department • Larimer County • Larimer County Parks and Open Lands • Larimer County Planning Department • Little Thompson Water District • Middle Park Water Conservancy District • Municipal Subdistrict, Northern Colorado Water Conservancy District • Northern Colorado Water Conservancy District • Northwest Colorado Council of Government • Platte River Power Authority • Town of Evans • Town of Granby • Town of Erie • Town of Superior • Weld County
Local Businesses
• Colorado River Center • Lakota Rafting • MAD Adventures
Local Organizations
• Colorado Natural Heritage Program • Nature Conservancy • Trout Unlimited • Western Resource Advocates
Consulting and Legal Firms
• Bishop-Brogden, Associates, Inc. • Habitech, Inc. • HDR Engineering, Inc. • Sullivan Green Seavy, LLC • Trout, Raley, Montaño, Witwer & Freeman, P.C. • URS Corporation
Native American Tribes
• Apache Tribe of Oklahoma • Cheyenne-Arapaho Tribes of Oklahoma • Cheyenne River Sioux Tribe • Comanche Nation of Oklahoma • Crow Creek Sioux Tribe • Fort Sill Apache Tribe • Jicarilla Apache Tribe • Kiowa Indian Tribe of Oklahoma • Northern Arapaho Tribe • Northern Cheyenne Tribe • Mescalero Apache Tribe • Northern Ute Tribe • Oglala Sioux Tribe • Pawnee Nation of Oklahoma • Rosebud Sioux Tribe • Shoshone Tribe (Eastern Band) • Southern Ute Tribe • Spirit Lake Sioux Tribe • Standing Rock Sioux Tribe • Ute Mountain Ute Tribe

4.3 Distribution List

Notice on the availability of the DEIS was sent to area libraries, federal agencies, Native American organizations, state agencies, county agencies, city agencies, elected officials, and private individuals. Libraries received paper copies of the DEIS; all others received an Executive Summary and a CD with an electronic version of the DEIS. Paper copies are available upon request.

4.3.1 Federal Agencies

Arapaho-Roosevelt National Forest and Pawnee National Grassland
Natural Resource Conservation Service
Rocky Mountain National Park
Upper Colorado River Commission
U.S. Army Corps of Engineers, Omaha District
U.S. Army Corps of Engineers, Sacramento District Field Offices
U.S. Army Corps of Engineers, Western Regulatory Office
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Department of Energy
U.S. Environmental Protection Agency, Region 8
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Forest Service, Pawnee National Grasslands
U.S. Geological Survey
Western Area Power Administration

4.3.2 Native American Organizations

Apache Tribe of Oklahoma
Cheyenne and Arapaho Tribes of Oklahoma
Cheyenne River Sioux Tribe
Comanche Nation of Oklahoma
Crow Creek Sioux Tribe
Fort Sill Apache Tribe
Jicarilla Apache Tribe
Kiowa Tribe of Oklahoma
Mescalero Apache Tribe
Northern Arapaho Tribe
Northern Cheyenne Tribe
Northern Ute Tribe
Oglala Sioux Tribe
Pawnee Nation of Oklahoma
Rosebud Sioux Tribe
Shoshone Tribe (Eastern Band)
Southern Cheyenne
Southern Ute Indian Tribe
Standing Rock Sioux Tribe
Ute Mountain Ute Tribe

4.3.3 State Agencies

Colorado Department of Agriculture
Colorado Department of Local Affairs
Colorado Department of Natural Resources
Colorado Department of Public Health and Environment
Colorado Division of Parks and Outdoor Recreation
Colorado Division of Water Resources
Colorado Division of Water Resources, South Platte River Basin-Division 1
Colorado Division of Water Resources, Colorado River Basin-Division 5
Colorado Division of Wildlife
Colorado Office of Archaeology and Historic Preservation
Colorado River Water Conservation District
Colorado Water Congress
Colorado Water Conservation Board

4.3.4 Local Agencies

Big Thompson Watershed Forum
Boulder County Parks and Open Space
Boulder County Planning Department
Boulder Public Works Department
Broomfield Public Works
Central Weld County Water District
City of Fort Collins
City of Greeley
City of Longmont
City of Louisville
City of Loveland
Denver Regional Council of Governments
Denver Water Department

East Grand Water Quality Board
Erie Community Development
Estes Park Department of Planning and Zoning
Estes Park Water Department
Estes Valley Recreation and Park District
Evans Planning and Zoning
Fort Collins Natural Resource Department
Fort Collins Park Planning and Development Division
Fort Collins Planning and Zoning Board
Fort Collins-Loveland Water District
Fraser Public Works
Fraser Sanitation District
Grand County Department of Zoning and Planning
Grand County Water and Sanitation
Grand County Water Forum
Greater Granby Area Chamber of Commerce
Greeley Water and Sewer Department
Kremmling Chamber of Commerce
Lafayette Public Works
Larimer County Information Manager
Larimer County Parks and Open Lands
Larimer County Planning and Building Services
Little Thompson Water District
Longmont Open Space and Trails Department
Longmont Planning Division
Loveland Utilities Commission
Middle Park Water Conservancy District
North Front Range Water Quality Association
Northeastern Colorado Association of Local Governments
Northwest Colorado Council of Governments
Platte River Power Authority
Superior Metropolitan District No. 1
Three Lakes Water and Sanitation District
Three Lakes Watershed Association
Town of Estes Park
Town of Superior
Town of Winter Park
Weld County Planning and Zoning Department
Winter Park Water and Sanitation District

4.3.5 Elected Officials

U.S. Senator Wayne Allard
U.S. Senator Ken Salazar

Colorado Congressman Mark Udall, District 2
Colorado Congressman John T. Salazar, District 3
Colorado Congresswoman Marilyn Musgrave, District 4

Colorado State Senator Scott Renfroe, District 13
Colorado State Senator Bob Bacon, District 14
Colorado State Senator Steve Johnson, District 15
Colorado State Senator Dan Gibbs, District 16
Colorado State Senator Brandon C. Shaffer, District 17
Colorado State Senator Ron Tupa, District 18
Colorado State Senator Shawn Mitchell, District 23

Colorado State Representative Anne McGihon, District 3
Colorado State Representative Alice Madden, District 10
Colorado State Representative John Pommer, District 11
Colorado State Representative Paul Weissmann, District 12
Colorado State Representative Claire Levy, District 13
Colorado State Representative Dianne Primavera, District 33
Colorado State Representative Glenn Vaad, District 48
Colorado State Representative Kevin Lundberg, District 49
Colorado State Representative James Riesberg, District 50
Colorado State Representative Don Marsotica, District 51
Colorado State Representative John Kefalas, District 52
Colorado State Representative Randy Fischer, District 53
Colorado State Representative Christine Scanlan, District 56
Colorado State Representative Al White, District 57
Colorado State Representative Cory Gardner, District 63

Colorado State Representative Jerry Sonnenberg, District 65

Mayor Tom Clark, Kremmling
Mayor Fran Cook, Fraser
Mayor Barbara Davis, Dillon
Mayor Hershal Deputy, Hot Sulphur Springs
Mayor Dave Koop, Silverthorne
Mayor Andrew Moore, Erie
Mayor Andrew Muckle, Superior
Mayor Jim Myers, Winter Park
Mayor Patrick Quinn, Broomfield
Mayor Pro-Tem Aron Rhone, Grand Lake
Mayor Dr. John Warner, Breckenridge
Mayor Bernie Zurbriggen, Frisco

Boulder County Commissioner Cindy Domenico
Boulder County Commissioner Ben Pearlman
Boulder County Commissioner Will Toor
City and County of Broomfield Council Member Bob Gaiser, Ward 1
City and County of Broomfield Council Member Todd Schumacher, Ward 1
City and County of Broomfield Council Member Lori Cox, Ward 2
City and County of Broomfield Council Member Dennis P. McCloskey, Ward 2
City and County of Broomfield Council Member Bette Erickson, Ward 3
City and County of Broomfield Council Member Kevin Jacobs, Ward 3
City and County of Broomfield Council Member Randy Ahrens, Ward 4
City and County of Broomfield Council Member Walt Spader, Ward 4
City and County of Broomfield Council Member Brian Kenyon, Ward 5
City and County of Broomfield Council Member Linda Reynolds, Ward 5
Grand County Commissioner, James Newberry, District 1
Grand County Commissioner Nancy Stuart, District 2
Grand County Commissioner Gary Bumgarner, District 3
Larimer County Commissioner Randy Eubanks
Larimer County Commissioner Kathay Rennels
Larimer County Commissioner Glenn Gibson
Weld County Commissioner David Long, District 1
Weld County Commissioner Douglas Rademacher, District 2
Weld County Commissioner Rob Masden, District 3
Weld County Commissioner William Jerke, At Large
Weld County Commissioner Bill Garcia, At Large
Summit County Commissioner Thomas Davidson
Summit County Commissioner Bob French
Summit County Commissioner Tom Long

Breckenridge Town Manager, Tim Gagen
Dillon Town Manager, Devin Granbery
Estes Park Town Administrator, Jacqueline Halburnt
Fraser Town Manager, Jeff Durbin
Frisco Town Manager, Michael Penny
Granby Town Manager, David Huseman
Grand County Manager, Lurline Underbrink-Curran
Grand Lake Town Planner, Abbi Jo Wittman
Grand Lake Town Manager, Shane Hale
Kremmling Town Manager, Ted Soltis
Larimer County Manager, Frank Lancaster
Silverthorne Town Manager, Kevin Batchelder
Summit County Manager, Gary Martinez
Winter Park Town Planner, Drew Nelson
Winter Park Town Manager, Dave Torgler

4.3.6 Organizations and Private Individuals

An Executive Summary and notification of the DEIS's availability was sent via U.S. mail to about 700 recipients. A list of these recipients is maintained by Reclamation.

4.4 Preparers

This section includes a list of preparers and contributors to the EIS.

Name/Title	Responsibilities	Education	Experience
U.S. BUREAU OF RECLAMATION			
Will Tully	Project manager	B.S. Wildlife Management	34 years
Tara Moberg	Natural resources	B.S. Environmental Resources Management	4 years
Bob Burton	Cultural resources	B.A. Anthropology M.A. Anthropology	42 years
Kara Lamb	Public involvement and media relations	B.A. English and Philosophy M.A. Environmental Ethics	10 years
ERO RESOURCES CORPORATION			
Mark DeHaven Senior Natural Resource Specialist	Project manager	M.S. Natural Resources B.A. Business	29 years
Barbara Galloway Senior Hydrologist	Water quality, water resources, and stream morphology	M.S. Water Resources B.A. Biology and Environmental Conservation	21 years
Liz Payson Tucker Senior Plant Ecologist	Vegetation	M.S. Biological Sciences B.S. English Literature	15 years
Craig Sommers Water Resource Specialist	Socioeconomics	M.S. Agricultural Economics B.S. Soil and Water Science	28 years
Richard Trenholme Project Manager	Quality assurance	B.S. Agronomy	29 years
Michael Galloway Senior Hydrogeologist	Ground water	M.S. Geology B.S. Geology	36 years
Steve Dougherty Senior Ecologist	Wetlands	B.S. Biology	32 years
Denise Larson Ecologist	Vegetation, wetlands	M.A. Biology and Plant Ecology B.A. Biology	14 years
Stacey Antilla Natural Resource Planner	Recreation	M.S. Recreation Resources B.S. Biology	5 years
Ron Beane Wildlife Biologist	Wildlife	M.A. Biology B.S. Wildlife Biology	27 years
Clint Henke Natural Resource Specialist	Wetland and wildlife	M.S. Environmental Sciences B.S. Biology	6 years

Name/Title	Responsibilities	Education	Experience
Bill Mangle	Recreation and land use	M.S. Natural Resource Policy and Planning B.A. History/Political Science	8 years
Scott Babcock Environmental Planner	Recreation, land use, socioeconomics	M.S. Resource Economics and Policy B.S. Biology and Env. Conservation	8 years
Craig Sovka Geologist	Geology	B.S. Geology	15 years
Sean Larmore Senior Archaeologist	Cultural resources	M.A. Anthropology B.A. Anthropology	11 years
David Hesker Graphic Designer	Graphic design	B.A. Fine Arts	16 years
Jana Pedersen GIS Specialist	GIS and maps	B.S. Geosciences	5 years
Kay Wall Technical Editor	Technical editor	A.A. Microsoft Office Specialist	25 years
Martha Clark Technical Editor	Technical editor	B.A. English	19 years
Arlene Gregoire Technical Editor	Technical editor	Microsoft Office Specialist	30 years
BOYLE ENGINEERING			
Blaine Dwyer	Water resources, hydrologic modeling, infrastructure layout and cost estimates	M.S. Water Resources Engineering	27 years
Heather Thompson (Ecological Resource Consultants)	Water resources, hydrologic modeling	B.S. Civil Engineering M.S. Water Resources Engineering	14 years
Jeff Bandy	Water resources, hydrologic modeling, infrastructure layout and cost estimates	M.S. Civil Engineering	10 years
Darren Brinker	Infrastructure layout and cost estimates	M.S. Civil Engineering	11 years
Meg Frantz	Water resources, hydrologic modeling	M.S. Water Resources and Hydrologic Engineering	23 years
Don Poulter	Geotechnical	M.S. Civil Engineering	30 years
Bill Bliton	Geology	B.S. Geology	35 years
Tom Roode	Water Conveyance Systems	M.A. Business Administration B.S. Mechanical Engineering	13 years

Name/Title	Responsibilities	Education	Experience
AMEC EARTH AND ENVIRONMENTAL (FORMERLY HYDROSPHERE)			
Jean Marie Boyer	Water quality	Ph.D. Civil Engineering M.S. Chemical Engineering B.S. Chemical Engineering	25 years
R. Blair Hanna	Water quality	Ph.D. Civil Engineering M.S. Civil Engineering B.S. Computer Science	16 years
Laura Belanger	Water quality	M.S. Civil Engineering B.A. Social Thought and Political Economy	13 years
John Winchester	Hydrology	M.S. Civil Engineering B.S. Watershed Science	17 years
MILLER ECOLOGICAL CONSULTANTS			
Bill Miller Senior Aquatic Ecologist	Aquatic resources	Ph.D. Fisheries M.S. Recreation Resources B.A. Biology	27 years
HARVEY ECONOMICS			
Ed Harvey Principal	Water demand projections	MSBA Economics	34 years
Melinda Ogle Research Associate	Demographic forecasting	B.A. Economics	6 years
Chris Goemans Senior Associate	Water provider forecasting	Ph.D. Economics	3 years
Andy Fritsch Associate	Water provider forecasting	B.A. Economics	4 years
WESTERN CULTURAL RESOURCE MANAGEMENT, INC.			
Tom Lennon	Cultural resources	Ph. D. Anthropology M.A. Anthropology M.A Human Communications B.A. History	34 years
Collette Chambellan	Cultural resources	M.A. Anthropology B.A. Anthropology	32 years
HOLDEMAN LANDSCAPE ARCHITECTURE, INC.			
Mark Holdeman Landscape Architect	Visual resources	B.A. Landscape Architecture	25 years

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Glossary

acre-foot (AF): A volume of water equal to 1 foot in depth covering an area of 1 acre. Also 43,560 cubic feet or 325,851 gallons. Used to measure stored water quantities.

adjudicated water rights: Water rights that have been decreed in water court. Adjudicated water rights may be either an absolute water right, a conditional water right, a finding of reasonable diligence, an exchange, an augmentation plan, a change of water right, or a right to withdraw tributary water or ground water that is outside of a designated ground water basin.

adjudication date: The date when a water court enters a decree confirming a water right.

aggradation: The raising of streambeds or floodplains by deposition of sediment eroded and transported from upstream.

algae: Microscopic plants that grow in sunlit water containing phosphates, nitrates, and other nutrients. Algae add oxygen to the water and are important in the fish food chain.

allottees: Shareholders in a ditch company, the C-BT system, special water district, or other mutual water supply entity.

alluvial ground water: Ground water that is hydrologically part of a surface stream present in permeable soil material, usually small rock and gravel.

annual yield: The amount of water available during a given year. The annual yield may vary from year to year.

anoxic: The absence of oxygen, as in a body of water.

appropriation date: The date of appropriation of waters of the state. The appropriation date establishes the seniority of a water right.

appropriation: Placement of a specified portion of the waters of the state to a beneficial use pursuant to the procedures prescribed by law.

aquifer: An underground deposit of sand, gravel, or rock through which water can pass or is stored. Aquifers supply the water for wells and springs. In an unconfined aquifer, the upper surface of the saturated aquifer is a changing water table under atmospheric pressure. In a confined (artisan) aquifer, the water is maintained under pressure by nonporous rocks surrounding it.

augmentation plan: A court-approved plan that allows a water user to divert water out of priority so long as adequate replacement is made to the affected stream system preventing injury to the water rights of senior users.

augmentation: Replacing the quantity of water depleted from the stream system caused by an out-of-priority diversion.

average yield: The yield that is available during an average water year.

bankfull discharge: The stage at which a stream first begins to overflow its natural banks. Typically occurs every 1.5 to 2 years.

bedrock: Continuous solid rock that outcrops at the surface locally, but generally is overlain by unconsolidated material (such as alluvium).

benthic: Relating to the bottoms of lakes, reservoirs, and streams.

Best Management Practices (BMPs): Practices that provide sufficient data to clearly indicate their value, are technically and economically reasonable, are environmentally and socially acceptable, are reasonably capable of being implemented, and for which significant conservation or conservation-related benefits can be achieved.

big game: Large wildlife species that are hunted, such as elk, deer, antelope, and bighorn sheep.

buildout: The area of land that is projected to be developed as part of a municipality or district in the future. Generally, the prediction is for maximum capacity for the residential, commercial, industrial, and municipal development of that community.

call: The exercise of a senior water right holder of "calling" for his or her water rights, requiring upstream junior water right holders to allow water to flow to the senior right holder.

C-BT quota: The allocation of water per C-BT unit or share. The quota is set annually by C-BT Directors and is usually expressed as a percentage of one acre-foot (e.g., 80% quota is equivalent to 0.8 AF).

C-BT share or C-BT unit: A share in, or unit of, the Colorado-Big Thompson project. A C-BT share (unit) ranges from 0.5 acre-feet to 1.0 acre-feet depending on the year.

C-BT: Colorado-Big Thompson Project. A project owned by the U.S. Bureau of Reclamation that collects water in the headwaters of the Colorado River and delivers it to water users on the northern Front Range of Colorado. The Northern Colorado Water Conservancy District is the local agency that was established to administer delivery of C-BT water to local water users.

chlorophyll *a*: The green pigments of plants.

Clean Water Act (CWA): The federal law that sets forth how the United States will restore and maintain the chemical, physical, and biological integrity of the country's waters (oceans, lakes, streams and rivers, ground water, and wetlands). The law provides protection to the country's surface waters from both point and nonpoint sources of pollution.

Conservancy District: Established by decree of a court under the Water Conservancy District Act of 1937. A conservancy district can obtain rights-of-way for works; contract with the United States or otherwise provide for the construction of facilities; assume contractual or bonded indebtedness; administer, operate, and maintain physical works; have authority to conserve, control, allocate, and distribute water supplies; and have contracting and limited taxing authority to derive the revenues necessary to accomplish its purposes. There are currently 46 conservancy districts in Colorado.

conservation: Obtaining the benefits of water more efficiently.

consumptive use: Any use of water that permanently removes water from the natural stream system.

Continental Divide: An imaginary boundary line that runs north-south along the crest of the Rocky Mountains, separating river and drainages that flow into the Atlantic Ocean or Gulf of Mexico from those that flow into the Pacific Ocean.

cooperating agency: A federal, state, tribal, or local agency having special expertise with respect to an environmental issue or jurisdiction by law. A cooperating agency has the responsibility to assist the lead agency by participating in the National Environmental Policy Act (NEPA) process at the earliest possible time; by participating in the scoping process; in developing information and preparing environmental analyses including portions of the environmental impact statement concerning which the cooperating agency has special expertise; and in making available staff support at the lead agency's request to enhance the lead agency's interdisciplinary capabilities.

cubic feet per second (cfs): A rate of water flow at a given point, amounting to a volume of 1 cubic foot for each second of time. Equal to 7.48 gallons per second, 448.8 gallons per minute, or 1.984 acre-feet per day.

cumulative impacts: The incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions.

cyanobacteria: A group of phytoplankton that often cause nuisance conditions in water (blue-green algae).

decree: A court decision about a water right that is then administered by Colorado's Water Resources Department.

degradation: Any lowering of a streambed, such as from scouring of sediments.

demand management: Reduced water use, accomplished either through temporary measures such as restrictions during a drought, or through long-term conservation programs. These programs include replacement of inefficient fixtures with more efficient fixtures such as 1.6-gallon toilets, installation and maintenance of landscapes that have low water requirements, or changes in customer attitudes that lead to reduction in water use.

direct flow (also direct right): Water diverted from a river or stream for use without interruption between diversion and use except for incidental purposes, such as settling or filtration.

dissolved oxygen: Concentration of oxygen dissolved in water and readily available to fish and other aquatic organisms.

diversion: The removal of water from its natural course or location, or controlling water in its natural course or location by means of a ditch, canal, flume, reservoir, bypass, pipeline, conduit, well, pump, or other device.

domestic use water: Water used by people for personal needs (home and business) from an individual well. Also may refer to water use in restrooms in commercial and business buildings.

drought: A long period of below average precipitation.

effluent exchange: The practice of using wastewater effluent from transbasin water, non-tributary water sources, or other sources without causing injury to other water rights as a replacement source of water for diversion of water farther upstream that would otherwise have been out of priority.

effluent: Water discharged after use, as in water leaving a wastewater treatment plant; an outflowing branch of a stream or lake.

Endangered Species Act (ESA): The federal law that governs how animal and plant species whose populations are dangerously in decline or close to extinction will be protected and recovered. The law protects not only threatened and endangered species, but also the ecosystems upon which they depend.

ephemeral stream: An intermittent stream that flows only in direct and immediate response to precipitation, and has no prolonged flow from ground water sources.

epilimnion: The upper layer of water in a thermally stratified lake or reservoir.

eutrophic: A lake or body of water containing a rich supply of plant nutrients and characterized by seasonal periods of oxygen deficiency as a result of excessive growth of algae.

eutrophication: A process that depletes oxygen needed for fish and aquatic wildlife to thrive. Polluted runoff often contains nitrogen and phosphorous, nutrients that promote algae growth. As algae growth decomposes, water bodies are depleted of oxygen.

evapotranspiration (ET): The total moisture loss from an area controlled by climatic conditions and plant processes.

exchange: A process by which water, under certain conditions, may be diverted out of priority at one point by replacing it with a like amount of water at another point.

federal action: An action by a federal agency. Federal actions may include supplying funding for a project, authorizing or permitting a project, undertaking or sponsoring a project.

firm annual yield: The yearly amount of water that can be dependably supplied from the raw water sources of a given water supply system.

firming storage: Storage necessary to firm, or make available, a water right.

floodplain: That portion of a stream valley, adjacent to its channel, that is built of sediments deposited by the stream and is covered with water when the stream overflows its banks during floods.

flow duration curve: A cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded.

forebay: A reservoir used to regulate flow.

gaining stream: A reach of stream that receives inflow from ground water seepage or an underlying aquifer.

gallons per capita per day (gpcd): A term generally used to approximate the average amount of drinking or treated water used per day, per person, in a year's time.

ground water: Water found below the earth's surface. Typically stored in alluvial deposits or in bedrock.

hepatotoxin: A poisonous substance produced during the metabolism and growth of certain microorganisms that affects the liver.

historic use: The documented diversion and consumptive use of water over a period of years.

hydraulic conductivity: The rate of flow of water through a cross-section of an aquifer under a unit hydraulic gradient (units are gpd/ft^2, ft/sec, or m/sec).

hydrogeology: The study of the geology, movement, and chemistry of subsurface water (ground water).

hypolimnion: The bottom layer of cold water in a thermally stratified lake or reservoir.

indirect economic impact: The change in sales, income, or employment within the local region in industries that supply goods and services to directly affected businesses.

instantaneous delivery: Instantaneous delivery of Windy Gap water as allowed by the existing Carriage Contract between Reclamation, the NCWCD, and Municipal Subdistrict, Northern Colorado Water Conservancy District allows Windy Gap water in Granby Reservoir to be delivered to the Subdistrict anywhere in the C-BT system, with the same amount of water being exchanged with C-BT. Instantaneous deliveries reduce conveyance constraints in the Adams Tunnel.

instream flows: Water flowing in its natural streambed, such as water required for maintaining flowing streams, or for fish.

instream use: Any use of water that does not require a diversion.

intermittent stream: A stream that carries water only part of the time, generally in response to periods of heavy runoff from snowmelt or precipitation events.

junior water right: A water right that is more recent than an older or more senior right.

lek: An area used by sage grouse for mating displays.

losing stream: A stream reach that loses water by seepage into the ground.

macroinvertebrate: An animal lacking a backbone or internal skeleton that lives on or near the bottom of a body of water.

maximum contaminant level: The legal threshold limit on the amount of a hazardous substance that is allowed in drinking water under the Safe Drinking Water Act. The limit is usually expressed as a concentration in milligrams or micrograms per liter of water.

mesotrophic: A lake or water body of fresh water having an intermediate amount of plant nutrients and therefore moderately productive.

metalimnion: The middle layer of a thermally stratified lake or reservoir.

microcystin: A hepatotoxin that targets the liver and can be produced by some cyanobacteria.

mitigation measures: Measures taken to avoid or offset the adverse impacts resulting from an action or activity.

MODSIM: A general purpose simulation model for evaluating the operations of river and reservoir systems including the historical operation and administration of major direct flow and water storage rights.

Municipal Subdistrict, Northern Colorado Water Conservancy District: A water conservancy district organized under the Water Conservancy Act that developed, owns, and operates the original Windy Gap Project.

municipal water use: Domestic (residential) use plus commercial, industrial, and governmental use in urban areas.

National Environmental Policy Act (NEPA): The federal law enacted to ensure the integration of natural and social sciences and environmental design in planning and decision making for projects that may impact the quality of the human environment.

National Pollutant Discharge Elimination System (NPDES) Permit: A permit required under Section 401 of the Clean Water Act regulating discharge of pollutants to the nation's waterways.

nonpoint source: Pollution discharged over a wide land area, not from one specific location. Runoff from city streets, parking lots, home lawns, agricultural land, individual septic systems, and construction sites that finds its way into lakes and streams constitutes an important source of water pollutants.

officially eligible (for listing in the National Register of Historic Places): Historic or archaeological resources that have an official determination of eligibility from the State Historic Preservation Office (SHPO). The SHPO has concurred with the cultural resource specialist that the resource under consideration meets eligibility criteria codified under 36 CFR 60.4.

oligotrophic: A lake deficient in plant nutrients and contains little aquatic plant or animal life. It is characterized by an abundance of dissolved oxygen in its lower layer.

Participants: Municipalities, water districts, and entities in the Windy Gap Firming Project including the cities of Broomfield, Evans, Fort Lupton, Greeley, Lafayette, Longmont, Louisville, Loveland, the towns of Erie and Superior, Central Weld County Water District, Little Thompson Water District, Middle Park Water Conservancy District, and the Platte River Power Authority.

period of record: The historical period for which streamflow records exist.

permeability: In this document, used interchangeability with hydraulic conductivity when referring to water.

point of diversion: A specifically named place where water is removed from a body of water.

potable: Water considered safe for domestic consumption; drinkable.

prepositioning: Under the Proposed Action, prepositioning involves the storage of Colorado-Big Thompson Project water in Chimney Hollow Reservoir. Windy Gap water pumped into Lake Granby would then be exchanged for C-BT water stored in Chimney Hollow. Windy Gap water stored in Chimney Hollow would be delivered and allocated to the Windy Gap Firming Project (WGFP) Participants.

prior appropriation doctrine: A legal concept in which the first person to appropriate water and apply it to a beneficial use has the first right to use that amount of water from that source. Each successive appropriator may only take a share of the water remaining after all senior water rights are satisfied. This is the historical basis for Colorado water law and is sometimes known as the Colorado Doctrine or the principle of "first in time, first in right."

priority date: The date of establishment of a water right. The rights established by application have the application date as the date of priority.

priority: The right of an earlier appropriator to divert from a natural stream in preference to a later appropriator.

quota: See “C-BT quota”.

raw water: Untreated water.

recharge: The addition of water to ground water.

reservoir: An impoundment of collected water controlled by a dam (raw water) or storage tank (potable water).

return flows: Unconsumed water that returns to its source—surface or ground water—after use.

reusable return flows: Return flows that the owner of a water right has the right to reuse.

reuse: To use water again; to intercept for subsequent beneficial use either directly or by exchange water that would otherwise return to the stream system.

riparian: Relating to the bank of a natural watercourse (as a river) or sometimes of a lake or a tidewater.

river basin: The land area surrounding one river from its headwaters to its mouth.

runoff: Water that flows on the earth's surface to streams, rivers, lakes, and oceans.

salinity: A measure of water quality—the amount of dissolved salts in water.

salmonid: belonging to, or characteristic of the family Salmonidae, which includes the salmon, trout, and whitefish

Secchi depth: A measure of the turbidity or clarity of water based on the depth at which a Secchi disk, which is about 10-12 inches in diameter and painted in a black and white pattern, can no longer be seen.

secondary economic impact: The change in economic activity that results from subsequent rounds of re-spending tourism dollars or direct road construction expenditures. Secondary impacts may be further divided into indirect or induced impacts.

