RECLAMATION

Managing Water in the West

Colorado-Big Thompson Project West Slope Collection System Grand County, Colorado

Preliminary Alternatives Development Report

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

August 2012

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

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.

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Acknowledgements

This Preliminary Alternatives Development Report for the Colorado-Big Thompson Project, West Slope Collection System was prepared under the direction and authority of the Bureau of Reclamation, Eastern Colorado Area Office in Loveland, Colorado in consultation with Tetra Tech (under contract), Grand County, Colorado, and Northern Colorado Water Conservancy District.

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EXECUTIVE SUMMARY

The goal of this report is to determine whether further development of alternatives is possible to improve water clarity in Grand Lake, Colorado as part of the Colorado Big Thompson Project (C-BT Project) west slope collection system, in response to a proposed State water clarity standard to take effect in 2015. Grand Lake, Colorado's largest natural lake, lies within the headwaters of the Colorado River, in the Rocky Mountains, one mile from western border of Rocky Mountain National Park. Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir, often referred to as the "Three Lakes" system, are located on the western slope of the continental divide in north central Colorado. See Figure ES 1.

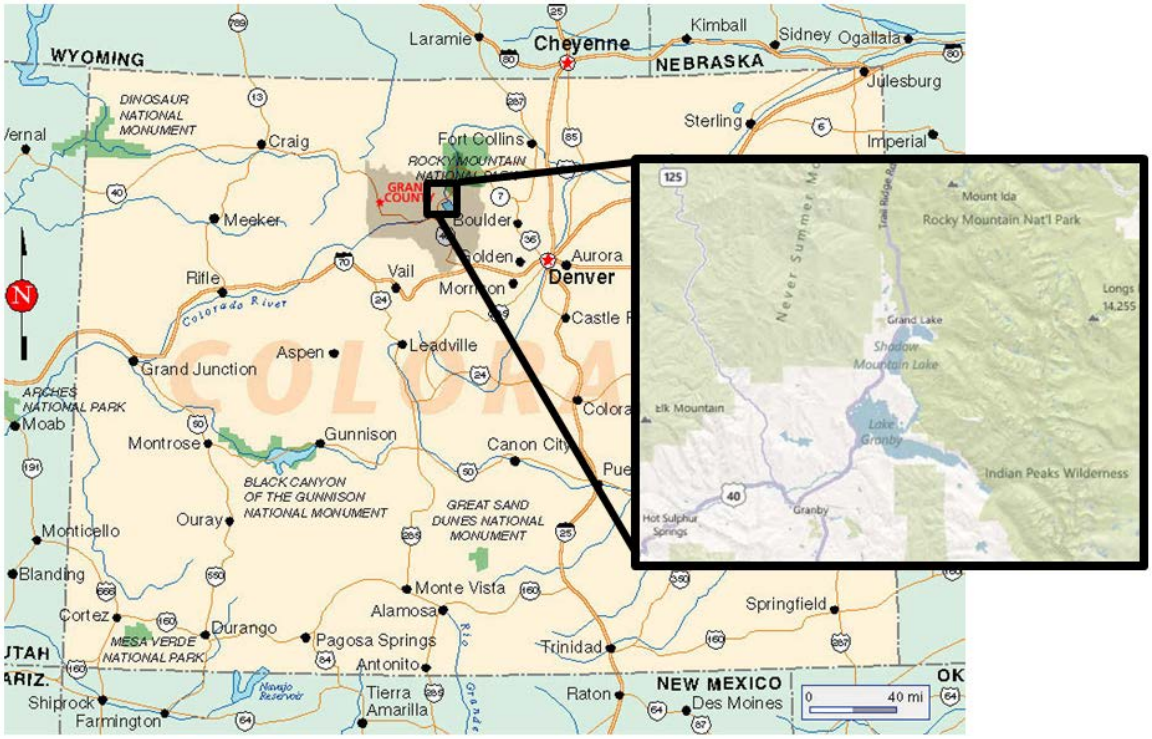

Figure ES 1. Vicinity map.

Colorado-Big Thompson Project (C-BT Project)

The C-BT Project is owned by the Bureau of Reclamation and operated jointly by Reclamation and the Northern Colorado Water Conservancy District (Northern Water). The C-BT Project is a system of diversions, canals, tunnels, pump stations, powerplants, and reservoirs designed to collect west slope water from the headwaters of the Colorado River and divert it to northern Colorado's east slope communities and agricultural lands. See Figure ES-2 for an overview schematic of C-BT Project facilities. The Three Lakes are an integral component to the C-BT Project as they comprise a portion of the west slope conveyance system, moving water to the east slope via the Adams Tunnel. The average annual Adams Tunnel diversion over the last 30 years (water years 1982-2011) has been approximately 230,000 acre-feet. Approximately 20 percent of this total is directly diverted from the native inflow to Grand Lake and Shadow Mountain Reservoir. The remaining 80 percent must be pumped from Granby Reservoir to Shadow Mountain Reservoir via the Farr Pumping Plant and then routed to the Adams Tunnel through

Grand Lake. Water diverted through the Adams Tunnel and from the Big Thompson River is routed through a series of powerplants on the east slope, generating an annual average of 760,000 Megawatt-hours of power (Reclamation 2011a).

The C-BT Project was authorized in 1937 by the 75th Congress and constructed by Reclamation between 1938 and 1956. Authorizing legislation for the C-BT Project was described in Senate Document 80 (SD 80). According to SD 80, the C-BT Project contemplated the diversion of surplus waters from the headwaters of the Colorado River to lands in northeastern Colorado greatly in need of supplemental irrigation water. It also makes reference to Grand Lake in the Manner of Operation section. SD 80 is appended to this report.

Water Clarity

The first documented clarity measurement in Grand Lake was taken in September of 1941 using a single Secchi disk[1] depth and measuring 9.2 meters. This was prior to C-BT Project pumping. In 1953, following C-BT Project pumping, the greatest Secchi disk depth recording made in 1953 was 4.6 meters and was based on several measurements. Both the 1941 and 1953 measurements were made by Pennak (1955). Since the mid-1950s Secchi disk depths generally ranged from 1.2 through 5.8 meters (Hydros 2011). Secchi disk depths measurements taken in 2007-2009 show a range of values in Grand Lake from 1.4 meters to 4.9 meters with a seasonal trend toward degradation between July and late August/early September (Hydros 2011).
In 2008, the Colorado Water Quality Control Commission (Commission) elected to adopt water clarity standards for Grand Lake. Two standards were established. The first is a narrative clarity standard requiring "the highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life." The second is a numerical clarity standard of 4 meter Secchi disk depth that will be assessed by comparing the 85th percentile of available Secchi depth data collected during the months of July, August and September to the 4 meter clarity standard. Fifteen percent of the Secchi depth measurements may have Secchi depths shallower than 4 meters. The numerical standard has an effective date of January 1, 2015 to allow for assessment of data and to evaluate standard attainability. Clean Water Act Section 313 requires Federal agencies with jurisdiction over property or facilities, or engaged in activities that may result in water pollution, to comply with State and local water pollution control regulations and authorities to the same extent as any non-governmental entity.

[1] The Secchi disk is a circular disk used to measure water transparency in oceans and lakes. The disc is mounted on a pole or line, and lowered slowly down in the water. The average of the depths at which the pattern on the disk disappears upon lowering and reappears upon raising is taken as a measure of the transparency of the water.

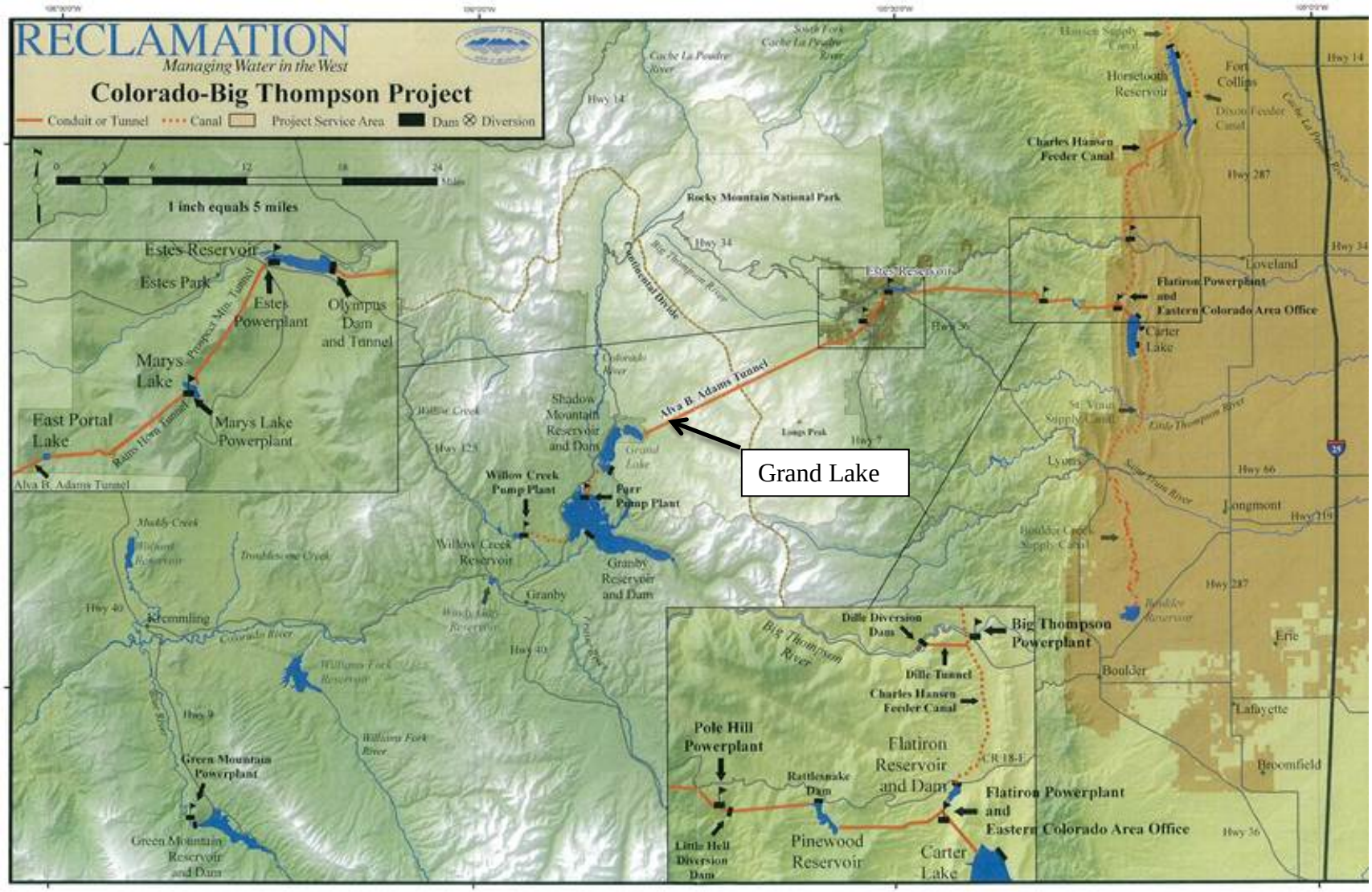

Figure ES 2. Colorado-Big Thompson Overview (Source: Reclamation, Eastern Colorado Area Office).

Alternatives, Options, and Solutions Deferred for Future Consideration and Not Evaluated Further in this Report

The problems and opportunities identified indicate that mixing of water from Granby and Shadow Mountain Reservoirs with Grand Lake is contributing to reduced clarity in Grand Lake. Stop-pump tests provided insight into several possible opportunities for improving clarity. Dramatic or sudden changes in flow rates also affect clarity.

Many ideas are considered for inclusion in this report. Through stakeholder input and input from the external peer review panel, some of these proposed solutions are not evaluated further in this report in order to focus effort on alternatives that appeared to have the highest likelihood of meeting the goal of this report. However, this does not preclude analysis of these as alternatives into the future.

The alternatives that are evaluated in this report generally fall into several categories: (1) alter the timing of diversions through Grand Lake and the Adams Tunnel ('Stop and Modify Pumping Alternatives'), (2) Bypass Grand Lake and connect directly into the Adams Tunnel with a pipeline or tunnel ('Bypass Alternatives'), and (3) options to enhance alternatives including watershed improvements and several other structural modifications described in the body of this report. Specific alternatives assessed in this report include:

Alternative I: Stop pumping at Farr Pumping Plant in July, August and September (Stop Pump Alternative). Alternative I proposes to cease pumping at Farr Pumping Plant and maintain a positive flow from Grand Lake to Shadow Mountain Reservoir between July and September of each and every year. This alternative eliminates the introduction of Granby and Shadow Mountain Reservoir water into Grand Lake and restores the natural down-gradient flow from the North and East Inlet to Grand Lake into Shadow Mountain Reservoir and further down-gradient to Granby Reservoir during the clarity standard's July to September 4-meter Secchi depth requirement. Alternative I eliminates almost all operational flexibility that has historically been used to optimize power generation within the Project. As a result, this alternative is expected to have negative impacts to power generation.

This alternative could potentially create a change in water levels in Grand Lake and Shadow Mountain Reservoir due to the reliance on natural hydrology. In order to maintain water levels, an outlet control structure or cutoff wall between Grand Lake and Shadow Mountain Reservoir may be required. Because the outlet control structure or cut-off wall could impact boating access between lakes, a boat lock is included in the analysis.

Alternative II: Modify pumping at Farr Pumping Plant in July, August and September (Modify Pump Alternative). Alternative II proposes to produce steady low flows through Shadow Mountain Reservoir and Grand Lake during July, August and September, to minimize the transport of low quality water into Grand Lake. This alternative attempts to maintain constant flow through Shadow Mountain Reservoir to prevent stratification (and associated internal loading/undesired algae growth) in the reservoir during the hot summer months. This alternative maintains some operational flexibility to optimize power generation within the Project.

This alternative targets a steady diversion of approximately 250 cfs through Adams Tunnel in July through September. This alternative would not create a change in water levels in Grand Lake and Shadow Mountain Reservoir. No outlet control structure or cutoff wall between Grand Lake and Shadow Mountain Reservoir would be required.

Alternative III: Bypass Grand Lake with a buried pipeline and pump flows directly to Adams Tunnel (Bypass Grand Lake Alternative). Alternative III proposes to bypass flows around Grand Lake by piping water from the northeast shoreline of Shadow Mountain Reservoir and connecting directly to Adams Tunnel. See Figure ES-3. Water would be pumped from Farr Pumping Plant into Shadow Mountain Reservoir via the existing Granby Pump Canal, and then pumped via a new pump station at the northeast end of Shadow Mountain Reservoir through a new pipeline connected to Adams Tunnel. This alternative eliminates the introduction of Granby and Shadow Mountain Reservoir water into Grand Lake, and restores the natural down-gradient flow from the North and East Inlet to Grand Lake into Shadow Mountain Reservoir and further down-gradient to Granby Reservoir.

This alternative also utilizes the available regulating storage capacity in Shadow Mountain Reservoir to: 1) continue to operate Farr Pumping Plant per current conditions (particularly during off-peak power times); and 2) provide operational flexibility at the new pump station to divert water during on-peak power times. This alternative could potentially create a slight increase in the fluctuation of water levels in Grand Lake and Shadow Mountain Reservoir, greater than the current 1-foot maximum fluctuation. In order to maintain Grand Lake within the range of desired surface water elevations, an outlet control or cut-off wall may be required to allow Shadow Mountain Reservoir to decrease to levels below Grand Lake. Because an outlet control or cut-off wall could impact boating access between lakes, a boat lock is included in the analysis.

Alternative IV: Bypass Grand Lake and Shadow Mountain Reservoir with a buried pipeline and pump flows directly to Adams Tunnel (Bypass Grand Lake and Shadow Mountain Reservoir Alternative). Alternative IV proposes to bypass flows around both Shadow Mountain Reservoir and Grand Lake by piping water from the Granby Pump Canal and connecting directly to Adams Tunnel. See Figure ES-4. Water would be pumped from the Farr Pumping Plant into the Granby Pump Canal and from the Granby Pump Canal through a pipeline connected to Adams Tunnel. This alternative eliminates the introduction of Granby and Shadow Mountain Reservoir water into Grand Lake, and restores the natural down-gradient flow from the North and East Inlet to Grand Lake into Shadow Mountain Reservoir and further down-gradient to Granby Reservoir.

This alternative could potentially create a change in water levels in Grand Lake and Shadow Mountain Reservoir due to the reliance on natural hydrology. In order to maintain water levels, an outlet control structure or cutoff wall between Grand Lake and Shadow Mountain Reservoir may be required. Because the outlet control structure or cut-off wall could impact boating access between lakes, a boat lock is included in the analysis.

Several options are assessed in this report and worth additional consideration in combination with the four alternatives identified above to support clarity management. It does not appear that

options alone are sufficiently robust in managing factors affecting clarity to warrant evaluation as stand-alone alternatives, but further consideration may be warranted to confirm that preliminary assessment. Options A-C are described below.

Option A proposes changes to Shadow Mountain Reservoir to reduce the degradation of water quality that currently occurs as water is transferred to Grand Lake. Option A has several potential variations, including deepening and narrowing of Shadow Mountain Reservoir or removal of Shadow Mountain Reservoir dam.

Option B is watershed improvements including but, not limited to: additional land use regulations and stormwater runoff control, further replacement of septic systems, and other best management practices. Note that land use restrictions are in place, but there are still unregulated activities occurring within the developed areas of the watershed, including directly adjacent to Shadow Mountain Reservoir, Granby Reservoir, and Grand Lake. Also, natural geology contributes nutrient loading to tributaries from undeveloped portions of the watershed to both Granby and Shadow Mountain Reservoirs, which is naturally-occurring nutrient loading and difficult to control.

Option C proposes to capture water from Grand Lake and divert directly into the Adams Tunnel similarly as it does under conditions today, except that the direct diversions would be in concert with one of three Alternatives. Option C combined with Alternative I under normal (non-maintenance) operations and under optimal hydrologic conditions, would allow a portion of the native inflows into Adams Tunnel to improve water quality of the diverted water while still maintaining sufficient flows from the East and North Inlets to flow naturally down-gradient to maintain water clarity in Grand Lake and water quality in Shadow Mountain Reservoir.

Option C could also be combined with Alternatives III and IV by modifying the Adams Tunnel inlet connection to allow for some direct diversion of Grand Lake water to mix with water being piped from Shadow Mountain Reservoir or the Granby Pump Canal in order to dilute and improve the quality of water being diverted to the east slope. Here again this would be conducted under normal (non-maintenance) operations and under optimal hydrologic conditions, that would allow a portion of the native inflows into Adams Tunnel to improve water quality of the diverted water. Flows from the East and North Inlets would continue to flow naturally down-gradient to maintain water clarity in Grand Lake and water quality in Shadow Mountain Reservoir.

Option C, combined with these alternatives, also provides operational redundancy in the case of outages to the proposed pumping plants or pipelines and operational redundancy for normal maintenance during months other than the three regulatory months of July, August and September.

Prior to further consideration of Option C, additional analysis is required to: (1) assess impacts of the alternatives on the quality of diverted water, (2) assess the trade-off between the quality of diverted water versus the water quality in the Three Lakes and specifically clarity in Grand Lake, and (3) weigh the benefits of the quality of diverted water.

In addition to the Alternatives and Options considered in this report, there are solutions deferred for future consideration and not evaluated further in this report that merit further consideration. These are presented in Chapter 3. In order to focus effort for this report on alternatives that appeared to have the highest likelihood of meeting the goal of this report, these solutions were not evaluated in this report. However, that does not preclude analysis of these as alternatives into the future.

Potential Effects and Comparison of Alternative

Alternative considered in this report are analyzed to determine their potential effects and are summarized in the following tables. Benefits of each alternative are assessed for their ability to improve water clarity in Grand Lake; potential impacts on water quality in Shadow Mountain and Granby Reservoirs; potential impacts to sediment transport into Grand Lake; impacts on the quality of water diverted to the east slope; and impacts on power generation. Alternatives are rated for providing the noted benefits with a "+" if it is likely to provide a positive benefit; "0" if it is likely to produce little benefit or is neutral, balancing positive and negative impacts; and "-" if the alternative is likely a poor benefit or could possibly worsen conditions. Some ratings also include a '-/0' to indicate weak negative and '+/0' to indicate weak positive. See table ES-1

Each alternative is also assessed for its ability to meet the four tests of viability for acceptance, effectiveness, constructability and completeness. A rating of good, fair or poor is assigned to each alternative, along with a brief discussion and for each test of viability. See Table ES-2.

Table ES-1. Alternatives benefits rating.

Benefits	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain
Water clarity in Grand Lake	+/0	-/0	+	+
Water quality in Shadow Mountain Reservoir	-/0	0	0	-/0
Water quality in Granby Reservoir	-/0	0	0	-/0
Particulate matter and sediment transport into Grand Lake	+/0	+/0	+	+
Water quality of diverted water	-/0	0	-	-
Power Generation	-/0	0	0	0

+ positive benefit, 0/+ weak positive, 0 no change, fair or neutral benefit
-/0 weak negative benefit - negative benefit

Table ES-2. Summary of viability.

Viability	Alternatives			
	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain Reservoir
Acceptability				
Publically supported today?	good likely to be perceived as proactive	fair might be perceived as proactive	good to fair supported by some but construction may be met with resistance	good to fair supported by some but construction may be met with resistance
Publically supported in the future?	fair likely to be perceived as failure when clarity is not achieved	fair likely to be perceived as failure when clarity is not achieved	good post-construction will be perceived as yielding consistent results	good post-construction will be perceived as yielding consistent results
Overall Acceptability Rating	good to fair	fair	good to slightly fair	good to slightly fair
Effectiveness				
Meet proposed State standards for Secchi depth?	fair to good some uncertainty due to changes in residence time	fair to poor likely to improve clarity but may not meet stds	good will maintain a consistent clarity, reflective of natural hydrology, with relatively high probability of meeting clarity stds	good will maintain a consistent clarity, reflective of natural hydrology, with relatively high probability of meeting clarity stds
Maintain current water quality conditions in the Three Lakes?	fair to poor stop pumping may slightly impact SMR* and GR* water quality during the three no pumping months, but will have positive impacts in GL*	fair steady pumping periods likely to be minor on all three water bodies	good to fair deliveries through SMR remains per current operations so unlikely to alter water quality of SMR and GR. GL water quality will improve	fair to poor GL water quality will improve; bypass of SMR could negatively impact water quality in SMR and GR; unknowns and uncertainty with alternative.
Affect the quality of diverted water?	fair increases in pumping in Oct-June may diminish quality of diverted water	good unlikely to result in notable changes from current conditions	fair to poor alters location of mixing, thus may diminish quality of diverted water	fair to poor alters location of mixing, thus may to diminish quality of diverted water

Viability	Alternatives			
	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain Reservoir
Maintain the yield to CBT?	fair may require additional east slope storage; further study required	good no additional east slope storage required	good provides flexibility to divert on demand	good provides flexibility to divert on demand
Overall Effectiveness Rating	fair to poor	fair to poor	good to slightly fair	good to fair
Efficiency				
Constructability	fair to good additional storage might be required	good no construction required	fair relatively large scale project but physically possible using one of several viable variations	fair large scale project but physically possible using one of several viable variations
Extent of permitting required to comply with existing laws, regulations	good minimal NEPA and permitting required	good minimal NEPA and permitting required	fair NEPA and extensive permitting required	fair NEPA and extensive permitting required
Overall Efficiency Rating	fair	fair	good to fair	good to fair
Completeness				
Completeness	good to fair some uncertainty in ability to meet clarity stds	poor difficult to consistently meet clarity stds	good likely to meet clarity stds; flexibility to divert on demand; uncertainty with quality of diverted water	good to fair likely to meet clarity stds; flexibility to divert on demand; uncertainty with quality of diverted water
Overall Completeness Rating	poor to fair	poor	good	good to fair

*SMR=Shadow Mountain Reservoir, GR=Granby Reservoir, GL=Grand Lake

Findings

The results of this report suggest that further development of alternatives is possible relative to improving water clarity in Grand Lake, Colorado as part of the Colorado Big Thompson Project (C-BT Project) west slope collection system in response to a proposed State water clarity standard to take effect in 2015. Of the alternatives selected for consideration in this report, it appears that Alternatives I, III, and IV should be included for further refinement and consideration. A combination of Alternatives I and II should also be included for further refinement and consideration. In addition, the *Solutions Deferred for Future Consideration and Not Evaluated Further in This Report* and *Further Options* listed in Chapter 3 should be included for consideration as stand-alone alternatives or for combination with other alternatives. Finally,

due to the findings in this report, a comprehensive consideration of any new alternatives should be included, especially as new information is gained. During future development of alternatives, there should be an effort to minimize redirected impacts.

Next Steps

A technical review should be prepared to identify the requirements for advancing the project. Some of the more detailed analyses needed to support alternatives evaluation are listed below, although the list in not exhaustive.

1. Assess C-BT Project operations and evaluate in detail, operations at Farr Pumping Plant, diversions for power generation, and capacity of the East Slope facilities including dry, average and wet year diversions and daily diurnal flow data. Analysis should include Reclamation, and Northern Water operational considerations and requirements for power customers coordinated with Western Area Power Administration (Western).
2. Prepare a fully integrated short-term and long-term power analysis that incorporates Reclamation's detailed operations of pumping plants and power plants for the C-BT Project, Windy Gap and Windy Gap Firming Projects, and operations of Western.
3. Analyze east slope C-BT Project operations conducted by Reclamation and Northern Water including, estimated costs of alternative implementation and recommendations for improvements to existing C-BT Project features and operations as required to accommodate alternative implementation.
4. Evaluate water level impacts to Shadow Mountain Reservoir and Grand Lake and any required changes that may arise due to C-BT Project operations. Assess the need for a cutoff wall/boat locks associated with Alternatives I, III and IV.
5. Assess the water quality monitoring program and prepare recommendations to ensure a meaningful baseline is established and that an effective monitoring system is in place to evaluate water quality changes associated with future with-project implementation.
6. Expand water quality monitoring for other constituents based on targeted analysis of existing monitoring and pending regulatory standards, e.g., chlorophyll *a* in Grand Lake and dissolved oxygen (DO) and chlorophyll *a* in Shadow Mountain Reservoir.
7. Assess impacts of alternatives on water quality in Shadow Mountain and Granby Reservoirs using the three lakes water quality model, other relevant modeling tools, studies, or monitoring.
8. Consider the merits of further aquatic weed control in Shadow Mountain Reservoir in consultation with the U.S. Forest Service and Colorado Division of Parks and Recreation. Removal of aquatic weeds could potential change nutrient levels and increase algal production.
9. Expand water quality analysis to include Granby Reservoir, including long-term water quality trends associated with pumping from Willow Creek, Windy Gap Project and the future Windy Gap Firming Project.
10. Investigate existing water quality of diverted water and forecast impacts of potential alternatives on other C-BT Project facilities.

11. Investigate construction related issues including:
    a. Easement acquisition for pump station and pipe
    b. Rock or geologic concerns with the feasibility for construction
    c. Utility conflicts
    d. Elevation profiles for pipeline construction
    e. The lowering of lake and reservoir elevations for construction purposes
    f. Connection to the Adams Tunnel headworks
    g. Capacity of backup power from the C-BT Project eastern slope generation for the new pump station.
12. Conduct thorough analysis of costs.
13. Assess capacity of backup power from the C-BT Project eastern slope generation for the new pump station.
14. Conduct analysis to determine appropriate repayment source(s) for potential alternatives developed for future consideration.

The Technical Review will consider existing information and identify additional data requirements, next steps, critical paths tasks and schedules necessary to reach the thirty percent engineering design level, , including both physical and operational evaluations. These activities might include, but are not limited to the following.

- Collection of additional data;
- Additional data analysis;
- Limited engineering design or analysis tasks;
- Evaluation of any existing cost estimation data with regard to a common basis, method, and accuracy level
- Plans for next step cost estimation
- Statutory and legal process and notice requirements
- Environmental and cultural resources

- Technically feasible pre-construction work schedule alternatives;
- Technically feasible construction schedule alternatives;
- Required environmental compliance documentation, including but not limited to;
    - National Environmental Policy Act (NEPA);
    - Fish and Wildlife Coordination Act;
    - Endangered Species Act;
    - National Historical Preservation Act.
    - Clean Water Act

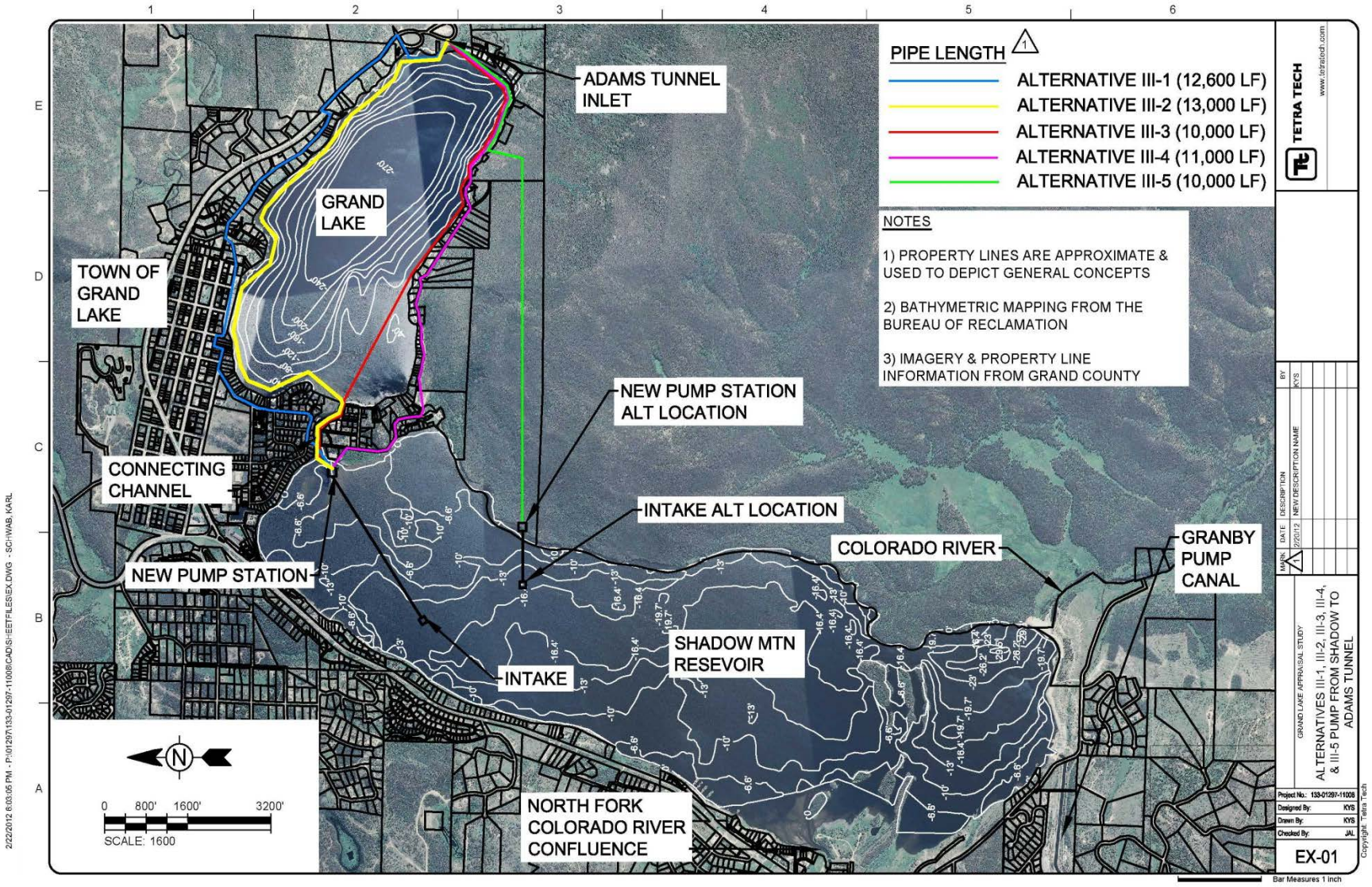

Figure ES 3. Alternative III: Bypass Grand Lake.

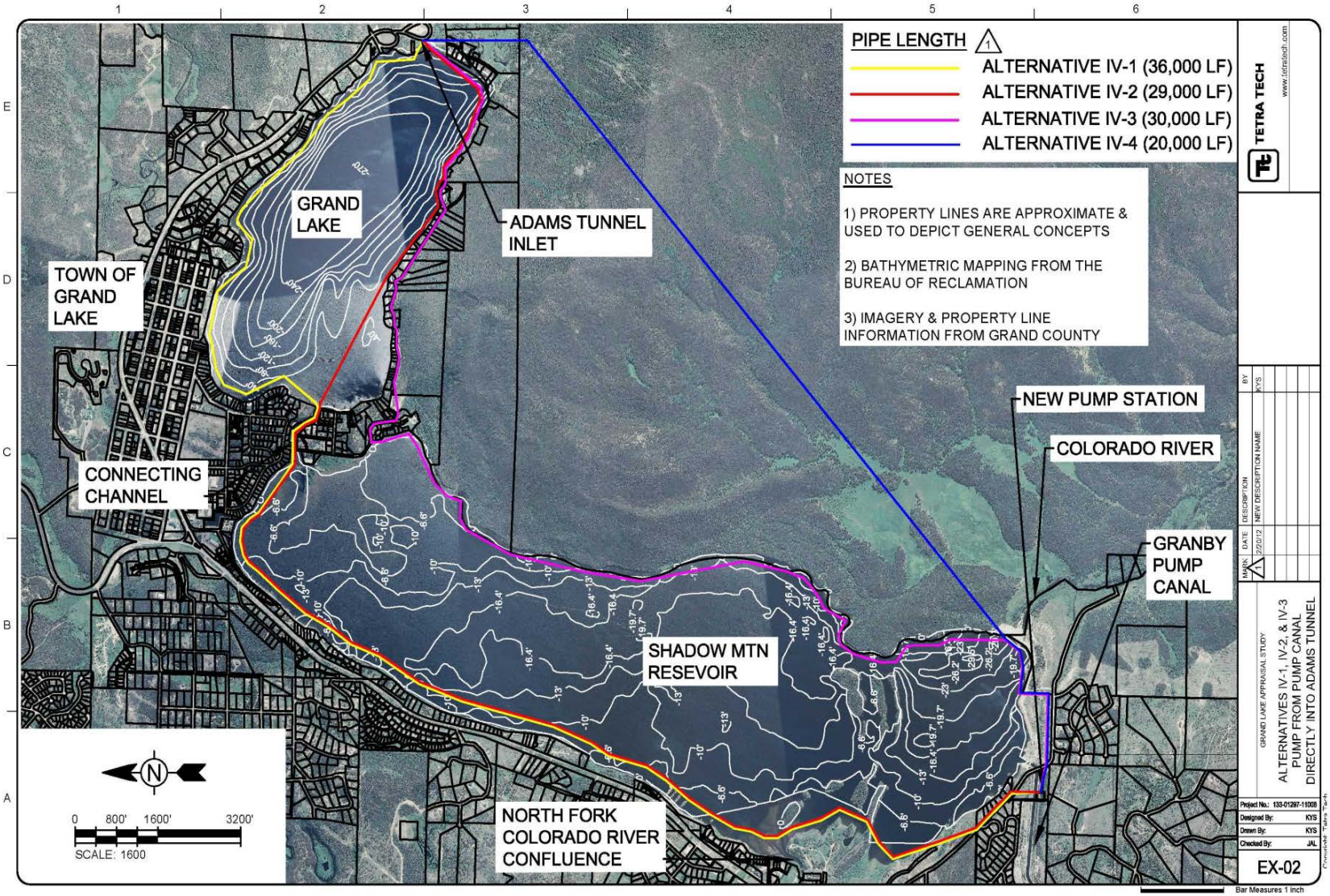

Figure ES 4. Alternative IV: Bypass Grand Lake and Shadow Mountain Reservoir.

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1 INTRODUCTION

1.1 Report Goal

The goal of this Preliminary Development Alternatives Report (report) is to determine whether further development of alternatives is possible to improve water clarity in Grand Lake, Colorado as part of the Colorado Big Thompson Project (C-BT Project) west slope collection system in response to a proposed State water clarity standard to take effect in 2015.

Specifically this report documents findings from each of the following steps:

- Outline the Colorado-Big Thompson Project (C-BT Project, Senate Document 80 [SD 80]) and its relationship to this report (Chapter 1, Section 1.5)
- Summarize water quality problems (Chapter 2)
- Formulate alternatives (Chapter 3)
- Prepare technical evaluation (Chapter 4)
- Compare Alternatives (Chapter 5)
- Present findings (Chapter 6)

This report is being prepared to identify problems and needs; identify whether or not there is at least one alternative or an array of alternatives that address the problem; and recommend next steps for further consideration and action. The analyses for this report relied on existing information and are based on the minimum information needed to evaluate alternatives and develop recommendations. Extensive baseline water quality monitoring and modeling in the Three Lakes area is being conducted by Reclamation and Northern Colorado Water Conservancy District (Northern Water). The Grand County Water Information Network (GCWIN), funded by Northern Water, Reclamation, and Grand County is also monitoring water clarity.

1.2 Participants and Coordination

In 2010, Northern Water, Grand County and Reclamation officials signed an agreement to cooperatively fund this report. This report is being conducted under the direction of Reclamation's Eastern Colorado Area Office, with support from a study team comprised of representatives from Grand County, Colorado, and Northern Water . Reclamation's Technical Services Center and Great Plains Region staff participated in technical reviews of the report encompassing water quality modeling, planning, and engineering. In addition, Reclamation retained an external peer review panel of experts specializing in water quality and environmental engineering. Two meetings were conducted with all the stakeholders and the external peer review panel. The first was on November 28, 2011, with the purpose of developing conceptual alternatives. Following this November 28 meeting the alternatives were assessed and a report prepared for review by the stakeholders and peer review panel. On February 9, 2012, the second meeting was held to review the report and provide comments and feedback. This report incorporates technical, stakeholder and peer review panel comments and feedback. On June 28, 2012, a comment resolution meeting was held with all stakeholders and on July 11, 2012 the peer review panel submitted their final review comments (Review Panel, 2012), which is appended, with follow-up discussions for clarification (McCutchan 2012). Reclamation conducted a final review session and incorporated comments as appropriate.

1.3 Study Area

Grand Lake, Colorado's largest natural lake is located in Grand County, Colorado, on the west slope of the continental divide as shown on Figure 1.1. Grand Lake lies within the headwaters of the Colorado River, in the Rocky Mountains. The Study area comprises three bodies of water, and is often referred to as the Three Lakes system. These water bodies include Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir, both man-made reservoirs constructed as part of the C-BT Project.

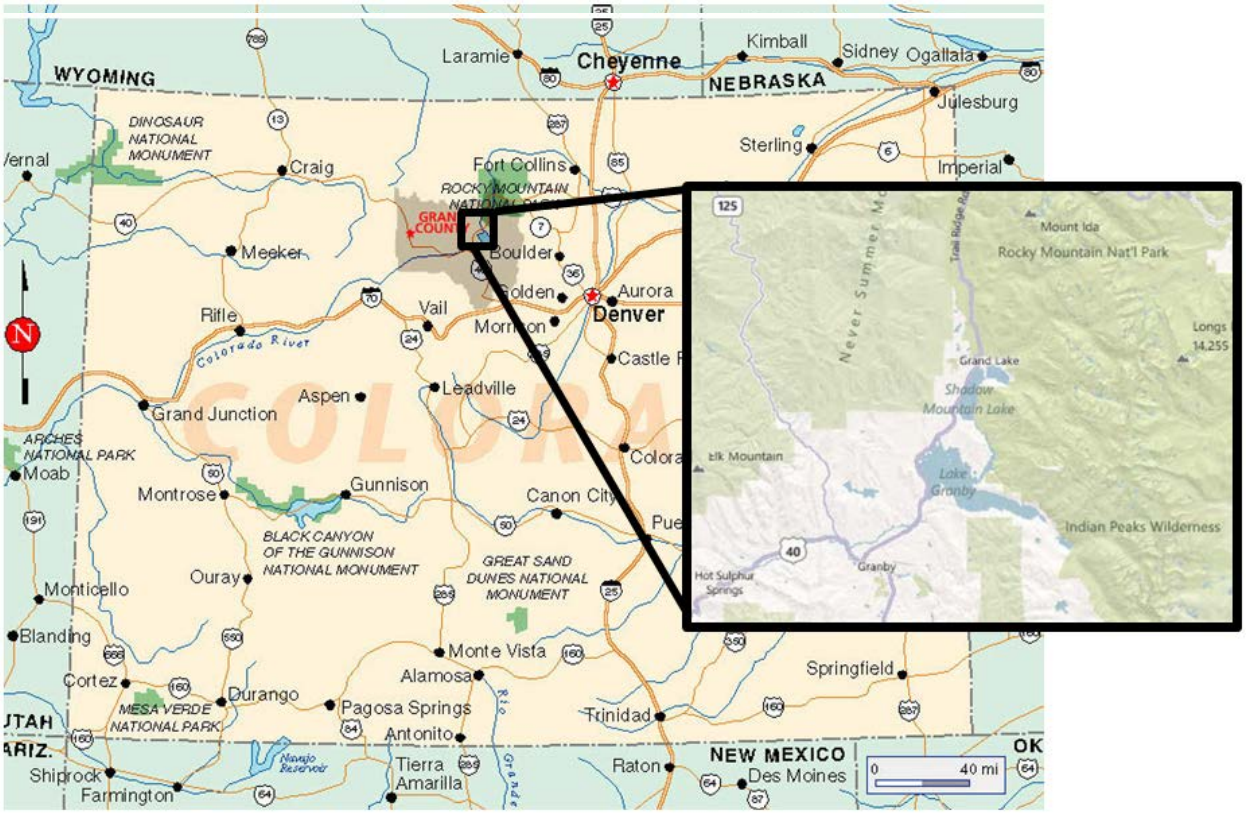


Figure 1.1. Vicinity map.

There are seven major natural drainages tributary to the Three Lakes system: North and East Inlets, directly tributary to Grand Lake; North Fork of the Colorado River, tributary to Shadow Mountain Reservoir; and Columbine Creek, Roaring Fork, Arapaho Creek and Stillwater Creek, tributary to Granby Reservoir. In addition, there are two pumped tributaries, which include water from the Willow Creek watershed and the Colorado/Fraser watershed (Figure 1.2).

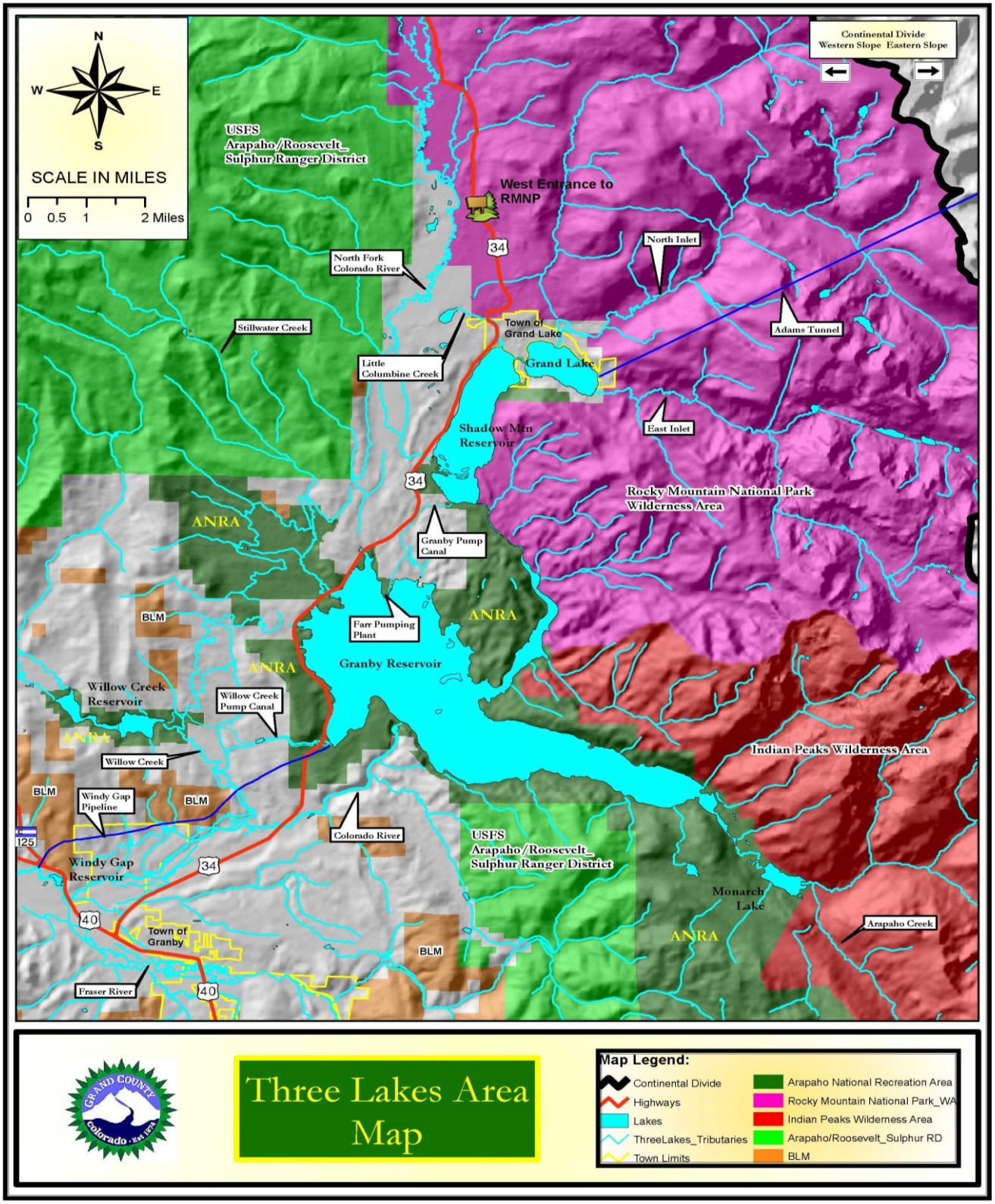


Figure 1.2. Three Lakes area map (Source: Grand County).

1.4 Setting

The Three Lakes area lies within the high elevation, mountain environment of the Rocky Mountains, on the western slope of the continental divide. The majority of the watershed is undeveloped, public lands, dominated by lodgepole pine, aspen, spruce and fir. The area is surrounded by the Arapahoe National Forest, Arapahoe National Recreation Area, Indian Peaks Wilderness Area, Rocky Mountain National Park, unincorporated Grand County and the Town of Grand Lake, Colorado. Grand Lake, Colorado lies within one mile of Rocky Mountain National Park's western park entrance.

As of 2002, approximately 18% of the County's 12,500 people reside in the watershed surrounding the Three Lakes (Hydrosphere 2003). Based upon 2010 census figures, the population in the Three Lakes drainage is 2,359 full time residents. There are 4,300 homes in the areas, with roughly 1,140 of those occupied, indicating a vacancy or second home-ownership rate of 74% (US Census and Town of Grand Lake). Summer recreation in the region includes camping, hiking, mountain biking, boating, wildlife viewing, water skiing, swimming and fishing. Winter activities include skiing, ice-fishing and snowmobiling. Average visitors to Rocky Mountain National Park (2001-2010) totaled 3,059,929. Of those, 548,805 entered the park through Grand Lake access points (RMNP visitation records available online).

1.5 Colorado-Big Thompson Project Background

The C-BT Project is a system of diversions, canals, tunnels, pump stations, hydropower plants, and reservoirs designed to collect west slope mountain water from the headwaters of the Colorado River and divert it to Colorado's east slope communities and agricultural industries. The C-BT Project is owned by Reclamation and operated jointly by Reclamation and Northern Water. Northern Water also manages the water for use in irrigation and municipal/industry in east slope communities (Reclamation 2011a).

On July 5, 1938, Reclamation and Northern Water executed a contract for the construction and operation, maintenance, and replacement (OM&R) of the C-BT Project. This contract, as amended and supplemented, allocates the multipurpose OM&R costs to be repaid 50% by Northern Water and 50% by Reclamation through the power customers.

Grand Lake was integrated into the original design of the C-BT Project water collection and conveyance system. Water collected from the surrounding watershed is routed into Grand Lake through both gravity flow and pumped systems. From Grand Lake, water is diverted to the east slope via the Adams Tunnel. The Adams Tunnel inlet is located along the east shoreline of Grand Lake. The Adams Tunnel is 13 miles long and runs under the continental divide to the east slope. The east portal of the Adams Tunnel discharges flows to a system of diversions, canals, tunnels, pump stations, hydropower plants and reservoirs. Water diverted through the Adams Tunnel and from the Big Thompson River are routed through a series of powerplants on the east slope, generating an annual average of 760,000 Megawatt-hours of power (Reclamation 2011a). A plan view layout and pumping schematic are included in the Appendix.

1.6 Windy Gap Project

The C-BT Project facilities are also used to convey water for the nonfederal Windy Gap Project if and when excess capacity is available. Reclamation holds a conveyance contract for the Windy Gap Project with the Municipal Subdistrict of Northern Water (Subdistrict), which is composed of multiple entities, including cities of Boulder, Estes Park, Fort Collins, Greeley, Longmont, and Loveland. The Windy Gap Project was completed in 1985 and consists of a diversion dam on the Colorado River, a 445-acre-foot reservoir, a pumping plant, and a six-mile pipeline to Granby Reservoir. The Windy Gap Project is downstream of the Three Lakes area. Water is pumped to Granby Reservoir and stored before it is delivered to Windy Gap water users on the east slope via the C-BT Project facilities by routing the water from Granby Reservoir through Shadow Mountain Reservoir, Grand Lake and Adams Tunnel, and other east slope facilities.

The Windy Gap Firming Project is a proposed project (2012) designed to firm existing water rights by improving delivery and storage of water associated with the original Windy Gap Project. The Windy Gap Firming Project will continue to utilize the C-BT Project facilities if and when excess capacity is available in conjunction with the construction of a new east slope reservoir called Chimney Hollow Reservoir. The Windy Gap Firming Project would divert additional water from the Colorado River to Granby Reservoir and beyond to the east slope. The Windy Gap Firming Project, combined with C-BT and Windy Gap Project flows, is projected to deliver approximately 262,000 acre-feet per year through the Adams Tunnel under the preferred Alternative 2 (Chimney Hollow with prepositioning) (Reclamation 2011c). Figure 1.3 presents an overview of the C-BT System. Figure 1.4 presents an overview of the Windy Gap system.

1.7 Arapahoe National Recreation Area

In 1978, the 95th congress authorized the creation of the Arapahoe National Recreation Area. The Arapahoe National Recreation Area covers 35,235 acres within the Arapaho and Roosevelt National Forests and the C-BT Project Area. Within the authorization, Congress notes that it is in the nation's interest to create the Arapahoe National Recreation Area …so as to preserve and protect the natural scenic, historic, pastoral, and wildlife resources of the area and to enhance the recreational opportunities provided. Further, the Secretary [of Agriculture] was directed to administer the Arapahoe National Recreation Area in such a manner as will best provide for, among other things, *the management of water quality in the recreation area consistent with the development of needed water supply and waste-water system, including the control of aquatic vegetation in the streams, lakes and reservoirs within the recreation area*. (Public Law No. 95-450).

Prior to the creation of Arapahoe National Recreation Area, the Shadow Mountain National Recreation Area existed, predominately covering what is now the Arapahoe National Recreation Area. In 1955, Reclamation transferred lands to the Department of Agriculture, U.S. Forest Service for protection of Shadow Mountain and Granby Reservoirs for recreation except as required by Reclamation for operation of said reservoirs. Reclamation retained control of the flow, water surface elevation and utilization of the water for its purposes as well as all dams, pumping plants, canals, power lines and other features appurtenant to the water control project,

including such lands adjacent to these features as are required by Reclamation for administration, operation and maintenance purposes. Reclamation also retained the right to settle any controversy between the recreation uses and the project. However, both agencies agreed to work closely on land use changes and project modifications, and if this cannot be agreed upon, the issue goes to the Secretary of Agriculture (USDOT 1955).

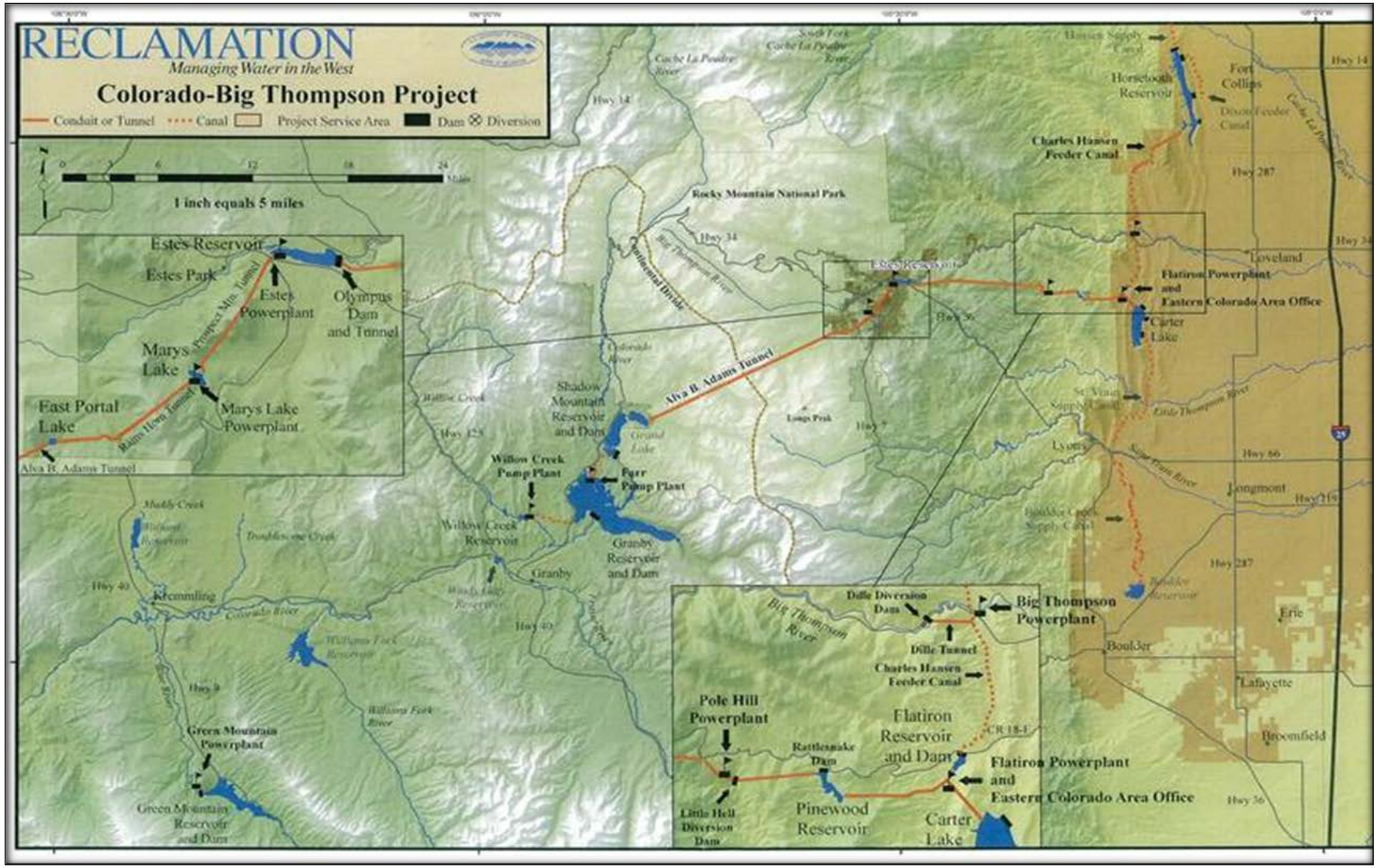


Figure 1.3. Colorado-Big Thompson Overview (Source: Reclamation, Eastern Colorado Area Office).

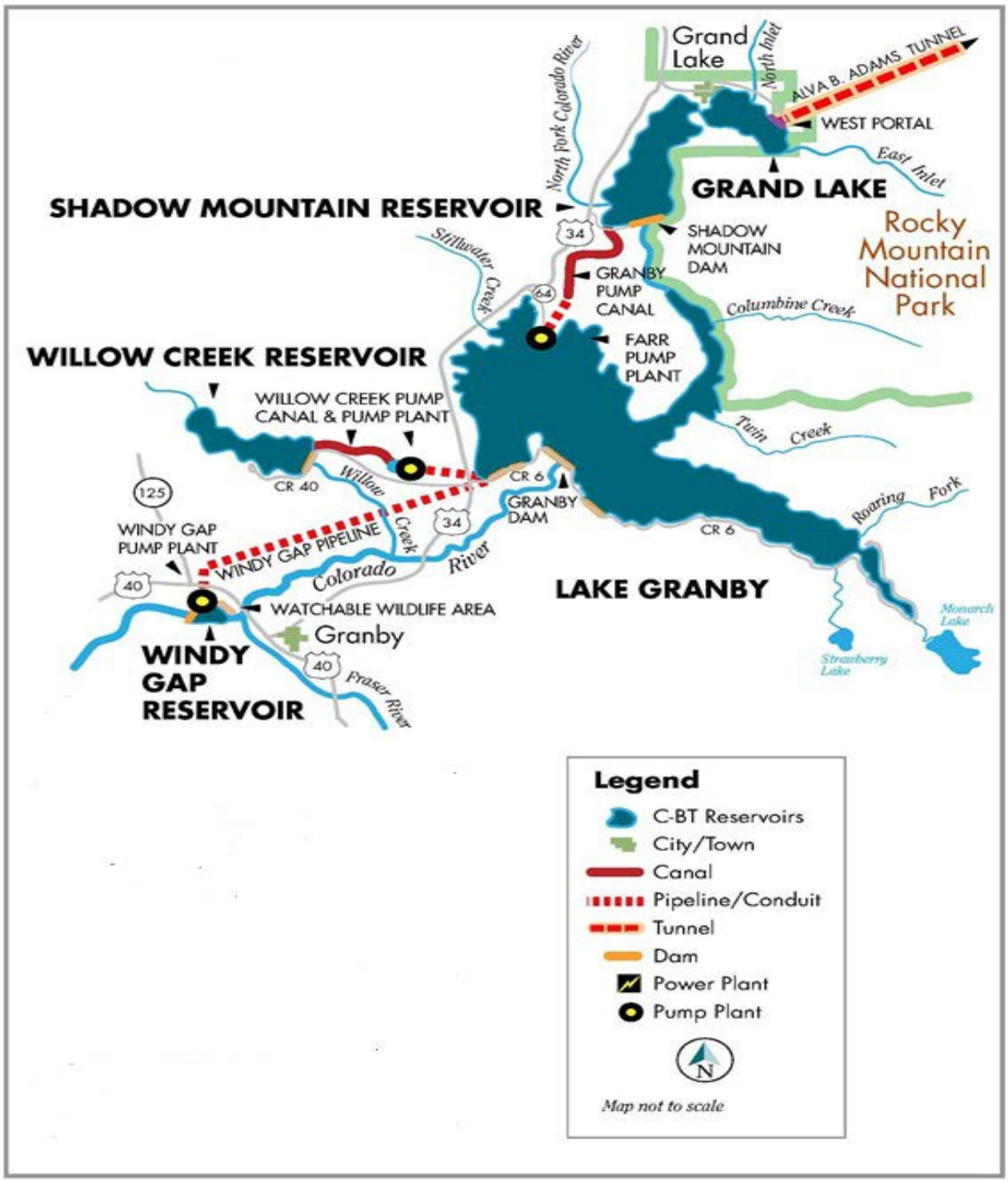


Figure 1.4. Windy Gap System (Source: Northern Water).

2 Problems and Needs: Summary of Water Quality Issues

2.1 Water Quality Standards

Under the Clean Water Act (CWA) administered by the U.S. Environmental Protection Agency (EPA), states have primary responsibility for the development and use (including restoration, preservation, and enhancement) of land and water resources (CWA Section 101(b)). The Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Department (WQCD) is the agency responsible for maintaining, restoring and improving the quality of Colorado's waters. The Colorado Water Quality Control Commission (Commission) develops the water quality standards and regulations. Clean Water Act Section 313 requires Federal agencies with jurisdiction over property or facilities, or engaged in activities that may result in the discharge of runoff or pollutants, to comply with State and local water pollution control regulations and authorities to the same extent as any non-governmental entity.

There are several state water quality standards that are relevant to factors affecting water clarity. Clarity refers to the absence of light reducing factors that affect water transparency. Particulates and dissolved components that include inorganic and organic constituents such as nutrients (nitrogen and phosphorus), algae (chlorophyll a), and detrital (plant) material can all affect water transparency, reducing water clarity. The state of Colorado has established clarity standards, nutrient criteria, and dissolved oxygen limits.

In an April 26, 2012 meeting between Northern Water and Colorado Division of Water Resources staff, compliance issues related to clarity and nutrients were discussed. Should the clarity standard not be met, the state would likely develop total maximum daily load (TMDL) for nutrients, chlorophyll, and dissolved oxygen with a focus on point source control and non-point source best management practices and incentive programs. The timeframe for developing a TMDL would likely extend into 2016 to 2020 (ECAO File Memorandum, Personal Communication, Harger, 2012). Specific state standards related to clarity, nutrient criteria, dissolved oxygen, and other regulated constituents are discussed in the following sections.

2.1.1 Clarity

In 2008, the Commission elected to adopt water clarity standards for Grand Lake. Two standards were established. The first standard is a narrative clarity standard currently in effect requiring "the highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life." This standard was the first such standard adopted in Colorado pursuant to Basic Standards Section 31.13(3), which states "In special cases where protection of beneficial uses requires standards not provided by the classification above, special standards may be assigned after full public notice and hearings." Improvement of clarity in Grand Lake was expected to improve the quality of recreational uses of this unique resource (CDPHE, 2012a). In establishing the narrative standard, the Commission intended that attainability of the proposed numerical standard be judged over an approximately 20-year implementation period to see whether or not clarity could be attained by any recognized control techniques that are environmentally, economically, and socially acceptable (CDPHE, 2012b).

The second standard is a proposed seasonal numerical clarity standard of 4 meter Secchi depth effective January 1, 2015. Attainment of the 4 meter Secchi disk depth standard will be assessed by comparing the 85th percentile of available Secchi depth data collected during the months of July through September to the 4 meter standard. The 85-percent compliance goal means that 15 percent of the measurements in the compliance period may have Secchi disk depth shallower than 4 meters. When the samples are collected in different locations or by different agencies on the same day, the Secchi disk depth value used for compliance determination is the average of those samples (CDPHE, 2012b).

The numerical clarity standard has an effective date of January 1, 2015 to allow for assessment of data and to evaluate standard attainability. The WQCC recognized that Section 25-8-104, C.R.S. states in part that "Nothing in this article [the Colorado Water Quality Control Act] shall be construed, enforced, or applied so as to cause or result in material injury to water rights".

2.1.2 Nutrients

At hearings in March 2012, the Commission proposed interim numeric nutrient criteria for protection of Colorado's cold and warm water lakes and reservoirs and for the protection of aquatic life and recreation. More stringent criteria have recently been adopted for chlorophyll a (a measure of algal abundance) in lakes and reservoirs classified as Direct Use Water Supplies (DUWS). The Three Lakes water bodies are classified as cold water lakes and the implementation of future alternatives to mitigate clarity impacts may affect whether an individual water body is classified as a DUWS. Likewise Grand Lake is already a direct connection to Adams Tunnel and by definition a Direct Use Water Supply (with or without clarity considerations). The C-BT Project east slope reservoirs, Carter Lake and Horsetooth Reservoir are already subject to the more stringent DUWS criteria. The proposed criteria are listed in Table 2.1 and may be adopted as interim standards in specific water bodies, including those contemplated in this analysis, between May 31, 2017 and May 31, 2022. After May 31, 2022, the interim values can be adopted in any segment through the basin hearings process.

2.2 Dissolved Oxygen

Section 303(d) of the Federal Clean Water Act requires that states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards, and establish priorities for development of total maximum daily loads (TMDLs) based on the severity of the pollution and the sensitivity of the uses to be made of the waters. Shadow Mountain Reservoir is currently listed on Colorado's 2010 303(d) list for dissolved oxygen. Factors contributing to low dissolved oxygen concentrations in Shadow Mountain Reservoir include the low dissolved oxygen water pumped from the hypolimnion of Granby Reservoir via the Farr Pumping Plant. Coupled with a long hydraulic residence time in Shadow Mountain Reservoir, further oxygen depletion occurs as algae and other aquatic organisms deplete available oxygen supplies.

Table 2.1. Colorado Nutrient Criteria–Draft Final Nutrient Interim Values (Reg. 31.17).

COLD WATER				WARM WATER		
Water Body	Total Phosphorus (mgL)	Total Nitrogen (mg/L)	Chlorophyll	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Chlorophyll
Rivers & Streams	0.11[1]	1.25[1]	150[2,3] mg/m^2	0.17[1]	2.01[1]	150[2,3] mg/m^2
Lakes & Reservoirs (Aquatic Life & Recreation Uses)	0.025[2]	0.426[2]	8[2] ug/L	0.083[2]	0.910[2]	20[2] ug/L
Direct Use Water Supply Lakes & Reservoirs	NA	NA	5[4] ug/L	NA	NA	5[4] ug/L

[1]Annual median; 1-in-5 year exceedence frequency, aquatic life use
[2]July 1 – Sept 30 average in mixed layer (median of multiple depths); 1-in-5 year exceedence frequency, for lakes & reservoirs >25 acres
[3]July 1 – Sept 30 maximum attached algae, not to exceed. Recreational use.
[4]March 1 – November 30 average chlorophyll in mixed layer (median of multiple depths; 1-in-5 year exceedence frequency

2.2.1 Other Constituents

Granby Reservoir is currently listed on Colorado's 2010 303(d) list for mercury in fish tissues impairing aquatic life cold water class 1 uses. The potential sources of mercury in Granby Reservoir are not explicitly identified. TMDL development is recommended to address further mercury loading in Granby Reservoir. Colorado's Water Quality Control Act does not include enforcement provisions related to nonpoint sources for constituents such as biological nutrients, biological material, rock, sand, or agricultural waste. However, Clean Water Act Section 101(g) encourages federal agencies to work with State and local agencies to develop comprehensive solutions to nonpoint source problems.

2.3 Water Quality Issues in the Three Lakes

Water quality issues have been discussed in several previous technical reports with recent focus on changes to water clarity in Grand Lake during various water operations scenarios, including pumping cessation. During the past several years, operational modifications were conducted during late summer (as described in Section 2.5.3) where water conveyance from Granby Reservoir ceased or was reduced to a low and steady flow, and sampling in Shadow Mountain Reservoir and Grand Lake was more intensive. A general summary of water quality issues and factors affecting water quality are summarized from these reports and include the following:

Water Quality Issues:

- Decreased clarity pre/post C-BT Project;
- Algal productivity in Shadow Mountain Reservoir and Grand Lake

- Sedimentation (delta) in Shadow Mountain Reservoir and Grand Lake
- Aquatic weeds growth in Shadow Mountain Reservoir
- Low dissolved oxygen levels in Shadow Mountain Reservoir
- Taste and odor problems in east slope drinking water
- Compliance with proposed clarity standard for Grand Lake
- Compliance with nutrient criteria in the Three Lakes
- Presence and transport of non-algal organic particulate matter and inorganic particulates in pumped flows (McCutchan 2010).

Water Quality Drivers:

- Nutrient loading into the Three Lakes (Granby Reservoir, Shadow Mountain Reservoir, Grand Lake) from natural and anthropogenic sources;
- Human development in the watershed;
- Hydraulic residence time;
- Water management/operation of the C-BT system
- Stormwater
- Climate variables
- Particulate matter
- Sediment loading from the North Fork of the Colorado River
- Particulate matter transport in Shadow Mountain and Grand Lake, including higher temperature of pumped flows (J. Anthony)
- Break down and re-suspension of aquatic weeds in Shadow Mountain Reservoir
- Internal loading

2.4 Summary of Pertinent Available Data and Studies

Water quality and quantity data sources referenced frequently in this report are listed in Table 2.2, and includes original source and date of publication. A full listing is included in the Appendix. Some of these reports are a synthesis of multiple years of information. The water quality issues were identified through monitoring efforts over time and many of the issues vary in magnitude and intensity from year to year.

Water quality observations have been recorded from Grand Lake prior to construction of the C-BT Project (Pennak 1955). Among several of the water quality characteristics described at that time was water clarity (e.g., Secchi disk depth) that was measured at deepest points in a series of high-elevation Colorado lakes. Results from this original work include a historical Grand Lake Secchi disk measurement and plankton community characteristics and have been used as a reference point for comparison with post-C-BT Project pumping conditions in Grand Lake. The historical Secchi disk depth measured by Pennak (1955) in September of 1941 was a single observation of 9.2 meters. Following C-BT Project pumping operations, the greatest Secchi disk depth recording made in 1953 was 4.6 meters and was based on several measurements by Pennak (1955). Subsequent monitoring efforts in the Three Lakes have focused on systematically characterizing changes in water quality. The majority of Secchi disk depth measurements began in the early 2000s.

Table 2.2. Data sources.

Data Type	Period of Record	Data Sources
Secchi Depth	1941-2011	CDPHE, CU, Northern Water, EPA, GCWIN, Reclamation, USGS
Nutrients	2007-2010	Northern Water
Streamflow/Operations	1991-2011	Reclamation
Connecting Channel	2010	USGS
Aquatic Weeds	2010	Northern Water/Dave Sisneros

As shown in the Appendix, the Three Lakes have been the subject of numerous studies and reports over the years. However, most reports focused on short periods of records or on specific issues. It is only recently that more intensive and long-term monitoring efforts were undertaken and comprehensive reports prepared to inform water quality dynamics in the system.

An in-depth analysis of 2005 through 2007 data collected by Reclamation was performed by Lieberman (2008) and further extended the analysis of previous water quality and clarity conditions in the Three Lakes. Recent analysis of changes in water clarity and factors related to these changes can be found in Hydros (2011) and include data collected by Northern Water from 2007 through 2010. 2011 data collected by GCWIN and Northern Water were also reviewed to supplement this report although the data had not been formally analyzed at the time of writing.

In addition to published reports used to analyze water quality and clarity conditions (Table 2.3), a separate table containing a summary of available data was prepared and included in the Appendix. The tables provide greater detail about water quality results including range of concentrations (where applicable), seasonality, and depth at which samples were collected. Observations contained within this table provided a historical perspective in comparison to current conditions.

Current knowledge about the Three Lakes water quality conditions relies on monitoring at various stations throughout the reservoirs, streams, lake, and canals associated with these water bodies. Station locations were established to monitor effects on water quality associated with the movement of water within the Three Lakes system. Data collected from these stations (Figure 2.1) helped describe changes in water chemistry dynamics occurring during changes in water operations. The data set with observations for Secchi depth extends from to 1941 through the present (Figure 2.2).

Table 2.3. Water quality and clarity reports.

Report Title	Author	Year
Comparative Limnology of Eight Colorado Mountain Lakes	Robert Pennak, CU	1955
An Assessment of Information on Water Quality in Lake Granby, Shadow Mountain Reservoir and Grand Lake	William Lewis, Jr, CU	1992
Water Quality and Trend Analysis of Colorado-Big Thompson System Reservoirs and Related Conveyances, 1969 through 2000	USGS	2003
Northern Water 2007 Water Quality Report	Esther Vincent, Northern Water	2008
Report of Refined Analysis on Grand Lake Water Clarity	Mark Coleman, Coleman Ecological	2008
2010 Shadow Mountain Reservoir Aquatic Weed Ground Truthing Survey	David Sisneros	2010
Factors Controlling Transparency in Grand Lake, Colorado	James McCutchan, CU	2010
Physical, Chemical, and Biological Attributes of Western and Eastern Slope Reservoir, Lake, and Flowing Water Sites on Colorado-Big Thompson Project, 2005-2007: Lake Granby, Grand Lake, Shadow Mountain Reservoir, Horsetooth Reservoir, Carter Lake	Davine Leiberman	2008
Operational and Water Quality Summary Report for Grand Lake and Shadow Mountain Reservoir	Jean Marie Boyer and Christine Hawley, Hydros Consultants	2011

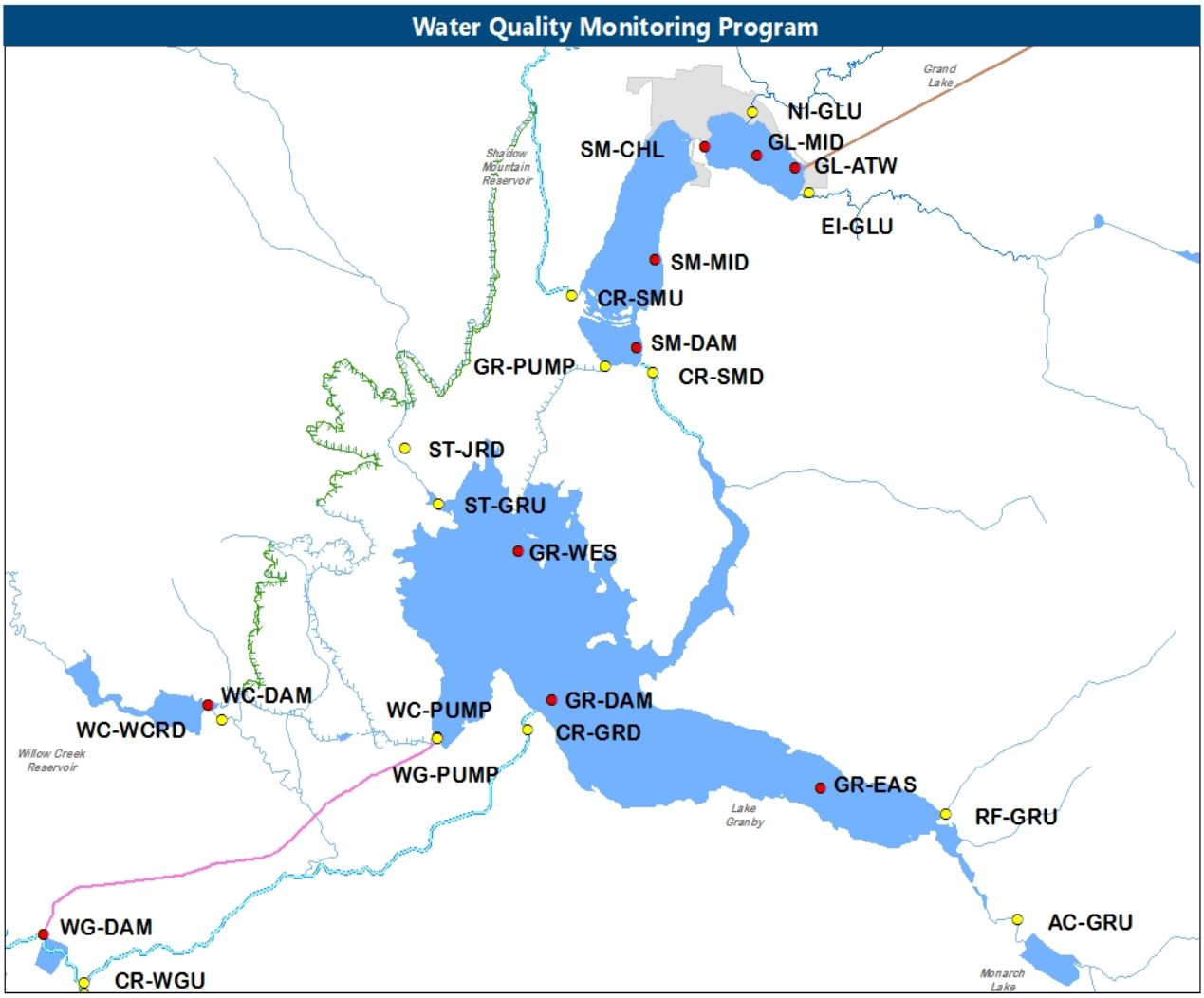


Figure 2.1. Location of Shadow Mountain Reservoir and Grand Lake Drainage surface water-sampling stations.