Section 404 permit: An authorization granted by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act to place dredged or fill material into a water of the U.S.

sediments: Soil particles eroded from land such as construction sites, cropland, and stream banks.

senior water right: A water right that is staked at the earliest date with the water court.

species of concern: Federally listed threatened and endangered species; species listed by the Colorado Division of Wildlife (CDOW) as state threatened, endangered, and other species of concern; and species ranked as rare, vulnerable, or imperiled in the state by the Colorado Natural Heritage Program (CNHP).

specific conductance: Measure of the ability of water to conduct an electrical current, expressed in micromhos per centimeter at 250C.

spill: A water release from a reservoir for operational reasons or because it is full.

storage right: A type of water right that is measured in terms of volume. Storage rights allow a water user to store water for later beneficial use.

storage to yield ratio: The relationship between the amount of storage necessary to provide for a given amount of firm yield.

stream morphology: The study of the form and structure of a stream, including its channel, banks, floodplain, and drainage area.

Subdistrict: The Municipal Subdistrict of the Northern Water Conservancy District, acting by and through the Windy Gap Firming Project water activity enterprise. The Subdistrict is the entity responsible for the Windy Gap Firming Project.

supply management: Methods by which a utility maximizes use of available raw water.

surface water: Water present on the earth's surface.

sustainability: A decision-making concept describing development that meets current needs without compromising the ability of future generations to meet their needs.

system loss: An amount of water, expressed as a percentage, lost from a water storage or distribution system due to leaks, evaporation, seepage, and unauthorized use.

tap: A physical connection made to a public water distribution system that provides service to an individual customer.

total dissolved solids (TDS): The combined content of all inorganic and organic substances contained in a liquid that are present in a molecular, ionized, or micro-granular form. Primary sources of TDS are agricultural runoff, leaching of soil contamination, and point source water pollution discharge from industrial or sewage treatment plants.

total water delivery: The amount of water that must be delivered to meet a Participant's water need.

transbasin diversion: The conveyance of water from its natural drainage basin into another basin for beneficial use.

transfer: The sale and/or purchase of a water right.

transmountain diversion: The conveyance of water from one drainage basin to another across the Continental Divide.

transpiration: The process by which plants remove soil moisture by losing water vapor through their leaves.

treated water: Water that has been filtered and/or disinfected; sometimes used interchangeably with "potable" water.

tributary: A stream or river that flows into a larger one.

Trophic State Index: A measure of the eutrophication of a body of water using a combination of measures of water clarity, chlorophyll *a* concentrations, and total phosphorus levels.

trophic state: A measure of the eutrophication or productivity of a lake based on variables such as phosphorus concentrations, chlorophyll *a*, Secchi disk depth.

turbidity: A cloudy condition in water due to suspended silt or organic matter.

unappropriated water: Water of the state that has not been placed in beneficial use by being diverted, stored, or captured.

ungulate: A hoofed mammal such as elk, deer, bighorn sheep, mountain goat, and moose.

upland: Areas on hills, plains, mesas, or any other areas not in a riparian area or wetland area, and where the vegetation is not supplied by hydrology from a stream or drainage.

water and sanitation districts: A special taxing district formed by the residents of the district for the combined purpose of providing potable water and sanitary wastewater services.

water audit: A service that identifies water waste and leaks, and offers ways to conserve water.

water court: A special division of the district court with a district judge (called the water judge) that deals with water matters.

water delivery: The amount of water delivered to a water user.

water demand: The amount of water that municipalities or regions require for everyday functioning.

water requirement: The amount of water required to achieve a specific delivery goal. Water requirements include system losses and evaporation, and generally are larger than the delivery goal. Water requirements are based on, but may not be equal to use, demand, and delivery goals.

water right: A property right to make beneficial use of a particular amount of water with a specified priority date.

waters of the U.S.: As defined in the Clean Water Act, all waters that are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide. All interstate waters including interstate wetlands. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce.

watershed: The area of land that catches rain and snow that drains or seeps into a marsh, stream, river, lake, or ground water. The highest ground, such as mountains or ridges, forms boundaries between watersheds.

wetlands: Areas with standing water or a high water table either permanently or for some significant period each year. Generally includes swamps, marshes, bogs, and areas with water-loving vegetation that grows in or around water.

Windy Gap Firming Project (WGFP): A project proposed by the Subdistrict to firm the yield from the Windy Gap Project.

Windy Gap Project: A project operated by the Municipal Subdistrict, Northern Colorado Water Conservancy District that collects and stores water on the western slope and delivers it through the C-

BT project to the owners of allotment contracts for the original Windy Gap Project.

Xeriscape™: A landscape concept to describe beautiful landscaping that has low water needs. The term was developed by Denver Water in 1981.

yield: The amount of water that a water right supplies under a defined scenario.

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Windy Gap Firming Project

Appendix A

Hydrologic Model Output: Streamflow and Reservoir Data

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Table A-1. Windy Gap Firming Project Participant Demands, Firm Yield and Average Yield for each Alternative.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Chimney Hollow with Jasper East			Chimney Hollow with Rockwell			Dry Creek and Rockwell		
	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)
Oct	1,520	0	780	3,820	940	2,080	2,560	2,560	2,560	2,550	2,550	2,550	2,550	2,550	2,550	2,580	2,580	2,580
Nov	2,350	0	1,440	2,980	0	1,820	2,500	2,500	2,500	2,380	2,380	2,380	2,380	2,380	2,380	2,490	2,490	2,490
Dec	2,350	0	1,270	2,980	0	1,650	2,500	2,500	2,500	2,380	2,380	2,380	2,380	2,380	2,380	2,490	2,490	2,490
Jan	2,350	0	1,110	2,980	0	1,420	2,500	2,500	2,500	2,380	2,380	2,380	2,380	2,380	2,380	2,490	2,490	2,490
Feb	2,350	0	960	2,980	0	1,260	2,500	2,500	2,500	2,380	2,380	2,380	2,380	2,380	2,380	2,490	2,490	2,490
Mar	2,350	0	850	2,980	0	1,120	2,500	2,500	2,500	2,380	2,380	2,380	2,380	2,380	2,380	2,490	2,490	2,490
Apr	1,040	0	680	1,605	0	960	1,370	1,370	1,370	1,350	1,350	1,350	1,350	1,350	1,350	1,380	1,380	1,380
May	930	0	820	1,540	0	1,360	1,320	1,320	1,320	1,300	1,300	1,300	1,300	1,300	1,300	1,330	1,330	1,330
Jun	930	0	660	1,540	106	1,150	1,320	1,320	1,320	1,300	1,300	1,300	1,300	1,300	1,300	1,330	1,330	1,330
Jul	1,490	0	960	3,020	183	2,360	2,150	2,150	2,150	2,130	2,130	2,130	2,130	2,130	2,130	2,170	2,170	2,170
Aug	1,500	0	910	3,420	0	2,410	2,350	2,350	2,350	2,340	2,340	2,340	2,340	2,340	2,340	2,380	2,380	2,380
Sep	1,520	0	830	3,820	0	2,320	2,560	2,560	2,560	2,550	2,550	2,550	2,550	2,550	2,550	2,580	2,580	2,580
Total	20,680	0	1,1270	33,665	1,229	19,910	26,130	26,130	26,130	25,420	25,420	25,420	25,420	25,420	25,420	26,200	26,200	26,200

Table A-2. Windy Gap Non-Participant Demands, Firm Yield, and Average Yield for each Alternative.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Chimney Hollow with Jasper East			Chimney Hollow with Rockwell			Dry Creek and Rockwell		
	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)
Oct	10	0	10	290	0	100	290	0	110	290	0	110	290	0	110	290	0	110
Nov	10	0	0	70	0	20	70	0	30	70	0	30	70	0	30	70	0	30
Dec	10	0	0	70	0	20	70	0	30	70	0	30	70	0	30	70	0	30
Jan	0	0	0	50	0	20	50	0	20	50	0	20	50	0	20	50	0	20
Feb	0	0	0	40	0	10	40	0	10	40	0	10	40	0	10	40	0	10
Mar	10	0	0	60	0	20	60	0	20	60	0	20	60	0	20	60	0	20
Apr	10	0	0	120	0	60	120	0	70	120	0	70	120	0	70	120	0	70
May	30	0	30	730	0	610	730	0	610	730	0	620	730	0	620	730	0	620
Jun	40	0	30	1050	0	670	1,050	0	670	1,050	0	690	1,050	0	690	1,050	0	690
Jul	50	0	30	870	0	400	870	0	440	870	0	440	870	0	440	870	0	440
Aug	30	0	20	440	0	150	440	0	170	440	0	170	440	0	170	440	0	170
Sep	20	0	20	310	0	110	310	0	120	310	0	110	310	0	110	310	0	120
Total	220	0	140	4,100	0	2,190	4,100	0	2,300	4,100	0	2,320	4,100	0	2,320	4,100	0	2,330

Table A-3. Middle Park Water Conservancy District Demands, Firm Yield and Average Yield for each Alternative.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Chimney Hollow with Jasper East			Chimney Hollow with Rockwell			Dry Creek and Rockwell		
	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)	Demand (ac-ft)	Firm Yield (ac-ft)	Average Yield (ac-ft)
Oct	21	0	15	429	0	292	429	0	419	429	0	419	429	0	419	429	0	419
Nov	21	0	15	429	0	292	429	0	419	429	0	419	429	0	419	429	0	419
Dec	21	0	15	429	0	292	429	0	419	429	0	419	429	0	419	429	0	419
Jan	21	0	15	429	0	287	429	0	415	429	0	415	429	0	415	429	0	415
Feb	21	0	15	429	0	283	429	0	410	429	0	410	429	0	410	429	0	410
Mar	21	0	15	429	0	283	429	0	372	429	0	330	429	0	354	429	0	362
Apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	21	0	15	429	0	298	429	429	425	429	429	425	429	429	426	429	429	426
Total	145	0	102	3,000	0	2,026	3,000	429	2,880	3,000	429	2,839	3,000	429	2,864	3,000	429	2,871

Table A-4. Lake Granby Spills (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**0**	**18**	**352**	**216**	**41**	**10**	**5**	**0**	**53**
Alt 1 (No Action)	0	17	316	189	37	9	4	0	**48**
Alt 2 (Proposed Action)	0	13	260	163	24	9	4	0	**40**
Alt 3	0	14	282	170	28	10	4	0	**42**
Alt 4	0	14	282	170	28	10	4	0	**42**
Alt 5	0	14	282	168	28	10	4	0	**42**
Flow change from Existing Conditions									
Alt 1 (No Action)	0	-1	-37	-27	-4	0	-1	0	**-6**
Alt 2 (Proposed Action)	0	-5	-92	-53	-17	0	0	0	**-14**
Alt 3	0	-4	-70	-46	-12	0	-1	0	**-11**
Alt 4	0	-4	-70	-46	-12	0	-1	0	**-11**
Alt 5	0	-4	-71	-47	-12	0	-1	0	**-11**
Percent change in flow from Existing Conditions									
Alt 1 (No Action)	0%	-4%	-10%	-13%	-9%	-4%	-18%	0%	**-11%**
Alt 2 (Proposed Action)	0%	-26%	-26%	-24%	-41%	-3%	-9%	0%	**-26%**
Alt 3	0%	-22%	-20%	-21%	-30%	2%	-12%	0%	**-21%**
Alt 4	0%	-22%	-20%	-21%	-30%	2%	-12%	0%	**-21%**
Alt 5	0%	-22%	-20%	-22%	-30%	2%	-13%	0%	**-21%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All Alternatives	0	0	0	0	0	0	0	0	**0**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**0**	**123**	**845**	**887**	**249**	**23**	**0**	**0**	**178**
Alt 1 (No Action)	0	122	845	744	249	25	0	0	**166**
Alt 2 (Proposed Action)	0	126	859	696	155	30	0	0	**156**
Alt 3	0	132	845	722	188	23	0	0	**160**
Alt 4	0	132	845	722	188	23	0	0	**160**
Alt 5	0	131	839	719	174	23	0	0	**158**

Table A-4 (cont'd). Lake Granby Spills (cfs).

Flow change from Existing Conditions

Alt 1 (No Action)	0	-1	0	-143	0	2	0	0	**-12**
Alt 2 (Proposed Action)	0	2	14	-191	-94	7	0	0	**-22**
Alt 3	0	8	0	-166	-61	0	0	0	**-18**
Alt 4	0	8	0	-165	-61	0	0	0	**-18**
Alt 5	0	8	-6	-169	-75	0	0	0	**-21**

Percent change in flow from Existing Conditions

Alt 1 (No Action)	0%	-1%	0%	-16%	0%	9%	0%	0%	**-7%**
Alt 2 (Proposed Action)	0%	2%	2%	-22%	-38%	29%	0%	0%	**-13%**
Alt 3	0%	7%	0%	-19%	-25%	1%	0%	0%	**-10%**
Alt 4	0%	7%	0%	-19%	-25%	1%	0%	0%	**-10%**
Alt 5	0%	6%	-1%	-19%	-30%	0%	0%	0%	**-12%**

Table A-5. Adams Tunnel Diversions (cfs).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**409**	**523**	**417**	**285**	**430**	**406**	**224**	**206**	**263**	**252**	**225**	**404**	**336**
Alt 1	415	522	416	285	450	411	295	236	283	262	235	410	**351**
Alt 2	450	518	343	282	477	421	282	282	321	276	254	450	**362**
Alt 3	424	523	357	292	479	411	335	285	304	267	247	414	**361**
Alt 4	424	524	357	292	479	411	335	285	304	267	247	414	**361**
Alt 5	435	530	357	291	476	414	320	277	304	271	252	423	**362**
Flow change from Existing Conditions													
Alt 1	6	-1	-1	-1	20	5	72	30	20	10	10	6	**15**
Alt 2	41	-6	-74	-3	47	15	58	76	58	24	29	47	**26**
Alt 3	15	0	-60	6	50	5	112	79	41	15	22	11	**25**
Alt 4	15	0	-60	6	49	5	111	79	42	15	22	11	**25**
Alt 5	26	6	-60	6	46	8	96	71	42	19	27	20	**26**
Percent change in flow from Existing Conditions													
Alt 1	2%	0%	0%	0%	5%	1%	32%	15%	8%	4%	4%	2%	**4%**
Alt 2	10%	-1%	-18%	-1%	11%	4%	26%	37%	22%	10%	13%	12%	**8%**
Alt 3	4%	0%	-14%	2%	12%	1%	50%	38%	16%	6%	10%	3%	**7%**
Alt 4	4%	0%	-14%	2%	12%	1%	50%	38%	16%	6%	10%	3%	**7%**
Alt 5	6%	1%	-14%	2%	11%	2%	43%	35%	16%	8%	12%	5%	**8%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**452**	**541**	**426**	**293**	**550**	**550**	**541**	**407**	**458**	**296**	**250**	**449**	**434**
All Alternatives	457	541	426	293	550	550	542	410	468	299	261	448	**437**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**372**	**497**	**426**	**293**	**255**	**134**	**85**	**105**	**116**	**219**	**168**	**340**	**250**
Alt 1	386	500	426	293	310	135	134	211	120	223	190	349	**272**
Alt 2	424	465	297	250	379	153	108	135	150	242	212	381	**265**
Alt 3	391	491	364	293	399	135	172	261	150	230	196	339	**284**
Alt 4	391	491	364	293	399	135	172	260	150	230	196	339	**284**
Alt 5	398	508	364	293	382	135	151	207	151	238	200	344	**280**

Table A-5 (cont'd). Adams Tunnel Diversions (cfs).

Flow change from Existing Conditions

Alt 1	13	3	0	0	55	0	49	106	3	4	22	9	**22**
Alt 2	51	-32	-129	-43	124	19	23	30	34	23	44	40	**16**
Alt 3	18	-7	-62	0	144	0	87	156	34	11	28	-1	**35**
Alt 4	19	-7	-62	0	144	0	87	156	34	11	28	-1	**35**
Alt 5	26	11	-62	0	127	0	67	102	35	19	32	3	**30**

Percent change in flow from Existing Conditions

Alt 1	4%	1%	0%	0%	22%	0%	58%	102%	3%	2%	13%	3%	**9%**
Alt 2	14%	-7%	-30%	-15%	49%	14%	27%	29%	29%	10%	26%	12%	**6%**
Alt 3	5%	-1%	-15%	0%	56%	0%	103%	149%	29%	5%	17%	0%	**14%**
Alt 4	5%	-1%	-15%	0%	56%	0%	103%	149%	29%	5%	17%	0%	**14%**
Alt 5	7%	2%	-15%	0%	50%	0%	79%	97%	30%	8%	19%	1%	**12%**

Table A-6. Windy Gap Diversions (AF).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**4522**	**17648**	**11053**	**2869**	**439**	**0**	**0**	**0**	**36532**
Alt 1	4522	18571	12462	6780	1238	0	0	0	**43573**
Alt 2	4521	19866	14618	6006	1072	0	0	0	**46084**
Alt 3	4521	19738	14204	8050	1538	0	0	0	**48052**
Alt 4	4521	19738	14195	8007	1536	0	0	0	**47997**
Alt 5	4521	20070	14726	7720	1446	0	0	0	**48483**
Flow change from Existing Conditions									
Alt 1	0	923	1408	3911	799	0	0	0	**7041**
Alt 2	0	2218	3565	3137	633	0	0	0	**9552**
Alt 3	0	2090	3151	5181	1099	0	0	0	**11520**
Alt 4	0	2090	3142	5138	1097	0	0	0	**11466**
Alt 5	0	2421	3672	4850	1007	0	0	0	**11951**
Percent change in flow from Existing Conditions									
Alt 1	0%	5%	13%	136%	182%	0%	0%	0%	**19%**
Alt 2	0%	13%	32%	109%	144%	0%	0%	0%	**26%**
Alt 3	0%	12%	29%	181%	250%	0%	0%	0%	**32%**
Alt 4	0%	12%	28%	179%	250%	0%	0%	0%	**31%**
Alt 5	0%	14%	33%	169%	229%	0%	0%	0%	**33%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**1049**	**3723**	**2658**	**374**	**0**	**0**	**0**	**0**	**7804**
All Alternatives	1049	3723	2658	374	0	0	0	0	**7804**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**2808**	**20532**	**14280**	**892**	**0**	**0**	**0**	**0**	**38512**
Alt 1	2808	21384	16116	17029	6532	0	0	0	**63870**
Alt 2	2808	29670	22293	15516	3636	0	0	0	**73923**
Alt 3	2808	29003	21738	19215	6177	0	0	0	**78940**
Alt 4	2808	29000	21729	19084	6153	0	0	0	**78775**
Alt 5	2808	29676	21745	18463	4851	0	0	0	**77543**

Table A-6 (cont'd). Windy Gap Diversions (AF).

Flow change from Existing Conditions

Alt 1	0	852	1836	16137	6532	0	0	0	**25357**
Alt 2	0	9138	8013	14624	3636	0	0	0	**35411**
Alt 3	0	8471	7458	18323	6177	0	0	0	**40428**
Alt 4	0	8468	7449	18192	6153	0	0	0	**40262**
Alt 5	0	9144	7465	17571	4851	0	0	0	**39031**

Percent change in flow from Existing Conditions

Alt 1	0%	4%	13%	1809%	0%	0%	0%	0%	**66%**
Alt 2	0%	45%	56%	1639%	0%	0%	0%	0%	**92%**
Alt 3	0%	41%	52%	2054%	0%	0%	0%	0%	**105%**
Alt 4	0%	41%	52%	2039%	0%	0%	0%	0%	**105%**
Alt 5	0%	45%	52%	1970%	0%	0%	0%	0%	**101%**

Table A-7. Big Thompson River Streamflow below Lake Estes (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**39**	**176**	**410**	**186**	**114**	**59**	**39**	**26**	**92**
Alt 1	39	176	415	188	114	59	39	26	**93**
Alt 2	40	191	425	204	117	60	40	26	**97**
Alt 3	40	183	415	189	114	59	39	26	**93**
Alt 4	40	183	415	189	114	59	39	26	**93**
Alt 5	40	185	418	191	115	59	39	26	**94**
Flow change from Existing Conditions									
Alt 1	0	0	5	2	0	0	0	0	**1**
Alt 2	1	15	14	18	3	1	1	0	**4**
Alt 3	1	7	5	3	0	0	0	0	**1**
Alt 4	1	7	5	3	0	0	0	0	**1**
Alt 5	1	10	7	5	1	0	0	0	**2**
Percent change in flow from Existing Conditions									
Alt 1	0%	0%	1%	1%	0%	0%	0%	0%	**1%**
Alt 2	2%	9%	4%	9%	3%	1%	2%	1%	**5%**
Alt 3	2%	4%	1%	2%	0%	0%	0%	0%	**1%**
Alt 4	2%	4%	1%	2%	0%	0%	0%	0%	**1%**
Alt 5	2%	5%	2%	2%	1%	0%	0%	1%	**2%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**36**	**165**	**274**	**156**	**97**	**50**	**38**	**23**	**74**
All Alternatives	36	165	274	157	97	50	38	23	**74**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**38**	**128**	**362**	**328**	**162**	**65**	**38**	**25**	**101**
Alt 1	38	128	363	328	162	65	38	25	**101**
Alt 2	37	134	381	336	162	65	38	25	**103**
Alt 3	38	128	363	328	162	65	38	25	**101**
Alt 4	38	128	363	328	162	65	38	25	**101**
Alt 5	38	128	363	328	162	65	38	25	**101**

Table A-7 (cont'd). Big Thompson River Streamflow below Lake Estes (cfs).

Flow change from Existing Conditions

Alt 1	0	0	0	0	0	0	0	0	**0**
Alt 2	0	6	19	8	0	0	0	0	**3**
Alt 3	0	0	0	0	0	0	0	0	**0**
Alt 4	0	0	0	0	0	0	0	0	**0**
Alt 5	0	0	0	0	0	0	0	0	**0**

Percent change in flow from Existing Conditions

Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Alt 2	-1%	4%	5%	2%	0%	0%	0%	0%	**3%**
Alt 3	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Alt 4	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	**0%**

Table A-8. Colorado River Streamflow below Lake Granby at USGS gage (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**20**	**84**	**400**	**258**	**68**	**28**	**25**	**20**	**82**
Alt 1	20	83	363	232	65	28	24	20	**76**
Alt 2	20	81	310	213	56	27	24	20	**69**
Alt 3	20	82	332	218	59	28	24	20	**72**
Alt 4	20	82	332	218	59	28	24	20	**72**
Alt 5	20	82	331	217	58	28	24	20	**72**
				Flow change from Existing Conditions					
Alt 1	0	-1	-37	-26	-3	0	-1	0	**-6**
Alt 2	0	-3	-90	-45	-13	-1	-1	0	**-13**
Alt 3	0	-2	-68	-40	-10	0	-1	0	**-10**
Alt 4	0	-2	-68	-40	-10	0	-1	0	**-10**
Alt 5	0	-2	-69	-41	-10	0	-1	0	**-10**
				Percent change in flow from Existing Conditions					
Alt 1	0%	-1%	-9%	-10%	-4%	-2%	-4%	0%	**-7%**
Alt 2	0%	-3%	-23%	-17%	-18%	-3%	-3%	2%	**-15%**
Alt 3	0%	-3%	-17%	-15%	-14%	-1%	-4%	0%	**-12%**
Alt 4	0%	-3%	-17%	-15%	-14%	-1%	-4%	0%	**-12%**
Alt 5	0%	-3%	-17%	-16%	-15%	-1%	-4%	0%	**-13%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**20**	**57**	**57**	**57**	**30**	**20**	**20**	**20**	**30**
All Alternatives	20	57	57	57	30	20	20	20	**30**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**20**	**181**	**886**	**896**	**245**	**33**	**20**	**20**	**199**
Alt 1	20	180	886	769	245	35	20	20	**189**
Alt 2	20	184	899	721	167	37	20	24	**180**
Alt 3	20	189	886	747	192	31	20	20	**183**
Alt 4	20	189	886	747	192	31	20	20	**183**
Alt 5	20	189	880	743	178	31	20	20	**181**
				Flow change from Existing Conditions					
Alt 1	0	-1	0	-127	0	2	0	0	**-11**
Alt 2	0	2	14	-175	-77	4	0	4	**-19**
Alt 3	0	8	0	-149	-52	-3	0	0	**-17**
Alt 4	0	8	0	-149	-52	-3	0	0	**-17**
Alt 5	0	8	-6	-153	-66	-3	0	0	**-19**
				Percent change in flow from Existing Conditions					
Alt 1	0%	-1%	0%	-14%	0%	6%	0%	0%	**-5%**
Alt 2	0%	1%	2%	-20%	-32%	11%	0%	18%	**-10%**
Alt 3	0%	5%	0%	-17%	-21%	-8%	0%	0%	**-8%**
Alt 4	0%	5%	0%	-17%	-21%	-8%	0%	0%	**-8%**
Alt 5	0%	4%	-1%	-17%	-27%	-9%	0%	0%	**-9%**

Table A-9. Colorado River Streamflow above Windy Gap (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**213**	**545**	**1137**	**519**	**168**	**83**	**79**	**78**	**260**
Alt 1	213	544	1084	487	164	82	78	78	**252**
Alt 2	213	540	1020	462	152	82	78	79	**243**
Alt 3	213	541	1047	469	156	82	78	78	**246**
Alt 4	213	541	1047	469	156	82	78	78	**246**
Alt 5	213	540	1045	467	155	82	78	78	**246**

Flow change from Existing Conditions

Alt 1	0	-1	-52	-32	-3	0	-1	0	**-7**
Alt 2	0	-5	-117	-57	-16	-1	-1	0	**-16**
Alt 3	0	-4	-90	-50	-12	0	-1	0	**-13**
Alt 4	0	-4	-90	-50	-12	0	-1	0	**-13**
Alt 5	0	-4	-91	-52	-12	0	-1	0	**-13**

Percent change in flow from Existing Conditions

Alt 1	0%	0%	-5%	-6%	-2%	-1%	-1%	0%	**-3%**
Alt 2	0%	-1%	-10%	-11%	-9%	-1%	-1%	1%	**-6%**
Alt 3	0%	-1%	-8%	-10%	-7%	0%	-1%	0%	**-5%**
Alt 4	0%	-1%	-8%	-10%	-7%	0%	-1%	0%	**-5%**
Alt 5	0%	-1%	-8%	-10%	-7%	0%	-2%	0%	**-5%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**145**	**197**	**187**	**133**	**94**	**66**	**67**	**74**	**104**
All Alternatives	145	197	187	133	94	66	67	74	**104**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**179**	**1041**	**2660**	**1730**	**462**	**124**	**82**	**86**	**558**
Alt 1	179	1040	2604	1565	462	126	82	86	**539**
Alt 2	179	1044	2618	1517	367	128	82	89	**529**
Alt 3	179	1050	2605	1543	397	121	82	87	**533**
Alt 4	179	1050	2605	1543	398	121	82	87	**533**
Alt 5	179	1049	2598	1540	383	121	82	87	**531**

Flow change from Existing Conditions

Alt 1	0	-1	-56	-165	0	2	0	0	**-19**
Alt 2	0	2	-42	-213	-95	4	0	3	**-29**
Alt 3	0	8	-55	-187	-64	-3	0	2	**-25**
Alt 4	0	8	-55	-187	-64	-3	0	2	**-25**
Alt 5	0	8	-62	-190	-78	-3	0	2	**-27**

Percent change in flow from Existing Conditions

Alt 1	0%	0%	-2%	-10%	0%	2%	0%	0%	**-3%**
Alt 2	0%	0%	-2%	-12%	-21%	3%	0%	4%	**-5%**
Alt 3	0%	1%	-2%	-11%	-14%	-2%	0%	2%	**-5%**
Alt 4	0%	1%	-2%	-11%	-14%	-2%	0%	2%	**-5%**
Alt 5	0%	1%	-2%	-11%	-17%	-2%	0%	2%	**-5%**

Table A-10. Colorado River Streamflow below Windy Gap at USGS gage (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**137**	**258**	**951**	**472**	**161**	**83**	**79**	**78**	**209**
Alt 1	137	242	875	377	144	82	78	78	**192**
Alt 2	137	217	774	365	135	82	78	79	**180**
Alt 3	137	220	808	338	131	82	78	78	**180**
Alt 4	137	220	808	339	131	82	78	78	**180**
Alt 5	137	214	798	341	132	82	78	78	**179**

Flow change from Existing Conditions

Alt 1	0	-16	-76	-95	-16	0	-1	0	**-17**
Alt 2	0	-41	-177	-108	-26	-1	-1	0	**-29**
Alt 3	0	-38	-143	-135	-30	0	-1	0	**-29**
Alt 4	0	-38	-143	-134	-29	0	-1	0	**-29**
Alt 5	0	-44	-153	-131	-29	0	-1	0	**-30**

Percent change in flow from Existing Conditions

Alt 1	0%	-6%	-8%	-20%	-10%	-1%	-1%	0%	**-8%**
Alt 2	0%	-16%	-19%	-23%	-16%	-1%	-1%	1%	**-14%**
Alt 3	0%	-15%	-15%	-28%	-18%	0%	-1%	0%	**-14%**
Alt 4	0%	-15%	-15%	-28%	-18%	0%	-1%	0%	**-14%**
Alt 5	0%	-17%	-16%	-28%	-18%	0%	-2%	0%	**-14%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**127**	**136**	**142**	**127**	**94**	**66**	**67**	**74**	**93**
All Alternatives	127	136	142	127	94	66	67	74	**93**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**132**	**707**	**2420**	**1716**	**462**	**124**	**82**	**86**	**505**
Alt 1	132	692	2333	1288	355	126	82	86	**451**
Alt 2	132	561	2243	1265	308	128	82	89	**427**
Alt 3	132	578	2239	1231	297	121	82	87	**423**
Alt 4	132	578	2239	1233	297	121	82	87	**424**
Alt 5	132	566	2233	1239	305	121	82	87	**423**

Flow change from Existing Conditions

Alt 1	0	-15	-87	-427	-106	2	0	0	**-54**
Alt 2	0	-146	-177	-450	-154	4	0	3	**-78**
Alt 3	0	-130	-181	-485	-165	-3	0	2	**-81**
Alt 4	0	-129	-181	-483	-164	-3	0	2	**-81**
Alt 5	0	-141	-187	-476	-157	-3	0	2	**-81**

Percent change in flow from Existing Conditions

Alt 1	0%	-2%	-4%	-25%	-23%	2%	0%	0%	**-11%**
Alt 2	0%	-21%	-7%	-26%	-33%	3%	0%	4%	**-15%**
Alt 3	0%	-18%	-7%	-28%	-36%	-2%	0%	2%	**-16%**
Alt 4	0%	-18%	-7%	-28%	-36%	-2%	0%	2%	**-16%**
Alt 5	0%	-20%	-8%	-28%	-34%	-2%	0%	2%	**-16%**

Table A-11. Willow Creek Streamflow at USGS/NCWCD gage (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**6**	**51**	**143**	**32**	**12**	**3**	**8**	**8**	**25**
Alt 1	6	51	127	26	11	3	8	8	**23**
Alt 2	6	49	116	20	9	4	8	8	**22**
Alt 3	6	50	121	22	10	3	8	8	**22**
Alt 4	6	50	121	22	10	3	8	8	**22**
Alt 5	6	49	120	21	10	3	7	8	**22**
Flow change from Existing Conditions									
Alt 1	0	0	-16	-6	-1	0	0	0	**-2**
Alt 2	0	-2	-27	-11	-3	0	0	0	**-4**
Alt 3	0	-1	-22	-10	-2	0	0	0	**-3**
Alt 4	0	-1	-22	-10	-2	0	0	0	**-3**
Alt 5	0	-2	-23	-11	-2	0	0	0	**-3**
Percent change in flow from Existing Conditions									
Alt 1	0%	0%	-11%	-19%	-5%	0%	0%	0%	**-7%**
Alt 2	0%	-4%	-19%	-36%	-25%	3%	0%	1%	**-14%**
Alt 3	0%	-3%	-15%	-32%	-18%	0%	-1%	3%	**-12%**
Alt 4	0%	-3%	-15%	-32%	-18%	0%	-1%	3%	**-12%**
Alt 5	0%	-4%	-16%	-34%	-16%	0%	-4%	3%	**-12%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**4**	**0**	**10**	**0**	**2**	**2**	**6**	**7**	**5**
All Alternatives	4	0	10	0	2	2	6	7	**5**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**5**	**184**	**434**	**112**	**58**	**14**	**7**	**11**	**73**
Alt 1	5	184	378	75	58	14	7	11	**65**
Alt 2	5	184	378	75	40	14	7	11	**64**
Alt 3	5	184	378	75	46	14	7	12	**64**
Alt 4	5	184	378	75	46	14	7	12	**64**
Alt 5	5	184	378	75	46	14	7	13	**64**
Flow change from Existing Conditions									
Alt 1	0	0	-56	-38	0	0	0	0	**-8**
Alt 2	0	0	-56	-38	-18	0	0	0	**-9**
Alt 3	0	0	-56	-38	-12	0	0	2	**-9**
Alt 4	0	0	-56	-38	-12	0	0	2	**-9**
Alt 5	0	0	-56	-38	-12	0	0	2	**-9**
Percent change in flow from Existing Conditions									
Alt 1	0%	0%	-13%	-34%	0%	0%	0%	0%	**-11%**
Alt 2	0%	0%	-13%	-34%	-30%	0%	0%	0%	**-13%**
Alt 3	0%	0%	-13%	-34%	-20%	0%	0%	15%	**-12%**
Alt 4	0%	0%	-13%	-34%	-20%	0%	0%	15%	**-12%**
Alt 5	0%	0%	-13%	-34%	-20%	0%	0%	18%	**-12%**

Table A-12. Colorado River Streamflow at Hot Sulphur Springs at USGS/NCWCD gage (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**146**	**278**	**953**	**482**	**170**	**87**	**87**	**83**	**216**
Alt 1	146	262	877	386	153	87	86	83	**199**
Alt 2	146	237	776	374	144	86	86	84	**187**
Alt 3	146	240	810	347	140	87	86	84	**187**
Alt 4	146	240	810	348	140	87	86	84	**187**
Alt 5	146	235	800	351	141	87	86	84	**186**
Flow change from Existing Conditions									
Alt 1	0	-16	-76	-95	-16	0	-1	0	**-17**
Alt 2	0	-41	-177	-108	-26	-1	-1	0	**-29**
Alt 3	0	-38	-143	-135	-30	0	-1	0	**-29**
Alt 4	0	-38	-143	-134	-29	0	-1	0	**-29**
Alt 5	0	-44	-153	-131	-29	0	-1	0	**-30**
Percent change in flow from Existing Conditions									
Alt 1	0%	-6%	-8%	-20%	-10%	-1%	-1%	0%	**-8%**
Alt 2	0%	-15%	-19%	-22%	-15%	-1%	-1%	1%	**-14%**
Alt 3	0%	-14%	-15%	-28%	-17%	0%	-1%	0%	**-13%**
Alt 4	0%	-14%	-15%	-28%	-17%	0%	-1%	0%	**-13%**
Alt 5	0%	-16%	-16%	-27%	-17%	0%	-2%	0%	**-14%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**137**	**137**	**139**	**142**	**101**	**67**	**75**	**80**	**98**
All Alternatives	137	137	139	142	101	67	75	80	**98**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**150**	**730**	**2414**	**1709**	**468**	**127**	**90**	**90**	**511**
Alt 1	150	715	2328	1282	361	129	90	90	**457**
Alt 2	150	584	2237	1259	314	130	90	93	**433**
Alt 3	150	601	2234	1224	303	124	90	91	**430**
Alt 4	150	601	2234	1227	303	124	90	91	**430**
Alt 5	150	589	2227	1233	311	124	90	92	**429**
Flow change from Existing Conditions									
Alt 1	0	-15	-87	-427	-106	2	0	0	**-54**
Alt 2	0	-146	-177	-450	-154	4	0	3	**-78**
Alt 3	0	-130	-181	-485	-165	-3	0	2	**-81**
Alt 4	0	-129	-181	-483	-164	-3	0	2	**-81**
Alt 5	0	-141	-187	-476	-157	-3	0	2	**-81**
Percent change in flow from Existing Conditions									
Alt 1	0%	-2%	-4%	-25%	-23%	2%	0%	0%	**-10%**
Alt 2	0%	-20%	-7%	-26%	-33%	3%	0%	4%	**-15%**
Alt 3	0%	-18%	-7%	-28%	-35%	-2%	0%	2%	**-16%**
Alt 4	0%	-18%	-7%	-28%	-35%	-2%	0%	2%	**-16%**
Alt 5	0%	-19%	-8%	-28%	-34%	-2%	0%	2%	**-16%**

Table A-13. Colorado River below Williams Fork (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**186**	**308**	**1194**	**735**	**276**	**191**	**232**	**209**	**341**
Alt 1	186	292	1118	641	261	190	231	208	**324**
Alt 2	186	267	1017	629	251	190	231	209	**312**
Alt 3	186	270	1051	602	247	190	231	209	**312**
Alt 4	186	270	1051	603	247	190	231	209	**312**
Alt 5	186	264	1041	606	248	190	230	209	**311**
Flow change from Existing Conditions									
Alt 1	0	-16	-76	-94	-15	-1	-1	0	**-17**
Alt 2	0	-41	-176	-106	-24	-1	-1	0	**-29**
Alt 3	0	-38	-143	-133	-28	-1	-1	0	**-29**
Alt 4	0	-38	-143	-132	-28	-1	-1	0	**-29**
Alt 5	0	-44	-153	-129	-27	-1	-2	0	**-30**
Percent change in flow from Existing Conditions									
Alt 1	0%	-5%	-6%	-13%	-5%	-1%	-1%	0%	**-5%**
Alt 2	0%	-13%	-15%	-14%	-9%	-1%	-1%	0%	**-9%**
Alt 3	0%	-12%	-12%	-18%	-10%	0%	-1%	0%	**-9%**
Alt 4	0%	-12%	-12%	-18%	-10%	0%	-1%	0%	**-8%**
Alt 5	0%	-14%	-13%	-18%	-10%	0%	-1%	0%	**-9%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**190**	**148**	**146**	**338**	**266**	**178**	**214**	**206**	**204**
All Alternatives	190	148	146	338	266	178	214	206	**204**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**216**	**803**	**2965**	**2314**	**639**	**215**	**242**	**220**	**704**
Alt 1	216	788	2878	1887	533	217	242	220	**651**
Alt 2	216	657	2787	1864	485	219	242	223	**626**
Alt 3	216	674	2784	1829	475	212	242	222	**623**
Alt 4	216	674	2784	1832	475	212	242	222	**623**
Alt 5	216	662	2778	1838	482	212	242	222	**623**
Flow change from Existing Conditions									
Alt 1	0	-15	-87	-427	-106	2	0	0	**-54**
Alt 2	0	-146	-177	-450	-154	4	0	3	**-78**
Alt 3	0	-130	-181	-485	-165	-3	0	2	**-81**
Alt 4	0	-129	-181	-483	-164	-3	0	2	**-81**
Alt 5	0	-141	-187	-476	-157	-3	0	2	**-81**
Percent change in flow from Existing Conditions									
Alt 1	0%	-2%	-3%	-18%	-17%	1%	0%	0%	**-8%**
Alt 2	0%	-18%	-6%	-19%	-24%	2%	0%	2%	**-11%**
Alt 3	0%	-16%	-6%	-21%	-26%	-1%	0%	1%	**-12%**
Alt 4	0%	-16%	-6%	-21%	-26%	-1%	0%	1%	**-11%**
Alt 5	0%	-18%	-6%	-21%	-25%	-1%	0%	1%	**-12%**

Table A-14. Colorado River Streamflow near Kremmling at USGS gage (cfs).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Exist. Conditions	**664**	**1145**	**2619**	**1745**	**1026**	**909**	**832**	**583**	**969**
Alt 1	664	1129	2542	1660	1010	901	830	583	**952**
Alt 2	664	1104	2442	1647	1002	899	830	583	**940**
Alt 3	664	1107	2476	1620	998	901	830	583	**940**
Alt 4	664	1107	2476	1621	998	901	830	583	**940**
Alt 5	664	1101	2466	1624	999	901	830	583	**939**

Flow change from Existing Conditions

Alt 1	0	-15	-76	-85	-16	-8	-1	0	**-17**
Alt 2	0	-40	-176	-98	-24	-10	-1	0	**-29**
Alt 3	0	-37	-143	-125	-28	-8	-2	0	**-29**
Alt 4	0	-37	-142	-124	-28	-8	-2	0	**-29**
Alt 5	0	-43	-153	-121	-28	-8	-2	0	**-30**

Percent change in flow from Existing Conditions

Alt 1	0%	-1%	-3%	-5%	-2%	-1%	0%	0%	**-2%**
Alt 2	0%	-4%	-7%	-6%	-2%	-1%	0%	0%	**-3%**
Alt 3	0%	-3%	-5%	-7%	-3%	-1%	0%	0%	**-3%**
Alt 4	0%	-3%	-5%	-7%	-3%	-1%	0%	0%	**-3%**
Alt 5	0%	-4%	-6%	-7%	-3%	-1%	0%	0%	**-3%**

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**615**	**422**	**473**	**924**	**943**	**866**	**674**	**547**	**622**
All Alternatives	615	422	473	924	943	866	674	547	**622**

No change in flow between Existing Conditions and all other alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**764**	**2231**	**5885**	**4725**	**1694**	**945**	**804**	**633**	**1681**
Alt 1	764	2216	5798	4298	1588	947	804	633	**1627**
Alt 2	764	2086	5707	4274	1540	948	804	637	**1603**
Alt 3	764	2102	5704	4240	1529	942	804	635	**1600**
Alt 4	764	2102	5704	4242	1530	942	804	635	**1600**
Alt 5	764	2091	5697	4249	1537	942	804	635	**1600**

Flow change from Existing Conditions

Alt 1	0	-15	-87	-427	-106	2	0	0	**-54**
Alt 2	0	-145	-178	-450	-154	4	0	4	**-78**
Alt 3	0	-129	-182	-485	-165	-3	0	2	**-81**
Alt 4	0	-129	-181	-483	-164	-3	0	2	**-81**
Alt 5	0	-140	-188	-476	-157	-3	0	2	**-81**

Percent change in flow from Existing Conditions

Alt 1	0%	-1%	-1%	-9%	-6%	0%	0%	0%	**-3%**
Alt 2	0%	-7%	-3%	-10%	-9%	0%	0%	1%	**-5%**
Alt 3	0%	-6%	-3%	-10%	-10%	0%	0%	0%	**-5%**
Alt 4	0%	-6%	-3%	-10%	-10%	0%	0%	0%	**-5%**
Alt 5	0%	-6%	-3%	-10%	-9%	0%	0%	0%	**-5%**

Table A-15. Colorado River at Hot Sulphur Springs Channel Maintenance Flows (1950-1996).

				Average flow (cfs)					
Recurrence Interval	**Flow Range**	**Range of dates flow occurs**	**When most of flow occurs**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alternative 3**	**Alternative 4**	**Alternative 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	late March to mid-October	May through July	768	783	783	784	795	802
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	May 1 to late September	June and July	2,018	2,050	2,039	2,041	2,047	2,054
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	late May to mid-July	June	3,750	3,713	3,756	3,757	3,736	3,772
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	late May to mid-July	June	5,016	5,290	5,359	5,360	5,337	5,298
At or greater than 25-yr flow	**6,520 cfs or greater**	12-Jul	one day	6,545	-	-	-	-	-

		Average Number of Days/Year Flow Occurs				Percentage of Years Flow Occurs			
Recurrence Interval	**Flow Range**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alts 3 - 5**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alts 3 - 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	23	21	19	19-20	62%	53%	53%	51-53%
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	23.5	21.5	22	22	38%	36%	34%	34%
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	10	10	11	11	28%	26%	19%	17-19%
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	4	4.2	5.3	5.3	13%	11%	6%	6%
At or greater than 25-yr flow	**6,520 cfs or greater**	1	0	0	0	2%	0%	0%	0%

		Number of Days/Year Flow Occurs in 47-yr model period					
Recurrence Interval	**Flow Range**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alternative 3**	**Alternative 4**	**Alternative 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	663	520	466	466	457	490
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	423	365	346	348	342	353
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	135	118	96	96	95	82
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	24	21	16	16	16	18
At or greater than 25-yr flow	**6,520 cfs or greater**	1	0	0	0	0	0

Table A-16. Colorado River Stage below Windy Gap Reservoir at USGS gage (feet).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**0.68**	**0.90**	**1.81**	**1.19**	**0.71**	**0.58**	**0.57**	**0.57**
Alt 1	0.67	0.88	1.71	1.05	0.69	0.58	0.57	0.57
Alt 2	0.67	0.83	1.59	1.03	0.67	0.58	0.57	0.57
Alt 3	0.67	0.84	1.63	0.99	0.66	0.58	0.57	0.57
Alt 4	0.67	0.84	1.63	1.00	0.66	0.58	0.57	0.57
Alt 5	0.67	0.83	1.61	1.00	0.67	0.58	0.57	0.57
Change in stage from existing conditions								
Alt 1	0.00	-0.03	-0.10	-0.13	-0.03	0.00	0.00	0.00
Alt 2	0.00	-0.07	-0.22	-0.16	-0.04	0.00	0.00	0.00
Alt 3	0.00	-0.06	-0.18	-0.19	-0.05	0.00	0.00	0.00
Alt 4	0.00	-0.06	-0.18	-0.19	-0.05	0.00	0.00	0.00
Alt 5	0.00	-0.07	-0.19	-0.19	-0.05	0.00	0.00	0.00
Percent change in stage from existing conditions								
Alt 1	-0.1%	-3.0%	-5.4%	-11.3%	-4.0%	-0.2%	-0.3%	0.0%
Alt 2	-0.3%	-7.8%	-12.2%	-13.2%	-6.1%	-0.3%	-0.2%	0.1%
Alt 3	-0.3%	-7.1%	-10.1%	-16.2%	-7.0%	-0.2%	-0.3%	0.1%
Alt 4	-0.3%	-7.1%	-10.0%	-16.1%	-7.0%	-0.2%	-0.3%	0.1%
Alt 5	-0.3%	-8.1%	-10.7%	-15.8%	-6.8%	-0.2%	-0.4%	0.1%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**0.65**	**0.67**	**0.68**	**0.65**	**0.60**	**0.55**	**0.55**	**0.57**
All Alternatives	0.65	0.67	0.68	0.65	0.60	0.55	0.55	0.57

No change in stage between Existing Conditions and all alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**0.69**	**1.58**	**3.20**	**2.59**	**1.19**	**0.66**	**0.58**	**0.59**
Alt 1	0.69	1.56	3.12	2.19	1.03	0.67	0.58	0.59
Alt 2	0.68	1.39	3.05	2.16	0.96	0.66	0.58	0.59
Alt 3	0.68	1.41	3.05	2.13	0.95	0.66	0.58	0.59
Alt 4	0.68	1.41	3.05	2.13	0.95	0.66	0.58	0.59
Alt 5	0.68	1.39	3.04	2.14	0.96	0.65	0.58	0.59
Change in stage from existing conditions								
Alt 1	0.00	-0.02	-0.08	-0.40	-0.16	0.00	0.00	0.00
Alt 2	-0.01	-0.19	-0.15	-0.43	-0.23	0.00	0.00	0.01
Alt 3	-0.01	-0.17	-0.15	-0.46	-0.25	-0.01	0.00	0.00
Alt 4	-0.01	-0.17	-0.15	-0.46	-0.25	-0.01	0.00	0.00
Alt 5	-0.01	-0.19	-0.16	-0.45	-0.24	-0.01	0.00	0.00
Percent change in stage from existing conditions								
Alt 1	-0.1%	-1.4%	-2.4%	-15.4%	-13.7%	0.5%	0.0%	0.0%
Alt 2	-1.0%	-12.2%	-4.6%	-16.5%	-19.3%	0.2%	0.0%	1.0%
Alt 3	-0.8%	-10.9%	-4.7%	-17.9%	-20.8%	-1.1%	0.0%	0.5%
Alt 4	-0.8%	-10.9%	-4.7%	-17.8%	-20.7%	-1.1%	0.0%	0.5%
Alt 5	-0.9%	-11.8%	-4.9%	-17.5%	-19.8%	-1.3%	0.0%	0.6%

Table A-17. Colorado River Stage near Kremmling at USGS gage (feet).

Average Year (1950-1996)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**4.68**	**6.01**	**8.67**	**7.22**	**5.66**	**5.32**	**5.11**	**4.43**
Alt 1	4.68	5.97	8.55	7.06	5.62	5.30	5.11	4.43
Alt 2	4.68	5.91	8.39	7.03	5.60	5.30	5.11	4.43
Alt 3	4.68	5.92	8.44	6.98	5.59	5.30	5.11	4.43
Alt 4	4.68	5.92	8.44	6.98	5.59	5.30	5.11	4.43
Alt 5	4.68	5.90	8.43	6.99	5.59	5.30	5.11	4.43
Change in stage from existing conditions								
Alt 1	0.00	-0.04	-0.12	-0.17	-0.04	-0.02	0.00	0.00
Alt 2	0.00	-0.10	-0.28	-0.20	-0.06	-0.03	0.00	0.00
Alt 3	0.00	-0.09	-0.23	-0.25	-0.07	-0.02	0.00	0.00
Alt 4	0.00	-0.09	-0.23	-0.24	-0.07	-0.02	0.00	0.00
Alt 5	0.00	-0.11	-0.24	-0.24	-0.07	-0.02	-0.01	0.00
Percent change in stage from existing conditions								
Alt 1	0.0%	-0.7%	-1.4%	-2.3%	-0.7%	-0.4%	-0.1%	0.0%
Alt 2	-0.1%	-1.7%	-3.2%	-2.7%	-1.1%	-0.5%	-0.1%	0.0%
Alt 3	-0.1%	-1.6%	-2.6%	-3.4%	-1.3%	-0.4%	-0.1%	0.0%
Alt 4	-0.1%	-1.6%	-2.6%	-3.4%	-1.3%	-0.4%	-0.1%	0.0%
Alt 5	-0.1%	-1.8%	-2.8%	-3.3%	-1.2%	-0.4%	-0.1%	0.0%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**4.49**	**4.01**	**4.17**	**5.31**	**5.39**	**5.19**	**4.70**	**4.33**
All Alternatives	4.49	4.01	4.17	5.31	5.39	5.19	4.70	4.33

No change in stage between Existing Conditions and all alternatives in dry years.

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Exist. Conditions	**5.03**	**8.26**	**12.17**	**11.20**	**7.25**	**5.46**	**5.04**	**4.57**
Alt 1	5.03	8.23	12.08	10.81	7.03	5.46	5.04	4.57
Alt 2	5.02	8.02	12.01	10.79	6.93	5.46	5.04	4.58
Alt 3	5.02	8.04	12.01	10.76	6.91	5.44	5.04	4.58
Alt 4	5.02	8.04	12.01	10.76	6.91	5.44	5.04	4.58
Alt 5	5.02	8.02	12.00	10.76	6.93	5.44	5.04	4.58
Change in stage from existing conditions								
Alt 1	0.00	-0.03	-0.08	-0.39	-0.22	0.00	0.00	0.00
Alt 2	-0.01	-0.24	-0.16	-0.42	-0.31	0.00	0.00	0.01
Alt 3	-0.01	-0.22	-0.16	-0.45	-0.33	-0.02	0.00	0.00
Alt 4	-0.01	-0.22	-0.16	-0.45	-0.33	-0.02	0.00	0.00
Alt 5	-0.01	-0.23	-0.16	-0.44	-0.32	-0.02	0.00	0.01
Percent change in stage from existing conditions								
Alt 1	0.0%	-0.3%	-0.7%	-3.5%	-3.0%	0.0%	0.0%	0.0%
Alt 2	-0.2%	-2.9%	-1.3%	-3.7%	-4.3%	-0.1%	0.0%	0.2%
Alt 3	-0.2%	-2.6%	-1.3%	-4.0%	-4.6%	-0.3%	0.0%	0.1%
Alt 4	-0.2%	-2.6%	-1.3%	-4.0%	-4.6%	-0.3%	0.0%	0.1%
Alt 5	-0.2%	-2.8%	-1.4%	-3.9%	-4.4%	-0.3%	0.0%	0.1%

Table A-18. Carter Lake Elevations (feet).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5738**	**5746**	**5751**	**5753**	**5751**	**5741**	**5721**	**5707**	**5705**	**5709**	**5718**
Alt 1	5729	5738	5746	5751	5752	5750	5740	5720	5706	5704	5709	5718
Alt 2	5729	5737	5745	5750	5752	5750	5740	5721	5707	5704	5709	5718
Alt 3	5729	5738	5746	5751	5752	5751	5740	5720	5706	5704	5709	5719
Alt 4	5729	5738	5746	5751	5752	5751	5740	5720	5706	5704	5709	5719
Alt 5	5729	5738	5746	5751	5752	5750	5740	5720	5706	5704	5709	5719
Elevation change from existing conditions												
Alt 1	0	0	0	0	-1	-1	-1	-1	-1	-1	0	0
Alt 2	0	0	-1	-1	-1	-1	-1	0	0	-1	-1	0
Alt 3	0	0	0	0	0	-1	-1	-1	-1	0	0	0
Alt 4	0	0	0	0	0	-1	-1	-1	-1	0	0	0
Alt 5	0	0	0	0	-1	-1	-1	-1	-1	-1	0	0

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5738**	**5746**	**5753**	**5754**	**5750**	**5736**	**5716**	**5704**	**5704**	**5709**	**5718**
Alt 1	5729	5738	5746	5753	5754	5749	5736	5716	5704	5704	5709	5718
Alt 2	5729	5738	5747	5753	5754	5750	5736	5716	5705	5703	5708	5719
Alt 3	5729	5738	5746	5752	5754	5749	5736	5716	5704	5704	5708	5718
Alt 4	5729	5738	5746	5752	5754	5749	5736	5716	5704	5704	5708	5718
Alt 5	5729	5737	5745	5752	5753	5749	5735	5716	5704	5703	5708	5718
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	1	0	0	0	0	0	0	0	0	-1	-1	0
Alt 3	0	0	0	0	0	0	0	0	0	-1	0	0
Alt 4	0	0	0	0	0	0	0	0	0	-1	0	0
Alt 5	0	-1	-1	-1	-1	-1	-1	0	0	-1	-1	0

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5737**	**5746**	**5750**	**5752**	**5756**	**5753**	**5736**	**5718**	**5706**	**5711**	**5719**
Alt 1	5729	5737	5746	5750	5752	5755	5752	5734	5715	5705	5710	5719
Alt 2	5730	5738	5745	5748	5750	5754	5752	5734	5715	5706	5711	5720
Alt 3	5729	5738	5746	5751	5752	5755	5752	5735	5716	5706	5711	5720
Alt 4	5729	5738	5746	5751	5752	5755	5752	5735	5716	5706	5711	5719
Alt 5	5729	5738	5746	5750	5752	5755	5752	5734	5716	5705	5711	5719
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	-1	-1	-2	-2	-1	-1	0
Alt 2	1	1	-1	-2	-2	-2	-2	-2	-2	0	0	1
Alt 3	1	1	1	0	0	0	-1	-2	-2	0	0	1
Alt 4	1	1	1	0	0	0	-1	-2	-2	-1	0	1
Alt 5	1	1	0	0	0	-1	-1	-2	-2	-1	0	1

Table A-19. Carter Lake Surface Area (acres).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1016**	**1056**	**1092**	**1114**	**1119**	**1115**	**1070**	**980**	**913**	**901**	**924**	**968**
Alt 1	1016	1056	1092	1113	1117	1110	1064	974	908	898	922	967
Alt 2	1016	1054	1089	1110	1115	1111	1067	978	912	898	921	968
Alt 3	1018	1057	1093	1113	1118	1111	1066	976	910	899	923	970
Alt 4	1018	1057	1093	1113	1118	1111	1066	976	910	899	923	970
Alt 5	1017	1056	1091	1112	1117	1111	1065	976	910	897	922	969
Surface area change from existing conditions												
Alt 1	0	0	0	0	-2	-4	-6	-6	-5	-4	-2	-1
Alt 2	0	-1	-3	-4	-4	-4	-3	-2	-1	-4	-3	0
Alt 3	2	2	1	0	-1	-3	-5	-4	-3	-2	0	2
Alt 4	2	2	1	0	-1	-3	-5	-4	-3	-2	0	2
Alt 5	2	1	-1	-2	-2	-4	-5	-4	-3	-4	-2	1
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	-1%	-1%	-1%	0%	0%	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1017**	**1057**	**1093**	**1119**	**1124**	**1107**	**1048**	**956**	**900**	**901**	**922**	**967**
Alt 1	1017	1057	1093	1119	1123	1105	1046	955	900	898	922	967
Alt 2	1019	1058	1095	1120	1124	1107	1049	958	902	895	918	969
Alt 3	1017	1056	1093	1119	1123	1106	1047	955	900	897	920	967
Alt 4	1017	1056	1093	1119	1123	1106	1047	955	900	897	920	967
Alt 5	1015	1054	1089	1116	1122	1105	1046	954	898	893	917	966
Surface area change from existing conditions												
Alt 1	0	0	0	0	-1	-2	-2	-1	0	-2	0	0
Alt 2	2	1	1	1	0	0	1	2	2	-6	-4	2
Alt 3	0	0	-1	0	-1	-1	-1	-1	0	-4	-2	0
Alt 4	0	0	-1	0	-1	-1	-1	-1	0	-4	-2	0
Alt 5	-1	-3	-4	-3	-2	-2	-2	-2	-2	-7	-5	-1
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
Alt 3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1015**	**1054**	**1091**	**1111**	**1118**	**1130**	**1121**	**1049**	**964**	**909**	**934**	**970**
Alt 1	1015	1054	1091	1111	1116	1127	1116	1041	952	902	928	969
Alt 2	1019	1057	1088	1102	1109	1125	1115	1040	953	907	934	974
Alt 3	1018	1058	1093	1112	1118	1129	1116	1042	955	906	933	973
Alt 4	1018	1058	1093	1112	1118	1129	1116	1042	955	906	933	973
Alt 5	1018	1057	1091	1110	1117	1128	1116	1041	954	906	933	973
Surface area change from existing conditions												
Alt 1	0	0	0	0	-2	-3	-6	-9	-12	-6	-5	-2
Alt 2	4	3	-3	-9	-9	-5	-6	-9	-10	-2	0	4
Alt 3	3	3	3	1	0	-2	-5	-8	-8	-2	0	2
Alt 4	3	3	3	1	0	-2	-5	-8	-8	-2	0	2
Alt 5	3	2	0	-1	-1	-2	-6	-8	-10	-3	-1	2
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-1%	-1%	0%
Alt 2	0%	0%	0%	-1%	-1%	0%	-1%	-1%	-1%	0%	0%	0%
Alt 3	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%
Alt 4	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%