2.5 Factors Impacting Clarity

Between 1941 and 2010 the full range of Secchi depth measurements, taken both with and without a view scope (pvc tube with glass on one end, which eliminates surface reflection), extended from 1.2 meters through 9.2 meters. Figure 2.2 illustrates this and includes red lines to delineate boundaries of the measurements (only one reading of 9.2 meters was observed outside of this range). Recent data generated by GCWIN from observations in 2011 (taken with view scope) show a range of 1.11 meters (June 8, 2011) through 7.56 meters (August 24, 2011). Note that in 2011, abnormally high runoff and resultant high flows occurred. The 7.56-meter readings in August occurred during a time with no pumping at Farr Pumping Plant and no diversions at Adams Tunnel and water flowed from Grand Lake to Shadow Mountain Reservoir (GCWIN 2011 Secchi Report). Secchi depth was reduced to less than three meters once pumping began

and diversions through Adams Tunnel resumed in early September of 2011. See Section 2.5.3 for additional discussion on operational modifications.

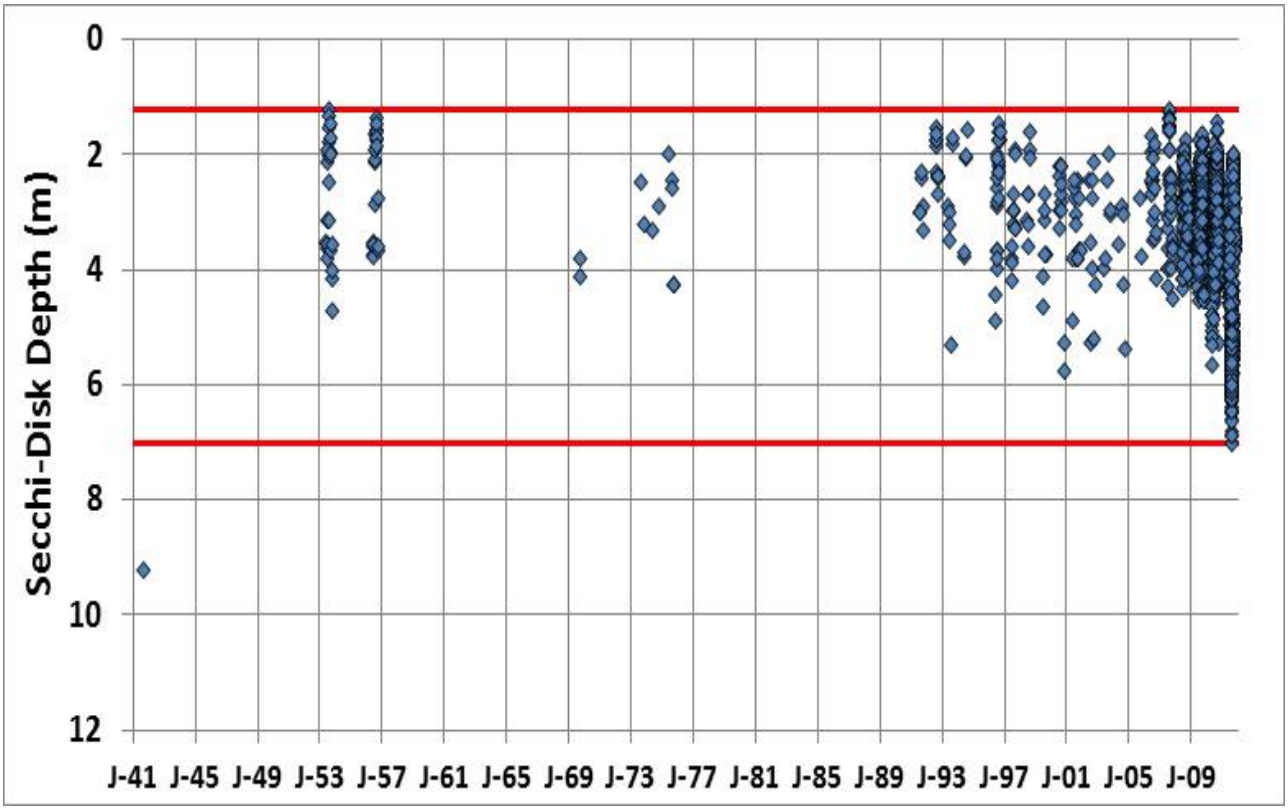
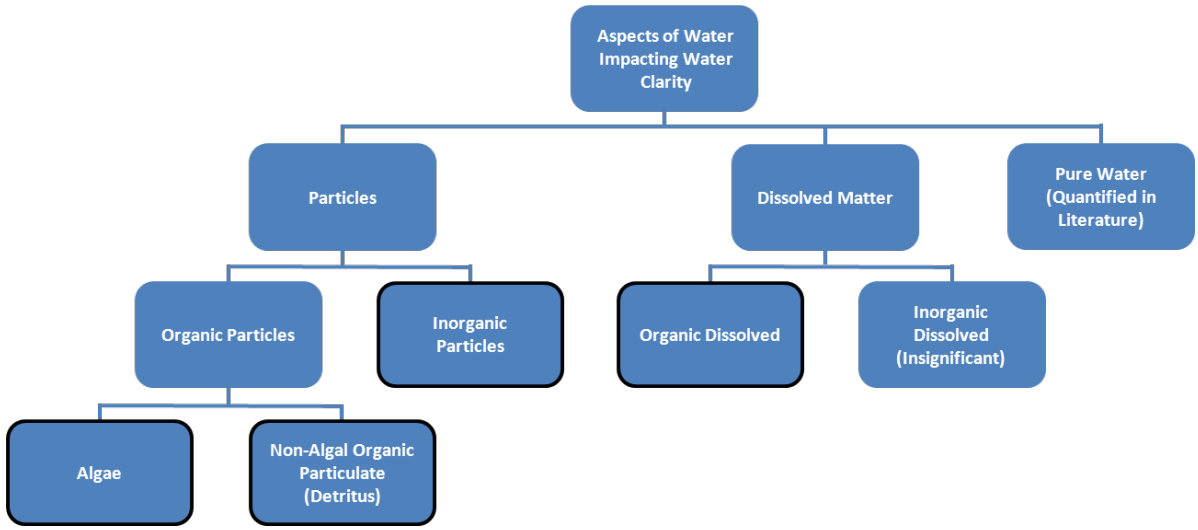


Figure 2.2. Historical Secchi-Disk Depth Measurements for Grand Lake (various locations and without view scope) (Source: Hydros, 2012).

Factors that affect water clarity in Grand Lake have been presented in McCutchan (2010) and Hydros (2011). Those light-attenuating factors identified as having greater influence on diminishing water clarity to having least influence in Grand Lake were determined to be, in the following order:

- Non-algal organic particles
- Algal particles
- Inorganic particles (suspended sediment)

Characteristics for each type of factor that attenuate light in the water column include the beam attenuation coefficient, spectral absorption coefficient, and the spectral scattering coefficient (Arst et al. 1997). Overall, an effective way to relate light-attenuating factors that diminish water clarity in Grand Lake can be conceptualized in Figure 2.3. Factors influencing water clarity are either directly influencing light attenuation or are influencing other factors that affect light attenuation (indirect effects; e.g., algae). Additional studies are underway to determine the composition of particulates.



Algae: Algal biomass is typically described as chlorophyll *a*. Chlorophyll *a* absorbs strongly and usually scatters strongly. Often the scattering is higher than absorption and the scattering is dependent on cell size (small algae are much more efficient at scattering). Algae typically grows within the water body, depending on light, temperature, and nutrient concentrations although algae can also be transported from one water body to another via flow (e.g. through the connecting channel between Grand Lake and Shadow Mountain Reservoir).

Non-Algal Organic Particulates (Detritus): Detritus is non-living particulate matter and includes fragments of dead organisms. A potentially important source of detritus for the Three Lakes is dead and decomposing aquatic macrophytes from shallow Shadow Mountain Reservoir. Detritus typically absorbs strongly and scatters strongly.

Inorganic Particulates: Inorganic particulates (inorganic suspended solids) are of mineral origin and include sand-, silt – and clay-sized particles. Sources include inflowing water, shoreline erosion, and re-suspension from the bottom of the lake/reservoir. Re-suspension may be particularly important in Shadow Mountain Reservoir due to its shallow depth and often, large flow rates. Inorganic suspended solids absorb weakly and scatter intensely.

Figure 2.3. Light-attenuating constituents in water (Source: Hydros 2011).

McCutchan (2010) reported that non-algal particles account for a greater portion of light attenuation in Grand Lake compared to other components that scatter and absorb light like algal matter and dissolved organic matter. Source for non-algal micro-particles may be derived from aquatic macrophytes that occur near the shallow, northern end of Shadow Mountain Reservoir (Sisneros 2010). The U.S. Forest Service manually cuts and harvests the heavy growth of aquatic plants in Shadow Mountain Reservoir, which may also contribute plant fragments that are not removed from the reservoir.

Lieberman (2008) concluded that water clarity is affected by Shadow Mountain Reservoir water conveyance and detectable by the mid-Grand Lake station extending to the Adams Tunnel station. Conversely the influence of natural water flowing into Grand Lake is reflected in high (improved) Secchi disk depth readings (GCWIN 2011).

2.6 Hydrodynamics of the Three Lakes

2.6.1 Overview

The Three Lakes System is comprised of Granby Reservoir, Shadow Mountain Reservoir and Grand Lake. Granby Reservoir collects and stores the waters of its direct tributaries and also receives and stores pumped water from Willow Creek and Windy Gap Reservoirs. Willow Creek Reservoir is located approximately three miles to the west of Granby Reservoir and Windy Gap Reservoir is located about 6 miles, downstream and southwest of Granby Reservoir. Shadow Mountain Reservoir, constructed as part of the C-BT Project, collects and stores water from its tributaries and also serves to help convey flows to Grand Lake. Shadow Mountain Reservoir and Grand Lake are operated with relatively constant water levels. Physical characteristics of the Three Lakes are described in Table 2.4. Figure 2.4 provides a schematic of the C-BT Project.

Table 2.4. Three Lakes physical characteristics[1].

Metric	Grand Lake	Shadow Mountain Reservoir	Granby Reservoir
Volume, acre-feet	68,621	17,354	539,758
Surface Area, acres	507	1,852	7,256
Mean Depth, feet	135	9.4	74
Shoreline, miles	3.8[2]	8	40

Sources: [1] AMEC 2008, [2]Estimated from aerial mapping

The system is generally described as follows: During the spring runoff period when natural inflow to Grand Lake exceeds the Adams Tunnel diversion, flows move from Grand Lake to Shadow Mountain Reservoir and from Shadow Mountain Reservoir to Granby Reservoir and from Granby Reservoir to the Colorado River. However, when the Adams Tunnel diversions exceed the natural inflow to Grand Lake, water must be pumped from Granby Reservoir. Water from Granby Reservoir is pumped by the Farr Pumping Plant into the Granby Pump Canal, which then flows 1.8 miles to the north into Shadow Mountain Reservoir. Once in, Shadow Mountain Reservoir water continues north and into Grand Lake. Once in Grand Lake, water is combined with flows from the East and North Inlets, and is diverted by gravity flow to the Adams Tunnel. Once in Adams Tunnel water flows 13 miles and discharges at the eastern portal. From the eastern portal, water descends about 2,800 feet through a series of diversions and power stations. The diverted west slope water is used for power generation, often augmented by east slope flows from the Big Thompson River. The Three Lakes hydrologic elements including system gains and losses are conceptually represented on Figure 2.5.

A detailed description of the C-BT Project is provided on the Reclamation web site at www.usbr.gov/projects. Schematics of the system, also provided by Reclamation, are presented in the Appendix.

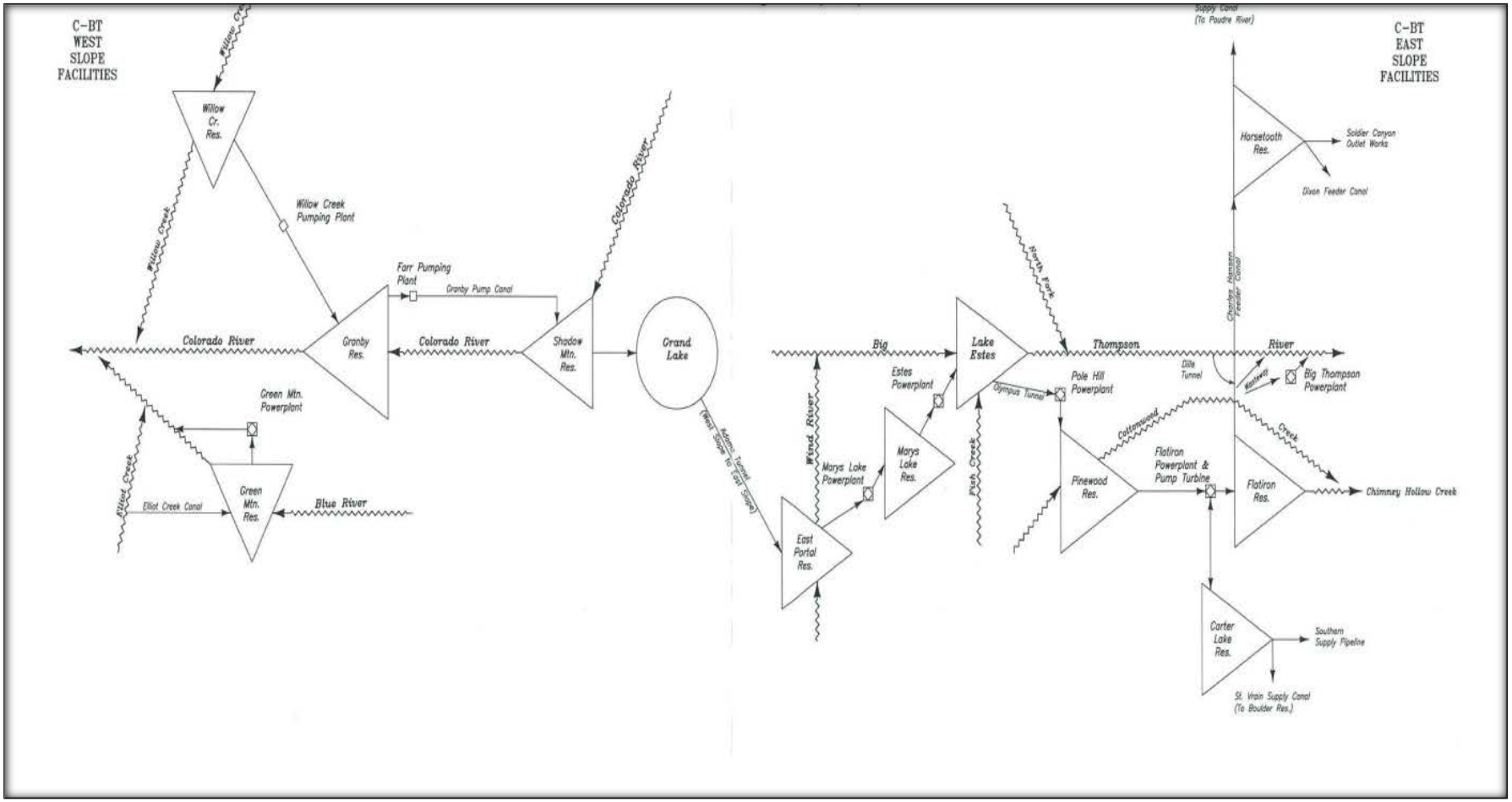


Figure 2.4. C-BT project schematic (Source: Reclamation, Eastern Area Office).

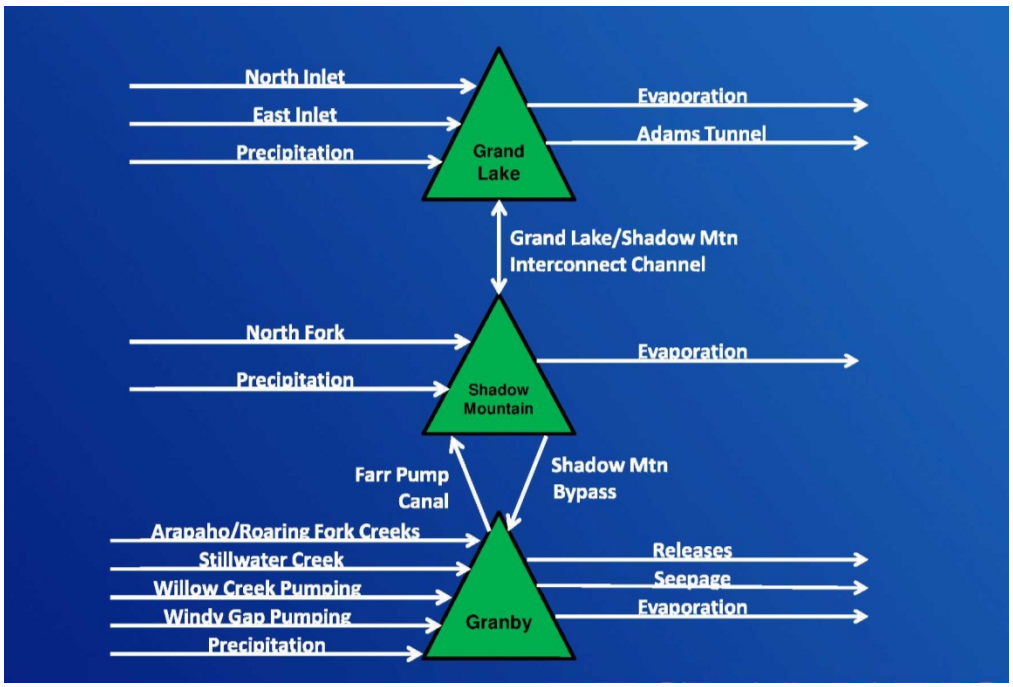


Figure 2.5. Three Lakes Hydrologic Elements (Source: Reclamation 2011c).

2.6.2 Current Conditions in the Three Lakes

Nutrient loading and movement of water into and between the reservoirs and lakes was analyzed by Hydros (2011) and partitioned by source for flows and nutrients including total phosphorus and total nitrogen. The following information summarizes some of the information and conclusions. Note that Windy Gap Firming Project nutrient mitigation requires a minimum 1:1 reduction in total phosphorus and total nitrogen loadings to the Three Lakes to be accomplished through point and non-point source reduction measures (Reclamation 2011c).

2.6.2.1 Flows

Total inflows and outflows for Granby Reservoir, Shadow Mountain Reservoir and Grand Lake are summarized by Hydros (2011) and shown in Tables 2.5 through 2.7 for 2007-2010. Based on these four years of data, there was an average of approximately 207,000 acre-feet of water pumped from Granby Reservoir to Shadow Mountain Reservoir, 199,000 acre-feet of water moved from Shadow Mountain Reservoir to Grand Lake and 247,000 acre-feet of water diverted through Adams Tunnel. The average inflow from the East and North Inlets for the period 2007-2010 was 92,000 acre-feet. The precipitation values were computed based on rainfall records at weather station Grand Lake 6 SSW and the surface area of the water body (when full).

Table 2.5. Grand Lake inflows, outflow, and residence time (2007-2010) (Source: Hydros 2011).

		2007	2008	2009	2010
Inflows (AF/yr)	North Inlet	46,460	61,554	59,357	51,490
	East Inlet	32,652	39,376	41,799	33,376
	From SMR	224,626	206,064	193,605	171,838
	Gains	12,289	9,740	20,200	18,701
	Precipitation	579	592	515	611
	Total	316,606	317,326	315,476	276,016
Outflows (AF/yr)	To SMR	47,853	24,043	73,162	68,430
	Adams Tunnel	262,643	285,822	236,628	202,320
	Evap and Losses	6,124	7,471	5,655	5,292
	Total	316,620	317,336	315,445	276,042
Hydraulic Residence Time (days)	Average Annual Based on Total Volume*	78	78	79	90
	Average July-September Based on Epilimnetic Volume**	5	5	6	4

*Average Total Volume for 2010 = 67,882 AF
**Average Epilimnetic Volume for 2010 = 4,407 AF

Table 2.6. Shadow Mountain Reservoir inflows, outflow and residence time (2007-2010) (Source: Hydros 2011).

		2007	2008	2009	2010
Inflows (AF/yr)	North Fork	28,545	52,335	52,079	50,954
	From Grand	47,853	24,043	73,162	68,430
	From Granby	233,796	213,336	200,118	182,014
	Gains	19,687	15,604	32,360	29,959
	Precipitation	1,536	1,571	1,367	1,622
	Total	331,417	306,889	359,086	332,979
Outflows (AF/yr)	To Grand	224,626	206,064	193,605	171,838
	To Granby	95,786	87,431	155,187	151,345
	Evap and Losses	11,084	13,275	10,349	9,822
	Total	331,496	306,770	359,141	333,005
Hydraulic Residence Time (days)	Average Annual Based on Total Volume*	19	20	17	18
	Average July-September Based on Total Volume*	19	21	23	16

*Average Total Volume for 2010 = 16,830 AF

Table 2.7. Granby Resource inflows, outflow, and residence time (2007-2010) (Source: Hydros 2011).

		2007	2008	2009	2010
Inflows (AF/yr)	Arapaho	49,252	57,988	61,837	52,176
	Stillwater	8,239	9,616	8,719	8,255
	Roaring Fork	12,952	19,030	14,148	15,539
	Columbine	8,808	13,282	9,888	10,468
	Windy Gap	40,992	33,523	26,368	6,758
	Willow Creek	39,348	57,709	57,078	45,201
	Gains	2,689	3,994	2,971	3,214
	From SMR	95,786	87,431	155,187	151,345
	Precipitation	8,284	8,477	7,377	8,750
	Total	266,350	291,050	343,573	301,706
Outflows (AF/yr)	To SMR	233,796	213,336	200,118	182,014
	To CO River	32,542	29,829	33,006	36,331
	Evap and Losses	30,677	23,115	39,007	34,996
	Total	297,015	266,280	272,131	253,341
Annual Hydraulic Residence Time (yr)		440	496	543	650

*Average Total Volume for 2010 = 451,082 AF

Monitoring information continues to be generated in each of the reservoirs and lake and is periodically synthesized (Hydros 2011) to determine if additional and more recent data are able to illuminate some of the dynamics and factors affecting water clarity. A synthesis completed by Lieberman (2008) examined electronically available data supplied by Northern Water and identified several data gaps. One of the data gaps identified, at that time, was the lack of information regarding hydraulic residence time (HRT) in each of the reservoirs and lake. This was also stated earlier by Lewis (1992) and related to source and time of travel for nutrients and phytoplankton between the reservoirs and lake. Transfer of phytoplankton from Shadow Mountain Reservoir to Grand Lake was inferred through comparison of algal densities and community structure (similar in both reservoir and lake following transfer during pumping). Prior to the beginning of resuming pumping after spring runoff (usually August), the natural flowing waters (North and East Inlets) have a greater influence on Grand Lake in the spring with contribution of low nutrient concentrations and cooler water than waters pumped through Shadow Mountain Reservoir during the summer pumping season. More recently, as data collection efforts in the Three Lakes have intensified, annual HRT was determined by Hydros (2011) and is shown in Tables 2.5 through 2.7.

2.6.2.2 Total Phosphorus

Total phosphorus (TP) load for Granby Reservoir, Shadow Mountain Reservoir and Grand Lake and TP concentrations for tributaries and pumped inflows are summarized by Hydros (2011) and shown in Tables 2.8 and 2.9 for 2007-2010. TP transferred from Granby Reservoir into Shadow Mountain Reservoir was consistently higher than the TP load transferred to Grand Lake. Hydros (2011) report and 2007-2010 data indicate the following:

- Shadow Mountain Reservoir, the smallest water body by volume, receives a disproportionate amount of total phosphorus.
- TP load into Grand Lake is higher than it would be under more natural conditions (from East and North Inlets) by a factor of four to seven depending on the year.
- Stormwater contributions are significant for Shadow Mountain and Granby Reservoir
- Internal loading is significant for both Shadow Mountain and Granby Reservoir
- Based on average values from the four years, the highest TP load coming into the Three Lakes system is Willow Creek pipeline, followed by the North Fork of the Colorado River, Windy Gap pipeline, and Stillwater Creek.
- The highest concentrations of TP coming into the Three Lakes system occur at Stillwater Creek, Windy Gap pipeline, Willow Creek pipeline, and North Fork of the Colorado River.
-

The average TP loading into Granby Reservoir during 2007-2010 was higher (15,812 kg/yr.) than in Shadow Mountain Reservoir (10,873 kg/yr.) or in Grand Lake (5,529 kg/yr.). Based on averages, 71% of the TP loading into Grand Lake is from Shadow Mountain Reservoir. The average annual volume-weighted TP concentrations for tributaries and pumped inflows are shown in Table 2.9.

The Total Phosphorus loading to Granby Reservoir is one of the sources for low dissolved oxygen concentrations in the hypolimnion. The hypolimnetic phosphorus released in a low dissolved oxygen environment is available for conveyance to Shadow Mountain Reservoir if near the intake of the Farr Pumping Plant.

Table 2.8. Total phosphorus loads (kg/yr) by water body (2007-2010) (Source: Hydros, 2011).

Water Body	Source	2007	2008	2009	2010
Grand Lake	North Inlet	510	1,141	831	652
	East Inlet	266	496	451	402
	From SMR	4,314	4,377	3,869	3,148
	Gains	65	104	160	145
	Precipitation	29	30	26	31
	Stormwater	166	118	137	58
	Internal Load	147	147	147	147
	Total	5,497	6,413	5,621	4,583
Shadow Mtn Reservoir	North Fork	778	4,792	1,294	1,611
	From Grand	421	400	852	795
	From Granby	4,966	6,055	5,982	4,747
	Gains	104	167	256	232
	Precipitation	78	79	69	82
	Stormwater	1,659	1,175	1,521	2,074
	Internal Load	1,328	661	656	656
	Total	9,334	13,329	10,630	10,197
Granby Reservoir	Arapaho	391	669	626	505
	Stillwater	1,034	1,579	1,641	1,065
	Roaring Fork	113	259	144	167
	Columbine	77	190	103	115
	Windy Gap	2,696	3,535	1,897	150
	Willow Creek	1,168	2,934	2,699	1,945
	Gains	16	45	23	26
	From SMR	1,317	3,637	2,702	2,954
	Precipitation	419	429	373	442
	Stormwater	4,147	2,938	3,802	5,184
	Internal Load	2,079	2,118	2,306	2,589
	Total	13,457	18,333	16,316	15,142

Table 2.9. Annual volume-weighted total phosphorus concentrations for tributaries and pumped inflows (ug/L) (2007-2010) (Source: Hydros, 2011).

Inflow	2007	2008	2009	2010
North Inlet	9	15	11	10
East Inlet	7	10	9	10
North Fork	22	74	20	26
Arapaho	6	9	8	8
Stillwater	102	133	153	105
Roaring Fork	7	11	8	9
Columbine	7	12	8	9
Windy Gap	53	85	58	18
Willow Creek	21	41	38	35

2.6.2.3 Total Nitrogen

Total nitrogen (TN) load for Granby Reservoir, Shadow Mountain Reservoir and Grand Lake and TN concentrations for tributaries and pumped inflows are summarized by Hydros (2011) and shown in Tables 2.10 and 2.11 for 2007-2010. Hydros (2011) report and 2007-2010 data indicate the following:

- Shadow Mountain Reservoir, the smallest water body by volume, receives a disproportionate amount of total nitrogen.
- TN load into Grand Lake is higher than it would be under more natural conditions (from East and North Inlets) by a factor of four to six depending on the year.
- Stormwater contributions are significant for Shadow Mountain and Granby Reservoir
- Based on average values from the four years, the highest TN load coming into the Three Lakes system is Windy Gap pipeline, followed by the North Fork of the Colorado River, Willow Creek pipeline, and Stillwater Creek.
- The highest concentrations of TN coming into the Three Lakes system occur at Stillwater Creek, Windy Gap pipeline, North Fork of the Colorado River, and North Inlet.

The average TN loading into Granby Reservoir during 2007-2010 was higher (190,730 kg/yr.) than in Shadow Mountain Reservoir (123,871 kg/yr.) or in Grand Lake (119,816 kg/yr.). Based on averages, 60 percent of the TN loading into Grand Lake is from Shadow Mountain Reservoir. The average annual volume-weighted TN concentration for tributaries and pumped flows are shown in Table 2.11.

Total Nitrogen load transferred from Granby Reservoir to Shadow Mountain Reservoir was on average of 122,999 kg/yr during 2007 – 2009 (Hydros 2011). Water entering Shadow Mountain Reservoir from Granby Reservoir may have some effect on increasing water clarity, but only temporarily (McCutchan 2010). Hydros (2011) indicated that regardless of the Farr Pumping Plant pumping rate during the summer, algal growth appears to reach a summer maximum and then slowly diminishes toward September of each year.

Table 2.10. Total nitrogen loads (kg/yr) by water body (2007-2010) (Source: Hydros, 2011).

Water Body	Source	2007	2008	2009	2010
Grand Lake	North Inlet	13,215	19,355	17,519	14,695
	East Inlet	7,848	10,444	12,678	10,612
	From SMR	83,713	76,060	66,355	60,539
	Gains	2,752	2,401	3,746	4,277
	Precipitation	523	535	466	552
	Stormwater	12,960	9,180	11,465	12,053
	Internal Load	6,624	6,234	6,233	6,231
	Total	127,635	124,209	118,462	108,959
Shadow Mtn Reservoir	North Fork	7,796	20,068	17,848	16,018
	From Grand	14,025	8,108	25,276	24,208
	From Granby	75,760	71,496	62,762	55,748
	Gains	4,409	3,847	6,000	6,851
	Precipitation	1,387	1,420	1,236	1,465
	Stormwater	17,626	12,485	16,157	22,032
	Internal Load	962	165	164	164
	Total	121,965	117,589	129,443	126,486
Granby Reservoir	Arapaho	11,359	13,274	11,886	12,020
	Stillwater	4,449	6,566	5,799	4,446
	Roaring Fork	2,986	5,585	3,035	3,315
	Columbine	2,081	4,124	2,194	2,290
	Windy Gap	18,917	29,172	14,789	2,905
	Willow Creek	9,526	18,248	14,280	12,318
	Gains	574	1,122	588	630
	From SMR	31,085	36,813	58,390	59,286
	Precipitation	7,485	7,660	6,665	7,906
	Stormwater	61,690	43,697	56,549	77,112
	Internal Load	27,611	18,879	20,435	23,180
	Total	177,763	185,140	194,610	205,408

Table 2.11. Annual volume-weighted total nitrogen concentrations for tributaries and pumped inflows (ug/L) (2007-2010) (Source: Hydros, 2011).

Inflow	2007	2008	2009	2010
North Inlet	231	255	239	231
East Inlet	195	215	246	258
North Fork	221	311	278	255
Arapaho	187	186	156	187
Stillwater	438	554	539	437
Roaring Fork	187	238	174	173
Columbine	192	252	180	177
Windy Gap	374	705	455	349
Willow Creek	196	256	203	221

2.6.2.4 Chlorophyll-a

Buirgy (2008) examined several parameters relating to Secchi disk depth measurements and found chlorophyll-*a* as a strong correlate ($R^2 = 0.73$) with clarity. Similarly, Coleman (2008) analyzed several variables for correlates that would explain changes in water clarity. Water clarity in Grand Lake was a function of time of year and chlorophyll-a concentration. Coleman further states that chlorophyll-*a* is also a function of nutrient availability, so it would not be used solely as an indicator as the only correlate with water clarity. Hydros (2011) notes seasonal flucuations in chlorophyll *a* that correspond to a decrease in clarity from roughly mid-July through mid-August, and corresponds with the timing of an increase in chlorophyll-*a* in the connecting channel between Shadow Mountain Reservoir and Grand Lake (Figure 2.6). Examination of Secchi disk depth by Coleman (2008) measured from between 1969 and 2007 showed no apparent trends over time. However, water moving from Grand Lake to Shadow Mountain Reservoir did not have high chlorophyll-*a* concentrations, but water in the reverse direction to Grand Lake had resulted in substantially higher chlorophyll-*a* increases at times despite influence for time of year.

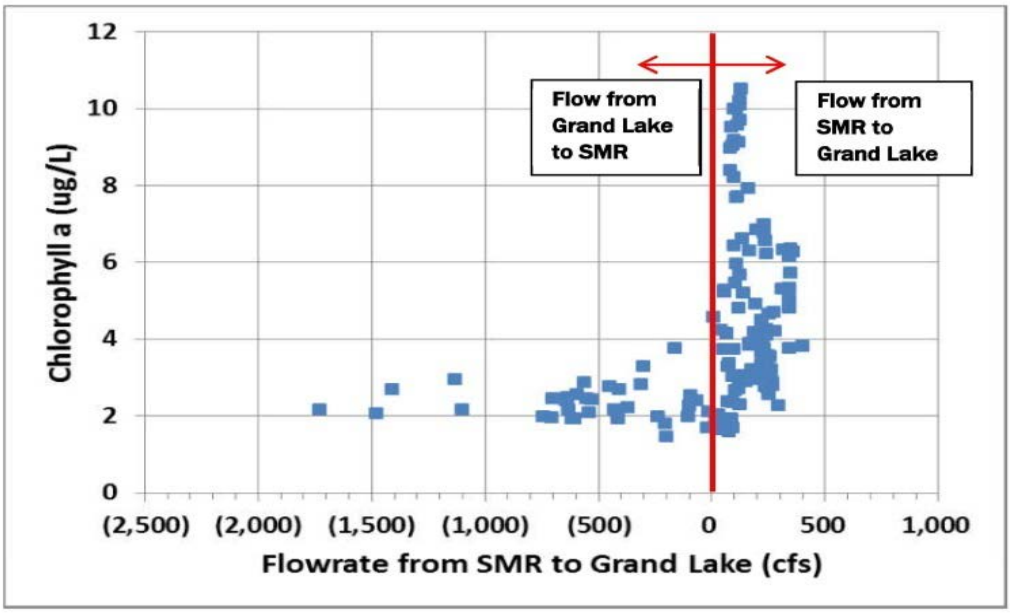


Figure 2.6. Chlorophyll a as a Function of Flow Rate at the Connecting Channel between Grand Lake and Shadow Mountain Reservoir (2010) (Source: Hydros 2011).

2.6.2.5 Turbidity

Turbidity is lower (improved water clarity) whenever water flows from Grand Lake to Shadow Mountain Reservoir (Figure 2.7).

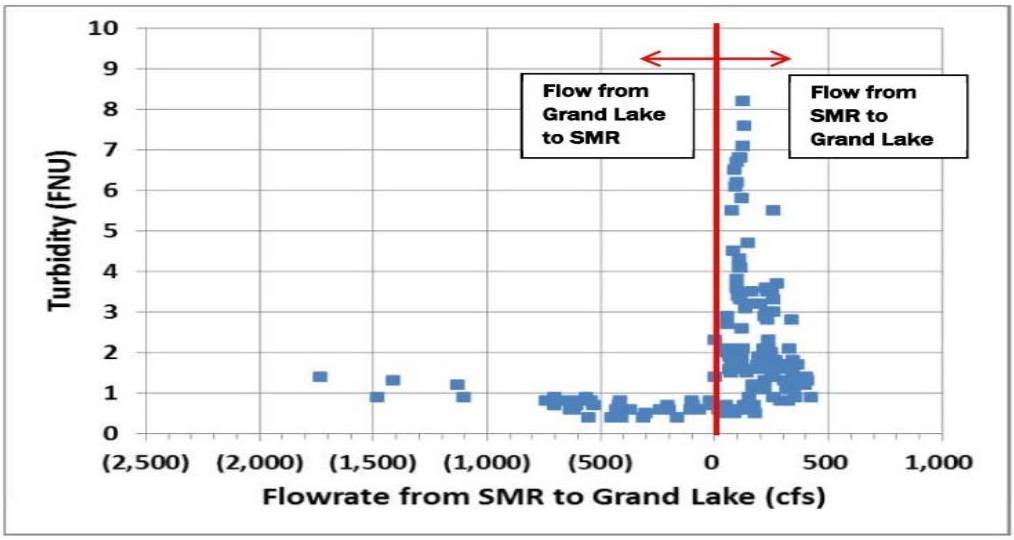


Figure 2.7. Turbidity as a Function of Flow rate from SMR to Grand Lake (Source: Hydros, 2011).

2.6.3 Operational Modifications

In 2008-2011, Reclamation, Grand County, and Northern Water cooperatively altered summer C-BT Project operations to look at potential effects to clarity. Modifications and resulting Secchi disk depths (taken with view scope) varied from year to year and are described as follows:

- 2008: no water was pumped from Granby Reservoir to Shadow Mountain Reservoir for two weeks in late summer. Initially planned for four weeks, the stop pump experiment was shortened to two weeks due to east slope reservoir water level concerns (Reclamation 2011b). The variety of operational, hydrologic and environmental conditions that occurred in 2008 improved water clarity with Secchi disk depths from 2.2 to 3.5 m during the stop pump period (Hydros 2011).
- 2009: no water was pumped from Granby Reservoir to Shadow Mountain Reservoir for two weeks in late summer (Reclamation 2011b). The variety of operational, hydrologic and environmental conditions that occurred in 2009 improved water clarity with Secchi disk depths from 3.2 to 3.4 m during the stop pump period (Hydros 2011).
- 2010: a constant flow of water was maintained by daily pumping in an attempt to keep Shadow Mountain Reservoir from becoming stratified by minimizing the detention time of the water. This experiment lasted eight weeks while Reclamation balanced effects on power production, meeting water customer demands, and maintaining necessary reservoir elevations (Reclamation 2011b). Hydros (2011) notes that in August clarity degraded and then improved with plots showing a range generally between 1.6 and 4.8 meters during July, August and September.
- 2011: no water was pumped from Granby Reservoir to Shadow Mountain Reservoir for June, July and August with pumping restarting on or about September 7th. Diversions through Adams Tunnel varied all summer from almost no flow during July and August to near capacity in June and September (GCWIN). This extended period of no pumping and no diversions was possible due to the unusually high snow pack and runoff from the 2010-2011 winter period coupled with low east slope demands for water and power. Secchi disk depths in July and August were at or greater than 4 meters with maximum values measured in August of 7.56 meters. In September, when pumping resumed, Secchi disk depths dropped to approximately 2 to 3 meters.

Secchi disk depths versus flows for 2008-2011 are shown on Figures 2.8 through 2.11.

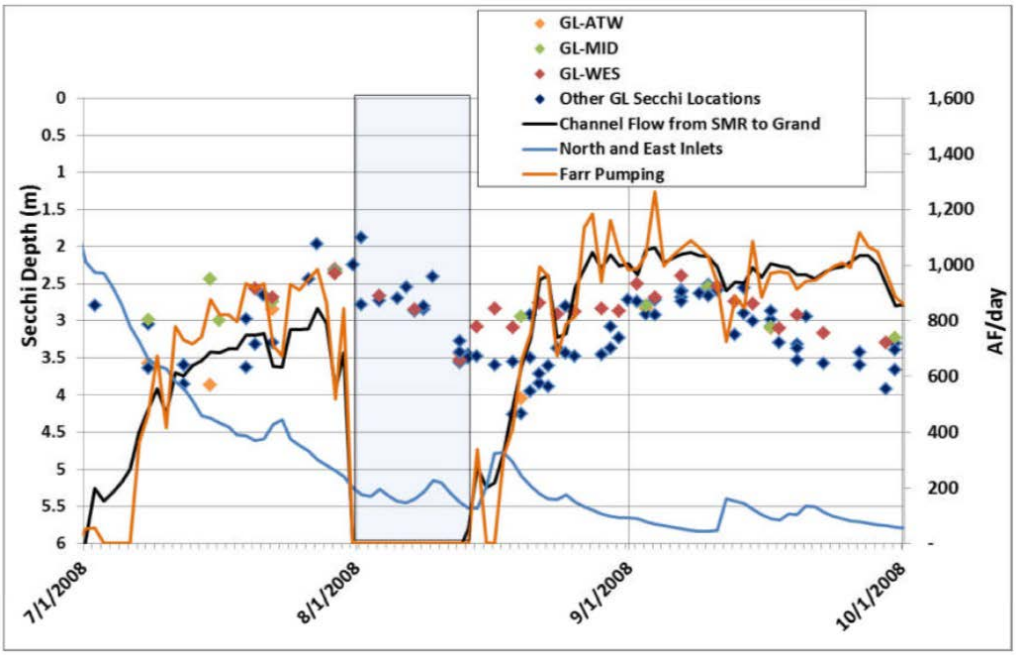


Figure 2.8. Grand Lake Secchi-Depth Data During 2008 Stop-Pump Period (All Locations, View Scope). Stop-pump period is shaded. Inflow and Farr Pumping are also indicated (Source: Hydros 2011).

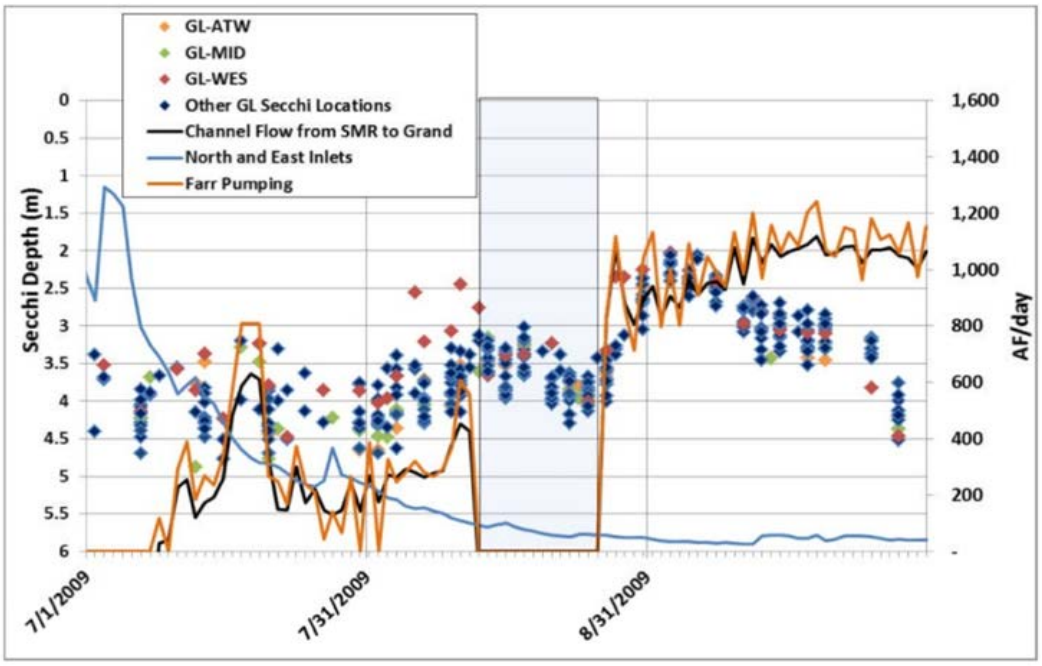


Figure 2.9. Grand Lake Secchi-depth data during 2009 Stop-pump period (All Locations, View Scope) Stop-pump period is shaded. Inflow and Farr Pumping are also indicated (Source: Hydros 2011).

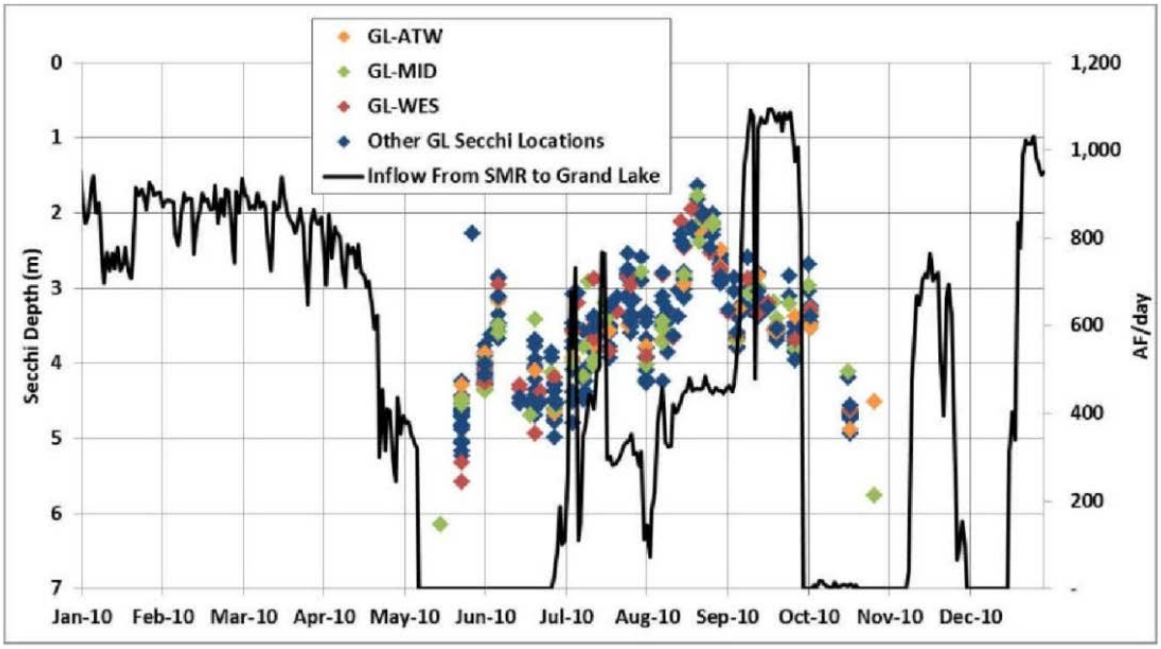


Figure 2.10. Grand Lake Secchi Depth and flow from Shadow Mountain Reservoir to Grand Lake, 2010 (Source: Hydros 2011).

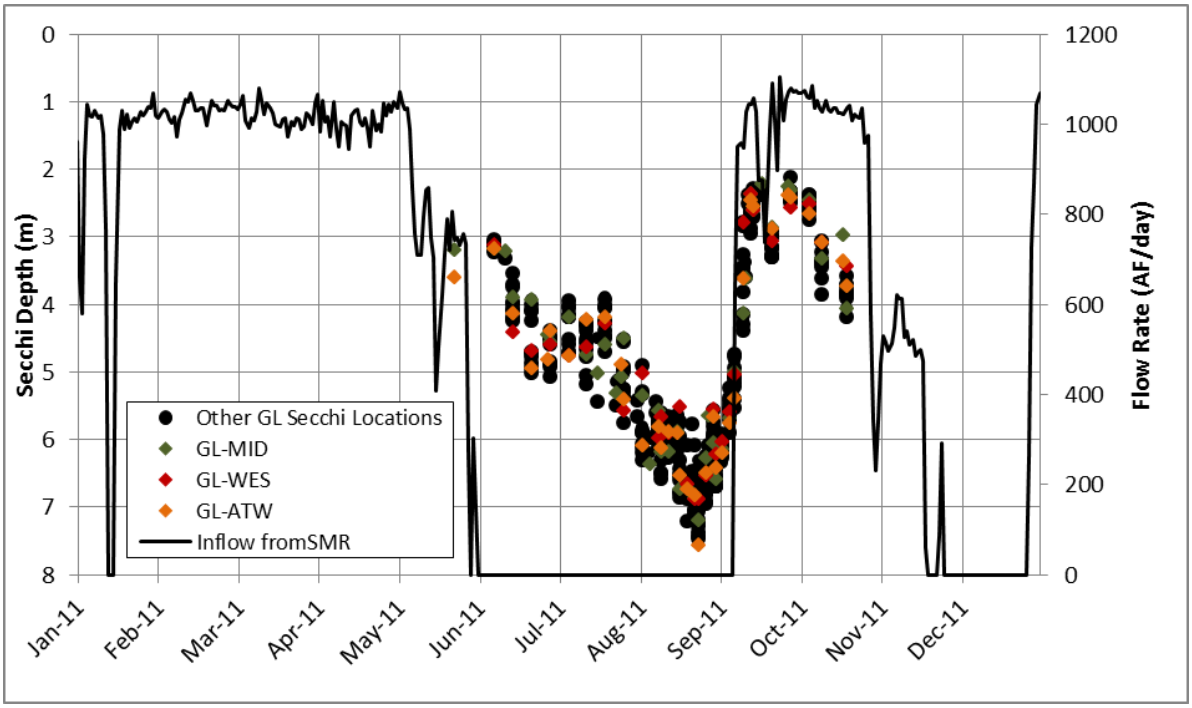


Figure 2.11. Grand Lake Secchi Depth and Flow from Shadow Mountain Reservoir to Grand Lake, 2011(Source: Hydros 2012).

Hydros (2011) aggregated Secchi disk depth data from multiple locations and dates (July through October 2009) in Shadow Mountain Reservoir and Grand Lake and related the results to pumping rates for this time period. In general, quiescent periods where no pumping has occurred, followed by slow and then high pumping rates transfer water from Shadow Mountain Reservoir to Grand Lake resulting in diminished water clarity in Grand Lake. Regardless of the specific elements entrained and suspended in the water column from Shadow Mountain Reservoir, the receiving water in Grand Lake will lose some of the light penetrating capacity (reduced clarity) for a period of time. Specifically:

- The variety of operational, hydrologic and environmental conditions that occurred in 2007-2010 improved water clarity in Grand Lake (with Secchi disk depths of 2.2 m to 3.5 m in 2008 and from 3.2 to 3.4 m in 2009) but did not result in meeting the proposed numeric clarity standard of 4 m. In 2011 when pumping was halted in July and August the water clarity reached and exceeded 4 m, however, it did not result in meeting the proposed numeric clarity standard for all three months because pumping and diversions resumed on September 7th.
- Shadow Mountain Reservoir water clarity improved during one stop-pump period in 2008 but declined during the 2009 test. Thus the amount and quality of inflow during the stop-pump test may have impacted Shadow Mountain Reservoir water clarity.
- Shadow Mountain Reservoir spatial patterns in the Secchi data set suggest a gradient of increasing clarity where there is inflow. That is, clarity is improved near Granby Pump canal during pumping and near Grand Lake inflow when natural flows exceed diversions in Adams Tunnel. This is likely a clarity dilution effect of clearer water flowing in; however re-suspension of sediment material or other particulate matter may also be occurring.
- Declining clarity during the summer in Shadow Mountain Reservoir seems to occur regardless of pumping rates, likely reflecting algal growth in the warm season, which is then diminished later in the season.

Aerial photographs taken before and after pumping resumed are shown on Figure 2.12.

Figure 2.12. Looking at Grand Lake and the connecting canal to Shadow Mountain Reservoir. Picture Photo on left was taken 30 August 2011. Picture Photo on right taken 8 September 2011. Both photos taken by Byron Hetzler. Delta formation can be observed in both photos (Source: GCWIN).

2.7 Summary and Recommendations for Improving Water Clarity in Grand Lake

Water clarity in Grand Lake and Shadow Mountain Reservoir is predominately a function of non-algal organic particulate matter, algae particles, inorganic suspended solids, and dissolved organic matter. Factors affecting the concentrations of these constituents include hydrology, operations, weather and quality of inflowing water. Water clarity in Grand Lake responds to changes in C-BT Project pumping operations. The conveyance of water from Shadow Mountain Reservoir to Grand Lake appears to be related to detected declines in water clarity. To improve water clarity in Grand Lake between July and September, Hydros (2011) suggests the following:

1. Minimize the inflow of water with poor water quality into the lake.
2. Develop management strategies to improve water quality of inflow such as:
   a. Decrease water pumped at the Farr Pumping Plant
   b. Improve water quality of Shadow Mountain Reservoir
   c. By passing the flow from Shadow Maintain Reservoir around Grand Lake

Hydros (2011) notes that improving water quality in Shadow Mountain Reservoir will be difficult due to shallow conditions, sources of nutrients and weather conditions. Further, Reclamation noted that decreasing pumping at Farr Pumping Plant is not possible with future demands. Therefore, for the purposes of this report, the primary focus on the alternatives, as developed further in Chapter 4, will be to 1) minimize the inflow of poor quality water into Grand Lake, and 2) bypassing flow around Grand Lake.

2.8 Uncertainties related to Water Clarity

The proposed numeric standard of 4-meter Secchi depth for clarity was adopted by the Commission with a delayed effective date of 2015 and with the understanding that if a more appropriate standard was developed by 2014, the proposed numeric standard could be reevaluated. One of the uncertainties in predicting effects to water clarity from future pumping operations is the unknown contribution from internal nutrient loading in Shadow Mountain Reservoir and the impacts of 'first flush' when the pumps are on. In addition, the sources and relative contributions of organic and inorganic particles affecting light attenuation in the water column of Shadow Mountain Reservoir and Grand Lake have not been evaluated for tributaries and internal loading mobilization from Granby Reservoir to Shadow Mountain Reservoir during Farr Pumping Plant pumping activity. The re-suspension and transfer of inorganic and organic particles has yet to be investigated and the quantity of material that can be entrained by different pumping rates will affect predictions and preclude detecting small, incremental changes in water clarity.

Other uncertainties include the following:

- Source of non-algal organic particles
- Importance of macrophytes to clarity
- Role of phosphorus and nitrogen
- Relative importance of watershed control for nutrients
- Implications of increased hydraulic residence time

Finally, an uncertainty exists as to the attainable level of clarity. Isolating Grand Lake or diverting C-BT Project water around Grand Lake will improve clarity; however, there remains some uncertainty of achieving the proposed numeric clarity standard consistently over the long-term in a highly variable hydroclimatic environment.

2.8.1 Three Lakes Water-Quality Model

The Three Lakes Water-Quality Model was developed and used as part of the Windy Gap Firming Project to estimate potential impacts of the project to the water quality of Grand Lake, Shadow Mountain Reservoir, and Granby Reservoir. The Three Lakes Water-Quality Model is a dynamic, mechanistic water-quality model that simulates flow and water-quality of the Three Lakes System and the constituents associated with the eutrophication process. Grand Lake and Granby Reservoir are simulated as three-layer systems to account for reservoir stratification. Shadow Mountain Reservoir is represented as a one-layer, well-mixed reservoir due to its shallow depth (Reclamation 2011c). Further water quality modeling using the Three Lakes Water-Quality Model to evaluate some if not all of the alternatives identified for future consideration is warranted. This is discussed further in Chapter 4, Technical Evaluation.

2.9 Other Environmental Factors and Ongoing Projects

2.9.1 Grand River Ditch

The Grand River Ditch is a trans-basin diversion canal, constructed in the late 1800s, and located in the northwest corner of the Rocky Mountain National Park. In 2003, the ditch breached its banks generating 47,600 cubic yards (RMNP 2011) of mud and debris, which flowed and deposited into Lulu Creek and the headwaters of the North Fork of the Colorado River, filling the existing streams

and wetlands. Although the breach site is located 22 river miles upstream of the North Fork confluence with Shadow Mountain Reservoir, ditch breach materials may have reached Shadow Mountain Reservoir. Ditch restoration and mitigation for impacted streams and wetlands are in the planning stages. This issue is not explicitly addressed further in this report, but it may be useful to revisit in future studies.

2.9.2 Fisheries

The Windy Gap Firming Project Final Environmental Impact Statement (FEIS) (Reclamation 2011c) was reviewed for relevant information regarding the fisheries resources in the Three Lakes. 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 fishery. 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 Colorado Department of Parks and Wildlife.

Improving clarity in Grand Lake, particularly improvements to the fine particle matter in suspension, could be a benefit as trout are sight-feeders, and their ability to find food would be improved with improved clarity (Tetra Tech et al., 2010). However, overall the potential impacts to the fisheries relative to improvements have not yet been assessed in previous studies and will therefore be deferred to future detailed studies.

2.9.3 Zebra/Quagga Mussels

Monitoring and inspections for Zebra and Quagga Mussels are currently on-going at the water bodies of the Three Lakes system. Adults have not been detected. However, if adults become established, future negative impacts of mussel proliferation could include disruptions to the local ecosystem and physical obstructions limiting the water delivery capacity of intake structures at the Adams Tunnel, Farr Pumping Plant, and Granby Pump Canal as well as to any infrastructure constructed as a result of improvements for water clarity. The impacts to clarity are uncertain as mussels are filter feeders that can improve clarity but, mussels are also correlated with a greater occurrence of blue-green algae blooms that could worsen clarity.

As there is insufficient data to ascertain whether or not an adult mussel population may develop in the Three Lakes system, no further consideration of this issue will be addressed in this report. If future conditions indicate otherwise, these concerns and issues could be reassessed in future studies.

2.9.4 10825 Water

10825 Water refers to a proposal for the release of water from the Upper Colorado River Basin for use in support of the Endangered Fish Recovery Program. Contracting actions for the proposed releases are not in place, but the proposal call for approximately 5,400 acre-feet of water to be released from Granby Reservoir and conveyed downstream for the benefit of Upper Colorado Endangered Fish. Required water would be secured through the curtailment of irrigation on two ranches diverting from the Red Top Valley Ditch (Grand River 2009). The Red Top Valley Ditch diverts from the North Fork of the Colorado River. The impacts on water quality relative to the Three Lakes area was analyzed in the 10825 EA and found no effects to reservoir water quality. According to the March 2012, Water Resources Assessment of Proposed 10825 Alternative, Stillwater Creek streamflow is expected to increase during the irrigation season to a maximum monthly flow of 295%

of average in a dry year (Grand River 2012). For the purposes of this report, it is assumed that implementation of 10825 water will impact all alternatives relatively equally and not have a notable influence on the selection or evaluation of the alternatives. If future conditions indicate otherwise, this issue could be reassessed in future studies.

2.9.5 Mountain Pine Beetle

Since the 1980s, Colorado, including Grand County, has experienced a Mountain Pine Beetle outbreak. As a result, lodgepole pine populations have seriously declined. Mortality estimates vary from as low as 20% to as high as 90%, depending on forest composition and structure. Recent studies of over 200 watersheds in Colorado by McCutchan and Lewis (2012), including locations in the watersheds of Grand Lake and Shadow Mountain Reservoir, found that the effects of beetle kill on water quality are generally very small (not statistically significant after other factors have been considered). Further, McCutchan and Lewis (2012) indicate that other researchers have reached similar conclusions regarding effects of beetle kill on water quality. While the issue is important in terms of overall forest health and pre-fire mitigation, no further considerations are addressed in this report relative to the Mountain Pine Beetle outbreak and effects on water clarity. If future conditions indicate otherwise, this issue could be reassessed in future studies.

2.9.6 Existing Watershed and Best Management Practices

A number of programs, studies, and operations have been completed and best management practices (BMPs) are being implemented with the goal of improving the water quality of non-point sources tributary to the Three Lakes. This includes efforts by Reclamation to consider the effects of limited pumping on Grand Lake clarity and using draw-downs in Shadow Mountain Reservoir to control nuisance aquatic plants; proposals by Northern Water related to the Windy Gap Firming Project to offset nutrient loading to the Three Lakes; programs by Grand County related to the effects of watershed development including storm water controls and land use regulations, zoning, and programs by the Town of Grand Lake related to land use and storm water control; Three Lakes Water and Sanitation District (District) residential and business connections to a centralized wastewater treatment facility that discharges treated effluent into a tributary of the Colorado River, below Granby Dam; the National Park Service, Rocky Mountain National Park improvements for the Grand Ditch (previously mentioned); US Forest Service watershed protection activities; and ongoing major data/scientific studies funded by Reclamation, Northern Water, and Grand County with input from Stakeholders.

A comprehensive list of ongoing efforts was provided by Reclamation (Harger 2011) and is included in the Appendix. The extent of impacts these projects will have to Grand Lake water clarity is not well understood and outside of the scope of this report. However, it is likely that these efforts will provide some improvement to water quality in all Three Lakes water bodies for years to come.

2.9.7 Climate Change

The States of Colorado's 2008 report on climate change suggests that there are no consistent trends identified in the precipitation patterns to allow for projections of mean annual precipitation. However runoff patterns do suggest a reduction in snowpack, reduced snowmelt runoff and earlier peak runoff conditions, (Ray J.R *et al*. 2008) all of which could impact watershed yield and reservoir operations of the C-BT Project. Specific potential impacts that might affect any of the alternatives evaluated in this report include:

- Changes in reservoir management and timing of diversions,
- Reduction in water supply available to the water users junior to C-BT Project,
- Water quality degradation due to reduced dilution and warmer tributary waters,
- Higher demand for power, and
- Changes in water quality of runoff due to watershed habitat shifts.

There are many uncertainties associated with predicting impacts of climate change making it difficult to quantify impacts. However, the above noted trends do indicate a need to track and monitor for worsening water quality conditions in the Three Lakes area as a result of reduced water supply, increasing water temperatures and decreasing water quality of surface-water runoff. Due to limitations of this preliminary report, no further assessment of climate change in addressed. However, it is important to continue to consider and acknowledge these factors as evaluation of the alternatives to improve water quality continue into the next phases of detailed analysis.

2.10 Summary of Problems and Needs

During the initial public kickoff meeting (July 28, 2011) and two stakeholder and peer review meetings, (November 28, 2011 and February 9, 2012) the problems and needs related to water clarity and quality were summarized and discussed relative to the general objectives of this report. This is summarized in Table 2.12. Some of these problems and needs are not considered further, due to limitations inherent to an initial type of study such as this, and due to the uncertainty regarding the relationship to clarity in Grand Lake and are so noted.

Table 2.12. Summary of problems and needs.

Problem		Related Grand Lake Clarity Problem	Needs
1	Mixing of water from Shadow Mountain and Granby Reservoirs in Grand Lake reduces clarity in Grand Lake.	The mixing of lower quality water from Shadow Mountain and Granby Reservoir reduces clarity. Stop pump tests indicate an improvement in clarity when water is not moved from Shadow Mountain Reservoir through Grand Lake.	Specific water quality issues in Granby Reservoir will be deferred for further evaluation. Consider methods to reduce or eliminate mixing of Shadow Mountain and Granby Reservoir in Grand Lake
2	Water quality in Granby is generally good but, not well understood, including the impacts of nutrient loads from natural and pumped sources and internal loading.	Granby water is pumped into Shadow Mountain Reservoir which contributes to increased nutrient loading in Shadow Mountain Reservoir, and subsequently in Grand Lake.	Specific water quality issues in Granby Reservoir will be deferred for further evaluation. Consider methods to reduce or eliminate mixing of Granby Reservoir, with the Shadow Mountain Reservoir and/or Grand Lake.
3	Water quality and clarity in Shadow Mountain Reservoir are not completely understood, including the impacts of nutrient loads from natural and pumped sources, internal loading and hydrodynamics of C-BT Project system.	As documented by Hydros (2011) there is a gradient in Shadow Mountain Reservoir clarity between where the inflows come in and the opposite end of the reservoir, regardless of which way the water is flowing. The magnitude and pattern of this gradient may be caused by several possible factors, including flow rates, Granby water quality, and re-suspension of sediments from the bottom of Shadow Mountain Reservoir.	Specific water quality and clarity issues in Shadow Mountain are recommended for further evaluation. Consider methods to reduce or eliminate mixing of Shadow Mountain Reservoir in Grand Lake Water and also the potential impacts of the alternatives on these conditions.
4	Algae blooms in Shadow Mountain Reservoir are occurring, likely a combination of many factors including internal/external loading, shallow depths, residence time and elevated water temperatures.	Algae blooms in Shadow Mountain Reservoir are likely introducing lower quality water into Grand Lake, reducing Grand Lake clarity and quality of water.	Consider methods to reduce or eliminate mixing of Shadow Mountain Reservoir in Grand Lake, and methods to decrease algal productivity in Shadow Mountain Reservoir and sediment transports.

Problem		Related Grand Lake Clarity Problem	Needs
5	Low DO in Shadow Mountain Reservoir; 303(d) list.	Direct impacts on clarity in Grand Lake are not known. However, anoxic conditions in Shadow Mountain Reservoir are likely to increase nutrients which can be moved into Grand Lake.	DO issues in Shadow Mountain are recommended for further evaluation. Consider whether this is appropriate for the other C-BT west slope water bodies also.
6	The transport of fine particulate matter into Grand Lake is decreasing clarity.	The source of fine particulate matter is not well understood, although it is likely a mixture of non-algal organic and inorganic particles. Particulate matter transport can be minimized with reduced transfer of flow from Shadow Mountain Reservoir.	Specific water quality and clarity issues in Shadow Mountain are recommended for further evaluation. Consider methods to reduce or eliminate mixing of Shadow Mountain and Granby Reservoir in Grand Lake.
7	Aquatic Plant community in Shadow Mountain Reservoir impacts recreation and water quality.	Macrophyte impact on clarity in Grand Lake is not fully understood.	Specific issues in Shadow Mountain are recommended for further evaluation.
8	The reoperation of Red Top Ditch for 10825 water needs to be understood, particularly as it pertains to impacts on water quality in the Three Lakes System.	The impacts of Red Top Ditch on water quality in Shadow Mountain Reservoir and Granby Reservoir have been analyzed in the 10825 EA. Red Top Ditch operations were found to have no effect on reservoir water quality. Grand Lake was outside the scope of the EA and not analyzed for direct effects, however, it can be concluded that if there are no effects to Shadow Mountain or Granby Reservoirs water quality, there would be no effects to Grand Lake water quality.	If future conditions indicate otherwise, this issue could be reassessed in future studies.

Problem		Related Grand Lake Clarity Problem	Needs
9	Nutrient loading are relatively high from several of the Tributaries to Granby and Shadow Mountain Reservoirs, as well as from the pumped sources (Windy Gap and Willow Creek).	Control of many anthropogenic impacts on the Three Lakes, outside of pumped sources, is being addressed in ongoing efforts by local and non-governmental agencies. However, direct impacts of watershed contributions, pumped sources, and internal processes' contribution to Grand Lake clarity require further analysis.	Specific water quality and clarity issues in Shadow Mountain, Grand Lake, and Granby related to nutrient loading are recommended for further evaluation. Identify watershed issues that may directly impact clarity in Grand Lake; however, these most likely will require evaluation. Some of these watershed issues are identified under item 15, 'other sources.'
10	Particulate matter contributions as part of the total loading needs to be better understood.	Particulate matter was identified as the most important driver for decreased clarity in Grand Lake in McCutchan (2010). Current C-BT Project pumping operations transfer particulate matter from Shadow Mountain Reservoir to Grand Lake.	The sources and characterization of particulate matter in Grand Lake is currently being studied, however, specific water quality and clarity issues in Shadow Mountain, Grand Lake, and Granby related to particulate matters are recommended for further evaluation. Much remains to be learned about transport mechanisms and the nature and source of the particulate matter that contributes to clarity issues.
11	A delta in Shadow Mountain Reservoir has been forming due to sediment inputs from the North Fork of the Colorado River	Re-suspension of these sediments may be related to sediment inputs to Grand Lake that contribute to decreased clarity	A characterization study of particulate matter in Grand Lake and Shadow Mountain Reservoir is underway and will need to be reviewed in the Feasibility Study. Additional investigations of sediment sources may be needed.
12	Non-compliance with nutrient criteria is expected in the Three Lakes, in particular in Shadow Mountain and Grand Lake.	Nutrient enrichment contributes to algal productivity, which itself is related to decreases in clarity.	Consider nutrient control strategies and alternatives.

Problem		Related Grand Lake Clarity Problem	Needs
13	Total organic carbon (TOC) levels in the Three Lakes impact east slope drinking water treatment	Algal productivity can be related to TOC levels and decreased clarity.	This issue needs to be considered in the Feasibility study for potential impacts related to the alternatives.
14	Cyanobacteria in the Three Lakes could occur during algae blooms and present a human health concern.	Cyanobacteria is related to algal productivity, which is itself related to clarity.	Consider nutrient control strategies and alternatives.
15	Other issues as noted in Chapter 2 include: o Grand River Ditch o Fisheries o Zebra and Quagga Mussels o 10825 Water o Watershed Improvements (local BMP. Mtn Pine Beetle) o Climate change	The relevancy of each of these issues to this report is described in previous sections of Chapter 2. Watershed Improvements include a wide range of improvements or modifications that may provide improved water quality conditions. Some of these potentially could improve clarity in Grand Lake.	Address several specific watershed improvements. See Chapters 4-6. Other issues will require further evaluation.

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3 ALTERNATIVES FORMULATION

3.1 Preliminary Formulation

This report was initiated in July 2011. Reclamation and a study group comprised of representatives from Grand County and Northern Water along with an external peer review panel of water quality experts have been involved. Available data and ongoing studies are reviewed; and initial problems, needs, and preliminary alternatives are identified for this report. The remainder of the report presents and discusses this information.

3.1.1 Problems and Needs

The problems and needs identified in Chapter 2, many of which are identified for further evaluation, appear to indicate that mixing of water from Granby and Shadow Mountain Reservoirs with Grand Lake contributes to reduced clarity in Grand Lake. Dramatic or sudden changes in flow rates also affect clarity. Stop-pump tests provide insight into several opportunities for improving clarity, discussed in Chapter 2.

3.1.2 Constraints

There are a number of constraints that require consideration for the development of alternatives. Many of these are related to the physical operations of C-BT Project and are discussed in detail in Chapter 4, Technical Evaluation. In general constraints include:

1. Maintain overall yield of the C-BT Project including contracted and reasonably foreseeable contracted water transported using C-BT Project infrastructure.
2. The capacity to pump at Farr Pumping Plant, divert water at Adams Tunnel, and store water on both east and west slopes have limitations affecting formulation and evaluation of alternatives.
3. Current operations typically result in water levels that fluctuate approximately one foot at Grand Lake.
4. Scheduling of Adams Tunnel diversions and pumping from Farr Pumping Plant should, where possible, be considered in conjunction with power generation requirements (minimum flows, timing of power demands) and maximizing power generation to the extent possible.
5. Scheduled annual maintenance of east slope C-BT Project facilities typically requires a 6 to 8 week period of no diversions through the Adams Tunnel. Unscheduled maintenance typically results in an additional two weeks annually of limited Adams Tunnel diversions.
6. Avoid or minimize degradation to water quality in other water bodies of the C-BT Project.
7. Avoid or minimize impacts to boating and recreation.
8. Comply with current water quality criteria and consider impacts of potential proposed water quality criteria.
9. Comply with Government Performance and Results Act criteria, which regulates powerplant generating unit availability. Currently the requirement is 85% of Reclamation powerplant

peak is available from 7:00 am to 7:00 pm, Monday through Friday, June 1 through August 31.

3.2 Alternatives Identification

During the alternatives development workshop and subsequent stakeholder group review meetings, a number of ideas were suggested. These are presented below as an array of possible solutions, some of which are combined to form alternatives for further analysis in this report. Some of these possible solutions are not considered further in this report, due to limitations on currently available information, but could be included in future detailed studies. Also, there are likely other solutions that exist that would need to be identified and considered further in the future.

The array of possible solutions is assembled into three primary categories. The first category is solutions that propose **operational** modifications to pumping at Farr Pumping Plant and diversion at Adams Tunnel. These consider either no pumping during the three regulated summer months (July, August and September), or operations which generate a steady constant flow to minimize sudden changes in loading and/or minimize the amount of time water is held in Shadow Mountain Reservoir. The second category is physical or structural solutions that **bypass** Grand Lake and/or Shadow Mountain Reservoir with a pipeline to convey flows directly into the Adams tunnel thereby eliminating the mixing of water from Granby Reservoir and Shadow Mountain Reservoir with Grand Lake. The remaining potential solutions fall into a **miscellaneous** category and cover a broad range of approaches. An array of possible solutions as categorized in the three primary categories is summarized in Table 3.1.

Table 3.1 Array of possible solutions considered in this effort.

Array of Possible Solutions
Operational
• Stop pumping at Farr Pumping Plant and no diversions through Adams Tunnel in July, August and September. • Modify pumping at Farr Pumping Plant and diversions at Adams Tunnel to operate continuously at low and steady rates. • Operate Farr Pumping Plant and divert at Adams Tunnel continuously at high and steady rates after spring runoff.
Bypass
• Bypass Grand Lake with a buried pipeline and pump flows directly to Adams Tunnel. • Bypass Grand Lake with a submerged pipeline and pump flows directly to Adams Tunnel. • Bypass Grand Lake with a removable (seasonal) boating course and submerged funnel shaped curtain deflectors to reduce mixing in the top four feet of Grand Lake. • Bypass Grand Lake with a tunnel from Shadow Mountain Reservoir to Adams Tunnel. • Bypass Grand Lake and Shadow Mountain Reservoir with a buried pipeline and pump flows directly to Adams Tunnel.

Array of Possible Solutions
• Bypass Grand Lake and Shadow Mountain Reservoir with a tunnel directly to Adams Tunnel. • Bypass Grand Lake with a floating pipe and pump flows directly to Adams Tunnel.
Miscellaneous
• Modify Shadow Mountain Reservoir by removing the dam, or deepen and narrow Shadow Mountain Reservoir to improve its water quality. • Oxygenate Shadow Mountain Reservoir to improve DO. • Change position/elevation of intakes at Farr Pumping Plant intake, relative to lake layers and seasonal stratification to improve quality of water pumped and transferred to Shadow Mountain Reservoir. • Implement watershed improvements (such as sediment controls and BMPs) to reduce watershed influences on nutrients and other particulate matter loading. • Allow for partial diversion of Grand Lake water to mix with and dilute diverted water with cleaner water from Grand Lake.

3.2.1 Solutions Deferred for Future Consideration and Not Evaluated Further in this Report

Through stakeholder input and input from the external peer review panel, some of these proposed solutions were not evaluated further in this report in order to focus effort on alternatives that appeared to have the highest likelihood of meeting the goal of this report (Table 3.1). However, this does not preclude analysis of these as alternatives in the future. The deferred solutions include the following:

- *Operate Farr Pumping Plant and divert at Adams Tunnel continuously at high and steady rates after spring runoff*. The goal of this solution is to provide a flush through Shadow Mountain Reservoir and Grand Lake thereby cleaning the system of clarity reducing constituents. However, the general consensus from the stakeholders and expert panel was that this solution may not be effective in improving clarity, and could possibly worsen water quality in all three water bodies.
- *B-pass Grand Lake with a floating pipeline and pump flows directly to Adams Tunnel*. This solution may have unresolvable conflicts with the recreational activities and would likely be difficult to construct and maintain.
  Bypass Grand Lake with a removable (seasonal) boating course and submerged funnel shaped curtain deflectors to reduce mixing in the top four feet of Grand Lake. This solution may have unresolvable conflicts with the recreational activities, would reduce but not eliminate the mixing of Granby and Shadow Mountain Reservoir with Grand Lake Water, and would likely be difficult to construct and maintain.
- *Bypass Grand Lake with a submerged pipeline and pump flows directly to Adams Tunnel.* Conceptually the logistics for a submerged pipeline through the center of Grand Lake appears to be possible; however, based on discussions with pipe manufacturers, there would be several challenges. First, the external pressure on the pipeline at 240 to 250 foot depths requires the pipeline be full at all times to prevent collapse, and would be problematic for maintenance. Secondly manufacturers recommend a maximum pipe deflection of 10%. The

lakes natural shoreline slopes exceed this limit. And last, anchors are required to limit the lateral movement of the pipeline which would be difficult to install in this deep lake.

- *Oxygenate Shadow Mountain Reservoir to improve DO*. This solution has merit in terms of improving water quality in Shadow Mountain Reservoir. However, the direct correlation with Grand Lake is not clear and should be assessed further at a later time.
- *Change position/elevation of intake at Farr Pumping Plant intake, relative to lake layers and seasonal stratification, to improve quality of water pumped and transferred to Shadow Mountain Reservoir*. This solution may have merit in terms of improving water quality in Shadow Mountain Reservoir, and hence clarity in Grand Lake. However, at this time, there is insufficient existing data and information to further assess this solution.

3.2.2 Further Options

Three of the miscellaneous solutions that warrant further consideration in this report are identified as options and are listed below. These options, however, would need further consideration to assess if they could fully address clarity issues on their own. These options, in combination with an alternative, may enhance the alternative or further improve water quality in the Three Lakes system. Further discussion and recommendations are provided in the Technical Evaluation in Chapter 5. The options include the following:

- Option A: Modify Shadow Mountain Reservoir by removing the dam or deepening and narrowing Shadow Mountain Reservoir to improve its water quality.
- Option B: Implement watershed improvements (such as sediment controls and BMPs) to reduce watershed influences on nutrient, sediment, and other particulate matter loading. This could include consideration of additional water treatment and upgrades to existing treatment.
- Option C: Under conditions where clarity standards are being met, allow for partial diversion of Grand Lake water to mix with and dilute diverted water with cleaner water from Grand Lake. This may require modifications to the Adams Tunnel inlet if Option C is combined with Alternatives III or IV.

3.2.3 Identification of Alternatives

The remaining solutions comprise the alternatives retained for further assessment in Chapters 4, 5, and 6, due to appearing to have the highest likelihood of meeting the goal of this report. Some refinement and combining of the various solutions are made to stream line the technical evaluation as noted below.

Many of these potential solutions could be developed as alternatives in various combinations with or without use of the options and if viable, advanced to future detailed studies. Some alternatives and options with further analysis might warrant elimination. However, the goal of this report is to determine whether further development of alternatives is possible. Therefore, the following four alternatives were formulated for further analyses is this report:

- **Alternative I:** Stop pumping at Farr Pumping Plant and stop diversions through the Adams Tunnel in July, August and September.
- **Alternative II:** Modify pumping at Farr Pumping Plant to allow continuous diversion through the Adams Tunnel at low and steady rates.

- **Alternative III:** Bypass Grand Lake with a pipeline and pump flows directly from Shadow Mountain Reservoir to Adams Tunnel. Evaluate buried pipeline and tunnel configurations.
- **Alternative IV:** Bypass Grand Lake and Shadow Mountain Reservoir with a pipeline and pump flows directly to Adams Tunnel. Evaluate buried pipeline and tunnel configurations.

Prior to implementing further detailed studies, additional alternatives and options could be identified and included for further analysis if so indicated by future studies, changes in conditions, additional information, and public and stakeholder input.

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4 ALTERNATIVES: TECHNICAL EVALUATION

The purpose of this Chapter is to describe the alternatives and options, and to present a conceptual technical evaluation of each. C-BT operations and associated power generation program summaries are provided for introduction and then each alternative is investigated in detail under the following criteria. Evaluation of other topics are beyond the scope of this report, but are identified in the Next Steps section with each evaluation. Evaluation of each alternative is generally presented for the following:

1. Operations assessment to evaluate water deliveries to the east slope,
2. Construction and logistical issues for implementation,
3. Real estate considerations,
4. Power impacts at pumping plants
5. Potential impacts to power generation,
6. Cost discussion, and
7. Data gaps.

4.1 Operations Overview

The C-BT system consists of 10 reservoirs, 18 dams and dikes, a thirteen mile tunnel (Adams Tunnel), and 6 power plants, all components of a very complex system with complex operations that are further challenged by changing hydrologic conditions and limited capacities of many of the system components. Some of the more important aspects of C-BT Project operations are described below.

1. On a daily basis Reclamation schedules the amount and timing of water that will be diverted through the Adams Tunnel. Factors considered in scheduling Adams Tunnel diversions include available east slope water, east slope water demands, storage conditions in C-BT Project reservoirs, power demands, maintenance issues, and flooding concerns. The water diversion order is provided to Northern Water, which in turn, schedules how much and when to pump at the Farr Pumping Plant.
2. Under current operations, when the required Adams Tunnel diversions exceed the natural inflow to Grand Lake, water must be pumped from Granby Reservoir. Water is drawn through the Granby Reservoir intake structure and pumped through the Farr Pumping Plant up to the Granby Pump Canal. The pumping rates and timing employed are a function of Granby Reservoir elevation (affecting the pumping head), and the capacity of the Granby Pump Canal (a maximum of 1,100 cubic feet per second (cfs)). To minimize pumping costs, the Farr Pumping Plant typically operates at night, during the non-peak power periods. The Farr Pumping Plant has the option to run one, two or three pumps simultaneously to meet diversion demands and reservoir and lake level requirements within the desired time frame. Note that when Adams Tunnel diversions are less than the natural inflow to Grand Lake then no pumping at Farr Pumping Plant is required. In this case it is possible to divert through Adams Tunnel and have sufficient flows to move down-gradient from north to south. Data provided by Reclamation for 1991 to 2011 indicates that down-gradient flows typically occur most years during spring runoff lasting several weeks to several months.

3. From Farr Pumping Plant, water is pumped approximately 125 vertical feet to the Granby Pump Canal, where it flows north for 1.8 miles until it reaches Shadow Mountain Reservoir. Water is conveyed through Shadow Mountain Reservoir an additional three miles into Grand Lake and diverted into Adams Tunnel. Shadow Mountain Reservoir stores and attenuates flows being diverted through the Granby Pump Canal. For example 1,100 cfs delivered for 12 hours via the Granby Pump Canal, is stored and attenuated in Shadow Mountain Reservoir resulting in a 550 cfs delivery over 24 hours through the Adams Tunnel.
4. Adams Tunnel is a 9' 9"diameter, 13-mile long tunnel with a capacity of 550 cfs conveying water under the continental divide to the east slope. Water is discharged from the tunnel and directed through a series of power plants, tunnels, canals, and reservoirs to various east slope delivery points.
5. Scheduled maintenance for the east slope facilities typically requires 6 to 8 weeks and is usually performed in mid-October to mid-December, whereby reduced flows, or in some cases no flows, are diverted through Adams Tunnel.
6. Requirements for power generation affecting flows through the Adams Tunnel vary depending on natural flows available on the east slope. However, one of the more relevant and restrictive power generation requirements is at Mary's Lake Powerplant. Here, the plant is fed by the East Portal Reservoir which essentially has no attenuating storage capabilities. Thus, Mary's Lake powerplant operates directly from the flow rates discharged through the Adams Tunnel. To generate power, flows must be at or above 250 cfs and the powerplant should not be subject to frequent on and off cycling.
7. During the spring months, when runoff is available on the east slope, it is preferable to reduce Adams Tunnel diversions to allow diversion of native east slope water under the C-BT Project's water rights when in priority, or to utilize the east slope water for power generation when the water rights are not in priority.

In order to evaluate the ability of the Project to meet east slope delivery requirements under the non-structural alternatives, a simple monthly spreadsheet model using a 47-year analysis period (Water Years 1950-1996) was developed. The model is intended to provide an initial evaluation of whether the existing C-BT Project infrastructure along with the additional facilities proposed in the preferred alternative, Alternative 2: Chimney Hollow with pre-positioning of the Windy Gap Firming Project EIS, are sufficient to maintain the yield of the C-BT Project and contracts that use C-BT Project infrastructure to divert water from the west slope to the east slope (Reclamation 2011c). The major components and assumptions are described below (and more fully described with calculations in the Appendix):

1. The model uses the same 47-year analysis period (Water Years 1950-1996) as that used in the Windy Gap Firming Project (WGFP) Environmental Impact Statement (EIS).
2. The model uses the same C-BT Project demands as those used in the WGFP EIS model. Under that model's assumptions, the average annual C-BT Project demand is 234,556 af/year and ranges from 159,000 to 306,000 af/year.
3. The model uses the same Windy Gap Project deliveries as those used in the WGFP EIS model for the Preferred Alternative with cumulative effects. Under those conditions, the

average annual east slope Windy Gap Project deliveries is 25,664 af/year and ranges from 24,000 to 28,000 af/year.

4. On the west slope, the Three-Lakes system is conceptualized as one large reservoir that is not supply limited. This assumption implies:
   a. The Three-Lakes system has sufficient storage capacity and/or inflow to meet all desired Adams Tunnel diversion requirements.
   b. The Farr Pumping Plant can be operated in a manner consistent with those diversion requirements.
   c. The combination of Adams Tunnel diversions and Granby Reservoir capacity is sufficient to keep from spilling inflow to the Three-Lakes system that would result in a loss of C-BT Project yield or that of contracts that use the C-BT Project infrastructure.
5. To insure maximum utilization of the east slope C-BT Project water rights, diversion of Big Thompson River water to storage is considered as the first supply for meeting east slope reservoir storage needs.
6. In order to insure sufficient water supplies are available on the East Slope, diversions of west slope water through the Adams Tunnel are always maximized to the extent possible.
7. Diversion of Big Thompson River water for power generation is given lowest priority for available Olympus Tunnel capacity. However, the diversion is maximized by utilizing all remaining tunnel capacity after consideration of diversion of Big Thompson River water to C-BT Project storage and Adams Tunnel diversions.
8. Horsetooth Reservoir, Carter Lake, and the proposed Windy Gap Firming Project east slope storage facilities are conceptualized as one large storage reservoir with an active capacity of 326,000 af (Horsetooth Reservoir 136,000 af; Carter Lake 100,000 af; Chimney Hollow 90,000 af).
9. East slope reservoir evaporation is computed from average monthly evaporation rates used in the Bureau of Reclamation's monthly operations planning model.
10. Seepage from the east slope C-BT Project system is estimated to be 200 af/month.
11. East slope demands, both C-BT Project and Windy Gap, are all considered to be delivered from the conceptualized large east slope reservoir.

Note that given the complexity of the C-BT Project operations, a detailed technical evaluation will be required to fully understand and determine impacts of a given alternative on the C-BT Project operations for delivery of water and power generation. This is a task that should be implemented in a future more detailed modeling study and should include consideration of future impacts related to climate change.

4.2 Power Overview

The C-BT Project makes use of the water for power generation. The following excerpt is from Reclamation's web site which describes the power plant profile located on the east slope. Figure 2.4 is a graphic representation of the same.

> *Emerging from Alva B. Adams Tunnel into the East Portal Reservoir, the water flows across Aspen Creek Valley in a siphon and then under Rams Horn Mountain through a tunnel. At this point, it enters a steel penstock and falls 205 feet to Marys Lake Powerplant. This powerplant is located on the west shore of Marys Lake, which provides afterbay and forebay capacity for reregulating the flow. Between Marys Lake and Estes Powerplant, on the shore of Lake Estes, the water is conveyed by Prospect Mountain Conduit and Prospect Mountain Tunnel.*
>
> *Lake Estes, below Estes Powerplant, is formed by Olympus Dam constructed across the Big Thompson River. The afterbay storage in Lake Estes and the forebay storage in Marys Lake enable the Estes Powerplant to meet daily variations in energy demand.*
>
> *Water from Lake Estes and some Big Thompson River floodwaters are conveyed by Olympus Siphon and Tunnel and Pole Hill Tunnel and Canal to a penstock through which the water drops 815 feet to Pole Hill Powerplant. It is then routed through Pole Hill Powerplant afterbay, Rattlesnake Tunnel, Pinewood Lake, and Bald Mountain Pressure Tunnel, and dropped 1,055 feet through two penstocks to Flatiron Powerplant. This powerplant discharges into Flatiron Reservoir, which regulates the water for release to the foothills storage and distribution system. The afterbay storage in Flatiron Reservoir and the forebay storage in Pinewood Lake enable Flatiron Powerplant to meet daily power loads.*
>
> *Southward, the Flatiron reversible pump lifts water from Flatiron Reservoir, a maximum of 297 feet and delivers it through Carter Lake Pressure Conduit and Tunnel to Carter Lake. When the flow is reversed, the unit acts as a turbine-generator and produces electric energy.*

Gross power generation averages 760 million kilowatt-hours of which 70 million kilowatt-hours are used by C-BT Project pumps and 690 million kilowatt-hours are marketed to customers in northern Colorado, eastern Wyoming, and western Nebraska (Reclamation 2011a). For the purposes of this report, a quantitative estimate of the monthly impacts of the alternatives on power generation is provided and incorporates the basic assumption that all Alternatives will divert the same volume of water. However, a more detailed evaluation of power generation impacts would be required to adequately address daily power generation and timing of prospective alternatives.

4.3 Alternative I: Stop Pumping

4.3.1 Alternative description

The goal of this alternative is to eliminate flow from Shadow Mountain Reservoir to Grand Lake during July, August and September, minimizing the transport of low quality water into Grand Lake. This alternative ceases pumping from Farr Pumping Plant and ceases diversions through the Adams Tunnel every year during the months of July, August and September. Surface water elevations in Grand Lake and Shadow Mountain Reservoir would need to be managed in accordance with SD 80.

4.3.2 Operations

Operations are evaluated for the 'Stop Pump' Alternative using the simple operational model described in Section 4.1. The goal of the analysis is to determine whether sufficient system capacity exists to implement this alternative. The parameters used in the model for this alternative are described below and the calculations are presented in the Appendix.

1. No pumping at Farr Pumping Plant and no Adams Tunnel diversions from July through September.
2. With the exception of no diversion periods described in parameter #4 below, Adams Tunnel diversions are maintained at the maximum rate from October through June and only limited by the maximum east slope aggregate storage.
3. The 6 to 8 week scheduled maintenance period for east slope facilities is moved from its traditional fall time frame to the July through September period to coincide with the no Adams Tunnel diversion time period. This requires a modification to Reclamation's current powerplant unit availability performance criteria.
4. Unscheduled maintenance will impact diversions through the Adams Tunnel, and is modeled as 1.5 days per month.

The analysis of the 'Stop Pump' alternative indicates that, under the assumed conditions noted above, there is sufficient system capacity to implement this alternative and preserve the yield of the C-BT Project including contracted and reasonably foreseeable contracted water transported using C-BT Project infrastructure. The analysis indicates that east slope reservoir storage would be severely strained in a series of high demand years similar to water years 1974-1977, leaving only 17,000 af of active storage before storage levels could be recovered. However, with the exception of the 1974-1977 period, active storage was consistently maintained above 70,000 af. These storage levels are based upon the assumption that no Adams Tunnel diversions were allowed between July and September. However, if some Adams Tunnel diversions were allowed during this time, as suggested by combining this alternative with Option C (see chapter 4.7.3), storage levels might not be as severely strained, It should be noted that under this alternative east slope reservoir storage is maintained higher in early spring than under future conditions without water clarity considerations. As a result, there is less diversion of Big Thompson River water to storage in some wetter years. A more detailed analysis of the assumed conditions for both east and west slope operations should be conducted to confirm the alternatives' ability to meet C-BT Project yield including existing contract and reasonably foreseeable contracted water transported using C-BT Project infrastructure.

4.3.3 Construction and Logistical Issues

The 'Stop Pump' alternative is not expected to require new facilities on the west slope. The operations analysis also indicates that no additional east slope facilities over and above the proposed Chimney Hollow Reservoir would be required. However, it should be noted that east slope operations are very complex and this complexity may impede the ability to optimize the east slope storage as assumed in the operations analysis. As a result, this alternative may require some additional east slope storage to keep from adversely affecting yield through a sequence of

years similar to the 1974-1977 period mentioned above. However, the detailed analysis of east slope operations necessary to evaluate this risk is beyond the scope of this report.

Shadow Mountain Reservoir and Grand Lake may need grade control structures to maintain water levels during the three no-pumping months if the natural hydrology is insufficient to maintain water levels.

4.3.4 Pumping Requirements at Farr Pumping Plant

Under this alternative pumping requirements at Farr Pumping Plant are impacted through an increase in total volume of water that must be pumped and by an increase in on-peak pumping. This represents a loss in power revenue. Due to no Adams Tunnel diversions occurring between July and September, the natural inflow to Grand Lake and Shadow Mountain Reservoir is bypassed to Granby Reservoir and must be pumped at a later date. Further, to the extent possible, the pumping at Farr Pumping Plant is timed to occur during times of off-peak power demands. However, under this alternative Farr Pumping Plant would have to operate more frequently during the peak power demand times between 7am and 11pm to compensate for the lack of Adams Tunnel diversions between July and September and to accommodate the additional volume of water that was bypassed to Granby during that period.

This alternative also requires additional pumping at the Flatiron Pumping Plant which pumps water from Flatiron Reservoir to Carter Lake on the east slope. Demands along the Big Thompson River are normally met by direct diversion from the west slope through the Adams Tunnel. However, with little or no Adams Tunnel diversions between July and September, the demands must be met from Carter Lake during this period. An equivalent volume of water must then be pumped back up to Carter Lake at a later date. This represents a loss in power revenue because the cost to pump into Carter Lake is greater than revenue from Flatiron Unit #3 generation for the same volume of water.

4.3.5 Potential Impacts to Power Generation

The results of the operation analysis are used to analyze the potential impact of this alternative to power generation and are summarized in Table 4.1. Under this alternative there will be a shift in power generation away from the high power demand months of July, August, and September to the remainder of the year. Based upon monthly and on-peak/off-peak prices for power this shift in the timing of power generation could result in a loss of power revenue.

4.3.6 Costs

In this report costs are discussed qualitatively. Significant effort will be required to make reliable estimates later in project evaluation and development. Because no new facilities or structures, other than those planned for the Windy Gap Firming Project, are necessary to implement this alternative, the primary cost is expected to be loss of power revenue and additional pumping costs. Due to the simplified analysis methodology employed in the operations analysis, this alternative's additional pumping costs could not be estimated. However it is expected to be much less than the loss of power revenue.

Table 4.1. Estimated monthly distribution of total East Slope power generation, Alternative I.

Month	Alternative I: Stop Pump - No Adams Tunnel Diversions Jul 1 – Sep 30 (GWH)	Without modifications for clarity considerations (GWH)
Oct	71.89	38.83
Nov	69.29	34.44
Dec	71.51	60.80
Jan	71.51	60.58
Feb	63.97	63.73
Mar	66.47	47.59
Apr	60.20	38.62
May	65.35	69.92
Jun	63.11	68.46
Jul	20.63	55.89
Aug	0.85	42.76
Sep	0.61	43.65
Total	625.38	625.27

4.3.7 Data Gaps

Additional data gaps and studies that might be required should this alternative be selected for additional consideration include:

1. Detailed daily analysis of both east slope and west slope operations to better assess impacts to water deliveries, pumping requirements, power generation (including black start and spinning reserve requirements), and the potential need for additional east slope storage,
2. A detailed routing and operations assessment including contributions from other tributaries including the North Fork of the Colorado River,
3. A water quality assessment and/or water quality modeling of the alternative and the impacts to the Three Lakes as outlined in Chapter 2, and
4. Consideration of water quality impacts to east slope reservoirs.

4.4 Alternative II: Modify Pumping

4.4.1 Alternative Description

The goal of this alternative is to produce steady low flows through Shadow Mountain Reservoir and Grand Lake during July, August and September, to minimize the transport of lower quality water into Grand Lake while also allowing for some diversion of water during this time period. This alternative also seeks to minimize the possible re-suspension of material in Shadow Mountain Reservoir This alternative targets a steady diversion of approximately 250 cfs through

Adams Tunnel in July through September. Surface water elevations in Grand Lake and Shadow Mountain Reservoir would need to be managed in accordance with SD 80.

4.4.2 Operations

1. Operations are evaluated for the 'Modify Pumping' Alternative using the simple operational model described in Section 4.1. The goal of the analysis is to determine whether sufficient capacity exists to implement this alternative. The parameters used in the model for this alternative is described below and the calculations are presented in the Appendix. To simplify the analysis of this alternative, the Adams Tunnel diversions are maintained at 250 cfs from July through September each and every year. Actual operations may deviate from this operation based upon hydrologic conditions and the desire to maintain low steady low flows through Shadow Mountain Reservoir.
2. With the exception of no diversion periods described in parameters #4 and #5 below, Adams Tunnel diversions are maintained at the maximum rate from October through May and only limited by the maximum east slope aggregate storage and diversion of east slope water to storage.
3. Adams Tunnel diversions are limited to 370 cfs in June to allow for larger diversions of Big Thompson River water for power generation. The analysis indicates that this diversion limitation could be tolerated while maintaining sufficient system capacity to meet demands. However, if actual hydrologic conditions warrant, this limitation could be removed to maintain necessary system capacity.
4. Six weeks of no Adams Tunnel diversions from November through mid-December are assumed to accommodate scheduled maintenance of east slope facilities.
5. Unscheduled maintenance will impact diversions through the Adams Tunnel, and is modeled as 1.5 days per month.

The analysis of the 'Modify Pumping' alternative indicates that, under the assumed conditions noted above, there is sufficient system capacity to implement this alternative and preserve the yield of the C-BT Project including contracted and reasonably foreseeable contracted water transported using C-BT Project infrastructure. The analysis indicates that east slope reservoir storage would be reduced to approximately 17,000 af of active capacity in a series of high demand years similar to water years 1974-1977, before storage levels could be recovered. However, with the exception of the 1974-1977 period, active storage was consistently maintained above 70,000 af. This level of available active east slope reservoir storage combined with the ability to increase the Adams Tunnel diversions in June if necessary should provide sufficient operational flexibility to negate the need for any additional east slope reservoir storage. However, a more detailed analysis of the assumed conditions should be performed to verify this conclusion.

4.4.3 Construction and Logistical Issues

This 'Modify Pump' alternative is not expected to require new facilities on the east or west slopes. It should be noted that east slope operations are very complex and this complexity may impede the ability to optimize the east slope storage. As a result, this alternative may require some additional east slope storage to keep from adversely affecting yield through a sequence of

years similar to the 1974-1977 period mentioned above. However, the detailed analysis of east slope operations necessary to evaluate this risk is beyond the scope of this report.

4.4.4 Pumping Requirements

Under this alternative pumping requirements at Farr Pumping Plant are impacted through an increase in total volume of water that must be pumped and by an increase in on-peak pumping. This represents a loss in power revenue. Because some water is diverted through the Adams Tunnel during the July through September period, the impacts to Farr Pumping Plant pumping requirements are less than that of the 'Stop Pump' alternative. Due to reduced Adams Tunnel diversions occurring between July and September a portion of the natural inflow to Grand Lake and Shadow Mountain Reservoir is bypassed to Granby Reservoir during this period and must be pumped at a later date. Further, to the extent possible, the pumping at Farr Pumping Plant is timed to occur during times of off-peak power demands. Under this alternative Farr Pumping Plant would operate within its current operational rules, but would have to operate more frequently during the peak power demand times between 7am and 11pm to compensate for the reduced Adams Tunnel diversions between July and September and to accommodate the additional volume of water that was bypassed to Granby during that period.

This alternative also requires some additional pumping at the Flatiron Pumping Plant which pumps water from Flatiron Reservoir to Carter Lake on the east slope. Demands along the Big Thompson River are normally met by direct diversion from the west slope through the Adams Tunnel. However, with reduced Adams Tunnel diversions between July and September, Big Thompson River demands in excess of 250 cfs must be met from Carter Lake during this period. An equivalent volume of water must then be pumped back up to Carter Lake at a later date. This represents a loss in power revenue because the cost to pump into Carter Lake is greater than the revenue from Flatiron Unit #3 generation for the same volume of water.

4.4.5 Potential Impacts to Power Generation

The results of the operation analysis are used to analyze the potential impact of this alternative to power generation and are summarized in Table 4.2. While total power generation increases under this alternative, there is a shift in power generation away from the high power demand months of July, August, and September to the remainder of the year. Based upon monthly and on-peak/off-peak prices for power generation, the combined effect of the increased generation and shift in the timing of power could result in some loss of power revenue.

4.4.5.1 Costs

In this report costs are discussed qualitatively. Significant effort will be required to make reliable estimates later in project evaluation and development. Because no new facilities or structures, other than those planned for the Windy Gap Firming Project, are necessary to implement this alternative, the primary cost is expected to be loss of power revenue and additional pumping costs.

Table 4.2. Estimated monthly distribution of total East Slope power generation, Alternative II.

Month	Alternative II: Modify Pumping 250 cfs Adams Tunnel Diversions Jul 1 – Sep 30 (GWH)	Without modifications for clarity considerations (GWH)
Oct	71.89	38.83
Nov	0.00	34.44
Dec	38.77	60.80
Jan	71.51	60.58
Feb	64.74	63.73
Mar	70.04	47.59
Apr	66.49	38.62
May	69.17	69.92
Jun	59.40	68.46
Jul	49.25	55.89
Aug	39.76	42.76
Sep	35.81	43.65
Total	636.83	625.27

4.4.6 Data Gaps

Additional data gaps and studies that might be required should this alternative be selected for additional consideration include:

1. Detailed daily analysis of both east slope and west slope operations to better assess impacts to water deliveries, pumping requirements, power generation (including black start and spinning reserve requirements),
2. A detailed routing and operations assessment including contributions from other tributaries including the North Fork of the Colorado River,
3. A water quality assessment and/or water quality modeling of the alternative and the impacts to the Three Lakes as outlined in Chapter 2, and
4. Consideration of water quality impacts to east slope reservoirs.

4.5 Alternative III: Bypass Grand Lake

4.5.1 Alternative Description

The goal of this alternative is to eliminate the mixing of Granby Reservoir and Shadow Mountain Reservoir water with water in Grand Lake. Water would be pumped around or through Grand Lake and piped directly into the Adams Tunnel. This scenario restores the natural

down-gradient flow from the North and East Inlet to Grand Lake into Shadow Mountain Reservoir and further down gradient to Granby Reservoir.

Deliveries for this alternative would be pumped from Farr Pumping Plant into Shadow Mountain Reservoir via the existing Granby Pump Canal, and then pumped via a new pump station at the north end of Shadow Mountain Reservoir through a new pipeline connected directly to the Adams Tunnel.

This scenario utilizes the available regulating storage capacity in Shadow Mountain Reservoir to 1) continue to operate Farr Pumping Plant per current conditions (particularly during off-peak power times) and 2) provide operational flexibility at the new pump station to divert water during peak power times. This alternative could potentially create a slight increase in the fluctuation of water levels in Shadow Mountain Reservoir. In order to maintain water levels, an outlet control structure would be required, or a cutoff wall between Grand Lake and Shadow Mountain Reservoir and possibly, a boat lock.

Four variations are evaluated for this alternative to assess an array of possible pipeline alignments to convey the flow of water to the Adams Tunnel. The potential pipeline alignments include: (1) piping through the existing Town streets of Grand Lake, (2) an alignment along either the north or south shore of Grand Lake, (3) a roadway alignment along the roads and private property on the south side of Grand Lake, and finally, (4) a tunnel on the south side of Grand Lake on Arapahoe National Recreation Area and private properties. Several of the pipeline alignments involve varying elevation differences along the pipeline alignment. Increased elevation differences result in higher friction losses which require higher horsepower at the new pump station. To minimize horsepower requirements for the new pump station a number of the alternative variations include two-8’ diameters pipelines. The remaining variations were evaluated using a single 10’ diameter pipeline. This array of alternative variations is depicted on Exhibit 1.

4.5.2 Operations

In this alternative the Shadow Mountain Pump Station would run at rates requested by Reclamation in its’ diversion orders. Farr Pumping Plant would operate as necessary to meet the diversion order, minimize on-peak pumping, and maintain desired reservoir elevations in Shadow Mountain Reservoir. Shadow Mountain Reservoir would provide some regulating capacity because in most instances it would be necessary to run the new Shadow Mountain Reservoir pump station at a lower rate than Farr Pumping Plant and for a longer time period. For example, if Farr Pumping Plant ran for 12 hours at 1100 cfs, then the Shadow Mountain Reservoir pump station could pump for 24 hours at 550 cfs. Operations scenarios are not modeled for this alternative since there are no restrictions on when and how much flow can be moved through the pumping stations and tunnel, except as restricted by the capacity of the infrastructure. Under these assumed conditions it is envisioned that the diversion requirements of the C-BT Project and contracts that use C-BT Project infrastructure to divert water from the west slope to the east slope are feasible by matching pumping rates of the new pumping station with the diversion requirements needed through Adams Tunnel. A minor loss of storage would occur by eliminating flows currently regulated by storage at Grand Lake.

This alternative will use the Farr Pumping Plant in a manner similar to present operations, with water being pumped up to 1,100 cfs during the off-peak hours. Shadow Mountain Reservoir will

continue to provide attenuation, however, there may be slightly more variability in lake level fluctuation estimated at less than 6 inches to help compensate for the loss of Grand Lake regulating capacity. This might affect boat docks and boat houses along the shores of Shadow Mountain Reservoir and could potentially require an outlet control structure or cutoff wall to ensure separation of water with Grand Lake is maintained. This alternative will require additional evaluation such as a hydraulic routing analysis through Shadow Mountain Reservoir.

4.5.3 Construction and Logistical Issues

The infrastructure for all of the above variations includes a pumping station along the northeastern part of Shadow Mountain Reservoir, an inlet located in the deeper portion of the Shadow Mountain Reservoir, and a pipeline that would connect the pump station to the Adams Tunnel. Two power sources would be required.

The land based alignments have higher elevation head requirements compared to the shoreline alignments which increase the horsepower requirements for the proposed pump station. Thus the inclusion of two-8 foot diameter pipelines and one-10 foot diameter pipeline for the different alignments.

Each of the variations will require further review should any of the variations be advanced for further assessment in more detailed future studies. Constraints could include:

1. Easement acquisition for the pipeline and pump station,
2. Utility conflicts and temporary disruption of roadways and utilities in town streets,
3. Approvals to temporarily lower Grand Lake for installation of the shoreline alignments,
4. Temporary disruption during construction due to drawdown of Grand Lake operations, boat docks and recreation for the shoreline alignments,
5. Rock and excavation concerns for the road and shore line alignments, and
6. Temporary drawdown of Grand Lake and Shadow Mountain Reservoir during construction, and
7. Temporary diversion of flows to Adams Tunnel during construction.

4.5.4 Real Estate Requirements

The Shadow Mountain Reservoir pump station would be located along the north or northeastern edge of Shadow Mountain Reservoir. The exact location would be selected as part of future studies; however, it is likely that the pump station would be located within the Arapahoe National Recreation Area property. Electrical and other utility easements will be required as well as rights-of-way and other easements. Pipeline installation will also be required along the canal between Shadow Mountain Reservoir and Grand Lake. Assessor’s records indicate property along the canal is controlled by a local homeowners association which should be verified with future studies. Land acquisition may be required for short sections of pipeline and, should alignment variation 1 be selected (alignments in Town streets), easements will be required for installation within the road rights-of-ways. Actual ownership and conditions of use may require further investigation.

Easements south of Grand Lake would be required for the tunnel alignment and is generally on Arapahoe National Recreation Area property. Arapahoe National Recreation Area property is administered by the U.S. Forest Service with the contingency that C-BT Project related management be conducted by Reclamation. Specifically, as set out in Memorandum of Understanding (MOU) 0-07-70-L1126, operations areas are defined. Coordination with the U.S. Forest Service would be necessary to amend the MOU for additional features.

Easements for the Grand Lake shoreline pipeline alignment would be required; however ownership below normal water level of Grand Lake is not well defined. Additional property ownership research is required, depending on which alternative and variation(s) are considered in future studies.

4.5.5 Pumping Requirements at Farr Pumping Plant

Because a quantitative analysis was not conducted due to the scope of this analysis, no associated costs were computed. However a qualitative description is provided. In this alternative the Farr Pumping Plant would operate as it historically has and therefore there would be no power impacts attributable to changes at Farr Pumping Plant or the proposed pumping plant. However, additional power will be needed to operate the proposed Shadow Mountain pumping plant. The additional power will be required to pump all west slope diversions through the pipeline to the Adams Tunnel that would otherwise have been routed through Grand Lake by gravity.

4.5.6 Potential Impacts to Power Generation

Power generation impacts are difficult to predict given the high variability in flows from year to year and the complexity of the system. From a qualitative standpoint, this alternative is likely to have a relatively minor impact to power generation given the ability to divert on demand, without restrictions to pumping.

4.5.7 Costs

In this report costs are discussed qualitatively. Significant effort will be required to make reliable estimates later in project evaluation and development. The cost of this alternative includes a new pump station located along the north and east shoreline of Shadow Mountain Reservoir, and a new pipeline from the pump station to Adams Tunnel. Costs also include a concrete cutoff wall and boat lock system at the Shadow-Grand Lake canal; design, construction and operational and maintenance costs for the new pumping station in Shadow Mountain Reservoir; and power costs for the new pump station. There are no additional power costs for Farr Pumping Plant as it is anticipated that all the pumping can occur as they would under future conditions without modifications for water clarity considerations.

4.5.8 Data Gaps

Additional data gaps and studies that might be required should this alternative be selected for additional consideration include:

1. Detailed evaluation of operations for both delivery of water and impacts to power generation,
2. Detailed evaluation of impacts to water surface elevations of both Grand Lake and Shadow Mountain, including routing of flows, and timing of operations at the new pump station,

3. A detailed routing and operations assessment including contributions from other tributaries including the North Fork of the Colorado River,
4. Water quality assessment and/or water quality modeling of the alternative and the impacts to the Three Lakes as outlined in Chapter 2, and
5. Consideration of water quality impacts to east slope reservoirs due to reduction of the mixing of high quality Grand Lake water with reduced quality Shadow Mountain Reservoir and Granby Reservoir water.

4.6 Alternative IV: Bypass Shadow Mountain Reservoir and Grand Lake

4.6.1 Alternative Description

This alternative eliminates the introduction of Granby and Shadow Mountain Reservoir water into Grand Lake, and restores the natural down-gradient flow from the North and East Inlet to Grand Lake into Shadow Mountain Reservoir and further down gradient to Granby Reservoir. This is accomplished by pumping Granby water from Farr Pumping Plant to the Granby Pump Canal and from a new pump station in the Granby Pump Canal piped directly to the Adams Tunnel.

Diversions for this alternative would be pumped from Farr Pumping Plant into the Granby Pump Canal and then pumped via a new pumping station located in the Granby Pump Canal near its confluence with Shadow Mountain Reservoir or along the south end of Shadow Mountain Reservoir through a new pipeline connected directly to the Adams Tunnel. Four variations were evaluated for this alternative to assess a spectrum of possible alignments to convey the flows to the Adams Tunnel. Due to the elevation head differences variations, two pipeline sizes are considered and include a single 10’ diameter or two-8’ diameters pipelines to minimize horsepower requirements for the new pump station.

This alternative could potentially change water levels in Grand Lake and Shadow Mountain Reservoir due to the reliance on natural hydrology. In order to maintain water levels, an outlet control structure would be required, or a cutoff wall between Grand Lake Shadow Mountain Reservoir and potentially a boat lock. Both water level control elements are included in the analysis.

Four variations to this alternative are reviewed for a variety of conditions that will affect the feasibility and constructability of the overall alternative. The four variations include: (1) a pipeline along the northwestern shore of Shadow Mountain Reservoir and Grand Lake, (2) a pipeline along the west shore line of Shadow Mountain Reservoir and east shoreline of Grand Lake, (3) a pipeline along the east shore lines of Shadow Mountain Reservoir and Grand Lake, and (4) a tunnel constructed directly to the Adams Tunnel.

The shoreline alignments assume the pipeline is installed approximately 20 feet from shoreline, submerged and buried with 3 to 5 feet of cover. Some of the different pipeline alignments involve varying elevation differences along the pipeline alignment. Large elevation differences have higher friction losses resulting in higher horsepower requirements at the new pump station. Thus to minimize horsepower requirements for the new pump station some of the variations include two-8 foot diameter pipes and others, one-10 foot diameter pipe. The alternative is depicted on Exhibit 2.

4.6.2 Operations

In this alternative the Granby Pump Station must run parallel with the Farr Pumping Plant matching each other in rate and length of time to pump due to the lack of regulating capacity in Granby Pump Canal. Operations scenarios are not conducted for this alternative since there are no restrictions on when flow can be moved through the pump stations and Adams Tunnel, except as restricted by the capacity of the infrastructure. Under these assumed conditions it is envisioned that the diversion requirements of the C-BT Project and contracts that use C-BT Project infrastructure to divert water from the west slope to the east slope are feasible by matching pumping rates of the new pump station with the diversion requirements needed through Adams Tunnel.

This alternative eliminates storage that is currently provided in Shadow Mountain Reservoir and Grand Lake. Approximately 4,700 acre-feet of regulating capacity will be lost with this alternative. This loss of regulating storage will change operations at Farr Pumping Plant such that pumping rates will be reduced to a maximum of 550 cfs, and requires pumps to operate continuously in order to maintain a continuous flow through Mary's Lake Powerplant.

This alternative could potentially result in slightly more variability in lake level fluctuation due to the natural hydrology. This may require an outlet control structure or cutoff wall to maintain water levels and to ensure separation of Shadow Mountain Reservoir water with Grand Lake. This will require further evaluation including a hydraulic routing analysis through Shadow Mountain Reservoir.

4.6.3 Construction and Logistical Issues

The infrastructure for all of the variations for this alternative includes a pump station in the Granby Pump Canal, a lake inlet located in the deeper portion of the Shadow Mountain Reservoir and a pipeline that would connect the pumping station to the Adams Tunnel. Two power sources would be required.

Some alignments may have higher elevation head requirements which increase the horsepower requirements for the proposed pump station. Thus the inclusion of two-8 foot diameter pipelines and a single 10' diameter pipeline.

Each of the variations have challenges and constraints and will need further review should this alternative be advance for further assessment. Constraints could include:

1. Easement acquisition for the pipeline and pump station,
2. Utility conflicts and temporary disruption of roadways and utilities in town streets,
3. Approvals to temporarily lower Shadow Mountain Reservoir and Grand Lake for installation of the shoreline alignments,
4. Temporary disruption during construction due to drawdown of Shadow Mountain Reservoir and Grand Lake operations, boat docks and recreation for the shoreline alignments,
5. Rock and excavation concerns for the road and shore line alignments,
6. Temporary drawdown of Grand Lake and Shadow Mountain Reservoir during construction, and

7. Temporary diversion of flows to Adams Tunnel during construction.

4.6.4 Real Estate Considerations

The Granby Pump Canal pumping station would likely be placed on property already owned or leased by Northern Water or within the Arapahoe National Recreation Area similarly to the Farr Pumping Plant. The exact location would be selected as part of future detailed studies and the environmental compliance process. Electrical and other utility easements will be required as well as rights-of-way and/or easements. The pipeline alignments along the Grand Lake shoreline could be similar as described in Alternative III. The pipeline alignments along Shadow Mountain Reservoir would also be placed approximately 20 feet away from the shoreline, buried below the lake bed with at least three to five feet of cover for frost protection. Shadow Mountain Reservoir is within Arapahoe National Recreation Area property.

Pipeline installation will also be required along the canal between Shadow Mountain Reservoir and Grand Lake. Assessor's records indicate the property along the canal is controlled by a local homeowners association which needs to be verified.

Easements south of Grand Lake would be required for the tunnel alignment variation and are generally on Rocky Mountain Nation Park and Arapahoe National Recreation Area property. Arapahoe National Recreational Area property is administered by the U.S. Forest Service with the contingency that C-BT Project related management is conducted by Reclamation. Specifically, as set out in Memorandum of Understanding (MOU) 0-07-70-L1126, operations areas are defined. Coordination with the U.S. Forest Service would be necessary to amend the MOU for additional features. Easement acquisition for the tunnel would also be required form the National Park Service.

Easements for the shoreline pipeline alignment would be required; however, ownership below normal water level of Grand Lake is not well defined. Further land ownership research is required, depending on which variation is being considered in future studies.

4.6.5 Pumping Requirements

Under this alternative pumping requirements at Farr Pumping Plant are impacted through an increase in total volume of water that must be pumped and by an increase in on-peak pumping. This represents a loss in power revenue. Under this alternative the natural inflow to Grand Lake and Shadow Mountain Reservoir is bypassed to Granby Reservoir and must be pumped back up to the new pumping station. Further, due to the lack of regulating capacity in Granby Pump Canal, Farr Pumping Plant would have to operate continuously in order to maintain a continuous flow through Mary's Lake Powerplant, requiring significantly more on-peak pumping than under future conditions without considerations for water clarity. Additional power will also be needed to operate the proposed Shadow Mountain pumping plant at the confluence with the Granby Pump Canal. The additional power will be required to pump all west slope diversions through the pipeline to the Adams Tunnel that would otherwise have been routed through Grand Lake by gravity.

4.6.6 Potential Impacts to Power Generation

Power generation impacts are difficult to predict given the high variability in flows from year to year and the complexity of the system. From a qualitative standpoint, this alternative is likely to have a relatively minor impact to power generation given the ability to divert on demand, without restrictions to pumping.

4.6.7 Costs

In this report costs are discussed qualitatively. Significant effort will be required to make reliable estimates later in project evaluation and development. The cost of this alternative includes a new pumping station located in the Granby Pump Canal, and new pipeline from the pumping station to Adams Tunnel. Costs include an outlet control structure or cutoff wall and boat lock system at the canal between Shadow Mountain Reservoir and Grand Lake; design, construction, and operational and maintenance costs for the new pumping station in the Granby Pump Canal; power costs for the new pumping station; and increased power costs anticipated for Farr Pumping Plant as a result of pumping a greater annual volume and during peak demand times..

4.6.8 Data Gaps

Additional data gaps and studies that might be required should this alternative be selected for additional consideration include:

1. Detailed evaluation of operations for both delivery of water and impacts to power generation and Farr Pumping Plant pumping requirements,
2. Detailed evaluation, of impacts to water surface elevations of both Grand Lake and Shadow Mountain, including routing of flows, and timing of operations at the new pump station,
3. A detailed routing and operations assessment including contributions from other tributaries including the North Fork of the Colorado River,
4. A water quality assessment and/or water quality modeling of the alternative and the impacts to the Three Lakes as outlined in Chapter 2, and
5. Consideration of water quality impacts to east slope reservoirs due to reduction of the mixing of high quality Grand Lake water with reduced quality Shadow Mountain Reservoir and Granby Reservoir water.

4.7 Options to Enhance Alternative

Several options presented below could possibly improve water clarity in concert with some of the alternatives. It does not appear that options alone are sufficiently robust in managing factors affecting clarity to warrant evaluation as stand-alone alternatives, but further consideration may be warranted to confirm that preliminary assessment. Additional combinations of alternatives and variations, options, and further modifications are possible with further detailed modeling and analysis and stakeholder and public input.

4.7.1 Option A: Modify Shadow Mountain Reservoir

Several variations of this option could be implemented. One is to reconfigure Shadow Mountain Reservoir into a deeper, narrower lake to reduce water quality degradation currently occurring in

this shallow reservoir. The first variation of reconfiguring the reservoir would likely be a sizeable undertaking. Earthwork requirements alone could make this unfeasible. Further it is likely to be met with a great deal of resistance from local citizens and property owners and State and Federal agencies due to impacts to recreation, property values, and fisheries.

A second variation of this option is to remove the dam and allow the river to return to its pre C-BT Project configuration. The second variation is slightly more feasible in terms of implementation, but also would likely encounter a great deal of resistance from local citizens and property owners as well as State and Federal agencies due to impacts to recreation, property values, and fisheries. This variation would also likely require Congressional approval, as Shadow Mountain Dam and Reservoir are features of the C-BT Project. Removal of Shadow Mountain Reservoir dam would also require the implementation of Alternative IV (Bypass Shadow Mountain and Grand Lake), since it would eliminate the ability to utilize Shadow Mountain Reservoir as a conveyance to either Grand Lake or a new Shadow Mountain pumping plant (for Alternative III).

Future detailed analyses could consider adding one or more options to formulated alternatives to further enhance the potential to meet the proposed clarity standard. For example, Alternative IV - Bypass Grand Lake and Shadow Mountain could be combined with Option A as noted above and adding the potential solution of using a selective intake at the Farr Pumping Plant pumping plant that selectively draws from various elevations within Granby Reservoir to improve water quality impacts caused by water drawn from Shadow Mountain Reservoir, eliminate the need to manage aquatic vegetation in Shadow Mountain Reservoir. Data and consideration gaps for Option A include:

1. Assess the effects of Option A (either variation) relative to impacts to water quality and whether water clarity issues would be improved in Grand Lake,
2. Impacts of lost regulating capacity on C-BT Project operations and effects on boat docks and boat houses along the shores of Shadow Mountain Reservoir,
3. An assessment of property and recreational impacts, and
4. Consideration of water quality impacts to east slope reservoirs.

4.7.2 Option B: Watershed Improvements

As outlined in Section 2.8.6 past and current implementation of best management practices (BMPs) in the Three Lakes watershed are occurring, including land use regulations for new development and stormwater runoff control; the replacement of septic systems with centralized treatment; watershed protection efforts in the Rocky Mountain National Park and Forest Service; and various studies and analyses to investigate the impacts of the C-BT Project on water quality and clarity. Best management practices and good land use planning are important to the health of a watershed and should continue to be pursued in concert with the recommendations of this report.

As discussed in Chapter 2, nutrient loading into Granby Reservoir and Shadow Mountain Reservoir is generally occurring from stormwater via direct runoff and tributary inflows to both Shadow Mountain Reservoir and Granby Reservoir, including two pumped sources: Windy Gap

and Willow Creek. Given the largely undeveloped nature of the watershed surrounding both reservoirs, it is likely that much of the nutrient loading is from natural sources and difficult to control or reduce. However, there are also watershed impacts related to the concentrated development and related anthropogenic sources directly adjacent to Shadow Mountain Reservoir, Granby Reservoir, and Grand Lake. Therefore, the role of watershed nutrient contributions and, further, the ability to control and improve the water quality related impacts warrant further investigation.

Several specific investigations are suggested:

1. Further evaluation of watershed management opportunities using the Three Lakes Nutrient Study,
2. Investigate Stillwater Creek's influence at the Farr Pumping Plant intake due to the depositing of nutrients near the intake,
3. Assess the conversion of Red Top Ditch for 10825 water for impacts to the North Fork Colorado River and particulate matter loading and water quality impacts in the Three Lakes, and
4. Monitor the Grand River Ditch restoration, to ensure sediments are contained near the restoration site.

Data gaps for Option B will vary widely with each investigation. Detailed study objectives, outcomes and goals for each will dictate the specific data gaps of each.

4.7.3 Option C: Modify Adams Tunnel Inlet

Option C proposes to capture water from Grand Lake and divert directly into the Adams Tunnel similarly as it does under conditions today except that the direct diversions would be in concert with one of three Alternatives. Option C combined with Alternative I under normal (non-maintenance) operations and under optimal hydrologic conditions, would allow a portion of the native inflows into Adams Tunnel to improve water quality of the diverted water while still maintaining sufficient flows from the East and North Inlets to flow naturally down-gradient to maintain water clarity in Grand Lake and water quality in Shadow Mountain Reservoir.

Option C could also be combined with Alternatives III and IV by modifying the Adams Tunnel inlet connection to allow for some direct diversion of Grand Lake water to mix with water being piped from Shadow Mountain Reservoir or the Granby Pump Canal in order to dilute and improve the quality of water being diverted to the east slope. Here again this would be conducted under normal (non-maintenance) operations and under optimal hydrologic conditions, that would allow a pre-determined portion of the native inflows into Adams Tunnel to improve water quality of the diverted water while still maintaining sufficient flows from the East and North Inlets to flow naturally down-gradient to maintain water clarity in Grand Lake and water quality in Shadow Mountain Reservoir.

Option C, combined with these alternatives, also provides operational redundancy in the case of outages to the proposed pumping plants or pipelines and operational redundancy for normal maintenance during months other than the three regulatory months of July, August and September.

Prior to further consideration of Option C, additional analysis is required to: (1) assess impacts of the alternatives on the quality of diverted water, (2) assess the trade-off between the quality of diverted water versus the water quality in the Three Lakes and specifically clarity in Grand Lakes, and (3) weigh the benefits of the quality of diverted water.

5 POTENTIAL EFFECTS AND COMPARISON OF ALTERNATIVES

This section describes the potential effects of alternatives compared with current/existing conditions.

5.1 Benefits Analysis

The alternatives are assessed for the following factors:

- Water clarity in Grand Lake
- Water quality in Shadow Mountain Reservoir
- Water quality in Granby Reservoir
- Particulate matter transport into Grand Lake
- Water quality of diverted water
- Power generation

Each alternative is rated with a "+" if it is likely to provide a positive benefit; "0" if it is likely to produce little benefit or is neutral, balancing positive and negative impacts; and "-" if the alternative is likely a poor benefit or could possibly worsen conditions. Some ratings also include a '-/0' to indicate weak negative and '+/0' to indicate weak positive. Note that alternative performance is difficult to predict and ratings rely on existing data and analyses and professional judgment. A summary is provided in Table 5.1 followed by a detailed description of each rating.

Table 5.1. Alternatives benefits rating.

Benefits	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain
Water clarity in Grand Lake	+/0	-/0	+	+
Water quality in Shadow Mountain Reservoir	-/0	0	0	-/0
Water quality in Granby Reservoir	-/0	0	0	-/0
Particulate matter and sediment transport into Grand Lake	+/0	+/0	+	+
Water quality of diverted water	-/0	0	-	-
Power Generation	-/0	0	0	0

+ positive benefit, 0/+ weak positive, 0 no change, fair or neutral benefit
-/0 weak negative benefit - negative benefit

5.1.1 Water Clarity in Grand Lake

Due to the variety of factors discussed in Chapter 2, Grand Lake water clarity is diminished in the summer months. Farr Pumping Plant operations today are based on many factors including east slope water demands, storage conditions in C-BT Project reservoirs, power demands, maintenance operations, and flooding concerns. Therefore, C-BT Project diversions change from day to day and the effects on water clarity in Grand Lake are not well understood except that when pumping occurs during the summer, water clarity is reduced. Prolonged pumping may also increase nutrients and biochemical oxygen demand (BOD) in Grand Lake, until sufficient Shadow Mountain Reservoir water is flushed through the system and better quality water transferred from Granby Reservoir moves into Grand Lake (typically occurring in early fall). Based on insight from the stop pumping operations and the current water quality data, if there were no modifications made for water clarity considerations, water clarity in Grand Lake is not likely to meet the proposed State standard for a Secchi disk depth of 4 meters from July through September.

The dilution of Shadow Mountain Reservoir water by tributaries, Granby Reservoir pumped flows, and Grand Lake determines the longevity of favorable water clarity conditions. Current concerns for increased oxygen demand and nutrient loading, and algal "seeding" in Shadow Mountain Reservoir from pumped water will continue to result in negative effects to Grand Lake. C-BT Project stop-pump operations indicate that Alternative I could improve clarity relatively quickly (days or weeks). However, the increased nutrient loading during October-June period combined with a longer residence time in Grand Lake during July-September (stop pump period) brings some uncertainty at this point with current information whether Alternative I will consistently meet the proposed clarity standard of 4 meters (Review Panel 2012). Therefore Alternative I is rated as a weak positive.

Alternative II, 'Modify Pumping' is rated as a weak negative as it may improve water clarity in Grand Lake, but because the mixing of water sources remains during July, August and September, this alternative may not reliably meet the proposed clarity standard.

Alternatives promoting elimination of water transfer between Shadow Mountain Reservoir and Grand Lake (Alternatives III and IV Bypass Grand Lake and Bypass Shadow Mountain Reservoir and Grand Lake, respectively) will likely improve water clarity in Grand Lake. They will both be consistently effective and sustainable in meeting the clarity standard because they permanently separate C-BT Project water from Grand Lake and cause less influence from non-algal particulate matter. It should be noted that this isolation may result in a longer residence time which, in turn may cause algal biomass processes to be the dominate factor controlling clarity (Review Panel 2012).

5.1.2 Water Quality in Shadow Mountain Reservoir

Water quality in the relatively shallow Shadow Mountain Reservoir is distinctly different from that in Grand Lake. Part of the reason for these differences is the bathymetry that affects the internal physical and chemical dynamics in Shadow Mountain Reservoir. These dynamics are influenced by input of water from Granby Reservoir introduced by the Farr Pumping Plant, contribution of spring runoff from tributaries, surrounding watershed conditions, and land development. Assimilation of particles, composition of the particle load (e.g., organic/inorganic),

and transferability of these particles are the focus for determining effective management options that will improve water clarity in both Shadow Mountain Reservoir and Grand Lake.

Hydraulic residence time of water pumped from the Farr Pumping Plant into Shadow Mountain Reservoir mediates algal growth and community density during July through September. Alterations in C-BT Project pumping operations or re-direction of water transfer to circumvent flow through Shadow Mountain Reservoir are possible solutions for restricting entry of Shadow Mountain Reservoir water to Grand Lake. Alterations in C-BT Project pumping operations (as proposed in Alternatives I and II) are not likely to improve conditions for long periods of time, when compared to a future without water clarity considerations. Under Alternative I the flow through Shadow Mountain Reservoir is limited to the natural flows emerging from Grand Lake and the North Fork during July through September. There is a possible benefit to Shadow Mountain Reservoir water quality that may be realized from the introduction of "clearer" (colder, higher quality, lower conductivity, lower nutrients) Grand Lake water, but is uncertain that this would entirely offset the negative impacts of reduced flow and/or increases in residence time. Given these factors Alternatives I is rated as a weak negative. Alternative II, modify pumping is not likely to worsen or improve conditions in Shadow Mountain Reservoir.

Alternative III proposes to pump from the northeast end of Shadow Mountain Reservoir near the location of the connecting channel where flows now move into Grand Lake. Alternative III aims to move the same amount of water at the same rate through Shadow Mountain Reservoir as would be desired to support the C-BT Project and contractual commitments. While Shadow Mountain Reservoir water quality may deteriorate under future conditions due to other considerations, Alternative III itself is not likely worsening or improving the water quality in Shadow Mountain Reservoir when compared to current or future conditions without water clarity considerations. Alternative IV bypasses both Shadow Mountain Reservoir and Grand Lake, altering the flow through Shadow Mountain Reservoir. This may deteriorate water quality as the flow through Shadow Mountain Reservoir is dramatically reduced to that of the natural flows emerging from Grand Lake and the North Fork. There is a possible benefit to Shadow Mountain Reservoir water quality that may be realized from the introduction of "clearer" (colder, higher quality, lower conductivity, lower nutrients) Grand Lake water, but is uncertain that this would entirely offset the negative impacts. Given these factors, this alternative is rated with a weak negative. Additional studies are warranted to evaluate water quality impacts.

5.1.3 Water Quality in Granby Reservoir

Granby Reservoir has the water quality characteristics typical of a natural lake due to its bathymetric characteristics and timing of reservoir turnover. A distinct hypolimnion with low dissolved oxygen concentrations develops later in the season (usually October) and is characterized by the occurrence of nutrients and soluble iron and manganese originating from metals associated with surrounding soils. The dissolved iron and manganese have little or no effect on water quality when transferred to Shadow Mountain Reservoir and the relatively "clean" colder water from Granby Reservoir serves in diluting the receiving waters of Shadow Mountain Reservoir.

Impacts from the alternatives proposed to improve Grand Lake clarity, which may impact Shadow Mountain Reservoir water quality, could potentially impact Granby Reservoir given the

direct tributary connection, although to a lesser extent than Shadow Mountain Reservoir given the size and depth differences. As the magnitude of impact is unknown, but the trends are expected to be similar, the same ratings assigned to Shadow Mountain Reservoir are also applied to Granby Reservoir.

Future water quality conditions may also be influenced by increased delivery of water from Windy Gap Reservoir, as proposed in the Windy Gap Firming Project. Currently, water quality in Granby Reservoir does not appear to be affected by water quality impacts from Windy Gap and Willow Creek. It is not known whether water quality in Granby Reservoir will change as the Windy Gap Firming Project is fully implemented and inflows increased. Conclusions from the Final EIS for Windy Gap Firming Project indicate mitigation actions for the Firming Project are expected to maintain a nutrient-neutral status.

5.1.4 Particulate Matter and Sediment Transport into Grand Lake

Particulate matter can be broken down between inorganic and organic particles. Organic particles can be further separated between algal cells and non-algal detritus. Non-algal particulate matter was identified as the most important driver for decreased clarity in Grand Lake by McCutchan (2010). The sources and characterization of particulate matter in Shadow Mountain and Grand Lake is of great interest and is currently the subject of a two-year study. It is suspected that fragmentation of aquatic weeds in Shadow Mountain may play a role, however other factors may be at work and remain to be identified. Current C-BT Project pumping operations transfer particulate matter from Shadow Mountain Reservoir to Grand Lake, however much remains to be learned about transport mechanisms and the nature and source of the particulate matter that contributes to clarity issues.

Generally speaking, a clarity gradient can be observed from the inflow point to the opposite end of Shadow Mountain Reservoir, regardless of the inflow source as explained in the Hydros report (2011). That is, when Granby Reservoir water or Grand Lake water, both of which have higher clarity then Shadow Mountain Reservoir, flow into Shadow Mountain Reservoir, a clarity gradient is created, going from high clarity on the inflow side to low clarity on the outflow side. This gradient may be created or exasperated by the re-suspension of material in Shadow Mountain Reservoir as flows move through the reservoir.

Additionally, sedimentation in Shadow Mountain Reservoir and Grand Lake have been an issue of concern for many years. Sediment loading from the North Fork of the Colorado River has resulted in the formation of a delta in Shadow Mountain. A delta has also formed in Grand Lake as result of settlement of the larger sediment particles (see figure 2.12). It is unknown at this time whether the Grand Lake delta is actively growing or has been stable over the years.

Changes in pumping operations, as proposed in Alternative I, would be expected to improve particulate matter transport of material during the three proposed regulatory months for water clarity (July, August, and September). However, as evidenced by the stop pumping operations in 2007-2010, once pumping resumes particulate matter influx will also resume and in some cases be temporarily higher than under steady pumping. Thus Alternative I is rated as a weak positive given that it will improve particulate matter transport during the regulatory months but likely the overall particulate matter transport of all materials will not be altered over the long run.

Alternative II, modify pumping is intended to provide a steady, but relatively low flow, through Shadow Mountain Reservoir and Grand Lake. Thus it is possible that some of the larger particulates will not be transported during the three regulatory months. However, as evidenced by the stop pumping operations in 2007-2010, once pumping increases, particulate matter influx will also resume and in some cases be temporarily higher than under steady pumping. Thus Alternative II is also rated as a weak positive given that, although it may improve particulate matter transport during the regulatory months, the overall particulate matter transport of all materials will likely not be altered over the long run.

Alternatives III and IV, where reservoir waters are no longer pumped into Grand Lake, will improve (reduce) particulate matter transport into Grand Lake.

5.1.5 Quality of Diverted Water

Under current operations, the water diverted through Adams Tunnel is mixed with inflows from the native North and East Inlets thus likely providing a higher quality of water then might be obtained if diverted directly from Granby or Shadow Mountain Reservoirs. Alternatives I and II both modify pumping operations and allow mixing at the Adams Tunnel inlet. However, Alternative I may have a slightly negative impact on the diverted water quality even with the positive effects of mixing at the Adams Tunnel inlet. Under Alternative I, nutrient loading is expected to increase during October-June when pumping would be occurring. This increased nutrient loading combined with a longer residence time in Grand Lake during the July-September stop pump may create conditions that will degrade the quality of Grand Lake water that is diverted (Review Panel 2012). Alternative II is unlikely to have a notable impact on the diverted water quality as the mixing will remain at the Adams Tunnel inlet and Grand Lake residence time will not be affected. . Thus, Alternative I is rated a weak negative and Alternative II is rated neutral for maintaining the quality of diverted water. Alternatives III and IV bypass Grand Lake and connect directly to the Adams Tunnel. Under both of these alternatives, water would be pumped directly from Shadow Mountain Reservoir or the Granby Pump Canal into the Adams Tunnel, which means there would be a change in dilution of the diverted water. Under both Alternatives III and IV Grand Lake will flow into Shadow Mountain and Granby Reservoirs but the effects of the dilution of this clean water will likely be reduced as the water moves into and through Shadow Mountain Reservoir to the proposed pumping station locations. Under these alternatives, it is likely that there would be an adverse impact to diverted water and east slope water quality. Therefore Alternative III and IV are rated as negative. More information and analyses need to be developed on the impacts of these alternatives on diverted water and east slope water quality.

5.1.6 Power Generation

Alternatives are rated as discussed in Chapter 4, based on the likelihood of a relatively minor impact to power generation (Alternatives II, III and IV) versus a relatively significant impact to power generation (Alternatives I). As compared to the structural alternatives (III and IV) and compared to future conditions without water clarity considerations, there is essentially no change in total power generation (Table 5.2 and Figure 5.1). However, under Alternative I there is a shift in power generation away from the high energy demand months of July, August, and September, to the lower energy demand months.

Table 5.2. Estimated monthly distribution of total East Slope power generation.

Month	Without Water Clarity Considerations (GWH)	Alternative I: Stop Pump - No Adams Tunnel Diversions Jul 1 - Sep 30 (GWH)	Alternative II: Modify Pumping - 250 cfs Adams Tunnel Diversions Jul 1 - Sep 30 (GWH)	Alternative III: Structural Bypass of Grand Lake (GWH)	Alternative IV: Structural Bypass of Grand Lake and Shadow Mountain (GWH)
Oct	38.83	71.89	71.89	38.83	38.83
Nov	34.44	69.29	0.00	34.44	34.44
Dec	60.80	71.51	38.77	60.80	60.80
Jan	60.58	71.51	71.51	60.58	60.58
Feb	63.73	63.97	64.74	63.73	63.73
Mar	47.59	66.47	70.04	47.59	47.59
Apr	38.62	60.20	66.49	38.62	38.62
May	69.92	65.35	69.17	69.92	69.92
Jun	68.46	63.11	59.40	68.46	68.46
Jul	55.89	20.63	49.25	55.89	55.89
Aug	42.76	0.85	39.76	42.76	42.76
Sep	43.65	0.61	35.81	43.65	43.65
Total	625.27	625.38	636.83	625.27	625.27

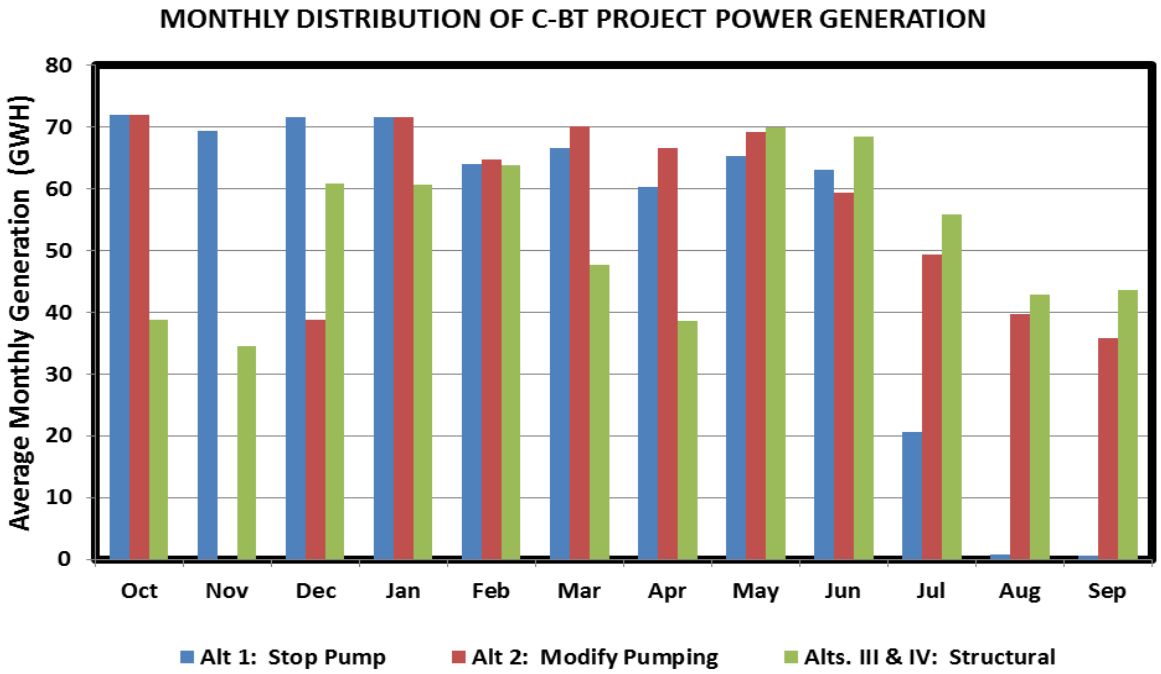

Figure 5.1. Estimated monthly distribution of total East Slope power generation.

5.2 Test of Viability

This section provides an evaluation of the alternatives using Acceptability, Effectiveness, and Constructability criteria described in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (U.S. Water Resources Council 1983)* to test viability. The P&G also suggests a discussion on Efficiency, however, for the purposes of this report and evaluation the Efficiency discussion only includes 1) constructability and 2) permitting and regulatory compliance considerations. Project cost are not considered here because the goal of this report is to determine whether further development of alternatives is possible. Costs are discussed qualitatively in this report. Significant effort will be required to make reliable estimates, which will be done later in project evaluation and development. Identification of funding sources is also outside the scope of this report. For the purposes of this 'test of viability' the following definitions apply:

1. Acceptability: the workability and viability of the alternative with regard to acceptance by Federal, State and local interests and the public, and compatibility with existing laws, regulations, and public policies,
2. Effectiveness: the extent to which alternatives would contribute to achieving meeting State standards,
3. Efficiency: the extent to which alternatives are physical possibility to be constructed and achieve permitting and regulatory compliance, and
4. Completeness: the extent to which alternatives provide and account for all necessary investment or other actions necessary, including Actions by other Federal and non-Federal entities.

Each alternative is assessed as good, fair or poor relative to its ability to meet the four tests of viability. As previously noted with the benefits analysis, alternative performance is difficult to predict and these assessment rely on existing data and analyses and professional judgment. Each assessment summarized and annotated in Table 5.3 and discussed in detail following the table.

Table 5.3. Summary of viability.

Viability	Alternatives			
	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain Reservoir
Acceptability				
Publically supported today?	good likely to be perceived as proactive	fair might be perceived as proactive	good to fair supported by some but construction may be met with resistance	good to fair supported by some but construction may be met with resistance
Publically supported in the future?	fair likely to be perceived as failure when clarity is not achieved	fair likely to be perceived as failure when clarity is not achieved	good post-construction will be perceived as yielding consistent results	good post-construction will be perceived as yielding consistent results
Overall Acceptability Rating	good to fair	fair	good to slightly fair	good to slightly fair
Effectiveness				
Meet proposed State standards for Secchi depth?	fair to good some uncertainty due to changes in residence time	fair to poor likely to improve clarity but may not meet stds	good will maintain a consistent clarity, reflective of natural hydrology, with relatively high probability of meeting clarity stds	good will maintain a consistent clarity, reflective of natural hydrology, with relatively high probability of meeting clarity stds
Maintain current water quality conditions in the Three Lakes?	fair to poor stop pumping may slightly impact SMR* and GR* water quality during the three no pumping months, but will have positive impacts in GL*	fair steady pumping periods likely to be minor on all three water bodies	good to fair deliveries through SMR remains per current operations so unlikely to alter water quality of SMR and GR. GL water quality will improve	fair to poor GL water quality will improve; bypass of SMR could negatively impact water quality in SMR and GR; unknowns and uncertainty with alternative.
Affect the quality of diverted water?	fair increases in pumping in Oct-June may diminish quality of diverted water	good unlikely to result in notable changes from current conditions	fair to poor alters location of mixing, thus may diminish quality of diverted water	fair to poor alters location of mixing, thus may to diminish quality of diverted water

Viability	Alternatives			
	I. Stop Pumping	II. Modify Pumping	III. Bypass Grand Lake	IV. Bypass Grand Lake and Shadow Mountain Reservoir
Maintain the yield to CBT?	fair may require additional east slope storage; further study required	good no additional east slope storage required	good provides flexibility to divert on demand	good provides flexibility to divert on demand
Overall Effectiveness Rating	fair to poor	fair to poor	good to slightly fair	good to fair
Efficiency				
Constructability	fair to good additional storage might be required	good no construction required	fair relatively large scale project but physically possible using one of several viable variations	fair large scale project but physically possible using one of several viable variations
Extent of permitting required to comply with existing laws, regulations	good minimal NEPA and permitting required	good minimal NEPA and permitting required	fair NEPA and extensive permitting required	fair NEPA and extensive permitting required
Overall Efficiency Rating	fair	fair	good to fair	good to fair
Completeness				
Completeness	good to fair some uncertainty in ability to meet clarity stds	poor difficult to consistently meet clarity stds	good likely to meet clarity stds; flexibility to divert on demand; uncertainty with quality of diverted water	good to fair likely to meet clarity stds; flexibility to divert on demand; uncertainty with quality of diverted water
Overall Completeness Rating	poor to fair	poor	good	good to fair

*SMR=Shadow Mountain Reservoir, GR=Granby Reservoir, GL=Grand Lake

5.2.1 Acceptability

There is a great deal of local interest in Grand Lake clarity issues in addition to other local Project operations, such as with the C-BT Project and the Subdistrict's Windy Gap Project. There is also a great deal of concern for water quality in Shadow Mountain Reservoir, citing worsening conditions based on shallow reservoir depths that create a 'petri-like' environment. Thus, it is likely that the public will support any of the proposed alternatives, now and in the future, although it is also possible that Alternative II will lose support over the years as the lack of consistency and dependability in maintaining clarity becomes evident. There may also be

some resistance to construction of the structural alternatives (Alternatives III and IV) from the public, which is reflected in a 'good to fair' rating for public support today.