Table A-20. Horsetooth Reservoir Elevations (feet).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5395**	**5403**	**5410**	**5414**	**5416**	**5420**	**5418**	**5406**	**5396**	**5390**	**5388**	**5390**
Alt 1	5395	5402	5410	5413	5416	5420	5417	5405	5395	5390	5387	5390
Alt 2	5393	5401	5406	5407	5410	5414	5412	5401	5393	5388	5385	5387
Alt 3	5395	5403	5409	5412	5415	5419	5417	5405	5396	5390	5388	5390
Alt 4	5395	5403	5409	5412	5415	5419	5417	5405	5396	5390	5388	5390
Alt 5	5395	5402	5409	5411	5414	5418	5416	5404	5395	5390	5387	5389

Elevation change from existing conditions

Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	-2	-2	-4	-6	-6	-6	-6	-4	-3	-3	-3	-3
Alt 3	0	0	-1	-2	-1	-1	-1	-1	0	0	0	0
Alt 4	0	0	-1	-2	-1	-1	-1	-1	0	0	0	0
Alt 5	0	0	-1	-3	-2	-2	-2	-1	-1	0	-1	-1

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5394**	**5402**	**5410**	**5412**	**5411**	**5411**	**5405**	**5395**	**5386**	**5389**	**5386**	**5388**
Alt 1	5394	5403	5410	5412	5411	5411	5405	5394	5386	5389	5385	5388
Alt 2	5392	5400	5406	5405	5403	5402	5397	5388	5383	5386	5382	5385
Alt 3	5394	5403	5409	5410	5409	5408	5403	5393	5386	5389	5385	5388
Alt 4	5394	5403	5409	5410	5409	5408	5403	5393	5386	5389	5385	5388
Alt 5	5393	5402	5408	5408	5406	5406	5400	5391	5385	5388	5384	5387

Elevation change from existing conditions

Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	-2	-2	-4	-7	-8	-8	-9	-7	-3	-3	-3	-3
Alt 3	0	0	-1	-2	-2	-2	-2	-2	0	0	0	0
Alt 4	0	0	-1	-2	-2	-2	-2	-2	0	0	0	0
Alt 5	-1	-1	-2	-4	-5	-5	-5	-3	-1	-1	-1	-1

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5397**	**5403**	**5410**	**5414**	**5419**	**5425**	**5425**	**5415**	**5404**	**5393**	**5392**	**5393**
Alt 1	5396	5403	5410	5414	5419	5425	5424	5415	5404	5392	5391	5393
Alt 2	5396	5402	5406	5408	5413	5421	5421	5411	5400	5390	5390	5391
Alt 3	5397	5403	5410	5413	5418	5425	5424	5415	5405	5393	5393	5394
Alt 4	5397	5403	5410	5413	5418	5425	5424	5415	5405	5393	5393	5394
Alt 5	5397	5403	5409	5412	5418	5424	5424	5414	5404	5393	5393	5394

Elevation change from existing conditions

Alt 1	-1	0	-1	-1	0	0	0	0	0	-1	-1	-1
Alt 2	-1	-1	-4	-7	-6	-4	-3	-4	-4	-3	-2	-2
Alt 3	0	0	-1	-1	0	0	0	0	0	0	1	0
Alt 4	0	0	-1	-1	0	0	0	0	0	0	1	0
Alt 5	0	0	-1	-2	-1	-1	-1	-1	0	0	1	0

Table A-21. Horsetooth Reservoir Surface Area (acres).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1570**	**1664**	**1759**	**1803**	**1834**	**1892**	**1854**	**1703**	**1579**	**1505**	**1475**	**1505**
Alt 1	1569	1663	1757	1801	1832	1888	1849	1697	1574	1501	1471	1502
Alt 2	1546	1639	1706	1722	1751	1813	1781	1648	1541	1472	1438	1470
Alt 3	1570	1666	1748	1783	1818	1879	1842	1696	1576	1504	1474	1504
Alt 4	1570	1666	1748	1783	1818	1879	1842	1696	1576	1504	1474	1504
Alt 5	1566	1661	1741	1770	1804	1866	1830	1687	1570	1499	1468	1497
Surface area change from existing conditions												
Alt 1	-1	-1	-2	-2	-2	-4	-6	-6	-5	-4	-4	-3
Alt 2	-24	-24	-53	-81	-83	-79	-74	-55	-38	-33	-36	-35
Alt 3	0	2	-11	-21	-16	-14	-13	-7	-3	-1	-1	-1
Alt 4	0	2	-11	-21	-16	-14	-13	-7	-3	-1	-1	-1
Alt 5	-5	-2	-18	-33	-30	-26	-25	-16	-8	-6	-7	-8
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	-2%	-1%	-3%	-5%	-5%	-4%	-4%	-3%	-2%	-2%	-2%	-2%
Alt 3	0%	0%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%
Alt 4	0%	0%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%
Alt 5	0%	0%	-1%	-2%	-2%	-1%	-1%	-1%	-1%	0%	0%	-1%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1560**	**1661**	**1754**	**1778**	**1769**	**1764**	**1697**	**1565**	**1458**	**1491**	**1446**	**1482**
Alt 1	1561	1663	1757	1780	1771	1765	1694	1560	1454	1486	1445	1483
Alt 2	1531	1636	1702	1696	1675	1662	1588	1481	1411	1456	1402	1438
Alt 3	1560	1665	1743	1751	1741	1735	1668	1546	1452	1487	1441	1478
Alt 4	1560	1665	1743	1751	1741	1735	1668	1546	1452	1487	1441	1478
Alt 5	1547	1653	1726	1726	1710	1701	1631	1521	1444	1482	1431	1464
Surface area change from existing conditions												
Alt 1	1	3	3	2	2	1	-3	-6	-4	-4	-1	1
Alt 2	-29	-25	-52	-82	-94	-102	-109	-84	-46	-35	-44	-44
Alt 3	0	4	-12	-27	-28	-29	-29	-19	-6	-3	-5	-4
Alt 4	0	4	-12	-28	-28	-29	-29	-20	-6	-3	-5	-4
Alt 5	-13	-8	-29	-52	-59	-63	-66	-44	-14	-9	-15	-18
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	-2%	-1%	-3%	-5%	-5%	-6%	-6%	-5%	-3%	-2%	-3%	-3%
Alt 3	0%	0%	-1%	-2%	-2%	-2%	-2%	-1%	0%	0%	0%	0%
Alt 4	0%	0%	-1%	-2%	-2%	-2%	-2%	-1%	0%	0%	0%	0%
Alt 5	-1%	0%	-2%	-3%	-3%	-4%	-4%	-3%	-1%	-1%	-1%	-1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1594**	**1670**	**1760**	**1812**	**1872**	**1962**	**1955**	**1820**	**1684**	**1537**	**1532**	**1548**
Alt 1	1585	1664	1754	1806	1868	1960	1952	1815	1680	1529	1522	1537
Alt 2	1582	1656	1710	1727	1794	1907	1904	1766	1630	1505	1502	1523
Alt 3	1597	1675	1753	1799	1866	1959	1954	1821	1689	1543	1544	1554
Alt 4	1597	1675	1753	1799	1866	1959	1954	1821	1689	1543	1544	1554
Alt 5	1594	1673	1748	1787	1855	1952	1946	1813	1679	1538	1540	1550
Surface area change from existing conditions												
Alt 1	-8	-6	-6	-7	-4	-3	-4	-5	-5	-8	-11	-11
Alt 2	-12	-14	-49	-86	-79	-55	-51	-54	-54	-32	-30	-24
Alt 3	3	4	-7	-14	-7	-3	-2	1	4	6	12	6
Alt 4	3	4	-7	-14	-7	-3	-2	1	4	6	12	6
Alt 5	0	2	-12	-25	-18	-10	-9	-7	-6	1	7	2
Percent change in surface area from existing conditions												
Alt 1	-1%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-1%
Alt 2	-1%	-1%	-3%	-5%	-4%	-3%	-3%	-3%	-3%	-2%	-2%	-2%
Alt 3	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	1%	0%
Alt 4	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	1%	0%
Alt 5	0%	0%	-1%	-1%	-1%	-1%	0%	0%	0%	0%	0%	0%

Table A-22. Lake Granby Elevations (feet).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8258**	**8254**	**8250**	**8248**	**8253**	**8263**	**8268**	**8269**	**8268**	**8266**	**8264**	**8262**
Alt 1	8255	8251	8247	8245	8250	8260	8267	8267	8266	8264	8262	8259
Alt 2	8251	8246	8242	8241	8246	8257	8264	8264	8263	8260	8258	8255
Alt 3	8255	8251	8247	8245	8249	8259	8265	8266	8265	8263	8261	8259
Alt 4	8255	8251	8247	8245	8249	8259	8265	8266	8265	8263	8261	8259
Alt 5	8255	8251	8247	8246	8249	8259	8265	8266	8265	8263	8261	8259
Elevation change from existing conditions												
Alt 1	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	-2	-2
Alt 2	-7	-8	-8	-8	-7	-6	-5	-5	-5	-6	-6	-7
Alt 3	-3	-3	-3	-3	-4	-3	-3	-3	-3	-3	-3	-3
Alt 4	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Alt 5	-3	-3	-3	-2	-3	-4	-3	-3	-3	-3	-3	-3

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8263**	**8259**	**8255**	**8253**	**8253**	**8256**	**8255**	**8252**	**8248**	**8269**	**8270**	**8267**
Alt 1	8261	8257	8253	8250	8251	8254	8253	8250	8246	8267	8268	8265
Alt 2	8258	8253	8249	8247	8248	8250	8250	8245	8240	8264	8266	8263
Alt 3	8261	8256	8252	8251	8251	8253	8253	8249	8245	8266	8267	8265
Alt 4	8261	8256	8252	8251	8251	8253	8253	8249	8245	8266	8267	8265
Alt 5	8261	8256	8253	8251	8252	8254	8253	8249	8245	8266	8267	8265
Elevation change from existing conditions												
Alt 1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Alt 2	-5	-6	-6	-5	-5	-5	-5	-6	-8	-5	-4	-4
Alt 3	-3	-3	-2	-2	-2	-2	-2	-3	-3	-3	-3	-3
Alt 4	-3	-3	-2	-2	-2	-2	-2	-3	-3	-3	-3	-3
Alt 5	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	-3	-2

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8257**	**8254**	**8250**	**8248**	**8253**	**8266**	**8277**	**8280**	**8280**	**8265**	**8262**	**8260**
Alt 1	8253	8250	8245	8243	8248	8262	8275	8280	8280	8262	8259	8257
Alt 2	8248	8244	8240	8239	8245	8260	8274	8279	8280	8258	8254	8252
Alt 3	8253	8249	8246	8243	8248	8261	8274	8279	8279	8261	8257	8256
Alt 4	8253	8249	8246	8243	8248	8261	8274	8279	8279	8261	8257	8256
Alt 5	8253	8249	8246	8244	8248	8261	8274	8279	8279	8261	8257	8256
Elevation change from existing conditions												
Alt 1	-4	-4	-4	-5	-5	-4	-2	0	0	-3	-3	-4
Alt 2	-9	-10	-9	-9	-8	-6	-3	-1	-1	-7	-8	-8
Alt 3	-5	-5	-4	-4	-5	-5	-3	-1	-1	-4	-5	-5
Alt 4	-5	-5	-4	-4	-5	-5	-3	-1	-1	-4	-5	-5
Alt 5	-5	-5	-4	-4	-5	-5	-3	-1	-1	-4	-5	-5

Table A-23. Lake Granby Surface Area (acres).

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6221**	**6026**	**5824**	**5732**	**5970**	**6440**	**6722**	**6750**	**6691**	**6597**	**6512**	**6392**
Alt 1	6094	5891	5680	5584	5830	6327	6632	6662	6595	6493	6401	6274
Alt 2	5868	5644	5440	5359	5620	6159	6497	6524	6440	6324	6221	6075
Alt 3	6075	5880	5692	5600	5798	6270	6582	6610	6542	6445	6362	6246
Alt 4	6076	5880	5692	5601	5799	6271	6583	6611	6542	6446	6363	6246
Alt 5	6073	5878	5696	5609	5803	6265	6575	6607	6541	6445	6363	6245
Surface area change from existing conditions												
Alt 1	-127	-135	-144	-148	-140	-113	-90	-88	-96	-104	-111	-118
Alt 2	-353	-382	-384	-374	-351	-281	-225	-226	-251	-273	-290	-317
Alt 3	-146	-147	-132	-132	-172	-170	-140	-140	-149	-152	-150	-147
Alt 4	-145	-146	-132	-132	-171	-169	-140	-139	-149	-151	-149	-146
Alt 5	-148	-148	-128	-123	-167	-174	-147	-143	-150	-152	-149	-147
Percent change in surface area from existing conditions												
Alt 1	-2%	-2%	-2%	-3%	-2%	-2%	-1%	-1%	-1%	-2%	-2%	-2%
Alt 2	-6%	-6%	-7%	-7%	-6%	-4%	-3%	-3%	-4%	-4%	-4%	-5%
Alt 3	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-2%
Alt 4	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-2%
Alt 5	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-2%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6469**	**6263**	**6061**	**5957**	**5998**	**6108**	**6076**	**5910**	**5727**	**6751**	**6802**	**6662**
Alt 1	6381	6169	5960	5853	5894	6007	5975	5805	5611	6663	6723	6579
Alt 2	6224	5991	5787	5691	5734	5852	5817	5600	5336	6526	6606	6447
Alt 3	6346	6137	5950	5858	5890	5991	5955	5776	5574	6611	6675	6539
Alt 4	6347	6138	5950	5859	5890	5992	5956	5777	5574	6612	6675	6540
Alt 5	6350	6142	5964	5879	5914	6017	5983	5792	5573	6614	6679	6544
Surface area change from existing conditions												
Alt 1	-88	-94	-101	-104	-103	-100	-101	-106	-116	-88	-79	-83
Alt 2	-246	-273	-274	-266	-263	-256	-259	-311	-391	-225	-196	-215
Alt 3	-123	-126	-111	-99	-108	-116	-121	-135	-154	-140	-127	-123
Alt 4	-123	-126	-111	-98	-107	-116	-120	-134	-153	-139	-127	-122
Alt 5	-120	-121	-98	-78	-84	-91	-93	-118	-154	-137	-123	-119
Percent change in surface area from existing conditions												
Alt 1	-1%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-1%	-1%	-1%
Alt 2	-4%	-4%	-5%	-4%	-4%	-4%	-4%	-5%	-7%	-3%	-3%	-3%
Alt 3	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-3%	-2%	-2%	-2%
Alt 4	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-3%	-2%	-2%	-2%
Alt 5	-2%	-2%	-2%	-1%	-1%	-1%	-2%	-2%	-3%	-2%	-2%	-2%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6192**	**6013**	**5819**	**5714**	**5968**	**6619**	**7151**	**7298**	**7297**	**6545**	**6426**	**6339**
Alt 1	5999	5806	5599	5486	5745	6429	7068	7298	7295	6412	6256	6158
Alt 2	5738	5529	5352	5280	5581	6317	6984	7253	7270	6227	6043	5925
Alt 3	5966	5787	5607	5505	5718	6373	7019	7259	7262	6348	6188	6108
Alt 4	5967	5788	5608	5506	5719	6374	7020	7259	7262	6349	6189	6109
Alt 5	5964	5785	5611	5516	5722	6366	7003	7249	7261	6347	6186	6105
Surface area change from existing conditions												
Alt 1	-193	-207	-221	-228	-223	-190	-84	0	-2	-133	-170	-181
Alt 2	-454	-484	-468	-435	-388	-302	-167	-45	-27	-318	-383	-414
Alt 3	-226	-226	-212	-209	-250	-246	-132	-39	-35	-197	-238	-231
Alt 4	-225	-225	-211	-208	-250	-246	-132	-39	-35	-196	-238	-230
Alt 5	-228	-228	-208	-198	-246	-254	-148	-49	-36	-198	-240	-233
Percent change in surface area from existing conditions												
Alt 1	-3%	-3%	-4%	-4%	-4%	-3%	-1%	0%	0%	-2%	-3%	-3%
Alt 2	-7%	-8%	-8%	-8%	-6%	-5%	-2%	-1%	0%	-5%	-6%	-7%
Alt 3	-4%	-4%	-4%	-4%	-4%	-4%	-2%	-1%	0%	-3%	-4%	-4%
Alt 4	-4%	-4%	-4%	-4%	-4%	-4%	-2%	-1%	0%	-3%	-4%	-4%
Alt 5	-4%	-4%	-4%	-3%	-4%	-4%	-2%	-1%	0%	-3%	-4%	`-4%

Table A-24. Windy Gap Firming Project Participant Demands, Firm Yield, and Average Yield (AF), Cumulative Effects.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Dry Creek and Rockwell		
	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)
Oct	1,520	0	780	3,820	579	1,807	2,385	2,385	2,385	2,366	2,366	2,366
Nov	2,350	0	1,440	2,980	0	1,719	2,202	2,202	2,202	2,228	2,228	2,228
Dec	2,350	0	1,270	2,980	0	1,497	2,202	2,202	2,202	2,228	2,228	2,228
Jan	2,350	0	1,110	2,980	0	1,240	2,202	2,202	2,202	2,228	2,228	2,228
Feb	2,350	0	960	2,980	0	1,060	2,202	2,202	2,202	2,228	2,228	2,228
Mar	2,350	0	850	2,980	0	921	2,202	2,202	2,202	2,228	2,228	2,228
Apr	1,040	0	680	1,605	0	897	1,249	1,249	1,249	1,221	1,221	1,221
May	930	0	820	1,540	0	1,344	1,203	1,203	1,203	1,176	1,176	1,176
Jun	930	0	660	1,540	0	1070	1,203	1,203	1,203	1,176	1,176	1,176
Jul	1,490	0	960	3,020	0	2,247	1,992	1,992	1,992	1,970	1,970	1,970
Aug	1,500	0	910	3,420	0	2,235	2,189	2,189	2,189	2,168	2,168	2,168
Sep	1,520	0	830	3,820	0	2,112	2,385	2,385	2,385	2,366	2,366	2,366
Total	20,680	0	11,270	33,365	579	18,149	23,616	23,616	23,616	23,583	23,583	23,583

Table A-25. Windy Gap Firming Project Non-Participant Demands, Firm Yield, and Average Yield (AF), Cumulative Effects.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Dry Creek and Rockwell		
	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)
Oct	10	0	10	290	0	70	290	0	80	290	0	80
Nov	10	0	0	70	0	20	70	0	20	70	0	20
Dec	10	0	0	70	0	20	70	0	20	70	0	20
Jan	0	0	0	50	0	10	50	0	10	50	0	10
Feb	0	0	0	40	0	10	40	0	10	40	0	10
Mar	10	0	0	60	0	20	60	0	20	60	0	20
Apr	10	0	0	120	0	60	120	0	60	120	0	60
May	30	0	30	730	0	600	730	0	600	730	0	610
Jun	40	0	30	1,050	0	630	1,050	0	650	1,050	0	650
Jul	50	0	30	870	0	340	870	0	350	870	0	360
Aug	30	0	20	440	0	130	440	0	140	440	0	140
Sep	20	0	20	310	0	80	310	0	90	310	0	90
Total	220	0	140	4,100	0	1,990	4,100	0	2,050	4,100	0	2,070

Table A-26. Middle Park Water Conservancy District Demands, Firm Yield, and Average Yield (AF), Cumulative Effects.

Month	Existing Conditions			No Action			Chimney Hollow with Prepositioning			Dry Creek and Rockwell		
	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)	Demand (AF)	Firm Yield (AF)	Average Yield (AF)
Oct	21	0	15	429	0	289	429	0	407	429	0	409
Nov	21	0	15	429	0	274	429	0	401	429	0	401
Dec	21	0	15	429	0	274	429	0	401	429	0	401
Jan	21	0	15	429	0	269	429	0	397	429	0	397
Feb	21	0	15	429	0	260	429	0	387	429	0	392
Mar	21	0	15	429	0	255	429	0	347	429	0	338
Apr	0	0	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0
Sep	21	0	15	429	0	0	429	429	419	429	429	419
Total	147	0	105	3,000	0	1,922	3,000	429	2,759	3,000	429	2,757

Table A-27. Lake Granby Spills (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**0**	**0**	**0**	**0**	**18**	**352**	**216**	**41**	**10**	**5**	**0**	**0**	**53**
Alt 1	0	0	0	0	17	296	176	28	7	5	0	0	**44**
Alt 2	0	0	0	0	13	227	160	24	3	5	0	0	**36**
Alt 5	0	0	0	0	14	250	163	24	6	4	0	0	**39**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	-1	-56	-40	-13	-3	0	0	0	**-9**
Alt 2	0	0	0	0	-5	-125	-56	-17	-6	0	0	0	**-17**
Alt 5	0	0	0	0	-4	-102	-53	-16	-4	0	0	0	**-15**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	-5%	-16%	-18%	-32%	-29%	5%	0%	**0%**	-18%
Alt 2	0%	0%	0%	0%	-26%	-35%	-26%	-41%	-68%	2%	0%	**0%**	-32%
Alt 5	0%	0%	0%	0%	-23%	-29%	-24%	-40%	-38%	-6%	0%	**0%**	-28%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

Exist. Conditions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

Exist. Conditions	**0**	**0**	**0**	**0**	**123**	**845**	**887**	**249**	**23**	**0**	**0**	**0**	**178**
Alt 1	0	0	0	0	122	845	744	171	25	0	0	0	**160**
Alt 2	0	0	0	0	125	858	664	154	29	0	0	0	**153**
Alt 5	0	0	0	0	130	843	689	151	23	0	0	0	**154**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	-1	0	-144	-77	2	0	0	0	**-19**
Alt 2	0	0	0	0	2	13	-224	-95	6	0	0	0	**-25**
Alt 5	0	0	0	0	7	-2	-199	-98	0	0	0	0	**-25**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	-1%	0%	-16%	-31%	8%	0%	0%	**0%**	-11%
Alt 2	0%	0%	0%	0%	1%	2%	-25%	-38%	27%	0%	0%	**0%**	-14%
Alt 5	0%	0%	0%	0%	6%	0%	-22%	-39%	1%	0%	0%	**0%**	-14%

Table A-28. Adams Tunnel Diversions (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**409**	**523**	**417**	**285**	**430**	**406**	**224**	**206**	**263**	**252**	**225**	**404**	**336**
Alt 1	411	518	416	283	446	411	295	232	278	258	232	405	**348**
Alt 2	439	515	343	282	473	420	277	280	315	274	253	441	**359**
Alt 5	427	527	357	291	473	412	318	268	297	267	248	417	**358**
Flow change from Existing Conditions													
Alt 1	2	-5	-1	-2	17	5	71	26	15	6	8	1	**12**
Alt 2	31	-8	-74	-3	43	14	53	74	52	22	28	38	**23**
Alt 5	19	3	-60	6	43	6	94	63	34	15	23	13	**22**
Percent change in flow from Existing Conditions													
Alt 1	1%	-1%	0%	-1%	4%	1%	32%	13%	6%	2%	3%	**0%**	4%
Alt 2	7%	-2%	-18%	-1%	10%	3%	24%	36%	20%	9%	12%	**9%**	7%
Alt 5	5%	1%	-14%	2%	10%	1%	42%	30%	13%	6%	10%	**3%**	6%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**452**	**541**	**426**	**293**	**550**	**550**	**541**	**407**	**458**	**296**	**250**	**449**	**434**
Alt 1	456	541	426	293	550	550	538	399	462	299	261	449	**435**
Alt 2	507	550	364	293	550	550	550	543	530	301	278	484	**458**
Alt 5	494	550	364	293	550	550	550	498	486	302	276	467	**448**
Flow change from Existing Conditions													
Alt 1	4	0	0	0	0	0	-3	-8	4	3	10	0	**1**
Alt 2	55	9	-62	0	0	0	9	136	73	6	27	36	**24**
Alt 5	42	9	-62	0	0	0	9	91	28	6	26	19	**14**
Percent change in flow from Existing Conditions													
Alt 1	1%	0%	0%	0%	0%	0%	0%	-2%	1%	1%	4%	**0%**	0%
Alt 2	12%	2%	-15%	0%	0%	0%	2%	33%	16%	2%	11%	**8%**	6%
Alt 5	9%	2%	-15%	0%	0%	0%	2%	22%	6%	2%	10%	**4%**	3%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**372**	**497**	**426**	**293**	**255**	**134**	**85**	**105**	**116**	**219**	**168**	**340**	**250**
Alt 1	385	500	426	288	307	135	134	210	118	222	185	348	**271**
Alt 2	399	457	297	250	374	153	106	133	150	241	211	379	**262**
Alt 5	389	507	364	293	386	135	144	167	166	236	195	340	**276**
Flow change from Existing Conditions													
Alt 1	13	3	0	-5	52	0	49	106	2	3	17	8	**21**
Alt 2	26	-40	-129	-43	118	18	21	28	34	21	43	39	**12**
Alt 5	16	9	-62	0	131	0	59	62	50	17	28	0	**26**
Percent change in flow from Existing Conditions													
Alt 1	3%	1%	0%	-2%	20%	0%	58%	101%	2%	1%	10%	**2%**	8%
Alt 2	7%	-8%	-30%	-15%	46%	14%	25%	27%	29%	10%	26%	**11%**	5%
Alt 5	4%	2%	-15%	0%	51%	0%	70%	60%	43%	8%	16%	**0%**	10%

Table A-29. Windy Gap Diversions (AF), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**0**	**0**	**0**	**4522**	**17648**	**11053**	**2869**	**439**	**0**	**0**	**0**	**0**	**36532**
Alt 1	0	0	0	4376	17449	10585	5661	902	0	0	0	0	**38973**
Alt 2	0	0	0	4368	18851	12697	4098	777	0	0	0	0	**40791**
Alt 5	0	0	0	4368	19055	12561	6071	937	0	0	0	0	**42991**
Flow change from Existing Conditions													
Alt 1	0	0	0	-146	-199	-469	2792	463	0	0	0	0	**2441**
Alt 2	0	0	0	-154	1203	1643	1229	338	0	0	0	0	**4259**
Alt 5	0	0	0	-154	1406	1507	3202	498	0	0	0	0	**6459**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	-3%	-1%	-4%	97%	105%	0%	0%	0%	**0%**	7%
Alt 2	0%	0%	0%	-3%	7%	15%	43%	77%	0%	0%	0%	**0%**	12%
Alt 5	0%	0%	0%	-3%	8%	14%	112%	113%	0%	0%	0%	**0%**	18%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**0**	**0**	**0**	**1049**	**3723**	**2658**	**374**	**0**	**0**	**0**	**0**	**0**	**7804**
Alt 1	0	0	0	1038	2288	534	0	0	0	0	0	0	**3860**
Alt 2	0	0	0	1038	2288	534	0	0	0	0	0	0	**3860**
Alt 5	0	0	0	1038	2288	534	0	0	0	0	0	0	**3860**
Flow change from Existing Conditions													
Alt 1	0	0	0	-11	-1436	-2124	-374	0	0	0	0	0	**-3944**
Alt 2	0	0	0	-11	-1435	-2124	-374	0	0	0	0	0	**-3944**
Alt 5	0	0	0	-11	-1435	-2124	-374	0	0	0	0	0	**-3944**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	-1%	-39%	-80%	-100%	0%	0%	0%	0%	**0%**	-51%
Alt 2	0%	0%	0%	-1%	-39%	-80%	-100%	0%	0%	0%	0%	**0%**	-51%
Alt 5	0%	0%	0%	-1%	-39%	-80%	-100%	0%	0%	0%	0%	**0%**	-51%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**0**	**0**	**0**	**2808**	**20532**	**14280**	**892**	**0**	**0**	**0**	**0**	**0**	**38512**
Alt 1	0	0	0	2801	20804	17894	15463	5157	0	0	0	0	**62118**
Alt 2	0	0	0	2801	28406	22218	13167	2826	0	0	0	0	**69417**
Alt 5	0	0	0	2801	28575	21711	16016	2595	0	0	0	0	**71699**
Flow change from Existing Conditions													
Alt 1	0	0	0	-8	272	3614	14571	5157	0	0	0	0	**23606**
Alt 2	0	0	0	-8	7874	7938	12275	2826	0	0	0	0	**30905**
Alt 5	0	0	0	-8	8043	7431	15124	2595	0	0	0	0	**33186**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	1%	25%	1633%	0%	0%	0%	0%	**0%**	61%
Alt 2	0%	0%	0%	0%	38%	56%	1376%	0%	0%	0%	0%	**0%**	80%
Alt 5	0%	0%	0%	0%	39%	52%	1696%	0%	0%	0%	0%	**0%**	86%