In terms of acceptance related to adherence to existing laws, regulations, and policies, the goals of this report are, in part, to promote adherence to existing and proposed state water quality standards. The Clean Water Act requires federal agencies to comply with state and local regulatory standards and this report seeks to inform Reclamation concerning whether viable alternatives exist. The narrative and numeric clarity standards were developed by the state of Colorado as delegated under the Clean Water Act. Evaluation factors used to evaluate alternative performance specifically include the ability to meet existing and proposed regulatory standards as outlined in the Effectiveness and Efficiency categories.

5.2.2 Effectiveness

This rating assesses the extent to which alternatives contribute to meeting State standards for clarity, ability to maintain existing water quality conditions in the Three Lakes and the ability to maintain C-BT Project deliveries.

5.2.2.1 Will the alternatives meet proposed State standards for clarity?

Past C-BT Project pumping experimenting with slow and steady transfer rates showed mixed results when attempting to achieve the proposed State clarity standard of a 4 meter Secchi disk depth. The active transfer of water appears to affect water clarity in Grand Lake. A "slug" of water appears to move through with a short duration of reduced water clarity. Water clarity eventually improves as Granby water is ultimately transferred, but operational changes do not appear likely to reliably meet the proposed 4 m Secchi disk depth clarity standard. Constant monitoring of water clarity would be required to provide data to more finely adjust operations at the Farr Pumping Plant. Adjustments to the pumping rate would be required to optimize maximum water clarity potential at any time during the day. It is not clear whether current pumps could accommodate such a fine-tuning of water transfers in response to clarity concerns. There would also be a time delay between monitoring water quality conditions and response of pumping operations. Thus, water clarity may still experience some oscillation between acceptable conditions and exceedence of the proposed water clarity standard. Clarity standards are most likely to be met with the bypass alternatives (III and IV) and are rated as 'good.' Alternative I is rated fair to good, because the increased nutrient loading during October-June period combined with a longer residence time in Grand Lake during July-September (stop pump period) brings some uncertainty at this point with current information whether Alternative I will consistently meet the proposed clarity standard of 4 meters (Review Panel 2012). Alternative II, modify pumping, is rated as fair to poor given the likelihood that the proposed numeric clarity standard will not be met on a frequent basis due to the mixing of water sources during July, August and September.

5.2.2.2 Will the alternatives maintain water quality conditions in the Three Lakes?

Water quality impacts to the Three Lakes are discussed in detail in Section 5.1. In summary, Alternative I will likely improve water quality in Grand Lake but may slightly decrease the water quality in Shadow Mountain and Granby Reservoir during the stop-pump periods as flow

through Shadow Mountain is reduced to that of the natural flows emerging from Grand Lake and the North Fork. Therefore Alternative I is rated a 'fair to poor'. Alternative II, modify pumping is not likely to worsen or improve conditions in all three water bodies, compared to current and/or future without water clarity considerations and is rated as 'fair'. Alternative III is not worsening or improving the water quality in Shadow Mountain and Granby Reservoir when compared to current and/or a future without water clarity considerations conditions, and Grand Lake water quality will improve. Therefore Alternative III is rated good to fair'. Alternative IV, however, bypasses both Shadow Mountain Reservoir and Grand Lake, altering the flow through Shadow Mountain Reservoir. This may deteriorate water quality in Shadow Mountain and Granby Reservoirs as the flow through the reservoirs is dramatically reduced to that of the natural flows emerging from Grand Lake and the North Fork. There is a possible benefit to Shadow Mountain Reservoir water quality that may be realized from the introduction of "clearer" (colder, higher quality, lower conductivity, lower nutrient) Grand Lake water, but is unlikely that this would entirely offset the negative impacts. Therefore, this alternative is rated fair to poor.

5.2.2.3 Will the alternatives affect the quality of diverted water?

As discussed in Chapter 5.1, the water currently being diverted through Adams Tunnel is mixed with inflows from the native North and East Inlets at the Adams Tunnel inlet providing a higher quality of water then might be obtained if diverted directly from Granby or Shadow Mountain Reservoirs. Alternatives I and II both modify pumping operations and allow mixing at the Adams Tunnel inlet. However, Alternative I may have a slightly negative impact on the diverted water quality even with the positive effects of mixing at the Adams Tunnel inlet. Under Alternative I, nutrient loading is expected to increase during October-June when pumping would be occurring. This increased nutrient loading combined with a longer residence time in Grand Lake during the July-September stop pump may create conditions that will degrade the quality of Grand Lake water that is diverted (Review Panel 2012). Alternative II is unlikely to have a notable impact on the diverted water quality as the mixing will remain at the Adams Tunnel inlet and Grand Lake residence time will not be affected. Thus, Alternative I is rated as fair and Alternative II is rated good for maintaining the quality of diverted water. Alternatives III and IV will result in the passage of water from Grand Lake through Shadow Mountain Reservoir to the proposed pump stations (northeast corner for Alternative III or Granby Pump Canal in Alternative IV), changing the point of mixing from the Adams Tunnel inlet to the location of the proposed pump stations. As the clean Grand Lake water moves through Shadow Mountain Reservoir to the proposed pumping station the water quality may degrade. Under these alternatives, it is likely that there would be reduction in the quality of diverted water, thus resulting in a rating of fair to poor.

5.2.2.4 Will the alternatives maintain the C-BT Project yield?

Review of the alternatives indicate that Alternatives I, II, III and IV will likely meet the criteria of preserving C-BT Project yield including contracted and reasonably foreseeable contracted water transported using C-BT Project infrastructure. However, Alternative I is rated as fair given that east slope operations are very complex and this complexity may impede the ability to optimize the east slope storage. As a result, Alternative I may require some additional east slope

storage to keep from adversely affecting yield through a sequence of years similar to the 1974-1977 period mentioned above.

5.2.3 Efficiency

This rating assesses the extent to which alternatives would be the most cost effective means of achieving the objects, including consideration of issues regarding constructability and permitting. The cost effectiveness of the projects will be calculated after project cost estimates are completed.

5.2.3.1 Constructability

This criteria evaluates the physical possibility as to whether an alternative could be constructed. A brief overview of the constructability issues for each alternative is listed below.

Alternatives I and II, based upon the assumptions made in the operational analysis, does not require new facilities on either the west or east slopes. It should be noted that east slope operations are very complex and this complexity may impede the ability to optimize the east slope storage. As a result, Alternative I may require some additional east slope storage to keep from adversely affecting yield through a sequence of years similar to the 1974-1977 period mentioned above and thus is rated 'fair to good'. However, the detailed analysis of east slope operations necessary to evaluate this risk is beyond the scope of this report.

Alternatives III and IV each include a new pump station and pipeline that would connect the pump station directly to the Adams Tunnel. Several variations for each alternative are considered all of which appear physically possible including overland, off-shore and tunnel alignments. Each of the variations will need further review including easement acquisition, utility conflicts resolution and temporary disruption of C-BT Project operations to lower water body contents to accommodate construction and are both rated as 'fair'.

5.2.3.2 Permitting and Regulatory Issues

The following is a list of potential permitting and regulatory compliance issues that might be required for implementation of any of the proposed alternatives. These permits and regulatory compliance issues must be further defined in future detailed analyses.

- NEPA compliance will be required to evaluate potential impacts on the human environment associated with the construction and/or placement of new structures that would serve as a conduit for water transfer within or around Grand Lake. Construction activities and habitat alterations, especially in the aquatic environment, will require notification of appropriate government regulatory and natural resource agencies who manage the land and recreation on and around the water bodies. Environmental resources that could be impacted by development of structures required through completion of Alternatives include: water quality, fish habitat, and direct take of fish (e.g., impact to fish populations). NEPA

compliance activities would typically be performed in conjunction with more detailed engineering analyses.

- Water quality regulation is overseen by the CDPHE and will require assurances for protection of water quality under Section 401 Certification under the federal CWA. In the event that dredge and fill materials are produced that may impact the aquatic environment, the U.S. Army Corps of Engineers requires a Section 404 Permit as authorized under the federal CWA. Both the State Section 401 Certification and the federal Section 404 Permit will be integrated as these regulations are related, but will involve different levels of government under the established regulatory process.
- Fisheries issues that arise from Alternatives implementation would be addressed by the Colorado Parks and Wildlife. If any changes to the aquatic environment could result in habitat loss or destruction affecting threatened and endangered species the U.S. Fish and Wildlife Service will require Endangered Species Act consultation and compliance. The Colorado Parks and Wildlife requires, under state law, that fish and wildlife mitigation plans be prepared and reviewed by the agency in any water transfer project (Memo, from Monahan 2010). A review of situations in which water resources (and by association, fisheries) may be impacted by proposed construction, operation or maintenance of water diversion is further discussed in this Memo and whether a project will be required to develop such a plan.
- A 1041 permit from Grand County will be required to identify, designate, and regulate areas and activities of state interest through their local permitting process.
- Easements or Use Authorizations for improvements may be required from private landowners, National Park Service, and United States Forest Service.
- All alternatives would need to consider future water quality standards for Direct Use Water Supplies (DUWS). Alternatives III and IV would require more extensive NEPA compliance and permitting.

5.2.4 Completeness

Completeness is rated as the extent to which an alternative provides and accounts for all of the necessary components and project features. This criteria creates an overall rating that reflects the relative importance of the previous ratings. For instance, if an alternative rates ‘good’ in several categories, but is not likely to maintain C-BT deliveries, this criteria represents only a partial response to achieving the proposed clarity standard and will likely result in a completeness rating of poor. Each alternative is discussed below.

5.2.4.1 Alternative I: Stop Pumping

The act of ‘stop pumping’ resulted in Secchi disk depths in excess of 4 meters in 2011. The operational analysis indicates that this alternative should be retained for further consideration. There are uncertainties to the impacts on Shadow Mountain Reservoir water levels and water quality given the reduction in flows to those generated naturally from the North Fork and North and East Inlets. Thus, this alternative is rated as good to fair for overall completeness.

5.2.4.2 Alternative II: Modify Pumping

Pumping operations, which includes a broad range of pumped flows and durations, conducted over the last few years resulted in improved water clarity in Grand Lake, although none of the

operations would have met the proposed clarity standards. The operational analysis indicates that Alternative II would meet delivery requirements, however given the results of previous operational efforts and minimum improvements to clarity, Alternative II is rated as poor in the overall completeness category.

A combination of Alternatives I and II may also be possible, which considers a broader range of operational scenarios. Pumping operations for a given year would be identified and selected on an annual basis, dependent on the projected characteristics of the upcoming year and would include consideration of the hydrologic year, the amount of storage available within the C-BT Project system, and anticipated water and power demands. The menu of operational flexibilities would be developed and evaluated in conjunction with water quality modeling. The decision to implement a particular operation would be based on the ability to meet C-BT Project yield objectives including water and power demands, and the complexities of implementation.

5.2.4.3 Alternatives III: Bypass Grand Lake

This alternative is likely to meet the State clarity standard. However, this alternative diverts directly from Shadow Mountain Reservoir via the Adams Tunnel and may exacerbate water quality in east slope reservoirs as dilution and mixing with Grand Lake waters is diminished. This alternative offers flexibility in operations for diversions as needed for the purposes of water delivery and power generation, independent of concerns for variable project demands, variable hydrology and unscheduled facility outages. Shadow Mountain Pump Station requires little operation head and will therefore be relatively inexpensive to operate. Water quality modeling is needed to clarify the unknown impacts on water quality diverted to the east slope. The results of such modeling may indicate the need to modify this alternative by implementing Option C, a modified Adams Tunnel inlet, or other mitigating options related to water quality. Thus, this alternative is rated as good for ‘completeness’.

5.2.4.4 Alternatives IV: Bypass Grand Lake and Shadow Mountain Reservoir

This alternative is likely to meet the State clarity standard. However, this alternative diverts directly from Granby Pump Canal via the Adams Tunnel and may also have the potential to exacerbate water quality in east slope reservoirs as dilution and mixing with Grand Lake waters is diminished and from uncertain effects in the Granby pump canal. This is a relatively expensive alternative compared to others due the distance of a constructed bypass. There will be impacts to Farr Pumping Plant operations; particularly that flow attenuation is eliminated in Shadow Mountain Reservoir which in turn requires that Farr Pumping Plant (and the new Granby Pump Canal Pump Station) must operate at or less then the capacity of Adams Tunnel. Furthermore there are uncertainties to the impacts on Shadow Mountain Reservoir water levels and water quality given the reduction in flows to those generated naturally from the North Fork and North and East Inlets. In consideration of these factors, this alternative is rated as good to fair for ‘completeness’.

6 FINDINGS

6.1 Summary

The results of this report suggest that further development of alternatives is possible relative to improving water clarity in Grand Lake, Colorado as part of the Colorado Big Thompson Project (C-BT Project) west slope collection system in response to a proposed State water clarity standard to take effect in 2015.

Of the alternatives selected for consideration in this report, it appears that Alternatives I, III, and IV should be included for further refinement and consideration. A combination of Alternatives I and II should also be included for further refinement and consideration. In addition, the *Solutions Deferred for Future Consideration and Not Evaluated Further in This Report* and *Further Options* listed in Chapter 3 should be included for consideration as stand-alone alternatives or for combination with other alternatives. Finally, due to the findings in this report, a comprehensive consideration of any new alternatives should be included, especially as new information is gained.

During future development and consideration of alternatives, to the extent possible there should be an effort to minimize redirected impacts and/or mitigation of those impacts. Topics for consideration include but are not limited to water quality impacts in other C-BT water bodies, power generation, revenue, or cost impacts

6.2 Alternatives and Options Considered in This Report

From the analysis included in this report, Alternatives I, III, and IV have the highest likelihood, especially when combined with Options and/or additional mitigations, of improving Grand Lake clarity without adverse effects to water quality in C-BT Project water bodies or adverse yield effects on the diversion of water from the west to east slope via the C-BT Project infrastructure, including contracted and reasonably foreseeable contracted water.

2011 C-BT Project operations, which included no pumping or diversions for the months of July and August, demonstrated that water clarity of 4 meters was achievable when water from Shadow Mountain and Granby Reservoir were not mixed with Grand Lake water. Although the actual clarity standard was not met in 2011, it was an unusual year due to the large snowpack and high runoff volume and was revealing in terms of what can be achieved given today's watershed conditions but without C-BT Project water in Grand Lake.

The 'Bypass' and 'Stop Pump' alternatives appear to be viable to move to the next level of consideration. Alternative I provides reduced operational flexibility. However, this alternative ranks high in overall net benefits. Therefore, it is recommended that Alternative I be advanced to further analysis. Alternatives III and IV offer overall flexibility in operations for diversions as needed for the purposes of water delivery and power generation, independent of concerns for variable project demands, variable hydrology and unscheduled facility outages. Therefore, it is recommended that both Alternatives III and IV also be advanced for more advanced engineering analysis.
In addition to the above recommendation, a third 'Modify Operations' Alternative that combines the 'Stop Pumping' (Alternative I) and 'Modify Pumping' (Alternative II) alternatives could be

considered in future detailed analyses. This combined alternative would allow additional operational flexibility and reduce the power generation impact of the stand-alone 'Stop Pump' alternative. As alternatives that propose to change C-BT Project operations are highly dependent on snowpack, timing of runoff, water demand, and reservoir conditions on the east slope, it is likely that annual operation scenarios would vary from year to year. For example, in 2011, during the no-pumping and diversion time period, improved clarity was achieved. This was largely due to the high runoff year, the large amount of water stored on the east slope, decreased water demand due to abundant early summer precipitation, and low power generation needs. In moderate runoff years, it may be likely that steady 'modified' pumping could be employed with some success. Yearly forecasts of runoff are already considered in annual planning for C-BT Project operations. Thus, given the anticipated type of runoff year, one of the above methods would be selected for implementation early in the season and included with the annual operations plan for a given year, subject to mid-season adjustments as water availability and demand become more certain. Note that this combined alternative will likely improve water clarity but may not reliably meet the proposed numeric clarity standards. Further assessment would be required to determine its ability to meet the standard.

Several options are presented and worth advancing for more analysis. Note that one variation of Option A (Shadow Mountain Reservoir modifications), which proposes to remove the Shadow Mountain Dam, would require the implementation of Alternative IV as it relies on the conveyance of water from the Granby Pump Canal to Adams Tunnel via a pipeline. Any proposal to remove Shadow Mountain Dam and Reservoir may also require Congressional approval. Option B (Watershed Improvements) includes a variety of improvements that warrant further analysis and are worth advancing to a greater level of development. By consensus of the expert review panel, Option B (Watershed Improvements) is not a stand-alone alternative, but proposed watershed improvements will enhance any of the alternatives (Review Panel, 2012), Finally Option C (modify Adams Tunnel inlet) may also have merit, however, further analysis is required to 1) assess the impacts of the alternatives on the quality of diverted water, and 2) assess the tradeoff between the quality of water diverted to the east slope versus the water quality in the Three Lakes and specifically clarity in Grand Lake.

6.3 Risk and Uncertainty

6.3.1 Water Clarity and Quality

Risks and uncertainties related to attaining proposed future water clarity and nutrient standards based on the data and studies review is presented in Chapter 2. The proposed numeric standard of 4-meter Secchi depth for clarity was adopted with a delayed effective date of 2015 by the Commission with the understanding that if a more appropriate standard was developed by 2014 it could be reevaluated. There are potential long term water quality impacts related to internal loading, watershed sources and pumped sources on the Three Lakes which, in combination with any of the alternatives, including future conditions without water clarity considerations, could result in degraded water quality, including the quality of water diverted through Adams Tunnel to the east slope.

6.3.2 Shadow Mountain Reservoir

Shadow Mountain Reservoir is a component facility of the C-BT Project, built to facilitate the movement of water to the Adams Tunnel. Due to its bathymetry, Shadow Mountain Reservoir is subject to different water quality issues that are deserving of additional consideration. Future monitoring and ongoing studies should be interfaced and integrated as needed with this effort to address clarity including the need to evaluate the water quality characteristics of diverted water (C-BT Project water at Adams Tunnel) compared to the water quality under with-project conditions as suggested in Alternatives III and IV and as modified by Options A and C. It is possible that future options and alternatives may also be identified as our understanding of water quality conditions in Shadow Mountain Reservoir increases.

6.3.3 Attainability of Water Clarity

2011 was an unusual year with unusually high snow pack and summer rain, thereby producing conditions that 1) resulted in no diversions of C-BT Project water flows through Grand Lake for several months, and 2) provided significant runoff from the pristine watersheds of the North and East Inlet which may have resulted in unusually high quality water in Grand Lake. The uncertainty lies in estimating whether the proposed water clarity standard is attainable under similar stop-pump or bypass conditions during dry and normal runoff conditions. However, 2011 stop-pump operations did provide some insight in terms of response in clarity to changes in operations and informs on what can possibly be achieved given current watershed conditions, but without C-BT Project water in Grand Lake. It should be noted that the clarity standard was not met in 2011 when Secchi depth was reduced to less than three meters once pumping began and diversions through Adams Tunnel resumed on September 7, 2011.

6.3.4 Nutrient Standards

Alternatives III and IV would connect the Adams Tunnel directly to either Shadow Mountain Reservoir or Granby Reservoir, resulting in these reservoirs becoming classified, by definition, as Direct Use Water Supply (DUWS). This classification could subject the reservoir to more stringent nutrient standards recently adopted by the Colorado Water Quality Control Commission. Likewise Grand Lake is already a direct connection to Adams Tunnel and by definition a Direct Use Water Supply (with or without clarity considerations). Grand Lake will also likely not meet the DUWS nutrient standard in all years, so this may be problematic with or without action taken for clarity.

Nutrient standards and other emerging regulatory criteria should also be considered in further detailed analysis of alternatives and their impacts to other features of the C-BT Project and related facilities.

6.3.5 Water Rights

Water rights issues associated with Alternatives III and IV (Bypass Alternatives) may change the diversions and storage and will likely require review by legal counsel for opinions concerning impacts to existing water rights. As recognized in the clarity standard, “Nothing in this article [the Colorado Water Quality Control Act] shall be construed, enforced, or applied so as to cause or result in material injury to water rights.”

6.3.6 East Slope Operations

East slope operations are very complex and require further assessment. Potential for east slope facility improvements could be considered to help facilitate individual alternatives and could include pump upgrades, changes in diversion operations etc., all of which require careful assessment by Reclamation, Western Area Power Administration (Western), and Northern Water.

6.3.7 Watershed Improvements and Geologic Considerations

As discussed in Chapter 2, nutrient loading into the Three Lakes is generally occurring from storm water (via direct runoff), several tributaries and two pumped sources. Given the largely undeveloped nature of these watersheds surrounding both reservoirs, it is likely that much of the nutrient loading is natural in origin and therefore difficult to control or reduce. The role of watershed nutrient contributions and, further, the ability to control and improve the water quality related impacts warrant further investigation.

6.3.8 Granby Reservoir

Water quality information from Granby Reservoir is currently limited and due to its bathymetry, water quality impacts from changes in nutrient loads are not readily discernible. While mitigation of two of the point sources with relatively high nutrient loading, Windy Gap and Willow Creek, is already proposed, the long term impacts are uncertain. Thus a review of mass loading of pollutants to Granby Reservoir may be warranted to investigate factors that may reduce water clarity that could be passed along to Shadow Mountain Reservoir and the Adams Tunnel during pumping operations.

6.3.9 Climate Change

As discussed in Chapter 2, there are many uncertainties associated with predicting impacts of climate change making it difficult to quantify impacts. Due to limitations of this preliminary report, no further assessment of climate change in addressed. However, it is important to continue to consider and acknowledge these factors as further consideration of the alternatives to improve water quality continue into the next phases of detailed analysis.

6.3.10 Funding Sources

In future steps of project evaluation and development, effort will be required to formulate reliable costs estimates of the alternatives. The funding source(s) needed are uncertain at this time as is the likelihood of success of procuring the funding from those source(s).

6.4 Next Steps

A technical review should be prepared to identify the requirements for advancing the project. The Technical Review will consider existing information and identify additional data requirements, next steps, critical paths tasks and schedules necessary to reach the thirty percent engineering design level, including both physical and operational evaluations. These activities might include, but are not limited to the following: (1) purpose and scope, (2) consideration of this report, (3) develop a work breakdown structure, (4) provide scopes of work for task and

activities to be accomplished including the deliverables furnished, (5) describe responsibility assignments to accomplish the work, (6) provide a schedule, (7) recommend what design level of cost estimate to prepare next, (8) provide a Quality Management Plan, (9) outline the procedures and criteria to be used, and (10) provide an Involvement Plan.

Some of the more detailed analyses needed to support alternatives evaluation are listed below, although the list in not exhaustive.

1. Assess C-BT Project operations and evaluate in detail, operations at Farr Pumping Plant, diversions for power generation, and capacity of the East Slope facilities including dry, average and wet year diversions and daily diurnal flow data. Analysis should include Reclamation and Northern Water's operational considerations and requirements for power customers coordinated with Western.
2. Prepare a fully integrated short-term and long-term power analysis that incorporates Reclamation's detailed operations of pumping plants and power plants for the C-BT Project, and includes the Windy Gap and Windy Gap Firming Projects and operations of Northern Water, the Subdistrict and Western.
3. Analyze east slope C-BT Project operations conducted by Reclamation and Northern Water including, estimated costs of alternative implementation and recommendations for improvements to existing C-BT Project features and operations as required to accommodate alternative implementation.
4. Evaluate water level impacts to Shadow Mountain Reservoir and Grand Lake and any required changes that may arise due to C-BT Project operations. Assess the need for a cutoff wall/boat locks associated with Alternatives I, III and IV.
5. Assess the water quality monitoring program and prepare recommendations to ensure a meaningful baseline is established and that an effective monitoring system is in place to evaluate water quality changes associated with future with-project implementation.
6. Expand water quality monitoring for other constituents based on targeted analysis of existing monitoring and pending regulatory standards, e.g., chlorophyll *a* in Grand Lake and dissolved oxygen (DO) and chlorophyll *a* in Shadow Mountain Reservoir.
7. Assess impacts of alternatives on water quality in Shadow Mountain and Granby Reservoirs using the Three Lakes water quality model, and other relevant modeling tools, studies, or monitoring.
8. Consider the merits of further aquatic weed control in Shadow Mountain Reservoir in consultation with the U.S. Forest Service and Colorado Division of Parks and Recreation. Removal of aquatic weeds could potential change nutrient levels and increase algal production.
9. Expand water quality analysis to include Granby Reservoir, including long-term water quality trends associated with pumping from Willow Creek, Windy Gap Project and the future Windy Gap Firming Project.

10. Investigate existing water quality of diverted water and forecast impacts of potential alternatives on other C-BT Project facilities.
11. Investigate construction related issues including:
    a. Easement acquisition for pump station and pipe
    b. Rock or geologic concerns with the feasibility for construction
    c. Utility conflicts
    d. Elevation profiles for pipeline construction
    e. The lowering of lake and reservoir elevations for construction purposes
    f. Connection to the Adams Tunnel headworks
12. Assess capacity of backup power from the C-BT Project eastern slope generation for the new pump station.
13. Conduct thorough analysis of costs.
14. Conduct analysis to determine appropriate repayment source(s) for potential alternatives developed for future consideration.

A Technical Review should identify the next specific activities, likely to be accomplished in multiple steps, which need to be accomplished to bring the Grand Lake Clarity Project to 30-percent engineering design level, including both physical and operational evaluations. These activities might include, but are not limited to the following.

- Collection of additional data;
- Additional data analysis;
- Limited engineering design or analysis tasks;
- Evaluation of existing cost estimation data with regard to a common basis, method, and accuracy level
- Plans for next step cost estimation
- Statutory and legal process and notice requirements
- Environmental and cultural resources

- Technically feasible pre-construction work schedule alternatives;
- Technically feasible construction schedule alternatives;
- Required environmental compliance documentation, including but not limited to;
    - National Environmental Policy Act (NEPA);
    - Fish and Wildlife Coordination Act;
    - Endangered Species Act;
    - National Historical Preservation Act.
    - Clean Water Act

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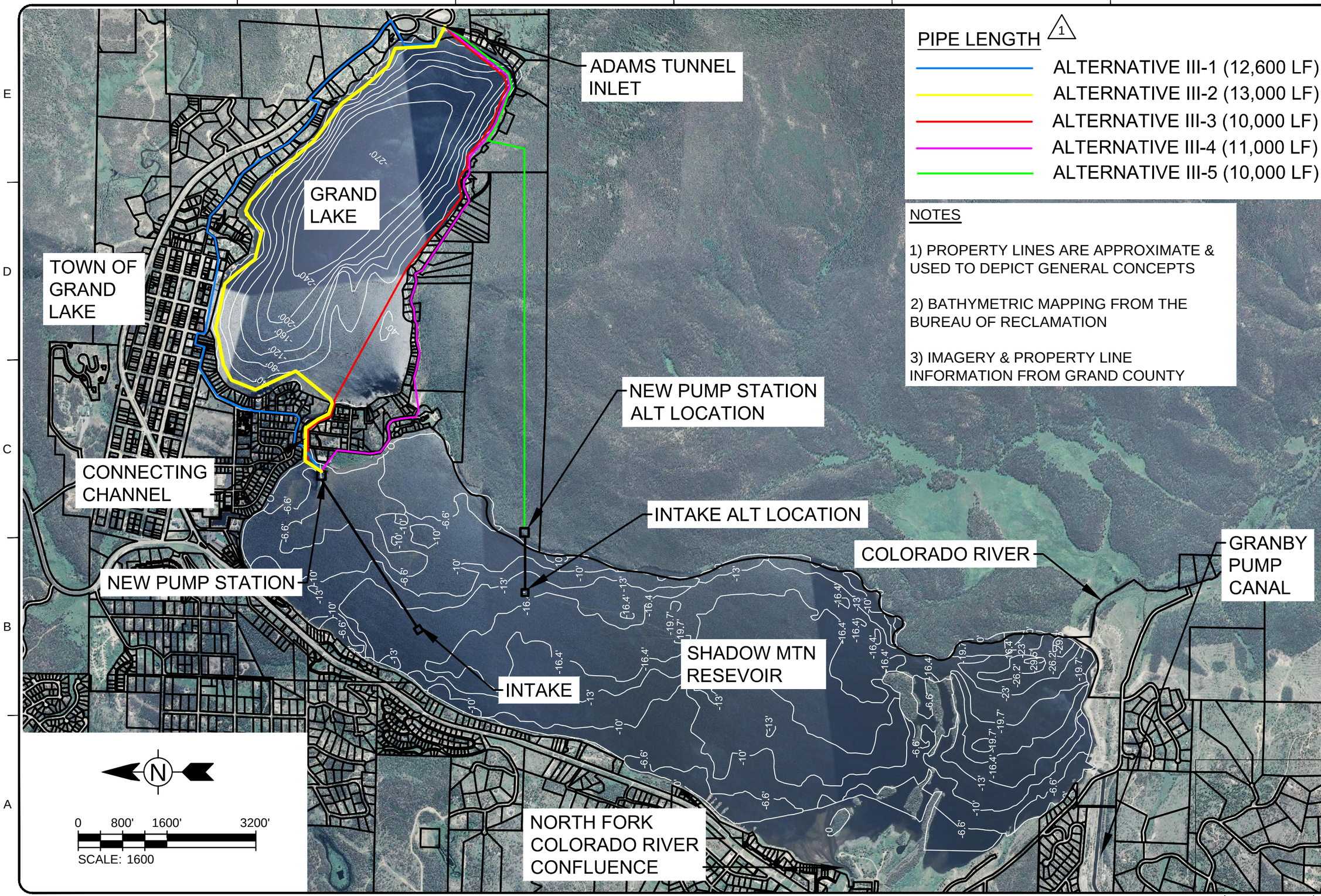
EXHIBITS



PIPE LENGTH (1)

- ALTERNATIVE III-1 (12,600 LF)
- ALTERNATIVE III-2 (13,000 LF)
- ALTERNATIVE III-3 (10,000 LF)
- ALTERNATIVE III-4 (11,000 LF)
- ALTERNATIVE III-5 (10,000 LF)

NOTES

1) PROPERTY LINES ARE APPROXIMATE & USED TO DEPICT GENERAL CONCEPTS

2) BATHYMETRIC MAPPING FROM THE BUREAU OF RECLAMATION

3) IMAGERY & PROPERTY LINE INFORMATION FROM GRAND COUNTY

TETRA TECH
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MARK	DATE	DESCRIPTION	BY
1	2/20/12	NEW DESCRIPTION NAME	KYS

GRAND LAKE APPRAISAL STUDY

ALTERNATIVES III-1, III-2, III-3, III-4, & III-5 PUMP FROM SHADOW TO ADAMS TUNNEL

Project No.:	133-01297-11008
Designed By:	KYS
Drawn By:	KYS
Checked By:	JAL

EX-01

Copyright: Tetra Tech

Bar Measures 1 inch

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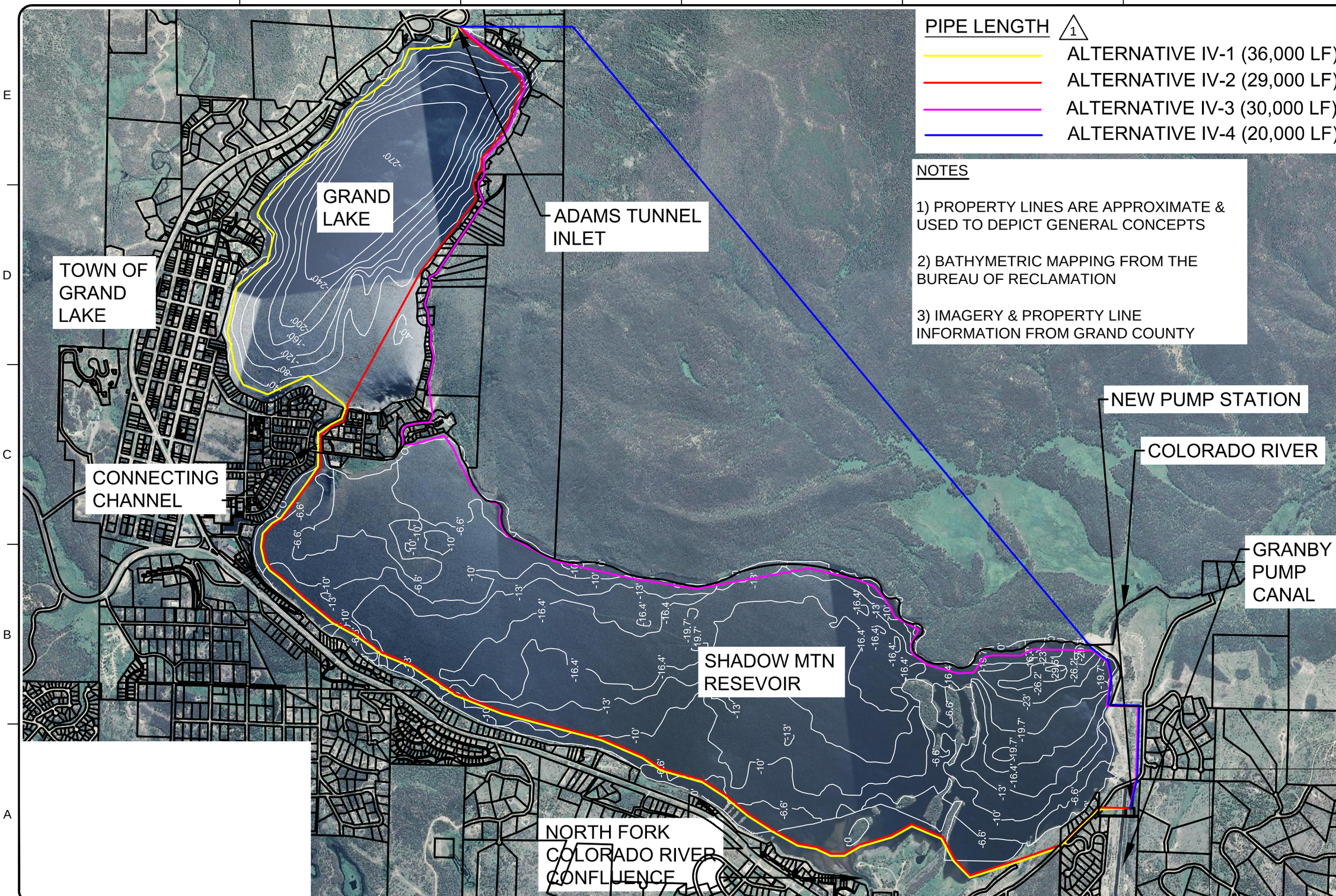

TETRA TECH
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MARK	DATE	DESCRIPTION	BY
1	2/20/12	NEW DESCRIPTION NAME	KYS

GRAND LAKE APPRAISAL STUDY

ALTERNATIVES IV-1, IV-2, & IV-3
PUMP FROM PUMP CANAL
DIRECTLY INTO ADAMS TUNNEL

Project No.:	133-01297-11008
Designed By:	KYS
Drawn By:	KYS
Checked By:	JAL

EX-02

Copyright: Tetra Tech

APPENDIX

Senate Document 80

C-BT Project Maps

Alternatives Analysis Meeting Notes

Existing Watershed and Best Management Practices

Operations Summary

Literature Review and Water Quality Studies

Final Report of the External Review Panel

75TH CONGRESS
1st Session

SENATE

DOCUMENT
No. 80

COLORADO-BIG THOMPSON PROJECT

SYNOPSIS OF REPORT

ON

COLORADO-BIG THOMPSON PROJECT, PLAN OF DEVELOPMENT AND COST ESTIMATE PREPARED BY THE BUREAU OF RECLAMATION, DEPARTMENT OF THE INTERIOR

PRESENTED BY MR. ADAMS

JUNE 15, 1937—Ordered to be printed without illustrations

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1937

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LETTER OF TRANSMITTAL

FEBRUARY 3, 1937.

From Senior Engineer Porter J. Preston.
To Chief Engineer.
Subject: Colorado-Big Thompson project.

1. Transmitted herewith is a synopsis of the report of plan of development and cost estimate of the Colorado-Big Thompson project.

2. The plans and designs upon which the estimates are based are shown in the full report to follow this synopsis.

3. The detail estimates have been worked out in the Denver office under the following divisions:

Canals: H. R. McBirney.
Reservoirs: K. B. Keener.
Power: L. N. McClellan.
Hydraulics: E. B. Debler.

4. The field work was done under the supervision of M. E. Bunger.

5. The economic study was carried on by R. L. Parshall, senior irrigation engineer, Bureau of Agricultural Engineering, United States Department of Agriculture. This study is later proposed to be issued as a separate document.

PORTER J. PRESTON.

Revised synopsis of report submitted June 11, 1937.

LETTERS OF SUBMITTAL

JUNE 11, 1937.

Hon. HAROLD L. ICKES,
Secretary of the Interior.

MY DEAR MR. SECRETARY: There is attached hereto the portion of the report on the Colorado-Big Thompson project in Colorado covering the principles and stipulations governing the construction and operation of said project for the protection of the rights and interests dependent on the Colorado River in Colorado.

The provisions contained therein have been considered by the Northern Colorado Water Users' Association, representing the irrigation and other interests on the eastern slope in Colorado, and we respectfully submit that they are satisfactory and meet the approval of said association.

We ask that acknowledgment be made of this communication.

Respectfully yours,

NORTHERN COLORADO WATER USERS' ASSOCIATION,
CHAS. HANSEN, *President.*
MOSES E. SMITH, *Vice President.*
THOMAS A. NIXON, *Attorney.*

JUNE 11, 1937.

Hon. HAROLD L. ICKES,
Secretary of the Interior.

MY DEAR MR. SECRETARY: There is attached hereto the portion of the report on the Colorado-Big Thompson project in Colorado covering the principles and stipulations governing the construction and operation of said project for the protection of the rights and interests dependent on the Colorado River in Colorado.

The provisions contained therein have been considered by the Western Slope Protective Association, representing the irrigation and other interests on the western slope in Colorado, and we respectfully submit that they are satisfactory and meet the approval of said association.

We ask that acknowledgment be made of this communication.

Respectfully yours,

THE WESTERN SLOPE PROTECTIVE ASSOCIATION,
SILMON SMITH, *Secretary.*
CLIFFORD H. STONE, *Director.*
A. C. SUDAN,
Special Representative of Grand County.

SYNOPSIS OF REPORT, COLORADO-BIG THOMPSON PROJECT

OUTLINE OF CONSTRUCTION AND OPERATING CONDITIONS

The Colorado-Big Thompson project in Colorado contemplates the diversion of surplus waters from the headwaters of the Colorado River on the Pacific or western slope to lands in northeastern Colorado on the Atlantic or eastern slope greatly in need of supplemental irrigation water.

To accomplish this diversion, the following features are required:

ON COLORADO RIVER

(1) Storage on the Blue River in what is called Green Mountain Reservoir located about 16 miles southeast of Kremmling, Colo., where the Blue enters the Colorado River. This reservoir is to be used to replace water diverted to the eastern slope that would be required by prior rights along the Colorado River.

(2) A hydroelectric plant below the Green Mountain Dam to utilize the flow of the Blue River and water stored in the reservoir for the generation of electrical energy.

(3) A storage reservoir located on the Colorado River about 6 miles northeast of Granby, Colo., to be known as Granby Reservoir. This reservoir will store the flow of the Colorado at this point as well as water diverted from Willow Creek, a tributary of the Colorado and Strawberry and Meadow Creeks, tributaries of the Fraser River.

(4) A diversion dam located about one-half mile below the junction of the North Fork and Grand Lake outlet and about 3 miles south of the village of Grand Lake. This dam will create a lake known as Shadow Mountain Lake which will have the same elevation as Grand Lake and will aid in supplying the transmountain diversion tunnel with water pumped from Granby Reservoir. This lake together with Grand Lake is to be kept at nearly constant level.

(5) An electrically driven pumping plant on the shore of Granby Reservoir, where water will be pumped into a canal feeding Shadow Mountain and Grand Lakes. The length of the canal is 4½ miles.

(6) An outlet channel at the east end of Grand Lake connecting the lake with the portal of a transmountain diversion tunnel and provided with control features that will regulate the level of Grand Lake within a fluctuating range of 1 foot.

(7) A transmountain diversion tunnel under the Continental Divide 13.1 miles in length extending from Grand Lake to a point in Wind River about 5 miles southwest of Estes Park village.

ON EASTERN SLOPE

(8) A conduit 5.3 miles in length extending from diversion tunnel outlet to penstock of a power plant on the Big Thompson River just below Estes Park village. This conduit will be made up of buried

pipe, siphons, tunnels, and open canal. It will be entirely concealed through the area authorized to be taken into Rocky Mountain National Park.

(9) The waste rock from the tunnel is to be terraced and landscaped and all structures connected with the tunnel will be constructed to blend into their natural surroundings.

(10) A power plant known as power plant no. 1 constructed along the Big Thompson River just below the village of Estes Park utilizing the western slope water.

(11) Four additional power plants down the Big Thompson Canyon to utilize all available fall and also all water available for power in the Big Thompson River in addition to the western slope water diverted.

(12) A diversion dam on Big Thompson River about 12 miles west of Loveland to divert the water by means of a canal 9 miles in length to a storage reservoir known as Carter Lake.

(13) Carter Lake Reservoir located 8 miles northwest of Berthoud, Colo., to store water brought over during winter months. Water is released from this reservoir through a 4-mile canal into the Big Thompson River and through a 9-mile canal into the St. Vrain River for irrigation purposes.

(14) A siphon across the Big Thompson River, 9 miles west of Loveland, Colo., and a canal 10 miles in length to convey water from the fourth power plant to a storage reservoir, located about 5 miles west of Fort Collins, known as Horsetooth Reservoir.

(15) A canal from Horsetooth Reservoir to the Cache La Poudre River and extended north to a pumping plant which lifts water high enough to serve the North Poudre Canal.

(16) A storage reservoir near the mouth of Buckhorn Creek to be known as Arkins Reservoir, supplied from a canal diverting from the Big Thompson River just below the last power plant. It is to be used to aid in balancing the demands for power and irrigation, also storing excess water available in the Big Thompson River. Water will be released from the reservoir for supplemental irrigation in the South Platte area.

(17) Transmission lines connecting the Valmont steam plant of the Public Service Co. with all the hydroelectric plants contemplated, also connecting with the transmountain tunnel portals and the Granby and North Poudre pumping plants. The line connecting power plant no. 1 and Granby pumping plant will run east, and south of the outside boundaries of the Rocky Mountain National Park, crossing the Continental Divide at Buchanan Pass.

In order to carry out the construction, operation, and maintenance of the project as outlined above, it will be necessary to comply with the following requirements as agreed to by representatives of the eastern and western slopes in Colorado and here made as a part of this report.

MANNER OF OPERATION OF PROJECT FACILITIES AND AUXILIARY FEATURES

The construction and operation of this project will change the regimen of the Colorado River below the Granby Reservoir. The project contemplates the maximum conservation and use of the waters of the Colorado River, and involves all of the construction features

heretofore listed. In addition thereto certain supplemental construction will be necessary. This will be for the primary purpose of preserving insofar as possible the rights and interests dependent on this water, which exist on both slopes of the Continental Divide in Colorado. The project, therefore, 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.

In order to accomplish these purposes 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 the following particular stipulations:

(*a*) The Green Mountain Reservoir, or similar facilities, shall be constructed and maintained on the Colorado River above the present site of the diversion dam of the Shoshone power plant, above Glenwood Springs, Colo., with a capacity of 152,000 acre-feet of water, with a reasonable expectancy that it will fill annually. Of said capacity, 52,000 acre-feet of water stored therein shall be available as replacement in western Colorado, of the water which would be usable there if not withheld or diverted by said project; 100,000 acre-feet shall be used for power purposes; and all of said stored waters shall be released under the conditions and limitations hereinafter set forth.

(*b*) Whenever the flow in the Colorado River at the present site of said Shoshone diversion dam is less than 1,250 cubic feet per second, there shall, upon demand of the authorized irrigation division engineer or other State authority having charge of the distribution of the waters of this stream, be released from said reservoir as a part of said 52,000 acre-feet, the amount necessary with other waters available, to fill the vested appropriations of water up to the amount concurrently being diverted or withheld from such vested appropriations by the project for diversion to the eastern slope.

(*c*) Said 100,000 acre-feet shall be stored primarily for power purposes, and the water released shall be available, without charge, to supply existing irrigation and domestic appropriations of water, including the Grand Valley reclamation project, to supply all losses chargeable in the delivery of said 52,000 acre-feet of water, and for future use for domestic purposes and in the irrigation of lands thereafter to be brought under cultivation in western Colorado. It shall be released within the period from April 15 to October 15 of each year as required to supply a sufficient quantity to maintain the specified flow of 1,250 cubic feet per second of water at the present site of said Shoshone diversion dam, provided this amount is not supplied from the 52,000 acre-feet heretofore specified. Water not required for the above purposes shall also be available for disposal to agencies for the development of the shale oil or other industries.

(*d*) The cost of construction and perpetual operation and maintenance of said reservoir or reservoirs shall be a charge against the project and shall be paid from revenues collected from this project as may be provided in contracts between the Secretary of the Interior and the beneficiaries of the project in eastern Colorado, and any other contracting parties.

(*e*) In the event said reservoir or reservoirs are not maintained with a capacity of 52,000 acre-feet, the Secretary of the Interior should withhold the diversion of water from the western to the eastern slope of Colorado until such storage capacity is made available.

(*f*) The Secretary of the Interior shall have the option to require the transfer to the United States of any and all rights initiated or acquired by the appropriation or use of water through the works of the project in eastern Colorado, at any time: *Provided, however,* That the title so taken shall be subject to a beneficial use of such water as may be provided in the repayment contract or contracts; and the rights to store water to the extent of said 152,000 acre-feet shall be initiated, acquired, and held by the appropriate authorities for use in western Colorado, for replacement of water diverted to the eastern slope, and for other purposes contemplated for this project.

(*g*) The Secretary of the Interior shall operate this project in accordance with the following stipulations as to priorities of water use as between the parties claiming or using project water and within the limits of his legal authority. Said 52,000 acre-feet of replacement storage in Green Mountain or other reservoirs shall be considered to have a date of priority for the storage and use of replacement water earlier than that of the priorities for the water diverted or stored for delivery to the eastern slope. The 100,000 acre-feet of storage in said reservoir shall be considered to have the same date of priority of appropriation as that for water diverted or stored for transmountain diversion.

(*h*) Said Green Mountain Reservoir, or such other replacement reservoirs as provided in paragraph (*a*) herein, as are planned as a part of the project, shall be constructed at the same time as the other parts of the project and shall be completed before any water is diverted to the eastern slope of the Continental Divide by means of said project.

(*i*) Inasmuch as the State of Colorado has ratified the Colorado River Compact, and inasmuch as the construction of this project is to be undertaken by the United States, the project, its operation, maintenance, and use must be subject to the provisions of said Colorado River Compact of November 24, 1922 (42 Stat. 171), and of section 13 of the Boulder Canyon Project Act, dated December 21, 1928 (45 Stat. 1057–1064). Notwithstanding the relative priorities specified in paragraph (*g*) herein, if an obligation is created under said compact to augment the supply of water from the State of Colorado to satisfy the provisions of said compact, the diversion for the benefit of the eastern slope shall be discontinued in advance of any western slope appropriations.

(*j*) An adequate system, as determined by the Secretary of the Interior, shall be provided for the irrigation of the lands in the vicinity of Kremmling, now irrigated by either natural or artificial means, and the installation made therefor shall be a part of this project. The rights to the use of water for the irrigation of these lands shall be considered to have a date of priority earlier than that of the rights to the use of water to be diverted through the works of this project to the eastern slope. This system shall be designed and built in a manner requiring the least possible continuing annual expense for operation

and maintenance but the cost thereof shall not exceed $300,000; and said system shall be provided and in operation before any water is stored for transmountain diversion. In addition, the Secretary shall protect, add to, or improve the source of supply of domestic waters for the municipalities of Kremmling and Hot Sulphur Springs in the manner and to the extent which he may determine to be necessary to provide a source of supply not less than that now available for these municipalities. The cost of these features shall be included in the total project cost.

(*k*) To compensate Grand County for the loss of taxes through the transfer of property to the United States for the construction of this project, $100,000 shall be paid to said Grand County. This payment shall be made in 10 annual installments of $10,000 each, commencing upon the date when 10 percent of the total property in Grand County required for said project has been removed from taxation.

(*l*) The project and all of its features shall be operated in a manner determined by the Secretary of the Interior as necessary to provide the water to preserve at all times that section of the Colorado River between the reservoir to be constructed near Granby 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 determination of the need for and the amount and times of release of water from Granby Reservoir to accomplish these purposes shall be made by the Secretary of the Interior, whose findings shall be final.

In order to facilitate compliance with the stipulation in paragraphs (*j*), (*k*), and (*l*) hereof a representative may be selected and designated by the interests dependent thereon in Grand County, Colo., and when so designated he will be recognized as the official spokesman of said interests in all matters dealing with project operations affecting Grand County.

The principles and provisions expressed in these stipulations have been approved by the Western Colorado Protective Association, representing interests in western Colorado, and the Northern Colorado Water Users Association as evidenced by the letters hereto attached.

SUMMARY

The Colorado-Big Thompson project comprises 615,000 acres of irrigated lands, out of approximately 800,000 acres lying under the canal systems in the northern and northeastern portions of Colorado.

The water supply for the area is to be derived from a portion of 782 square miles of drainage area above Hot Sulphur Springs lying west of the Continental Divide in Grand County, Colorado, and varying in elevation from 8,050 to 14,000 feet.

HISTORY

The first irrigation in northeastern Colorado occurred about 1860 where the early settlers plowed out small ditches with sufficient grade and length to irrigate a few acres of land in the first bottom—i. e lands not far above the high-water line of the streams and adjacent to them.

The first irrigation of the higher or second bench lands along the Cache La Poudre River was by the Old Union Colony, of Greeley, in

1870. This colony was organized by Horace Greeley, then editor of the New York Tribune, who will be remembered here especially for his advice to eastern young men to "Go west and grow up with the country."

This colony irrigated about 12,000 acres under their first project and it was a success from the start, due in a large measure to the fact that they were people of considerable means and were then able to finance themselves over the period required to bring raw prairie land into profitable cultivation.

This colony was soon followed by others along the Poudre at Fort Collins, on the Big Thompson, at Loveland and the St. Vrain near Longmont.

The difficulties experienced by these colonists in distributing the water between them led to the creation of Colorado's irrigation laws which have been copied by most of the irrigation States of the West.

This irrigated area of six hundred to eight hundred thousand acres was developed by means of individual initiative and by small scale cooperative enterprises. Today there are 6,400 irrigated farms, served by 124 canals and ditches and 60 storage reservoirs.

IRRIGATION USE

In the early days irrigation in this area was confined to growing crops to supply local needs, the lack of transportation contributing to high prices for the home-grown production and prohibiting shipping to distant points. The crops grown were mainly the grains and hay for local consumption, with some vegetables. Such irrigation corresponded with the run-off of the streams.

As mining developed in the State, Denver and other towns grew into cities, and after these cities were connected to the East by railroads the markets demanded a more diversified agriculture to supply their needs. Thus a gradual demand developed for late water which the streams could not supply.

This change created a need for storing the flood waters for late irrigation. From 1890 to 1910 was a period of reservoir construction, during which storage was provided for all the available water supply of the streams over and above the direct irrigation requirements for the area here under discussion. Much of this development took place during a decade of more than normal run-off on the eastern slope and also during a period expanding the agricultural area throughout the West.

Attempts to maintain the area under cultivation with the depleted run-offs during the past 10 years have spread the water supply to such an extent that much acreage has had an insufficient water supply to produce full crops or crops producing the higher values. Attempts have been made to supplement the individual farm water supply by the development of the underground sources by pumping from numerous wells throughout the region. This is lowering the water table and already is affecting the water supply of the lower South Platte Valley which receives its irrigation supply largely from return waters.

NEED OF SUPPLEMENTAL WATER

Under such conditions only the older water rights have any assurance of an adequate water supply, and in the dryer years the owners of junior rights are forced to confine their farming to crops that can

be matured by the early flood flow or that require a minimum amount of water. In years when the supply is not correctly estimated considerable loss results. Ordinarily the crops raised in this and other irrigated areas do not compete with those grown under rainfall conditions, but a shortage of water always leads to the raising of more of the competing crops. Such crops also cut the income of the irrigation farmer below what he can earn with the higher type, noncompetitive crops.

On fully three-fourths of the 615,000 acres in this area the water supply is inadequate, in spite of every effort to conserve, store flood water, or otherwise add to the water supply that has been within the financial ability of the farmer. This inadequacy is due not only to a development probably too large for the period when run-off of the streams was much higher than at present, but to the fact that the last 10 years have seen a very marked decrease in the stream flow. It must be emphasized that the additional water supply here contemplated is to be used for a supplemental supply and not to create a large new additional irrigated acreage.

There has been expended in this area to date for various types of irrigation works, including nearly $750,000 for pumping plants, most of which have been installed in the last 10 years, about $35,000,000 against which there is an outstanding indebtedness of only $1,510,650. These people, however, have about reached their limit as individuals and mutual irrigation companies to provide for themselves a supplemental water supply so badly needed to make their present water supply secure and are obliged to seek Government aid to bring this about.

It has been conceded by a majority of the irrigation interests in this section of the State that the water supply in 1926 was ample for all their present acreage now irrigated. In order, therefore, to determine the normal shortage in acre-feet over a period of years a comparison of the supply in these years with that of 1926 was made and the difference obtained. These differences are set up in the following table:

TABLE 1.—*Showing water districts, acreage irrigated, deficiencies 1925 to 1935 with tentative allocation of total supplemental supply*

Water district no.	Area irrigated	1926 diversion, acre-feet	Average diversion, 1925-35	Difference, 1926, 11-year average required supplementary water in acre-feet	Tentative allocation of supplemental supply			
					Colorado-Big Thompson project water	Moffat and Jones Pass tunnel water return	Present seepage return, acre-feet	Total supplemental supply, acre-feet
(1)	(2)	(3)	(7)	(15)	(16)	(17)	(18)	(19)
3	213,640	530,000	398,000	132,000	104,000	.....	49,500	153,500
4	68,408	235,000	163,000	72,000	44,100	.....	21,000	65,100
5	81,806	113,000	94,000	19,000	38,800	.....	18,500	57,300
1	92,394	663,000	457,000	206,000	81,400	11,000	83,000	175,400
2	37,899	170,000	154,000	16,000	5,000	4,500	5,100	14,600
64	121,289	513,000	383,000	130,000	36,700	14,500	37,400	88,600
Total	615,436	2,224,000	1,649,000	575,000	310,000	30,000	214,500	554,500

It will be noted from column no. 15 that the total average shortage in this project area which comprises water districts 3, 4, 5, 1, 2, and 64 is 575,000 acre-feet. Column no. 16 is a tentative allocation of the proposed supplemental supply to the various districts. Column no. 18 is the estimated usable return flow that would arise from the addition of 310,000 acre-feet of new water to this area. Column no. 19 is the total usable supplemental supply amounting to 554,520 acre-feet, an amount within 5 percent of the 10-year average shortage. The sale or rental of supplemental water, when available, in the Poudre Valley has averaged $4.50 per acre-foot over a period of years. In extreme cases it has sold as high as $9 per acre-foot.

The deficiency in water supply for the period 1925 to 1934, inclusive, reflected a direct economic loss in crop production of approximately $42,355,000.

The following shows the approximate annual loss in value of crops because of inadequate water supply:

Sugar beets	$1,900,000
Alfalfa	948,000
Small grain	470,000
Beans	302,000
Corn	228,000
Potatoes	425,000
All other crops	444,000
Total	4,700,000

This average annual direct crop loss is about 19 percent of the $24,800,000 estimated cost of the Colorado-Big Thompson irrigation project.

The crop loss in 1934, due to shortage of water, as compared to 1926, after variation in price and acreage factors had been accounted for, amounted to $12,400,000, or just one-half the cost of the project.

The losses here given are the farm losses and do not include the losses that are due to processing, transporting, or handling of that quantity of production, which would add several million dollars to the loss of the community as a whole.

The effect of such inadequate water supply for the period 1925–35 is shown graphically on drawing no. 1 following.

SUPPLEMENTAL WATER SUPPLY

In 1929 the State engineers of Colorado, in cooperation with the Platte Valley Water Conservation League, and the United States Army engineers, made a comprehensive study of the water resources of the South Platte Basin in northeastern Colorado. This study included the Cache La Poudre River in water district no. 3, the Big Thompson River in water district no. 4, and the St. Vrain River in district no 5. The investigators determined the excess water available on these streams above present normal demands and also above the normal demands on the South Platte River proper below where these streams enter.

The investigators also determined the location, capacity, and cost of the most feasible reservoir sites for the storage of this excess water.

The results are shown in the following table and have been brought up to date by using the same demands for irrigation as set up in the report and using the water-supply records furnished by the State engineer's office.

Stream	Excess supply available for storage, average, 1918–35	Capacity proposed reservoir by Army engineers	Average annual yields at reservoirs	Total reservoir costs	Cost per acre-foot capacity	Cost per acre-foot yield
	Acre-feet	*Acre-feet*				
Cache La Poudre	30,000	52,000	25,500	$2,747,000	$72	$147
Big Thompson	16,000	32,700	11,300	2,006,000	61	178
St. Vrain	16,000	30,000	14,000	2,186,000	73	156

From the foregoing table it is evident that there is not sufficient excess water available that originates in this area to supply the demands for supplemental water, and the cost of making use of what is available is prohibitive. It will be shown, however, that 16,000 acre-feet of this surplus is available for storage in the Colorado-Big Thompson project reservoirs on the eastern slope with no additional cost.

The water users in northeastern Colorado have now exhausted every possible source of obtaining supplemental water or augmenting their present supply either by storage, transmountain diversion within their individual cooperative means, and by pumping. Fortunately, however, there exists a surplus of water on the headwaters of the Colorado River west of this area and separated from it by the Continental Divide.

In the spring of 1935, $150,000 was allocated to the Bureau of Reclamation to make surveys and prepare plans and cost estimates for bringing water from the headwaters of the Colorado River into the area in northeastern Colorado in need of supplemental water.

In August 1935 the Bureau of Reclamation started surveys for the project and previously there had been started a land classification to determine the irrigated and arable land in the Colorado River Basin in Colorado in order to arrive at the approximate amount of water now used in the area and how much might be used when full development has been made. Both surveys have been completed, insofar as this project is involved, and the following is the result of the land classification.

LAND CLASSIFICATION—COLORADO RIVER AREA

Since the quantity of water available for diversion from the headwaters of Colorado River might be limited now by the water rights of lands already irrigated, or might in the future limit in turn the development of lands in the Colorado Basin within the State, all the land on Colorado River and its tributaries above the Colorado-Utah line, except the Gunnison River area, has been classified to show the location and extent of irrigated lands and of lands capable of irrigation.

This classification was undertaken in all areas covered by former reports, supplemented by local information as to possible projects and by reconnaissance. For localities with no records of water supply it was assumed to exist unless the contrary was obvious, and doubtful areas were included rather than excluded from the classification. The land was measured by plane-table survey except some small isolated areas which were estimated.

Land that had customarily been irrigated was so classed, no matter how inadequate the supply. Land capable of irrigation was

tested according to a set of standards which fairly represent the experience on this area and others as to what constitutes arable land. Where pumping for irrigation was involved land was classified up to 200 feet above the source of supply.

The result of the survey of the irrigated and arable land appears in the following table.

It should be stated, that, as will be shown under the discussion of water supply which follows, the present irrigated area above the Utah State line does not limit the diversion possible at the location chosen. It is also true that the diversion when in operation, and replacing the summer flow of Colorado River in the manner contemplated by the project plan, will not limit the future development of all the arable land on Colorado River and its tributaries above Gunnison River.

Colorado River drainage—Gunnison excepted—Colorado (land classification according to streams)

Stream name	Irrigated	Arable	Total
Colorado River:	*Acres*	*Acres*	*Acres*
1. To Granby Dam	2,600	1,100	3,700
2. Granby Dam to Hot Sulphur Springs	1,300	350	1,650
3. Hot Sulphur Springs to Kremmling	3,200	1,200	4,400
4. Kremmling to Glenwood Springs	1,100	260	1,360
5. Glenwood Springs to Palisade	7,000	2,500	9,500
6. Palisade to State line	70,600	32,800	103,400
Total	85,800	38,210	124,010
Tributaries:			
Willow Creek	860	120	980
Fraser River	7,100	650	7,750
South Fork Colorado River	610	30	640
Small streams [1]	2,300	4,000	6,300
Williams Fork River	3,600	10,900	14,500
Troublesome Creek	4,200	7,200	11,400
Muddy Creek	4,900	5,100	10,000
Blue River	8,400	3,100	11,500
Small streams [2]	610	570	1,180
Sheephorn Creek	1,200	50	1,250
Piney Creek	790	50	840
Egeria Creek	5,700	9,300	15,000
Cabin Creek area	5,700	2,600	8,300
Catamount Creek	1,000	10	1,010
Sweetwater Creek area	1,100	380	1,480
Eagle River	16,400	5,000	21,400
Small streams [3]	930	60	990
Roaring Fork River	33,100	9,400	42,500
Garfield Creek	2,100	----------	2,100
Elk Creek	3,000	130	3,130
Divide and Main Creeks	13,700	9,100	22,000
Rifle Creek	11,100	3,200	14,300
Parachute Creek	1,700	370	2,070
Roan Creek	5,600	3,300	8,900
Plateau Creek	24,000	7,000	31,600
Small streams [4]	10,200	3,000	13,200
Grand total	256,300	122,830	379,130

[1] Above Hot Sulphur Springs.
[2] Between Hot Sulphur Springs and Kremmling.
[3] Between Kremmling and Glenwood Springs.
[4] Between Glenwood Springs and Palisade.

WATER SUPPLY

The stream flow records at the different stations in the Colorado River Basin show the amount of water passing the stations after all present irrigation has taken place above, so there is no need for any further adjustment of stream flow to take care of water consumed in this irrigation.

It is assumed that all arable lands as shown will be irrigated some time in the future, notwithstanding the fact that quite a percentage

is so located that it would never be feasible to irrigate. It is also further assumed that reservoirs would be built on the tributaries to conserve a portion of the flood flows to make the irrigation of these arable lands possible.

With the above assumptions it has been found that in a year like 1931, with the run-off only 40 percent of the average for a 31-year period, and the lowest year of record, the Colorado-Big Thompson project would only have to supply approximately 53,000 acre-feet to replace water diverted by the proposed project that could have been used by the Colorado River water users for power and irrigation, provided the project was in operation at that time.

The average run-off of the Colorado for the years of record are: Hot Sulphur, 31 years, 523,000 acre-feet; Glenwood Springs, including Roaring Fork, 3,413,000 acre-feet, Fruita, 6,300,000 acre-feet. These amounts are exclusive of supply consumed in present irrigation of Colorado River Basin lands.

The following is the estimated amount of water available for diversion from the drainage area above the Colorado-Big Thompson collection system at 8,260 feet elevation.

YIELD OF GRANBY RESERVOIR

Stream-flow records available on the Colorado River near the Granby Dam site for the years 1908–11 and 1935–36, and on Willow Creek for the years of 1935 and 1936, were supplemented by estimates based on available stream-flow records on the Colorado River at Hot Sulphur Springs and Glenwood Springs to cover the 37-year period, 1900 to 1936, inclusive.

A capacity of 482,000 acre-feet was selected as the best capacity for the Granby Reservoir, considering cost and use. Of this capacity, 20,000 acre-feet were set aside for dead storage to reduce pumping lifts for waters delivered to Shadow Mountain Reservoir. A further objective is to keep to the lowest practicable area the exposure of reservoir bed when storage is exhausted. This leaves an active capacity of 462,000 acre-feet.

Reservoir operating studies are based on the following conditions:

(*a*) Recorded (or estimated) past flows of Colorado River at Shadow Mountain and Granby Dams reduced by 27 percent prior to 1906, and 13 percent thereafter, of the flow of the North Fork at Grand Lake to allow for increasing diversions by the Grand River ditch.

(*b*) Willow Creek diverted to reservoir to the extent of 90 percent of the flow of Willow Creek and other streams intercepted by the diversion canal from May to October, inclusive, of each year.

(*c*) Strawberry, Meadow, and Walden Hollow Creeks also diverted whenever practicable. The flow of these streams, together with some additional waters capturable from Willow Creek at times, are expected to offset evaporation and seepage losses in excess of present losses from the Granby and Shadow Mountain Reservoir sites.

(*d*) No releases from Granby Dam for any reason.

(*e*) Transmountain tunnel to be operated at full capacity from October 1 until March 31 following, with operations thereafter gaged to fit run-off conditions so as to avoid spills and yet concentrate flows in the period of July 15 to September 15, for the purposes of best

distribution in power production and to minimize reregulating storage requirements on the eastern slope. The computations assumed infallible forecasts of run-off.

(*f*) A minimum storage hold-over of 100,000 acre-feet on September 30 of each year to assure dependable power production in winter.

Under these conditions, a yield of 320,000 acre-feet of primary water is secured as follows:

Unit 1,000 acre-feet

Run-off year (October to September)	Inflow to Granby Reservoir		Tunnel diversion	Spills	Shortages
	Colorado River	Willow Creek			
1899-1900	242.8	52.4	320.0	----------	----------
1900-1901	246.9	53.4	320.0	----------	----------
1901-2	164.9	34.7	255.1	----------	64.9
1902-3	222.0	48.8	270.8	----------	49.2
1903-4	253.5	51.2	304.7	----------	15.3
1904-5	287.9	64.9	310.2	----------	9.8
1905-6	292.4	58.7	320.0	----------	----------
1906-7	381.0	78.3	320.0	----------	----------
1907-8	190.6	25.6	320.0	----------	----------
1908-9	323.8	91.5	320.0	----------	----------
1909-10	200.1	32.5	320.0	----------	----------
1910-11	268.5	53.6	320.0	----------	----------
1911-12	350.4	79.3	320.0	----------	----------
1912-13	215.4	40.3	320.0	----------	----------
1913-14	371.0	85.1	320.0	----------	----------
1914-15	223.2	43.8	320.0	----------	----------
1915-16	249.5	47.8	320.0	----------	----------
1916-17	348.3	79.7	320.0	----------	----------
1917-18	322.9	81.2	356.4	18.7	----------
1918-19	189.6	36.4	320.0	----------	----------
1919-20	361.2	78.4	345.6	----------	----------
1920-21	347.9	90.7	368.6	70.0	----------
1921-22	196.8	39.5	320.0	----------	----------
1922-23	280.3	60.2	320.0	----------	----------
1923-24	262.2	54.4	320.0	----------	----------
1924-25	202.6	36.7	320.0	----------	----------
1925-26	346.4	70.0	320.0	----------	----------
1926-27	275.0	54.8	320.0	----------	----------
1927-28	317.5	61.9	338.3	----------	----------
1928-29	297.1	61.2	358.3	----------	----------
1929-30	247.4	42.9	320.0	----------	----------
1930-31	171.5	36.6	320.0	----------	----------
1931-32	243.9	48.0	320.0	----------	----------
1932-33	239.6	54.5	320.0	----------	----------
1933-34	128.9	26.2	320.0	----------	----------
1934-35	209.2	41.8	252.5	----------	67.5
1935-36	279.7	53.8	310.0	----------	10.0
Average	263.6	55.4	318.7	2.5	5.5

Operating results cannot be expected to result so favorably. The operating conditions enumerated imply superhuman ability to forecast stream flow. Occasional releases will be required from Granby Reservoir although small in amount. Interruptions in tunnel operation cannot always be arranged so as to lose no water.

In view of these conditions, it is concluded that the firm yield of tunnel water from the Granby and Shadow Mountain Reservoirs should be taken as 300,000 acre-feet annually. Shortages of 5 percent may be expected on an average of once every 5 years and shortages of 25 percent may be expected on an average of once every 20 years. Secondary water may be expected to be available in some years in amounts up to 50,000 acre-feet.

EFFECT OF THE PROPOSED TRANSMOUNTAIN DIVERSION ON FUTURE WESTERN SLOPE DEVELOPMENT

Most of the diverted water is derived from the spring floods, when there is an excess of water over all present and future requirements along the Colorado River in the State. To permit full use of the inflow to the Granby Reservoir, Ranch Creek Reservoir may be constructed near Tabernash to store water locally surplus. The waters there conserved would in part be utilized to replace the waters withheld at Granby Dam, but the greater part of the conserved water would be used to augment irrigation supplies down to Hot Sulphur Springs and to maintain a satisfactory stream flow in this locality for recreational purposes.

With the region above Hot Sulphur Springs taken care of by the Ranch Creek Reservoir, the critical points along the Colorado River, from the standpoint of present and future use of water, are at Glenwood Springs, where the Shoshone power plant of the Public Service Co. uses present stream-flows up to 1,250 second-feet, and near Palisades at the head of the Grand Valley, where the Government high-line canal diverts water for irrigation and power purposes. The present irrigated area along the Colorado River between Palisades and the Colorado-Utah State line is 70,600 acres.

The additional arable area in this region, not now irrigated, is as follows:

	Acres
Under constructed canals	13,800
Pumping unit of Grand Valley project, for which canal capacity has been provided	10,000
Lands on Mack Flat, no present provision for water service	9,000
Total	32,800

Maximum irrigation demand at the head of the Grand Valley for the present irrigated area and for the additional area of 23,800 acres for which provision has been made in the constructed canals, is estimated as 1,700 second-feet, and this amount is being demanded in the pending adjudication proceeding.

With maximum irrigation demands there is a full water supply for the Orchard Mesa pumping plant and for the Grand Valley power plant. In the nonirrigation season the controlling requirement is for power with a total demand of 800 second-feet for power and for domestic needs under the higher canals. With the new area of 9,000 acres developed, the future demands are then estimated as 1,800 second-feet in the months of May to August, inclusive, tapering off uniformly to 800 second-feet on April 1 and on November 30.

In determination of the effect of the Colorado-Big Thompson transmountain diversion on the western slope, the past stream flows at Glenwood Springs and at the head of the Grand Valley were first depleted to show the resulting stream flows with the following developments:

(*a*) Full irrigation development of 276,000 acres of irrigated and arable lands along the Colorado River and tributaries above Palisades (the present irrigated area is 186,000 acres).

(*b*) Full development of Moffat Tunnel diversion from Fraser River and tributaries, Jones Pass diversion from Williams River, and Independence Pass diversion from the Roaring Fork, including

replacement storage so that these projects may divert all flows interceptible.

From the reconstructed flows, thus computed, there was subtracted the water estimated to be withheld at the Granby Reservoir site. The reductions in stream flow at Glenwood Springs and at the head of the Grand Valley, during those periods of each year when the resulting stream flows would be less than the future demands above described, then represents the effect of the project on the western slope if no replacement storage were provided. These computations were made for the years 1926 to 1936, inclusive, at Glenwood Springs, and for the entire period of record, 1902 to 1936, inclusive, at the head of the Grand Valley, with the following results:

Year	Shortages at Glenwood Springs (acre-feet)			Shortages at head of Grand Valley (acre-feet)		
	End of flood season, Oct. 31 [1]	Nov. 1 to flood season of following year [2]	Total	Before flood season in spring [3]	After flood season to Oct. 31	Total
1902	(4)	(4)		6,000	39,000	45,000
1903	(4)	(4)		3,000	12,000	15,000
1904	(4)	(4)		None	2,000	2,000
1905	(4)	(4)		None	14,000	14,000
1906	(4)	(4)		None	None	None
1907	(4)	(4)		None	None	None
1908	(4)	(4)		None	6,000	6,000
1909	(4)	(4)		None	None	None
1910	(4)	(4)		None	12,000	12,000
1911	(4)	(4)		None	1,000	1,000
1912	(4)	(4)		None	None	None
1913	(4)	(4)		None	7,000	7,000
1914	(4)	(4)		None	None	None
1915	(4)	(4)		None	9,000	9,000
1916	(4)	(4)		None	None	None
1917	(4)	(4)		None	None	None
1918	(4)	(4)		None	1,000	1,000
1919	(4)	(4)		None	7,000	7,000
1920	(4)	(4)		2,000	None	2,000
1921	(4)	(4)		None	None	None
1922	(4)	(4)		None	None	None
1923	(4)	(4)		None	None	None
1924	(4)	(4)		None	4,000	4,000
1925	(4)	(4)		None	None	None
1926	18,000	19,000	37,000	None	2,000	2,000
1927	7,000	32,000	39,000	None	None	None
1928	10,000	18,000	28,000	None	None	None
1929	None	20,000	20,000	None	None	None
1930	12,000	14,000	26,000	None	None	None
1931	37,000	16,000	53,000	1,000	27,000	28,000
1932	14,000	24,000	38,000	None	3,000	3,000
1933	23,000	21,000	44,000	5,000	15,000	20,000
1934	31,000	17,000	48,000	None	28,000	28,000
1935	20,000	15,000	35,000	2,000	11,000	13,000

[1] Encroachment on irrigation supplies.
[2] Encroachment on winter power waters.
[3] These shortages occur in years of late run-off when irrigation requirements rise faster than stream flow. Winter flows are always adequate Nov. 1 to Apr. 1.
[4] Not computed.

DIVERSION PLAN AND STRUCTURES

REPLACEMENT

In order to protect the water users in the Colorado River Basin against any depletion of their water supply by diversions through the Continental Divide tunnel to northeastern Colorado, a storage reservoir is planned on the Blue River about 16 miles southeast of Kremmling, Colo. This reservoir is to be known as the Green Mountain.

The dam site is located in the E ½ of sec. 15, T. 2 S., R. 80 W., sixth principal meridian, near the head of a box canyon, between Green and Little Green Mountains, caused by the river cutting through a porphyry sill. The foundation bedrock consists of sedimentary rocks, either Dakota sandstone or Morrison shales, and the intrusive porphyry.

The irrigation outlet capacity is 1,000 cubic feet per second, and the power outlet capacity is 1,500 cubic feet per second. The spillway capacity is 25,000 cubic feet per second.

The reservoir will flood 2,100 acres of land and will have a capacity of 152,000 acre-feet.

From the water-supply studies it was found, assuming that full development had taken place in the Colorado River Basin and that the Big Thompson project had been in operation the last 35 years, that in the year 1931, the lowest year of dependable run-off record, the Colorado Basin users above Glenwood Springs would have been shorted 37,000 acre-feet for irrigation use and the Public Service Co. would have been shorted 16,000 acre-feet at their power plant at Shoshone during the nonirrigation season, or a total shortage of 53,000 acre-feet. Accordingly, 50,000 acre-feet of Green Mountain storage have been allocated to replacement purposes for which the water users in northeastern Colorado will pay $1,500,000. The remaining 100,000 acre-feet are allocated to power and will be paid for out of power revenues.

Since the average shortage for both power and irrigation for the last 10 years, the lowest 10 years of run-off record is 36,000 acre-feet. There would be the 16,000 acre-feet difference, and a portion of the 100,000 acre-feet let out for power that could be used by the Colorado Basin users to supply shortages that might occur in their irrigation use in years of extreme low run-off, these shortages not being caused by the transmountain diversion.

The total estimated cost of the dam and reservoir is $3,776,032, $2,276,032 of which will be paid for from power revenues.

GRANBY RESERVOIR AND STORAGE

The storage of Colorado River waters for the project is to be made in what is known as Granby Reservoir which is located in Tps. 2 and 3 N., Rs. 75 and 76 W., sixth principal meridian, in Grand County, Colorado. The reservoir basin occupies the valleys of Stillwater Creek, the south fork or Arapaho Creek, and the main Colorado River.

The damsite is located about 4 miles northeast of the town of Granby, Colo., in the NE¼ of sec. 11, T. 2 N., R. 76 W., in Grand County, Colo. It is located at the head of a short canyon which the river has cut through pre-Cambrian rocks forming a spur of the main Rocky Mountain mass. At the damsite the canyon at river-bottom level is 200 feet wide, while at elevation 8,275 it is 720 feet in width.

The dam is to be a combination earth and rockfill structure with a maximum height of 223 feet. The outlet capacity is 300 cubic feet per second and the spillway capacity is 12,000 cubic feet per second.

With the high-water line at elevation 8,275 feet the reservoir has a capacity of 482,860 acre-feet, and will flood an area of 6,943 acres.

This reservoir will not only intercept the flow of the Colorado at that point, but the flow of Willow Creek will be intercepted near Dexter, Colo., and brought into the reservoir through a canal of 1,000

cubic feet per second capacity. Willow Creek enters the Colorado about 2 miles below Granby Dam.

It is estimated that Willow Creek will supply an average of about 60,000 acre-feet per year, and that the total estimated cost of this diversion is $733,203.

The storage in Granby Reservoir will also be augmented by the flow of Meadow and Strawberry Creeks, tributaries of Fraser River which enters the Colorado about 5 miles below the dam. The canal intercepting these two creeks will have a capacity of 500 cubic feet per second, and it is estimated they will produce an average of 12,000 acre-feet a year. The total estimated cost of this diversion is $133,600.

If water supply records kept in the future show there is sufficient water supply left in the Fraser River below the City of Denver's diversion, a canal could be taken out of it just below the mouth of St. Louis Creek near the town of Fraser, Colo., and extend from there to Granby Reservoir, intercepting Ranch, Meadow, and Strawberry Creeks on the way. A small regulating reservoir should be built on Ranch Creek above where the Canal intercepts it.

NORTH FORK DIVERSION DAM AND SHADOW MOUNTAIN LAKE

In order to divert the water of the North Fork of the Colorado into Grand Lake and thence to the channel extending from it to the west portal of the Continental Divide tunnel, it is planned to construct a concrete overflow dam 35 feet in height, above streamed, across the North Fork about one-half mile below its junction with the Grand Lake outlet.

The dam site proper is located in the NW¼ of sec. 19, T. 3 N., R. 75 W., and is a glacial morain cut through by the river.

The water backed up by this dam will form a lake called Shadow Mountain, the name of a nearby mountain, which will have a surface area of 1,356 acres. The elevation of this lake will be the same as Grand Lake and connected with it by means of the present outlet.

NORTH FORK DIVERSION DAM

The dam proper is a concrete gravity overflow spillway section, 90 feet long, with crest elevation at 8,370. This spillway is designed for maximum discharge of 1,800 cubic feet per second. On each side of the overflow section is a concrete gravity section containing three automatic siphon spillways on each side. The total spillway capacity is 9,400 cubic feet per second.

The total estimated cost is $483,928.

GRANBY PUMPING PLANT

As stated before, the water surface elevation of Granby Reservoir is 8,275 and the water surface of Shadow Mountain and Grand Lakes is 8,369. In order to get the water stored in Granby Reservoir into Shadow Mountain Lake and available for delivery through the Continental Divide tunnel, a pumping plant is located on the north shore of Granby Reservoir about one-half mile above the junction of the South Fork with the Colorado. A granite spur juts out into the reservoir site at that point making it ideal for the intake tunnels and a shaft for the pump.

The proposed pumping plant will contain three motor-driven vertical-shaft pumping units having a total capacity of 900 cubic feet per second with full reservoir and 550 cubic second-feet at low water. At normal water surface the capacity will be 870 cubic feet per second.

Each pump will be driven by a 6,500-horsepower synchronous motor.

Power will be delivered to the plant from a 69,000-volt transmission line extending from power plant no. 1 just below Estes Park, around the Rocky Mountain National Park, and crossing the Continental Divide at Buchanan Pass about 5 miles south of the park boundary.

The water from the pumps empties into a canal of 900 cubic second-feet capacity and runs by gravity into Shadow Mountain Lake. It is planned to operate this canal all winter when temperatures get as low as 40° below zero. The latent heat in the water and the friction heat absorbed from the pumps will prevent this water from freezing and will keep quite an area open after the water reaches Shadow Mountain Lake.

The total estimated cost of the pumping plant is $1,250,000.

The total estimated cost of the pump canal is $417,553.

CONTINENTAL DIVIDE TUNNEL

The west tunnel portal is connected with Grand Lake by means of a channel constructed 67.5 feet in width and 15 feet in depth. At the lake end of this channel a permanent concrete barrier or weir will be placed with a crest elevation at 8,368 which would be the minimum elevation to which the water in Grand Lake could be drawn. Since the barrier is so constructed that it requires the water to be 1 foot in depth over it to supply the normal capacity of the tunnel, the normal elevation of Grand and Shadow Mountain Lakes would be 8,369 feet.

The present maximum fluctuation of Grand Lake is about 4 feet, or from an elevation of 8,368 in winter to 8,372 feet during the peak run-off from melting snow. The automatic control gates at the North Fork Diversion Dam and at tunnel inlet will so control the elevation of the water surface in Grand Lake that it would never fluctuate more than 1 foot.

The Continental Divide tunnel extends from the easterly end of Grand Lake to Wind River, southwest of Estes Park, with an azimuth of 242° 20′ 30″, and length of 69,023 feet. It is to be horseshoe shape 9.5 feet in diameter and lined throughout with a 9-inch concrete lining.

It will be located entirely in pre-Cambrian rock consisting of the Longs Peak and related granites and the gneisses and schists of the Idaho Springs formation. The granites are strong massive rocks. Gneisses predominate over schists and only a small proportion have prominent and continuous cleavage planes. The proportion of granite to gneiss and schist is approximately 4 to 1.

From a detailed geological survey of the tunnel and comparing it with conditions actually encountered in the Moffat Railroad tunnel, which was built under the Continental Divide for the Denver & Salt Lake Railroad, and about 25 miles due south of this one, it was estimated there would be only 400 feet of bad ground and 5,200 feet of ground needing support. However, for purposes of estimate, it was figured there would be 6,900 feet of bad ground and 17,500 feet of ground needing support.

The total estimated cost is $7,271,371.

POWER CONDUIT NO. 1

Power conduit no. 1 extends from the east portal of the Continental Divide tunnel in Wind River to the penstock of power plant no. 1 on the northeast slope of Prospect Mountain.

Both ends of the Continental Divide tunnel are without the national-park boundaries but the area east of the east portal is authorized by Congress to be taken in, through that area. The water will be taken through a closed conduit consisting of a 10-foot reinforced concrete pipe completely buried. The total length of power conduit is 5.36 miles, of which 1.86 miles is closed conduit, 1.19 miles is concrete lined tunnel, 0.98 mile is siphon, and the remainder is open canal.

The total estimated cost of power conduit no. 1 is $1,101,000.

POWER PLANT NO. 1

Power plant no. 1 will be located on the south bank of the Big Thompson River about one-half mile east of Estes Park. It will contain two 15,000 kilovolt-ampere generating units with auxiliaries. Each unit will consist of a vertical-shaft, single-runner, spiral-casing type hydraulic turbine operating under an effective head of 705 feet direct connected to a 15,000 kilovolt-ampere water-wheel type generator. A complete description with cost estimate will be found in Power and Pumping Summary.

Until there has developed a sufficient market for power to justify the construction of power plants nos. 2 and 3, the water will be turned into the Big Thompson at power plant no. 1 and carried by that stream to a diversion dam located in SE¼ sec. 1, T. 5 N., R. 71 W., about midway between the present diversion dam and power plant for the town of Loveland, Colo.

POWER CANAL NO. 4

From this diversion dam the water will be carried in a canal of 750 cubic second-feet capacity on the south side of the stream a distance of 4.93 miles to a point just above the mouth of the Big Thompson Canyon. At this point a portion of the water will drop direct into the Big Thompson River to supply the supplemental water demands of that stream and a portion will be siphoned across to elevation 5,450 to supply the canal going to the Poudre River, which will be described later. Power plants nos. 4 and 4–A will be constructed at this point to take advantage of a fall of 550 feet into the Thompson and 358 feet to the Poudre Canal when the power market justifies.

CARTER LAKE SUPPLY CANAL

About 3.07 miles below the diversion dam mentioned above, a canal of 300 cubic feet per second takes off toward the south and supplies Carter Lake.

This canal is 8.78 miles in length, of which 7,040 feet is tunnel 1,878 feet siphon, and the remainder is open canal.

The estimated cost of this supply canal is $710,629.

CARTER LAKE RESERVOIR

This site is located in Ts. 4 and 5 N., R. 70 W., of sixth principal meridian, about 1 mile north and 7 miles west of Berthoud, Colo.

The reservoir will occupy a valley about 2¾ miles long and from one-half to 1 mile wide. The northern portion of the area is a natural

basin called Carter Lake. This lake dried up during the last 5 drought years, for the first time within the memory of the white settlers.

The proposed maximum water surface in the reservoir is at elevation 5,760 with a capacity of 111,963 acre-feet. The area of high water line is 1,150 acres. For this water surface three dams will be required. Dam no. 1 is located at the natural outlet of the valley and will contain the outlet works for the reservoir; the other two dams will occupy saddles. These dams are earth and rock fill; the main dam is 243 feet high, and the saddles 43 and 48, respectively.

The capacity of the outlet to St. Vrain supply canal is 300 cubic feet per second, the outlet to the Big Thompson has a capacity of 1,000 cubic feet per second.

The total estimated cost of the reservoir is $1,822,202.

ST. VRAIN FEEDER CANAL

A canal of 300 cubic feet per second capacity will extend from the small outlet of Carter Lake to the St. Vrain, reaching the St. Vrain high enough to supply all ditches.

The length of this canal is 9.76 miles with 3,445 feet in tunnel, 1,575 feet of siphons, and the remainder open canal.

The estimated cost of the St. Vrain feeder is $368,951.

BIG THOMPSON FEEDER

About one-half mile below Carter Lake Dam a canal will be taken out of the draw leading from the dam, and will run into Cottonwood Creek, a tributary of the Big Thompson. This canal will have a capacity of 1,000 cubic feet per second and be 5.37 miles in length.

The cost is estimated at $155,246.

HORSETOOTH SUPPLY CANAL

This canal starts at the end of a siphon across the Big Thompson from power conduit no. 4. This water will pass through power plant no. 4–A when constructed. The canal starts at elevation 5,450 with a capacity of 250 cubic feet per second. The structures, however, are designed for a capacity of 400 cubic feet per second on the theory that some time in the future it might be necessary to increase the capacity of the canal to that amount. The length of this canal is 9.88 miles, of which 12,863 feet is tunnel, 3,296 feet is siphons, and the remainder open canal.

The elevation of 5,450 was chosen because it not only puts the water above all present diversions on the Poudre River, but it afforded the most direct and economical route.

The estimated cost of this feeder is $1,208,391.

HORSETOOTH RESERVOIR

The proposed Horsetooth Reservoir will occupy a valley 6 miles long and from one-quarter to three-quarters miles wide, extending in a north-south direction, formed by the erosion of soft red beds of Lykens formation between harder ridges of Lyons on the west and Dakota sandstone on the east. There are three natural outlets to the east through the Dakota hogback, namely, Soldier, Dixon, and

Spring Canyons, which are the sites of three proposed dams of the same names. The fourth proposed dam, Horsetooth, will cross the valley at the north end on a low saddle separating the valley from drainage to the north into the Poudre River. The outlet will be through the Horsetooth Dam saddle. There are no outlets through the other dams. The proposed water surface is at 5,400 feet in elevation which gives a capacity of 96,756 acre-feet. The area flooded will be 1,513 acres. The outlet capacity was designed for 1,200 cubic feet per second with reservoir full. This large capacity is necessary as the irrigation use requires that the entire amount of supplemental water be delivered at a rate that would supply it in 60 days.

The advantages of a reservoir at this point are: It is high enough to supply all users from the main Cache La Poudre River and is located close to it. It takes the place of 6 miles of canal through rough country and allows a canal of 250 cubic second-feet to be constructed from the Big Thompson instead of one for 1,000 cubic feet per second.

The estimated cost of the reservoir is $3,625,021.

POUDRE FEEDER CANAL

From the outlet of Horsetooth Reservoir a canal of 1,000 cubic second-feet capacity will extend north to Lewstone Creek, a tributary of the Poudre. The water will run down this creek to the Poudre above all the diversions except the Poudre Valley.

POUDRE VALLEY FEEDER CANAL

A canal will extend from Lewstone Creek to the Poudre Valley Canal about 1 mile below its headgate, crossing the Poudre River in a siphon. This canal will have a capacity of 400 cubic feet per second to take care of the supplemental demands of the Poudre Valley Canal and also the demands of the North Poudre irrigation district. The total length of the two canals is 5.48 miles.

The cost of the Poudre Feeder and Poudre Valley Canals is estimated at $632,843.46.

NORTH POUDRE FEEDER CANAL

It is planned to enlarge the Poudre Valley Canal for a distance of 3.58 miles from the point the supply canal enters to the location of the pumping plant for the North Poudre district. This will enlarge the canal from a capacity of 500 to 750 cubic feet per second and the estimated cost is $11,436.

NORTH POUDRE PUMPING PLANT

This pumping plant, constructed on the banks of the Poudre Valley Canal, will consist of two 75 cubic second-feet capacity vertical synchronous motor driven single stage pumps, operating against an effective head of 187 feet.

The estimated cost is $200,000.

NORTH POUDRE FEEDER CANAL

This canal of 150 cubic second-feet capacity extends from the pressure outlets of the pumping plant to the North Poudre Canal, a distance of 9.98 miles.

The estimated cost is $128,889.

ARKINS RESERVOIR

This reservoir is located on Buckhorn Creek, a tributary of the Big Thompson, in Tps. 5 and 6 N. R. 70 W., sixth principal meridian, and about 8 miles northwest of Loveland, Colo. The object of this reservoir is to provide storage for Colorado River waters brought over in the wintertime and to be used to supply supplemental water on the lower South Platte in water districts 1, 2, and 64. It will also serve in connection with the use of the 16,000 acre-feet of floodwater now available on the Big Thompson.

The bringing of more of the supplemental water over in the wintertime aids materially in the production of a maximum amount of power out of the waters of the Big Thompson River. For that reason the entire cost of the inlet to Arkins Reservoir and one-half the cost of the reservoir itself is assessed against power and paid for out of power revenues from plant no. 1.

The capacity of Arkins Reservoir is 50,000 acre-feet with a high water line at 5,275 feet elevation and floods 929 acres of land.

The dam site occupies a notch cut through the Dakota sandstone ridge by Buckhorn Creek.

The main dam is an earth- and rock-fill structure 155 feet in height with an outlet capacity of 650 cubic feet per second and a spillway of 10,000 cubic second feet capacity.

There is a saddle dam, in addition to the main dam of earth- and rock-fill construction, 50 feet maximum height, built across a saddle at the southern extremity of the reservoir.

The total estimated cost of the reservoir and dam is $1,740,737.

The estimated cost of the Arkins Reservoir inlet is $351,488.

This inlet diverts from the Big Thompson River just below the dam of the Handy Canal and follows around the north side of the river a distance of 2.33 miles to Arkins Reservoir.

ROCKY MOUNTAIN NATIONAL PARK

Every effort has been made in the survey and design of this project to not disturb the natural beauties of the Rocky Mountain National Park and its surrounding areas. The Continental Divide tunnel was lengthened 1.6 miles in order that its extremities should fall outside the boundaries of the park. The conduit leading from the east portal of the tunnel to power plant no. 1 is to be buried and the surface landscaped through the area authorized by Congress to be added to the park. The waste from the east portal of the tunnel placed in this area is to be terraced and planted with evergreen trees. The waste from the west portal is to be used to fill up some low areas and render the area suitable for the building of summer homes.

The approach to the Western Gateway of the Rocky Mountain National Park will be along the shores of Shadow Mountain Lake with

its fluctuation of only 1 foot instead of the swampy area that now breeds mosquitoes and exposes mud flats in low water.

The bill authorizing the creation of the Rocky Mountain National Park reserved the right for the Bureau of Reclamation to survey and construct an irrigation project within the boundaries of the park.

OPERATION OF THE SYSTEM

IRRIGATION PROJECT OPERATIONS

The system is planned and it is anticipated that it will be operated in a manner to have the water available in Carter Lake, Horsetooth and Arkins Reservoirs available by July 1, to the full capacity of those reservoirs, 256,000 acre-feet. The usual demand for supplemental water begins July 1 to 15 and extends to September 15 to 30. The outlets of the reservoirs are planned to deliver the water from the reservoirs in 60 to 75 days, including the water that must pass through them for direct delivery that may be in the way of being transferred from the Colorado River Basin to the eastern slope during the period of irrigation application. The balance of the 310,000 acre-feet, or 54-000 acre-feet, will be available for direct irrigation use as brought over during the above period or to some extent may be required prior to July 1.

The run-off of the waters of the Colorado River here contemplated to be used will largely be secured from the melting snows during May, June, and early July and stored in the Granby Reservoir. During the fall of that year, winter and spring of the following year, the water will be transferred from the Granby Reservoir through the Continental Divide tunnel at a uniform rate and restored in the Carter Lake, Horsetooth, and Arkins Reservoirs. This will permit a flow that is well suited to the development of firm power through the five power plants that will eventually be constructed along the Big Thompson as shown on the map of the general layout.

Granby Reservoir will act as a hold-over reservoir to carry the water from years of excessive run-off to years of subnormal flow.

POWER PROJECT OPERATION

Water will be carried through the Continental Divide tunnel at a uniform flow for the generation of power at the several power plants, except that the quantity will be reduced during the summer season when some water from the Big Thompson is available for power purposes in power plants nos. 2, 3, 4, and 4–A. At this period there will be little or no demand for power for pumping at the Granby pumping plant, which will permit the cutting down of the quantity of water to take care of the commercial power load.

It is planned to construct the Granby pumping plant and the Granby pump canal 150 percent of the capacity of the Continental Divide tunnel. This will permit the operation of the pumping plant at full capacity with off-peak power, and reduce the amount of pumping with firm power. The varying discharge of the pump ditch during the 24-hour period will be equalized by the Shadow Mountain and Grand Lakes, so that a uniform discharge will be maintained through the Continental Divide tunnel. The range in height of water surface in Shadow Mountain and Grand Lake to equalize this

flow will not exceed two-tenths of a foot, and will be greatest in the winter and early spring months.

There is an average of 16,000 acre-feet of surplus water on the Big Thompson available for storage in the system mainly in May and June. In order to take this water into the reservoirs it will be necessary to reserve capacity in the three reservoirs on the eastern slope until toward the latter part of June. The snowfall, the main source of this water supply, will be known well in advance so that operations of the several parts of the system, including the production of power at the several power plants, can be adjusted to take care of this water and hold back an equal amount in Granby Reservoir.

TENTATIVE PROJECT FINANCIAL SET-UPS

This proposed development consists of two projects: first, the irrigation project, and second, the power project.

It is planned that those features of the development that are used mainly for irrigation are grouped under the irrigation project set-up, while those used entirely, or are made of a greater capacity because of power development, are grouped in whole or in part in the power project set-up.

IRRIGATION PROJECT

The following major features with their appurtenant structures are given with the estimated field costs including 10 percent for engineering and 15 percent for contingencies. The full capacity of Arkins Reservoir is necessary to develop a larger portion of firm power than would otherwise be possible without it. At the same time, a reservoir of half its capacity or additional capacity in Horsetooth or Carter Lake Reservoirs would be necessary to provide capacity to deliver the irrigation water as needed. It is, therefore, deemed equitable to divide the cost of this reservoir equally between the irrigation and power projects.

The Green Mountain Reservoir, with a capacity of 152,000 acre-feet, is larger than is necessary to furnish replacement for a like amount of water diverted by the project above Granby Dam at a time when it would be required for irrigation, present and future, and to furnish the Shoshone power plant 1,250 second-feet or such lesser amount that they would be entitled to receive if the proposed project was not operating. From studies made, it appears that 50,000 acre-feet will be sufficient to replace all the water that the proposed project will take at a time when required for use lower down in the stream within the State. Therefore 52,000 acre-feet of the Green Mountain Reservoir capacity is allocated for replacement (including evaporation losses) and charged to the irrigation project. The balance of the capacity or 100,000 acre-feet is allocated to the power project and is to be paid for out of power revenues.

The following is a summary of the irrigation project costs:

Estimated cost chargeable to irrigation feature

Willow Creek feeder canal	$733, 203
Granby Reservoir	2, 813, 703
Granby pumping plant	1, 250, 000
Granby pump canal	417, 553
North Fork diversion dam	483, 928
Continental Divide tunnel	7, 271, 371

Estimated cost chargeable to irrigation feature—Continued

Carter Lake supply canal		$710, 629
Horsetooth supply canal		1, 208, 391
St. Vrain feeder canal		368, 951
Big Thompson feeder canal		155, 246
Poudre feeder canal		632, 843
Poudre Valley feeder canal		11, 436
North Poudre feeder canal		128, 889
North Poudre pumping plant		200, 000
Horsetooth Reservoir		3, 625, 021
Arkins Reservoir		1, 859, 323
Carter Lake Reservoir		1, 925, 253
Green Mountain Reservoir (52,000 acre-feet replacement) (100,000 acre-feet for power)		3, 776, 032
Improvement of Colorado River above Kremmling to maintain fishing and to adjust the present irrigation system to the altered conditions		300, 000
		27, 871, 772
Less the following items tentatively chargeable to power:		
One-half cost of Arkins Reservoir	$929, 661	
Portion of cost of Green Mountain Reservoir for 100,000 acre-feet	2, 276, 032	
		3, 205, 693
Cost of irrigation features		24, 666, 079
Say		24, 800, 000

REPAYMENT

Twenty-four million eight hundred thousand dollars upon 310,000 acre-feet at $80 per acre-foot.

Two dollars per acre-foot on 40-year repayment basis.

In the above repayment is predicated upon the contracts to be made upon a basis of 310,000 acre-feet. Beside the 320,000 acre-feet available from the Colorado River drainage there is an average of 16,000 acre-feet available for storage on the Big Thompson, making 336,000 acre-feet in all, leaving 26,000 acre-feet for losses on the eastern slope and for the uncertain, heretofore mentioned in operations on the western slope.

The power costs are shown under the heading "Power and pumping system."

The construction of power plant no. 1 as shown in the power set-up is a necessary development in order to secure power for pumping purposes at the Granby pumping plant.

POWER AND PUMPING SYSTEMS

The ultimate power and pumping system is proposed to consist of the major pumping plant at Granby, power plant no. 1 near the town of Estes Park, power plant no. 2 near Drake post office, power plant no. 3 at Cedar Cove, power plants nos. 4 and 4–A near the mouth of the Big Thompson Canyon, and power plant no. 5 at the Green Mountain Reservoir. If conditions justify, there may also be a pumping plant on the Poudre River near the point where the proposed Poudre supply canal crosses the river. Power plant no. 5, Granby pumping plant, and power plant no. 1, would be interconnected by a single circuit 69,000-volt transmission line. Power p ants nos. 1 to ~~4–A,~~ inclusive, would be interconnected by two 115,000-volt transmission lines and these same lines would extend to one or more load centers where the power could be disposed of commercially.

The buildings for the power and pumping plants would be of reinforced concrete construction of suitable size to house the machinery and provide space for such facilities as would be required for efficient and economical operation. For scenic reasons, special care would be taken in the architectural design of the buildings to make them blend in with the beauties of the surrounding territory so as to be both as inconspicuous as possible and also as artistic as feasible without undue expenditure. An artist's sketch of one of these buildings is included with the report.

Following is a tabulation covering the essential data for each of the power and pumping plants:

Power plants

Plant designation	Effective head in feet	Turbine capacity in cubic feet per second	Power available in horsepower	Number of units	Size of each unit in horsepower	Installed power in kilowatts
No. 1	704	550	38,800	2	20,000	30,000
No. 2	1,195	550	65,800	2	34,000	50,000
No. 3	328	550	18,000	2	9,000	13,500
No. 4	550	400	22,000	1	22,000	16,000
No. 4-A	381	250	9,500	1	9,500	7,000
No. 5	225	1,500	33,800	2	17,000	26,000
Total installed power in kilowatts						142,500

Pumping plants

Plant designation	Head in feet	Pump capacity in cubic feet per second	Capacity of each pump in cubic feet per second	Number of pumps	Rating of each motor in horsepower	Power required in kilowatts
Granby	130	870	290	3	6,500	15,000
Poudre	187	150	75	2	2,000	3,000
Total installed pumping, kilowatts						18,000

POWER PLANT NO. 1

Power plant no. 1 will be located on the south bank of the Big Thompson River about one-half mile east of the village of Estes Park and will contain two 15,000 kilovolt-ampere generating units with auxiliaries. Each unit will consist of a vertical-shaft, single-runner, spiral casing type hydraulic turbine operating under an effective head of approximately 705 feet and direct connected to a 15,000 kilovolt-ampere water-wheel type generator with direct connected exciter and pilot exciter. Water would be supplied to each turbine through a steel penstock approximately 5,000 feet long, with synchronous bypasses provided so that the flow through the penstock can be discharged either through the turbines or the bypasses into the Big Thompson River. The bypasses will be mechanically connected to the turbine gate operating mechanism so that rapid governing of the units under varying load conditions can be effected without creating excessive water hammer. Trashracks with shut-off gates for

each penstock will be provided in the forebay structure. The headgates will be controlled from the power plant. A spillway will be provided to care for the flow when the headgates are closed and the penstocks inoperative. The plant will be equipped with all necessary auxiliaries, including a traveling crane for handling the large pieces of equipment. A small machine shop will be provided for making minor repairs. An outdoor type substation with self-cooled transformers will be provided for stepping the voltage up to 69,000 for transmission to the Granby pumping plant, and to 115,000 volts for transmission to commercial markets. The substation structure will be of the conventional structural steel type with high voltage oil circuit breakers, lightning arresters and necessary auxiliaries. The control of the oil circuit breakers will be from the main power plant switchboard. Operators' quarters, a warehouse, and a large machine shop for general project repairs will be provided in the vicinity of the power plant.

POWER PLANT NO. 2

Power plant no. 2 will be located about one-half mile northwest of Drake, on the south bank of the north fork of the Thompson River just above its junction with the Big Thompson. The plant will contain two 25,000-kilovolt-ampere generating units of the horizontal shaft type. The net head will be approximately 1,195 feet. Each unit will consist of a double overhung impulse wheel hydraulic turbine with the generator mounted in the center, between the two runners. A direct connected exciter and pilot exciter will be mounted at one end. Water will be delivered to the turbines through two steel penstocks about 4,150 feet long. Each penstock will be provided with two branches to the turbine nozzles and each branch will be provided with a synchronous bypass arranged so that the flow through the penstock can be discharged through either the nozzles of the bypasses to the river. The bypasses will be mechanically connected to the turbine nozzle operating mechanism so that rapid governing can be effected under varying load conditions without excessive water hammer. The head-gate structure will be provided with trash racks and sliding gates at the end of the penstocks and a spillway to care for the flow when the gates are closed. The plant will be complete with all necessary auxiliaries for station service requirements and with a crane for handling the machinery. A structural steel outdoor type substation will be provided with self-cooled transformers for stepping the voltage to 115,000 volts, and with outdoor type oil circuit breakers, lightning arresters, and other necessary auxiliaries. The operation of the substation will be handled from the main switchboard of the power plant. Quarters for the operators will be provided adjacent to the power plant.

POWER PLANT NO. 3

Power plant no. 3 will be located about one-half mile east of the Loveland power-diversion dam on the north bank of the Big Thompson River. The plant will contain two 6,500 kilovolt-ampere generating units, each consisting of a vertical hydraulic turbine direct connected to a generator with main exciter and pilot exciter. The effective head will be approximately 328 feet. Water from the head-gate structure will be delivered to the turbines through steel

pen stocks about 650 feet long. Each pen stock will be provided with a synchronous bypass arranged so that the flow through the pen stock can be discharged either through the turbines or the bypasses to the Big Thompson River, and to allow rapid governing of the units without excessive water-hammer. The head-gate structure will be provided with trash racks and sliding gates at the head of the pen stocks and a spillway to care for the flow when the gates are closed. The plant will be complete with all necessary auxiliaries for station-service operation, and with a crane for handling equipment. The plant will be provided with a structural-steel outdoor-type substation similar to that proposed for plant no. 2.

POWER PLANTS NOS. 4 AND 4–A

Power plant no. 4 will be located about 2 miles east of Cedar Cove on the south bank of the Big Thompson River, while power plant no. 4–A will be located a short distance upstream from plant no. 4, and at an elevation about 175 feet above the river. The capacity of plant no. 4 will be 16,000 kilovolt-amperes and of plant no 4–A, 7,000 kilovolt-amperes. One unit only will be provided at each plant and will consist of a vertical-shaft, single-runner, spiral-casing type turbine direct connected to a vertical water wheel generator with direct connected main and pilot exciters. Plant no. 4 will have an effective head of about 550 feet, and plant no. 4–A, 380 feet. Plant no. 4 will receive its water through a single steel penstock about 1,960 feet long, and plant no. 4–A, through a similar pipe about 1,400 feet long. Each plant will be provided with synchronous bypasses similar to those in plants nos. 1 and 3. Plant no. 4 will discharge directly into the Big Thompson River. Plant no. 4–A will be siphoned under the river through a pressure tunnel to the proposed Poudre supply canal, but will have provisions so that if so desired, the water may be discharged directly into the Big Thompson River. The headgate structure will be provided with trashracks, sliding gates, and spillways similar to those in plants nos. 1, 2, and 3. A single outdoor structural steel type switchyard will be provided for the two plants. The equipment in this substation will be similar to that for plants nos. 1, 2, and 3. Plant no. 4–A will be remotely controlled from plant no. 4, so that the two plants can be operated with one set of operators. The plant will be complete with auxiliaries and cranes similar to that in other plants. Quarters for the operators will be provided in the vicinity of the plants.

POWER PLANT NO. 5

Power plant no. 5 will be located about 12½ miles southeast of Kremmling, on the east bank of the Blue River, immediately downstream from the dam forming the proposed Green Mountain Reservoir. The plant will contain two 13,000 kilovolt-ampere generating units of the vertical hydraulic-turbine driven type, with direct connected generator with main and pilot exciters. The plant will have a varying head depending upon reservoir water surface, but it is expected that the average head will be about 225 feet. The trashrack and intake structure will be located immediately upstream from the dam and a single steel penstock installed in the tunnel will conduct the water to the power plant. Each turbine will be provided with a

pressure regulator or relief valve to limit the water hammer under sudden change of load conditions. The plant will be complete with necessary auxiliaries for station service, a small machine shop for minor repairs, and a crane for handling equipment. An outdoor structural steel substation will be provided complete with equipment for stepping the voltage up to 69,000 volts for transmission and with oil circuit breakers and other necessary auxiliaries for the control and protection of the lines and equipment. The oil circuit breakers will be controlled from the main switchboard of the power plant. Quarters for operators will be constructed in the vicinity of the power plant.

GRANBY PUMPING PLANT

The Granby pumping plant will be located approximately 6 miles south of the village of Grand Lake on the north shore of the proposed Granby Reservoir. The plant will contain three motor-driven vertical-shaft pumping units having a total capacity of 900 second-feet at full reservoir, and 550 second-feet at low water. The total capacity at the normal water surface will be approximately 870 second-feet. The motors will be of the synchronous type and arranged for semi-magnetic operation. That is, the operator will be required only to close the main switch to the unit in order to place it in operation, and to open the same switch to discontinue operation. The motors will be equipped with direct connected exciters. The water from the Granby Reservoir will be delivered to the pumps through tunnels about 155 feet long. A channel in the reservoir will convey the water to the mouth of the intake tunnels in extreme low water. Water from each pump will be discharged through about 175 feet of tunnel, and 165 feet of steel pipe to the canal at elevation approximately 8,381. This canal, which will be approximately 4 miles in length, will discharge into the proposed Shadow Mountain Lake. The center line of each pump and propeller will be at approximately elevation 8,145, with the base of the motor driving the pump 135 feet above, or at elevation 8,280. Vertical shafts in the rock between the underground pump room and the motor room on the surface will accommodate the shafts connecting the pumps to the motors. Each pump will have a capacity of 290 second-feet when operating under a total dynamic head of 130 feet and will be driven by a 6,500-horsepower synchronous motor.

The entrances to the intake tunnels will be provided with trashrack and stop-log structures, and sliding gates will be installed at the intake and discharge of each pump. The intake gates will be located in the gallery adjoining the pump room and will be hydraulically operated. The discharge gates will be located at the head of the canal and will be of a type which will close automatically in the event power service is interrupted, so as to prevent water in the canal from running back down through the pump.

The pumping plant will be complete with auxiliary pumping units for unwatering the intake and discharge tunnels and the drainage sump. It will also be complete with all other necessary station auxiliaries, including a crane for handling the equipment. A small machine shop will be provided for making minor repairs. Quarters for the operators will be provided in the vicinity of the plant.

Power will be delivered to the plant from a 69,000-volt transmission line, through an outdoor structural steel type substation containing self-cooled transformers, together with all necessary protective appa-

ratus and auxiliaries. The operation of the substation will be handled from the main switchboard of the pumping plant.

POUDRE PUMPING PLANT

The Poudre pumping plant will be located on the Poudre Valley Canal at a point about 3 miles below the crossing of the proposed Poudre supply canal. It is proposed to have a capacity of 150 second-feet, composed of two 75-second-foot vertical synchronous-motor-driven single-stage pumps, operating against an effective head of 187 feet. The plant will be complete with all necessary auxiliaries, including a crane for handling the equipment. An outdoor substation will be provided for stepping the voltage down from transmission voltage to motor voltage. Due to the relatively short periods of operation, it is not probable that it will be necessary to construct operator's quarters at this plant.

TRANSMISSION SYSTEM

The transmission system will consist of a single 69,000-volt circuit connecting power plant no. 5 with the Granby pumping plant and power plant no. 1. Power plants nos. 1 to 4–A, inclusive, will be connected by two 115,000-volt lines and two 115,000-volt lines will continue to market. For the purpose of this report only, and to include a sufficient amount in the cost estimates for any probable transmission set-up, this market has been assumed as the valmont steam plant of the Public Service Co. of Colorado. Power plant no. 4 will be connected with the Poudre pumping plant by one 34,500-volt transmission line. The number of lines and mileage involved in each are as shown in the following tabulation:

From—	To—	Number of lines	Number of miles	Voltage
Power plant no. 5	Ka Rose	1	36	69,000
Granby pumping plant	Grand Lake	1	10	69,000
Do	Power plant no. 1	1	36	69,000
Power plant no. 1	Power plant no. 2	2	12	115,000
Power plant no. 2	Power plant no. 3	2	3	115,000
Power plant no. 3	Power plant no. 4	2	4	115,000
Power plant no. 4	Valmont	2	27	115,000
Do	Poudre pumping plant	1	18	34,500

The line to the Poudre pumping plant would be a wood-pole line with pin-type insulators. All other lines would be of the wood-pole, H-frame type, with suspension insulators, and combining all of the most modern features for continuity of service, ease of maintenance, and long life. The line from power plant no. 1 to the Granby pumping plant will probably require special construction to give added strength in the mountainous region near the Continental Divide.

In order to provide power for construction, it is proposed that one of the first features of the project would be to build one of the permanent 115,000-volt circuits from the Valmont plant to plant no. 1, the permanent 69,000-volt lines from plant no. 1 to Granby pumping plant and from Ka Rose to the Green Mountain dam site, and an extension from the Granby Pumping Plant to the west portal of the pro-

posed tunnel. Initially this entire line would be operated at 69,000 volts, and under such operation would be adequate for all contemplated construction activities. In connection with supplying construction power it would also be necessary to install a substation at the Valmont steam plant to step voltage up to 69,000 volts for transmission. Preliminary studies indicate that it would be advisable to make this substation of approximately 5,000 kilovolt-ampere capacity.

The estimated cost of installing the facilities to provide construction power are as indicated in the following tabulation:

From—	To—	Miles	Cost	
			Per mile	Total
Valmont	Power plant no. 2	34	$6,750	$229,500
Power plant no. 2	Power plant no. 1	12	4,100	49,200
Power plant no. 1	Granby pumping plant	36	3,600	129,600
Granby pumping plant	Grand Lake	10	3,200	32,000
Ka Rose	Power plant no. 5	36	3,600	129,600
Total transmission lines		128		569,900

Substation at Valmont	$61,300
Total to supply power for construction	631,200

The transmission system as provided to furnish construction power would be adequate for transmission of power to markets from power plant no. 1 or power plant no. 5 if either were built individually, but the additional complete system would probably be constructed when two or more plants are constructed. The additional costs of the lines involved in this construction are shown in the following tabulation:

From—	To—	Miles	Cost	
			Per mile	Total
Power plant no. 1	Power plant no. 2	12	$4,100	$49,200
Power plant no. 2	Valmont	34	6,750	229,500
Power plant no. 4	Poudre pumping plant	18	1,800	32,400
Total additional cost of permanent transmission system		64		311,100

In addition to the transmission lines required for the disposal of power, it may be necessary that the Government also construct a substation at the point of power disposal. As a market survey has not been conducted to establish the points at which this power can be disposed of, or the quantities involved at each point of disposal, it is assumed for the purpose of this report that the substations will average in cost $10 per kilowatt of capacity. Assuming that provision is made to dispose of a peak capacity of 140,000 kilowatts, this will involve an additional expenditure of $1,400,000.

POWER OUTPUT

Water supply studies indicate that with power plant no. 1 only constructed, there is available, above all requirements for pumping purposes, a constant power output at 100 percent load factor of 120,000,000 kilowatt-hours per year. Since the pumping plant capac-

ity proposed is sufficient to allow pumping to be done in 16 hours of each day it will be possible to handle peak commercial power requirements without undue interference. With this in mind, it has been assumed for the purpose of this report that a market can be found which has a load factor such that 60 percent of this power or 72,000,000 kilowatt-hours per year can be absorbed as firm energy. The balance of this energy, or 48,000,000 kilowatt-hours per year, plus about 40,000,000 kilowatt-hours additional, which is available during various parts of the year, is classed as secondary energy.

Since the Valmont steam plant of the Public Service Co. of Colorado has an installed capacity of 75,000 kilowatts, it appears that the 88,000,000 kilowatt-hours of secondary energy could be absorbed as a fuel saving measure if the price does not exceed fuel costs. Allowing 10 percent for line losses, this is equivalent to an average load of about 9,000 kilowatts.

FINANCIAL OPERATION OF POWER SYSTEM

It is contemplated that the initial power development would consist of the construction of power plant no. 1 only, together with such transmission lines and substations as are required to supply power to the Granby pumping plant and to commercial markets. The estimated construction cost of the strictly power features, as well as items which it is expected that power revenues will repay, is given below.

It is assumed that 5 mills per kilowatt-hour can be secured for firm energy and 1.8 mills per kilowatt-hour for secondary energy with delivery at the market. In each case 10 percent loss is allowed for transmission. The following gives the financial set-up for power plant no. 1, operation costs and returns.

While for the purpose of this report the allocation of construction cost to irrigation and power has been made on the basis set out below, it is understood that this allocation is not thereby fixed, and the same may be changed as further information may warrant until such time as the contract for repayment of the cost of the irrigation features has taken final form.

Power plant no. 1 construction costs

Power plant no. 1 near Estes Park	$1, 778, 000
Conduit from east portal continental divide tunnel to power plant no. 1	1, 101, 000
Transmission lines connecting power plant no. 1 with Granby pumping plant—with Valmont and line to North Poudre pumping plant	440, 000
Commercial substation (30,000 kilowatts)	300, 000
Headquarters at power plant no. 1 for operation of power system	100, 000
Subtotal	3, 719, 000
Interest during construction, 3 percent	112, 000
Total repayable in 50 years with interest	3, 831, 000
One-half cost of Arkins Reservoir	929, 661
Portion of cost Green Mountain Reservoir, for 100,000 acre-feet allocated to power	2, 276, 032
Payable on 40-year basis without interest	3, 205, 693
Total cost power plant no. 1 including other items that are required to be accomplished with the initial development	7, 036, 693

Annual revenues from power plant no. 1

From sale of 65,000,000 kilowatt-hours firm power, at $0.005	$325, 000
From sale of 79,000,000 kilowatt-hours secondary power, at $0.0018	142, 000
From rental of water for power development to privately owned plants	20, 000
Gross annual income	487, 000

Annual operation and maintenance plus retirement of principal

Brought forward	$487, 000
3.887 percent, on $3,831,000, interest and retirement of investment on basis of 50 years	148, 000
Repayment of $3,205,693 on basis of 40 years without interest	80, 000
Operation and maintenance of power plant	36, 000
Operation and maintenance Granby pumping plant	27, 000
Operation and maintenance of transmission lines	13, 800
Operation and maintenance conduit, tunnel, and canals	15, 000
Depreciation, 1.5 percent, on $3,831,000	57, 000
General expense	18, 200
Total annual costs	395, 000
Annual surplus during 40 years repayment period of the non-interest-bearing obligation	92, 000

FULL POWER DEVELOPMENT

The results of this study indicate that the initial installation proposed is sufficient from a financial standpoint to return all necessary costs of operation and repayments.

There are five additional plants that can be developed in the future in a manner that will keep pace with the power requirements of the section that may be served and not have a large unearning investment tied up for some years.

The following is an estimate of the cost of the additional power plants that may be constructed in the future, but are not a part of the initial development.

Power plant no. 5	$1, 190, 000
Green Mountain-Ka Rose transmission line	130, 000
Operators' quarters	60, 000
Substation (20,000 kilowatts)	200, 000
Subtotal	1, 580, 000
Interest during construction, 3 percent	47, 400
	1, 627, 400

The above plant, together with plant no. 1, will produce: 113,000,000 kilowatt-hours firm power annually; 92,000,000 kilowatt-hours secondary power annually.

The following are the construction costs of developing power plants nos. 2, 3, 4, and 4-A with appurtenant structures:

Power plant no. 2	$2, 325, 000
Power plant no. 3	665, 000
Power plant no. 4	760, 000
Power plant no. 4-A	420, 000
Power canal no. 2	2, 444, 000
Power canal no. 3	493, 000
Power canal no. 3-A	113, 000
Power canal no. 4	1, 194, 000
Operators' quarters	150, 000

Substations (90,000 kilowatt hours)	$900, 000
Additional transmission lines	311, 000
Subtotal	9, 775, 000
Interest during construction, 3 percent	293, 250
Total repayable in 50 years with interest	10, 068, 250
Arkins Canal feeder, payable in 40 years without interest	351, 000
Total power plants nos. 2, 3, 4, and 4-A	10, 419, 250
Total power plant no. 5	1, 627, 400
Total second-stage development	12, 046, 650
Primary development plant no. 1	7, 036, 693
Cost of full power development	19, 083, 243

The total salable output of the full development is estimated as follows, exclusive of that used for pumping:

	Kilowatt-hours
Firm power, annually	360, 000, 000
Secondary power, annually	[1] 200, 000, 000

[1] Out of an available production of 387,000,000 kilowatt-hours secondary power.

CONCLUSIONS

(1) There is a large area (615,000 acres) of irrigated land in northeastern Colorado, the major portion of which has an inadequate water supply.

(2) The feasible storage possibilities with the available water supply in the drainage area has been exhausted.

(3) There is at least an available water supply of 310,000 acre-feet on the upper drainage area of the Colorado River that can be diverted to supplement the present water supply on the eastern slope.

(4) That the diversion of this quantity of water from the Colorado River watershed will not interfere with or encroach upon the present or future irrigation along the Colorado River and tributaries within the State, with the protection provided in the Green Mountain Reservoir.

(5) That the plan for the project here laid out appears entirely feasible from a construction point of view.

(6) That the cost of construction estimated at $2 per acre-foot per annum over the repayment period of 40 years is less than storage water is now commanding and that it will increase the crop values five or more times this annual cost, showing its economic worth.

(7) That the power developments that may be made in the six power plants will produce a large quantity of cheap hydroelectric power that will materially benefit Colorado.

(8) That the revenues from the commercial power generated at power plant no. 1 will pay for the power features as set up under the initial power development, in addition to the power required for pumping at Granby pumping plant, and in lieu of the irrigation features used in power development, the operation of the system to a point where the water leaves the tailrace of the lower power plants can be taken care of by the power development.

(9) That the cost of the irrigation feature of the project is within the ability of the water users to pay.

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HADOW MOUNTAIN RESERVOIR

e — 1800 Acres
llway Elevation — 8370 Feet
rmal Water Elevation (shown) — 8368 Feet
h Species: Rainbow Trout, Brown Trout, Lake Trout, Kokanee Salmon

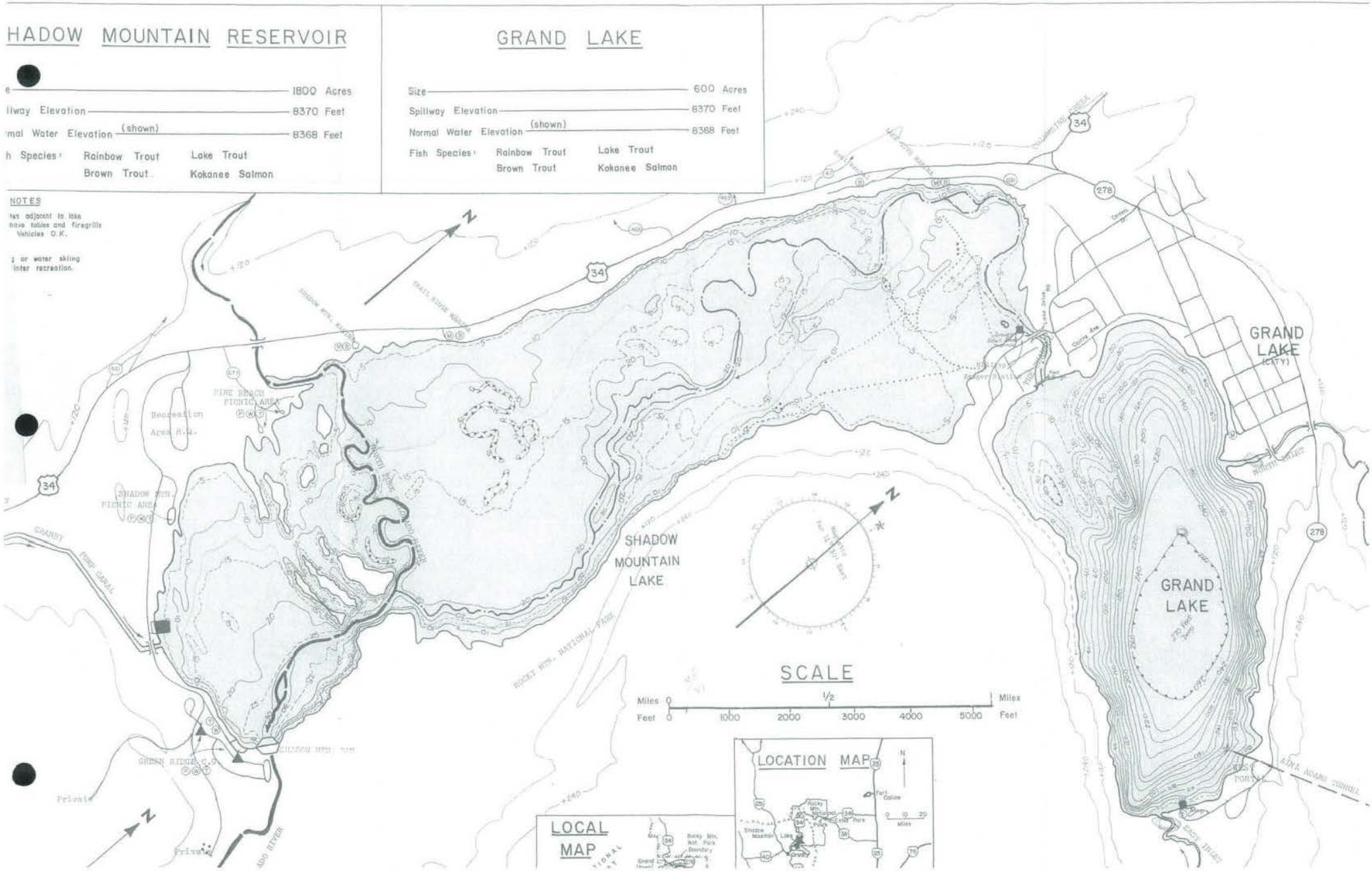
GRAND LAKE

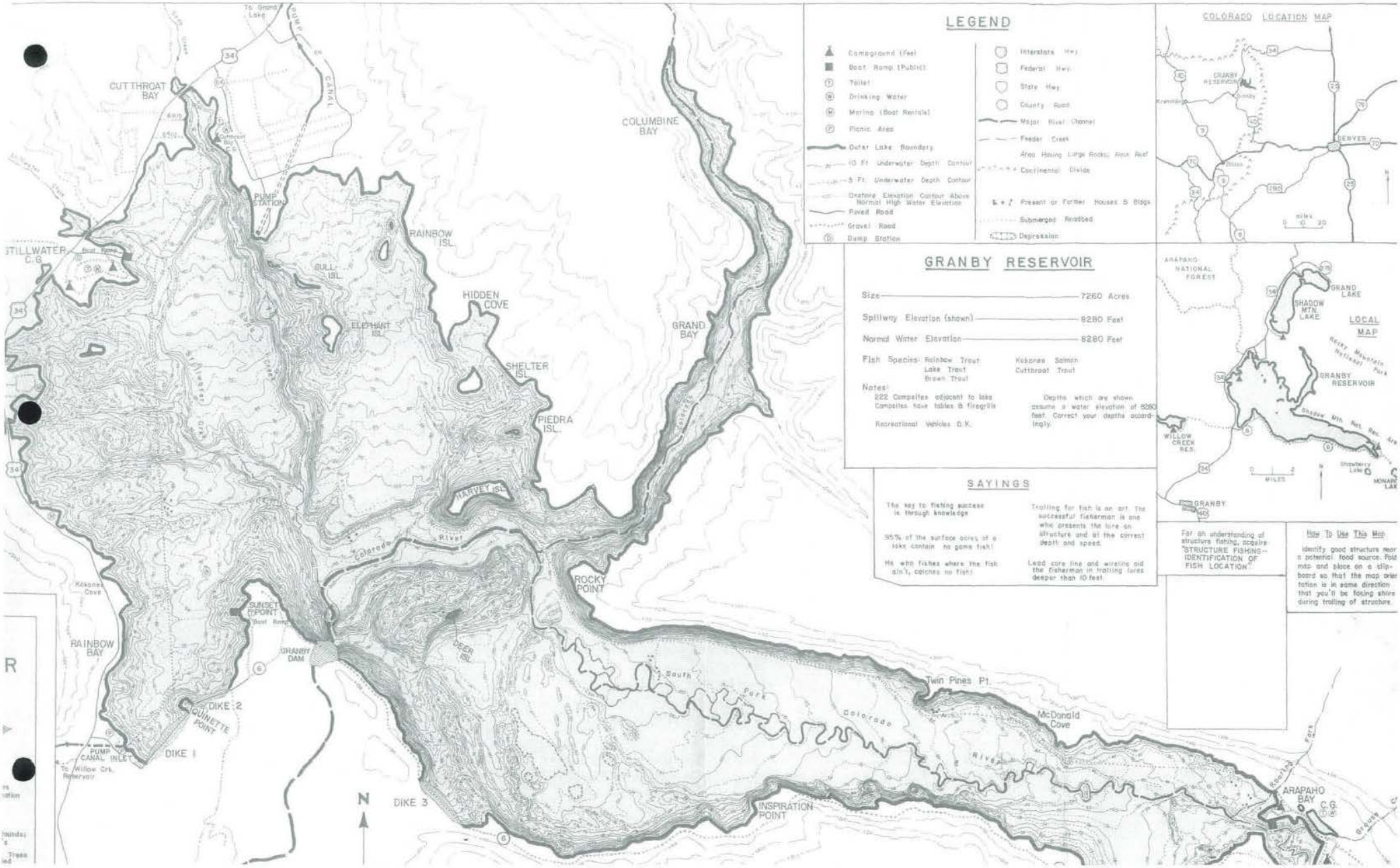
Size — 600 Acres
Spillway Elevation — 8370 Feet
Normal Water Elevation (shown) — 8368 Feet
Fish Species: Rainbow Trout, Brown Trout, Lake Trout, Kokanee Salmon

NOTES

tes adjacent to lake have tables and firegrills Vehicles O.K.

g or water skiing inter recreation.




LEGEND
Campground (Fee)
Boat Ramp (Public)
Toilet
Drinking Water
Marina (Boat Rentals)
Picnic Area
Outer Lake Boundary
10 Ft Underwater Depth Contour
5 Ft Underwater Depth Contour
Onshore Elevation Contour Above Normal High Water Elevation
Paved Road
Gravel Road
Dump Station
Interstate Hwy
Federal Hwy
State Hwy
County Road
Major River Channel
Feeder Creek
Area Having Large Rocks, Rock Reef
Continental Divide
Present or Former Houses & Bldgs
Submerged Roadbed
Depression
GRANBY RESERVOIR
Size — 7260 Acres
Spillway Elevation (shown) — 8280 Feet
Normal Water Elevation — 8280 Feet
Fish Species: Rainbow Trout, Lake Trout, Brown Trout, Kokanee Salmon, Cutthroat Trout
Notes:
222 Campsites adjacent to lake
Campsites have tables & firegrills
Recreational Vehicles O.K.
Depths which are shown assume a water elevation of 8280 feet. Correct your depths accordingly.
SAYINGS
The key to fishing success is through knowledge
95% of the surface acres of a lake contain no game fish!
He who fishes where the fish ain't, catches no fish!
Trolling for fish is an art. The successful fisherman is one who presents the lure on structure and at the correct depth and speed.
Lead core line and wireline aid the fisherman in trolling lures deeper than 10 feet.
For an understanding of structure fishing, acquire "STRUCTURE FISHING—IDENTIFICATION OF FISH LOCATION"
How To Use This Map
Identify good structure near a potential food source. Fold map and place on a clipboard so that the map orientation is in same direction that you'll be facing shore during trolling of structure.
COLORADO LOCATION MAP
GRANBY RESERVOIR
DENVER
Boulder
Colorado Springs
miles
LOCAL MAP
ARAPAHO NATIONAL FOREST
GRAND LAKE
SHADOW MTN. LAKE
GRANBY RESERVOIR
WILLOW CREEK RES.
Shadow Mtn. Nat. Rec. Area
Strawberry Lake
MONARCH LAKE
GRANBY
MILES
CUTTHROAT BAY
To Grand Lake
PUMP CANAL
PUMP STATION
STILLWATER C.G.
Boat Ramp
RAINBOW ISL.
BULL ISL.
ELEPHANT ISL.
HIDDEN COVE
SHELTER ISL.
PIEDRA ISL.
COLUMBINE BAY
GRAND BAY
HARVEY ISL.
Colorado River
ROCKY POINT
Kokanee Cove
RAINBOW BAY
SUNSET POINT
Boat Ramp
GRANBY DAM
DEER ISL.
DIKE 2
QUINETTE POINT
DIKE 1
PUMP CANAL INLET
To Willow Crk. Reservoir
DIKE 3
N
INSPIRATION POINT
South Fork
Colorado River
Twin Pines Pt.
McDonald Cove
Rawhide Park
ARAPAHO BAY
C.G.
Arapaho Park

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Grand Lake Clarity Appraisal Study
Alternatives Work Session
11/28/2011, 9:00am – 3:00pm
Attendees
Jeff Drager, Esther Vincent, Northern Colorado Water Conservancy District; Robert Plotnikoff, Peggy Bailey, Tetra Tech; Valda Terauds, Ron Thomasson, Laura Wheatley, US Bureau of Reclamation; Lurline Underbrink Curran, Katherine Morris, Grand County; James McCutchan, William Lewis, University of Colorado; Geoffrey Schladow, University of California

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In general, presentation content is supplied in paragraph form, and comments from discussion are identified with bullet points.

Introductions/Overview/Purpose of meeting – Peggy Bailey
Scope of Work states the purpose of this appraisal study is to "…study alternatives to improve Grand Lake water clarity without adverse water quality effects on the Three Lakes or adverse yield on the CBT project while remaining consistent with the primary project purposes outlined in Senate Document 80."

- The Reclamation purpose of an appraisal study is to see if there is a Reclamation interest in and a viable alternative to the problem, in this case improving clarity in Grand Lake
- Senate Document 80 was discussed; 5 primary purposes for C-BT Project include delivery of water, protection of the scenic attraction of Grand Lake, RMNP and the Colorado River, and power generation
- Guiding documents are the Reclamation Act of 1902, Senate Document 80, and the proposed State of Colorado clarity standard for Grand Lake
- Purpose of the day's meeting: discuss problem definition and present and refine alternatives identified to date, develop additional alternatives if appropriate, and discuss pros and cons of each

Summary of Water Quality Data Review—Robert Plotnikoff
In the absence of a time-step analysis of flow, which would be ideal, Tetra Tech conducted a review of the literature and data available on Grand Lake and the surrounding area.

Review of Chlorophyll a, Total Phosphorus, and Secchi values from water year 2009 and a "stop pump" experiment as described by Dr. McCutchan in 2010. Discussion:

- State of Colorado proposing 5 mg/l chlorophyll-a standard for water supply
- Granby Reservoir and Shadow Mountain Reservoir (SMR) will likely be out of compliance; the Town of Estes Park is able to source water directly from the Adams Tunnel (though not all the time) which may lead to Grand Lake falling into the "high quality water supply" category; it's unclear how SMR will be classified
- 8 mg/l chlorophyll-a will be the standard for cold water and recreation
- Dr. Schladow asked for clarification of seemingly contradictory statements between Dr. Lewis and Katherine about what improves clarity. Discussion followed that steady pumping did clear Grand Lake once Granby Reservoir water was moved through SMR, but that the best recorded clarity prior to the 2011 stop-pump period typically occurred in November, when temperatures were cool/cold and diversions stopped for annual maintenance of the Adams Tunnel.

High Phosphorus (P) coming from Granby Reservoir (total P load from Granby Pump Canal is >50%) is likely the fuel for biological activity in SMR and Grand Lake. This is supported by the high total

phosphorus and soluble reactive phosphorus values shown in Lieberman 2008. The subsequent decline in total phosphorus shown in Dr. McCutchan's graph is accounted for with biological activity, which illustrates how P is a non-conservative parameter. When the pumps turn on, P at GL-mid increases.
Discussion:

- Dr. Lewis commented that Granby Reservoir has 15 micrograms per liter (ug/L) of total P in the hypolimnion, which is 2-3 times what we'd see in unaffected waters. He is of the opinion that with high continuous pumping it might be possible to achieve higher clarity but probably would take until October, and high pumping is not possible until tributary flow declines.
- Esther pointed out that high total P coming from Stillwater might be a contributor. The source of this P may be geological in origin.
- Background or baseline nutrient levels were discussed; Katherine commented that the Roaring Fork is considered to be the cleanest of the 13 tributaries (number includes pumped flows) to Granby Reservoir.
- Lurline suggested Tetra Tech check on the Grand Ditch EIS as the 2003 breach and proposed restoration, particularly of the Lulu City wetland, could be a source of nutrients and sediment.

Rob explained that Tetra Tech team member Harry Gibbons is concerned that there might be a threshold of sediment loading to SMR that, once triggered, could cause a dramatic release of sediment based nutrient loading that could lead to a harmful algae bloom (HAB).

- Dr. Lewis cautioned against forgetting about nitrogen as he believes that the system is nitrogen limited during the season. Pumping reduces residence time, depressing production, but supplies 2-3 times regular P, and sustains nitrogen suppression.
- Esther discussed potential internal loading from SMR due to anoxic events (below 2ug/L). Low DO water coming from Granby (around 5ug/L) and the fact that SMR is on the 303(d) list for low DO was also explained.
- Nutrient loading from beetle kill was discussed and Dr. Lewis mentioned that a new study is due out soon that will say that watershed changes are not as dramatic as once thought, except in areas where heavy logging exacerbates soil disturbance leading to increased sediment yield.

Tetra Tech's conclusions are 1) best scenario for Grand Lake water quality is to simulate natural hydrology into Grand Lake (flowing from GL to SMR), 2) abate total phosphorus loading from the North Fork of the Colorado River during runoff, and 3) secondary water quality benefits could occur within SMR with dilution from Grand Lake. Discussion:

- Dr. Lewis supports modeling of Grand Lake clarity without influence of C-BT. He also stated that management interventions are only likely to control human influences affecting clarity. Regional watershed influences are less likely to be addressed successfully by management intervention.
- Dr. Schladow questioned if point number two would be valid considering Dr. Lewis' statement that there can be some perfectly natural sources of phosphorus in a watershed that eliminate gains from BMP efforts .
- Lurline explained that whatever the cause, the aesthetic attraction of Grand Lake is protected in Senate Document 80. She also explained to the group that an EIS is underway for restoration of the Grand Ditch Breach of 2003, which has already impacted the 3 Lakes and is likely to do so again as restoration efforts are undertaken.
- Dr. McCutchan explained that per his study, non-algal particulates is the major driver controlling clarity in Grand Lake, not chlorophyll-a. The particulates originate in SMR, therefore the focus needs to be on SMR rather than on Grand Lake. He suggested that the source of these

particulates may be senescing aquatic plant material, but that more work needs to be done to determine the source. In addition to providing decomposing material, he hypothesized that aquatic plants also provide substrate for suspended particles during quiescent periods, that are then mobilized when pumping resumes. Dr. McCutchan commented that concentrations of both non-algal organic matter and inorganic particulates are higher in the pump canal than in East Inlet, North Inlet, or the North Fork; non-organic matter was only slightly higher in the pump canal, but inorganic particulates were much higher in the pump canal than in East Inlet or North Inlet and about twice as high in the pump canal as in the North Fork. He wondered if canal lining might help with this. Non-algal organic particulates were slightly more abundant in the North Fork than in East Inlet or North Inlet, and inorganic particles were more than twice as high in the North Fork as in East Inlet or North Inlet. Thus, the North Fork and the pump canal were both higher in non-algal particles (organic and inorganic) than the major native sources to Grand Lake.

- Dr. Lewis explained that their invert microscope work (which resolves at 1 um) is showing there are two classes of non-algal particles; one at 1-3 um, and another in the 25-35 um range. This work is supporting Dr. McCutchan's conclusions about non-algal particulate matter. The smaller size class of particles is more likely to affect transparency as the specific gravity of these particulates is close that of water. If reduced clarity does not involve a change in color, particulates are likely the cause; whereas if there is change in color, then algal sources are likely.
- Dr. Lewis suggested that non-algal contributions need to be controlled if transparency is goal with a focus on SMR since that is the problem. Dr. Lewis also suggested that once Granby water reaches Grand Lake (after SMR water is flushed through) with periods of higher pumping, clarity in Grand Lake improves (typically in late October/November timeframe).
- Dr. McCutchan explained that inorganic is twice the concentration on North Fork of the
- Jeff noted the delta on SMR, and also asked if velocity from canal is the issue or could it be from boats?

Overview of Possible Alternatives—Peggy Bailey

Goals:

Primary Water Quality Objectives/Constraints

- Attainment of chlorophyll-a standard
- Meet or exceed 4 meter clarity standard measured July –September

Secondary water quality benefits

- Improve clarity and weed(?) conditions in SMR
- Improve WQ in GR
- Improve WQ downstream
  (Discussion: We discussed how the goals are to not adversely impact wq in the rest of the system, but a goal is not necessarily to improve the WQ but that it would be an added benefit. The emphasis should be placed on not negatively impacting.)

Logistics (Reclamation sees these as evaluation standards, not guidelines)

- Implementable
- Acceptable by general public
- Constraints include
  1) Delivery of water to meet east slope demands
  2) Maintain flexibility of delivery of (226,000 AFY on average; 310,000 AFY decreed) to accommodate maintenance
  3) Optimize power generation during peak demands

4) Minimize power requirements of any reoperation
5) Capacity limitations of canal and Adams tunnel
6) System storage
7) Grand Lake allowable seasonal elevation variances

Reclamation clarified that optimization means finding the best set of new operating conditions to meet multiple objectives.

The difference was explained between Principles and Standards (new, not yet adopted), which allow for sustainable environmental choices, and the 1983 Principles and Guidelines (currently applicable), in which choices are economically driven. According to the Principles and Guidelines the Appraisal and Feasibility studies should determine the net benefits of the proposed action(s).

Alternative 1:
Non-operational improvements including implementation of BMPs, reduction of nutrient loading from the North Fork, and redirection of Stillwater outflow away from Farr intake. Not a stand-alone solution.
Discussion:

- Dr. Lewis suggested that it is too expensive to implement BMPs and generally they don't work. He commented that even without CBT, GL would not be totally pristine.
- Dr. Lewis suggested septic systems and storm water BMPs be considered around GL. Katherine noted that all but 2 homes around Grand Lake are now on sewer and the City has street sweeping operations twice weekly in summer (not HEPA) in place, plus ultra-swirl treatment (2009) for stormwater discharges. In the greater 3 Lakes watershed, 85% of homes are connected to sewer. Dr Lewis explained that septic systems away from the Three Lakes could have a significant impact. The 300+ existing systems within the Three Lakes San District were also mentioned.
- Dr. Schladow noted that at Tahoe removing septic did not improve conditions but control of runoff from urbanized areas seems to make a difference.
- Valda expressed the USBR area manager wants a comprehensive and long-term fix to the problem.
- Lurline also pointed out that WWTPs should not be burdened with paying for improvements in Grand Lake water quality.

Alternative 2:
Pump from pump canal directly into Adams Tunnel

2A: pipe follows west (SMR) & north (GL) shores
2B: pipe through middle of SMR & GL
2C: pipe follows east shore (SMR) and south (GL) road

Issues surrounding this alternative included: how to maintain Grand Lake elevations per SD80; if not naturally maintained, who would provide the water. Water operations and power issues included a lack of re-regulation ability; pumps would cycle on and off with this alternative. Adams Tunnel requires the ability to fine-tune flows to avoid power losses. Variable pumps were discussed, but would add significant cost and operational complexity.

Proposed routing around GL would have issues with private access and easements. Subsurface construction would likely not be feasible; challenges to the south include national park, wilderness areas, rock substrate and 10' wide roadways. Around SMR, the shoreline access would be an easier installation. The 2B alternative could have boating issues depending on the depth to which the pipe is

installed. Ice, potential for structural collapse if pipe is not kept filled, etc. were other issues identified for consideration.

Alternative 3:
Pump from pump canal into Grand Lake

This alternative was not considered in great detail as it was not viewed as a reasonable option. It does keep SMR circulating and maintains regulating capacity. SMR may need to increase re-regulation capacity. This alternative also preserves head (decreases power requirements). May affect boat traffic between lakes (lock structure). Sediment, DO and particulate issues remain for SMR, but could be addressed through bubbling or other treatment measures. This alternative could also affect water rights decrees relative to storage and points of diversion and could re-open the Blue River decree. East slope water quality effects (water quality impacts to Horsetooth and Carter) were also of concern. Pump canal profiles would be needed to address pumping and cost of power issues.

Alternative 4:
Pump from SMR into Adams Tunnel

4A: Pipe follows roads in Grand Lake
4B: Pipe follows north shore
4C: Pipe goes through center of lake
4D: Pipe follows south road

Discussion:

- Private property and narrow roads will present a challenge to layout. Jerico road (south of Grand Lake) is terribly narrow and full of springs. Digging there raises a whole host of concerns.
- RMNP wilderness designation will make it difficult to secure approval for a tunnel.
- Ron voiced concern about the lack of re-regulation ability with alternative 2.
- Esther voiced concerns about alternatives that would result in a degradation of the quality of water diverted to the east slope.
- Alternative 4-Need to consider boat traffic
- Some of these alternatives have potential impacts on water rights
- Alternative 4 – add gravity intake at Adams to pull water from GL during spring runoff-should help with overall quality of water being diverted.
- It is possible that fluctuation of SMR surface elevation can be changed, but 1' for Grand Lake would require a change to SD 80.
- Lurline noted that USFS had to do a categorical exclusion for lowering SMR for weed control work.
- There was discussion on whether alternative 2 versus alternative 4 would lead to better water quality in SMR and on the east slope.
- Pre-positioning water through fall and winter storage concerns were also identified.

Alternative 5:
Modify pumping operations at Farr—no pumping in summer

Discussion:

- Not practicable; CBT delivery problems would occur in the average year.

- Could overlap with maintenance outages.
- Could affect peak power abilities – WAPA issues
- May require additional storage at Chimney Hollow.
- So far the 2 week stop pump tests have shown 50/50 chance that SMR water quality will degrade during a stop pump. While water quality was great in 2011, this being an exceptional water supply year, SMR water quality during the extended diversion-stop can't readily be considered as illustrative of possible future conditions.

Alternative 6:
Modify pumping operations at Farr—steady low pumping rates in summer months

Discussion:
- Ron explained that there are limited intervals available for pumping rates due to Pumps at Farr
- Expect ~200 cfs through SMR may be needed to attain a Secchi depth, but 250 cfs is needed to support Mary's Power Plant.

Alternative 7:
Alum treatment

Discussion:
- Lurline expressed concern that this would be unacceptable to community.
- Dr. Lewis dismissed this option as impractical for this system.
- Not expected to affect particulates
- Macrophyte issues may get worse
- Phosphorus inactivation would occur only in the water column
- Does not address nitrogen

The group proceeded to review a table entitled "Draft Alternatives Formulation Brainstorming" that Northern Water created detailing 13 concepts for consideration. These included pipelines, removal of Shadow Mountain Dam, BMPs, Shadow Mountain Dredging, oxygenation of SMR, Alum treatments, alterations to the connecting channel, operational changes, and oxygenation of pumped water.

There was some discussion about the Shadow Mountain removal option and how it is the only alternative that addresses all water quality issues in the system. Ron expressed that there are some water rights considerations with this alternative related to the Blue River decree that would be problematic, having to do with the direct use water rights associated with CBT and the possible loss of these due to a change of diversion point. Lurline expressed some concerns about how the homeowners around the reservoir would respond to this alternative and anticipated there would be some significant push back
The group also discussed the possibility of dredging Shadow Mountain Reservoir and the potential costs and there was consensus that this was not a viable option.

Watershed management and BMPs were also presented both regarding nutrient control and sediment control and Esther explained that the Three Lakes Nutrient Study Technical Committee is doing modeling and monitoring that would support both.

Two alternatives were added to the list that was presented: 1) a multi level intake tower at Farr that would allow to draw water from where the water quality was best for intended uses; 2)an upgrade and review of existing septic systems in the area – there was discussion about how significantly septic systems can impact watersheds, even in areas that don't have much groundwater. It was also mentioned that there are still over 300 active septic systems in the watershed.

Discussion of Implementation—Jim Lenzotti

Although no costs were developed for the various alternatives, it was estimated that all the structural alternatives would cost about 50-90 million dollars.