Table A-30. Big Thompson River Streamflow below Lake Estes (CFS), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**12**	**12**	**14**	**39**	**176**	**410**	**186**	**114**	**59**	**39**	**26**	**16**	**92**
Alt 1	12	12	14	39	176	415	188	114	59	39	26	16	**93**
Alt 2	12	12	14	40	189	423	203	117	60	40	26	16	**96**
Alt 5	12	12	14	40	183	416	190	115	59	39	26	16	**94**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	5	2	0	0	0	0	0	**1**
Alt 2	0	0	0	1	14	13	17	3	1	1	0	0	**4**
Alt 5	0	0	0	1	7	5	4	1	0	0	0	0	**2**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	-1%	0%	1%	1%	0%	0%	0%	0%	**0%**	1%
Alt 2	0%	0%	0%	2%	8%	3%	9%	3%	1%	2%	1%	**0%**	4%
Alt 5	0%	0%	0%	2%	4%	1%	2%	1%	0%	0%	1%	**0%**	2%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**9**	**9**	**12**	**36**	**165**	**274**	**156**	**97**	**50**	**38**	**23**	**15**	**74**
Alt 1	9	9	12	36	165	274	154	97	50	38	23	15	**74**
Alt 2	9	9	12	36	165	274	165	97	50	38	23	15	**75**
Alt 5	9	9	12	36	165	274	165	97	50	38	23	15	**75**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	0	-2	0	0	0	0	0	**0**
Alt 2	0	0	0	0	0	0	9	0	0	0	0	0	**1**
Alt 5	0	0	0	0	0	0	9	0	0	0	0	0	**1**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	0%	-1%	0%	0%	0%	0%	**0%**	0%
Alt 2	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	**0%**	1%
Alt 5	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	**0%**	1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**12**	**12**	**15**	**38**	**128**	**362**	**328**	**162**	**65**	**38**	**25**	**16**	**101**
Alt 1	12	12	15	38	128	363	328	162	65	38	25	16	**101**
Alt 2	12	12	15	37	134	381	335	162	65	38	25	16	**103**
Alt 5	12	12	15	38	128	363	328	162	65	38	25	16	**101**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 2	0	0	0	0	6	18	7	0	0	0	0	0	**3**
Alt 5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 2	0%	0%	0%	-1%	4%	5%	2%	0%	0%	0%	0%	**0%**	3%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%

Table A-31. Colorado River Streamflow below Lake Granby at USGS gage (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**20**	**20**	**20**	**20**	**84**	**400**	**258**	**68**	**28**	**25**	**20**	**20**	**82**
Alt 1	20	20	20	20	83	344	223	57	25	25	20	20	**73**
Alt 2	20	20	20	20	81	279	210	55	22	24	20	20	**66**
Alt 5	20	20	20	20	82	300	213	55	24	24	20	20	**68**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	-1	-56	-35	-11	-3	0	0	0	**-9**
Alt 2	0	0	0	0	-3	-121	-48	-13	-6	0	0	0	**-16**
Alt 5	0	0	0	0	-2	-100	-45	-13	-4	-1	0	0	**-14**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	-1%	-14%	-14%	-16%	-10%	0%	0%	**0%**	-11%
Alt 2	0%	0%	0%	0%	-4%	-30%	-19%	-19%	-22%	-1%	2%	**0%**	-19%
Alt 5	0%	0%	0%	0%	-3%	-25%	-17%	-19%	-15%	-3%	0%	**0%**	-17%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**20**	**20**	**20**	**20**	**57**	**57**	**57**	**30**	**20**	**20**	**20**	**20**	**30**
Alt 1	20	20	20	20	57	57	57	30	20	20	20	20	**30**
Alt 2	20	20	20	20	57	57	57	30	20	20	20	20	**30**
Alt 5	20	20	20	20	57	57	57	30	20	20	20	20	**30**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**20**	**20**	**20**	**20**	**181**	**886**	**896**	**245**	**33**	**20**	**20**	**20**	**199**
Alt 1	20	20	20	20	180	886	768	175	35	20	20	20	**183**
Alt 2	20	20	20	20	183	899	689	167	37	20	23	20	**177**
Alt 5	20	20	20	20	188	884	714	163	31	20	20	20	**177**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	-1	0	-128	-69	2	0	0	0	**-17**
Alt 2	0	0	0	0	2	13	-207	-78	3	0	3	0	**-22**
Alt 5	0	0	0	0	7	-2	-182	-81	-3	0	0	0	**-22**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	-1%	0%	-14%	-28%	5%	0%	0%	**0%**	-8%
Alt 2	0%	0%	0%	0%	1%	1%	-23%	-32%	10%	0%	16%	**0%**	-11%
Alt 5	0%	0%	0%	0%	4%	0%	-20%	-33%	-8%	0%	0%	**0%**	-11%

Table A-32. Colorado River Streamflow above Windy Gap (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**65**	**69**	**88**	**213**	**545**	**1137**	**519**	**168**	**83**	**79**	**78**	**68**	**260**
Alt 1	61	66	85	211	510	981	441	144	76	77	75	64	**233**
Alt 2	61	66	85	211	505	903	425	141	72	77	75	64	**224**
Alt 5	61	66	85	211	506	930	429	141	75	76	75	64	**227**
Flow change from Existing Conditions													
Alt 1	-4	-3	-3	-2	-35	-156	-78	-23	-6	-2	-4	-4	**-27**
Alt 2	-4	-3	-3	-2	-39	-234	-94	-26	-10	-2	-3	-4	**-35**
Alt 5	-4	-3	-3	-2	-38	-207	-90	-27	-8	-3	-3	-4	**-33**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-5%	-3%	-1%	-6%	-14%	-15%	-14%	-8%	-2%	-5%	**-6%**	-10%
Alt 2	-6%	-5%	-3%	-1%	-7%	-21%	-18%	-16%	-12%	-3%	-4%	**-6%**	-14%
Alt 5	-6%	-5%	-3%	-1%	-7%	-18%	-17%	-16%	-9%	-4%	-4%	**-6%**	-13%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**60**	**63**	**90**	**145**	**197**	**187**	**133**	**94**	**66**	**67**	**74**	**65**	**104**
Alt 1	55	60	88	144	187	168	125	82	60	64	71	60	**97**
Alt 2	55	60	88	144	187	168	124	82	60	64	71	60	**97**
Alt 5	55	60	88	144	187	168	124	82	60	64	71	60	**97**
Flow change from Existing Conditions													
Alt 1	-5	-3	-2	-1	-10	-19	-8	-11	-6	-2	-3	-5	**-6**
Alt 2	-5	-3	-2	-1	-10	-19	-9	-11	-6	-2	-3	-5	**-6**
Alt 5	-5	-3	-2	-1	-10	-19	-9	-11	-6	-2	-3	-5	**-6**
Percent change in flow from Existing Conditions													
Alt 1	-8%	-5%	-2%	-1%	-5%	-10%	-6%	-12%	-9%	-3%	-4%	**-7%**	-6%
Alt 2	-8%	-5%	-2%	-1%	-5%	-10%	-7%	-12%	-9%	-3%	-4%	**-7%**	-6%
Alt 5	-8%	-5%	-2%	-1%	-5%	-10%	-7%	-12%	-9%	-3%	-4%	**-7%**	-6%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**72**	**77**	**85**	**179**	**1041**	**2660**	**1730**	**462**	**124**	**82**	**86**	**77**	**558**
Alt 1	68	72	81	177	989	2440	1457	374	122	82	82	72	**503**
Alt 2	68	72	81	177	992	2454	1377	354	124	82	85	72	**496**
Alt 5	68	72	81	177	997	2439	1402	348	118	82	83	72	**496**
Flow change from Existing Conditions													
Alt 1	-4	-4	-4	-2	-52	-220	-273	-88	-2	1	-4	-5	**-55**
Alt 2	-4	-4	-4	-2	-49	-206	-353	-107	0	1	-1	-5	**-62**
Alt 5	-4	-4	-4	-2	-44	-221	-328	-113	-6	1	-2	-5	**-62**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-6%	-5%	-1%	-5%	-8%	-16%	-19%	-1%	1%	-5%	**-6%**	-10%
Alt 2	-6%	-6%	-5%	-1%	-5%	-8%	-20%	-23%	0%	1%	-1%	**-6%**	-11%
Alt 5	-6%	-6%	-5%	-1%	-4%	-8%	-19%	-25%	-5%	1%	-3%	**-6%**	-11%

Table A-33. Colorado River Streamflow below Windy Gap at USGS gage (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**65**	**69**	**88**	**137**	**258**	**951**	**472**	**161**	**83**	**79**	**78**	**68**	**209**
Alt 1	61	66	85	138	226	803	348	130	76	77	75	64	**179**
Alt 2	61	66	85	138	199	690	359	129	72	77	75	64	**168**
Alt 5	61	66	85	138	196	719	330	125	75	76	75	64	**167**
Flow change from Existing Conditions													
Alt 1	-4	-3	-3	0	-32	-148	-124	-31	-6	-2	-4	-4	**-30**
Alt 2	-4	-3	-3	0	-59	-261	-114	-32	-10	-2	-3	-4	**-41**
Alt 5	-4	-3	-3	0	-61	-232	-142	-35	-8	-3	-3	-4	**-42**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-5%	-3%	0%	-12%	-16%	-26%	-19%	-8%	-2%	-5%	**-6%**	-14%
Alt 2	-6%	-5%	-3%	0%	-23%	-27%	-24%	-20%	-12%	-3%	-4%	**-6%**	-20%
Alt 5	-6%	-5%	-3%	0%	-24%	-24%	-30%	-22%	-9%	-4%	-4%	**-6%**	-20%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**60**	**63**	**90**	**127**	**136**	**142**	**127**	**94**	**66**	**67**	**74**	**65**	**93**
Alt 1	55	60	88	126	149	159	125	82	60	64	71	60	**92**
Alt 2	55	60	88	126	149	159	124	82	60	64	71	60	**92**
Alt 5	55	60	88	126	149	159	124	82	60	64	71	60	**92**
Flow change from Existing Conditions													
Alt 1	-5	-3	-2	-1	13	17	-2	-11	-6	-2	-3	-5	**-1**
Alt 2	-5	-3	-2	-1	13	17	-3	-11	-6	-2	-3	-5	**-1**
Alt 5	-5	-3	-2	-1	13	17	-3	-11	-6	-2	-3	-5	**-1**
Percent change in flow from Existing Conditions													
Alt 1	-8%	-5%	-2%	-1%	10%	12%	-2%	-12%	-9%	-3%	-4%	**-7%**	-1%
Alt 2	-8%	-5%	-2%	-1%	10%	12%	-3%	-12%	-9%	-3%	-4%	**-7%**	-1%
Alt 5	-8%	-5%	-2%	-1%	10%	12%	-3%	-12%	-9%	-3%	-4%	**-7%**	-1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**72**	**77**	**85**	**132**	**707**	**2420**	**1716**	**462**	**124**	**82**	**86**	**77**	**505**
Alt 1	68	72	81	130	651	2139	1206	290	122	82	82	72	**417**
Alt 2	68	72	81	130	530	2080	1163	308	124	82	85	72	**400**
Alt 5	68	72	81	130	533	2074	1141	306	118	82	83	72	**397**
Flow change from Existing Conditions													
Alt 1	-4	-4	-4	-2	-57	-281	-510	-172	-2	1	-4	-5	**-88**
Alt 2	-4	-4	-4	-2	-177	-340	-552	-153	0	1	-1	-5	**-104**
Alt 5	-4	-4	-4	-2	-175	-346	-574	-156	-6	1	-2	-5	**-108**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-6%	-5%	-2%	-8%	-12%	-30%	-37%	-1%	1%	-5%	**-6%**	-17%
Alt 2	-6%	-6%	-5%	-2%	-25%	-14%	-32%	-33%	0%	1%	-1%	**-6%**	-21%
Alt 5	-6%	-6%	-5%	-2%	-25%	-14%	-33%	-34%	-5%	1%	-3%	**-6%**	-21%

Table A-34. Willow Creek Streamflow at USGS/NCWCD gage (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**8**	**9**	**14**	**6**	**51**	**143**	**32**	**12**	**3**	**8**	**8**	**9**	**25**
Alt 1	8	9	14	6	51	127	23	10	4	8	8	9	**23**
Alt 2	8	9	14	6	49	114	20	9	3	8	8	9	**21**
Alt 5	8	9	14	6	49	120	20	9	4	8	8	9	**22**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	-16	-9	-2	0	0	0	0	**-2**
Alt 2	0	0	0	0	-2	-29	-11	-3	0	0	0	0	**-4**
Alt 5	0	0	0	0	-2	-23	-11	-3	0	0	0	0	**-3**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	-11%	-29%	-15%	2%	3%	0%	**0%**	-9%
Alt 2	0%	0%	0%	0%	-4%	-20%	-36%	-27%	-13%	2%	1%	**0%**	-15%
Alt 5	0%	0%	0%	0%	-3%	-16%	-36%	-25%	2%	-1%	2%	**0%**	-13%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**8**	**8**	**12**	**4**	**0**	**10**	**0**	**2**	**2**	**6**	**7**	**7**	**5**
Alt 1	8	8	12	4	0	10	0	2	2	6	7	7	**5**
Alt 2	8	8	12	4	0	10	0	2	2	6	7	7	**5**
Alt 5	8	8	12	4	0	10	0	2	2	6	7	7	**5**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 2	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alt 5	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	0%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**9**	**10**	**18**	**5**	**184**	**434**	**112**	**58**	**14**	**7**	**11**	**12**	**73**
Alt 1	9	10	18	5	184	378	75	52	14	7	11	12	**65**
Alt 2	9	10	18	5	184	378	75	40	14	7	11	12	**64**
Alt 5	9	10	18	5	184	378	75	40	14	7	12	12	**64**
Flow change from Existing Conditions													
Alt 1	0	0	0	0	0	-56	-38	-6	0	0	0	0	**-8**
Alt 2	0	0	0	0	0	-56	-38	-18	0	0	0	0	**-9**
Alt 5	0	0	0	0	0	-56	-38	-18	0	0	2	0	**-9**
Percent change in flow from Existing Conditions													
Alt 1	0%	0%	0%	0%	0%	-13%	-34%	-10%	0%	0%	-1%	**0%**	-11%
Alt 2	0%	0%	0%	0%	0%	-13%	-34%	-30%	0%	0%	0%	**0%**	-13%
Alt 5	0%	0%	0%	0%	0%	-13%	-34%	-30%	0%	0%	15%	**0%**	-13%

Table A-35. Colorado River at Hot Sulphur Springs at USGS/NCWCD gage (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**69**	**72**	**93**	**146**	**278**	**953**	**482**	**170**	**87**	**87**	**83**	**72**	**216**
Alt 1	65	69	90	146	245	803	355	137	80	85	80	68	**185**
Alt 2	65	69	90	146	218	689	365	136	76	85	80	68	**174**
Alt 5	65	69	90	146	216	719	336	133	79	84	80	68	**174**
Flow change from Existing Conditions													
Alt 1	-4	-3	-3	0	-33	-150	-127	-32	-7	-2	-4	-4	**-31**
Alt 2	-4	-3	-3	0	-60	-263	-116	-33	-11	-2	-3	-4	**-42**
Alt 5	-4	-3	-3	0	-63	-234	-145	-37	-9	-3	-3	-4	**-42**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-5%	-3%	0%	-12%	-16%	-26%	-19%	-8%	-2%	-4%	**-6%**	-14%
Alt 2	-6%	-5%	-3%	0%	-22%	-28%	-24%	-20%	-13%	-3%	-4%	**-6%**	-19%
Alt 5	-6%	-5%	-3%	0%	-22%	-25%	-30%	-22%	-10%	-3%	-4%	**-6%**	-20%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**63**	**64**	**95**	**137**	**137**	**139**	**142**	**101**	**67**	**75**	**80**	**69**	**98**
Alt 1	58	61	93	136	149	154	136	88	61	73	77	64	**96**
Alt 2	58	61	93	136	149	154	135	88	61	73	77	64	**96**
Alt 5	58	61	93	136	149	154	135	88	61	73	77	64	**96**
Flow change from Existing Conditions													
Alt 1	-5	-4	-2	-1	12	15	-5	-13	-7	-2	-3	-5	**-2**
Alt 2	-5	-4	-2	-1	12	15	-6	-13	-7	-2	-3	-5	**-2**
Alt 5	-5	-4	-2	-1	12	15	-6	-13	-7	-2	-3	-5	**-2**
Percent change in flow from Existing Conditions													
Alt 1	-8%	-6%	-2%	-1%	9%	11%	-4%	-13%	-10%	-3%	-3%	**-7%**	-2%
Alt 2	-8%	-6%	-2%	-1%	9%	11%	-4%	-13%	-10%	-3%	-3%	**-7%**	-2%
Alt 5	-8%	-6%	-2%	-1%	9%	11%	-4%	-13%	-10%	-3%	-3%	**-7%**	-2%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**78**	**82**	**91**	**150**	**730**	**2414**	**1709**	**468**	**127**	**90**	**90**	**82**	**511**
Alt 1	74	77	86	148	672	2132	1196	294	124	89	85	77	**422**
Alt 2	74	77	86	148	552	2073	1154	313	125	89	89	77	**405**
Alt 5	74	77	86	148	554	2066	1132	311	120	89	87	77	**402**
Flow change from Existing Conditions													
Alt 1	-4	-5	-4	-3	-58	-283	-513	-173	-3	0	-4	-5	**-89**
Alt 2	-4	-5	-4	-3	-178	-342	-555	-154	-1	0	-1	-5	**-105**
Alt 5	-4	-5	-4	-3	-176	-348	-577	-157	-7	0	-3	-5	**-108**
Percent change in flow from Existing Conditions													
Alt 1	-6%	-6%	-5%	-2%	-8%	-12%	-30%	-37%	-2%	0%	-5%	**-6%**	-17%
Alt 2	-6%	-6%	-5%	-2%	-24%	-14%	-32%	-33%	-1%	0%	-1%	**-6%**	-21%
Alt 5	-6%	-6%	-5%	-2%	-24%	-14%	-34%	-34%	-5%	0%	-3%	**-6%**	-21%

Table A-36. Colorado River Streamflow below Williams Fork (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**179**	**189**	**210**	**186**	**308**	**1194**	**735**	**276**	**191**	**232**	**209**	**184**	**341**
Alt 1	177	188	212	181	273	1085	597	265	200	243	208	181	**317**
Alt 2	177	188	212	182	246	971	607	264	196	242	208	181	**306**
Alt 5	177	188	212	182	244	1000	578	261	199	242	208	181	**306**
Flow change from Existing Conditions													
Alt 1	-2	-1	2	-4	-34	-109	-138	-10	10	10	-1	-3	**-24**
Alt 2	-2	-1	2	-4	-61	-223	-128	-11	6	10	-1	-3	**-35**
Alt 5	-2	-1	2	-4	-64	-193	-157	-15	8	9	-1	-3	**-35**
Percent change in flow from Existing Conditions													
Alt 1	-1%	-1%	1%	-2%	-11%	-9%	-19%	-4%	5%	4%	-1%	**-2%**	-7%
Alt 2	-1%	-1%	1%	-2%	-20%	-19%	-17%	-4%	3%	4%	0%	**-2%**	-10%
Alt 5	-1%	-1%	1%	-2%	-21%	-16%	-21%	-5%	4%	4%	0%	**-2%**	-10%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**173**	**180**	**213**	**190**	**148**	**146**	**338**	**266**	**178**	**214**	**206**	**186**	**204**
Alt 1	187	197	229	174	160	162	258	274	198	219	221	199	**207**
Alt 2	187	197	229	174	160	161	258	274	198	219	221	199	**207**
Alt 5	187	197	229	174	160	161	258	274	198	219	221	199	**207**
Flow change from Existing Conditions													
Alt 1	13	17	16	-16	12	15	-80	8	20	5	15	14	**3**
Alt 2	13	17	16	-16	12	15	-80	8	20	5	15	14	**3**
Alt 5	13	17	16	-16	12	15	-80	8	20	5	15	14	**3**
Percent change in flow from Existing Conditions													
Alt 1	8%	9%	8%	-8%	8%	10%	-24%	3%	11%	2%	8%	**7%**	2%
Alt 2	8%	9%	8%	-8%	8%	10%	-24%	3%	11%	2%	8%	**7%**	1%
Alt 5	8%	9%	8%	-8%	8%	10%	-24%	3%	11%	2%	8%	**7%**	1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**191**	**205**	**213**	**216**	**803**	**2965**	**2314**	**639**	**215**	**242**	**220**	**202**	**704**
Alt 1	192	207	215	200	737	2728	1844	482	215	253	222	203	**626**
Alt 2	192	207	215	200	616	2668	1802	501	216	253	225	203	**609**
Alt 5	192	207	215	200	619	2662	1780	498	211	253	223	203	**606**
Flow change from Existing Conditions													
Alt 1	1	1	2	-16	-66	-237	-470	-157	0	10	2	1	**-78**
Alt 2	1	1	2	-16	-187	-296	-512	-138	1	10	5	1	**-95**
Alt 5	1	1	2	-16	-185	-303	-534	-141	-4	10	3	1	**-98**
Percent change in flow from Existing Conditions													
Alt 1	0%	1%	1%	-7%	-8%	-8%	-20%	-25%	0%	4%	1%	**0%**	-11%
Alt 2	0%	1%	1%	-7%	-23%	-10%	-22%	-22%	1%	4%	2%	**0%**	-13%
Alt 5	0%	1%	1%	-7%	-23%	-10%	-23%	-22%	-2%	4%	2%	**0%**	-14%

Table A-37. Colorado River Streamflow near Kremmling at USGS gage (cfs), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**495**	**521**	**557**	**664**	**1145**	**2619**	**1745**	**1026**	**909**	**832**	**583**	**523**	**969**
Alt 1	491	519	558	643	975	2114	1303	953	864	812	563	504	**859**
Alt 2	490	519	558	643	948	2002	1313	953	859	812	564	504	**848**
Alt 5	490	519	558	643	945	2030	1286	948	862	811	564	504	**848**
Flow change from Existing Conditions													
Alt 1	-4	-2	1	-20	-170	-504	-442	-73	-46	-19	-20	-19	**-110**
Alt 2	-4	-2	1	-20	-197	-617	-432	-73	-50	-20	-20	-19	**-121**
Alt 5	-4	-2	1	-20	-199	-588	-459	-78	-47	-20	-20	-19	**-122**
Percent change in flow from Existing Conditions													
Alt 1	-1%	0%	0%	-3%	-15%	-19%	-25%	-7%	-5%	-2%	-3%	**-4%**	-11%
Alt 2	-1%	0%	0%	-3%	-17%	-24%	-25%	-7%	-5%	-2%	-3%	**-4%**	-13%
Alt 5	-1%	0%	0%	-3%	-17%	-22%	-26%	-8%	-5%	-2%	-3%	**-4%**	-13%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**454**	**483**	**557**	**615**	**422**	**473**	**924**	**943**	**866**	**674**	**547**	**493**	**622**
Alt 1	471	505	581	586	388	353	748	914	826	670	542	495	**591**
Alt 2	471	504	581	586	388	348	748	914	826	671	542	494	**590**
Alt 5	471	504	581	586	388	348	748	914	826	671	542	494	**590**
Flow change from Existing Conditions													
Alt 1	17	22	24	-29	-34	-120	-176	-29	-40	-4	-4	2	**-31**
Alt 2	17	22	24	-29	-34	-125	-176	-29	-39	-4	-5	2	**-32**
Alt 5	17	22	24	-29	-34	-125	-176	-29	-39	-4	-5	2	**-32**
Percent change in flow from Existing Conditions													
Alt 1	4%	5%	4%	-5%	-8%	-25%	-19%	-3%	-5%	-1%	-1%	**0%**	-5%
Alt 2	4%	4%	4%	-5%	-8%	-26%	-19%	-3%	-5%	-1%	-1%	**0%**	-5%
Alt 5	4%	4%	4%	-5%	-8%	-26%	-19%	-3%	-5%	-1%	-1%	**0%**	-5%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Exist. Conditions	**576**	**622**	**639**	**764**	**2231**	**5885**	**4725**	**1694**	**945**	**804**	**633**	**600**	**1681**
Alt 1	569	619	635	698	2015	4956	3930	1430	924	760	611	581	**1481**
Alt 2	569	619	635	698	1894	4897	3888	1449	924	760	615	581	**1464**
Alt 5	569	619	635	698	1896	4891	3866	1446	919	760	613	581	**1461**
Flow change from Existing Conditions													
Alt 1	-7	-3	-4	-66	-216	-929	-794	-264	-21	-44	-22	-19	**-200**
Alt 2	-7	-3	-4	-66	-337	-988	-837	-245	-21	-44	-19	-19	**-217**
Alt 5	-7	-3	-4	-66	-335	-994	-859	-248	-25	-44	-20	-19	**-220**
Percent change in flow from Existing Conditions													
Alt 1	-1%	-1%	-1%	-9%	-10%	-16%	-17%	-16%	-2%	-5%	-3%	**-3%**	-12%
Alt 2	-1%	-1%	-1%	-9%	-15%	-17%	-18%	-14%	-2%	-5%	-3%	**-3%**	-13%
Alt 5	-1%	-1%	-1%	-9%	-15%	-17%	-18%	-15%	-3%	-5%	-3%	**-3%**	-13%

Table A-38. Colorado River at Hot Sulphur Springs Channel Maintenance Flows (1950-1996), Cumulative Effects.

				Average flow (cfs)			
Recurrence Interval	**Flow Range**	**Range of Dates Flow Occurs**	**When most of Flow Occurs**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alternative 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	late March - mid-October	May through July	768	787	794	796
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	May 1 to late September	June and July	2,018	2,085	1,984	2,035
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	late May to mid-July	June	3,750	3,723	3,699	3,701
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	late May to mid-July	June	5,016	5,290	5,252	5,246
At or greater than 25-yr flow	**6,520 cfs or greater**	12-Jul	one day	6,545	6,545	-	-

		Average Number of Days/Year Flow Occurs				Percentage of Years Flow Occurs			
Recurrence Interval	**Flow Range**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alt 5**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alt 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	23	21	21	19	62%	49%	47%	47%
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	23.5	21	21	21	38%	34%	32%	32%
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	10.5	8	9	9.5	28%	26%	17%	17%
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	4	8	8	7.5	13%	4%	4%	4%
At or greater than 25-yr flow	**6,520 cfs or greater**	1	1	0	0	2%	2%	0%	0%

		Number of Days Occurs in 47-yr model period			
Recurrence Interval	**Flow Range**	**Existing Conditions**	**No Action**	**Proposed Action**	**Alt 5**
0.8x1.5-yr flow to 2-yr flow	**510 cfs to 1,240 cfs**	663	476	463	423
2-yr flow to 5-yr flow	**1,240 cfs to 3,160 cfs**	423	331	315	311
5-yr flow to 10-yr flow	**3,160 cfs to 4,600 cfs**	137	98	73	76
10-yr flow to 25-yr flow	**4,600 cfs to 6,520 cfs**	24	16	16	15
At or greater than 25-yr flow	**6,520 cfs or greater**	1	1	0	0

Table A-39. Colorado River Stage below Windy Gap Reservoir at USGS gage (feet), Cumulative Effects.

Average Year (1950-1996)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Exist. Conditions	**0.55**	**0.56**	**0.59**	**0.68**	**0.90**	**1.81**	**1.19**	**0.71**	**0.58**	**0.57**	**0.57**	**0.55**
Alt 1	0.54	0.55	0.58	0.67	0.85	1.62	1.01	0.66	0.57	0.57	0.57	0.55
Alt 2	0.54	0.55	0.58	0.67	0.80	1.48	1.02	0.66	0.56	0.57	0.57	0.55
Alt 5	0.54	0.55	0.58	0.67	0.80	1.51	0.98	0.65	0.57	0.57	0.57	0.55
Change in stage from existing conditions												
Alt 1	-0.01	-0.01	0.00	0.00	-0.06	-0.19	-0.18	-0.05	-0.01	0.00	-0.01	-0.01
Alt 2	-0.01	-0.01	0.00	0.00	-0.10	-0.33	-0.17	-0.05	-0.02	0.00	-0.01	-0.01
Alt 5	-0.01	-0.01	0.00	0.00	-0.10	-0.29	-0.21	-0.06	-0.01	0.00	-0.01	-0.01
Percent change in stage from existing conditions												
Alt 1	-1.2%	-1.0%	-0.7%	-0.1%	-6.1%	-10.3%	-15.0%	-7.3%	-2.0%	-0.5%	-1.0%	-1.3%
Alt 2	-1.2%	-1.0%	-0.7%	-0.3%	-11.3%	-18.2%	-14.2%	-7.5%	-3.1%	-0.7%	-0.9%	-1.3%
Alt 5	-1.2%	-1.0%	-0.7%	-0.3%	-11.5%	-16.3%	-17.5%	-8.3%	-2.4%	-0.8%	-1.0%	-1.3%
Dry Year Average (1954, 1966, 1977, 1981, 1989)												
Exist. Conditions	**0.54**	**0.55**	**0.59**	**0.65**	**0.67**	**0.68**	**0.65**	**0.60**	**0.55**	**0.55**	**0.57**	**0.55**
Alt 1	0.53	0.54	0.59	0.65	0.69	0.71	0.65	0.58	0.54	0.55	0.56	0.54
Alt 2	0.53	0.54	0.59	0.65	0.69	0.71	0.65	0.58	0.54	0.55	0.56	0.54
Alt 5	0.53	0.54	0.59	0.65	0.69	0.71	0.65	0.58	0.54	0.55	0.56	0.54
Change in stage from existing conditions												
Alt 1	-0.01	-0.01	0.00	0.00	0.02	0.03	0.00	-0.02	-0.01	0.00	0.00	-0.01
Alt 2	-0.01	-0.01	0.00	0.00	0.02	0.03	-0.01	-0.02	-0.01	0.00	0.00	-0.01
Alt 5	-0.01	-0.01	0.00	0.00	0.02	0.03	-0.01	-0.02	-0.01	0.00	0.00	-0.01
Percent change in stage from existing conditions												
Alt 1	-1.5%	-1.1%	-0.6%	-0.1%	3.2%	4.1%	-0.7%	-3.1%	-1.9%	-0.7%	-0.8%	-1.4%
Alt 2	-1.5%	-1.1%	-0.6%	-0.1%	3.2%	4.0%	-0.9%	-3.1%	-1.9%	-0.7%	-0.8%	-1.4%
Alt 5	-1.5%	-1.1%	-0.6%	-0.1%	3.2%	4.0%	-0.9%	-3.1%	-1.9%	-0.7%	-0.8%	-1.4%
Wet Year Average (1957, 1983, 1984, 1986, 1995)												
Exist. Conditions	**0.56**	**0.57**	**0.58**	**0.69**	**1.58**	**3.20**	**2.59**	**1.19**	**0.66**	**0.58**	**0.59**	**0.57**
Alt 1	0.56	0.56	0.58	0.68	1.50	2.98	2.10	0.93	0.66	0.58	0.58	0.56
Alt 2	0.56	0.56	0.58	0.68	1.34	2.93	2.05	0.96	0.66	0.58	0.58	0.56
Alt 5	0.56	0.56	0.58	0.68	1.34	2.92	2.03	0.96	0.65	0.58	0.58	0.56
Change in stage from existing conditions												
Alt 1	-0.01	-0.01	-0.01	-0.01	-0.08	-0.22	-0.49	-0.26	-0.01	0.00	-0.01	-0.01
Alt 2	-0.01	-0.01	-0.01	-0.01	-0.24	-0.27	-0.54	-0.23	-0.01	0.00	0.00	-0.01
Alt 5	-0.01	-0.01	-0.01	-0.01	-0.24	-0.28	-0.56	-0.24	-0.02	0.00	0.00	-0.01
Percent change in stage from existing conditions												
Alt 1	-1.3%	-1.3%	-1.2%	-0.9%	-5.2%	-7.0%	-19.0%	-21.7%	-1.1%	0.2%	-1.2%	-1.3%
Alt 2	-1.3%	-1.3%	-1.2%	-1.7%	-15.2%	-8.6%	-20.7%	-19.5%	-0.9%	0.2%	-0.2%	-1.3%
Alt 5	-1.3%	-1.3%	-1.2%	-1.6%	-15.1%	-8.8%	-21.6%	-19.9%	-2.3%	0.2%	-0.7%	-1.3%

Table A-40. Colorado River Stage near Kremmling at USGS gage (feet), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**4.18**	**4.25**	**4.36**	**4.68**	**6.01**	**8.67**	**7.22**	**5.66**	**5.32**	**5.11**	**4.43**	**4.26**
Alt 1	4.17	4.25	4.36	4.62	5.58	7.82	6.30	5.45	5.20	5.06	4.38	4.21
Alt 2	4.17	4.25	4.36	4.61	5.51	7.63	6.32	5.45	5.19	5.06	4.38	4.21
Alt 5	4.17	4.25	4.36	4.61	5.51	7.67	6.26	5.44	5.20	5.05	4.38	4.21
Change in stage from existing conditions												
Alt 1	-0.01	-0.01	0.00	-0.07	-0.43	-0.85	-0.92	-0.21	-0.12	-0.05	-0.06	-0.05
Alt 2	-0.01	-0.01	0.00	-0.07	-0.50	-1.04	-0.91	-0.21	-0.13	-0.05	-0.06	-0.05
Alt 5	-0.01	-0.01	0.00	-0.07	-0.51	-1.00	-0.96	-0.22	-0.12	-0.06	-0.06	-0.05
Percent change in stage from existing conditions												
Alt 1	-0.3%	-0.1%	0.1%	-1.5%	-7.1%	-9.8%	-12.7%	-3.7%	-2.2%	-1.0%	-1.3%	-1.3%
Alt 2	-0.3%	-0.1%	0.1%	-1.5%	-8.4%	-12.0%	-12.6%	-3.7%	-2.4%	-1.1%	-1.3%	-1.3%
Alt 5	-0.3%	-0.1%	0.1%	-1.5%	-8.4%	-11.5%	-13.3%	-3.9%	-2.3%	-1.1%	-1.3%	-1.3%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**4.06**	**4.14**	**4.36**	**4.49**	**4.01**	**4.17**	**5.31**	**5.39**	**5.19**	**4.70**	**4.33**	**4.17**
Alt 1	4.11	4.21	4.43	4.41	3.90	3.82	4.87	5.30	5.09	4.68	4.32	4.18
Alt 2	4.11	4.21	4.43	4.41	3.90	3.80	4.87	5.30	5.09	4.68	4.31	4.18
Alt 5	4.11	4.21	4.43	4.41	3.90	3.80	4.87	5.30	5.09	4.68	4.31	4.18
Change in stage from existing conditions												
Alt 1	0.05	0.06	0.07	-0.08	-0.11	-0.35	-0.45	-0.09	-0.10	-0.01	-0.01	0.01
Alt 2	0.05	0.06	0.07	-0.08	-0.11	-0.37	-0.45	-0.09	-0.10	-0.01	-0.01	0.00
Alt 5	0.05	0.06	0.07	-0.08	-0.11	-0.37	-0.45	-0.09	-0.10	-0.01	-0.01	0.00
Percent change in stage from existing conditions												
Alt 1	1.2%	1.5%	1.6%	-1.8%	-2.8%	-8.5%	-8.4%	-1.7%	-1.9%	-0.3%	-0.3%	0.1%
Alt 2	1.2%	1.5%	1.6%	-1.8%	-2.8%	-8.8%	-8.4%	-1.7%	-1.9%	-0.3%	-0.3%	0.1%
Alt 5	1.2%	1.5%	1.6%	-1.8%	-2.8%	-8.8%	-8.4%	-1.7%	-1.9%	-0.3%	-0.3%	0.1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**4.41**	**4.55**	**4.59**	**5.03**	**8.26**	**12.17**	**11.20**	**7.25**	**5.46**	**5.04**	**4.57**	**4.48**
Alt 1	4.39	4.54	4.58	4.84	7.85	11.40	10.42	6.69	5.39	4.93	4.51	4.43
Alt 2	4.39	4.54	4.58	4.83	7.64	11.34	10.37	6.73	5.39	4.93	4.52	4.43
Alt 5	4.39	4.54	4.58	4.83	7.65	11.34	10.35	6.72	5.38	4.93	4.52	4.43
Change in stage from existing conditions												
Alt 1	-0.02	-0.01	-0.01	-0.19	-0.40	-0.76	-0.79	-0.55	-0.07	-0.11	-0.06	-0.05
Alt 2	-0.02	-0.01	-0.01	-0.19	-0.62	-0.82	-0.83	-0.52	-0.07	-0.11	-0.05	-0.05
Alt 5	-0.02	-0.01	-0.01	-0.19	-0.61	-0.83	-0.86	-0.53	-0.08	-0.11	-0.06	-0.05
Percent change in stage from existing conditions												
Alt 1	-0.5%	-0.2%	-0.2%	-3.7%	-4.9%	-6.3%	-7.0%	-7.6%	-1.4%	-2.3%	-1.3%	-1.2%
Alt 2	-0.5%	-0.2%	-0.2%	-3.9%	-7.5%	-6.7%	-7.4%	-7.2%	-1.4%	-2.3%	-1.1%	-1.2%
Alt 5	-0.5%	-0.2%	-0.2%	-3.9%	-7.4%	-6.8%	-7.6%	-7.3%	-1.5%	-2.3%	-1.2%	-1.2%

Table A-41. Carter Lake Elevations (feet), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5738**	**5746**	**5751**	**5753**	**5751**	**5741**	**5721**	**5707**	**5705**	**5709**	**5718**
Alt 1	5729	5738	5746	5751	5752	5750	5740	5720	5706	5704	5709	5718
Alt 2	5729	5737	5745	5750	5752	5750	5740	5721	5707	5704	5709	5719
Alt 5	5729	5738	5746	5751	5752	5751	5740	5720	5707	5704	5709	5719
Elevation change from existing conditions												
Alt 1	0	0	0	0	-1	-1	-1	-1	-1	0	0	0
Alt 2	0	0	-1	-1	-1	-1	-1	0	0	0	0	0
Alt 5	0	0	0	0	0	-1	-1	-1	0	0	0	0

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5738**	**5746**	**5753**	**5754**	**5750**	**5736**	**5716**	**5704**	**5704**	**5709**	**5718**
Alt 1	5729	5738	5746	5753	5754	5749	5736	5716	5705	5704	5709	5718
Alt 2	5730	5738	5747	5753	5754	5750	5736	5717	5705	5704	5709	5719
Alt 5	5729	5737	5745	5752	5753	5749	5736	5716	5704	5704	5708	5718
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	1	0	0	0	0	0	0	1	0	-1	0	1
Alt 5	0	0	-1	-1	0	0	0	0	0	-1	-1	0

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5729**	**5737**	**5746**	**5750**	**5752**	**5756**	**5753**	**5736**	**5718**	**5706**	**5711**	**5719**
Alt 1	5729	5737	5746	5751	5752	5755	5752	5734	5715	5705	5710	5719
Alt 2	5730	5738	5745	5748	5750	5754	5751	5734	5715	5706	5711	5720
Alt 5	5729	5738	5746	5750	5752	5755	5752	5735	5716	5706	5711	5720
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	-1	-1	-2	-2	-1	-1	0
Alt 2	1	1	-1	-2	-2	-2	-2	-2	-2	0	0	1
Alt 5	1	1	0	0	0	-1	-1	-2	-2	0	0	1

Table A-42. Carter Lake Surface Area (acres), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1016**	**1056**	**1092**	**1114**	**1119**	**1115**	**1070**	**980**	**913**	**901**	**924**	**968**
Alt 1	1016	1056	1093	1113	1117	1110	1065	975	910	899	923	968
Alt 2	1016	1054	1089	1110	1115	1111	1068	979	913	899	922	969
Alt 5	1018	1057	1091	1112	1117	1111	1066	977	912	900	924	970
Surface area change from existing conditions												
Alt 1	0	0	0	0	-2	-4	-5	-5	-3	-2	-1	0
Alt 2	0	-1	-3	-4	-4	-4	-2	-1	0	-2	-1	1
Alt 5	2	1	-1	-1	-2	-3	-4	-3	-1	-1	0	2
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1017**	**1057**	**1093**	**1119**	**1124**	**1107**	**1048**	**956**	**900**	**901**	**922**	**967**
Alt 1	1017	1057	1093	1119	1123	1106	1048	957	902	899	922	967
Alt 2	1019	1059	1095	1120	1124	1108	1050	959	902	897	921	971
Alt 5	1016	1055	1090	1117	1122	1105	1047	955	900	897	920	967
Surface area change from existing conditions												
Alt 1	0	0	0	0	-1	-1	0	1	2	-1	0	0
Alt 2	3	2	1	1	0	1	2	3	2	-4	-2	3
Alt 5	0	-2	-3	-2	-2	-2	-1	-1	0	-4	-3	0
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1015**	**1054**	**1091**	**1111**	**1118**	**1130**	**1121**	**1049**	**964**	**909**	**934**	**970**
Alt 1	1015	1054	1092	1112	1116	1127	1116	1041	953	905	930	969
Alt 2	1019	1057	1087	1101	1109	1125	1115	1040	954	908	935	974
Alt 5	1019	1057	1092	1110	1118	1129	1117	1042	955	908	935	974
Surface area change from existing conditions												
Alt 1	0	0	1	1	-2	-3	-6	-9	-11	-4	-4	-1
Alt 2	4	3	-3	-10	-9	-6	-7	-9	-10	-1	1	4
Alt 5	4	3	1	-1	0	-2	-5	-7	-9	-1	1	3
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%
Alt 2	0%	0%	0%	-1%	-1%	-1%	-1%	-1%	-1%	0%	0%	0%
Alt 5	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%

Table A-43. Horsetooth Reservoir Elevation (feet), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5395**	**5403**	**5410**	**5414**	**5416**	**5420**	**5418**	**5406**	**5396**	**5390**	**5388**	**5390**
Alt 1	5395	5403	5410	5414	5416	5420	5417	5405	5395	5390	5388	5390
Alt 2	5394	5401	5407	5408	5410	5415	5413	5402	5393	5388	5386	5388
Alt 5	5395	5403	5409	5411	5414	5419	5416	5405	5395	5390	5388	5390
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	-1	-1	-4	-6	-6	-5	-5	-4	-2	-2	-2	-2
Alt 5	0	0	-1	-2	-2	-2	-2	-1	0	0	0	0

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5394**	**5402**	**5410**	**5412**	**5411**	**5411**	**5405**	**5395**	**5386**	**5389**	**5386**	**5388**
Alt 1	5394	5403	5410	5412	5411	5411	5405	5394	5386	5389	5386	5388
Alt 2	5393	5401	5407	5406	5405	5404	5398	5390	5384	5387	5383	5386
Alt 5	5394	5402	5408	5408	5407	5406	5401	5392	5386	5388	5385	5388
Elevation change from existing conditions												
Alt 1	0	0	0	0	0	0	0	0	0	0	0	0
Alt 2	-1	-1	-3	-5	-6	-7	-7	-5	-2	-2	-3	-3
Alt 5	0	0	-2	-3	-4	-4	-4	-2	0	-1	-1	-1

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**5397**	**5403**	**5410**	**5414**	**5419**	**5425**	**5425**	**5415**	**5404**	**5393**	**5392**	**5393**
Alt 1	5396	5403	5410	5414	5419	5425	5424	5415	5404	5392	5391	5393
Alt 2	5397	5402	5407	5408	5414	5422	5421	5411	5400	5391	5391	5393
Alt 5	5397	5403	5410	5413	5418	5424	5424	5414	5404	5393	5393	5394
Elevation change from existing conditions												
Alt 1	-1	0	0	0	0	0	0	0	0	-1	-1	-1
Alt 2	0	-1	-3	-6	-5	-3	-3	-4	-4	-2	-1	-1
Alt 5	0	0	-1	-2	-1	-1	-1	-1	0	0	1	0

Table A-44. Horsetooth Reservoir Surface Area (acres), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1570**	**1664**	**1759**	**1803**	**1834**	**1892**	**1854**	**1703**	**1579**	**1505**	**1475**	**1505**
Alt 1	1570	1663	1758	1803	1833	1889	1850	1699	1575	1502	1473	1504
Alt 2	1553	1645	1714	1732	1762	1823	1790	1657	1548	1480	1447	1479
Alt 5	1569	1664	1745	1775	1809	1870	1834	1691	1573	1501	1472	1502
Surface area change from existing conditions												
Alt 1	0	0	-1	-1	-1	-3	-4	-4	-4	-3	-2	-1
Alt 2	-17	-18	-45	-72	-72	-69	-64	-46	-30	-25	-28	-26
Alt 5	-1	1	-14	-28	-25	-22	-20	-12	-6	-4	-3	-3
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	-1%	-1%	-3%	-4%	-4%	-4%	-3%	-3%	-2%	-2%	-2%	-2%
Alt 5	0%	0%	-1%	-2%	-1%	-1%	-1%	-1%	0%	0%	0%	0%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1560**	**1661**	**1754**	**1778**	**1769**	**1764**	**1697**	**1565**	**1458**	**1491**	**1446**	**1482**
Alt 1	1562	1664	1757	1781	1771	1766	1696	1562	1455	1487	1445	1483
Alt 2	1541	1648	1716	1712	1692	1680	1608	1502	1431	1463	1410	1447
Alt 5	1555	1660	1734	1734	1720	1712	1644	1535	1453	1484	1435	1472
Surface area change from existing conditions												
Alt 1	2	3	3	3	2	1	-1	-3	-2	-3	-1	1
Alt 2	-19	-13	-39	-66	-77	-84	-89	-64	-27	-27	-36	-35
Alt 5	-5	-1	-21	-44	-49	-52	-53	-30	-5	-7	-11	-11
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Alt 2	-1%	-1%	-2%	-4%	-4%	-5%	-5%	-4%	-2%	-2%	-2%	-2%
Alt 5	0%	0%	-1%	-2%	-3%	-3%	-3%	-2%	0%	0%	-1%	-1%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**1594**	**1670**	**1760**	**1812**	**1872**	**1962**	**1955**	**1820**	**1684**	**1537**	**1532**	**1548**
Alt 1	1586	1665	1756	1809	1872	1963	1954	1817	1682	1529	1521	1537
Alt 2	1592	1662	1717	1735	1802	1912	1907	1769	1634	1514	1514	1537
Alt 5	1597	1674	1752	1791	1857	1953	1947	1813	1679	1540	1542	1553
Surface area change from existing conditions												
Alt 1	-8	-5	-4	-3	0	0	-2	-3	-3	-8	-11	-10
Alt 2	-2	-9	-43	-78	-70	-50	-48	-51	-51	-23	-19	-11
Alt 5	3	4	-8	-21	-15	-9	-9	-7	-6	3	9	6
Percent change in surface area from existing conditions												
Alt 1	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%	-1%
Alt 2	0%	-1%	-2%	-4%	-4%	-3%	-2%	-3%	-3%	-1%	-1%	-1%
Alt 5	0%	0%	0%	-1%	-1%	0%	0%	0%	0%	0%	1%	0%

Table A-45. Lake Granby Elevations (feet), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8258**	**8254**	**8250**	**8248**	**8253**	**8263**	**8268**	**8269**	**8268**	**8266**	**8264**	**8262**
Alt 1	8254	8250	8246	8244	8249	8259	8265	8266	8265	8263	8261	8258
Alt 2	8249	8245	8241	8239	8244	8255	8262	8263	8261	8259	8256	8253
Alt 5	8254	8250	8246	8244	8248	8258	8264	8265	8263	8262	8260	8257
Elevation change from existing conditions												
Alt 1	-4	-4	-4	-4	-4	-3	-3	-3	-3	-3	-3	-3
Alt 2	-9	-9	-9	-9	-9	-7	-6	-6	-7	-7	-8	-8
Alt 5	-4	-4	-4	-4	-5	-5	-4	-4	-4	-4	-4	-4

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8263**	**8259**	**8255**	**8253**	**8253**	**8256**	**8255**	**8252**	**8248**	**8269**	**8270**	**8267**
Alt 1	8260	8256	8252	8249	8250	8252	8251	8248	8244	8266	8267	8265
Alt 2	8257	8252	8248	8246	8247	8249	8248	8243	8238	8263	8265	8262
Alt 5	8260	8256	8252	8250	8251	8253	8252	8248	8244	8265	8267	8264
Elevation change from existing conditions												
Alt 1	-3	-3	-3	-3	-3	-3	-4	-4	-4	-3	-3	-3
Alt 2	-6	-7	-7	-7	-7	-7	-7	-8	-10	-6	-5	-6
Alt 5	-3	-3	-3	-2	-3	-3	-3	-4	-4	-4	-3	-3

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**8257**	**8254**	**8250**	**8248**	**8253**	**8266**	**8277**	**8280**	**8280**	**8265**	**8262**	**8260**
Alt 1	8252	8248	8244	8242	8247	8261	8275	8279	8280	8261	8258	8256
Alt 2	8247	8243	8239	8238	8244	8259	8273	8278	8278	8257	8253	8250
Alt 5	8252	8248	8244	8242	8247	8260	8273	8278	8278	8259	8256	8255
Elevation change from existing conditions												
Alt 1	-5	-5	-6	-6	-6	-5	-3	-1	-1	-4	-5	-5
Alt 2	-11	-11	-11	-10	-9	-7	-5	-2	-2	-8	-9	-10
Alt 5	-6	-6	-5	-5	-6	-6	-4	-2	-2	-5	-6	-6

Table A-46. Lake Granby Surface Area (acres), Cumulative Effects.

Average Year (1950-1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6221**	**6026**	**5824**	**5732**	**5970**	**6440**	**6722**	**6750**	**6691**	**6597**	**6512**	**6392**
Alt 1	6048	5844	5631	5535	5779	6275	6578	6609	6544	6444	6353	6227
Alt 2	5793	5568	5360	5277	5539	6086	6422	6444	6361	6247	6145	5999
Alt 5	6019	5824	5638	5549	5742	6208	6516	6545	6482	6389	6307	6191
Surface area change from existing conditions												
Alt 1	-173	-182	-192	-198	-191	-165	-144	-141	-147	-153	-159	-165
Alt 2	-428	-458	-463	-456	-431	-354	-300	-306	-330	-350	-367	-393
Alt 5	-202	-203	-185	-183	-228	-232	-207	-205	-209	-208	-205	-202
Percent change in surface area from existing conditions												
Alt 1	-3%	-3%	-3%	-3%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	-3%
Alt 2	-7%	-8%	-8%	-8%	-7%	-5%	-4%	-5%	-5%	-5%	-6%	-6%
Alt 5	-3%	-3%	-3%	-3%	-4%	-4%	-3%	-3%	-3%	-3%	-3%	-3%

Dry Year Average (1954, 1966, 1977, 1981, 1989)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6469**	**6263**	**6061**	**5957**	**5998**	**6108**	**6076**	**5910**	**5727**	**6751**	**6802**	**6662**
Alt 1	6337	6123	5912	5803	5839	5939	5898	5726	5533	6617	6679	6535
Alt 2	6167	5932	5726	5627	5665	5770	5724	5500	5234	6459	6548	6390
Alt 5	6306	6100	5920	5835	5866	5963	5923	5731	5513	6563	6636	6500
Surface area change from existing conditions												
Alt 1	-133	-140	-149	-154	-158	-168	-178	-184	-194	-134	-122	-127
Alt 2	-302	-332	-336	-330	-333	-338	-352	-410	-493	-292	-254	-272
Alt 5	-163	-163	-141	-122	-131	-145	-153	-180	-214	-188	-166	-162
Percent change in surface area from existing conditions												
Alt 1	-2%	-2%	-2%	-3%	-3%	-3%	-3%	-3%	-3%	-2%	-2%	-2%
Alt 2	-5%	-5%	-6%	-6%	-6%	-6%	-6%	-7%	-9%	-4%	-4%	-4%
Alt 5	-3%	-3%	-2%	-2%	-2%	-2%	-3%	-3%	-4%	-3%	-2%	-2%

Wet Year Average (1957, 1983, 1984, 1986, 1995)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Exist. Conditions	**6192**	**6013**	**5819**	**5714**	**5968**	**6619**	**7151**	**7298**	**7297**	**6545**	**6426**	**6339**
Alt 1	5944	5748	5538	5425	5687	6384	7023	7258	7268	6360	6203	6104
Alt 2	5668	5464	5285	5212	5514	6257	6925	7187	7202	6154	5972	5852
Alt 5	5907	5727	5549	5453	5661	6308	6945	7193	7206	6291	6130	6049
Surface area change from existing conditions												
Alt 1	-248	-265	-282	-289	-281	-236	-129	-39	-29	-185	-224	-235
Alt 2	-524	-549	-534	-502	-454	-362	-227	-110	-95	-391	-454	-487
Alt 5	-285	-286	-270	-262	-308	-311	-207	-105	-91	-254	-296	-290
Percent change in surface area from existing conditions												
Alt 1	-4%	-4%	-5%	-5%	-5%	-4%	-2%	-1%	0%	-3%	-3%	-4%
Alt 2	-8%	-9%	-9%	-9%	-8%	-5%	-3%	-2%	-1%	-6%	-7%	-8%
Alt 5	-5%	-5%	-5%	-5%	-5%	-5%	-3%	-1%	-1%	-4%	-5%	-5%

Appendix B
Section 404(b)(1) Analysis
Windy Gap Firming Project

1. Introduction

The Bureau of Reclamation (Reclamation), as the lead agency responsible for preparation of the Windy Gap Firming Project (WGFP) Environmental Impact Statement (EIS), and the U.S. Army Corps of Engineers (Corps), a cooperating agency responsible for compliance with the Clean Water Act (CWA), conducted a 404(b)(1) analysis concurrent with preparation of the EIS. The purpose of the 404(b)(1) analysis was to determine the least environmentally damaging practicable alternative (LEDPA) to the aquatic ecosystem and document compliance with the 404(b)(1) guidelines.

Because the proposed WGFP would involve the discharge of dredged and fill material into wetlands or other waters of the U.S., a permit is required from the Corps under Section 404 of the CWA. The Municipal Subdistrict, Northern Colorado Water Conservancy District (Subdistrict), acting by and through the Windy Gap Firming Project Water Activity Enterprise, has notified the Corps that it will seek a Section 404 permit for the WGFP. Issuance of a permit would be a Corps federal action. This 404(b)(1) analysis documents the Corps' compliance with the 404(b)(1) guidelines.

Sections 2 and 3 of this document include an overview of the 404(b)(1) guidelines and the alternative analysis process. The remaining sections of the document discuss the potential effects associated with the proposed discharge of dredged or fill material under the alternative actions per Subparts C to H of 404(b)(1) guidelines.

2. Project Purpose

The purpose of the WGFP is deliver a firm annual yield of about 30,000 AF of water from the existing Windy Gap Project to meet a portion of the water deliveries anticipated from the original Windy Gap Project and to provide up to 3,000 AF of storage to firm water deliveries for the Middle Park Water Conservancy District (MPWCD). Firm water deliveries from the Windy Gap Project are needed to meet a portion of the existing and future demands of the Project Participants. Project Participants include the City and County of Broomfield, , the towns of Erie and Superior, the cities of Evans, Fort Lupton, Greeley, Lafayette, Longmont, Louisville, Loveland, Little Thompson Water District, Central Weld County Water District, Platte River Power Authority and the Middle Park Water Conservancy District (MPWCD).

3. 404(b)(1) Guidelines

Projects subject to the individual permitting process by the Corps under the CWA must comply with the Section 404(b)(1) guidelines (40 CFR, Part 230) for discharge of dredged and fill material into waters of the U.S. Section 404(b)(1) guidelines of the CWA require that "except as provided under Section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (Section 230.10(a)). The guidelines consider an alternative practicable "if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."