Discussion points regarding all alternatives discussed:

- Dr. Lewis suggested that alternatives 1 & 4 provide the most reliable combination of strategies. The combination is most likely to improve water quality in Grand Lake. He also indicated that an analysis should consider Grand Lake conditions in the absence of the C-BT project, but with added development and associated nutrient sources
- Dr. Lewis also indicated that large volume water movement between Granby Reservoir and Grand Lake helps water quality issues in the 3-Lakes once SMR water is flushed through.
- Also consider new development planned above Windy Gap – golf course, nutrient loads. Discussion suggested that septic tank inputs would be much greater than golf course impacts regarding additional nutrient loads.
- Occasional high nitrogen spikes, with chlorophyll a spikes later have occurred in the system – sources unknown.
- Ammonia inputs from Arapahoe Creek – wetlands contributions may also be contributing
- Tahoe experience suggests that 80% of clarity issues were associated with urban uses – specifically atmospheric deposition of inorganic particulates. BMPs that were effective included street sweeping in winter; artificial wetlands, drainage/stormwater improvements. Multi-spectral imaging was used to detect nitrogen plumes with trace back to septic systems. Significance of atmospheric deposition near Grand Lake not clear, possible sources: wood-burning stoves, wind-swept sediments, snowmobiles, other recreational activities.
- The economics of power production over the life of each project should be considered.

Develop Methods and Evaluate Alternatives—All

Reviewed rating matrix and alternative selection—TT will revise per discussion

- The 1983 P&Gs should provide the foundation for the preliminary analysis, but added ecosystem benefits should also be considered, not just the economic to avoid prematurely excluding alternatives with wider benefits. Included in the environmental and social acceptability should be consideration of recreational impacts, adjacent park lands, and game species effects.
- Valda suggested Tetra Tech incorporate language from SOW (no adverse effects vs "will improve"). Also suggested that rather than ratings from 1-10, a question simply have a minus, zero or a plus rating. In the absence of detailed analysis, this type of rating system simply suggests that an alternative could be beneficial (+), neutral (0) or negative (-) in its impact.
- Lurline asked if we will have a chance to discuss the alternatives for social and environment acceptability. The general consensus is that these will be reviewed with the draft report. Peggy suggested a separate meeting with the County and TT.

- It was also agreed that rather than attempting to rate costs, they will simply be listed.

Reclamation Interest, Authority and Regulatory Compliance—Valda Terauds

The analysis of federal interest should include a discussion of applicable federal law, policy, guidance, and regulatory compliance issues. Senate Document 80 provides the overview of authorized project purposes and operational guidance for the C-BT project.

Schedule
Draft out week of January 19th and review comments back out on February 2nd
Next meeting Feb. 9th 9:00 at Tetra Tech, Golden

Appraisal Study – DRAFT Alternatives Formulation Brainstorming

X: adressed P: partially adressed ↘: likely to worsen ?: uncertain

Alternative	Description	Objective	ISSUES ADDRESSED									Data Gaps/Follow Up Studies	Possible Impacts	Structural Considerations	Legal, Regulatory and Institutional Considerations
			Grand Lake Clarity	Shadow Mountain Algae Blooms + cyanotoxins	Shadow Mountain DO Std	Transport of sediments	Shadow Mountain Delta	Grand Lake Delta	Shadow Mountain Internal Loading	Shadow Mountain Weeds	East Slope T&O				
1	Pipeline bypassing Grand Lake	Re-route lower quality water around Grand Lake to prevent water from Shadow Mountain from entering Grand Lakes	X	↘	↘	P		X				Modeling to estimate possible water quality impacts to Shadow Mountain and Granby Res, T&O + Geosmin issues on East Slope, hydraulic modeling	Further degradation of Shadow Mountain wq, degradation of Colorado River dowsntream of SM, degradation of water quality in Lake Granby, East Slope T&O and Geosmin issues, maintaining water level in Grand Lake, economic impact (no more boating access between Grand Lake & Shadow Mountain)	Pipeline Route through town of Grand Lake. Very limited construction season. Or flowing pipeline through Grand Lake. Hydraulic capability to push water to Adams Tunnel likely an issue and would require a pump station. Thick ice conditions during winter likely an issue with floating pipeline. Structure between Grand Lake and Shadow Mountain to regulate Grand Lake levels.	NEPA, SD80 compliance, 404+401 permits
2	Pipeline bypassing Shadow Mountain and Grand Lake	Water pumped directly from Lake Granby to Adam Tunnel	X	?	X			X	?		X	Modeling to estimate possible water quality impacts to Shadow Mountain and Granby Res, T&O + Geosmin issues on East Slope, circulation study in Granby to see where Shadow Mountain reservoir water enters Granby Res and how it impacts the reservoir when water is pumped to Adams Tunnel	uncertain: higher residence time in Shadow Mountain and possible degradation of water quality, degradation of Colorado River DS of SM, degradation of water quality in Lake Granby. Difficulty maintaining Grand Lake water levels.	Tunnel from Granby Pump Canal to Adams Tunnel going through RMNP. Boring under RMNP, greater pipe friction leading to increased pumping costs.	NEPA, SD80 compliance, RMNP authorization, 404+401 permits
3	Removal of Shadow Mountain Dam and pipeline or tunnel from Lake Granby to Adams Tunnel	Removal of Shadow Mountain Reservoir would adress most of the water quality issues as they are related to the reservoir's morphology and sedimentous substrate.	X	X	X	P	P	X	X	X	X	modeling to estimate possible water quality impacts to Granby Res. Study sediment transport to Colorado River and possible impacts to Granby Res. Understand chemical characteristics of bottom sediments due to possible migration to Colorado River and Granby Reservoir.	sediment inputs from North Fork would make their way into the Colorado River and possibly into Lake Granby. Economic impacts due to removal of recreational facility and associated fishery, and impact on Lake front properties. Trade off: green project, restoration of headwaters of Colorado River, restoration of wildlife habitat and wetland. Water quality impacts on Colorado River and Granby Reservoir due to possible erosion of sediments.	Mechanism for maintaining Grand Lake water level? Cut off wall/grade wall to prevent migration of sediments from reservoir to Colorado River after removal of dam. Perform stabilization of delta to minimize migration of sediments throught bank-cutting as original streambed is restored.	NEPA, SD80 compliance, 404+401 permits, RMNP authorization
4	Sedimentation Control (Land Use Planning and Erosion Control)	Reduce both sediment and nutrient inputs to the Three Lakes system	P	P		P	P	P				modeling to estimate possible water quality impacts (sensitivity analysis); sediment transport model. Identify sources.	Possible issue with sediment disposal associated with BMPs (could trigger CERCLA depending on quality of sediments). Impacts to recreaction if reduced ATV opportunities in watershed.	dependent upon type of BMPs implemented	Implementation authority (Grand County, Town of Gd Lake, RMNP, USFS?), voluntary BMPs, control regulations, CERCLA
5	Nutrient Source Control	Reduce nutrient inputs to the Three Lakes System	P	P							P	modeling to estimate water quality impacts (sensitivity analysis). Identify controllable sources.	dependent upon identified sources.	dependent upon type of BMPs implemented	Implementation authority (Grand County, Town of Gd Lake, RMNP, USFS?), voluntary BMPs, control regulations

Alternative	Description	Objective	ISSUES ADDRESSED									Data Gaps/Follow Up Studies	Possible Impacts	Structural Considerations	Legal, Regulatory and Institutional Considerations
			Grand Lake Clarity	Shadow Mountain Algae Blooms + cyanotoxins	Shadow Mountain DO Std	Transport of sediments	Shadow Mountain Delta	Grand Lake Delta	Shadow Mountain Internal Loading	Shadow Mountain Weeds	East Slope T&O				
6	Shadow Mountain Dredging	Deepen Shadow Mountain Reservoir to prevent dymictic conditions and allow stable stratification to occur throughout the summer	P	P	X		P	?	timing	X		modeling to estimate possible water quality impacts to Shadow Mountain Res, Grand Lake and Granby Res. Determine how deep is deep enough. Circulation study and sediment transport model.	disposal of dredged material (possible hazardous waste depending on chemical characteristics). Release of nutrients from disturbed bottom sediments.		NEPA, CERCLA, 401+404 permits
7	Oxygenation of Shadow Mountain Reservoir through mixing	Prevent continuous stratification/mixing of Shadow Mountain Reservoir that causes anoxic conditions and nutrient releases from sediments that support algae blooms	?	P	X				X			modeling to estimate possible water quality impacts to Shadow Mountain Res, Grand Lake and Granby Res, circulation study.			NEPA, USFS Permit
8	Oxygenation of Shadow Mountain Reservoir through oxygen diffusers systems	inject oxygen into the water column to prevent anoxic conditions	?	P	X				X			modeling to estimate possible water quality impacts to Shadow Mountain Res, Grand Lake and Granby Res, circulation study.			NEPA, USFS Permit

Alternative	Description	Objective	ISSUES ADDRESSED									Data Gaps/Follow Up Studies	Possible Impacts	Structural Considerations	Legal, Regulatory and Institutional Considerations
			Grand Lake Clarity	Shadow Mountain Algae Blooms + cyanotoxins	Shadow Mountain DO Std	Transport of sediments	Shadow Mountain Delta	Grand Lake Delta	Shadow Mountain Internal Loading	Shadow Mountain Weeds	East Slope T&O				
9	Alum treatments of Shadow Mountain Reservoir	Prevent nutrient releases from sediments that support algae blooms	P	↘					X	↘	↘	modeling to estimate possible water quality impacts to Shadow Mountain Res, Grand Lake and Granby Res	impacts associated with chemical treatment (?), aquatic life(?), public perception. Possible increase in aquatic weeds due to increased clarity. More weeds, might add more organic matter to the cycle and worsen algae blooms. Alum does not address Nitrogen supply and system is P-N co-limited. Might worsen blue green blooms, cyanotoxins and T&O problems.		NEPA, USFS Permit
10	Widening and Lining of Shadow Mountain Reservoir Channel	prevent migration of sediment from Shadow Mountain to Grand Lake (assuming suspension of sediments in the channel is a cause of turbidity)	P			X		X?				sediment transport study - need to determine where sediments are coming from (North Fork, SM bottom, channel?), turbidity study, water quality modeling to assess changes in water quality in Grand Lake. Sedimen sampling in channel to obtain size distribution. Need to understand whether thin colloidal material is moving back and forth on both sides of the channel depending on current			NEPA, 401+404 permits
11	Operational changes	interrupt pumping in July and August	P	P					↘		↘	assess water quality impacts of such operation using the water quality model (operational modeling); assess probability of implementation of such scenarios	yield, power interferences, East Slope recreation, water supply reliability, increase vulnerability of system to supply interruptions, ability to move water through		Power interferences, rescheduling of maintenance work. WAPA
12	Operational changes	continuously move water to keep Shadow Mountain residence time below 50 days while minimizing pumping to Grand Lake	P	P					?		↘	assess water quality impacts of such operation using the water quality model (operational modeling); assess probability of implementation of such scenarios			Power interferences, rescheduling of maintenance work, WAPA
13	Oxygenation by Granby Farr or in Granby Pump Canal	Remedy DO levels to meet the 6mg/L standard in Shadow Mountain when Farr is pumping.			X										NEPA, USFS Permit, 401+404 permits

Grand Lake Appraisal Study

Report of the External Review Panel on Proposed Scope of Work for the Appraisal Study

The three member External Review Panel met with representatives of the Northern District (Northern Colorado Water Conservancy District), Grand County, TetraTech and the Bureau of Reclamation on November 28, 2011, in order to hear presentations about and discuss the proposed scope of work for an appraisal study on Grand Lake relevant to CBT operations. The meeting was coordinated by Tetra Tech and Atkins Corporation. Tetra Tech personnel made presentations based on the material provided by Grand County and the Northern District. The discussion, which lasted between 9:00am – 3:00pm, was wide ranging and substantive. The present report is intended to satisfy the responsibility of the three external reviewers for comments on the scope of work as presented at the meeting on 28 November.

1. *Constraints, Objectives, and Goals*

The Review Panel understands that the scope of work for the appraisal study is in part defined by certain constraints, objectives, and goals that are fixed at the outset. The most formal constraints are derived from Senate Bill 80, which reflects the vested interests of Western Slope residents and of Eastern Slope water users as well as a general desire to maintain overall efficiency in use of Colorado water resources. Specific constraints of interest to the scope of work include the following: (1) avoid impairment of water quality in the Three Lakes (Grand Lake, Shadow Mountain Reservoir, Granby Reservoir), (2) insure full water availability (indexed to design capacity) to East Slope water users. In addition, the scope of work must take into account a general desire to maximize hydropower production and minimize energy use for the CBT Project.

The component of Senate Bill 80 that relates to the status of Grand Lake is not clearly defined. Scenic attractions and limits on water level variation are specified in the Bill, but language of the Bill would seem also to apply to other considerations, including water quality. The scope of work for appraisal focuses on improvement of water quality for Grand Lake as a major goal, and can be based in part on the Colorado standard for Grand Lake transparency (4 m Secchi depth for more than 85% of measurement dates, July through September of any given year) as a numerical objective, although the feasibility of attaining this objective has not yet been established. The Review Panel believes that use of this objective is reasonable; its attainability is part of the scope of work.

The Review Panel suggests adding a second goal to the scope of work. The State of Colorado has proposed nutrient standards that will be presented to the Colorado Water Quality Control Commission as required by the USEPA on some future date. The nutrient standards relate to maximum allowable concentrations of phosphorus, nitrogen, and chlorophyll in waters of the State. The nitrogen and phosphorus standards as currently proposed would be easily attainable by Grand Lake in its present state. The standard for chlorophyll *a*, however, might or might not be consistent with the current status of Grand Lake. The proposed standard calls for no more than 5 μg/L of chlorophyll *a* (growing season mean) in water supply lakes and reservoirs, which would include Grand Lake in its current capacity as a water source used for domestic purposes. Even though this numeric value has not been adopted by the Commission and could be changed, the Review Panel believes that it is a good guideline or goal as part of the scope of work.

The Review Panel believes that any change in operation of the CBT Project that might improve water clarity in Grand Lake will likely have some effect on energy consumption or

energy production by the CBT Project. The Panel believes that the study should be conducted with the understanding that changes in energy efficiency either in production or consumption can occur, but must be minimized by thoughtful design of any specific operational change.

2. *Water Quality Evaluation*

Water quality monitoring has been under way for a number of years. In addition, several types of studies have been conducted on water quality as it relates specifically to clarity of Grand Lake, and the construction and calibration of a water quality model has been approved under direction from the Northern District. A question relevant to the scope of work is whether additional extended studies involving field work should be undertaken or whether there is sufficient information at hand to proceed with identification and refinement of alternatives and for a decision to be made by the US Bureau of Reclamation about its involvement in the development of alternatives.

The Panel believes that the information at hand provides a substantial basis for consideration of alternatives, and that the weighing of alternatives is a proper activity for the appraisal study. In addition, the Panel believes that the weighing of alternatives, as outlined in the meeting on November 28, will assist the USBR in deciding what its role will be in pursuing one or more alternatives that would provide substantial improvements in Grand Lake water quality. If the USBR decides to proceed with a feasibility study plan, additional field studies of water quality may be appropriate, but the Panel does not believe that additional field studies are necessary to move forward with the appraisal process.

3. *Nutrients*

Phosphorus and nitrogen are essential elements for suspended algae and other aquatic

plants. In many lakes, the maximum abundance of suspended algae (phytoplankton) is determined by concentrations of nitrogen and phosphorus. The nutrient that is exhausted first (P or N) determines the maximum amount of biomass in any given case. The likelihood of phosphorus or nitrogen limitation is approximately equal across lakes globally (1,2).

The proposed scope of work focuses on analysis of phosphorus concentrations in Grand Lake and in waters reaching Grand Lake through CBT operations. Phosphorus content of Grand Lake is augmented by phosphorus from both Lake Granby and Shadow Mountain Reservoir. Bioassays show, however, that Grand Lake is generally nitrogen limited (3). Therefore, the appraisal study needs to consider nitrogen availability in the various water sources that affect Grand Lake. Consideration of phosphorus need not be eliminated, but exclusive emphasis on phosphorus could be misleading with respect to predicted capacity of lake waters to support phytoplankton.

In addition to the external nutrient loads provided by the source waters, consideration of internal nutrient loads should also be an important part of the proposed scope. This relates to the release of both phosphorus and nitrogen from the sediments of the various water bodies. The release rates are strongly tied to the hypolimnetic dissolved oxygen concentration, which is likely to vary with changed operations, future hydrology, winter ice cover, and other factors.

The transparency component of the appraisal study appears to be focusing almost exclusively on suspended algae (phytoplankton). Phytoplankton do absorb light efficiently and therefore contribute to loss of water clarity if it becomes abundant. They also may change water color and impair water use. Because high Secchi depths are a goal for Grand Lake, the lake must maintain very low abundances of algae, consistent with chlorophyll

concentrations below 5 μg/L. Thus, considerable attention to the potential of Grand Lake water to grow algae is a proper part of the appraisal study.

Clarity of Grand Lake and in the water entering Grand Lake is also affected by dissolved organic carbon (DOC) and by nonalgal particles. The appraisal study needs to take these two additional factors into account as part of its study of clarity in Grand Lake and prediction of clarity under future conditions with altered operations. According to the 2009 Transparency Study (4), the influence of DOC in Grand Lake, either in its original condition or in its current condition, is very low in proportion to other influences (e.g., 15% of light absorbance). Therefore, further detailed consideration of DOC is not required, but it must remain on the list of factors that contribute to reduced clarity.

Very important are nonalgal particles, as shown by the 2009 study and confirmed by a reanalysis of the 2009 data by J. M. Boyer. The data show that the absorbance of light in Grand Lake and Shadow Mountain Reservoir could not be accounted for by chlorophyll plus DOC. A large amount of absorbance that was measured for these waters was due to a third factor, which is nonalgal particles. Although there were variations from month to month in the relative contribution of nonalgal particles to total absorbance of light in Grand Lake and Shadow Mountain Reservoir, nonalgal particles were approximately twice as important as algae in reducing the clarity of Grand Lake and Shadow Mountain Reservoir. Thus, both algae and nonalgal particles were important and neither can be ignored.

The Panel believes that nonalgal particles should be brought into the discussion of current and future water clarity for Grand Lake. Data collected as part of the 2009 transparency study are relevant to such a discussion. Just as the relative importance of nonalgal particles varied during the 2009 transparency study, concentrations of total suspended solids and

chlorophyll *a* have varied across years. In some years, algal particles may have had a greater role in light attenuation than in 2009, and in other years algal particles may have been less important than in 2009. Nonetheless, the Panel believes that nonalgal particles are generally important as a factor controlling transparency and must be considered.

4. *Alternatives*

A full array of alternatives has been proposed as part of the appraisal study. The Panel believes that the alternatives cover all of the significant possibilities that need to be considered. Although there is no harm in studying all of the alternatives prior to making decisions, the Panel believes that the alternatives fall into three groups. Group one is for alternatives 2 (pump from Canal to Tunnel) and 4 (pump from SMR to Tunnel), either of which would lead to substantial improvements in the clarity of Grand Lake. For either of these alternatives, the exclusive water source for Grand Lake would be water derived from the Grand Lake watershed and not water in transit from other watersheds. While substantial improvement in transparency is expected to occur with either of these alternatives, it is still not clear whether there is sufficient nutrient loading from the watershed of Grand Lake (developed areas) to cause phytoplankton to be more abundant than desirable. Thus, pursuit of either one of these alternatives should be accompanied by consideration of nutrient sources in the Grand Lake watershed. These nutrient sources are currently trivial because of the large volume of water from points outside the watershed that passes through the lake. If the lake is hydrologically isolated, however, the effect of these nutrient sources will be magnified by changes in water-residence time. The effect may be significant or insignificant, which can only be determined by loading estimates. These alternatives effectively return Grand Lake to behaving hydrologically like a natural lake. This would most likely result in

water level changes in excess of 1 foot, as prescribed in Senate Bill 80, although not necessarily greater than the natural range of about 4 feet. Whether this is permissible or whether limited flow exchange with SMR is maintained needs to be considered.

A second group of alternatives consists of all alternatives except for 2 and 4 plus alum treatment (alternative 7). This second group of alternatives involves passage of at least some water derived from Shadow Mountain Reservoir or Lake Granby through Grand Lake. The alternatives seek to capture advantages that might come from temporal changes in the amount of water flowing from these sources. The Panel believes that none of these alternatives can be relied upon to sustain substantial increased clarity of Grand Lake because the water sources outside of Grand Lake have potential to increase nutrient concentrations, introduce phytoplankton into Grand Lake, or bring nonalgal particles to Grand Lake.

The third group of alternatives consists of a single alternative, which is alum treatment of Shadow Mountain Reservoir. This alternative is flawed in that it does not deal with the issue of nonalgal particles, which account about for two-thirds of the impairment of transparency in Grand Lake. It is also not a viable option because of very likely extensive opposition to chemical treatment of water on a continuing basis and the ongoing costs of such treatments.

The alternatives analysis will show, in the opinion of the Panel, that the US Bureau of Reclamation can reach a sound determination that at least one alternative (either 2 or 4, possibly in combination with one or more other alternatives) is viable as a means of improving the clarity of Grand Lake through changes in operations.

5. *Downstream Users*

The Northern District has expressed the opinion that downstream users will be

questioning any alteration of water sources because of possible changes in water quality. Therefore, the appraisal study should include explicit consideration of data collection that will be useful in answering concerns that come from water users as alternatives are considered, leading to changes in water management. Specifically, monitoring of the output of water through the Adams Tunnel under current conditions must be well documented from the perspective of water treatment plant operators. Relevant factors include those that might directly affect water treatment (DOC, geosmin) or alter the potential of water supply reservoirs downstream to produce algae or organic matter (POC, chlorophyll, nitrogen, phosphorus).

6. *Potential for Continued Use of Grand Lake*

The Bureau of Reclamation staff has pointed out that it might be possible to continue to use some Grand Lake water even with alternatives 2 and 4, given that some water must be released from Grand Lake during or following runoff in order to maintain an appropriate water level. This is a proper element to be added to the scope of work, and might ease some of the concerns of downstream water users. The technical challenge is to predict an amount of water that could be released without threat to the water level restrictions or other aesthetic qualities inherent in Senate Bill 80.

For alternatives 2 and 4, which involve pumping water past Grand Lake to the Adams Tunnel, some form of operational redundancy is desirable so that East Slope water deliveries could be ensured during rare and unanticipated events, even when natural inflows to Grand Lake are insufficient to meet demands. Maintaining the option to pump water through Grand Lake, as with current operations, would provide such redundancy. If such an option is considered as a part of alternatives 2 or 4, however, the Panel believes that it would be

necessary to specify the conditions under which pumping through Grand Lake could occur and also to specify the anticipated effects on water quality in Grand Lake.

7. *Management of Shadow Mountain Reservoir*

Shadow Mountain Reservoir will be a significant supply for CBT under alternatives 2 and 4 and under other alternatives as well. The reservoir could benefit from artifical destratification sufficient to reduce the tendency for density stratification or aeration, in that it might suppress algal growth and prevent oxygen depletion in deep water. Aeration of the Granby Pump Canal also may be a possibility. These possibilities should be explored as a means of reducing concerns for downstream water users.

8. *Watershed Management Upstream of Grand Lake*

The scope of work currently includes some topics that relate to watershed management for nutrients and sediment transport outside the Grand Lake watershed. The Panel believes that most of the nutrients and particles reaching Shadow Mountain Reservoir are from natural sources, and that significant change in the hypolimnetic conditions of Lake Granby are unlikely to occur through any watershed management program. Therefore, these activities should be of low priority and should not be developed to the point of becoming a distraction from alternatives 2 and 4 or other alternatives that may be considered viable for improvement of water quality in Grand Lake.

References

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(2) Lewis, W. M. Jr, and W. W. Wurtsbaugh. 2008. Control of Lacustrine Phytoplankton by Nutrients: Erosion of the Phosphorus Paradigm. *Internat. Rev. Hydrobiol*. 93: 446-465.

(3) Morris, D. P. and W. M. Lewis, Jr. 1988. Phytoplankton nutrient limitation in Colorado mountain lakes. *Freshwater Biology* 20: 315-327.

(4) Factors Controlling Transparency in Grand Lake, Colorado. Prepared by: James H. McCutchan, Jr. July 2, 2010, Report 299.

William M. Lewis, Jr.
Geoffrey Schladow
James H. McCutchan, Jr.
December 6, 2011

APPENDIX

Senate Document 80

C-BT Project Maps

Alternatives Analysis Meeting Notes

Existing Watershed and Best Management Practices

Operations Summary

Literature Review and Water Quality Studies

Final Report of the External Review Panel

Comprehensive list of stakeholder projects and best management practices (BMPs) being implemented to address water quality in the Three Lakes system near Grand Lake, Colorado.

Source: Harger, L.T., 2012

Date: November 14, 2011
Attachment A

Bureau of Reclamation
Grand Lake Clarity Operations: From 2008-2011, operational experiments were performed annually that focus on Adams Tunnel diversions, with limited pumping from Granby to Shadow Mountain Reservoir, in an effort to observe effects to Grand Lake clarity. These operational experiments are commonly referred to as "stop pump periods". The operational experiments involve extensive coordination between the Municipal Subdistrict of Northern Colorado Water Conservancy District (Northern Water), Western Area Power Administration (WAPA), and Grand County. Results from 2008-2010 will be presented in an "Annual Operations and Water Quality Summary Report for Grand Lake and Shadow Mountain Reservoir" expected by December 2011.

Shadow Mountain Reservoir Drawdown: In 2006, Shadow Mountain Reservoir water level was lowered in an effort to control nuisance aquatic plants affecting aesthetics, recreation, and water quality. The drawdown action was successful in temporarily controlling aquatic weeds in Shadow Mountain Reservoir. However, vegetation remnants may have contributed to observed degraded clarity in Grand Lake afterwards when the reservoir refilled and water moved into Grand Lake. The drawdown action involved coordination with Northern, Grand County (County), WAPA, Colorado Division of Wildlife, U.S. Forest Service, Greater Grand Lake Shoreline Association, and the Three Lakes Watershed Association. Previous drawdowns were done in 1990 as well as 1991, another drawdown action is proposed for 2013 or 2014.

Munipical Subdistrict of the Northern Colorado Water Conservancy District
Windy Gap Firming Project (WGFP): If the preferred alternative is selected and implemented to offset nutrient loading to the Three Lakes, Northern Water would fund improvements to the Fraser Sanitation District wastewater treatment plant (WWTP), implement nonpoint source BMPs in the Colorado River basin, and adopt other measures as needed to offset WGFP impacts. Such measures would seek to avoid adverse impacts to water quality in the Three Lakes reservoirs and provide a year-round benefit to water quality in the Colorado River, Fraser River and Willow Creek.
Proposed point source reductions:

- Improvements to Fraser Sanitation District WWTP, located just north of the Town of Fraser, upstream of the WGFP diversion.

Proposed nonpoint source reductions:

- Improving agricultural practices and reduced fertilizer application for E-Diamond H Ranch and C-Lazy-U Ranch in the Willow Creek watershed, which is tributary to the Colorado River above Windy Gap Reservoir.

Grand County, Colorado

1. Initiated an inspection program of all newly constructed septic systems in subdivisions and assessed a water quality impact fee used to address water quality issues throughout Grand County.
2. If a septic system fails, the County requires connection to the Three Lakes Sanitation District main line regardless of the distance.
3. Funded a construction site inspection program and a staff person dedicated to water resource issues.
4. Adopted land use regulations that are protective of water quality, including the following specific provisions:
   - All new development must provide for erosion control during construction and incorporate final site stabilization with native vegetation.
   - Stormwater detention basins or sedimentation facilities are required for all new subdivisions, re-divisions, planned development, or other proposed construction, public or private, per the Grand County Storm Drainage Design and Technical Criteria Manual (first adopted in 1998 and last updated in 2006).
   - Post development peak flows cannot exceed predevelopment rates.
   - No development is allowed within 30 feet of waterbodies.
   - New subdivisions, Planned Unit Developments or other large developments are referred to Northwest Colorado Council of Governments (NWCCOG) to determine if they are in compliance with water quality performance standards contained in the Regional Water Quality Management Plan.
   - Regulations provide for the protection of water quality from impacts of new or expansions of existing wastewater treatment and municipal drinking water facilities.
5. Using advanced treatment for nutrient removal in the Fraser area so the effluent that is discharged to the Fraser River is improved. Therefore, the quality of water pumped to the Three Lakes system via Windy Gap is also improved..

Town of Grand Lake

1. All construction projects involving ground disturbance (including municipal, commercial, and residential projects) in the Town are required to have sediment and erosion control, if applicable.
2. Implemented additional stormwater water quality control measures.
3. Installed Aqua Swirl stormwater treatment system in 2009 that blocks solid sediments and filters dissolved metals from stormwater that enters Grand Lake.
4. Utilizes a street sweeper two times a week, except in winter months. The sweepings are recycled and used as a low-grade fill material. The material is not used on projects near Grand Lake, streams or other waterbodies.
5. Headwaters Marina at Grand Lake was recently awarded the “Green Marina” designation from the State. This designation recognizes efforts to manage pollutants going into the water from marina operations.
6. Currently updating Zoning and Land Use Development Regulations to help protect water quality. Including, working on Shoreline Regulations (which include a 5’ non-disturbance zone and a 30’ water quality setback from all natural and manmade lakes, rivers, streams, wetlands, etc.).

Three Lakes Water and Sanitation District (District)
1. Completed 2010 septic system survey to provide locations of all septic tanks within the District.
2. Requires homes within 400 feet of the District's main sanitary sewerline to connect, reducing the amount of individual septic systems.
3. Spent $500,000 on infrastructure upgrades to prevent leakage.

National Park Service, Rocky Mountain National Park
The Grand Ditch Breach restoration will strive to improve water quality in the project area and downstream throughout the Kawuneeche Valley (empties into Shadow Mountain Reservoir). Though not finalized, the Grand Ditch Breach Draft EIS proposes mitigation measures that will be implemented during the construction phase to reduce sediment transport downstream.

US Forest Service
Watershed protection activities including three culvert replacement projects in the Three Lakes area.

- Eliminates erosion, provides continuity of suspended load, prevents diversion onto the road, and reduces plugging from debris/sediment slugs.

<u>B) Major Data/Scientific Studies funded by Reclamation, Northern, and Grand County with input from Stakeholders</u>

- **Ongoing Water Quality Monitoring:** Baseline C-BT Project water quality monitoring, algae toxin, meteorology, atmospheric deposition.
- **Three Lakes Secchi Study:** Ongoing study that supports weekly clarity measurements (Secchi Disk) from May to October in Grand Lake and Shadow Mountain Reservoir with increased sampling to three times per week from mid August to Mid September. The study includes 14 sampling sites in Grand Lake, three in Shadow Mountain Reservoir and one reference site at Columbine Lake. The reference site serves to measure clarity at a natural body of water not connected to the Colorado Big-Thompson project.
- **Annual Operations and Water Quality Summary Report for Grand Lake and Shadow Mountain Reservoir:** Report documenting CB-T project operations and non-structural factors potentially affecting water quality and clarity in the Three Lakes system on an annual basis. 2007-2010 data was combined and analyzed into a single 2010 report. A final 2010 report is expected by December 2011.
- **Water Quality Endpoints Study:** The Colorado Water Quality Control Commission (WQCC) adopted a Secchi depth numerical clarity 4-meter standard for Grand Lake with an effective date of 2015, unless a more appropriate standard has not been adopted. In an effort to develop a recommendation of an attainable and scientifically defensible level of clarity to the WQCC. This study, guided by an associated workgroup, was formed as an offshoot of the existing nutrient and clarity stakeholder workgroups.
- **Three Lakes Model**: The numerical water quality model was developed with input from multiple clarity stakeholders and will be used to optimize water quality/clarity in Three Lakes system within the limits of C-BT Project operation using monitoring and operational data input. The model is complete and modeling runs are expected to commence in January 2012. 2011 water quality and operational data is expected to be

run through the model by May-June 2012. Where available, model results will be used to inform ongoing and future operations and planning studies.

- **Colorado-Big Thompson Project West Slope Collection System Appraisal Study (Appraisal Study)**: Reclamation is working together with Grand County, Northern Water and their consultant in preparing the Appraisal Study. The Appraisal Study is a preliminary investigation using existing data to identify viable alternatives that meet current and projected needs or satisfy problems in the Three Lakes system and if there is a federal interest. The Appraisal Study kickoff meeting was held July 28, 2011 and the Appraisal Study Alternatives meeting is scheduled for November 28, 2011. The Appraisal Study will be peer reviewed by internal and external reviewers with a draft Appraisal Study report expected in the winter of 2012 and a final Appraisal Study report expected to be available in the summer of 2012.

APPENDIX

Senate Document 80

C-BT Project Maps

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Colorado Big Thompson Project Operations Analysis

To determine whether the Alternatives can maintain the yield of the CBT Project and contracts that use the CBT Project infrastructure, it is necessary to analyze the operations of each Alternative. Under a future without water clarity considerations condition, C-BT Project operations are anticipated to be similar to those described in the Windy Gap Firming Project EIS for the Preferred Alternative with cumulative effects (WGFP EIS Alternative 2, Chimney Hollow with pre-positioning). Under the two structural alternatives for addressing the Grand Lake water clarity issue (Alternatives III and IV of this report) it is assumed that C-BT Project operations would also be similar to those under the Preferred Alternative.

In order to evaluate the ability of the Project to meet east slope delivery requirements under the non-structural alternatives (Alternatives I & II), a simple monthly spreadsheet model was developed. A schematic of the model is provided as Figure A-1 and the major components and assumptions are described below:

1. The model uses the same 47-year analysis period (Water Years 1950-1996) as that used in the WGFP EIS.
2. The model uses the same CBT Project demands as those used in the WGFP EIS. Under that model's assumptions, the average annual CBT Project demand is 234,556 af/year.
3. The model uses the same Windy Gap Project demands as those used in the WGFP EIS for the Preferred Alternative with cumulative effects. Under those conditions, the average annual east slope Windy Gap Project demands are 25,664 af/year.
4. On the west slope, the 3-Lakes system is conceptualized as one large reservoir that is not supply limited. This assumption implies:
    a. The 3-Lakes system has sufficient storage capacity and/or inflow to meet all desired Adams Tunnel diversion requirements.
    b. The Farr can be operated in a manner consistent with those diversion requirements.
    c. The combination of Adams Tunnel diversions and Granby Reservoir capacity is sufficient to keep from spilling inflow to the 3-Lakes system that would result in a loss of CBT Project yield or that of contracts that use the CBT Project infrastructure.
5. To insure maximum utilization of the east slope CBT Project water rights, diversion of Big Thompson River water to storage is considered as the first supply for meeting east slope reservoir storage needs. The monthly amount diverted is the lesser of:
    a. The amount of Big Thompson River water available for diversion under the CBT Project's east slope water rights. The monthly amounts used in these calculations are those computed as being diverted in the WGFP EIS for all cumulative effects model runs.
    b. The maximum Olympus Tunnel capacity of 550 cfs for the month.
    c. The amount of available east slope storage capacity (after consideration of that month's east slope demands, reservoir evaporation, and seepage).
6. In order to insure sufficient water supplies are available on the East Slope, diversions of west slope water through the Adams Tunnel are always maximized to the extent

possible. For every month of the study period the diversions are computed as the lesser of:

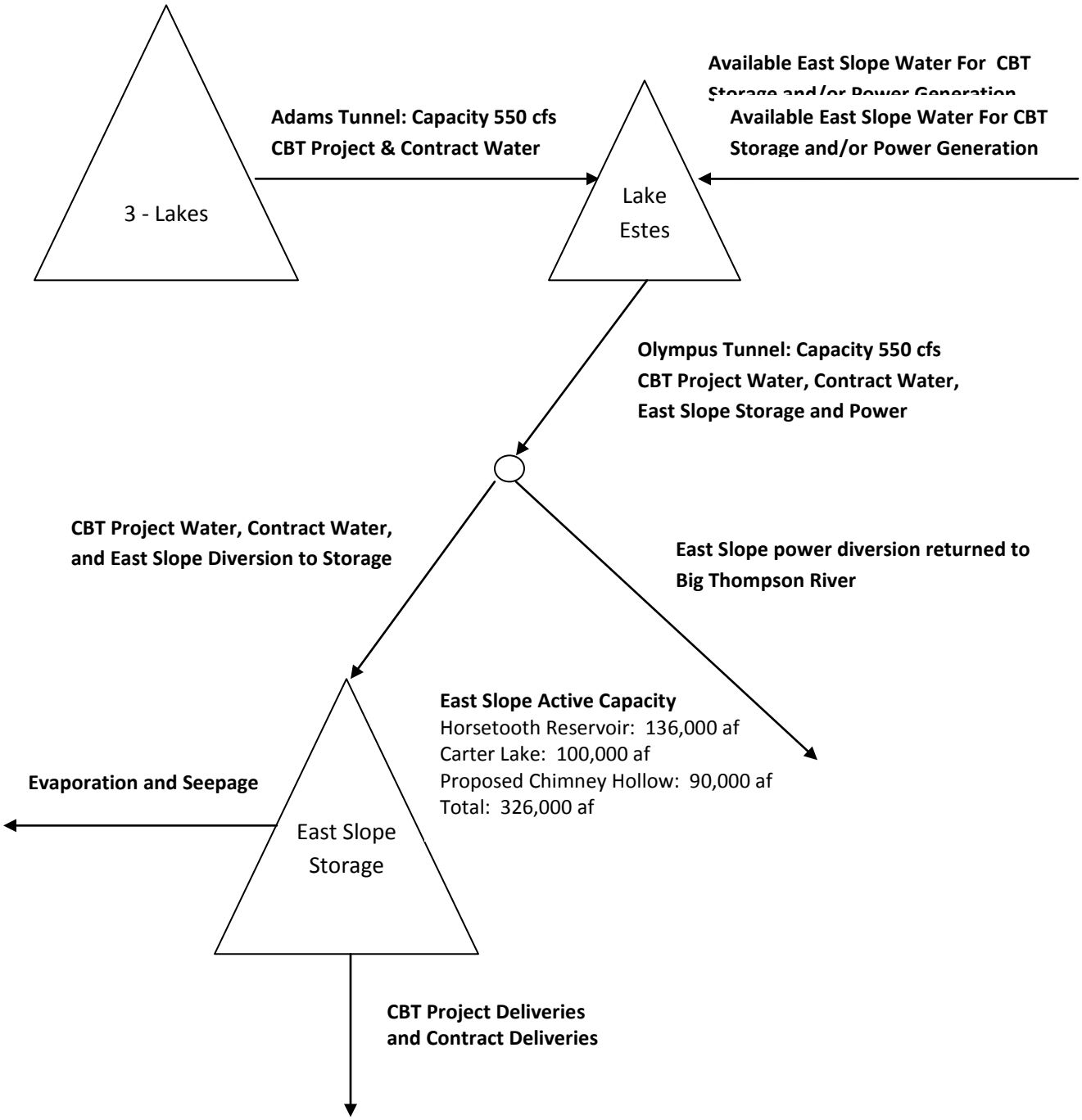
   a. The amount described in the alternative during July through September (i.e. 0 cfs for Alt I and 250 cfs for Alt II).
   b. The maximum Adams Tunnel capacity of 550 cfs for the month, limited by that month's estimated maintenance outage duration.
   c. The amount of available east slope storage capacity (after consideration of that month's east slope demands, reservoir evaporation, and seepage) minus the amount of Big Thompson River water diverted at Olympus Dam for storage in the East Slope reservoirs.

7. Diversion of Big Thompson River water for power generation is given lowest priority for available Olympus Tunnel capacity. However, the diversion is maximized by utilizing all remaining tunnel capacity after consideration of diversion of Big Thompson River water to CBT Project storage and Adams Tunnel diversions. The diversion of Big Thompson River water for power generation is computed as the lesser of:
   a. The amount of Big Thompson River water available for diversion. The monthly amounts were determined as the difference between the historic inflow to Lake Estes and the minimum required release from Olympus Dam. The amount available is then further reduced by the amount of Big Thompson River water diverted to storage under the CBT Project's east slope water rights as computed in #5 above.
   b. 550 cfs minus diversion of Big Thompson River water to CBT Project storage and Adams Tunnel diversions
8. Horsetooth Reservoir, Carter Lake, and the proposed Windy Gap Firming Project east slope storage facility are conceptualized as one large storage reservoir with an active capacity of 326,000 af (Horsetooth Reservoir 136,000 af; Carter Lake 100,000 af; Chimney Hollow 90,000 af).
9. East slope reservoir evaporation is computed from average monthly evaporation rates used in the Bureau of Reclamation's monthly operations planning model.
10. Seepage from the CBT Project system is estimated to be 200 af/month.
11. East slope demands, both CBT Project and Windy Gap, are all considered to be delivered from the conceptualized large east slope reservoir. The monthly CBT Project and Windy Gap delivery amounts were obtained from the WGFP EIS for the Preferred Alternative with cumulative effects model run as described in #2 and #3 above.
12. The end of month content for the one large east slope reservoir is computed as the greater of:
   a. The minimum allowable reservoir storage (i.e. dead pool or 0 af of active capacity)
   b. The previous end of month content plus Adams Tunnel diversions (#6) plus diversion of Big Thompson River water to storage under the CBT Project east slope water rights (#5) minus evaporation (#9) minus seepage (#10) minus deliveries of CBT Project water and Windy Gap east slope (#11)

13. If the content for the one large east slope reservoir is insufficient to meet demands, the demands are shorted to the extent necessary. This situation did not occur in the modeling for Alternatives I and II.
14. These conceptualized operations imply the ability to operate the east slope facilities to optimize east slope storage and water delivery (i.e. the ability to properly position water in all east slope reservoirs to meet all delivery requirements).

The monthly operations calculations are provided in the tables below for both Alternative I and Alternative II.

FIGURE A-1 : Schematic of Operations Model



Alternative 1 - Windy Gap Future Conditions - CBT Existing/Future Demands, WGFP Deliveries (Cumulative Effects Deliveries), Chimney Hollow in Operation

East Slope Storage			
	Initial Content (af)	Min Content (af)	Max Content (af)
Horsetooth Reservoir	74105	18000	154000
Carter Lake	53895	12000	112000
Chimney Hollow	0	0	90000
Additional Storage	0	0	0
Total East Slope Storage	128000	30000	356000

Evaporation Rates		
Month	Month	Evap (ft/mon)
Jan	1	0.06
Feb	2	0.08
Mar	3	0.07
Apr	4	0.16
May	5	0.16
Jun	6	0.29
Jul	7	0.35
Aug	8	0.33
Sep	9	0.23
Oct	10	0.14
Nov	11	0.07
Dec	12	0.06

Seepage		
Month	Month	Seepage (af/month)
Jan	1	200
Feb	2	200
Mar	3	200
Apr	4	200
May	5	200
Jun	6	200
Jul	7	200
Aug	8	200
Sep	9	200
Oct	10	200
Nov	11	200
Dec	12	200

Maximum Adams Tunnel Availability						
Month	Month	Input	Flow (cfs)	Volume (af)	Days / Month	Equivalent days/Month
Jan	1	95%	523	32127	31	29.45
Feb	2	95%	523	29018	28	26.6
Mar	3	95%	523	32127	31	29.45
Apr	4	95%	523	31091	30	28.5
May	5	95%	523	32127	31	29.45
Jun	6	95%	523	31091	30	28.5
Jul	7	0%	0	0	31	0
Aug	8	0%	0	0	31	0
Sep	9	0%	0	0	30	0
Oct	10	95%	523	32127	31	29.45
Nov	11	95%	523	31091	30	28.5
Dec	12	95%	523	32127	31	29.45
Total				282927		259

Maximum Olympus Tunnel Availability						
Month	Month	Input	Flow (cfs)	Volume (af)	Days / Month	Equivalent days/Month
Jan	1	95%	523	32127	31	29.45
Feb	2	95%	523	29018	28	26.6
Mar	3	95%	523	32127	31	29.45
Apr	4	95%	523	31091	30	28.5
May	5	95%	523	32127	31	29.45
Jun	6	95%	523	31091	30	28.5
Jul	7	95%	523	32127	31	29.45
Aug	8	0%	0	0	31	0
Sep	9	0%	0	0	30	0
Oct	10	95%	523	32127	31	29.45
Nov	11	95%	523	31091	30	28.5
Dec	12	95%	523	32127	31	29.45
				315054		289

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-49							128000														
Oct-49	0	0	0	32127	0	32127	136969	480	6844	5933	6593	137	388	589	1672	22	22678	22678	0	19507	2671
Nov-49	0	0	0	31091	0	31091	160242	349	2260	869	1997	73	600	212	1440	18	7469	7469	0	5199	2270
Dec-49	0	0	0	32127	0	32127	184587	334	2311	789	2000	75	600	212	1443	18	7448	7448	0	5175	2273
Jan-50	0	0	0	32127	0	32127	208695	343	2769	685	1901	73	600	212	1419	18	7677	7677	0	5428	2249
Feb-50	0	0	0	29018	0	29018	230216	401	2487	641	1661	66	600	212	1413	16	7095	7095	0	4854	2241
Mar-50	0	0	0	32127	0	32127	254190	384	2639	799	1995	73	600	212	1434	18	7770	7770	0	5506	2264
Apr-50	0	0	0	31091	0	31091	272399	639	4490	2855	3457	73	388	0	963	17	12243	12243	0	10875	1368
May-50	0	0	1958	32127	0	32127	277249	654	10153	4060	10358	115	388	98	1426	25	26623	26623	0	24686	1937
Jun-50	0	0	22962	31091	0	31091	278154	1039	10591	3441	12704	160	388	98	1729	37	29147	29147	0	26895	2252
Jul-50	0	0	6414	0	6414	6414	221322	1215	21925	6846	23797	224	388	196	2196	44	55616	55616	0	52792	2824
Aug-50	0	0	0	0	0	0	165036	1083	21561	7733	23069	208	388	393	1815	37	55204	55204	0	52571	2633
Sep-50	0	0	0	0	0	0	128743	744	12005	6998	13662	187	388	589	1690	31	35550	35550	0	32852	2698
Oct-50	0	0	0	32127	0	32127	140514	494	5921	5275	5873	122	388	589	1672	22	19862	19862	0	17191	2671
Nov-50	0	0	0	31091	0	31091	164365	350	1980	769	1806	65	600	212	1440	18	6890	6890	0	4620	2270
Dec-50	0	0	0	32127	0	32127	189284	336	2033	692	1808	67	600	212	1443	18	6872	6872	0	4599	2273

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-51	0	0	0	32127	0	32127	213999	344	2434	600	1720	65	600	212	1419	18	7068	7068	0	4819	2249
Feb-51	0	0	0	29018	0	29018	236063	403	2186	562	1503	59	600	212	1413	16	6551	6551	0	4310	2241
Mar-51	0	0	0	32127	0	32127	260648	386	2321	700	1806	65	600	212	1434	18	7156	7156	0	4892	2264
Apr-51	0	0	369	31091	0	31091	280113	644	3912	2531	3106	65	388	0	963	17	10982	10982	0	9614	1368
May-51	0	0	11858	32127	0	32127	287899	659	8825	3633	9185	103	388	98	1426	25	23683	23683	0	21746	1937
Jun-51	0	0	30962	31091	0	31091	291974	1051	9189	3113	11268	143	388	98	1729	37	25964	25964	0	23712	2252
Jul-51	0	0	22514	0	22514	22514	241479	1234	19079	6128	20996	199	388	196	2231	44	49261	49261	0	46402	2859
Aug-51	0	0	7507	0	0	0	191541	1113	18788	6872	20346	185	388	393	1815	37	48824	48824	0	46191	2633
Sep-51	0	0	881	0	0	0	159164	777	10442	6209	12087	166	388	589	1690	31	31601	31601	0	28903	2698
Oct-51	0	0	0	32127	0	32127	175188	520	4568	3286	4987	72	388	589	1672	22	15584	15584	0	12913	2671
Nov-51	0	0	0	31091	0	31091	199517	364	1368	1259	1443	58	600	212	1440	18	6397	6397	0	4127	2270
Dec-51	0	0	0	32127	0	32127	224775	347	2137	616	1436	59	600	212	1443	18	6522	6522	0	4249	2273
Jan-52	0	0	0	32127	0	32127	249218	356	3066	516	1440	58	600	212	1419	18	7329	7329	0	5080	2249
Feb-52	0	0	0	29018	0	29018	270456	418	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-52	0	0	0	32127	0	32127	295601	398	2197	602	1465	58	600	212	1434	18	6585	6585	0	4321	2264
Apr-52	0	0	2069	31091	0	31091	313722	668	4101	2225	4552	55	388	0	963	17	12301	12301	0	10933	1368
May-52	10928	10928	3430	21199	0	32127	328589	684	5197	2813	6548	82	388	98	1426	25	16577	16577	0	14640	1937

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-52	12179	12179	29183	18912	0	31091	341417	1098	5682	2358	6753	120	388	98	1729	37	17165	17165	0	14913	2252
Jul-52	0	0	11214	0	11214	11214	304684	1305	14197	3219	15832	144	388	196	1408	44	35428	35428	0	33392	2036
Aug-52	0	0	3407	0	0	0	250391	1202	19336	8039	23318	209	388	393	1408	0	53091	53091	0	50902	2189
Sep-52	0	0	681	0	0	0	220088	847	9010	7104	10776	182	388	589	1408	0	29456	29456	0	27071	2385
Oct-52	0	0	0	32127	0	32127	231238	566	6844	4498	6573	111	388	589	1408	0	20411	20411	0	18026	2385
Nov-52	0	0	0	31091	0	31091	254607	386	2260	804	1997	73	600	212	1390	0	7336	7336	0	5134	2202
Dec-52	0	0	0	32127	0	32127	279071	365	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-53	0	0	0	32127	0	32127	303203	371	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-53	0	0	0	29018	0	29018	324728	437	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-53	0	0	0	32127	0	32127	348733	414	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-53	0	0	0	19793	0	19793	356000	706	4490	2607	3405	70	388	0	861	0	11820	11820	0	10571	1249
May-53	0	0	2658	25421	2658	28079	356000	714	10153	3480	9161	106	388	98	1321	0	24708	24708	0	22901	1807
Jun-53	0	0	28562	29840	1251	31091	356000	1141	10591	3897	11826	170	388	98	1729	0	28700	28700	0	26485	2215
Jul-53	0	0	9114	0	9114	9114	303949	1336	21925	8762	17227	259	388	196	1914	44	50715	50715	0	48173	2542
Aug-53	0	0	3707	0	0	0	255234	1211	21561	7336	16221	197	388	393	1408	0	47504	47504	0	45315	2189
Sep-53	0	0	0	0	0	0	220611	854	12005	7434	11753	191	388	589	1408	0	33768	33768	0	31383	2385
Oct-53	0	0	0	32127	0	32127	226663	568	8690	6271	8008	154	388	589	1408	0	25508	25508	0	23123	2385

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-53	0	0	0	31091	0	31091	248891	385	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-53	0	0	0	32127	0	32127	272225	363	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-54	0	0	0	32127	0	32127	295142	370	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-54	0	0	0	29018	0	29018	315581	435	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-54	0	0	0	32127	0	32127	338363	412	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-54	0	0	0	31091	0	31091	354223	700	5846	3194	4157	84	388	0	861	0	14530	14530	0	13281	1249
May-54	0	0	3658	32127	0	32127	351509	714	12997	7050	12706	172	388	98	717	0	34128	34128	0	32925	1203
Jun-54	0	0	3962	31091	0	31091	344221	1139	13560	6663	15576	237	388	98	717	0	37240	37240	0	36037	1203
Jul-54	0	0	1314	0	1314	1314	275589	1323	27787	7855	29407	267	388	196	1408	0	67309	67309	0	65317	1992
Aug-54	0	0	0	0	0	0	208050	1175	27108	8314	28524	230	388	393	1408	0	66364	66364	0	64175	2189
Sep-54	0	0	0	0	0	0	165799	804	15132	6915	16815	200	388	589	1408	0	41446	41446	0	39061	2385
Oct-54	0	0	0	32127	0	32127	174343	528	6670	6958	6872	170	388	589	1408	0	23055	23055	0	20670	2385
Nov-54	0	0	0	31091	0	31091	196593	365	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-54	0	0	0	32127	0	32127	219942	347	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-55	0	0	0	32127	0	32127	242875	354	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-55	0	0	0	29018	0	29018	263333	416	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-55	0	0	0	32127	0	32127	286131	395	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-55	0	0	0	31091	0	31091	301979	663	5373	3194	4680	84	388	0	861	0	14579	14579	0	13330	1249
May-55	0	0	2658	32127	0	32127	288514	677	22279	5791	15163	152	388	98	1046	0	44916	44916	0	43384	1532
Jun-55	0	0	12562	31091	0	31091	284678	1068	12525	3719	16222	190	388	98	717	0	33859	33859	0	32656	1203
Jul-55	0	0	5814	0	5814	5814	217238	1228	24760	9494	29678	287	388	196	1408	0	66211	66211	0	64219	1992
Aug-55	0	0	1607	0	0	0	155450	1080	24841	7978	25468	233	388	393	1408	0	60709	60709	0	58520	2189
Sep-55	0	0	0	0	0	0	110679	733	15022	9293	17110	228	388	589	1408	0	44038	44038	0	41653	2385
Oct-55	0	0	0	32127	0	32127	123271	476	4605	5798	6134	138	388	589	1408	0	19059	19059	0	16674	2385
Nov-55	0	0	0	31091	0	31091	147328	341	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-55	0	0	0	32127	0	32127	172394	330	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202
Jan-56	0	0	0	32127	0	32127	197166	338	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-56	0	0	0	29018	0	29018	219276	396	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-56	0	0	0	32127	0	32127	243954	380	2321	676	1806	65	600	212	1390	0	7070	7070	0	4868	2202
Apr-56	0	0	69	31091	0	31091	264175	631	3676	2170	2963	62	388	0	963	17	10239	10239	0	8871	1368
May-56	0	0	16058	32127	0	32127	273256	648	9072	2768	8529	93	388	98	1426	25	22399	22399	0	20462	1937
Jun-56	0	0	23162	31091	0	31091	277942	1033	8194	3287	11499	139	388	98	1729	37	25372	25372	0	23120	2252
Jul-56	0	0	4014	0	4014	4014	223357	1211	19577	8074	22653	212	388	196	2231	44	53375	53375	0	50516	2859
Aug-56	0	0	807	0	0	0	178333	1083	18471	5633	17030	175	388	393	1815	37	43941	43941	0	41308	2633

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-56	0	0	0	0	0	0	140805	759	13428	6425	14054	164	388	589	1690	31	36769	36769	0	34071	2698
Oct-56	0	0	0	32127	0	32127	152466	506	3531	7058	6814	144	388	589	1414	22	19960	19960	0	17547	2413
Nov-56	0	0	0	31091	0	31091	176985	354	1368	1148	1443	58	600	212	1390	0	6218	6218	0	4016	2202
Dec-56	0	0	0	32127	0	32127	202381	340	2137	557	1436	59	600	212	1390	0	6391	6391	0	4189	2202
Jan-57	0	0	0	32127	0	32127	226882	349	3066	512	1440	58	600	212	1390	0	7278	7278	0	5076	2202
Feb-57	0	0	0	29018	0	29018	248168	409	3321	483	1266	52	600	212	1390	0	7323	7323	0	5121	2202
Mar-57	0	0	0	32127	0	32127	273402	391	2197	581	1465	58	600	212	1390	0	6502	6502	0	4300	2202
Apr-57	0	0	69	31091	0	31091	292185	652	3899	2024	4429	55	388	0	861	0	11656	11656	0	10407	1249
May-57	5351	5351	1807	26776	0	32127	310142	668	3096	2426	5986	82	388	98	1426	0	13502	13502	0	11590	1912
Jun-57	25991	25991	15571	5100	0	31091	324976	1070	4441	2152	6223	120	388	98	1729	37	15187	15187	0	12935	2252
Jul-57	3366	3366	34348	0	28761	32127	297109	1277	11217	3495	12214	172	388	196	2231	44	29957	29957	0	27098	2859
Aug-57	0	0	8107	0	0	0	243839	1186	21134	5124	23061	149	388	393	1797	37	52083	52083	0	49468	2615
Sep-57	0	0	981	0	0	0	203517	841	15640	6961	14041	141	388	589	1690	31	39481	39481	0	36783	2698
Oct-57	0	0	0	32127	0	32127	212000	559	6252	6984	7020	159	388	589	1672	22	23086	23086	0	20415	2671
Nov-57	0	0	0	31091	0	31091	233802	379	2699	1472	2380	88	600	212	1440	18	8910	8910	0	6640	2270
Dec-57	0	0	0	32127	0	32127	256411	359	3505	906	2385	91	600	212	1443	18	9161	9161	0	6888	2273
Jan-58	0	0	0	32127	0	32127	277684	366	5040	848	2263	88	600	212	1419	18	10488	10488	0	8239	2249

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Feb-58	0	0	0	29018	0	29018	295708	429	5470	799	1976	80	600	212	1413	16	10565	10565	0	8324	2241
Mar-58	0	0	0	32127	0	32127	318157	407	3585	962	2372	88	600	212	1434	18	9271	9271	0	7007	2264
Apr-58	0	0	0	31091	0	31091	333448	686	6661	3114	3886	84	388	0	963	17	15114	15114	0	13746	1368
May-58	17673	17673	4785	14454	0	32127	343366	700	5536	3639	10272	125	388	98	1426	25	21509	21509	0	19572	1937
Jun-58	9525	9525	13237	21566	0	31091	343752	1117	9752	4378	14009	208	388	98	717	37	29587	29587	0	28347	1240
Jul-58	0	0	2914	0	2914	2914	279586	1316	24506	9824	26225	303	388	196	1408	0	62850	62850	0	60858	1992
Aug-58	0	0	0	0	0	0	202930	1178	35609	10475	26946	258	388	393	1408	0	75478	75478	0	73289	2189
Sep-58	0	0	0	0	0	0	147253	804	18074	7374	26834	206	388	589	1408	0	54873	54873	0	52488	2385
Oct-58	0	0	0	32127	0	32127	155824	514	5283	7689	7508	177	388	589	1408	0	23041	23041	0	20656	2385
Nov-58	0	0	0	31091	0	31091	179223	356	2260	804	1997	73	600	212	1390	0	7336	7336	0	5134	2202
Dec-58	0	0	0	32127	0	32127	203711	341	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-59	0	0	0	32127	0	32127	227864	349	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-59	0	0	0	29018	0	29018	249417	409	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-59	0	0	0	32127	0	32127	273446	390	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-59	0	0	0	31091	0	31091	292446	653	4221	2607	3292	70	388	0	861	0	11439	11439	0	10190	1249
May-59	3156	3156	702	28971	0	32127	301597	668	7352	3331	9610	104	388	98	1426	0	22308	22308	0	20396	1912
Jun-59	1828	1828	25734	29263	0	31091	303509	1067	10786	2924	11997	152	388	98	1729	37	28112	28112	0	25860	2252

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jul-59	0	0	7214	0	7214	7214	249037	1255	21041	6826	22843	216	388	196	1663	44	53217	53217	0	50926	2291
Aug-59	0	0	1507	0	0	0	189059	1128	25401	8299	22751	210	388	393	1408	0	58849	58849	0	56660	2189
Sep-59	0	0	0	0	0	0	149407	779	14337	6339	15638	175	388	589	1408	0	38873	38873	0	36488	2385
Oct-59	0	0	0	32127	0	32127	160861	514	5559	5517	6568	131	388	589	1408	0	20160	20160	0	17775	2385
Nov-59	0	0	0	31091	0	31091	184828	359	1980	712	1806	65	600	212	1390	0	6765	6765	0	4563	2202
Dec-59	0	0	0	32127	0	32127	209881	343	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202
Jan-60	0	0	0	32127	0	32127	234640	351	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-60	0	0	0	29018	0	29018	256734	412	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-60	0	0	0	32127	0	32127	281375	393	2321	700	1806	65	600	212	1390	0	7094	7094	0	4892	2202
Apr-60	0	0	1569	31091	0	31091	301442	658	3676	2314	2963	62	388	0	963	0	10366	10366	0	9015	1351
May-60	635	635	5723	31492	0	32127	312822	674	6374	3136	8529	96	388	98	1426	25	20072	20072	0	18135	1937
Jun-60	1207	1207	25355	29884	0	31091	318743	1080	8041	2948	10707	143	388	98	1729	37	24090	24090	0	21838	2252
Jul-60	0	0	8914	0	8914	8914	271369	1275	17628	5324	20103	185	388	196	2231	44	46099	46099	0	43240	2859
Aug-60	0	0	0	0	0	0	214720	1157	23038	7945	21681	194	388	393	1815	37	55492	55492	0	52859	2633
Sep-60	0	0	0	0	0	0	179226	809	12797	6707	12311	171	388	589	1690	31	34685	34685	0	31987	2698
Oct-60	0	0	0	32127	0	32127	194698	537	3335	4991	5006	115	388	589	1672	22	16118	16118	0	13447	2671
Nov-60	0	0	0	31091	0	31091	219131	371	1368	1148	1443	58	600	212	1440	18	6286	6286	0	4016	2270

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Dec-60	0	0	0	32127	0	32127	244443	353	2137	557	1436	59	600	212	1443	18	6462	6462	0	4189	2273
Jan-61	0	0	0	32127	0	32127	268883	362	3066	512	1440	58	600	212	1419	18	7325	7325	0	5076	2249
Feb-61	0	0	0	29018	0	29018	290114	425	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-61	0	0	0	32127	0	32127	315273	404	2197	581	1465	58	600	212	1434	18	6564	6564	0	4300	2264
Apr-61	0	0	0	31091	0	31091	333907	682	3899	2024	4429	55	388	0	963	17	11775	11775	0	10407	1368
May-61	4885	4885	3273	27242	0	32127	351809	698	3096	2426	5986	82	388	98	1426	25	13527	13527	0	11590	1937
Jun-61	23700	20283	6062	0	6062	26345	356000	1123	4345	2152	6223	120	388	98	1607	37	14969	14969	0	12839	2130
Jul-61	0	0	8314	0	8314	8314	319028	1323	13052	4324	16094	186	388	196	1408	0	35649	35649	0	33657	1992
Aug-61	0	0	1907	0	0	0	261310	1221	23509	7135	23500	163	388	393	1408	0	56496	56496	0	54307	2189
Sep-61	0	0	4781	0	0	0	228694	862	11346	6354	11529	141	388	589	1408	0	31755	31755	0	29370	2385
Oct-61	0	0	0	32127	0	32127	244071	574	5026	3317	5363	85	388	589	1408	0	16176	16176	0	13791	2385
Nov-61	0	0	0	31091	0	31091	267800	390	2120	680	1902	69	600	212	1390	0	6972	6972	0	4770	2202
Dec-61	0	0	0	32127	0	32127	292545	368	2172	666	1904	71	600	212	1390	0	7015	7015	0	4813	2202
Jan-62	0	0	0	32127	0	32127	316976	375	2601	638	1810	69	600	212	1390	0	7321	7321	0	5119	2202
Feb-62	0	0	0	29018	0	29018	338768	442	2336	602	1582	62	600	212	1390	0	6784	6784	0	4582	2202
Mar-62	0	0	0	25025	0	25025	356000	418	2480	724	1900	69	600	212	1390	0	7375	7375	0	5173	2202
Apr-62	0	0	3869	11510	3869	15378	356000	711	3948	2306	3127	66	388	0	963	0	10799	10799	0	9448	1351

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
May-62	0	0	8658	24721	7406	32127	356000	713	8553	3785	10329	112	388	98	717	25	24008	24008	0	22780	1228
Jun-62	1733	1733	20729	23369	5989	31091	356000	1138	8295	2812	11509	145	388	98	717	0	23964	23964	0	22761	1203
Jul-62	0	0	16014	0	16014	16014	297319	1332	21433	9601	24061	261	388	196	1408	0	57349	57349	0	55357	1992
Aug-62	0	0	1707	0	0	0	243273	1200	21379	7413	21665	200	388	393	1408	0	52846	52846	0	50657	2189
Sep-62	0	0	0	0	0	0	207118	841	13737	6824	12195	174	388	589	1408	0	35315	35315	0	32930	2385
Oct-62	0	0	0	32127	0	32127	213758	560	6807	7322	8233	181	388	589	1408	0	24927	24927	0	22542	2385
Nov-62	0	0	0	31091	0	31091	236096	380	2820	883	2380	88	600	212	1390	0	8373	8373	0	6171	2202
Dec-62	0	0	0	32127	0	32127	259433	359	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-63	0	0	0	32127	0	32127	282354	366	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-63	0	0	0	29018	0	29018	302798	430	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-63	0	0	0	32127	0	32127	325618	408	3275	962	2372	88	600	212	1390	0	8900	8900	0	6698	2202
Apr-63	0	0	0	31091	0	31091	340156	691	6516	3324	4682	92	388	0	861	0	15862	15862	0	14613	1249
May-63	0	0	7958	32127	0	32127	320335	705	18106	9661	22104	169	388	98	717	0	51243	51243	0	50040	1203
Jun-63	0	0	14762	31091	0	31091	314378	1105	15261	4603	14674	202	388	98	717	0	35943	35943	0	34740	1203
Jul-63	0	0	3914	0	3914	3914	248834	1280	27416	6564	28033	260	388	196	1408	0	64264	64264	0	62272	1992
Aug-63	0	0	3607	0	0	0	192405	1135	23818	7284	21762	241	388	393	1408	0	55293	55293	0	53104	2189
Sep-63	0	0	2181	0	0	0	152106	782	13583	7643	15706	199	388	589	1408	0	39517	39517	0	37132	2385

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Oct-63	0	0	0	32127	0	32127	156951	516	6899	7908	9413	161	388	589	1408	0	26766	26766	0	24381	2385
Nov-63	0	0	0	31091	0	31091	179778	358	2540	895	2189	81	600	212	1390	0	7906	7906	0	5704	2202
Dec-63	0	0	0	32127	0	32127	203700	341	2590	797	2192	83	600	212	1390	0	7864	7864	0	5662	2202
Jan-64	0	0	0	32127	0	32127	227245	349	3104	764	2082	80	600	212	1390	0	8233	8233	0	6031	2202
Feb-64	0	0	0	29018	0	29018	248254	409	2787	720	1818	73	600	212	1390	0	7600	7600	0	5398	2202
Mar-64	0	0	0	32127	0	32127	271670	390	2957	898	2184	81	600	212	1390	0	8321	8321	0	6119	2202
Apr-64	0	0	0	31091	0	31091	289534	652	4786	2900	3563	77	388	0	861	0	12576	12576	0	11327	1249
May-64	0	0	5858	32127	0	32127	282584	667	15897	4481	15990	129	388	98	1426	0	38410	38410	0	36498	1912
Jun-64	0	0	13362	31091	0	31091	281752	1054	12564	3361	13117	171	388	98	1134	37	30870	30870	0	29213	1657
Jul-64	0	0	8814	0	8814	8814	219926	1224	23291	7690	27380	249	388	196	1408	0	60601	60601	0	58609	1992
Aug-64	0	0	0	0	0	0	162458	1082	23093	8771	22098	234	388	393	1408	0	56386	56386	0	54197	2189
Sep-64	0	0	0	0	0	0	125594	742	13326	7357	12854	202	388	589	1408	0	36123	36123	0	33738	2385
Oct-64	0	0	0	32127	0	32127	140510	491	3878	5069	5275	112	388	589	1408	0	16719	16719	0	14334	2385
Nov-64	0	0	0	31091	0	31091	165057	349	1700	621	1615	58	600	212	1390	0	6195	6195	0	3993	2202
Dec-64	0	0	0	32127	0	32127	190683	336	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-65	0	0	0	32127	0	32127	216056	345	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-65	0	0	0	29018	0	29018	238703	404	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Mar-65	0	0	0	32127	0	32127	263963	386	2002	602	1617	58	600	212	1390	0	6481	6481	0	4279	2202
Apr-65	0	0	469	31091	0	31091	285136	645	3150	2182	2633	59	388	0	861	0	9272	9272	0	8023	1249
May-65	0	0	5058	32127	0	32127	291125	662	12822	3155	7495	92	388	98	1426	0	25477	25477	0	23565	1912
Jun-65	11952	11952	30610	19139	0	31091	299895	1061	7111	2473	9302	122	388	98	1729	37	21260	21260	0	19008	2252
Jul-65	1177	1177	26237	0	26237	27414	266577	1243	10568	4456	15212	158	388	196	2231	44	33252	33252	0	30393	2859
Aug-65	0	0	8507	0	0	0	218794	1140	18353	6168	19325	164	388	393	1815	37	46643	46643	0	44010	2633
Sep-65	0	0	2281	0	0	0	186132	809	9725	6431	12842	156	388	589	1690	31	31852	31852	0	29154	2698
Oct-65	0	0	0	32127	0	32127	195826	541	6570	5606	6906	140	388	589	1672	22	21893	21893	0	19222	2671
Nov-65	0	0	0	31091	0	31091	218103	373	2820	883	2380	88	600	212	1440	18	8441	8441	0	6171	2270
Dec-65	0	0	0	32127	0	32127	241375	354	2868	884	2385	91	600	212	1443	18	8501	8501	0	6228	2273
Jan-66	0	0	0	32127	0	32127	264254	361	3440	848	2263	88	600	212	1419	18	8887	8887	0	6638	2249
Feb-66	0	0	0	29018	0	29018	284665	424	3088	799	1976	80	600	212	1413	16	8183	8183	0	5942	2241
Mar-66	0	0	0	32127	0	32127	307429	402	3275	962	2372	88	600	212	1434	18	8962	8962	0	6698	2264
Apr-66	0	0	0	31091	0	31091	324186	678	5324	2993	3886	84	388	0	963	17	13655	13655	0	12287	1368
May-66	0	0	4358	32127	0	32127	319701	692	13290	4618	15932	143	388	98	1426	25	35920	35920	0	33983	1937
Jun-66	0	0	7762	31091	0	31091	305477	1099	16977	4374	20628	195	388	98	1519	37	44216	44216	0	42174	2042
Jul-66	0	0	3414	0	3414	3414	231417	1268	28732	11646	30127	295	388	196	1408	0	72792	72792	0	70800	1992

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Aug-66	0	0	107	0	0	0	164480	1108	27018	10531	25796	294	388	393	1408	0	65830	65830	0	63641	2189
Sep-66	0	0	0	0	0	0	129082	747	13358	6797	11917	192	388	589	1408	0	34650	34650	0	32265	2385
Oct-66	0	0	0	32127	0	32127	139947	495	4479	7006	6742	155	388	589	1408	0	20768	20768	0	18383	2385
Nov-66	0	0	0	31091	0	31091	163996	350	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-66	0	0	0	32127	0	32127	189056	335	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202
Jan-67	0	0	0	32127	0	32127	213822	344	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-67	0	0	0	29018	0	29018	235925	403	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-67	0	0	0	32127	0	32127	260597	386	2321	676	1806	65	600	212	1390	0	7070	7070	0	4868	2202
Apr-67	0	0	0	31091	0	31091	280715	643	3830	2170	2917	62	388	0	963	0	10330	10330	0	8979	1351
May-67	0	0	3358	32127	0	32127	292487	660	7125	2768	7774	93	388	98	1426	25	19696	19696	0	17759	1937
Jun-67	3779	3779	17183	27312	0	31091	298015	1054	9530	2559	10032	135	388	98	1729	37	24508	24508	0	22256	2252
Jul-67	11482	11482	2532	0	2532	14014	274272	1244	13540	3768	13670	168	388	196	2206	44	33980	33980	0	31146	2834
Aug-67	0	0	7	0	0	0	209575	1156	23074	9378	28700	201	388	393	1408	0	63542	63542	0	61353	2189
Sep-67	0	0	1581	0	0	0	171492	803	15194	6506	13028	168	388	589	1408	0	37280	37280	0	34895	2385
Oct-67	0	0	0	32127	0	32127	183545	533	6117	6116	4785	139	388	589	1408	0	19542	19542	0	17157	2385
Nov-67	0	0	0	31091	0	31091	208136	368	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202
Dec-67	0	0	0	32127	0	32127	233748	350	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-68	0	0	0	32127	0	32127	259107	358	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-68	0	0	0	29018	0	29018	281736	421	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-68	0	0	0	32127	0	32127	307004	400	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-68	0	0	0	31091	0	31091	328483	676	3141	1897	2594	55	388	0	861	0	8935	8935	0	7686	1249
May-68	58	58	0	32069	0	32127	342370	693	6694	2547	6552	83	388	98	1185	0	17547	17547	0	15876	1671
Jun-68	2191	2191	24671	28900	0	31091	351363	1118	7084	2391	9343	120	388	98	1556	0	20980	20980	0	18938	2042
Jul-68	0	0	8414	0	8414	8414	303701	1323	16539	5488	22013	180	388	196	1536	0	46339	46339	0	44219	2120
Aug-68	0	0	2007	0	0	0	264040	1204	14967	5158	15971	148	388	393	1432	0	38457	38457	0	36244	2213
Sep-68	0	0	0	0	0	0	232096	857	11317	6420	10828	138	388	589	1408	0	31087	31087	0	28702	2385
Oct-68	0	0	0	32127	0	32127	245014	576	4884	5462	5773	129	388	589	1408	0	18633	18633	0	16248	2385
Nov-68	0	0	0	31091	0	31091	268912	390	1701	1229	1605	65	600	212	1390	0	6802	6802	0	4600	2202
Dec-68	0	0	0	32127	0	32127	293680	368	2479	644	1599	67	600	212	1390	0	6991	6991	0	4789	2202
Jan-69	0	0	0	32127	0	32127	317405	375	3560	596	1604	65	600	212	1390	0	8027	8027	0	5825	2202
Feb-69	0	0	0	29018	0	29018	337889	443	3858	562	1410	59	600	212	1390	0	8091	8091	0	5889	2202
Mar-69	0	0	0	25646	0	25646	356000	419	2544	676	1629	65	600	212	1390	0	7116	7116	0	4914	2202
Apr-69	0	0	69	14515	69	14583	356000	711	4906	2472	5012	62	388	0	963	0	13803	13803	0	12452	1351
May-69	8937	8937	9021	6207	9021	24165	356000	714	3755	2812	5831	95	388	98	1426	25	14430	14430	0	12493	1937

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-69	20523	18676	7939	0	7939	26615	356000	1130	6466	2403	6290	135	388	98	1729	37	17546	17546	0	15294	2252
Jul-69	840	840	13774	0	13774	14614	312500	1328	18499	4485	16981	188	388	196	2231	44	43012	43012	0	40153	2859
Aug-69	0	0	907	0	0	0	240597	1219	25327	10254	32262	226	388	393	1797	37	70684	70684	0	68069	2615
Sep-69	0	0	281	0	0	0	209751	841	9998	5654	11508	147	388	589	1690	31	30005	30005	0	27307	2698
Oct-69	0	0	0	32127	0	32127	222678	559	3297	6688	5830	154	388	589	1672	22	18640	18640	0	15969	2671
Nov-69	0	0	0	31091	0	31091	247039	381	1368	1210	1443	58	600	212	1440	18	6349	6349	0	4079	2270
Dec-69	0	0	0	32127	0	32127	272342	362	2137	557	1436	59	600	212	1443	18	6462	6462	0	4189	2273
Jan-70	0	0	0	32127	0	32127	296775	369	3066	512	1440	58	600	212	1419	18	7325	7325	0	5076	2249
Feb-70	0	0	0	29018	0	29018	317996	435	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-70	0	0	0	32127	0	32127	343125	413	2197	602	1465	58	600	212	1434	18	6585	6585	0	4321	2264
Apr-70	0	0	0	25836	0	25836	356000	702	4299	2148	4390	55	388	0	963	17	12259	12259	0	10891	1368
May-70	572	572	11886	12967	11886	25425	356000	714	3096	2622	5088	82	388	98	1426	25	12825	12825	0	10888	1937
Jun-70	21618	14608	8944	0	8944	23552	356000	1128	4345	2210	5565	120	388	98	717	37	13480	13480	0	12240	1240
Jul-70	626	626	15188	0	15188	15814	320281	1323	13253	3517	16104	155	388	196	1408	0	35021	35021	0	33029	1992
Aug-70	0	0	2507	0	0	0	258978	1224	25460	6438	25833	160	388	393	1408	0	60080	60080	0	57891	2189
Sep-70	0	0	1481	0	0	0	230896	862	9207	5534	9956	138	388	589	1408	0	27221	27221	0	24836	2385
Oct-70	0	0	0	32127	0	32127	247986	574	3295	4406	4277	99	388	589	1408	0	14463	14463	0	12078	2385

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-70	0	0	0	31091	0	31091	272406	390	1368	1210	1443	58	600	212	1390	0	6281	6281	0	4079	2202
Dec-70	0	0	0	32127	0	32127	297773	369	2137	557	1436	59	600	212	1390	0	6391	6391	0	4189	2202
Jan-71	0	0	0	32127	0	32127	322246	376	3066	512	1440	58	600	212	1390	0	7278	7278	0	5076	2202
Feb-71	0	0	0	29018	0	29018	343497	444	3321	483	1266	52	600	212	1390	0	7323	7323	0	5121	2202
Mar-71	0	0	0	19447	0	19447	356000	420	2197	602	1465	58	600	212	1390	0	6523	6523	0	4321	2202
Apr-71	0	0	769	12715	769	13484	356000	711	4061	2148	4390	55	388	0	963	0	12004	12004	0	10653	1351
May-71	5921	5921	37	7651	37	13609	356000	713	3130	2622	5088	82	388	98	1426	25	12859	12859	0	10922	1937
Jun-71	15985	14859	20077	0	16232	31091	356000	1128	4438	2210	5723	120	388	98	717	37	13731	13731	0	12491	1240
Jul-71	0	0	14314	0	14314	14314	310745	1324	17945	6781	16992	222	388	196	1408	0	43932	43932	0	41940	1992
Aug-71	0	0	1807	0	0	0	251478	1216	21622	6434	27649	158	388	393	1408	0	58051	58051	0	55862	2189
Sep-71	0	0	1781	0	0	0	226278	850	8467	4721	8649	127	388	589	1408	0	24349	24349	0	21964	2385
Oct-71	0	0	0	32127	0	32127	236096	570	6475	6991	5726	163	388	589	1408	0	21740	21740	0	19355	2385
Nov-71	0	0	0	31091	0	31091	259547	388	2260	720	1997	73	600	212	1390	0	7252	7252	0	5050	2202
Dec-71	0	0	0	32127	0	32127	284010	366	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-72	0	0	0	32127	0	32127	308140	372	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-72	0	0	0	29018	0	29018	329663	439	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-72	0	0	0	32127	0	32127	353695	416	2639	771	1995	73	600	212	1390	0	7680	7680	0	5478	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-72	0	0	0	14640	0	14640	356000	710	4580	2486	3240	71	388	0	861	0	11625	11625	0	10376	1249
May-72	0	0	5658	23996	5658	29654	356000	714	9408	3425	8432	105	388	98	1426	0	23283	23283	0	21371	1912
Jun-72	0	0	23162	29577	1514	31091	356000	1140	10495	3200	13346	156	388	98	717	37	28437	28437	0	27197	1240
Jul-72	0	0	3714	0	3714	3714	291801	1336	23886	7840	28924	221	388	196	1408	0	62863	62863	0	60871	1992
Aug-72	0	0	0	0	0	0	233735	1195	24861	7684	21932	204	388	393	1408	0	56871	56871	0	54682	2189
Sep-72	0	0	2181	0	0	0	202898	832	8734	6664	12038	184	388	589	1408	0	30004	30004	0	27619	2385
Oct-72	0	0	0	32127	0	32127	212782	554	6250	6032	6895	128	388	589	1408	0	21690	21690	0	19305	2385
Nov-72	0	0	0	31091	0	31091	236618	379	1701	1302	1605	65	600	212	1390	0	6875	6875	0	4673	2202
Dec-72	0	0	0	32127	0	32127	261395	359	2479	644	1599	67	600	212	1390	0	6991	6991	0	4789	2202
Jan-73	0	0	0	32127	0	32127	285128	367	3560	596	1604	65	600	212	1390	0	8027	8027	0	5825	2202
Feb-73	0	0	0	29018	0	29018	305624	431	3858	562	1410	59	600	212	1390	0	8091	8091	0	5889	2202
Mar-73	0	0	0	32127	0	32127	330202	409	2544	700	1629	65	600	212	1390	0	7140	7140	0	4938	2202
Apr-73	0	0	0	31091	0	31091	346955	693	4881	2441	5012	62	388	0	861	0	13645	13645	0	12396	1249
May-73	8477	8477	0	15762	0	24239	356000	708	3724	2957	5774	93	388	98	1426	25	14486	14486	0	12549	1937
Jun-73	12194	12194	16768	4442	14455	31091	356000	1130	5373	2468	6290	135	388	98	717	37	15506	15506	0	14266	1240
Jul-73	0	0	18914	0	18914	18914	315062	1326	15992	4949	16481	198	388	196	1408	0	39612	39612	0	37620	1992
Aug-73	0	0	3207	0	0	0	247353	1220	26724	7813	29562	201	388	393	1408	0	66489	66489	0	64300	2189

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-73	0	0	0	0	0	0	212637	850	10889	6784	13642	165	388	589	1408	0	33866	33866	0	31481	2385
Oct-73	0	0	0	32127	0	32127	222091	562	6589	5511	7494	133	388	589	1408	0	22112	22112	0	19727	2385
Nov-73	0	0	0	31091	0	31091	244322	383	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-73	0	0	0	32127	0	32127	267657	362	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-74	0	0	0	32127	0	32127	290575	368	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-74	0	0	0	29018	0	29018	311016	433	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-74	0	0	0	32127	0	32127	333799	410	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-74	0	0	0	31091	0	31091	350085	697	5528	3194	3952	84	388	0	963	0	14108	14108	0	12757	1351
May-74	517	517	9041	31610	0	32127	351761	711	10810	4685	12168	140	388	98	1426	25	29740	29740	0	27803	1937
Jun-74	3373	3373	16989	27718	0	31091	349762	1136	11521	3662	15343	187	388	98	717	37	31953	31953	0	30713	1240
Jul-74	0	0	9414	0	9414	9414	274217	1328	32300	8893	30629	276	388	196	1535	0	74217	74217	0	72098	2119
Aug-74	0	0	0	0	0	0	199443	1178	30771	10099	30278	260	388	393	1408	0	73596	73596	0	71407	2189
Sep-74	0	0	0	0	0	0	156534	797	13751	10384	15328	264	388	589	1408	0	42112	42112	0	39727	2385
Oct-74	0	0	0	32127	0	32127	162988	520	10662	5465	6520	123	388	589	1408	0	25154	25154	0	22769	2385
Nov-74	0	0	0	31091	0	31091	186356	361	2260	829	1997	73	600	212	1390	0	7361	7361	0	5159	2202
Dec-74	0	0	0	32127	0	32127	210842	343	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-75	0	0	0	32127	0	32127	234993	351	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Feb-75	0	0	0	29018	0	29018	256543	412	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-75	0	0	0	32127	0	32127	280569	393	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-75	0	0	0	31091	0	31091	299308	658	4477	2607	3292	70	388	0	861	0	11695	11695	0	10446	1249
May-75	440	440	2618	31687	0	32127	304394	674	10788	3947	9608	112	388	98	1426	0	26368	26368	0	24456	1912
Jun-75	11702	11702	12460	19389	0	31091	307823	1076	9300	2886	11996	151	388	98	1729	37	26586	26586	0	24334	2252
Jul-75	0	0	23214	0	23214	23214	259644	1260	17750	5403	20708	199	388	196	2231	44	46920	46920	0	44061	2859
Aug-75	0	0	3207	0	0	0	196323	1141	23840	8732	26759	216	388	393	1815	37	62180	62180	0	59547	2633
Sep-75	0	0	0	0	0	0	157116	787	11621	9115	14754	231	388	589	1690	31	38419	38419	0	35721	2698
Oct-75	0	0	0	32127	0	32127	160325	519	12769	5595	7227	138	388	589	1672	22	28400	28400	0	25729	2671
Nov-75	0	0	0	31091	0	31091	182526	361	2820	987	2380	88	600	212	1424	18	8529	8529	0	6275	2254
Dec-75	0	0	0	32127	0	32127	205014	342	2868	1751	2385	91	600	212	1390	0	9297	9297	0	7095	2202
Jan-76	0	0	0	32127	0	32127	227951	350	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-76	0	0	0	29018	0	29018	248415	410	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-76	0	0	0	32127	0	32127	271218	390	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-76	0	0	0	31091	0	31091	287456	652	5710	3206	3952	84	388	0	861	0	14201	14201	0	12952	1249
May-76	0	0	3458	32127	0	32127	290856	666	9869	4593	11767	136	388	98	1209	0	28061	28061	0	26366	1695
Jun-76	0	0	14262	31091	0	31091	282010	1056	15345	4654	17311	200	388	98	883	0	38880	38880	0	37511	1369

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jul-76	0	0	7114	0	7114	7114	210796	1229	29330	7974	30131	259	388	196	1707	0	69985	69985	0	67694	2291
Aug-76	0	0	707	0	0	0	145938	1074	25627	8033	27700	235	388	393	1408	0	63784	63784	0	61595	2189
Sep-76	0	0	281	0	0	0	101328	721	12603	11505	17104	292	388	589	1408	0	43889	43889	0	41504	2385
Oct-76	0	0	0	32127	0	32127	105918	463	11737	5836	6981	135	388	589	1408	0	27074	27074	0	24689	2385
Nov-76	0	0	0	31091	0	31091	128302	334	2820	883	2380	88	600	212	1390	0	8373	8373	0	6171	2202
Dec-76	0	0	0	32127	0	32127	151677	322	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-77	0	0	0	32127	0	32127	174632	332	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-77	0	0	0	29018	0	29018	195120	387	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-77	0	0	0	32127	0	32127	217976	371	3275	962	2372	88	600	212	1390	0	8900	8900	0	6698	2202
Apr-77	0	0	0	31091	0	31091	234479	611	5705	2987	3952	84	388	0	861	0	13977	13977	0	12728	1249
May-77	0	0	1858	32127	0	32127	231672	627	12600	6578	13772	154	388	98	717	0	34307	34307	0	33104	1203
Jun-77	0	0	7962	31091	0	31091	215228	980	18254	6311	20574	212	388	98	717	0	46554	46554	0	45351	1203
Jul-77	0	0	0	0	0	0	147142	1121	26784	8272	29654	265	388	196	1408	0	66966	66966	0	64974	1992
Aug-77	0	0	0	0	0	0	88988	951	22276	7441	25052	243	388	393	1408	0	57202	57202	0	55013	2189
Sep-77	0	0	0	0	0	0	47475	616	13915	9140	15208	250	388	589	1408	0	40898	40898	0	38513	2385
Oct-77	0	0	0	32127	0	32127	61729	379	4410	5785	4794	121	388	589	1408	0	17494	17494	0	15109	2385
Nov-77	0	0	0	31091	0	31091	86390	298	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Dec-77	0	0	0	32127	0	32127	112051	301	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-78	0	0	0	32127	0	32127	137455	314	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-78	0	0	0	29018	0	29018	160137	368	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-78	0	0	0	32127	0	32127	185448	356	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-78	0	0	169	31091	0	31091	206581	581	3424	1897	2633	55	388	0	963	17	9376	9376	0	8008	1368
May-78	0	0	8158	32127	0	32127	220670	602	5504	2464	7449	82	388	98	1426	25	17437	17437	0	15500	1937
Jun-78	7662	7662	33900	23429	0	31091	230374	953	6449	2311	9302	120	388	98	1729	37	20434	20434	0	18182	2252
Jul-78	0	0	21114	0	21114	21114	187916	1128	18396	4928	14966	182	388	196	2231	44	41330	41330	0	38471	2859
Aug-78	0	0	1507	0	0	0	136724	1020	19047	7546	20770	176	388	393	1815	37	50172	50172	0	47539	2633
Sep-78	0	0	0	0	0	0	107560	703	8377	5086	12171	128	388	589	1690	31	28461	28461	0	25763	2698
Oct-78	0	0	0	32127	0	32127	120421	468	6741	4209	5076	102	388	589	1672	22	18799	18799	0	16128	2671
Nov-78	0	0	0	31091	0	31091	144870	340	1700	659	1615	58	600	212	1440	18	6301	6301	0	4031	2270
Dec-78	0	0	0	32127	0	32127	169883	329	1754	1085	1615	59	600	212	1443	18	6786	6786	0	4513	2273
Jan-79	0	0	0	32127	0	32127	195216	337	2099	512	1539	58	600	212	1419	18	6456	6456	0	4207	2249
Feb-79	0	0	0	29018	0	29018	217832	395	1885	483	1345	52	600	212	1413	16	6007	6007	0	3766	2241
Mar-79	0	0	0	32127	0	32127	243038	379	2002	602	1617	58	600	212	1434	18	6543	6543	0	4279	2264
Apr-79	0	0	569	31091	0	31091	264236	630	3187	2021	2633	55	388	0	963	17	9263	9263	0	7895	1368

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
May-79	10518	10518	1540	21609	0	32127	278091	647	5497	2660	7449	82	388	98	1426	25	17625	17625	0	15688	1937
Jun-79	9364	9364	26398	21727	0	31091	287571	1033	6535	2370	9302	120	388	98	1729	37	20578	20578	0	18326	2252
Jul-79	758	758	18356	0	18356	19114	239400	1222	19610	4635	20450	153	388	196	2231	44	47707	47707	0	44848	2859
Aug-79	0	0	5207	0	0	0	197579	1111	16015	5378	16542	142	388	393	1815	37	40710	40710	0	38077	2633
Sep-79	0	0	481	0	0	0	167228	782	7956	8072	10632	209	388	589	1690	31	29569	29569	0	26871	2698
Oct-79	0	0	0	32127	0	32127	179772	525	4573	5978	5705	132	388	589	1672	22	19059	19059	0	16388	2671
Nov-79	0	0	0	31091	0	31091	203553	366	1701	1302	1605	65	600	212	1440	18	6943	6943	0	4673	2270
Dec-79	0	0	0	32127	0	32127	228269	349	2479	644	1599	67	600	212	1443	18	7062	7062	0	4789	2273
Jan-80	0	0	0	32127	0	32127	251965	357	3560	596	1604	65	600	212	1419	18	8074	8074	0	5825	2249
Feb-80	0	0	0	29018	0	29018	272434	419	3858	562	1410	59	600	212	1413	16	8130	8130	0	5889	2241
Mar-80	0	0	0	32127	0	32127	296961	399	2544	700	1629	65	600	212	1434	18	7202	7202	0	4938	2264
Apr-80	0	0	569	31091	0	31091	313536	669	4918	2441	5058	62	388	0	963	17	13847	13847	0	12479	1368
May-80	12292	12292	566	19835	0	32127	329405	684	3765	2957	6821	93	388	98	1426	25	15574	15574	0	13637	1937
Jun-80	27035	27035	18227	4056	0	31091	341931	1096	5555	2468	7057	135	388	98	1729	37	17468	17468	0	15216	2252
Jul-80	2327	2327	16987	0	16987	19314	298939	1305	20622	4264	16935	177	388	196	1408	24	44014	44014	0	41998	2016
Aug-80	0	0	1907	0	0	0	235448	1202	24086	6956	28883	176	388	393	1408	0	62290	62290	0	60101	2189
Sep-80	0	0	81	0	0	0	200273	834	10171	8381	13196	207	388	589	1408	0	34341	34341	0	31956	2385

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Oct-80	0	0	0	32127	0	32127	203036	553	10904	8004	7332	187	388	589	1408	0	28812	28812	0	26427	2385
Nov-80	0	0	0	31091	0	31091	224598	378	2820	1661	2380	88	600	212	1390	0	9151	9151	0	6949	2202
Dec-80	0	0	0	32127	0	32127	247939	356	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-81	0	0	0	32127	0	32127	270863	363	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-81	0	0	0	29018	0	29018	291311	426	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-81	0	0	0	32127	0	32127	314100	404	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-81	0	0	0	31091	0	31091	330585	683	5444	3194	3952	84	388	0	861	0	13922	13922	0	12673	1249
May-81	0	0	1258	32127	0	32127	334982	697	9863	4051	11790	125	388	98	717	0	27033	27033	0	25830	1203
Jun-81	0	0	12462	31091	0	31091	327764	1114	14698	4439	16662	194	388	98	717	0	37195	37195	0	35992	1203
Jul-81	0	0	3714	0	3714	3714	254242	1300	30248	8129	31591	262	388	196	1408	0	72222	72222	0	70230	1992
Aug-81	0	0	0	0	0	0	188528	1147	24805	9013	28316	245	388	393	1408	0	64567	64567	0	62378	2189
Sep-81	0	0	0	0	0	0	145339	778	15258	8972	15550	246	388	589	1408	0	42412	42412	0	40027	2385
Oct-81	0	0	0	32127	0	32127	152419	511	9649	6753	5608	140	388	589	1408	0	24535	24535	0	22150	2385
Nov-81	0	0	0	31091	0	31091	177021	357	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202
Dec-81	0	0	0	32127	0	32127	202643	340	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-82	0	0	0	32127	0	32127	228013	349	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-82	0	0	0	29018	0	29018	250654	409	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Mar-82	0	0	0	32127	0	32127	275931	391	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-82	0	0	0	31091	0	31091	296727	654	3226	2290	2812	64	388	0	861	0	9641	9641	0	8392	1249
May-82	0	0	1358	32127	0	32127	307983	670	6141	3373	8676	99	388	98	1426	0	20201	20201	0	18289	1912
Jun-82	0	0	19762	31091	0	31091	317316	1073	6700	2311	9302	120	388	98	1729	37	20685	20685	0	18433	2252
Jul-82	0	0	18814	0	18814	18814	274701	1270	14345	5121	18871	150	388	196	2231	44	41346	41346	0	38487	2859
Aug-82	0	0	5607	0	0	0	233751	1158	16050	4968	15998	143	388	393	1815	37	39793	39793	0	37160	2633
Sep-82	0	0	3081	0	0	0	204894	825	9470	5201	10819	146	388	589	1408	12	28032	28032	0	25635	2397
Oct-82	0	0	0	32127	0	32127	217411	556	8129	4724	3716	101	388	589	1408	0	19054	19054	0	16669	2385
Nov-82	0	0	0	31091	0	31091	242487	382	1035	1066	1280	50	600	212	1390	0	5633	5633	0	3431	2202
Dec-82	0	0	0	32127	0	32127	268463	360	1794	470	1274	52	600	212	1390	0	5791	5791	0	3589	2202
Jan-83	0	0	0	32127	0	32127	293693	368	2573	429	1275	50	600	212	1390	0	6529	6529	0	4327	2202
Feb-83	0	0	0	29018	0	29018	315722	434	2783	404	1121	45	600	212	1390	0	6556	6556	0	4354	2202
Mar-83	0	0	0	32127	0	32127	341549	412	1849	486	1302	50	600	212	1390	0	5889	5889	0	3687	2202
Apr-83	0	0	0	25430	0	25430	356000	700	3431	1751	3800	48	388	0	861	0	10279	10279	0	9030	1249
May-83	3717	3717	0	8791	0	12508	356000	712	2515	2123	5150	71	388	98	1426	25	11796	11796	0	9859	1937
Jun-83	27743	14337	13919	0	13919	28256	356000	1127	3563	1903	5388	104	388	98	1729	37	13211	13211	0	10959	2252
Jul-83	13718	13718	21796	0	18409	32127	341219	1321	9431	3724	11839	147	388	196	1408	44	27178	27178	0	25142	2036

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Aug-83	0	0	9707	0	0	0	293281	1249	15528	5636	23185	150	388	393	1408	0	46689	46689	0	44500	2189
Sep-83	0	0	881	0	0	0	266580	888	9105	5405	8797	121	388	589	1408	0	25813	25813	0	23428	2385
Oct-83	0	0	0	32127	0	32127	278716	598	5401	6218	5246	144	388	589	1408	0	19394	19394	0	17009	2385
Nov-83	0	0	0	31091	0	31091	302604	401	1701	1229	1605	65	600	212	1390	0	6802	6802	0	4600	2202
Dec-83	0	0	0	32127	0	32127	327356	377	2485	644	1599	67	600	212	1390	0	6997	6997	0	4795	2202
Jan-84	0	0	0	32127	0	32127	351044	384	3588	596	1604	65	600	212	1390	0	8055	8055	0	5853	2202
Feb-84	0	0	0	13504	0	13504	356000	455	3860	562	1410	59	600	212	1390	0	8093	8093	0	5891	2202
Mar-84	0	0	0	7543	0	7543	356000	424	2547	676	1629	65	600	212	1390	0	7119	7119	0	4917	2202
Apr-84	0	0	0	14042	0	14042	356000	711	4665	2297	5058	62	388	0	861	0	13330	13330	0	12081	1249
May-84	13549	13549	1309	1708	1309	16566	356000	714	3696	2730	6821	93	388	98	717	0	14543	14543	0	13340	1203
Jun-84	13806	13806	11256	4383	11256	29445	356000	1130	5792	2870	7057	138	388	98	717	0	17059	17059	0	15856	1203
Jul-84	0	0	20614	0	20614	20614	299923	1327	23679	8727	20119	232	388	196	1408	0	54750	54750	0	52758	1992
Aug-84	0	0	6507	0	0	0	244799	1207	20872	4356	26358	142	388	393	1408	0	53917	53917	0	51728	2189
Sep-84	0	0	2881	0	0	0	212675	842	9383	6344	12997	172	388	589	1408	0	31282	31282	0	28897	2385
Oct-84	0	0	0	32127	0	32127	226448	561	5484	4698	5112	114	388	589	1408	0	17794	17794	0	15409	2385
Nov-84	0	0	0	31091	0	31091	250383	384	1986	712	1806	65	600	212	1390	0	6771	6771	0	4569	2202
Dec-84	0	0	0	32127	0	32127	274779	363	2044	1248	1808	67	600	212	1390	0	7368	7368	0	5166	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-85	0	0	0	32127	0	32127	299399	370	2444	706	1720	65	600	212	1390	0	7137	7137	0	4935	2202
Feb-85	0	0	0	29018	0	29018	321465	436	2191	562	1503	59	600	212	1390	0	6517	6517	0	4315	2202
Mar-85	0	0	0	32127	0	32127	345989	413	2417	700	1806	65	600	212	1390	0	7190	7190	0	4988	2202
Apr-85	0	0	769	26613	769	27381	356000	704	6867	3133	4468	78	388	0	963	0	15897	15897	0	14546	1351
May-85	3212	3212	6146	19917	6146	29275	356000	716	9683	3071	7627	95	388	98	1426	25	22413	22413	0	20476	1937
Jun-85	4099	4099	20363	26992	0	31091	347758	1140	15644	4956	16174	179	388	98	717	37	38193	38193	0	36953	1240
Jul-85	0	0	7714	0	7714	7714	302609	1332	16993	5104	19551	178	388	196	1408	0	43817	43817	0	41825	1992
Aug-85	0	0	0	0	0	0	257349	1203	15004	6611	20030	174	388	393	1456	0	44057	44057	0	41820	2237
Sep-85	0	0	0	0	0	0	230929	851	7373	5748	9900	165	388	589	1408	0	25570	25570	0	23185	2385
Oct-85	0	0	0	32127	0	32127	248937	573	3726	2920	4443	72	388	589	1408	0	13546	13546	0	11161	2385
Nov-85	0	0	0	31091	0	31091	273470	391	1735	558	1615	58	600	212	1390	0	6167	6167	0	3965	2202
Dec-85	0	0	0	32127	0	32127	299056	369	1760	535	1615	59	600	212	1390	0	6172	6172	0	3970	2202
Jan-86	0	0	0	32127	0	32127	324398	376	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-86	0	0	0	29018	0	29018	346972	444	1917	483	1345	52	600	212	1390	0	6000	6000	0	3798	2202
Mar-86	0	0	0	16009	0	16009	356000	421	2102	581	1617	58	600	212	1390	0	6560	6560	0	4358	2202
Apr-86	0	0	1769	13911	1769	15680	356000	711	3132	5890	2719	109	388	0	963	0	13200	13200	0	11849	1351
May-86	1473	1473	5885	25422	5232	32127	356000	712	12963	3877	7306	99	388	98	1426	25	26183	26183	0	24246	1937

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-86	18831	18831	19831	3315	8945	31091	356000	1144	6673	2339	10629	120	388	98	717	37	21002	21002	0	19762	1240
Jul-86	0	0	18314	0	18314	18314	308477	1329	15715	4911	23399	177	388	196	1408	0	46194	46194	0	44202	1992
Aug-86	0	0	2507	0	0	0	267031	1210	15267	6149	16469	163	388	393	1408	0	40237	40237	0	38048	2189
Sep-86	0	0	481	0	0	0	244823	861	7812	3909	7119	123	388	589	1408	0	21347	21347	0	18962	2385
Oct-86	0	0	0	32127	0	32127	261166	583	4437	3253	5044	83	388	589	1408	0	15202	15202	0	12817	2385
Nov-86	0	0	0	31091	0	31091	285169	395	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-86	0	0	0	32127	0	32127	310184	373	2041	622	1808	67	600	212	1390	0	6740	6740	0	4538	2202
Jan-87	0	0	0	32127	0	32127	334915	379	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-87	0	0	0	28073	0	28073	356000	448	2213	562	1503	59	600	212	1390	0	6539	6539	0	4337	2202
Mar-87	0	0	0	7523	0	7523	356000	423	2351	676	1806	65	600	212	1390	0	7100	7100	0	4898	2202
Apr-87	0	0	1569	15876	1569	17444	356000	711	4571	5418	3756	83	388	0	948	0	15165	15165	0	13829	1336
May-87	5830	5830	6828	24255	2042	32127	356000	714	13550	5298	8530	139	388	98	1368	0	29371	29371	0	27517	1854
Jun-87	4923	4923	8839	24923	1245	31091	356000	1145	10748	3102	12492	143	388	98	1729	0	28701	28701	0	26486	2215
Jul-87	0	0	2614	0	2614	2614	301440	1336	21424	6515	22678	207	388	196	1771	44	53223	53223	0	50824	2399
Aug-87	0	0	0	0	0	0	258813	1206	14363	5065	19641	163	388	393	1408	0	41421	41421	0	39232	2189
Sep-87	0	0	0	0	0	0	231326	852	7863	5503	10721	164	388	589	1408	0	26636	26636	0	24251	2385
Oct-87	0	0	0	32127	0	32127	244944	573	5148	4581	5710	112	388	589	1408	0	17936	17936	0	15551	2385

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-87	0	0	0	31091	0	31091	268343	390	2310	720	1997	73	600	212	1390	0	7302	7302	0	5100	2202
Dec-87	0	0	0	32127	0	32127	292762	368	2353	710	2000	75	600	212	1390	0	7340	7340	0	5138	2202
Jan-88	0	0	0	32127	0	32127	316868	375	2790	680	1901	73	600	212	1390	0	7646	7646	0	5444	2202
Feb-88	0	0	0	29018	0	29018	338379	442	2496	641	1661	66	600	212	1390	0	7065	7065	0	4863	2202
Mar-88	0	0	0	25807	0	25807	356000	418	2727	771	1995	73	600	212	1390	0	7768	7768	0	5566	2202
Apr-88	0	0	469	13717	469	14186	356000	712	5563	2723	3292	76	388	0	963	0	13006	13006	0	11655	1351
May-88	0	0	7458	30395	1732	32127	356000	715	11776	5777	10086	104	388	98	1426	25	29680	29680	0	27743	1937
Jun-88	0	0	23462	29981	1110	31091	356000	1143	10314	3327	12794	152	388	98	1729	37	28838	28838	0	26586	2252
Jul-88	0	0	3814	0	3814	3814	298809	1335	21858	5117	25860	196	388	196	2196	44	55856	55856	0	53032	2824
Aug-88	0	0	0	0	0	0	241689	1203	19892	9833	23293	267	388	393	1815	37	55918	55918	0	53285	2633
Sep-88	0	0	0	0	0	0	204803	838	13679	6932	12604	196	388	589	1630	31	36048	36048	0	33410	2638
Oct-88	0	0	0	32127	0	32127	213093	558	6570	7241	6931	151	388	589	1408	0	23278	23278	0	20893	2385
Nov-88	0	0	0	31091	0	31091	235086	380	2904	1144	2380	88	600	212	1390	0	8718	8718	0	6516	2202
Dec-88	0	0	0	32127	0	32127	258351	359	2941	884	2385	91	600	212	1390	0	8503	8503	0	6301	2202
Jan-89	0	0	0	32127	0	32127	281240	366	3472	848	2263	88	600	212	1390	0	8872	8872	0	6670	2202
Feb-89	0	0	0	29018	0	29018	301683	430	3089	799	1976	80	600	212	1390	0	8145	8145	0	5943	2202
Mar-89	0	0	0	32127	0	32127	324070	407	3292	1378	2372	88	600	212	1390	0	9333	9333	0	7131	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-89	0	0	569	31091	0	31091	337795	690	6657	4079	4493	95	388	0	963	0	16676	16676	0	15325	1351
May-89	0	0	4058	32127	0	32127	330017	704	17575	6852	12891	185	388	98	1188	25	39202	39202	0	37503	1699
Jun-89	0	0	11062	31091	0	31091	325775	1117	13386	4844	14454	185	388	98	861	0	34216	34216	0	32869	1347
Jul-89	0	0	4914	0	4914	4914	247325	1294	30799	8909	35173	282	388	196	1408	0	77155	77155	0	75163	1992
Aug-89	0	0	1407	0	0	0	191306	1137	24805	6965	20693	231	388	393	1408	0	54883	54883	0	52694	2189
Sep-89	0	0	0	0	0	0	149117	781	11254	6997	20558	215	388	589	1408	0	41408	41408	0	39023	2385
Oct-89	0	0	0	32127	0	32127	150177	512	12106	7384	8522	159	388	589	1408	0	30555	30555	0	28170	2385
Nov-89	0	0	0	31091	0	31091	173788	357	1706	1543	1615	58	600	212	1390	0	7123	7123	0	4921	2202
Dec-89	0	0	0	32127	0	32127	199397	339	1768	535	1615	59	600	212	1390	0	6180	6180	0	3978	2202
Jan-90	0	0	0	32127	0	32127	224764	348	2102	512	1539	58	600	212	1390	0	6412	6412	0	4210	2202
Feb-90	0	0	0	29018	0	29018	247406	407	1886	483	1345	52	600	212	1390	0	5969	5969	0	3767	2202
Mar-90	0	0	0	32127	0	32127	272681	389	2005	581	1617	58	600	212	1390	0	6463	6463	0	4261	2202
Apr-90	0	0	2269	31091	0	31091	293953	651	3133	1897	2834	55	388	0	861	0	9167	9167	0	7918	1249
May-90	489	489	4569	31638	0	32127	304890	668	9656	2464	6632	82	388	98	1202	0	20522	20522	0	18834	1688
Jun-90	1566	1566	26696	29525	0	31091	314770	1075	6569	2324	9306	120	388	98	1332	0	20137	20137	0	18319	1818
Jul-90	0	0	9414	0	9414	9414	277639	1265	13347	5724	14646	156	388	196	1408	0	35865	35865	0	33873	1992
Aug-90	0	0	407	0	0	0	236682	1160	13514	3700	20262	131	388	393	1408	0	39796	39796	0	37607	2189

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-90	0	0	81	0	0	0	210699	826	7191	5538	9884	161	388	589	1408	0	25158	25158	0	22773	2385
Oct-90	0	0	0	32127	0	32127	224895	558	5148	4092	5645	103	388	589	1408	0	17373	17373	0	14988	2385
Nov-90	0	0	0	31091	0	31091	248351	383	2260	720	1997	73	600	212	1390	0	7252	7252	0	5050	2202
Dec-90	0	0	0	32127	0	32127	272817	363	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-91	0	0	0	32127	0	32127	296950	369	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-91	0	0	0	29018	0	29018	318473	435	2491	641	1661	66	600	212	1390	0	7060	7060	0	4858	2202
Mar-91	0	0	0	32127	0	32127	342496	412	2652	771	1995	73	600	212	1390	0	7693	7693	0	5491	2202
Apr-91	0	0	0	26793	0	26793	356000	702	4267	2442	4559	70	388	0	861	0	12587	12587	0	11338	1249
May-91	0	0	6158	25563	6158	31721	356000	714	10323	3498	9013	104	388	98	1426	0	24850	24850	0	22938	1912
Jun-91	3421	3421	21641	27670	0	31091	353911	1141	10591	3150	15887	159	388	98	1729	37	32040	32040	0	29788	2252
Jul-91	0	0	6914	0	6914	6914	280823	1333	27521	9065	32070	276	388	196	2196	44	71755	71755	0	68931	2824
Aug-91	0	0	1407	0	0	0	235409	1183	19026	6253	16207	189	388	393	1737	37	44231	44231	0	41676	2555
Sep-91	0	0	181	0	0	0	203032	829	11362	7341	10257	202	388	589	1408	0	31548	31548	0	29163	2385
Oct-91	0	0	0	32127	0	32127	217820	555	5238	4005	5056	100	388	589	1408	0	16784	16784	0	14399	2385
Nov-91	0	0	0	31091	0	31091	241370	381	1999	1087	1806	65	600	212	1390	0	7160	7160	0	4958	2202
Dec-91	0	0	0	32127	0	32127	266383	361	2055	622	1808	67	600	212	1390	0	6754	6754	0	4552	2202
Jan-92	0	0	0	32127	0	32127	291101	368	2459	596	1720	65	600	212	1390	0	7042	7042	0	4840	2202

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Feb-92	0	0	0	29018	0	29018	313170	433	2190	562	1503	59	600	212	1390	0	6516	6516	0	4314	2202
Mar-92	0	0	0	32127	0	32127	337808	410	2330	676	1806	65	600	212	1390	0	7079	7079	0	4877	2202
Apr-92	0	0	1369	29300	1369	30668	356000	699	3939	2170	2921	62	388	0	930	0	10410	10410	0	9092	1318
May-92	0	0	9658	32127	0	32127	355829	713	15583	5048	8936	106	388	98	1426	0	31586	31586	0	29674	1912
Jun-92	0	0	12962	24926	6164	31091	356000	1147	7773	3203	10243	137	388	98	1729	37	23608	23608	0	21356	2252
Jul-92	0	0	4914	0	4914	4914	299061	1331	20730	6204	26353	211	388	196	1482	44	55608	55608	0	53498	2110
Aug-92	0	0	0	0	0	0	251781	1202	16047	6428	21233	181	388	393	1408	0	46079	46079	0	43890	2189
Sep-92	0	0	0	0	0	0	226124	846	7473	6648	8120	185	388	589	1408	0	24811	24811	0	22426	2385
Oct-92	0	0	0	32127	0	32127	243630	569	4320	2787	4489	71	388	589	1408	0	14052	14052	0	11667	2385
Nov-92	0	0	0	31091	0	31091	267070	389	1734	1654	1615	58	600	212	1390	0	7262	7262	0	5060	2202
Dec-92	0	0	0	32127	0	32127	292628	368	1755	570	1615	59	600	212	1390	0	6201	6201	0	3999	2202
Jan-93	0	0	0	32127	0	32127	317971	374	2100	512	1539	58	600	212	1390	0	6410	6410	0	4208	2202
Feb-93	0	0	0	29018	0	29018	340579	442	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-93	0	0	0	22303	0	22303	356000	419	2005	581	1617	58	600	212	1390	0	6463	6463	0	4261	2202
Apr-93	0	0	69	9637	69	9705	356000	710	3132	1897	2594	55	388	0	861	0	8926	8926	0	7677	1249
May-93	0	0	10758	22084	10043	32127	356000	712	8650	3029	7699	82	388	98	1426	0	21372	21372	0	19460	1912
Jun-93	615	615	26947	21200	9275	31091	356000	1139	7006	2311	8988	120	388	98	1729	37	20677	20677	0	18425	2252

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jul-93	0	0	15714	0	15714	15714	304819	1329	22057	4927	19839	169	388	196	2231	44	49851	49851	0	46992	2859
Aug-93	0	0	3607	0	0	0	258705	1212	13106	8157	20799	207	388	393	1815	37	44902	44902	0	42269	2633
Sep-93	0	0	1281	0	0	0	234337	850	7206	5778	7677	159	388	589	1690	31	23518	23518	0	20820	2698
Oct-93	0	0	0	32127	0	32127	244370	575	7577	4310	6853	108	388	589	1672	22	21519	21519	0	18848	2671
Nov-93	0	0	0	31091	0	31091	266424	391	2823	1085	2380	88	600	212	1440	18	8646	8646	0	6376	2270
Dec-93	0	0	0	32127	0	32127	289681	368	2869	884	2385	91	600	212	1443	18	8502	8502	0	6229	2273
Jan-94	0	0	0	32127	0	32127	312542	374	3444	848	2263	88	600	212	1419	18	8891	8891	0	6642	2249
Feb-94	0	0	0	29018	0	29018	332935	441	3089	799	1976	80	600	212	1413	16	8184	8184	0	5943	2241
Mar-94	0	0	0	32127	0	32127	355677	417	3282	962	2372	88	600	212	1434	18	8969	8969	0	6705	2264
Apr-94	0	0	1469	14799	1469	16268	356000	712	5438	2987	3886	84	388	0	963	17	13764	13764	0	12396	1368
May-94	0	0	14058	32127	0	32127	354916	715	14299	5820	10311	129	388	98	1426	25	32497	32497	0	30560	1937
Jun-94	0	0	17062	31091	0	31091	341663	1145	18737	4625	17392	193	388	98	1729	37	43199	43199	0	40947	2252
Jul-94	0	0	1514	0	1514	1514	257082	1327	31736	10325	38050	319	388	196	2196	44	83255	83255	0	80431	2824
Aug-94	0	0	0	0	0	0	194867	1153	22301	8988	27325	265	388	393	1365	37	61062	61062	0	58879	2183
Sep-94	0	0	0	0	0	0	159655	784	10802	9307	11375	246	388	589	1690	31	34428	34428	0	31730	2698
Oct-94	0	0	0	32127	0	32127	173616	520	5826	3636	5424	89	388	589	1672	22	17646	17646	0	14975	2671
Nov-94	0	0	0	31091	0	31091	196887	364	2034	1310	1768	73	600	212	1440	18	7455	7455	0	5185	2270

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Dec-94	0	0	0	32127	0	32127	221004	347	2822	732	1762	75	600	212	1443	18	7664	7664	0	5391	2273
Jan-95	0	0	0	32127	0	32127	243939	355	4067	680	1769	73	600	212	1419	18	8837	8837	0	6588	2249
Feb-95	0	0	0	29018	0	29018	263614	417	4425	641	1554	66	600	212	1413	16	8927	8927	0	6686	2241
Mar-95	0	0	0	32127	0	32127	287546	396	2899	771	1792	73	600	212	1434	18	7799	7799	0	5535	2264
Apr-95	0	0	0	31091	0	31091	302999	663	5280	2569	5687	70	388	0	963	17	14974	14974	0	13606	1368
May-95	1380	1380	2278	30747	0	32127	317428	677	4290	3033	7658	104	388	98	1426	25	17022	17022	0	15085	1937
Jun-95	29907	29907	15355	1184	0	31091	328525	1082	5968	2648	7892	151	388	98	1729	37	18911	18911	0	16659	2252
Jul-95	18625	18625	13789	0	13502	32127	310313	1285	12530	4087	15867	208	388	196	2231	44	35551	35551	0	32692	2859
Aug-95	0	0	7607	0	0	0	226990	1208	33542	9865	35835	259	388	393	1797	37	82116	82116	0	79501	2615
Sep-95	0	0	1981	0	0	0	180757	831	16906	9391	16185	222	388	589	1690	31	45401	45401	0	42703	2698
Oct-95	0	0	0	32127	0	32127	198301	541	3826	3005	4464	76	388	589	1672	22	14042	14042	0	11371	2671
Nov-95	0	0	0	31091	0	31091	222790	373	1729	558	1615	58	600	212	1440	18	6229	6229	0	3959	2270
Dec-95	0	0	0	32127	0	32127	248324	355	1756	535	1615	59	600	212	1443	18	6239	6239	0	3966	2273
Jan-96	0	0	0	32127	0	32127	273631	363	2099	512	1539	58	600	212	1419	18	6457	6457	0	4208	2249
Feb-96	0	0	0	29018	0	29018	296213	426	1889	483	1345	52	600	212	1413	16	6010	6010	0	3769	2241
Mar-96	0	0	0	32127	0	32127	321412	405	2004	581	1617	58	600	212	1434	18	6524	6524	0	4260	2264
Apr-96	0	0	869	31091	0	31091	342771	686	3132	1897	2594	55	388	0	963	17	9045	9045	0	7677	1368

Alternative I – Stop Pump

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
May-96	0	0	15358	32127	0	32127	348642	703	9231	6224	8031	130	388	98	1426	25	25553	25553	0	23616	1937
Jun-96	3714	3714	26548	26927	450	31091	356000	1130	7537	3626	8644	150	388	98	1673	37	22152	22152	0	19956	2196
Jul-96	0	0	11814	0	11814	11814	315485	1330	18661	5310	13051	171	388	196	1408	0	39185	39185	0	37193	1992
Aug-96	0	0	1707	0	0	0	265330	1224	14548	5692	26351	152	388	393	1408	0	48932	48932	0	46743	2189
Sep-96	0	0	1881	0	0	0	240103	858	8640	4263	8951	129	388	589	1408	0	24368	24368	0	21983	2385
Average	896	848	3168	21717	1253	23818	262813	680	7951	3315	8164	116	476	252	1400	10	21686	21686	0	19546	2139
Maximum	29907	29907	34348	32127	28761	32127	356000	1336	35609	11646	38050	319	600	589	2231	44	83255	83255	0	80431	2859
Minimum	0	0	0	0	0	0	47475	298	1035	404	1121	45	388	0	717	0	5633	5633	0	3431	1203

Alternative 2 - Windy Gap Future Conditions - CBT Existing/Future Demands, WGFP Deliveries (Cumulative Effects Deliveries), Chimney Hollow in Operation

East Slope Storage			
	Initial Content (af)	Min Content (af)	Max Content (af)
Horsetooth Reservoir	74105	18000	154000
Carter Lake	53895	12000	112000
Chimney Hollow	0	0	90000
Additional Storage	0	0	0
Total East Slope Storage	128000	30000	356000

Evaporation Rates		
Month	Month	Evap (ft/mon)
Jan	1	0.06
Feb	2	0.08
Mar	3	0.07
Apr	4	0.16
May	5	0.16
Jun	6	0.29
Jul	7	0.35
Aug	8	0.33
Sep	9	0.23
Oct	10	0.14
Nov	11	0.07
Dec	12	0.06

Seepage		
Month	Month	Seepage (af/month)
Jan	1	200
Feb	2	200
Mar	3	200
Apr	4	200
May	5	200
Jun	6	200
Jul	7	200
Aug	8	200
Sep	9	200
Oct	10	200
Nov	11	200
Dec	12	200

Maximum Adams Tunnel Availability						
Month	Month	Input	Flow (cfs)	Volume (af)	Days / Month	Equivalent days/Month
Jan	1	95%	523	32127	31	29.45
Feb	2	95%	523	29018	28	26.60
Mar	3	95%	523	32127	31	29.45
Apr	4	95%	523	31091	30	28.50
May	5	95%	523	32127	31	29.45
Jun	6	67%	369	21927	30	20.10
Jul	7	45%	250	15372	31	14.09
Aug	8	45%	250	15372	31	14.09
Sep	9	45%	250	14876	30	13.64
Oct	10	95%	523	32127	31	29.45
Nov	11	0%	0	0	30	0.00
Dec	12	50%	275	16909	31	15.50
Total				273074		250

Maximum Olympus Tunnel Availability						
Month	Month	Input	Flow (cfs)	Volume (af)	Days / Month	Equivalent days/Month
Jan	1	95%	523	32127	31	29.45
Feb	2	95%	523	29018	28	26.6
Mar	3	95%	523	32127	31	29.45
Apr	4	95%	523	31091	30	28.5
May	5	95%	523	32127	31	29.45
Jun	6	95%	523	31091	30	28.5
Jul	7	95%	523	32127	31	29.45
Aug	8	95%	523	32127	31	29.45
Sep	9	95%	523	31091	30	28.5
Oct	10	95%	523	32127	31	29.45
Nov	11	0%	0	0	30	0
Dec	12	50%	275	16909	31	15.5
				331963		304

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-49							128000														
Oct-49	0	0	0	32127	0	32127	136969	480	6844	5933	6593	137	388	589	1672	22	22678	22678	0	19507	2671
Nov-49	0	0	0	0	0	0	129151	349	2260	869	1997	73	600	212	1440	18	7469	7469	0	5199	2270
Dec-49	0	0	0	16909	0	16909	138289	322	2311	789	2000	75	600	212	1443	18	7448	7448	0	5175	2273
Jan-50	0	0	0	32127	0	32127	162414	326	2769	685	1901	73	600	212	1419	18	7677	7677	0	5428	2249
Feb-50	0	0	0	29018	0	29018	183956	380	2487	641	1661	66	600	212	1413	16	7095	7095	0	4854	2241
Mar-50	0	0	0	32127	0	32127	207948	366	2639	799	1995	73	600	212	1434	18	7770	7770	0	5506	2264
Apr-50	0	0	0	31091	0	31091	226194	602	4490	2855	3457	73	388	0	963	17	12243	12243	0	10875	1368
May-50	0	0	1958	32127	0	32127	231079	619	10153	4060	10358	115	388	98	1426	25	26623	26623	0	24686	1937
Jun-50	0	0	22962	21927	9164	31091	222883	976	10591	3441	12704	160	388	98	1729	37	29147	29147	0	26895	2252
Jul-50	0	0	6414	15372	6414	21786	181516	1123	21925	6846	23797	224	388	196	2196	44	55616	55616	0	52792	2824
Aug-50	0	0	0	15372	0	15372	140672	1012	21561	7733	23069	208	388	393	1815	37	55204	55204	0	52571	2633
Sep-50	0	0	0	14876	0	14876	119288	711	12005	6998	13662	187	388	589	1690	31	35550	35550	0	32852	2698
Oct-50	0	0	0	32127	0	32127	131070	483	5921	5275	5873	122	388	589	1672	22	19862	19862	0	17191	2671
Nov-50	0	0	0	0	0	0	123834	346	1980	769	1806	65	600	212	1440	18	6890	6890	0	4620	2270
Dec-50	0	0	0	16909	0	16909	133551	320	2033	692	1808	67	600	212	1443	18	6872	6872	0	4599	2273
Jan-51	0	0	0	32127	0	32127	158286	324	2434	600	1720	65	600	212	1419	18	7068	7068	0	4819	2249
Feb-51	0	0	0	29018	0	29018	180375	378	2186	562	1503	59	600	212	1413	16	6551	6551	0	4310	2241
Mar-51	0	0	0	32127	0	32127	204981	365	2321	700	1806	65	600	212	1434	18	7156	7156	0	4892	2264

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-51	0	0	369	31091	0	31091	224491	599	3912	2531	3106	65	388	0	963	17	10982	10982	0	9614	1368
May-51	0	0	11858	32127	0	32127	232318	617	8825	3633	9185	103	388	98	1426	25	23683	23683	0	21746	1937
Jun-51	0	0	30962	21927	9164	31091	227305	976	9189	3113	11268	143	388	98	1729	37	25964	25964	0	23712	2252
Jul-51	0	0	22514	15372	16755	32127	192287	1129	19079	6128	20996	199	388	196	2231	44	49261	49261	0	46402	2859
Aug-51	0	0	7507	15372	7507	22879	157806	1029	18788	6872	20346	185	388	393	1815	37	48824	48824	0	46191	2633
Sep-51	0	0	881	14876	881	15757	140350	731	10442	6209	12087	166	388	589	1690	31	31601	31601	0	28903	2698
Oct-51	0	0	0	32127	0	32127	156389	504	4568	3286	4987	72	388	589	1672	22	15584	15584	0	12913	2671
Nov-51	0	0	0	0	0	0	149636	356	1368	1259	1443	58	600	212	1440	18	6397	6397	0	4127	2270
Dec-51	0	0	0	16909	0	16909	159693	330	2137	616	1436	59	600	212	1443	18	6522	6522	0	4249	2273
Jan-52	0	0	0	32127	0	32127	184157	334	3066	516	1440	58	600	212	1419	18	7329	7329	0	5080	2249
Feb-52	0	0	0	29018	0	29018	205422	391	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-52	0	0	0	32127	0	32127	230589	375	2197	602	1465	58	600	212	1434	18	6585	6585	0	4321	2264
Apr-52	0	0	2069	31091	0	31091	248759	620	4101	2225	4552	55	388	0	963	17	12301	12301	0	10933	1368
May-52	10928	10928	3430	21199	0	32127	263673	637	5197	2813	6548	82	388	98	1426	25	16577	16577	0	14640	1937
Jun-52	12179	12179	29183	9748	9164	31091	267421	1014	5682	2358	6753	120	388	98	1729	37	17165	17165	0	14913	2252
Jul-52	0	0	11214	15372	11214	26586	246176	1189	14197	3219	15832	144	388	196	1408	44	35428	35428	0	33392	2036
Aug-52	0	0	3407	15372	3407	18779	207342	1115	19336	8039	23318	209	388	393	1408	0	53091	53091	0	50902	2189
Sep-52	0	0	681	14876	681	15557	191965	797	9010	7104	10776	182	388	589	1408	0	29456	29456	0	27071	2385
Oct-52	0	0	0	32127	0	32127	203136	545	6844	4498	6573	111	388	589	1408	0	20411	20411	0	18026	2385

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-52	0	0	0	0	0	0	195424	376	2260	804	1997	73	600	212	1390	0	7336	7336	0	5134	2202
Dec-52	0	0	0	16909	0	16909	204689	347	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-53	0	0	0	32127	0	32127	228841	350	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-53	0	0	0	29018	0	29018	250394	410	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-53	0	0	0	32127	0	32127	274423	391	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-53	0	0	0	31091	0	31091	293040	653	4490	2607	3405	70	388	0	861	0	11820	11820	0	10571	1249
May-53	0	0	2658	32127	0	32127	299791	669	10153	3480	9161	106	388	98	1321	0	24708	24708	0	22901	1807
Jun-53	0	0	28562	21927	9164	31091	291950	1069	10591	3897	11826	170	388	98	1729	0	28700	28700	0	26485	2215
Jul-53	0	0	9114	15372	9114	24486	255370	1237	21925	8762	17227	259	388	196	1914	44	50715	50715	0	48173	2542
Aug-53	0	0	3707	15372	3707	19079	222098	1140	21561	7336	16221	197	388	393	1408	0	47504	47504	0	45315	2189
Sep-53	0	0	0	14876	0	14876	202390	816	12005	7434	11753	191	388	589	1408	0	33768	33768	0	31383	2385
Oct-53	0	0	0	32127	0	32127	208454	555	8690	6271	8008	154	388	589	1408	0	25508	25508	0	23123	2385
Nov-53	0	0	0	0	0	0	199598	379	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-53	0	0	0	16909	0	16909	207729	348	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-54	0	0	0	32127	0	32127	230665	351	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-54	0	0	0	29018	0	29018	251128	411	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-54	0	0	0	32127	0	32127	273930	391	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-54	0	0	0	31091	0	31091	289836	654	5846	3194	4157	84	388	0	861	0	14530	14530	0	13281	1249
May-54	0	0	3658	32127	0	32127	287168	668	12997	7050	12706	172	388	98	717	0	34128	34128	0	32925	1203

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-54	0	0	3962	21927	3962	25889	270799	1056	13560	6663	15576	237	388	98	717	0	37240	37240	0	36037	1203
Jul-54	0	0	1314	15372	1314	16686	217654	1208	27787	7855	29407	267	388	196	1408	0	67309	67309	0	65317	1992
Aug-54	0	0	0	15372	0	15372	165578	1084	27108	8314	28524	230	388	393	1408	0	66364	66364	0	64175	2189
Sep-54	0	0	0	14876	0	14876	138259	749	15132	6915	16815	200	388	589	1408	0	41446	41446	0	39061	2385
Oct-54	0	0	0	32127	0	32127	146826	505	6670	6958	6872	170	388	589	1408	0	23055	23055	0	20670	2385
Nov-54	0	0	0	0	0	0	137996	353	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-54	0	0	0	16909	0	16909	146148	327	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-55	0	0	0	32127	0	32127	169105	330	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-55	0	0	0	29018	0	29018	189595	384	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-55	0	0	0	32127	0	32127	212419	369	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-55	0	0	0	31091	0	31091	228324	606	5373	3194	4680	84	388	0	861	0	14579	14579	0	13330	1249
May-55	0	0	2658	32127	0	32127	214913	622	22279	5791	15163	152	388	98	1046	0	44916	44916	0	43384	1532
Jun-55	0	0	12562	21927	9164	31091	202015	967	12525	3719	16222	190	388	98	717	0	33859	33859	0	32656	1203
Jul-55	0	0	5814	15372	5814	21186	150087	1089	24760	9494	29678	287	388	196	1408	0	66211	66211	0	64219	1992
Aug-55	0	0	1607	15372	1607	16979	103795	955	24841	7978	25468	233	388	393	1408	0	60709	60709	0	58520	2189
Sep-55	0	0	0	14876	0	14876	73985	649	15022	9293	17110	228	388	589	1408	0	44038	44038	0	41653	2385
Oct-55	0	0	0	32127	0	32127	86628	425	4605	5798	6134	138	388	589	1408	0	19059	19059	0	16674	2385
Nov-55	0	0	0	0	0	0	79616	319	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-55	0	0	0	16909	0	16909	89498	296	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-56	0	0	0	32127	0	32127	114305	303	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-56	0	0	0	29018	0	29018	136457	354	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-56	0	0	0	32127	0	32127	161168	347	2321	676	1806	65	600	212	1390	0	7070	7070	0	4868	2202
Apr-56	0	0	69	31091	0	31091	181461	559	3676	2170	2963	62	388	0	963	17	10239	10239	0	8871	1368
May-56	0	0	16058	32127	0	32127	190610	580	9072	2768	8529	93	388	98	1426	25	22399	22399	0	20462	1937
Jun-56	0	0	23162	21927	9164	31091	186252	913	8194	3287	11499	139	388	98	1729	37	25372	25372	0	23120	2252
Jul-56	0	0	4014	15372	4014	19386	147199	1050	19577	8074	22653	212	388	196	2231	44	53375	53375	0	50516	2859
Aug-56	0	0	807	15372	807	16179	117687	943	18471	5633	17030	175	388	393	1815	37	43941	43941	0	41308	2633
Sep-56	0	0	0	14876	0	14876	95125	669	13428	6425	14054	164	388	589	1690	31	36769	36769	0	34071	2698
Oct-56	0	0	0	32127	0	32127	106836	456	3531	7058	6814	144	388	589	1414	22	19960	19960	0	17547	2413
Nov-56	0	0	0	0	0	0	100287	331	1368	1148	1443	58	600	212	1390	0	6218	6218	0	4016	2202
Dec-56	0	0	0	16909	0	16909	110497	308	2137	557	1436	59	600	212	1390	0	6391	6391	0	4189	2202
Jan-57	0	0	0	32127	0	32127	135032	314	3066	512	1440	58	600	212	1390	0	7278	7278	0	5076	2202
Feb-57	0	0	0	29018	0	29018	156359	367	3321	483	1266	52	600	212	1390	0	7323	7323	0	5121	2202
Mar-57	0	0	0	32127	0	32127	181629	356	2197	581	1465	58	600	212	1390	0	6502	6502	0	4300	2202
Apr-57	0	0	69	31091	0	31091	200486	578	3899	2024	4429	55	388	0	861	0	11656	11656	0	10407	1249
May-57	5351	5351	1807	26776	0	32127	218513	597	3096	2426	5986	82	388	98	1426	0	13502	13502	0	11590	1912
Jun-57	25991	25991	15571	0	5100	31091	228372	945	4441	2152	6223	120	388	98	1729	37	15187	15187	0	12935	2252
Jul-57	3366	3366	34348	12006	16755	32127	212667	1120	11217	3495	12214	172	388	196	2231	44	29957	29957	0	27098	2859

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Aug-57	0	0	8107	15372	8107	23479	174901	1054	21134	5124	23061	149	388	393	1797	37	52083	52083	0	49468	2615
Sep-57	0	0	981	14876	981	15857	149540	756	15640	6961	14041	141	388	589	1690	31	39481	39481	0	36783	2698
Oct-57	0	0	0	32127	0	32127	158067	515	6252	6984	7020	159	388	589	1672	22	23086	23086	0	20415	2671
Nov-57	0	0	0	0	0	0	148799	358	2699	1472	2380	88	600	212	1440	18	8910	8910	0	6640	2270
Dec-57	0	0	0	16909	0	16909	156217	330	3505	906	2385	91	600	212	1443	18	9161	9161	0	6888	2273
Jan-58	0	0	0	32127	0	32127	177523	333	5040	848	2263	88	600	212	1419	18	10488	10488	0	8239	2249
Feb-58	0	0	0	29018	0	29018	195587	389	5470	799	1976	80	600	212	1413	16	10565	10565	0	8324	2241
Mar-58	0	0	0	32127	0	32127	218070	373	3585	962	2372	88	600	212	1434	18	9271	9271	0	7007	2264
Apr-58	0	0	0	31091	0	31091	233436	611	6661	3114	3886	84	388	0	963	17	15114	15114	0	13746	1368
May-58	17673	17673	4785	14454	0	32127	243427	627	5536	3639	10272	125	388	98	1426	25	21509	21509	0	19572	1937
Jun-58	9525	9525	13237	12402	9164	31091	234781	987	9752	4378	14009	208	388	98	717	37	29587	29587	0	28347	1240
Jul-58	0	0	2914	15372	2914	18286	186159	1143	24506	9824	26225	303	388	196	1408	0	62850	62850	0	60858	1992
Aug-58	0	0	0	15372	0	15372	125030	1024	35609	10475	26946	258	388	393	1408	0	75478	75478	0	73289	2189
Sep-58	0	0	0	14876	0	14876	84337	696	18074	7374	26834	206	388	589	1408	0	54873	54873	0	52488	2385
Oct-58	0	0	0	32127	0	32127	92978	444	5283	7689	7508	177	388	589	1408	0	23041	23041	0	20656	2385
Nov-58	0	0	0	0	0	0	85319	324	2260	804	1997	73	600	212	1390	0	7336	7336	0	5134	2202
Dec-58	0	0	0	16909	0	16909	94630	300	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-59	0	0	0	32127	0	32127	118826	306	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-59	0	0	0	29018	0	29018	140431	357	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Mar-59	0	0	0	32127	0	32127	164502	349	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-59	0	0	0	31091	0	31091	183592	563	4221	2607	3292	70	388	0	861	0	11439	11439	0	10190	1249
May-59	3156	3156	702	28971	0	32127	192829	582	7352	3331	9610	104	388	98	1426	0	22308	22308	0	20396	1912
Jun-59	1828	1828	25734	20099	9164	31091	185730	914	10786	2924	11997	152	388	98	1729	37	28112	28112	0	25860	2252
Jul-59	0	0	7214	15372	7214	22586	146832	1054	21041	6826	22843	216	388	196	1663	44	53217	53217	0	50926	2291
Aug-59	0	0	1507	15372	1507	16879	102410	944	25401	8299	22751	210	388	393	1408	0	58849	58849	0	56660	2189
Sep-59	0	0	0	14876	0	14876	77767	646	14337	6339	15638	175	388	589	1408	0	38873	38873	0	36488	2385
Oct-59	0	0	0	32127	0	32127	89303	431	5559	5517	6568	131	388	589	1408	0	20160	20160	0	17775	2385
Nov-59	0	0	0	0	0	0	82216	321	1980	712	1806	65	600	212	1390	0	6765	6765	0	4563	2202
Dec-59	0	0	0	16909	0	16909	92096	298	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202
Jan-60	0	0	0	32127	0	32127	116902	304	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-60	0	0	0	29018	0	29018	139052	356	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-60	0	0	0	32127	0	32127	163737	348	2321	700	1806	65	600	212	1390	0	7094	7094	0	4892	2202
Apr-60	0	0	1569	31091	0	31091	183901	561	3676	2314	2963	62	388	0	963	0	10366	10366	0	9015	1351
May-60	635	635	5723	31492	0	32127	195374	582	6374	3136	8529	96	388	98	1426	25	20072	20072	0	18135	1937
Jun-60	1207	1207	25355	20720	9164	31091	192294	917	8041	2948	10707	143	388	98	1729	37	24090	24090	0	21838	2252
Jul-60	0	0	8914	15372	8914	24286	160504	1062	17628	5324	20103	185	388	196	2231	44	46099	46099	0	43240	2859
Aug-60	0	0	0	15372	0	15372	119418	966	23038	7945	21681	194	388	393	1815	37	55492	55492	0	52859	2633
Sep-60	0	0	0	14876	0	14876	98933	676	12797	6707	12311	171	388	589	1690	31	34685	34685	0	31987	2698

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Oct-60	0	0	0	32127	0	32127	114481	461	3335	4991	5006	115	388	589	1672	22	16118	16118	0	13447	2671
Nov-60	0	0	0	0	0	0	107860	336	1368	1148	1443	58	600	212	1440	18	6286	6286	0	4016	2270
Dec-60	0	0	0	16909	0	16909	117995	312	2137	557	1436	59	600	212	1443	18	6462	6462	0	4189	2273
Jan-61	0	0	0	32127	0	32127	142480	317	3066	512	1440	58	600	212	1419	18	7325	7325	0	5076	2249
Feb-61	0	0	0	29018	0	29018	163764	371	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-61	0	0	0	32127	0	32127	188968	359	2197	581	1465	58	600	212	1434	18	6564	6564	0	4300	2264
Apr-61	0	0	0	31091	0	31091	207700	585	3899	2024	4429	55	388	0	963	17	11775	11775	0	10407	1368
May-61	4885	4885	3273	27242	0	32127	225696	603	3096	2426	5986	82	388	98	1426	25	13527	13527	0	11590	1937
Jun-61	23700	23700	6062	0	6062	29762	233471	956	4345	2152	6223	120	388	98	1607	37	14969	14969	0	12839	2130
Jul-61	0	0	8314	15372	8314	23686	212065	1129	13052	4324	16094	186	388	196	1408	0	35649	35649	0	33657	1992
Aug-61	0	0	1907	15372	1907	17279	169885	1056	23509	7135	23500	163	388	393	1408	0	56496	56496	0	54307	2189
Sep-61	0	0	4781	14876	4781	19657	152255	752	11346	6354	11529	141	388	589	1408	0	31755	31755	0	29370	2385
Oct-61	0	0	0	32127	0	32127	167692	514	5026	3317	5363	85	388	589	1408	0	16176	16176	0	13791	2385
Nov-61	0	0	0	0	0	0	160358	361	2120	680	1902	69	600	212	1390	0	6972	6972	0	4770	2202
Dec-61	0	0	0	16909	0	16909	169918	334	2172	666	1904	71	600	212	1390	0	7015	7015	0	4813	2202
Jan-62	0	0	0	32127	0	32127	194387	338	2601	638	1810	69	600	212	1390	0	7321	7321	0	5119	2202
Feb-62	0	0	0	29018	0	29018	216226	395	2336	602	1582	62	600	212	1390	0	6784	6784	0	4582	2202
Mar-62	0	0	0	32127	0	32127	240600	379	2480	724	1900	69	600	212	1390	0	7375	7375	0	5173	2202
Apr-62	0	0	3869	31091	0	31091	260264	628	3948	2306	3127	66	388	0	963	0	10799	10799	0	9448	1351

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
May-62	0	0	8658	32127	0	32127	267738	646	8553	3785	10329	112	388	98	717	25	24008	24008	0	22780	1228
Jun-62	1733	1733	20729	20194	9164	31091	264676	1025	8295	2812	11509	145	388	98	717	0	23964	23964	0	22761	1203
Jul-62	0	0	16014	15372	16014	31386	221509	1191	21433	9601	24061	261	388	196	1408	0	57349	57349	0	55357	1992
Aug-62	0	0	1707	15372	1707	17079	182952	1083	21379	7413	21665	200	388	393	1408	0	52846	52846	0	50657	2189
Sep-62	0	0	0	14876	0	14876	161746	767	13737	6824	12195	174	388	589	1408	0	35315	35315	0	32930	2385
Oct-62	0	0	0	32127	0	32127	168422	524	6807	7322	8233	181	388	589	1408	0	24927	24927	0	22542	2385
Nov-62	0	0	0	0	0	0	159687	362	2820	883	2380	88	600	212	1390	0	8373	8373	0	6171	2202
Dec-62	0	0	0	16909	0	16909	167831	334	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-63	0	0	0	32127	0	32127	190781	337	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-63	0	0	0	29018	0	29018	211261	394	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-63	0	0	0	32127	0	32127	234111	377	3275	962	2372	88	600	212	1390	0	8900	8900	0	6698	2202
Apr-63	0	0	0	31091	0	31091	248716	624	6516	3324	4682	92	388	0	861	0	15862	15862	0	14613	1249
May-63	0	0	7958	32127	0	32127	228961	639	18106	9661	22104	169	388	98	717	0	51243	51243	0	50040	1203
Jun-63	0	0	14762	21927	9164	31091	213963	983	15261	4603	14674	202	388	98	717	0	35943	35943	0	34740	1203
Jul-63	0	0	3914	15372	3914	19286	163956	1114	27416	6564	28033	260	388	196	1408	0	64264	64264	0	62272	1992
Aug-63	0	0	3607	15372	3607	18979	123049	985	23818	7284	21762	241	388	393	1408	0	55293	55293	0	53104	2189
Sep-63	0	0	2181	14876	2181	17057	97726	683	13583	7643	15706	199	388	589	1408	0	39517	39517	0	37132	2385
Oct-63	0	0	0	32127	0	32127	102627	460	6899	7908	9413	161	388	589	1408	0	26766	26766	0	24381	2385
Nov-63	0	0	0	0	0	0	94390	330	2540	895	2189	81	600	212	1390	0	7906	7906	0	5704	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Dec-63	0	0	0	16909	0	16909	103129	306	2590	797	2192	83	600	212	1390	0	7864	7864	0	5662	2202
Jan-64	0	0	0	32127	0	32127	126714	310	3104	764	2082	80	600	212	1390	0	8233	8233	0	6031	2202
Feb-64	0	0	0	29018	0	29018	147769	362	2787	720	1818	73	600	212	1390	0	7600	7600	0	5398	2202
Mar-64	0	0	0	32127	0	32127	171224	352	2957	898	2184	81	600	212	1390	0	8321	8321	0	6119	2202
Apr-64	0	0	0	31091	0	31091	189170	569	4786	2900	3563	77	388	0	861	0	12576	12576	0	11327	1249
May-64	0	0	5858	32127	0	32127	182299	588	15897	4481	15990	129	388	98	1426	0	38410	38410	0	36498	1912
Jun-64	0	0	13362	21927	9164	31091	172448	908	12564	3361	13117	171	388	98	1134	37	30870	30870	0	29213	1657
Jul-64	0	0	8814	15372	8814	24186	126189	1030	23291	7690	27380	249	388	196	1408	0	60601	60601	0	58609	1992
Aug-64	0	0	0	15372	0	15372	84275	901	23093	8771	22098	234	388	393	1408	0	56386	56386	0	54197	2189
Sep-64	0	0	0	14876	0	14876	62422	605	13326	7357	12854	202	388	589	1408	0	36123	36123	0	33738	2385
Oct-64	0	0	0	32127	0	32127	77426	404	3878	5069	5275	112	388	589	1408	0	16719	16719	0	14334	2385
Nov-64	0	0	0	0	0	0	70920	311	1700	621	1615	58	600	212	1390	0	6195	6195	0	3993	2202
Dec-64	0	0	0	16909	0	16909	81374	290	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-65	0	0	0	32127	0	32127	106795	297	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-65	0	0	0	29018	0	29018	129496	349	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-65	0	0	0	32127	0	32127	154799	343	2002	602	1617	58	600	212	1390	0	6481	6481	0	4279	2202
Apr-65	0	0	469	31091	0	31091	176066	553	3150	2182	2633	59	388	0	861	0	9272	9272	0	8023	1249
May-65	0	0	5058	32127	0	32127	182142	574	12822	3155	7495	92	388	98	1426	0	25477	25477	0	23565	1912
Jun-65	11952	11952	30610	9975	9164	31091	181906	904	7111	2473	9302	122	388	98	1729	37	21260	21260	0	19008	2252

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jul-65	1177	1177	26237	14195	16755	32127	162986	1039	10568	4456	15212	158	388	196	2231	44	33252	33252	0	30393	2859
Aug-65	0	0	8507	15372	8507	23879	130754	961	18353	6168	19325	164	388	393	1815	37	46643	46643	0	44010	2633
Sep-65	0	0	2281	14876	2281	17157	113086	692	9725	6431	12842	156	388	589	1690	31	31852	31852	0	29154	2698
Oct-65	0	0	0	32127	0	32127	122845	475	6570	5606	6906	140	388	589	1672	22	21893	21893	0	19222	2671
Nov-65	0	0	0	0	0	0	114063	342	2820	883	2380	88	600	212	1440	18	8441	8441	0	6171	2270
Dec-65	0	0	0	16909	0	16909	122155	316	2868	884	2385	91	600	212	1443	18	8501	8501	0	6228	2273
Jan-66	0	0	0	32127	0	32127	145075	320	3440	848	2263	88	600	212	1419	18	8887	8887	0	6638	2249
Feb-66	0	0	0	29018	0	29018	165538	373	3088	799	1976	80	600	212	1413	16	8183	8183	0	5942	2241
Mar-66	0	0	0	32127	0	32127	188344	359	3275	962	2372	88	600	212	1434	18	8962	8962	0	6698	2264
Apr-66	0	0	0	31091	0	31091	205194	586	5324	2993	3886	84	388	0	963	17	13655	13655	0	12287	1368
May-66	0	0	4358	32127	0	32127	200799	603	13290	4618	15932	143	388	98	1426	25	35920	35920	0	33983	1937
Jun-66	0	0	7762	21927	7762	29689	177575	935	16977	4374	20628	195	388	98	1519	37	44216	44216	0	42174	2042
Jul-66	0	0	3414	15372	3414	18786	119108	1046	28732	11646	30127	295	388	196	1408	0	72792	72792	0	70800	1992
Aug-66	0	0	107	15372	107	15479	67761	889	27018	10531	25796	294	388	393	1408	0	65830	65830	0	63641	2189
Sep-66	0	0	0	14876	0	14876	47425	562	13358	6797	11917	192	388	589	1408	0	34650	34650	0	32265	2385
Oct-66	0	0	0	32127	0	32127	58407	378	4479	7006	6742	155	388	589	1408	0	20768	20768	0	18383	2385
Nov-66	0	0	0	0	0	0	51419	295	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-66	0	0	0	16909	0	16909	61321	275	2033	622	1808	67	600	212	1390	0	6732	6732	0	4530	2202
Jan-67	0	0	0	32127	0	32127	86148	283	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Feb-67	0	0	0	29018	0	29018	108320	334	2186	562	1503	59	600	212	1390	0	6512	6512	0	4310	2202
Mar-67	0	0	0	32127	0	32127	133046	331	2321	676	1806	65	600	212	1390	0	7070	7070	0	4868	2202
Apr-67	0	0	0	31091	0	31091	153276	531	3830	2170	2917	62	388	0	963	0	10330	10330	0	8979	1351
May-67	0	0	3358	32127	0	32127	165154	554	7125	2768	7774	93	388	98	1426	25	19696	19696	0	17759	1937
Jun-67	3779	3779	17183	18148	9164	31091	161705	867	9530	2559	10032	135	388	98	1729	37	24508	24508	0	22256	2252
Jul-67	11482	11482	2532	3890	2532	17904	142094	1003	13540	3768	13670	168	388	196	2206	44	33980	33980	0	31146	2834
Aug-67	0	0	7	15372	7	15379	92999	925	23074	9378	28700	201	388	393	1408	0	63542	63542	0	61353	2189
Sep-67	0	0	1581	14876	1581	16457	69970	625	15194	6506	13028	168	388	589	1408	0	37280	37280	0	34895	2385
Oct-67	0	0	0	32127	0	32127	82138	418	6117	6116	4785	139	388	589	1408	0	19542	19542	0	17157	2385
Nov-67	0	0	0	0	0	0	75690	316	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202
Dec-67	0	0	0	16909	0	16909	86140	293	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-68	0	0	0	32127	0	32127	111557	300	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-68	0	0	0	29018	0	29018	134255	352	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-68	0	0	0	32127	0	32127	159577	345	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-68	0	0	0	31091	0	31091	181176	557	3141	1897	2594	55	388	0	861	0	8935	8935	0	7686	1249
May-68	58	58	0	32069	0	32127	195177	579	6694	2547	6552	83	388	98	1185	0	17547	17547	0	15876	1671
Jun-68	2191	2191	24671	19736	9164	31091	195208	917	7084	2391	9343	120	388	98	1556	0	20980	20980	0	18938	2042
Jul-68	0	0	8414	15372	8414	23786	163174	1066	16539	5488	22013	180	388	196	1536	0	46339	46339	0	44219	2120
Aug-68	0	0	2007	15372	2007	17379	139119	970	14967	5158	15971	148	388	393	1432	0	38457	38457	0	36244	2213