4. ALTERNATIVE ANALYSIS

A number of alternatives were considered to meet the purpose and need of the proposed WGFP to firm the yield of the existing Windy Gap Project. The initial range of alternatives included 171 different project elements that individually or in combination might meet the project need. A series of alternative screening criteria were developed based on 404(b)(1) guidelines as well as NEPA guidelines (CEQ 1986) to evaluate alternatives and narrow down the selection of alternatives for inclusion in the EIS. Screening criteria were the project purpose and need, logistical and technological considerations, and environmental consequences. Cost was not used as a screening criterion. Environmental screening criteria included a preference for alternatives with the least impact to wetlands and those that avoided reservoir construction on perennial streams. The results of the alternative screening process resulted in the selection of the following alternatives for evaluation in the EIS:

1. No Action— Reclamation would not approve the connection of new WGFP facilities to C-BT facilities. The Subdistrict would maximize the delivery of Windy Gap water to participants under existing agreements between Reclamation and the Subdistrict. Participants would seek to maximize their delivery of Windy Gap water using existing facilities. In addition, the City of Longmont would enlarge Ralph Price Reservoir to firm its Windy Gap water. The City of Lafayette would not participate in the Windy Gap Project
2. Proposed Action by the Subdistrict—Chimney Hollow Reservoir (90,000 AF) with prepositioning (allowing storage of C-BT water in Chimney Hollow Reservoir).
3. Chimney Hollow Reservoir (70,000 AF) and Jasper East Reservoir (20,000 AF).
4. Chimney Hollow Reservoir (70,000 AF) and Rockwell/Mueller Creek Reservoir (20,000 AF).
5. Dry Creek Reservoir (60,000 AF) and Rockwell/Mueller Creek Reservoir (30,000 AF).

Additional discussion of the alternative selection process is found in Chapter 2 of the WGFP EIS and the WGFP Alternatives Report (ERO Resources 2005).

5. POTENTIAL IMPACTS ON PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM (SUBPART C)

5.1. Substrate (230.20)

5.1.1. Definition and Types of Possible Effects

The substrate of the aquatic ecosystem underlies open waters of the United States and constitutes the surface of wetlands. It consists of organic and inorganic solid materials and includes water and other liquids or gases that fill the spaces between solid particles.

The discharge of dredged or fill material can result in varying degrees of change in the complex physical, chemical, and biological characteristics of the substrate. Discharges which alter substrate elevation or contours can result in changes in water circulation, depth, current pattern, water fluctuation and water temperature. Discharges may adversely affect bottom-dwelling organisms at the site by smothering immobile forms or forcing mobile forms to migrate. Benthic forms present prior to a discharge are unlikely to recolonize on the discharged material if it is very dissimilar from that of the discharge site. Erosion, slumping, or lateral displacement of surrounding bottom of such deposits can adversely affect areas of the substrate outside the perimeters of the disposal site by changing or destroying habitat. The bulk and composition of the discharged material and the location, method, and timing of discharges may all influence the degree of impact on the substrate.

The Wetlands section of the WGFP EIS (Reclamation 2008) contains a description of wetlands and other waters that would be affected by the WGFP. Additional information is found in the Vegetation Resources Technical Report (ERO 2007a). The Aquatic Resources Technical Report (Miller Ecological 2008) contains detailed information about effects to aquatic resources.

5.1.2. Alternative 1—No Action

Under the No Action alternative, about 0.4 acres of substrate under wetlands and other waters would be affected. The effects would occur primarily from the inundation of wetland and waters from raising the Button Rock Dam at Ralph Price Reservoir. Additional wetlands or waters could be affected with dam enlargement depending on final design.

5.1.3. Alternative 2—Chimney Hollow Reservoir (Proposed Action)

The construction of Chimney Hollow Reservoir would involve discharge of fill in wetlands in the dam footprint and in locations where access roads and pipelines cross wetlands and other waters. Wetlands and other waters in the Chimney Hollow Reservoir footprint also would be inundated by water storage. Total permanent and temporary effects to the substrate under wetlands and other waters would be about 3.1 acres.

5.1.4. Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Alternative 3 would involve discharge of fill in wetlands in the dam footprint for Chimney Hollow and Jasper East reservoirs. Additional wetland effects would occur in locations where access roads and pipelines cross wetlands and other waters. Wetlands and other waters in the Chimney Hollow Reservoir and Jasper East Reservoir footprints also would be inundated by water storage. Total permanent and temporary effects to the substrate under wetlands and waters at both reservoir sites would be about 35.5 acres.

5.1.5. Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Alternative 4 would involve discharge of fill in wetlands in the Chimney Hollow Reservoir dam footprint and in the Rockwell/Mueller Creek Reservoir dam footprint. Additional wetland effects would occur in locations where access roads and pipelines cross wetlands and other waters. Wetlands and other waters in the Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir footprints also would be inundated by water storage. Total permanent and temporary effects to the substrate under wetlands and other waters at both reservoir sites would range from 13.3-27.3 acres.

5.1.6. Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Alternative 5 would involve discharge of fill in wetlands in the Dry Creek Reservoir dam footprint and in the Rockwell/Mueller Creek Reservoir dam footprint. Additional wetland effects would occur in locations where access roads and pipelines cross wetlands and other waters. Wetlands and other waters in the Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir footprints also would be inundated by water storage. Total permanent and temporary effects to the substrate under wetlands and other waters at both reservoir sites would range from 20.0 to 35.6 acres.

5.2. Suspended Particulate Materials/Turbidity (230.21)

5.2.1. Definition and Types of Possible Effects

Suspended particulates in the aquatic ecosystem consist of fine-grained mineral particles, usually smaller than silt, and organic particles. Suspended particulates may enter water bodies as a result of land runoff, flooding, vegetative and planktonic breakdown, resuspension of bottom sediments, and human activities including dredging and filling. Particulates may remain suspended in the water column for variable periods of time as a result of such factors as agitation of the water mass, particulate specific gravity, particle shape, and physical and chemical properties of particle surfaces.

The discharge of dredge or fill material can result in greatly elevated levels of suspended particulates in the water column for varying lengths of time. These new levels may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if they last long enough. Sight dependent species may suffer reduced feeding ability leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The biological and the chemical content of the suspended material may react with the dissolved oxygen in the water, which can result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or on the substrate. Significant increases in suspended particulate levels create turbid plumes that are highly visible and aesthetically displeasing. The extent and persistence of these adverse impacts caused by discharges depend upon the relative increase in suspended particulates above the amount occurring naturally; the duration of the higher levels; the current patterns, water level, and fluctuations present when such discharges occur; the volume, rate, and duration of the discharge; particulate deposition; and the seasonal timing of the discharge.

The Water Quality section of the WGFP EIS (Reclamation 2008) contains information on the estimated effects to suspended particulates. Additional information is found in the Water Resource Technical Report (ERO and Boyle 2007), the Stream Water Quality Technical Report (ERO and AMEC 2008), and the Lake and Reservoir Water Quality Report (AMEC 2008).

5.2.2. Suspended Particulate Effects Common to All Alternatives

All of the alternatives would result in additional diversions from the Colorado River at Windy Gap Reservoir with delivery to Granby Reservoir. Alternatives 3, 4, and 5 could also take delivery of Colorado River diversions to new Jasper East and Rockwell/Mueller Creek reservoirs before delivery to

Granby Reservoir. Sediment concentrations in the Colorado River fluctuate and are generally highest during high flows. Total suspended solids (TSS) in Granby Reservoir are not predicted to change under the No Action alternative, but are estimated to increase 4.3 percent under all the action alternatives. TSS is estimated to increase about 5 percent in Shadow Mountain Reservoir under all the alternatives. There would be no change in TSS in Grand Lake under the No Action alternative and Alternative 5, but TSS is estimated to increase 5.6 percent under Alternatives 2, 3, and 4. Suspended particulate concentrations may become elevated in the Three Lakes (Granby Reservoir, Shadow Mountain Reservoir, and Grand Lake) under Alternatives 3, 4, and 5 when the Jasper East or Rockwell/Mueller Creek reservoirs are drawn down rapidly or contain low volumes of stored water that are pumped to Granby Reservoir.

Delivery of Windy Gap water through the C-BT system to Carter Lake and Horsetooth Reservoir would generally have low suspended particulates under all the alternatives.

5.2.3. Alternative 1—No Action

The water used to fill the enlarged Ralph Price Reservoir would come from additional capture and storage of North St. Vrain Creek in exchange for Windy Gap deliveries to the St. Vrain River. North St. Vrain Creek water is of a high quality with low suspended particulates. Suspended particulates concentrations in the reservoir could be elevated from erosion of newly inundated shoreline. Windy Gap water deliveries to St. Vrain Creek via the C-BT system to replace water stored in Ralph Price Reservoir is generally of high quality with low suspended particulate concentrations similar to existing conditions.

5.2.4. Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Water delivery to Chimney Hollow Reservoir through the C-BT system would be low in suspended particulates. Because water levels in the reservoir would remain near full most of the time and the watershed source area to the reservoir is small, suspended particulate concentrations would be low.

5.2.5. Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Water delivery to Chimney Hollow Reservoir through the C-BT system would be low in suspended particulates. Greater water level fluctuations in Chimney Hollow Reservoir would increase the potential for particulate suspension compared to Alternative 2. The watershed source area to the reservoir is small and would contribute a minor quantity of sediment to the reservoir.

Water levels in Jasper East Reservoir would fluctuate substantially increasing the potential for suspension or re-suspension of sediments. The watershed source area to the reservoir is small and would contribute a minor quantity of sediment to the reservoir.

5.2.6. Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Suspended sediment effects at Chimney Hollow Reservoir would be the same as Alternative 3.

Water levels in Rockwell/Mueller Creek Reservoir would fluctuate substantially increasing the potential for suspension or re-suspension of sediments. The watershed source area to the reservoir is small and would contribute a minor quantity of sediment to the reservoir.

5.2.7. Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Water delivery to Dry Creek Reservoir through the C-BT system would generally be low in suspended particulates. Water level fluctuations in the reservoir would result in some shoreline erosion and the potential for suspension of sediment. The watershed source area to the reservoir is small and would contribute a minor quantity of sediment to the reservoir.

5.3. Water (230.22)

5.3.1. Definition and Types of Possible Effects

Water is the part of the aquatic ecosystem in which organic and inorganic constituents are dissolved and suspended. It constitutes part of the liquid phase and is contained by the substrate. Water forms part of a dynamic aquatic life-supporting system. Water clarity, nutrients and chemical content, physical and biological content, dissolved gas levels, pH, and temperature contribute to its life-sustaining capabilities.

The discharge of dredged or fill material can change the chemistry and the physical characteristics of the receiving water at a disposal site through the introduction of chemical constituents in suspended or dissolved form.

Changes in the clarity, color, odor, and taste of water and the addition of contaminants can reduce or eliminate the suitability of water bodies for populations of aquatic organisms, and for human consumption, recreation, and aesthetics. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as algae to the detriment of other more desirable types such as submerged aquatic vegetation, potentially causing adverse health effects, objectionable tastes and odors, and other problems.

The Water Quality section of the WGFP EIS (Reclamation 2008) contains detailed information about the estimated effects on water quality. Additional information is found in the Stream Water Quality Technical Report (ERO and AMEC 2008) and the Lake and Reservoir Water Quality Technical Report (AMEC 2008).

5.3.2. Water Quality Effects by Stream and Reservoir

Colorado River. Water quality effects to the Colorado River resulting from flow changes would be similar under all of the action alternatives, because the flow changes would be similar. The No Action alternative would have less impact on water quality because less water would be diverted from the Colorado River. All alternatives would result in an increase in Colorado River stream temperature below Windy Gap Reservoir. Specific conductivity would increase below the Williams Fork and dissolved oxygen would decrease slightly at minimum streamflows. Ammonia and inorganic phosphorus concentrations would increase for all alternatives. Water quality standards would be met with the exception of an increased potential for exceeding the temperature standard during periods of low flow and dropping below the dissolved oxygen standard in portions of the Colorado River during low flow.

Willow Creek. Willow Creek would see a slight reduction in water temperature and a slight increase in the concentration of ammonia, iron, and copper under all the alternatives. Water quality standards would be met under all alternatives.

Granby Reservoir. All of the alternatives result in an increase in total phosphorus concentrations and no change in Secchi-disk depth (clarity) or trophic state in Granby Reservoir. The No Action and Proposed Action alternatives would have an increase in total nitrogen concentrations and the other alternatives a slight decrease. Average chlorophyll *a* concentrations would increase under the Proposed Action and remain the same for other alternatives. Dissolved oxygen concentrations would decrease under the No Action and the Proposed Action alternatives and remain unchanged for other alternatives. Dissolved oxygen concentrations in the hypolimnion and manganese concentrations, which currently exceed water quality standards would continue to exceed standards. Temperature would not change under any of the alternatives, but would continue to exceed standards as it currently does.

Shadow Mountain Reservoir. Total phosphorus concentrations would increase under all the alternatives in Shadow Mountain Reservoir. Total nitrogen would increase under the No Action alternative and Alternatives 2 and 3 and decrease for Alternatives 4 and 5. Chlorophyll *a* would increase under Alternatives 1 to 3 and would not change for Alternatives 4 and 5. None of the alternatives would affect Secchi disk depth or the trophic state of the reservoir. Dissolved oxygen would decrease under the Proposed Action alternative and would not change under other alternatives. The lower dissolved oxygen concentration for the Proposed Action alternative indicates the manganese water quality standard may not be met, similar to existing conditions. Temperature and water quality standards for other parameters would continue to be met under all alternatives.

Grand Lake. Total phosphorus is estimated to increase under all the alternatives in Grand Lake. Total nitrogen would increase under No Action and the Proposed Action and would decrease for Alternatives 3 to 5. Average chlorophyll *a* is estimated to increase for all alternatives. Secchi-disk depth would decrease for all alternatives except Alternative 5. There would be no change in trophic status for any of the alternatives. Dissolved oxygen concentrations would decrease for all alternatives, which would result in continued exceedance of the manganese standard. Temperature and water quality standards for other parameters would continue to be met under all alternatives.

Jasper East Reservoir. Jasper East Reservoir, which is a feature of Alternative 3, is predicted to be oligotrophic to mesotrophic. Water quality in a newly constructed Jasper East Reservoir would generally be good, but would have higher total phosphorus concentrations and similar nitrogen concentrations compared to the Three Lakes reservoirs. Chlorophyll *a* concentrations would be lower than the Three Lakes and Secchi-disk would be greater.

Big Thompson River. Additional deliveries of Windy Gap water to the Big Thompson River below Lake Estes would result in a slight increase in nitrogen and phosphorus concentrations under all alternatives. All of the alternatives would result in a slight decrease in ammonia concentrations below the Loveland Wastewater Treatment Plant (WWTP) and an increase in copper. No exceedance of water quality standards is predicted for any of the alternatives.

North St. Vrain Creek. Increases and decreases in stream temperature and dissolved oxygen below Ralph Price Reservoir would occur depending on monthly flow changes under the No Action alternative.

St. Vrain Creek. Minimal effects to St. Vrain water quality between the confluence with North St. Vrain Creek and the St. Vrain Supply Canal under the No Action alternative are predicted. St. Vrain Creek below the Longmont WWTP would experience increased discharges from Windy Gap return flows resulting in an increase in ammonia and iron concentrations and a decrease in manganese concentration under all the alternatives. No exceedance of water quality standards is predicted.

Big Dry Creek. Additional WWTP discharges for all alternatives below the Broomfield WWTP would result in an increase in ammonia concentrations that could increase the potential for exceedance of the water quality standard, which occurs occasionally under current conditions. Iron and manganese concentrations would go down under all alternatives.

Coal Creek. All the alternatives would result in higher streamflow and ammonia concentrations below Superior, Louisville, Lafayette, and Erie WWTPs. The potential for exceedance of the ammonia standard is possible during low flows.

Cache la Poudre River. Ammonia and copper concentrations in the Cache la Poudre River below the Greeley WWTP would increase under all the alternatives. No exceedance of water quality standards is projected.

Carter Lake. Total phosphorus and total nitrogen would increase under all the alternatives. Chlorophyll *a* would increase under the No Action alternative, the Proposed Action alternative, and Alternative 5 and would not change for Alternatives 3 and 4. All alternatives would result in a decrease in Secchi-disk depth, but there would be no change in trophic status or temperature. Dissolved oxygen is likely to decrease with potential for an increase in manganese levels; the Proposed Action alternative would have the greatest effect. No exceedance of water quality standards is likely for any of the alternatives.

Horsetooth Reservoir. Total phosphorus, total nitrogen, and chlorophyll *a* concentrations would increase under all the alternatives. Secchi-disk depth would decrease for the Proposed Action alternative and would not change for other alternatives. There would be no change in the trophic status of the reservoir under any of the alternatives. All alternatives may slightly reduce dissolved oxygen concentrations, which would result in continued exceedance of the manganese standard.

New Reservoir Sites. Construction of new reservoirs at Chimney Hollow, Dry Creek, Jasper East, or Rockwell/Mueller Creek would inundate and fill the existing ephemeral or intermittent streams. Water quality below the dams would be similar to that described for each of the new reservoirs as describe below.

Chimney Hollow Reservoir and Dry Creek Reservoirs. The water quality of both reservoirs would be similar. Both reservoirs are predicted to be oligotrophic and would not exceed water quality standards.

Rockwell/Mueller Creek Reservoir. Water quality in Rockwell/Mueller Creek Reservoir would be similar to Jasper East Reservoir under Alternatives 4 and 5.

5.4. Current Patterns and Water Circulation (230.23)

5.4.1. Definition and Types of Possible Effects

Current patterns and water circulation are the physical movements of water in the aquatic ecosystem. Currents and circulation respond to natural forces as modified by basin shape and cover, physical and chemical characteristics of water strata and masses, and energy dissipating factors.

The discharge of dredged or fill material can modify current patterns and water circulation by obstructing flow, changing the direction or velocity of water flow and circulation, or otherwise changing the dimensions of a water body. As a result, adverse changes can occur in: location, structure, and dynamics of aquatic communities; shoreline and substrate erosion and deposition rates; the deposition of suspended particulates; the rate and extent of mixing of dissolved and suspended components of the water body; and water stratification.

The Surface Water Hydrology and Stream Morphology and Floodplain sections of the WGFP EIS (Reclamation 2008) contain information about the estimated changes in streamflow that would occur under the various alternatives and effects to stream morphology. Additional details are found in the Water Resource Technical Report (ERO and Boyle 2007).

5.4.2. Effects Similar for all Alternatives

All of the alternatives would result in additional pumping of water from the Colorado River at the existing Windy Gap Reservoir. No new water diversions or structures are required. Water diversions would result in a change in the volume and velocity of flows downstream from Windy Gap Reservoir primarily during May and June. Water pumped from Windy Gap Reservoir would be delivered to Granby Reservoir under all the alternatives and under Alternatives 3, 4, and 5 could also be delivered to new West Slope reservoirs prior to delivery to Granby Reservoir. The frequency of 2-year peak discharges at Hot Sulphur Springs would occur about 1 percent less than under existing conditions under all the alternatives. Channel maintenance flows would also occur about 1 percent less under the alternatives. The sediment transport rate of the Colorado River would still exceed the sediment supply and no aggradation of the channel is likely. A reduction in spills from Granby Reservoir would also affect flows in the Colorado River above the Windy Gap Reservoir. Granby Reservoir spills under all the alternatives would continue to provide flows sufficient to maintain channel capacity, provide periodic scouring, and sediment transport.

All alternatives would continue to result in transbasin diversions from the West Slope through the existing C-BT system and delivery to WGFP Participants on the East Slope in the same manner as currently occurs. Additional deliveries from the Adams Tunnel to the Big Thompson River below Lake Estes would be relatively small and are unlikely to affect channel morphology under any of the alternatives. The additional return flows to East Slope streams below Participant WWTPs on the Big Thompson River, St. Vrain Creek, Coal Creek, and Big Dry Creek are not expected to materially affect stream morphology or sediment transport because flows would be well within historical flows and the channel forming processes of these streams are already highly modified in the urban environment.

Construction of new reservoirs at Chimney Hollow, Dry Creek, Jasper East, or Rockwell/Mueller Creek would capture water from the existing ephemeral and intermittent streams, but would release water below the dam similar to current flows.

5.4.3. Alternative 1—No Action

Alternative 1 requires an exchange of Windy Gap water for North St. Vrain water captured in the enlarged Ralph Price Reservoir. This would result in a change in flows in North St. Vrain Creek and St. Vrain Creek below the reservoir until the water is replaced at Lyons from the St. Vrain Supply Canal. The volume of flow changes are well within the historical range of flows and would not substantially affect stream morphology in North St. Vrain or St. Vrain Creek. Enlargement of Ralph Price Reservoir would increase reservoir storage capacity by 13,000 AF, but would not substantially change current patterns and water circulation.

5.5. Normal Water Fluctuations (230.24)

5.5.1. Definition and Types of Possible Effects

Normal water fluctuations in a natural aquatic system consist of daily, seasonal, and annual tidal and flood fluctuations in water level. Biological and physical components of such a system are either attuned to or characterized by these periodic water fluctuations.

The discharge of dredge or fill material can alter the normal water-level fluctuation pattern of an area, resulting in prolonged periods of inundation, exaggerated extremes of high and low water, or a static nonfluctuating water level. Such water level modifications may change salinity patterns, alter erosion or sedimentation rates, aggravate water temperature extremes, and upset the nutrient and dissolved oxygen balance of the aquatic ecosystem. In addition, these modifications can alter or destroy communities and populations of aquatic animals and vegetation; induce populations of nuisance organisms; modify habitat; reduce food supplies; restrict movement of aquatic fauna; destroy spawning areas; and change adjacent, upstream, and downstream areas.

The Surface Water Hydrology section of the WGFP EIS (Reclamation 2008) contains detailed information about the estimated changes in streamflow and water storage that would occur under the alternatives. Additional information is found in the Water Resource Technical Report (ERO and Boyle 2007). The Stream Water Quality Technical Report (ERO and AMEC 2008) and the Lake and Reservoir Water Quality Technical Report (AMEC 2008) contain detailed information about potential effects to water quality. The Vegetation Resources Technical Report contains detailed information about potential effects to wetlands and riparian resources along the Colorado River, Willow Creek, and East Slope streams. The Wildlife Resources Technical Report (ERO 2007b) and Aquatic Resource Technical Report (Miller Ecological 2008) contain information about potential effects to aquatic fauna and threatened and endangered species.

5.5.2. Alternative Effects

Dredge and fill activities associated with new reservoir and dam construction and the associated inundation of the channels would directly impact existing periodic flows of these ephemeral and intermittent streams. New reservoirs would fluctuate according to specific operating conditions. Chimney Hollow Reservoir water levels would fluctuate the least under the Proposed Action alternative. Chimney Hollow Reservoir in Alternatives 3 and 4 and Dry Creek Reservoir in Alternative 5 would have moderate seasonal levels of fluctuation. Jasper East Reservoir and Rockwell/Mueller Creek Reservoir would fluctuate substantially throughout the year and from year to year.

Indirect effects of the discharge of fill material associated with dam construction result in a change in streamflow and reservoir levels at other locations. All of the alternatives would result in a change in flows in the Colorado River below Windy Gap Reservoir, as well as below Granby Reservoir. The majority of flow reductions would occur during May and June, but could occur from April to August. The largest percent reduction in flow below Windy Gap Reservoir would occur in July. Colorado River flow below Windy Gap Reservoir in July would decrease from about 20 percent for the No Action alternative to 23 percent for the Proposed Action alternative, and 28 percent for Alternatives 3, 4, and 5. There would be no change in Colorado River flow from existing conditions during dry years as a result of the WGFP. Colorado River diversions would reduce the potential for flooding downstream of Windy Gap Reservoir. All of the alternatives would also result in a reduction in streamflow for Willow Creek below Willow Creek Reservoir. The largest volume change in Willow Creek would be in June and the greatest percentage change in July.

Water levels in Granby Reservoir, Carter Lake, and Horsetooth Reservoir would be lower under all the alternatives. The greatest fluctuation in water levels would occur under the Proposed Action alternative. Water levels in Shadow Mountain Reservoir and Grand Lake would not change for any alternative.

All of the alternatives would result in increased streamflows on the East Slope at several locations. The Big Thompson River below Lake Estes would receive additional deliveries of Windy Gap water, and streams below Participant WWTPs would have increased discharges from Windy Gap return flows following municipal use. Predicted small changes in East Slope streamflow would slightly increase the potential for flooding, but the flow increases would generally be small relative to existing flows.

5.6. Salinity Gradients (230.25)

Salinity gradients form where salt water from the ocean meets and mixes with fresh water from land.

The project area is not located in or near an ocean; therefore, salinity gradients would not be affected by the Project.

6. POTENTIAL IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM (SUBPART D)

6.1. Threatened, Endangered, and Candidate Species (230.30)

6.1.1. Definition and Types of Possible Effects

An endangered species is a plant or animal in danger of extinction throughout all or a significant portion of its range. A threatened species is one in danger of becoming an endangered species in the foreseeable future throughout all or a significant portion of its range. The major potential impacts on threatened or endangered species from the discharge of dredged or fill material include covering or otherwise directly killing a species, the impairment or destruction of habitat, and facilitating incompatible activities.

The Threatened and Endangered Species section of the WGFP EIS (Reclamation 2008) contains information about threatened and endangered species that could be affected by the alternatives.

Additional detailed information is found in the Vegetation Resources Technical Report (ERO 2007a), Wildlife Resources Technical Report (ERO 2007b), and Aquatic Resource Technical Report (Miller Ecological 2008).

6.1.2. All Alternatives

All of the action alternatives would result in depletions to the Colorado River Basin. Future Windy Gap depletions to the Colorado River were incorporated into the Recovery Plan for endangered fish species (bonytail chub, Colorado pike minnow, humpback chub, and razorback sucker) in the Upper Colorado River. No effect to endangered fish species are expected with participation in the Recovery Plan and Programmatic Biological Opinion under any of the alternatives. Additional average annual WGFP depletions above existing conditions would range from about 7,000 AF under the No Action alternative to about 9,500 AF under the Proposed Action alternative and about 11,500 to 12,000 AF under Alternatives 3, 4, and 5.

The No Action alternative, Proposed Action alternative, and Alternative 3 would have no effect on other threatened or endangered species. Construction of Rockwell/Mueller Creek Reservoir may affect, but is unlikely to adversely affect lynx.

6.2. Fish, Crustaceans, Mollusks, and Other Aquatic Organisms (230.31)

6.2.1. Definition and Types of Possible Effects

Aquatic organisms in the food web include a variety of plant and animal species. The discharge of dredge or fill material can variously affect populations of fish, crustaceans, mollusks, and other food web organisms through the release of contaminants that adversely affect adults, juveniles, larvae, or eggs, or result in the establishment or proliferation of an undesirable competitive species at the expense of the desired species.

The Aquatic Resources section of the WGFP EIS (Reclamation 2008) provides information on the estimated effects to fish and aquatic life. Additional information is found in the Aquatic Resource Technical Report (Miller Ecological 2008).

6.2.2. Alternative Effects

Construction of new reservoirs (Chimney Hollow, Jasper East, and Rockwell/Mueller Creek) under the action alternatives would have no direct effects on fish because the reservoirs would not be constructed on perennial drainages. Portions of Dry Creek at the Dry Creek Reservoir site support minnows and aquatic invertebrates that would be impacted by reservoir construction. These drainages may support other aquatic invertebrates or insects. The new reservoirs as well as enlargement of Ralph Price Reservoir under the No Action alternative would provide habitat for establishing fish and other aquatic organisms. Chimney Hollow Reservoir under the Proposed Action alternative would be managed to support a sport fishery. This also may occur under other alternatives and reservoir sites if a managing entity is found. Suitability of Jasper East Reservoir and Rockwell/Mueller Creek Reservoir for establishing a sport fishery may be difficult because of fluctuations in water levels.

Effects to fish and other aquatic life are possible in the Colorado River from the changes in streamflow. All of the alternatives would result in a decrease in fish habitat below Windy Gap Reservoir. The greatest loss of habitat would occur during peak runoff; however, habitat is not typically a limiting factor during this period. For the No Action alternative, adult rainbow trout habitat in the Colorado River downstream of Windy Gap Reservoir would decrease up to 9 percent in 3 out of 10 years above Williams Fork. Adult rainbow trout habitat in the Colorado River below Windy Gap Reservoir in average years would decrease up to 24 percent in 4 out of 10 years under the Proposed Action and other alternatives. Rainbow and brown trout habitat in the Colorado River above the Blue River would decrease less than 10 percent under all the alternatives about 10 percent of the time on average. Predicted periodic decreases in fish habitat are unlikely to adversely impact fish populations or macroinvertebrate populations. Predicted water quality changes in the Colorado River are unlikely to measurably impact fish populations, although exceedance of the stream temperature for aquatic life would occur under some flow conditions, primarily above the Williams Fork River.

Under the No Action alternative, adult brown trout habitat in Willow Creek would decrease up to 9 percent in 2 out of 10 years, and juvenile trout habitat would decrease up to 6 percent in 2 out of 10 years. For the action alternatives, adult habitat for brown trout in Willow Creek would decrease up to 21 percent in 2 out of 10 years.

No adverse effect to fish or aquatic organisms is predicted for the Three Lakes as a result of changes in reservoir storage or water quality for any of the alternatives.

Projected increases in flow in the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek would slightly enhance fish habitat under all alternatives. A slight reduction in fish habitat in North St. Vrain and St. Vrain Creek above Lyons is possible with reduced flow in some summer months under the No Action alternative; however, higher flows in the fall and winter would benefit fish habitat. Predicted changes in reservoir storage and water quality in Carter Lake and Horsetooth Reservoir would not adversely impact fish habitat under all alternatives. A larger Ralph Price Reservoir under the No Action alternative would slightly benefit fish.

6.3. Impacts on Other Wildlife (230.32)

6.3.1. Definition and Types of Possible Effects

Wildlife associated with aquatic ecosystems are resident and transient mammals, birds, reptiles, and amphibians. The discharge of dredged or fill material can result in the loss or change of breeding and nesting areas, escape cover, travel corridors, and preferred food sources for resident and transient wildlife species associated with the aquatic ecosystem. These adverse impacts upon wildlife habitat may result from changes in water levels, water flow and circulation, salinity, chemical content, and substrate characteristics and elevation. Increased water turbidity can adversely affect wildlife species which rely upon sight to feed, and disrupt the respiration and feeding of certain aquatic wildlife and food chain organisms. The availability of contaminants from the discharge of dredged or fill material may lead to the bioaccumulation of such contaminants in wildlife. Changes in such physical and chemical factors of the environment may favor the introduction of undesirable plant and animal species at the expense of resident species and communities. In some aquatic environments, lowering plant and animal species diversity may disrupt the normal functions of the ecosystem and lead to reductions in overall biological productivity.

The Wildlife section of the WGFP EIS (Reclamation 2008) describes potential direct and indirect effects to wildlife that could result from the alternatives. The Wildlife Resources Technical Report (ERO 2007b) provides additional details.

6.3.2. Alternative Effects

Reservoir and dam construction for any of the new reservoirs would fill or inundate riparian and wetland habitat present along the ephemeral and intermittent drainages where these reservoirs are located. This would result in the loss of suitable habitat for a variety of migratory birds, amphibians, and reptiles. Chimney Hollow and Dry Creek reservoirs would support development of riparian vegetation for wildlife because reservoir levels would remain fairly stable. Chimney Hollow Reservoir under the Proposed Action alternative has the greatest potential for creating shoreline wildlife habitat because it would have the least fluctuation in water levels. Jasper East Reservoir and Rockwell/Mueller Creek Reservoir are unlikely to develop substantial riparian vegetation development and wildlife habitat because of wide fluctuations in water levels. All of the reservoirs would create additional waterfowl and water bird habitat. New reservoirs may also support foraging habitat for osprey and bald eagles.

All action alternatives would result in reduced flows in the Colorado River downstream of Granby Reservoir and in Willow Creek downstream of Willow Creek Reservoir (ERO and Boyle 2007). These reduced flows are not anticipated to cause a loss of riparian or wetland vegetation and hence would not adversely impact wildlife habitat bordering streams. Likewise, predicted fluctuations in existing reservoir water levels is not expected to adversely impact the limited adjacent riparian vegetation that support wildlife.

Minor increases in East Slope streamflow, under all the alternatives, are unlikely to substantially change stream channel characteristics or vegetation composition; hence, existing wildlife habitat values are unlikely to change.

7. POTENTIAL IMPACTS ON SPECIAL AQUATIC SITES (SUBPART E)

The estimated effect to special aquatic sites are discussed in the Aquatic Resource section of the WGFP EIS (Reclamation 2008) and the Vegetation Resources Technical Report (ERO 2007a).

7.1. Sanctuaries and Refuges (230.40)

7.1.1. Definition and Types of Possible Effects

Sanctuaries and refuges consist of areas designated under state and federal laws or local ordinances to be managed principally for the preservation and use of fish and wildlife resources. Sanctuaries and refuges may be affected by discharges of dredged or fill material that disrupt the breeding, spawning, migratory movements, or other critical life requirements of resident or transient fish and wildlife resources; create unplanned, easy and incompatible human access to remote aquatic areas; create the need for frequent maintenance activity; result in the establishment of undesirable competitive species of plants and animals; change the balance of water and land areas needed to provide cover, food, and other fish and wildlife habitat requirements in a way that modifies sanctuary or refuge management practices.

7.1.2. Alternative Effects

None of the alternatives would result in direct impacts to sanctuaries or wildlife areas. All of the alternatives would result in a change in Colorado River streamflow through portions of the Colorado Division of Wildlife Hot Sulphur Springs State Wildlife Area (SWA) and Kemp-Breeze SWA. Access or use of these SWAs would not be impacted.

7.2. Wetlands (230.41)

7.2.1. Definition and Types of Possible Effects

Wetlands consist of areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. The discharge of dredged or fill material in wetlands is likely to damage or destroy habitat and adversely affect the biological productivity of wetlands ecosystems by smothering, by dewatering, by permanently flooding, or by altering substrate elevation or periodicity of water movement. The addition of dredged or fill material may destroy wetland vegetation or result in advancement of succession to dry land species. It may reduce or eliminate nutrient exchange by a reduction of the system's productivity, or by altering current patterns and velocities. Disruption or elimination of the wetland system can degrade water quality by obstructing circulation patterns that flush large expanses of wetland systems, by interfering with the filtration function of wetlands, or by changing the aquifer recharge capability of a wetland. Discharges can also change the wetland habitat value for fish and wildlife. When disruptions in flow and circulation patterns occur, apparently minor loss of wetland acreage may result in major losses through secondary impacts. Discharging fill material in wetlands as part of municipal, industrial or recreational development may modify the capacity of wetlands to retain and store floodwaters and to serve as a buffer zone shielding upland areas from wave actions, storm damage and erosion.

The Wetland section of the WGFP EIS (Reclamation 2008) and the Vegetation Resources Technical Report (ERO 2007a) contain more information on the estimated wetland impacts.

7.2.2. Summary of Effects to Wetlands and Other Waters

The permanent and temporary effects to wetlands and other waters for the alternatives are summarized in Table 1. A discussion of effects by alternative follows.

Table 1. Summary of effects to wetlands and other waters by alternative.

Wetland and Other Waters	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3	Alternative 4	Alternative 5
Wetlands					
Permanent	0.3	1.6	22.7	4.5-15.1	9.2–21.8
Temporary	—	0.1	4.9	2.1-5.1	2.3–5.3
Total	0.3	1.7	27.6	6.6-20.2	11.0–27.1
Other Waters					
Permanent	0.1	1.3	7.6	4.9	6.5
Temporary	—	0.1	0.3	1.8	2.0
Total	0.1	1.4	7.9	6.7	8.5
TOTAL	**0.4**	**3.1**	**35.5**	**13.3—26.9**	**19.5–35.6**

7.2.3. Alternative 1—No Action Alternative

Enlargement of Ralph Price Reservoir under the No Action alternative would inundate about 0.3 acre of wetlands around the existing shoreline and at stream inlets (Table 1). At the North St. Vrain Creek inlet and inlets of other small tributaries to the reservoir, about 0.1 acre of waters would be inundated with a higher reservoir water level. Additional effects to waters and wetlands are possible depending on final design for the dam enlargement.

7.2.4. Alternative 2—Chimney Hollow Reservoir (Proposed Action)

The Proposed Action alternative would result in a permanent impact to 1.6 acres of wetlands from dam construction and facility construction, as well as wetlands inundated by the reservoir (Table 1). An additional 0.1 acre of wetlands would be temporarily disturbed by construction-related activities. The total impacts to wetlands from implementation of Alternative 2 would be 1.7 acres. About 1.4 acre of other waters would be filled by dam construction or inundated by the new reservoir.

7.2.5. Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Alternative 3 would affect a total of 27.6 acres of wetlands from construction of Chimney Hollow Reservoir and Jasper East Reservoir (Table 1). The majority of wetland impacts would occur at the Jasper East Reservoir site from dam construction and inundation of wetlands. Wetland impacts include 22.7 acres of permanent loss and 4.9 acres of temporary disturbance. Inundation or filling of the small channels at both reservoir sites would impact 7.9 acres of other waters.

7.2.6. Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Construction of Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir would affect 6.6 to 20.2 acres of wetlands (Table 1). The range in potential wetland effects is the result of the uncertainty in the amount of wetlands located at the Rockwell/Mueller Creek Reservoir site. Access to this site was denied by the landowners so no field data collection was conducted. The majority of wetland impacts would occur at the Rockwell/Mueller Creek Reservoir site. About 6.7 acres of other waters would be impacted by construction of both reservoirs under this alternative.

7.2.7. Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Construction of Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir would affect a total of 11.0 to 27.1 acres of wetlands (Table 1) depending on the wetlands present at the Rockwell site. Wetland impacts at Dry Creek Reservoir would be about 6.5 acres and the remainder of the impacts would be from construction of Rockwell/Mueller Creek Reservoir. About 8.5 acres of other waters would be impacted by construction of both reservoirs.

7.2.8. Indirect Wetland Impacts Similar for All Alternatives

All of the alternatives would result in reduced streamflow in the Colorado River and Willow Creek on the West Slope and increased flows for several East Slope streams. The action alternatives would result in greater diversions from the Colorado River and greater return flows on the East Slope on average than the No Action alternative. In addition, there would be changes in water levels at Granby Reservoir, Carter Lake, and Horsetooth Reservoir. An evaluation of the projected changes in channel maintenance flows and channel morphology indicates the conditions for growth, establishment, maintenance, and periodic scouring of riparian and wetland vegetation below Granby Reservoir and the Windy Gap diversion is unlikely to change substantially under any of the alternatives. Colorado River minimum flow requirements would be met under all the alternatives and the dry year diversions would not increase from existing conditions. None of the alternatives are predicted to adversely impact wetland and riparian vegetation as a result of changes in Colorado River streamflow.

Small seasonal decreases in Willow Creek flow below Willow Creek Reservoir are not expected to adversely impact channel maintenance flow or the hydrologic requirements for wetland or riparian vegetation adjacent to the stream.

There would be no change in water levels at Shadow Mountain Reservoir or Grand Lake under any of the alternatives; hence, there would be no impact wetlands or riparian vegetation. Lower average water levels in Granby Reservoir and to a lesser extent at Carter Lake and Horsetooth Reservoir are unlikely to adversely affect wetland or riparian vegetation under any of the alternatives because reservoir fluctuations would fall within the historical range of current reservoir fluctuations.

Projected small increases in streamflow from additional imports to the Big Thompson River below Lake Estes under all the alternatives are unlikely to adversely impact channel-forming hydrologic conditions or other conditions supporting riparian and wetland vegetation. The projected increases in streamflow below Participant WWTPs on the Big Thompson River, St. Vrain Creek, Big Dry Creek, and Coal Creek would not be large enough to measurably impact channel characteristics or other factors that are likely to adversely impact or benefit riparian or wetland vegetation. Projected seasonal increases and decreases in North St. Vrain Creek and St. Vrain Creek above Lyons under the No Action alternative would fall within historical flow fluctuations and are unlikely to impact channel morphology or the hydrologic conditions needed to support wetlands and riparian vegetation.

7.3. Mudflats

Mud flats are broad flat areas along the sea coast and in coastal rivers to the head of tidal influence and in inland lakes, ponds, and riverine systems.

No direct effects to mudflats were identified as part of the WGFP EIS.

7.4. Vegetated Shallows

Vegetated shallows are permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass in estuarine or marine systems as well as a number of freshwater species in rivers and lakes.

No direct effects to vegetated shallows were identified as part of the WGFP.

7.5. Riffle and Pool Complexes

7.5.1. Definition and Types of Possible Effects

Steep gradient sections of streams are sometimes characterized by riffle and pool complexes. Discharge of dredged or fill material can eliminate riffle and pool areas by displacement, hydrologic modification, or sedimentation.

The Stream Morphology and Floodplains section of the WGFP EIS addresses potential effects to streams and the Aquatic Resource section of the EIS discusses fish habitat (Reclamation 2008). Additional information on fish habitat is found in the Aquatic Resource Technical Report (Miller Ecological 2008). Additional information on stream morphology is found in the Water Resource Technical Report (ERO and Boyle 2007).

7.5.2. Effects Similar for All Alternatives

Dredge and fill activities associated with construction of any of the new reservoirs would have no direct effect on riffle and pool complexes because the reservoirs would be located on intermittent and ephemeral drainages that do not flow continuously. Enlargement of Ralph Price Reservoir would inundate about 500 feet of North St. Vrain Creek at the reservoir inlet that may contain riffles and pools. Riffle and pool complexes on North St. Vrain Creek below the dam could be impacted if dam enlargement extends into the channel.

Indirect effects to riffle and pools on the Colorado River and Willow Creek from a reduction in flow are not predicted to impact channel forming process or result in stream sedimentation. The Aquatic Resource Report addresses changes in fish habitat as a result of flow changes. Increased flows to East Slope streams would not result in adverse effects to channel morphology or existing riffle pool complexes.

8. POTENTIAL IMPACTS ON HUMAN USE CHARACTERISTICS

8.1. Municipal and Private Water Supplies

8.1.1. Definition and Types of Possible Effects

Municipal and private water supplies consist of surface water or ground water that is directed to the intake of a municipal or private water supply system. Discharges can affect the quality of water supplies with respect to color, taste, odor, chemical content and suspended particulate concentration, in such a way as to reduce the fitness of the water for consumption.

The Water Quality section of the WGFP EIS (Reclamation 2008) discuss potential impacts to water quality. Additional information is found in the Stream Water Quality Technical Report (ERO and AMEC 2008) and the Lake and Reservoir Water Quality Technical Report (AMEC 2008).

8.1.2. Alternative Effects

None of the alternatives would result in exceedance of water quality standards for a water supply in the Colorado River or Willow Creek. Manganese concentrations in Granby Reservoir, Shadow Mountain Reservoir, and Grand Lake currently exceed the manganese standard for a water supply. Lower dissolved oxygen concentrations for the No Action and Proposed Action alternatives may slightly increase manganese concentrations in Granby Reservoir, so there would be no improvement. Under the Proposed Action, a predicted decrease in dissolved oxygen concentration may slightly increase the manganese concentration in Shadow Mountain Reservoir, which would continue to exceed the water supply standard. All of the alternatives would result in lower dissolved oxygen concentrations in Grand Lake, which would increase manganese concentrations. The No Action alternative would have the greatest impact followed by the Proposed Action alternative. As a result, the water supply standard for manganese would remain above the standard in Grand Lake.

The presence of microcystin, a hepatotoxin that targets the liver and can be produced by some cyanobacteria is a concern for Grand Lake. Microcystin toxin levels of over 1 µg/l are of concern for drinking-water purposes (WHO 1998). The presence or excessive abundance of toxin-producing algae does not translate into the presence of toxins in the water column. All microcystin results received through July 24, 2007 for Granby Reservoir have been below the detection limit (0.1 to 0.4 µg/l) (Clements 2007). The relationships between the abundance of toxin-producing algae and levels of microcystin are unclear and the subject of research efforts. Current research indicates that microcystin production is not only controlled by environmental factors (such as light, nutrients, and grazing pressure) but also by genetic composition (Zurawell et al. 2005). There are toxic and non-toxic strains of microcystin-producing cyanobacteria. Although cell counts are sometimes used to assess the magnitude of a bloom, they are not an accurate measure of bloom toxicity. This is because cell counts do not differentiate between the different strains. According to Dyble (2006), “the underlying genetic structure of the population will profoundly affect the toxicity of individual blooms” and “predicting bloom toxicity requires an understanding of the genetic variation within the bloom and cannot be predicted based on cell counts alone.”

Thus, a water body could have optimum environmental conditions for microcystin production (which are not well understood) and a high microcystin-producing cyanobacteria cell count, and no microcystin production. High cell counts do not necessarily translate into high levels of microcystin production and the relationships are not well-understood. If there is a complete absence of microcystin-producing species, then one can conclude that microcystin should not be present. Relationships between environmental factors, cell counts, distributions of toxic versus non-toxic strains, and microcystin production are all being actively researched.

Lower dissolved oxygen concentrations in Carter Lake and Horsetooth Reservoir may increase manganese concentrations under all the alternatives. Higher manganese concentrations in Carter Lake are unlikely to result in a standard exceedance, but continued exceedance of the water quality standard for manganese would occur at Horsetooth Reservoir.

8.2. Recreational and Commercial Fisheries

8.2.1. Definition and Types of Possible Effects

Recreational and commercial fisheries consist of harvestable fish, crustaceans, shellfish, and other aquatic organisms used by man. The discharge of dredged or fill materials can affect the suitability of recreational and commercial fishing grounds as habitat for populations of consumable aquatic organisms.

The Recreation section of the WGFP EIS (Reclamation 2008) discusses the potential effects of the WGFP on recreation and angling. Additional information is found in the Recreation Resources Technical Report (ERO 2008) and the Aquatics Resource Technical Report (Miller Ecological 2008).

8.2.2. Alternative Effects

Dredge and fill activities associated with reservoir and facility construction for any of the alternatives would have no impact on recreational or commercial fishery because the reservoirs would be constructed on intermittent and ephemeral streams that do not support a fishery. The predicted changes in fish habitat in the Colorado River and Willow Creek from flow reductions under all the alternatives would result in a decrease in available fish habitat. During periods of low flow, higher water temperatures in the Colorado River could exceed the water quality standard for aquatic life. The No Action alternative would have the least impact because less water is diverted. The impact to fish habitat in the Colorado River and Willow Creek is not predicted to adversely impact fishing opportunities under any of the alternatives. Projected increases in streamflow to East Slope streams from the import of water would result in a slight increase in available fish habitat. Predicted increases and decreases in flow in North St. Vrain Creek under the No Action alternative would result in small reductions and improvements in fish habitat related to the timing of reservoir storage and release. Changes in water levels and water quality in the Three Lakes, Carter Lake, and Horsetooth Reservoir would not impact fishing opportunities.

8.3. Water-Related Recreation

8.3.1. Definition and Types of Possible Effects

Water-related recreation encompasses activities undertaken for amusement and relaxation. Activities encompass two broad categories of use: consumptive, e.g., harvesting resources by hunting and fishing; and non-consumptive, e.g. canoeing and sight-seeing. One of the more important direct impacts of dredged or fill disposal is to impair or destroy the resources that support recreation activities.

The Recreation section of the WGFP EIS (Reclamation 2008) contains information on the estimated effect to water-related recreation. The Recreation Resources Technical Report provides additional information on potential effects to recreation (ERO 2008).

8.3.2. Alternative Effects

WGFP diversions from the Colorado River under all of the alternatives would reduce the amount of flows available for rafting and kayaking in Byers Canyon, Gore Canyon, and the Pumphouse reach of the Colorado River. Preferred flows for boating would occur less frequently for all of the alternatives, with the greatest impact under the action alternatives.

Lower water levels in Granby Reservoir under all the alternatives would reduce the surface area for recreation, but substantial impacts to recreation use are unlikely. The relatively small reduction in boatable area on this large reservoir in most years is unlikely to noticeably affect recreation use of the reservoir or the quality of the recreation experience under any of the alternatives. Additional exposed shoreline at lower water levels could reduce the aesthetic value and affect the quality of the visitor experience. The Proposed Action alternative would have the greatest impact. In dry years, in particular, access to some boat ramps would be affected.

The projected changes in Carter Lake and Horsetooth Reservoir water surface area under all of the alternatives is unlikely to adversely affect visitor numbers or recreation activities. A large decline in surface area after several consecutive dry years, particularly under the Proposed Action alternative, could diminish the overall quality of the user experience by increasing the distance between land-based facilities and the water surface and potentially reducing the overall aesthetics of the experience.

Chimney Hollow Reservoir would provide water-based recreation for boating and fishing in Alternatives 2, 3, and 4. Dry Creek could potentially provide similar recreation use. Jasper East Reservoir in Alternative 3 and Rockwell/Mueller Creek Reservoir in Alternatives 4 and 5 would be less suitable for recreation because of large fluctuations in water levels.

8.4. Aesthetics

8.4.1. Definition and Types of Possible Effects

Aesthetics associated with the aquatic ecosystem consist of the perception of beauty by one or a combination of the senses of sight, hearing, touch, and smell. Aesthetics of aquatic ecosystems apply to the quality of life enjoyed by the general public and property owners. The discharge of dredged or fill material can mar the beauty of natural aquatic ecosystems by degrading water quality, creating distracting disposal sites, inducing inappropriate development, encouraging unplanned and incompatible human access, and by destroying vital elements that contribute to the compositional harmony or unity, visual distinctiveness, or diversity of an area.

The Visual Quality section of WGFP EIS (Reclamation 2008) discusses the estimated effect to visual resources. The Visual Resources Technical Report (HLA and ERO 2008) provides additional detail on the aesthetic conditions for the WGFP alternatives.

8.4.2. Alternative Effects

The dredge and fill activities associated with reservoir construction for the action alternatives would result in a change in the visual characteristics at each of the reservoir sites as described below for each of the alternatives. A decrease in the flow in the Colorado River and Willow Creek and lower water levels in Granby Reservoir on the West Slope may reduce visual quality. The change in Colorado River streamflow is unlikely to be noticeable since most diversions occur at high flows. Lower water levels in Granby Reservoir would expose additional shoreline and reduce the scenic quality. The Proposed Action alternative would have the greatest impact on scenic quality at Granby Reservoir. Reduced water clarity and algal growth have been issues of concern in Grand Lake and Shadow Mountain Reservoir that may contribute to a diminished aesthetic value. Predicted small reductions in water clarity would continue or slightly increase the potential for a diminished recreation experience under all the alternatives. The increased flow in East Slope streams from the import and return flow of Windy Gap water are unlikely to be perceptible and materially change aesthetic values.

8.4.3. Alternative 1—No Action Alternative

The enlargement of Ralph Price Reservoir would increase the surface area of the lake by about 77 acres. The aesthetic quality of the area would be similar to existing conditions. Visibility of the 50-foot higher dam would be limited because of the remote setting.

8.4.4. Alternative 2—Chimney Hollow Reservoir (Proposed Action)

Chimney Hollow Reservoir would be visible from a few homes on the hogback to the east. The dam face would be visible from lands to the north including Reclamation offices, Flatiron Reservoir, scattered residences, and County Road 18E. A relocated transmission line also would be visible from nearby locations.

8.4.5. Alternative 3—Chimney Hollow Reservoir and Jasper East Reservoir

Views of Chimney Hollow Reservoir would be similar to Alternative 2. The Jasper East Reservoir dams would be visible from surrounding lands to the north, east, and south. The dams would be visible from scattered residential areas and County Road 40. Because of wide fluctuations in water levels, substantial shoreline would be visible frequently.

8.4.6. Alternative 4—Chimney Hollow Reservoir and Rockwell/Mueller Creek Reservoir

Views of Chimney Hollow Reservoir would be similar to Alternative 2. The Rockwell/Mueller Creek Reservoir dams would be visible from surrounding lands including the town of Granby. The dams would be visible from scattered residential and commercial areas and county roads. Portions of the east dam would be visible from residential and commercial developments to the east and Highway 40. Views of the reservoir would be limited to scattered homes at higher elevations. Because of wide fluctuations in water levels, substantial shoreline would be visible frequently.

8.4.7. Alternative 5—Dry Creek Reservoir and Rockwell/Mueller Creek Reservoir

Dry Creek Reservoir would be visible from scattered locations to the west and east and from higher elevations to the south. The dam face would be visible from local roads along Little Thompson Creek and scattered residences. Views of Rockwell/Mueller Creek Reservoir would be similar to Alternative 4, although the dams would be slightly larger and more visible.

8.5. Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves (230.540)

8.5.1. Definition and Types of Possible Effects

These preserves consist of areas designated under federal and state laws or local ordinances to be managed for their aesthetic, educational, historical, recreational, or scientific value. The discharge of dredge or fill material into such areas may modify the aesthetic, educational, historical, recreational and/or scientific qualities thereby reducing or eliminating the uses for which such sites are set aside and managed.

8.5.2. Alternative Effects

There would be no direct effects to Parks, National and Historical Monuments, National Seashores, Wilderness Areas, research sites and similar preserves under any of the alternatives.

9. EVALUATION AND TESTING (SUBPART G)

Excavated earth and rock, as well as some dredge and fill materials, would be used for construction of the Chimney Hollow Reservoir dam under the Proposed Action. Excavated material would be obtained from areas within the project site, and would include soil, gravel, and rock. No hazardous material would be used as fill material in waters or wetlands.

10. ACTIONS TO MINIMIZE ADVERSE EFFECTS AND PRACTICABLE STEPS TO MINIMIZE POTENTIAL ADVERSE IMPACTS (SUBPART H)

Mitigation strategies associated with are discussed in the WGFP EIS (Reclamation 2008). The Subdistrict has agreed to avoid, minimize, and compensate the effects associated with implementation of the Proposed Action. The Subdistrict submitted a Section 404 permit that contains conditions that address mitigation. The following list is a summary of mitigation measures that would take place.

- To reduce potential drawdowns in Granby Reservoir under the Proposed Action, it may be possible to modify prepositioning operations to deliver less C-BT or Windy Gap water to Chimney Hollow Reservoir during dry years. Additional hydrologic evaluations would be conducted before completion of the Final EIS to determine if changes in the timing of water deliveries to the East Slope can reduce impacts to Granby Reservoir while still meeting the purpose and need for the project.
- The Subdistrict will commit to continued participation and funding of the ongoing Nutrient Studies, with participation and collaboration by Reclamation, Northern Water and Grand County, to better understand water quality issues in the Three Lakes system and provide guidance for future management decisions
- The Subdistrict will work with Grand County, the Colorado Division of Wildlife (CDOW), and others to determine if increasing bypass flows in the Colorado River from the existing minimum flow of 90 cfs to 135 cfs while Windy Gap is pumping during July and August would result in

temperature reductions downstream of Windy Gap that would measurably benefit the trout fishery. If studies indicate that increased bypass flows would be effective, Subdistrict would consider increasing required bypass flows under certain water supply conditions.

- A variety of best management practices will be implemented during and following construction to reduce erosion, protect water quality, suppress dust and noise, revegetate disturbed areas, and protect or avoid important wildlife habitat.
- All permanent wetland impacts will be replaced by purchasing credit in a wetland bank and on-site wetland creation.
- The Subdistrict will participate in the Recovery Program for endangered Colorado River fish.
- Opportunities for improvements to aquatic life habitat in the Colorado River and mitigation of impacts to fish will be coordinated with the CDOW, Grand County and other responsible agencies.
- Per an agreement with Larimer County Parks and Open Lands, Chimney Hollow Reservoir will be managed as open space. A plan for habitat restoration and enhancement, including development of a sport fishery at Chimney Hollow Reservoir, would be developed with Larimer County and CDOW. Similar agreements would be sought for other reservoir sites.
- The Subdistrict will curtail Colorado River diversions during the annual Big Gore Race, typically held the third week in August, if flows at the Kremmling gage are below 2,200 cfs.
- Additional specific mitigation measures are discussed in the DEIS.

10.1. Actions Concerning the Location of Discharge (230.70)

An extensive alternatives analysis was conducted, consisting of a coarse screening of 171 possible project elements to find an alternative that would minimize effects to wetlands and waters. Level 1 screening criteria eliminated reservoir sites that would impact more than 25 acres of wetlands, fens, or that would directly impact perennial streams (except for enlargement of existing reservoirs on a perennial stream). Three successive levels of screening using additional environmental analysis were used to preliminarily determine the LEDPA.

10.2. Actions Controlling the Material to be Discharged, the Material after Discharge, and the Method of Dispersion and Related Technology (230.71, 230.72, 230.73, and 230.74)

No material that contains hazardous materials will be discharged into a water of the U.S. Best Management Practices (BMPs) will be used to control the material after discharge. Temporary and permanent erosion-control devices will be used during construction of reservoir, road, pipeline, and attendant features, and during canal reconstruction to control discharges and methods of discharges into waters of the U.S.

10.3. Actions Affecting Plant and Animal Populations (230.75)

BMPs would be followed during all phases of WGFP construction. Temporary and permanent erosion control would take place, and would include efforts such as sediment control and revegetation. Weed control and weed management would take place during all phases of construction as well.

Preconstruction clearances will be performed to limit impacts to migratory birds in areas of potential habitat for these species, and construction would be timed so that active nests are not affected.

10.4. Actions Affecting Human Use (230.76)

The discharge site for construction of reservoirs under any of the action alternatives would be located on intermittent and ephemeral streams to avoid direct impacts to important aquatic areas. There is no on-going recreation at any of the action alternative reservoir sites that would be impacted by reservoir construction. Enlargement of Ralph Price Reservoir under the No Action alternative would temporarily suspended recreation activities at the Button Rock Preserve for several years during dam construction. No discharge would occur near any public water supply intake.

Construction of Chimney Hollow Reservoir under the Proposed Action and Alternatives 2, and 4 would have no impact residential property or existing land uses. Construction of Jasper East Reservoir would displace existing irrigated agricultural activities and livestock grazing, but would not impact any homes. County Road 40 to Willow Creek Reservoir also would have to be relocated to construct Jasper East Reservoir. Construction of Rockwell/Mueller Creek Reservoir would impact four private residences, livestock grazing, and shifting the alignment of an existing County Road. Dry Creek Reservoir construction would impact three residences and llama breeding operation and would impact state land currently leased for moss rock collection.

10.5. Other Actions (230.77)

Mitigation for impacts to wetlands, vegetation, and other resources is described in the WGFP EIS (Reclamation 2008).

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