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-68	0	0	0	14876	0	14876	122205	703	11317	6420	10828	138	388	589	1408	0	31087	31087	0	28702	2385
Oct-68	0	0	0	32127	0	32127	135213	486	4884	5462	5773	129	388	589	1408	0	18633	18633	0	16248	2385
Nov-68	0	0	0	0	0	0	128063	348	1701	1229	1605	65	600	212	1390	0	6802	6802	0	4600	2202
Dec-68	0	0	0	16909	0	16909	137659	322	2479	644	1599	67	600	212	1390	0	6991	6991	0	4789	2202
Jan-69	0	0	0	32127	0	32127	161433	326	3560	596	1604	65	600	212	1390	0	8027	8027	0	5825	2202
Feb-69	0	0	0	29018	0	29018	181980	381	3858	562	1410	59	600	212	1390	0	8091	8091	0	5889	2202
Mar-69	0	0	0	32127	0	32127	206625	366	2544	676	1629	65	600	212	1390	0	7116	7116	0	4914	2202
Apr-69	0	0	69	31091	0	31091	223312	601	4906	2472	5012	62	388	0	963	0	13803	13803	0	12452	1351
May-69	8937	8937	9021	23190	0	32127	240392	617	3755	2812	5831	95	388	98	1426	25	14430	14430	0	12493	1937
Jun-69	20523	20523	7939	1404	7939	29866	243793	979	6466	2403	6290	135	388	98	1729	37	17546	17546	0	15294	2252
Jul-69	840	840	13774	14532	13774	29146	215001	1152	18499	4485	16981	188	388	196	2231	44	43012	43012	0	40153	2859
Aug-69	0	0	907	15372	907	16279	158621	1068	25327	10254	32262	226	388	393	1797	37	70684	70684	0	68069	2615
Sep-69	0	0	281	14876	281	15157	142754	738	9998	5654	11508	147	388	589	1690	31	30005	30005	0	27307	2698
Oct-69	0	0	0	32127	0	32127	155735	506	3297	6688	5830	154	388	589	1672	22	18640	18640	0	15969	2671
Nov-69	0	0	0	0	0	0	149031	355	1368	1210	1443	58	600	212	1440	18	6349	6349	0	4079	2270
Dec-69	0	0	0	16909	0	16909	159148	330	2137	557	1436	59	600	212	1443	18	6462	6462	0	4189	2273
Jan-70	0	0	0	32127	0	32127	183616	334	3066	512	1440	58	600	212	1419	18	7325	7325	0	5076	2249
Feb-70	0	0	0	29018	0	29018	204881	390	3321	483	1266	52	600	212	1413	16	7362	7362	0	5121	2241
Mar-70	0	0	0	32127	0	32127	230049	375	2197	602	1465	58	600	212	1434	18	6585	6585	0	4321	2264

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-70	0	0	0	31091	0	31091	248261	619	4299	2148	4390	55	388	0	963	17	12259	12259	0	10891	1368
May-70	572	572	11886	31555	0	32127	266926	637	3096	2622	5088	82	388	98	1426	25	12825	12825	0	10888	1937
Jun-70	21618	21618	8944	309	8944	30871	274360	1014	4345	2210	5565	120	388	98	717	37	13480	13480	0	12240	1240
Jul-70	626	626	15188	14746	15188	30560	253514	1197	13253	3517	16104	155	388	196	1408	0	35021	35021	0	33029	1992
Aug-70	0	0	2507	15372	2507	17879	207680	1125	25460	6438	25833	160	388	393	1408	0	60080	60080	0	57891	2189
Sep-70	0	0	1481	14876	1481	16357	194533	802	9207	5534	9956	138	388	589	1408	0	27221	27221	0	24836	2385
Oct-70	0	0	0	32127	0	32127	211650	548	3295	4406	4277	99	388	589	1408	0	14463	14463	0	12078	2385
Nov-70	0	0	0	0	0	0	204992	378	1368	1210	1443	58	600	212	1390	0	6281	6281	0	4079	2202
Dec-70	0	0	0	16909	0	16909	215161	349	2137	557	1436	59	600	212	1390	0	6391	6391	0	4189	2202
Jan-71	0	0	0	32127	0	32127	239657	353	3066	512	1440	58	600	212	1390	0	7278	7278	0	5076	2202
Feb-71	0	0	0	29018	0	29018	260938	414	3321	483	1266	52	600	212	1390	0	7323	7323	0	5121	2202
Mar-71	0	0	0	32127	0	32127	286147	395	2197	602	1465	58	600	212	1390	0	6523	6523	0	4321	2202
Apr-71	0	0	769	31091	0	31091	304573	661	4061	2148	4390	55	388	0	963	0	12004	12004	0	10653	1351
May-71	5921	5921	37	26206	0	32127	323164	677	3130	2622	5088	82	388	98	1426	25	12859	12859	0	10922	1937
Jun-71	15985	15985	20077	5942	9164	31091	330273	1087	4438	2210	5723	120	388	98	717	37	13731	13731	0	12491	1240
Jul-71	0	0	14314	15372	14314	29686	300429	1285	17945	6781	16992	222	388	196	1408	0	43932	43932	0	41940	1992
Aug-71	0	0	1807	15372	1807	17179	256549	1200	21622	6434	27649	158	388	393	1408	0	58051	58051	0	55862	2189
Sep-71	0	0	1781	14876	1781	16657	246220	856	8467	4721	8649	127	388	589	1408	0	24349	24349	0	21964	2385
Oct-71	0	0	0	32127	0	32127	256023	584	6475	6991	5726	163	388	589	1408	0	21740	21740	0	19355	2385

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-71	0	0	0	0	0	0	248376	395	2260	720	1997	73	600	212	1390	0	7252	7252	0	5050	2202
Dec-71	0	0	0	16909	0	16909	257625	363	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-72	0	0	0	32127	0	32127	281762	366	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-72	0	0	0	29018	0	29018	303294	429	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-72	0	0	0	32127	0	32127	327334	407	2639	771	1995	73	600	212	1390	0	7680	7680	0	5478	2202
Apr-72	0	0	0	31091	0	31091	346109	692	4580	2486	3240	71	388	0	861	0	11625	11625	0	10376	1249
May-72	0	0	5658	32127	0	32127	354246	707	9408	3425	8432	105	388	98	1426	0	23283	23283	0	21371	1912
Jun-72	0	0	23162	21927	9164	31091	346599	1137	10495	3200	13346	156	388	98	717	37	28437	28437	0	27197	1240
Jul-72	0	0	3714	15372	3714	19086	297786	1322	23886	7840	28924	221	388	196	1408	0	62863	62863	0	60871	1992
Aug-72	0	0	0	15372	0	15372	255083	1204	24861	7684	21932	204	388	393	1408	0	56871	56871	0	54682	2189
Sep-72	0	0	2181	14876	2181	17057	239097	857	8734	6664	12038	184	388	589	1408	0	30004	30004	0	27619	2385
Oct-72	0	0	0	32127	0	32127	248954	580	6250	6032	6895	128	388	589	1408	0	21690	21690	0	19305	2385
Nov-72	0	0	0	0	0	0	241687	392	1701	1302	1605	65	600	212	1390	0	6875	6875	0	4673	2202
Dec-72	0	0	0	16909	0	16909	251244	361	2479	644	1599	67	600	212	1390	0	6991	6991	0	4789	2202
Jan-73	0	0	0	32127	0	32127	274980	364	3560	596	1604	65	600	212	1390	0	8027	8027	0	5825	2202
Feb-73	0	0	0	29018	0	29018	295480	428	3858	562	1410	59	600	212	1390	0	8091	8091	0	5889	2202
Mar-73	0	0	0	32127	0	32127	320061	406	2544	700	1629	65	600	212	1390	0	7140	7140	0	4938	2202
Apr-73	0	0	0	31091	0	31091	336821	686	4881	2441	5012	62	388	0	861	0	13645	13645	0	12396	1249
May-73	8477	8477	0	23650	0	32127	353762	701	3724	2957	5774	93	388	98	1426	25	14486	14486	0	12549	1937

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-73	12194	12194	16768	6677	12220	31091	356000	1127	5373	2468	6290	135	388	98	717	37	15506	15506	0	14266	1240
Jul-73	0	0	18914	15372	16755	32127	330434	1326	15992	4949	16481	198	388	196	1408	0	39612	39612	0	37620	1992
Aug-73	0	0	3207	15372	3207	18579	278074	1243	26724	7813	29562	201	388	393	1408	0	66489	66489	0	64300	2189
Sep-73	0	0	0	14876	0	14876	258203	882	10889	6784	13642	165	388	589	1408	0	33866	33866	0	31481	2385
Oct-73	0	0	0	32127	0	32127	267624	594	6589	5511	7494	133	388	589	1408	0	22112	22112	0	19727	2385
Nov-73	0	0	0	0	0	0	258749	398	2820	987	2380	88	600	212	1390	0	8477	8477	0	6275	2202
Dec-73	0	0	0	16909	0	16909	266861	366	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-74	0	0	0	32127	0	32127	289780	368	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-74	0	0	0	29018	0	29018	310221	433	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-74	0	0	0	32127	0	32127	333004	410	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-74	0	0	0	31091	0	31091	349290	696	5528	3194	3952	84	388	0	963	0	14108	14108	0	12757	1351
May-74	517	517	9041	31610	0	32127	350968	710	10810	4685	12168	140	388	98	1426	25	29740	29740	0	27803	1937
Jun-74	3373	3373	16989	18554	9164	31091	339806	1135	11521	3662	15343	187	388	98	717	37	31953	31953	0	30713	1240
Jul-74	0	0	9414	15372	9414	24786	279648	1313	32300	8893	30629	276	388	196	1535	0	74217	74217	0	72098	2119
Aug-74	0	0	0	15372	0	15372	220238	1186	30771	10099	30278	260	388	393	1408	0	73596	73596	0	71407	2189
Sep-74	0	0	0	14876	0	14876	192180	821	13751	10384	15328	264	388	589	1408	0	42112	42112	0	39727	2385
Oct-74	0	0	0	32127	0	32127	198604	549	10662	5465	6520	123	388	589	1408	0	25154	25154	0	22769	2385
Nov-74	0	0	0	0	0	0	190867	376	2260	829	1997	73	600	212	1390	0	7361	7361	0	5159	2202
Dec-74	0	0	0	16909	0	16909	200133	345	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-75	0	0	0	32127	0	32127	224288	348	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-75	0	0	0	29018	0	29018	245842	408	2487	641	1661	66	600	212	1390	0	7056	7056	0	4854	2202
Mar-75	0	0	0	32127	0	32127	269873	389	2639	799	1995	73	600	212	1390	0	7708	7708	0	5506	2202
Apr-75	0	0	0	31091	0	31091	288619	650	4477	2607	3292	70	388	0	861	0	11695	11695	0	10446	1249
May-75	440	440	2618	31687	0	32127	293712	666	10788	3947	9608	112	388	98	1426	0	26368	26368	0	24456	1912
Jun-75	11702	11702	12460	10225	9164	31091	287993	1061	9300	2886	11996	151	388	98	1729	37	26586	26586	0	24334	2252
Jul-75	0	0	23214	15372	16755	32127	255216	1228	17750	5403	20708	199	388	196	2231	44	46920	46920	0	44061	2859
Aug-75	0	0	3207	15372	3207	18579	207274	1134	23840	8732	26759	216	388	393	1815	37	62180	62180	0	59547	2633
Sep-75	0	0	0	14876	0	14876	182930	801	11621	9115	14754	231	388	589	1690	31	38419	38419	0	35721	2698
Oct-75	0	0	0	32127	0	32127	186118	540	12769	5595	7227	138	388	589	1672	22	28400	28400	0	25729	2671
Nov-75	0	0	0	0	0	0	177217	372	2820	987	2380	88	600	212	1424	18	8529	8529	0	6275	2254
Dec-75	0	0	0	16909	0	16909	184489	340	2868	1751	2385	91	600	212	1390	0	9297	9297	0	7095	2202
Jan-76	0	0	0	32127	0	32127	207433	343	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-76	0	0	0	29018	0	29018	227905	401	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-76	0	0	0	32127	0	32127	250715	383	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-76	0	0	0	31091	0	31091	266968	637	5710	3206	3952	84	388	0	861	0	14201	14201	0	12952	1249
May-76	0	0	3458	32127	0	32127	270382	652	9869	4593	11767	136	388	98	1209	0	28061	28061	0	26366	1695
Jun-76	0	0	14262	21927	9164	31091	252399	1030	15345	4654	17311	200	388	98	883	0	38880	38880	0	37511	1369
Jul-76	0	0	7114	15372	7114	22486	196603	1183	29330	7974	30131	259	388	196	1707	0	69985	69985	0	67694	2291

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Aug-76	0	0	707	15372	707	16079	147142	1049	25627	8033	27700	235	388	393	1408	0	63784	63784	0	61595	2189
Sep-76	0	0	281	14876	281	15157	117406	723	12603	11505	17104	292	388	589	1408	0	43889	43889	0	41504	2385
Oct-76	0	0	0	32127	0	32127	121978	482	11737	5836	6981	135	388	589	1408	0	27074	27074	0	24689	2385
Nov-76	0	0	0	0	0	0	113262	343	2820	883	2380	88	600	212	1390	0	8373	8373	0	6171	2202
Dec-76	0	0	0	16909	0	16909	121425	315	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-77	0	0	0	32127	0	32127	144393	319	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-77	0	0	0	29018	0	29018	164895	372	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-77	0	0	0	32127	0	32127	187763	359	3275	962	2372	88	600	212	1390	0	8900	8900	0	6698	2202
Apr-77	0	0	0	31091	0	31091	204292	585	5705	2987	3952	84	388	0	861	0	13977	13977	0	12728	1249
May-77	0	0	1858	32127	0	32127	201510	602	12600	6578	13772	154	388	98	717	0	34307	34307	0	33104	1203
Jun-77	0	0	7962	21927	7962	29889	175947	936	18254	6311	20574	212	388	98	717	0	46554	46554	0	45351	1203
Jul-77	0	0	0	15372	0	15372	123308	1045	26784	8272	29654	265	388	196	1408	0	66966	66966	0	64974	1992
Aug-77	0	0	0	15372	0	15372	80581	897	22276	7441	25052	243	388	393	1408	0	57202	57202	0	55013	2189
Sep-77	0	0	0	14876	0	14876	53964	595	13915	9140	15208	250	388	589	1408	0	40898	40898	0	38513	2385
Oct-77	0	0	0	32127	0	32127	68207	390	4410	5785	4794	121	388	589	1408	0	17494	17494	0	15109	2385
Nov-77	0	0	0	0	0	0	61772	304	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202
Dec-77	0	0	0	16909	0	16909	72233	283	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-78	0	0	0	32127	0	32127	97660	291	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-78	0	0	0	29018	0	29018	120367	343	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Mar-78	0	0	0	32127	0	32127	145696	338	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-78	0	0	169	31091	0	31091	166867	544	3424	1897	2633	55	388	0	963	17	9376	9376	0	8008	1368
May-78	0	0	8158	32127	0	32127	180991	566	5504	2464	7449	82	388	98	1426	25	17437	17437	0	15500	1937
Jun-78	7662	7662	33900	14265	9164	31091	181594	891	6449	2311	9302	120	388	98	1729	37	20434	20434	0	18182	2252
Jul-78	0	0	21114	15372	16755	32127	154599	1037	18396	4928	14966	182	388	196	2231	44	41330	41330	0	38471	2859
Aug-78	0	0	1507	15372	1507	16879	118844	956	19047	7546	20770	176	388	393	1815	37	50172	50172	0	47539	2633
Sep-78	0	0	0	14876	0	14876	104587	671	8377	5086	12171	128	388	589	1690	31	28461	28461	0	25763	2698
Oct-78	0	0	0	32127	0	32127	117451	464	6741	4209	5076	102	388	589	1672	22	18799	18799	0	16128	2671
Nov-78	0	0	0	0	0	0	110812	339	1700	659	1615	58	600	212	1440	18	6301	6301	0	4031	2270
Dec-78	0	0	0	16909	0	16909	120621	314	1754	1085	1615	59	600	212	1443	18	6786	6786	0	4513	2273
Jan-79	0	0	0	32127	0	32127	145973	318	2099	512	1539	58	600	212	1419	18	6456	6456	0	4207	2249
Feb-79	0	0	0	29018	0	29018	168612	372	1885	483	1345	52	600	212	1413	16	6007	6007	0	3766	2241
Mar-79	0	0	0	32127	0	32127	193837	360	2002	602	1617	58	600	212	1434	18	6543	6543	0	4279	2264
Apr-79	0	0	569	31091	0	31091	215076	589	3187	2021	2633	55	388	0	963	17	9263	9263	0	7895	1368
May-79	10518	10518	1540	21609	0	32127	228969	608	5497	2660	7449	82	388	98	1426	25	17625	17625	0	15688	1937
Jun-79	9364	9364	26398	12563	9164	31091	229353	965	6535	2370	9302	120	388	98	1729	37	20578	20578	0	18326	2252
Jul-79	758	758	18356	14614	16755	32127	195891	1127	19610	4635	20450	153	388	196	2231	44	47707	47707	0	44848	2859
Aug-79	0	0	5207	15372	5207	20579	169516	1036	16015	5378	16542	142	388	393	1815	37	40710	40710	0	38077	2633
Sep-79	0	0	481	14876	481	15357	154079	745	7956	8072	10632	209	388	589	1690	31	29569	29569	0	26871	2698

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Oct-79	0	0	0	32127	0	32127	166633	514	4573	5978	5705	132	388	589	1672	22	19059	19059	0	16388	2671
Nov-79	0	0	0	0	0	0	159329	361	1701	1302	1605	65	600	212	1440	18	6943	6943	0	4673	2270
Dec-79	0	0	0	16909	0	16909	168842	334	2479	644	1599	67	600	212	1443	18	7062	7062	0	4789	2273
Jan-80	0	0	0	32127	0	32127	192557	337	3560	596	1604	65	600	212	1419	18	8074	8074	0	5825	2249
Feb-80	0	0	0	29018	0	29018	213051	395	3858	562	1410	59	600	212	1413	16	8130	8130	0	5889	2241
Mar-80	0	0	0	32127	0	32127	237598	378	2544	700	1629	65	600	212	1434	18	7202	7202	0	4938	2264
Apr-80	0	0	569	31091	0	31091	254216	626	4918	2441	5058	62	388	0	963	17	13847	13847	0	12479	1368
May-80	12292	12292	566	19835	0	32127	270127	642	3765	2957	6821	93	388	98	1426	25	15574	15574	0	13637	1937
Jun-80	27035	27035	18227	0	4056	31091	278675	1019	5555	2468	7057	135	388	98	1729	37	17468	17468	0	15216	2252
Jul-80	2327	2327	16987	13045	16755	32127	248827	1206	20622	4264	16935	177	388	196	1408	24	44014	44014	0	41998	2016
Aug-80	0	0	1907	15372	1907	17279	200782	1127	24086	6956	28883	176	388	393	1408	0	62290	62290	0	60101	2189
Sep-80	0	0	81	14876	81	14957	180524	793	10171	8381	13196	207	388	589	1408	0	34341	34341	0	31956	2385
Oct-80	0	0	0	32127	0	32127	183302	537	10904	8004	7332	187	388	589	1408	0	28812	28812	0	26427	2385
Nov-80	0	0	0	0	0	0	173781	370	2820	1661	2380	88	600	212	1390	0	9151	9151	0	6949	2202
Dec-80	0	0	0	16909	0	16909	181921	339	2868	884	2385	91	600	212	1390	0	8430	8430	0	6228	2202
Jan-81	0	0	0	32127	0	32127	204866	342	3440	848	2263	88	600	212	1390	0	8840	8840	0	6638	2202
Feb-81	0	0	0	29018	0	29018	225339	400	3088	799	1976	80	600	212	1390	0	8144	8144	0	5942	2202
Mar-81	0	0	0	32127	0	32127	248150	382	3275	997	2372	88	600	212	1390	0	8934	8934	0	6732	2202
Apr-81	0	0	0	31091	0	31091	264683	635	5444	3194	3952	84	388	0	861	0	13922	13922	0	12673	1249

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
May-81	0	0	1258	32127	0	32127	269127	650	9863	4051	11790	125	388	98	717	0	27033	27033	0	25830	1203
Jun-81	0	0	12462	21927	9164	31091	252831	1029	14698	4439	16662	194	388	98	717	0	37195	37195	0	35992	1203
Jul-81	0	0	3714	15372	3714	19086	194798	1182	30248	8129	31591	262	388	196	1408	0	72222	72222	0	70230	1992
Aug-81	0	0	0	15372	0	15372	144556	1047	24805	9013	28316	245	388	393	1408	0	64567	64567	0	62378	2189
Sep-81	0	0	0	14876	0	14876	116302	719	15258	8972	15550	246	388	589	1408	0	42412	42412	0	40027	2385
Oct-81	0	0	0	32127	0	32127	123412	482	9649	6753	5608	140	388	589	1408	0	24535	24535	0	22150	2385
Nov-81	0	0	0	0	0	0	116937	343	1700	558	1615	58	600	212	1390	0	6132	6132	0	3930	2202
Dec-81	0	0	0	16909	0	16909	127364	317	1754	535	1615	59	600	212	1390	0	6166	6166	0	3964	2202
Jan-82	0	0	0	32127	0	32127	152760	321	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202
Feb-82	0	0	0	29018	0	29018	175435	375	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-82	0	0	0	32127	0	32127	200740	363	2002	581	1617	58	600	212	1390	0	6460	6460	0	4258	2202
Apr-82	0	0	0	31091	0	31091	221594	595	3226	2290	2812	64	388	0	861	0	9641	9641	0	8392	1249
May-82	0	0	1358	32127	0	32127	232907	614	6141	3373	8676	99	388	98	1426	0	20201	20201	0	18289	1912
Jun-82	0	0	19762	21927	9164	31091	233177	973	6700	2311	9302	120	388	98	1729	37	20685	20685	0	18433	2252
Jul-82	0	0	18814	15372	16755	32127	206069	1134	14345	5121	18871	150	388	196	2231	44	41346	41346	0	38487	2859
Aug-82	0	0	5607	15372	5607	20979	180601	1048	16050	4968	15998	143	388	393	1815	37	39793	39793	0	37160	2633
Sep-82	0	0	3081	14876	3081	17957	166686	759	9470	5201	10819	146	388	589	1408	12	28032	28032	0	25635	2397
Oct-82	0	0	0	32127	0	32127	179233	525	8129	4724	3716	101	388	589	1408	0	19054	19054	0	16669	2385
Nov-82	0	0	0	0	0	0	173233	367	1035	1066	1280	50	600	212	1390	0	5633	5633	0	3431	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Dec-82	0	0	0	16909	0	16909	184012	338	1794	470	1274	52	600	212	1390	0	5791	5791	0	3589	2202
Jan-83	0	0	0	32127	0	32127	209269	342	2573	429	1275	50	600	212	1390	0	6529	6529	0	4327	2202
Feb-83	0	0	0	29018	0	29018	231329	401	2783	404	1121	45	600	212	1390	0	6556	6556	0	4354	2202
Mar-83	0	0	0	32127	0	32127	257184	384	1849	486	1302	50	600	212	1390	0	5889	5889	0	3687	2202
Apr-83	0	0	0	31091	0	31091	277356	640	3431	1751	3800	48	388	0	861	0	10279	10279	0	9030	1249
May-83	3717	3717	0	28410	0	32127	297030	657	2515	2123	5150	71	388	98	1426	25	11796	11796	0	9859	1937
Jun-83	27743	27743	13919	0	3348	31091	310512	1051	3563	1903	5388	104	388	98	1729	37	13211	13211	0	10959	2252
Jul-83	13718	13718	21796	1654	16755	32127	297454	1252	9431	3724	11839	147	388	196	1408	44	27178	27178	0	25142	2036
Aug-83	0	0	9707	15372	9707	25079	264953	1184	15528	5636	23185	150	388	393	1408	0	46689	46689	0	44500	2189
Sep-83	0	0	881	14876	881	15757	253157	859	9105	5405	8797	121	388	589	1408	0	25813	25813	0	23428	2385
Oct-83	0	0	0	32127	0	32127	265301	590	5401	6218	5246	144	388	589	1408	0	19394	19394	0	17009	2385
Nov-83	0	0	0	0	0	0	258102	397	1701	1229	1605	65	600	212	1390	0	6802	6802	0	4600	2202
Dec-83	0	0	0	16909	0	16909	267648	365	2485	644	1599	67	600	212	1390	0	6997	6997	0	4795	2202
Jan-84	0	0	0	32127	0	32127	291352	368	3588	596	1604	65	600	212	1390	0	8055	8055	0	5853	2202
Feb-84	0	0	0	29018	0	29018	311844	433	3860	562	1410	59	600	212	1390	0	8093	8093	0	5891	2202
Mar-84	0	0	0	32127	0	32127	336441	411	2547	676	1629	65	600	212	1390	0	7119	7119	0	4917	2202
Apr-84	0	0	0	31091	0	31091	353504	698	4665	2297	5058	62	388	0	861	0	13330	13330	0	12081	1249
May-84	13549	13549	1309	4202	1309	19060	356000	712	3696	2730	6821	93	388	98	717	0	14543	14543	0	13340	1203
Jun-84	13806	13806	11256	4383	11256	29445	356000	1130	5792	2870	7057	138	388	98	717	0	17059	17059	0	15856	1203

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jul-84	0	0	20614	15372	16755	32127	315295	1327	23679	8727	20119	232	388	196	1408	0	54750	54750	0	52758	1992
Aug-84	0	0	6507	15372	6507	21879	275520	1230	20872	4356	26358	142	388	393	1408	0	53917	53917	0	51728	2189
Sep-84	0	0	2881	14876	2881	17757	258240	874	9383	6344	12997	172	388	589	1408	0	31282	31282	0	28897	2385
Oct-84	0	0	0	32127	0	32127	271980	593	5484	4698	5112	114	388	589	1408	0	17794	17794	0	15409	2385
Nov-84	0	0	0	0	0	0	264810	399	1986	712	1806	65	600	212	1390	0	6771	6771	0	4569	2202
Dec-84	0	0	0	16909	0	16909	273983	367	2044	1248	1808	67	600	212	1390	0	7368	7368	0	5166	2202
Jan-85	0	0	0	32127	0	32127	298604	370	2444	706	1720	65	600	212	1390	0	7137	7137	0	4935	2202
Feb-85	0	0	0	29018	0	29018	320670	435	2191	562	1503	59	600	212	1390	0	6517	6517	0	4315	2202
Mar-85	0	0	0	32127	0	32127	345194	413	2417	700	1806	65	600	212	1390	0	7190	7190	0	4988	2202
Apr-85	0	0	769	27407	769	28175	356000	704	6867	3133	4468	78	388	0	963	0	15897	15897	0	14546	1351
May-85	3212	3212	6146	19917	6146	29275	356000	716	9683	3071	7627	95	388	98	1426	25	22413	22413	0	20476	1937
Jun-85	4099	4099	20363	17828	9164	31091	338594	1140	15644	4956	16174	179	388	98	717	37	38193	38193	0	36953	1240
Jul-85	0	0	7714	15372	7714	23086	308830	1318	16993	5104	19551	178	388	196	1408	0	43817	43817	0	41825	1992
Aug-85	0	0	0	15372	0	15372	278934	1212	15004	6611	20030	174	388	393	1456	0	44057	44057	0	41820	2237
Sep-85	0	0	0	14876	0	14876	267367	872	7373	5748	9900	165	388	589	1408	0	25570	25570	0	23185	2385
Oct-85	0	0	0	32127	0	32127	285351	597	3726	2920	4443	72	388	589	1408	0	13546	13546	0	11161	2385
Nov-85	0	0	0	0	0	0	278782	402	1735	558	1615	58	600	212	1390	0	6167	6167	0	3965	2202
Dec-85	0	0	0	16909	0	16909	289149	371	1760	535	1615	59	600	212	1390	0	6172	6172	0	3970	2202
Jan-86	0	0	0	32127	0	32127	314493	374	2099	512	1539	58	600	212	1390	0	6409	6409	0	4207	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Feb-86	0	0	0	29018	0	29018	337070	441	1917	483	1345	52	600	212	1390	0	6000	6000	0	3798	2202
Mar-86	0	0	0	25907	0	25907	356000	418	2102	581	1617	58	600	212	1390	0	6560	6560	0	4358	2202
Apr-86	0	0	1769	13911	1769	15680	356000	711	3132	5890	2719	109	388	0	963	0	13200	13200	0	11849	1351
May-86	1473	1473	5885	25422	5232	32127	356000	712	12963	3877	7306	99	388	98	1426	25	26183	26183	0	24246	1937
Jun-86	18831	18831	19831	3096	9164	31091	355781	1144	6673	2339	10629	120	388	98	717	37	21002	21002	0	19762	1240
Jul-86	0	0	18314	15372	16755	32127	323631	1328	15715	4911	23399	177	388	196	1408	0	46194	46194	0	44202	1992
Aug-86	0	0	2507	15372	2507	17879	297533	1232	15267	6149	16469	163	388	393	1408	0	40237	40237	0	38048	2189
Sep-86	0	0	481	14876	481	15357	290171	892	7812	3909	7119	123	388	589	1408	0	21347	21347	0	18962	2385
Oct-86	0	0	0	32127	0	32127	306485	612	4437	3253	5044	83	388	589	1408	0	15202	15202	0	12817	2385
Nov-86	0	0	0	0	0	0	299383	410	1980	639	1806	65	600	212	1390	0	6692	6692	0	4490	2202
Dec-86	0	0	0	16909	0	16909	309176	376	2041	622	1808	67	600	212	1390	0	6740	6740	0	4538	2202
Jan-87	0	0	0	32127	0	32127	333907	379	2434	596	1720	65	600	212	1390	0	7017	7017	0	4815	2202
Feb-87	0	0	0	29018	0	29018	355938	448	2213	562	1503	59	600	212	1390	0	6539	6539	0	4337	2202
Mar-87	0	0	0	7585	0	7585	356000	423	2351	676	1806	65	600	212	1390	0	7100	7100	0	4898	2202
Apr-87	0	0	1569	15876	1569	17444	356000	711	4571	5418	3756	83	388	0	948	0	15165	15165	0	13829	1336
May-87	5830	5830	6828	24255	2042	32127	356000	714	13550	5298	8530	139	388	98	1368	0	29371	29371	0	27517	1854
Jun-87	4923	4923	8839	17004	8839	30766	348082	1145	10748	3102	12492	143	388	98	1729	0	28701	28701	0	26486	2215
Jul-87	0	0	2614	15372	2614	17986	308906	1324	21424	6515	22678	207	388	196	1771	44	53223	53223	0	50824	2399
Aug-87	0	0	0	15372	0	15372	281639	1218	14363	5065	19641	163	388	393	1408	0	41421	41421	0	39232	2189

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Sep-87	0	0	0	14876	0	14876	269005	874	7863	5503	10721	164	388	589	1408	0	26636	26636	0	24251	2385
Oct-87	0	0	0	32127	0	32127	282598	598	5148	4581	5710	112	388	589	1408	0	17936	17936	0	15551	2385
Nov-87	0	0	0	0	0	0	274894	402	2310	720	1997	73	600	212	1390	0	7302	7302	0	5100	2202
Dec-87	0	0	0	16909	0	16909	284093	370	2353	710	2000	75	600	212	1390	0	7340	7340	0	5138	2202
Jan-88	0	0	0	32127	0	32127	308202	372	2790	680	1901	73	600	212	1390	0	7646	7646	0	5444	2202
Feb-88	0	0	0	29018	0	29018	329716	439	2496	641	1661	66	600	212	1390	0	7065	7065	0	4863	2202
Mar-88	0	0	0	32127	0	32127	353659	416	2727	771	1995	73	600	212	1390	0	7768	7768	0	5566	2202
Apr-88	0	0	469	16056	469	16525	356000	710	5563	2723	3292	76	388	0	963	0	13006	13006	0	11655	1351
May-88	0	0	7458	30395	1732	32127	356000	715	11776	5777	10086	104	388	98	1426	25	29680	29680	0	27743	1937
Jun-88	0	0	23462	21927	9164	31091	347947	1143	10314	3327	12794	152	388	98	1729	37	28838	28838	0	26586	2252
Jul-88	0	0	3814	15372	3814	19186	306139	1323	21858	5117	25860	196	388	196	2196	44	55856	55856	0	53032	2824
Aug-88	0	0	0	15372	0	15372	264380	1214	19892	9833	23293	267	388	393	1815	37	55918	55918	0	53285	2633
Sep-88	0	0	0	14876	0	14876	242345	862	13679	6932	12604	196	388	589	1630	31	36048	36048	0	33410	2638
Oct-88	0	0	0	32127	0	32127	250609	585	6570	7241	6931	151	388	589	1408	0	23278	23278	0	20893	2385
Nov-88	0	0	0	0	0	0	241498	393	2904	1144	2380	88	600	212	1390	0	8718	8718	0	6516	2202
Dec-88	0	0	0	16909	0	16909	249542	361	2941	884	2385	91	600	212	1390	0	8503	8503	0	6301	2202
Jan-89	0	0	0	32127	0	32127	272434	364	3472	848	2263	88	600	212	1390	0	8872	8872	0	6670	2202
Feb-89	0	0	0	29018	0	29018	292880	427	3089	799	1976	80	600	212	1390	0	8145	8145	0	5943	2202
Mar-89	0	0	0	32127	0	32127	315270	404	3292	1378	2372	88	600	212	1390	0	9333	9333	0	7131	2202

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Apr-89	0	0	569	31091	0	31091	329001	684	6657	4079	4493	95	388	0	963	0	16676	16676	0	15325	1351
May-89	0	0	4058	32127	0	32127	321230	697	17575	6852	12891	185	388	98	1188	25	39202	39202	0	37503	1699
Jun-89	0	0	11062	21927	9164	31091	307835	1106	13386	4844	14454	185	388	98	861	0	34216	34216	0	32869	1347
Jul-89	0	0	4914	15372	4914	20286	244786	1266	30799	8909	35173	282	388	196	1408	0	77155	77155	0	75163	1992
Aug-89	0	0	1407	15372	1407	16779	204142	1132	24805	6965	20693	231	388	393	1408	0	54883	54883	0	52694	2189
Sep-89	0	0	0	14876	0	14876	176813	798	11254	6997	20558	215	388	589	1408	0	41408	41408	0	39023	2385
Oct-89	0	0	0	32127	0	32127	177850	534	12106	7384	8522	159	388	589	1408	0	30555	30555	0	28170	2385
Nov-89	0	0	0	0	0	0	170359	368	1706	1543	1615	58	600	212	1390	0	7123	7123	0	4921	2202
Dec-89	0	0	0	16909	0	16909	180751	338	1768	535	1615	59	600	212	1390	0	6180	6180	0	3978	2202
Jan-90	0	0	0	32127	0	32127	206125	341	2102	512	1539	58	600	212	1390	0	6412	6412	0	4210	2202
Feb-90	0	0	0	29018	0	29018	228774	400	1886	483	1345	52	600	212	1390	0	5969	5969	0	3767	2202
Mar-90	0	0	0	32127	0	32127	254055	383	2005	581	1617	58	600	212	1390	0	6463	6463	0	4261	2202
Apr-90	0	0	2269	31091	0	31091	275341	638	3133	1897	2834	55	388	0	861	0	9167	9167	0	7918	1249
May-90	489	489	4569	31638	0	32127	286291	655	9656	2464	6632	82	388	98	1202	0	20522	20522	0	18834	1688
Jun-90	1566	1566	26696	20361	9164	31091	287031	1050	6569	2324	9306	120	388	98	1332	0	20137	20137	0	18319	1818
Jul-90	0	0	9414	15372	9414	24786	265317	1221	13347	5724	14646	156	388	196	1408	0	35865	35865	0	33873	1992
Aug-90	0	0	407	15372	407	15779	239750	1143	13514	3700	20262	131	388	393	1408	0	39796	39796	0	37607	2189
Sep-90	0	0	81	14876	81	14957	228638	829	7191	5538	9884	161	388	589	1408	0	25158	25158	0	22773	2385
Oct-90	0	0	0	32127	0	32127	242822	571	5148	4092	5645	103	388	589	1408	0	17373	17373	0	14988	2385

Alternative II – Modify Pumping									CBT Demand				Windy Gap Demand								
Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Delivery to Big Thompson, Little Thompson and CHFC (af)	Delivery from Carter Lake (af)	Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Nov-90	0	0	0	0	0	0	235180	390	2260	720	1997	73	600	212	1390	0	7252	7252	0	5050	2202
Dec-90	0	0	0	16909	0	16909	244433	359	2311	710	2000	75	600	212	1390	0	7298	7298	0	5096	2202
Jan-91	0	0	0	32127	0	32127	268573	362	2769	680	1901	73	600	212	1390	0	7625	7625	0	5423	2202
Feb-91	0	0	0	29018	0	29018	290107	425	2491	641	1661	66	600	212	1390	0	7060	7060	0	4858	2202
Mar-91	0	0	0	32127	0	32127	314138	403	2652	771	1995	73	600	212	1390	0	7693	7693	0	5491	2202
Apr-91	0	0	0	31091	0	31091	331960	682	4267	2442	4559	70	388	0	861	0	12587	12587	0	11338	1249
May-91	0	0	6158	32127	0	32127	338540	697	10323	3498	9013	104	388	98	1426	0	24850	24850	0	22938	1912
Jun-91	3421	3421	21641	18506	9164	31091	327309	1119	10591	3150	15887	159	388	98	1729	37	32040	32040	0	29788	2252
Jul-91	0	0	6914	15372	6914	22286	269633	1292	27521	9065	32070	276	388	196	2196	44	71755	71755	0	68931	2824
Aug-91	0	0	1407	15372	1407	16779	239608	1167	19026	6253	16207	189	388	393	1737	37	44231	44231	0	41676	2555
Sep-91	0	0	181	14876	181	15057	222102	834	11362	7341	10257	202	388	589	1408	0	31548	31548	0	29163	2385
Oct-91	0	0	0	32127	0	32127	236876	569	5238	4005	5056	100	388	589	1408	0	16784	16784	0	14399	2385
Nov-91	0	0	0	0	0	0	229329	388	1999	1087	1806	65	600	212	1390	0	7160	7160	0	4958	2202
Dec-91	0	0	0	16909	0	16909	239127	357	2055	622	1808	67	600	212	1390	0	6754	6754	0	4552	2202
Jan-92	0	0	0	32127	0	32127	263852	360	2459	596	1720	65	600	212	1390	0	7042	7042	0	4840	2202
Feb-92	0	0	0	29018	0	29018	285932	423	2190	562	1503	59	600	212	1390	0	6516	6516	0	4314	2202
Mar-92	0	0	0	32127	0	32127	310578	402	2330	676	1806	65	600	212	1390	0	7079	7079	0	4877	2202
Apr-92	0	0	1369	31091	0	31091	330580	679	3939	2170	2921	62	388	0	930	0	10410	10410	0	9092	1318
May-92	0	0	9658	32127	0	32127	330426	696	15583	5048	8936	106	388	98	1426	0	31586	31586	0	29674	1912

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jun-92	0	0	12962	21927	9164	31091	327631	1116	7773	3203	10243	137	388	98	1729	37	23608	23608	0	21356	2252
Jul-92	0	0	4914	15372	4914	20286	286107	1288	20730	6204	26353	211	388	196	1482	44	55608	55608	0	53498	2110
Aug-92	0	0	0	15372	0	15372	254217	1183	16047	6428	21233	181	388	393	1408	0	46079	46079	0	43890	2189
Sep-92	0	0	0	14876	0	14876	243434	849	7473	6648	8120	185	388	589	1408	0	24811	24811	0	22426	2385
Oct-92	0	0	0	32127	0	32127	260928	582	4320	2787	4489	71	388	589	1408	0	14052	14052	0	11667	2385
Nov-92	0	0	0	0	0	0	253271	395	1734	1654	1615	58	600	212	1390	0	7262	7262	0	5060	2202
Dec-92	0	0	0	16909	0	16909	263615	364	1755	570	1615	59	600	212	1390	0	6201	6201	0	3999	2202
Jan-93	0	0	0	32127	0	32127	288965	367	2100	512	1539	58	600	212	1390	0	6410	6410	0	4208	2202
Feb-93	0	0	0	29018	0	29018	311583	432	1885	483	1345	52	600	212	1390	0	5968	5968	0	3766	2202
Mar-93	0	0	0	32127	0	32127	336838	410	2005	581	1617	58	600	212	1390	0	6463	6463	0	4261	2202
Apr-93	0	0	69	28786	69	28854	356000	697	3132	1897	2594	55	388	0	861	0	8926	8926	0	7677	1249
May-93	0	0	10758	22084	10043	32127	356000	712	8650	3029	7699	82	388	98	1426	0	21372	21372	0	19460	1912
Jun-93	615	615	26947	21200	9275	31091	356000	1139	7006	2311	8988	120	388	98	1729	37	20677	20677	0	18425	2252
Jul-93	0	0	15714	15372	15714	31086	320191	1329	22057	4927	19839	169	388	196	2231	44	49851	49851	0	46992	2859
Aug-93	0	0	3607	15372	3607	18979	289426	1235	13106	8157	20799	207	388	393	1815	37	44902	44902	0	42269	2633
Sep-93	0	0	1281	14876	1281	16157	279903	881	7206	5778	7677	159	388	589	1690	31	23518	23518	0	20820	2698
Oct-93	0	0	0	32127	0	32127	289907	605	7577	4310	6853	108	388	589	1672	22	21519	21519	0	18848	2671
Nov-93	0	0	0	0	0	0	280855	406	2823	1085	2380	88	600	212	1440	18	8646	8646	0	6376	2270
Dec-93	0	0	0	16909	0	16909	288890	372	2869	884	2385	91	600	212	1443	18	8502	8502	0	6229	2273

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Jan-94	0	0	0	32127	0	32127	311752	374	3444	848	2263	88	600	212	1419	18	8891	8891	0	6642	2249
Feb-94	0	0	0	29018	0	29018	332145	441	3089	799	1976	80	600	212	1413	16	8184	8184	0	5943	2241
Mar-94	0	0	0	32127	0	32127	354887	417	3282	962	2372	88	600	212	1434	18	8969	8969	0	6705	2264
Apr-94	0	0	1469	15589	1469	17057	356000	712	5438	2987	3886	84	388	0	963	17	13764	13764	0	12396	1368
May-94	0	0	14058	32127	0	32127	354916	715	14299	5820	10311	129	388	98	1426	25	32497	32497	0	30560	1937
Jun-94	0	0	17062	21927	9164	31091	332499	1145	18737	4625	17392	193	388	98	1729	37	43199	43199	0	40947	2252
Jul-94	0	0	1514	15372	1514	16886	263304	1313	31736	10325	38050	319	388	196	2196	44	83255	83255	0	80431	2824
Aug-94	0	0	0	15372	0	15372	216452	1162	22301	8988	27325	265	388	393	1365	37	61062	61062	0	58879	2183
Sep-94	0	0	0	14876	0	14876	196090	810	10802	9307	11375	246	388	589	1690	31	34428	34428	0	31730	2698
Oct-94	0	0	0	32127	0	32127	210022	550	5826	3636	5424	89	388	589	1672	22	17646	17646	0	14975	2671
Nov-94	0	0	0	0	0	0	202188	378	2034	1310	1768	73	600	212	1440	18	7455	7455	0	5185	2270
Dec-94	0	0	0	16909	0	16909	211085	349	2822	732	1762	75	600	212	1443	18	7664	7664	0	5391	2273
Jan-95	0	0	0	32127	0	32127	234023	352	4067	680	1769	73	600	212	1419	18	8837	8837	0	6588	2249
Feb-95	0	0	0	29018	0	29018	253702	413	4425	641	1554	66	600	212	1413	16	8927	8927	0	6686	2241
Mar-95	0	0	0	32127	0	32127	277636	393	2899	771	1792	73	600	212	1434	18	7799	7799	0	5535	2264
Apr-95	0	0	0	31091	0	31091	293097	656	5280	2569	5687	70	388	0	963	17	14974	14974	0	13606	1368
May-95	1380	1380	2278	30747	0	32127	307533	670	4290	3033	7658	104	388	98	1426	25	17022	17022	0	15085	1937
Jun-95	29907	29907	15355	0	1184	31091	317459	1069	5968	2648	7892	151	388	98	1729	37	18911	18911	0	16659	2252
Jul-95	18625	18625	13789	0	13502	32127	299265	1268	12530	4087	15867	208	388	196	2231	44	35551	35551	0	32692	2859

Alternative II – Modify Pumping

Month	Available East Slope Priority Water From The Big Thompson (af)	East Slope Water Diverted From The Big Thompson At Olympus Dam (af)	Available Big Thompson River Water Available for Power Generation (af)	Adams Tunnel Diversion (af)	Big Thompson River Water Diverted for Power Generation (af)	Olympus Tunnel (af)	East Slope Storage (af)	Seepage and East Slope Evap (af)	CBT Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	CBT Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	CBT Demand: Delivery from Carter Lake (af)	CBT Demand: Delivery above Flatiron (af)	Windy Gap Demand: Delivery from Horsetooth Res (includes CHSC and Dixon Feeder) (af)	Windy Gap Demand: Delivery to Big Thompson, Little Thompson and CHFC (af)	Windy Gap Demand: Delivery from Carter Lake (af)	Windy Gap Demand: Delivery above Flatiron (af)	Total Demand (af)	Total Delivery (af)	Demand Shortage (af)	Total CBT Demand (af)	Total East Slope Windy Gap Demand (af)
Aug-95	0	0	7607	15372	7607	22979	231330	1191	33542	9865	35835	259	388	393	1797	37	82116	82116	0	79501	2615
Sep-95	0	0	1981	14876	1981	16857	199968	836	16906	9391	16185	222	388	589	1690	31	45401	45401	0	42703	2698
Oct-95	0	0	0	32127	0	32127	217496	557	3826	3005	4464	76	388	589	1672	22	14042	14042	0	11371	2671
Nov-95	0	0	0	0	0	0	210887	380	1729	558	1615	58	600	212	1440	18	6229	6229	0	3959	2270
Dec-95	0	0	0	16909	0	16909	221207	351	1756	535	1615	59	600	212	1443	18	6239	6239	0	3966	2273
Jan-96	0	0	0	32127	0	32127	246523	354	2099	512	1539	58	600	212	1419	18	6457	6457	0	4208	2249
Feb-96	0	0	0	29018	0	29018	269114	416	1889	483	1345	52	600	212	1413	16	6010	6010	0	3769	2241
Mar-96	0	0	0	32127	0	32127	294321	396	2004	581	1617	58	600	212	1434	18	6524	6524	0	4260	2264
Apr-96	0	0	869	31091	0	31091	315700	667	3132	1897	2594	55	388	0	963	17	9045	9045	0	7677	1368
May-96	0	0	15358	32127	0	32127	321590	684	9231	6224	8031	130	388	98	1426	25	25553	25553	0	23616	1937
Jun-96	3714	3714	26548	18213	9164	31091	320269	1096	7537	3626	8644	150	388	98	1673	37	22152	22152	0	19956	2196
Jul-96	0	0	11814	15372	11814	27186	295181	1276	18661	5310	13051	171	388	196	1408	0	39185	39185	0	37193	1992
Aug-96	0	0	1707	15372	1707	17079	260427	1193	14548	5692	26351	152	388	393	1408	0	48932	48932	0	46743	2189
Sep-96	0	0	1881	14876	1881	16757	250082	853	8640	4263	8951	129	388	589	1408	0	24368	24368	0	21983	2385
Average	896	896	3168	21646	1828	24370	215866	639	7951	3315	8164	116	476	252	1400	10	21686	21686	0	19546	2139
Maximum	29907	29907	34348	32127	16755	32127	356000	1329	35609	11646	38050	319	600	589	2231	44	83255	83255	0	80431	2859
Minimum	0	0	0	0	0	0	47425	275	1035	404	1121	45	388	0	717	0	5633	5633	0	3431	1203

Power Generation Analysis

To estimate the effect of the Alternatives on CBT Project power generation a power analysis was conducted. The CBT Project includes 5 powerplants on the east slope; Mary's Lake, Estes, Pole Hill, Flatiron, and Big Thompson. Power is generated at Mary's Lake and Estes powerplants with flows derived from the Adams Tunnel. Power is generated at Pole Hill and Flatiron powerplants with flows derived from Olympus Tunnel. The flows used for power generation at the Big Thompson powerplant is based on complex east slope operations and for this analysis is assumed to be the same for each alternative as described below.

The power analysis uses the Adams Tunnel and Olympus Tunnel flows generated in the operations analysis to estimate the monthly power generation that would result from the implementation of each alternative. Under the No Action condition, future C-BT Project operation, and therefore the power generation, is anticipated to be similar to that described in the Windy Gap Firming Project EIS for the Preferred Alternative with cumulative effects (WGFP EIS Alternative 2, Chimney Hollow with pre-positioning). Under the two structural alternatives for addressing the Grand Lake water clarity issue (Alternatives III and IV of this report) it is assumed that C-BT Project operations would be similar to those of the No Action condition, and therefore, the estimated Project generation is assumed to be the same as under the No Action condition.

The assumptions used in the analysis are described below:

1. The monthly Big Thompson powerplant power generation was assumed to be the same for all Alternatives. For each Alternative in this report, the Big Thompson power generation was assumed to be identical to that for the Windy Gap Firming Project EIS Preferred Alternative with cumulative effects model run. Flows through the Big Thompson powerplant are a complex combination of Adams Tunnel flows, Big Thompson River diversions at Olympus Dam through the Olympus Tunnel, and diversions from the Big Thompson River through Dille Tunnel. In most situations any change in flows through the Adams Tunnel and Olympus Tunnel can be offset by modifying the diversions through the Dille Tunnel.
2. The monthly volume of water run through each powerplant will be done so at rates at or above the minimum operating flow rate.
3. Flows will be routed through Mary's and Pole Hill powerplants in a manner that minimizes the need to bypass flows for maintenance operations.
4. Maintenance schedules for Mary's Lake and Pole Hill powerplants are varied for Alternatives I and II according to the maintenance criteria of that alternative. The maintenance schedules for Alternatives III and IV are those used in the Windy Gap Firming Project EIS for the Preferred Alternative with cumulative effects (WGFP EIS Alternative 2, Chimney Hollow with pre-positioning).
5. With the multiple generating units at Estes and Flatiron powerplants, it is assumed that capacity is always available to generate with the flows routed through those powerplants.
6. Due to the unknown connection between the CBT east slope power system and Chimney Hollow reservoir and the simplifying assumptions in the operations analysis, it was assumed that water routed to Chimney Hollow Reservoir would flow

through the Flatiron powerplant and be pumped up to Chimney Hollow. The effect of this assumption on power generation differences between alternatives should be further investigated in future studies.

7. Because the generation flows are monthly, no attempt is made to analyze differences between on-peak versus off-peak generation.
8. For Alternatives III and IV, the diversion of Big Thompson River water for power generation had to be adjusted to accommodate differing Big Thompson River hydrology between the Windy Gap Firming Project EIS model runs and the procedure used in the operation analysis of this report to ensure consistency for comparison purposes. This adjustment resulted in 3,172 acre-feet of additional Big Thompson River water diversion for Alternatives III and IV.

The power computation methodology is described below:

1. For each powerplant the relationship between monthly flow volume and generation was obtained from the model used by Reclamation for developing its annual operating plans.
2. Mary's Lake powerplant generation was determined on a monthly basis from the table described in #1 above from the Adams Tunnel flow volume that did not bypass the powerplant. Due to maintenance operations it was possible that some of this volume must bypass the powerplant. The volume of bypass flow was determined by subtracting the Adams Tunnel flow from the maintenance adjusted capacity of the powerplant. The maintenance adjusted capacity of the powerplant was computed as the percentage of the month that the powerplant was operational by the monthly capacity of the powerplant.
3. Estes powerplant generation was determined on a monthly basis from the table described in #1 above from the Adams Tunnel flow volume. Because Estes powerplant has multiple generating units, no reduction in capacity was applied.
4. Pole Hill powerplant generation was determined on a monthly basis from the table described in #1 above from the Olympus Tunnel flow volume that did not bypass the powerplant. Due to maintenance operations it was possible that some of this volume must bypass the powerplant. The volume of bypass flow was determined by subtracting the Olympus Tunnel flow from the maintenance adjusted capacity of the powerplant. The maintenance adjusted capacity of the powerplant was computed as the percentage of the month that the powerplant was operational by the monthly capacity of the powerplant.
5. Flatiron powerplant generation was determined on a monthly basis from the table described in #1 above from the Olympus Tunnel flow volume. Because Flatiron powerplant has multiple generating units, no reduction in capacity was applied.
6. As described in the assumptions above, the Big Thompson powerplant generation are assumed to be the same as those for the Windy Gap Firming Project EIS Preferred Alternative with cumulative effects model run.
7. Total revenue is computed by multiplying the total generation for all powerplants by the monthly power rate. The monthly power rate was provided by WAPA.

The following tables show the monthly calculations of generation for Mary's Lake, Estes, and Flatiron Powerplants. All values are in GWH.

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1950	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1950	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1950	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1950	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1950	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1950	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1950	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1950	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1950	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1950	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	4.33	16.33	25.27
1950	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1950	9	100	100	100	0	100	100	0.00	2.59	4.21	0.00	6.94	10.37	0.00	11.21	17.64
1951	10	67	100	100	100	100	100	5.73	5.73	3.20	14.16	14.16	8.20	24.00	24.00	13.81
1951	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1951	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1951	1	100	100	100	100	100	100	5.73	5.73	4.71	14.16	14.16	11.72	24.00	24.00	19.83
1951	2	100	100	100	100	100	100	5.20	5.20	5.32	12.81	12.81	13.26	21.71	21.71	22.50
1951	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1951	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1951	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1951	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1951	7	100	100	0	100	0	100	0.00	0.00	1.74	0.00	7.15	4.49	16.86	24.00	24.46
1951	8	100	100	50	50	50	100	0.00	2.67	2.08	0.00	7.15	5.53	0.00	17.12	14.71
1951	9	100	100	100	0	100	100	0.00	2.59	3.11	0.00	6.94	8.02	0.00	11.91	14.11

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1952	10	67	100	100	100	100	100	5.73	5.73	2.52	14.16	14.16	6.62	24.00	24.00	10.76
1952	11	53	100	100	100	100	0	5.52	0.00	2.19	13.74	0.00	5.78	23.26	0.00	9.41
1952	12	100	100	100	100	100	50	5.73	2.98	4.57	14.16	7.76	11.36	24.00	12.92	19.21
1952	1	100	100	100	100	100	100	5.73	5.73	4.60	14.16	14.16	11.50	24.00	24.00	19.40
1952	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1952	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1952	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1952	5	100	100	100	100	100	100	3.74	3.74	2.90	9.38	9.38	7.59	24.00	24.00	23.07
1952	6	100	100	100	100	100	100	3.38	1.65	3.65	8.47	4.27	9.12	23.26	23.26	24.48
1952	7	100	100	0	100	0	100	0.00	0.00	0.73	0.00	7.15	1.82	8.47	19.87	11.72
1952	8	100	100	50	50	50	100	0.00	2.67	1.81	0.00	7.15	4.68	0.00	14.35	10.58
1952	9	100	100	100	0	100	100	0.00	2.59	1.65	0.00	6.94	4.27	0.00	11.75	7.42
1953	10	67	100	100	100	100	100	5.73	5.73	2.57	14.16	14.16	6.86	24.00	24.00	11.10
1953	11	53	100	100	100	100	0	5.52	0.00	2.19	13.74	0.00	5.77	23.26	0.00	9.41
1953	12	100	100	100	100	100	50	5.73	2.98	2.82	14.16	7.76	7.43	24.00	12.92	12.17
1953	1	100	100	100	100	100	100	5.73	5.73	4.58	14.16	14.16	11.40	24.00	24.00	19.26
1953	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1953	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1953	4	100	53	100	100	100	100	3.56	5.52	3.09	8.82	13.74	7.98	14.90	23.26	13.36
1953	5	100	100	100	100	100	100	4.54	5.73	6.06	11.21	14.16	14.93	20.96	24.00	25.27
1953	6	100	100	100	100	100	100	5.28	3.89	5.85	13.14	9.67	14.46	23.26	23.26	24.48
1953	7	100	100	0	100	0	100	0.00	0.00	1.77	0.00	7.15	4.57	6.18	18.34	14.73
1953	8	100	100	50	50	50	100	0.00	2.67	1.58	0.00	7.15	4.09	0.00	14.54	9.87
1953	9	100	100	100	0	100	100	0.00	2.59	2.76	0.00	6.94	7.32	0.00	11.21	11.95

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1954	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1954	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1954	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1954	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1954	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1954	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1954	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1954	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1954	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	19.32	24.48
1954	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	0.00	12.72	25.27
1954	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1954	9	100	100	100	0	100	100	0.00	2.59	5.34	0.00	6.94	13.30	0.00	11.21	22.56
1955	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1955	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1955	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1955	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1955	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1955	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1955	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1955	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1955	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1955	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	3.87	15.85	25.27
1955	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	12.98	25.27
1955	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1956	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1956	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1956	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1956	1	100	100	100	100	100	100	5.73	5.73	1.99	14.16	14.16	5.22	24.00	24.00	8.67
1956	2	100	100	100	100	100	100	5.20	5.20	0.39	12.81	12.81	1.03	21.71	21.71	1.62
1956	3	100	67	100	100	100	100	5.73	5.73	0.31	14.16	14.16	0.83	24.00	24.00	1.34
1956	4	100	53	100	100	100	100	5.52	5.52	1.26	13.74	13.74	3.29	23.26	23.26	5.31
1956	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1956	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1956	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	2.71	14.69	25.27
1956	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	12.26	25.27
1956	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48
1957	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1957	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1957	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1957	1	100	100	100	100	100	100	5.73	5.73	5.22	14.16	14.16	12.90	24.00	24.00	21.87
1957	2	100	100	100	100	100	100	5.20	5.20	2.54	12.81	12.81	6.71	21.71	21.71	10.90
1957	3	100	67	100	100	100	100	5.73	5.73	0.00	14.16	14.16	0.00	24.00	24.00	0.00
1957	4	100	53	100	100	100	100	5.52	5.52	0.76	13.74	13.74	1.93	23.26	23.26	3.09
1957	5	100	100	100	100	100	100	4.76	4.76	5.09	11.81	11.81	12.53	24.00	24.00	25.27
1957	6	100	100	100	100	100	100	0.82	0.00	1.07	2.14	0.00	2.79	23.26	23.26	24.48
1957	7	100	100	0	100	0	100	0.00	0.00	0.77	0.00	5.60	1.97	24.00	24.00	25.27
1957	8	100	100	50	50	50	100	0.00	2.67	1.03	0.00	7.15	2.61	0.00	17.58	10.86
1957	9	100	100	100	0	100	100	0.00	2.59	1.48	0.00	6.94	3.85	0.00	11.99	6.72

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1958	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1958	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1958	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1958	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1958	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1958	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1958	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1958	5	100	100	100	100	100	100	2.55	2.55	1.96	6.73	6.73	5.12	24.00	24.00	25.24
1958	6	100	100	100	100	100	100	3.81	2.18	4.14	9.53	5.76	10.20	23.26	23.26	24.48
1958	7	100	100	0	100	0	100	0.00	0.00	2.90	0.00	7.15	7.59	1.94	14.00	14.70
1958	8	100	100	50	50	50	100	0.00	2.67	4.55	0.00	7.15	11.27	0.00	11.60	19.08
1958	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48
1959	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1959	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1959	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1959	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1959	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1959	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1959	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1959	5	100	100	100	100	100	100	5.19	5.19	5.43	12.79	12.79	13.53	24.00	24.00	25.27
1959	6	100	100	100	100	100	100	5.23	3.61	5.48	12.91	8.94	13.65	23.26	23.26	24.48
1959	7	100	100	0	100	0	100	0.00	0.00	2.25	0.00	7.15	5.90	4.93	16.91	14.98
1959	8	100	100	50	50	50	100	0.00	2.67	2.59	0.00	7.15	6.94	0.00	12.89	12.46
1959	9	100	100	100	0	100	100	0.00	2.59	4.28	0.00	6.94	10.54	0.00	11.21	17.90

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1960	10	67	100	100	100	100	100	5.73	5.73	3.26	14.16	14.16	8.29	24.00	24.00	14.01
1960	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1960	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1960	1	100	100	100	100	100	100	5.73	5.73	4.60	14.16	14.16	11.49	24.00	24.00	19.39
1960	2	100	100	100	100	100	100	5.20	5.20	5.32	12.81	12.81	13.25	21.71	21.71	22.47
1960	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1960	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1960	5	100	100	100	100	100	100	5.60	5.60	5.94	13.90	13.90	14.67	24.00	24.00	25.27
1960	6	100	100	100	100	100	100	5.29	3.67	5.60	13.15	9.19	13.91	23.26	23.26	24.48
1960	7	100	100	0	100	0	100	0.00	0.00	1.39	0.00	7.15	3.63	6.04	18.20	13.30
1960	8	100	100	50	50	50	100	0.00	2.67	2.53	0.00	7.15	6.67	0.00	11.60	10.84
1960	9	100	100	100	0	100	100	0.00	2.59	3.26	0.00	6.94	8.29	0.00	11.21	14.00
1961	10	67	100	100	100	100	100	5.73	5.73	2.80	14.16	14.16	7.40	24.00	24.00	12.10
1961	11	53	100	100	100	100	0	5.52	0.00	2.17	13.74	0.00	5.73	23.26	0.00	9.33
1961	12	100	100	100	100	100	50	5.73	2.98	4.09	14.16	7.76	10.09	24.00	12.92	17.18
1961	1	100	100	100	100	100	100	5.73	5.73	4.60	14.16	14.16	11.49	24.00	24.00	19.39
1961	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1961	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1961	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1961	5	100	100	100	100	100	100	4.85	4.85	4.16	12.00	12.00	10.24	24.00	24.00	23.51
1961	6	100	100	100	100	100	100	0.00	0.00	0.52	0.00	0.00	1.34	19.68	22.23	24.48
1961	7	100	100	0	100	0	100	0.00	0.00	0.88	0.00	7.15	2.27	5.62	17.75	10.39
1961	8	100	100	50	50	50	100	0.00	2.67	1.35	0.00	7.15	3.53	0.00	13.22	7.06
1961	9	100	100	100	0	100	100	0.00	2.59	1.27	0.00	6.94	3.34	0.00	14.83	9.56

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1962	10	67	100	100	100	100	100	5.73	5.73	2.24	14.16	14.16	5.88	24.00	24.00	9.59
1962	11	53	100	100	100	100	0	5.52	0.00	2.15	13.74	0.00	5.69	23.26	0.00	9.26
1962	12	100	100	100	100	100	50	5.73	2.98	3.24	14.16	7.76	8.26	24.00	12.92	13.95
1962	1	100	100	100	100	100	100	5.73	5.73	4.58	14.16	14.16	11.42	24.00	24.00	19.29
1962	2	100	100	100	100	100	100	5.20	5.20	5.37	12.81	12.81	13.37	21.71	21.71	22.68
1962	3	100	67	100	100	100	100	4.50	5.73	3.97	11.01	14.16	9.85	18.72	24.00	16.75
1962	4	100	53	100	100	100	100	2.00	5.52	3.09	5.26	13.74	7.98	11.60	23.26	13.36
1962	5	100	100	100	100	100	100	4.44	5.73	6.06	10.89	14.16	14.93	24.00	24.00	25.27
1962	6	100	100	100	100	100	100	4.17	3.62	5.50	10.28	8.98	13.70	23.26	23.26	24.48
1962	7	100	100	0	100	0	100	0.00	0.00	2.84	0.00	7.15	7.48	12.11	23.47	24.07
1962	8	100	100	50	50	50	100	0.00	2.67	2.36	0.00	7.15	6.16	0.00	13.06	11.32
1962	9	100	100	100	0	100	100	0.00	2.59	3.25	0.00	6.94	8.27	0.00	11.21	13.97
1963	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1963	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1963	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1963	1	100	100	100	100	100	100	5.73	5.73	5.22	14.16	14.16	12.88	24.00	24.00	21.84
1963	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1963	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1963	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1963	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1963	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1963	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	2.64	14.64	25.27
1963	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	14.49	25.27
1963	9	100	100	100	0	100	100	0.00	2.59	5.83	0.00	6.94	14.43	0.00	13.05	24.48

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1964	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1964	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1964	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1964	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1964	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1964	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1964	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1964	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1964	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1964	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	5.97	18.13	25.27
1964	8	100	100	50	50	50	100	0.00	2.67	2.79	0.00	7.15	7.39	0.00	11.60	12.07
1964	9	100	100	100	0	100	100	0.00	2.59	4.21	0.00	6.94	10.39	0.00	11.21	17.66
1965	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1965	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1965	12	100	100	100	100	100	50	5.73	2.98	5.74	14.16	7.76	14.20	24.00	12.92	24.05
1965	1	100	100	100	100	100	100	5.73	5.73	4.49	14.16	14.16	10.98	24.00	24.00	18.66
1965	2	100	100	100	100	100	100	5.20	5.20	5.25	12.81	12.81	13.02	21.71	21.71	22.08
1965	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1965	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1965	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1965	6	100	100	100	100	100	100	3.43	1.70	3.68	8.56	4.39	9.21	23.26	23.26	24.48
1965	7	100	100	0	100	0	100	0.00	0.00	0.94	0.00	6.60	2.39	20.49	24.00	24.80
1965	8	100	100	50	50	50	100	0.00	2.67	1.36	0.00	7.15	3.54	0.00	17.90	12.81
1965	9	100	100	100	0	100	100	0.00	2.59	1.44	0.00	6.94	3.76	0.00	13.13	8.29

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1966	10	67	100	100	100	100	100	5.73	5.73	3.30	14.16	14.16	8.35	24.00	24.00	14.14
1966	11	53	100	100	100	100	0	5.52	0.00	2.25	13.74	0.00	5.90	23.26	0.00	9.63
1966	12	100	100	100	100	100	50	5.73	2.98	3.64	14.16	7.76	9.07	24.00	12.92	15.29
1966	1	100	100	100	100	100	100	5.73	5.73	4.88	14.16	14.16	12.06	24.00	24.00	20.48
1966	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1966	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1966	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1966	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1966	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	22.18	24.48
1966	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	2.29	14.35	25.27
1966	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.68	25.27
1966	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48
1967	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1967	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1967	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1967	1	100	100	100	100	100	100	5.73	5.73	5.63	14.16	14.16	13.96	24.00	24.00	23.66
1967	2	100	100	100	100	100	100	5.20	5.20	5.32	12.81	12.81	13.24	21.71	21.71	22.46
1967	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1967	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1967	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1967	6	100	100	100	100	100	100	4.86	3.23	5.19	12.02	8.24	12.77	23.26	23.26	24.48
1967	7	100	100	0	100	0	100	0.00	0.00	0.81	0.00	1.66	2.12	10.61	13.72	14.53
1967	8	100	100	50	50	50	100	0.00	2.67	2.00	0.00	7.15	5.26	0.00	11.60	8.71
1967	9	100	100	100	0	100	100	0.00	2.59	2.02	0.00	6.94	5.33	0.00	12.51	9.95

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1968	10	67	100	100	100	100	100	5.73	5.73	3.02	14.16	14.16	7.84	24.00	24.00	13.08
1968	11	53	100	100	100	100	0	5.52	0.00	1.99	13.74	0.00	5.22	23.26	0.00	8.66
1968	12	100	100	100	100	100	50	5.73	2.98	3.96	14.16	7.76	9.82	24.00	12.92	16.71
1968	1	100	100	100	100	100	100	5.73	5.73	4.49	14.16	14.16	10.98	24.00	24.00	18.66
1968	2	100	100	100	100	100	100	5.20	5.20	5.26	12.81	12.81	13.02	21.71	21.71	22.09
1968	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1968	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1968	5	100	100	100	100	100	100	5.71	5.71	5.75	14.13	14.13	14.21	24.00	24.00	24.13
1968	6	100	100	100	100	100	100	5.18	3.55	4.67	12.75	8.79	11.65	23.26	23.26	24.48
1968	7	100	100	0	100	0	100	0.00	0.00	1.77	0.00	7.15	4.57	5.69	17.83	14.33
1968	8	100	100	50	50	50	100	0.00	2.67	1.14	0.00	7.15	3.01	0.00	13.30	6.26
1968	9	100	100	100	0	100	100	0.00	2.59	2.46	0.00	6.94	6.41	0.00	11.21	10.45
1969	10	67	100	100	100	100	100	5.73	5.73	2.99	14.16	14.16	7.79	24.00	24.00	12.97
1969	11	53	100	100	100	100	0	5.52	0.00	2.16	13.74	0.00	5.72	23.26	0.00	9.31
1969	12	100	100	100	100	100	50	5.73	2.98	2.69	14.16	7.76	7.18	24.00	12.92	11.66
1969	1	100	100	100	100	100	100	5.73	5.73	4.57	14.16	14.16	11.33	24.00	24.00	19.16
1969	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1969	3	100	67	100	100	100	100	4.56	5.73	3.97	11.32	14.16	9.85	19.15	24.00	16.75
1969	4	100	53	100	100	100	100	2.55	5.52	3.09	6.76	13.74	7.98	11.01	23.26	13.36
1969	5	100	100	100	100	100	100	1.02	4.14	4.44	2.58	10.20	10.87	18.12	24.00	25.27
1969	6	100	100	100	100	100	100	0.00	0.00	0.76	0.00	0.00	1.92	19.89	22.31	24.48
1969	7	100	100	0	100	0	100	0.00	0.00	0.96	0.00	6.77	2.41	11.03	21.80	15.28
1969	8	100	100	50	50	50	100	0.00	2.67	2.15	0.00	7.15	5.70	0.00	12.35	9.93
1969	9	100	100	100	0	100	100	0.00	2.59	1.28	0.00	6.94	3.34	0.00	11.43	5.51

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1970	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1970	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1970	12	100	100	100	100	100	50	5.73	2.98	4.19	14.16	7.76	10.32	24.00	12.92	17.56
1970	1	100	100	100	100	100	100	5.73	5.73	4.60	14.16	14.16	11.50	24.00	24.00	19.39
1970	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1970	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1970	4	100	53	100	100	100	100	4.58	5.52	3.09	11.42	13.74	7.98	19.29	23.26	13.36
1970	5	100	100	100	100	100	100	2.29	5.61	5.33	5.99	13.92	13.27	19.00	24.00	25.27
1970	6	100	100	100	100	100	100	0.00	0.00	1.07	0.00	0.00	2.78	17.64	23.10	24.48
1970	7	100	100	0	100	0	100	0.00	0.00	0.82	0.00	6.87	2.15	11.95	22.85	15.65
1970	8	100	100	50	50	50	100	0.00	2.67	1.48	0.00	7.15	3.85	0.00	13.70	8.63
1970	9	100	100	100	0	100	100	0.00	2.59	1.32	0.00	6.94	3.46	0.00	12.42	6.51
1971	10	67	100	100	100	100	100	5.73	5.73	1.48	14.16	14.16	3.84	24.00	24.00	6.02
1971	11	53	100	100	100	100	0	5.52	0.00	2.20	13.74	0.00	5.80	23.26	0.00	9.45
1971	12	100	100	100	100	100	50	5.73	2.98	2.72	14.16	7.76	7.23	24.00	12.92	11.77
1971	1	100	100	100	100	100	100	5.73	5.73	4.54	14.16	14.16	11.20	24.00	24.00	18.99
1971	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1971	3	100	67	100	100	100	100	3.49	5.73	3.97	8.68	14.16	9.85	14.72	24.00	16.75
1971	4	100	53	100	100	100	100	2.24	5.52	3.09	5.89	13.74	7.98	10.19	23.26	13.36
1971	5	100	100	100	100	100	100	1.23	4.64	1.81	3.23	11.58	4.67	10.29	24.00	12.56
1971	6	100	100	100	100	100	100	0.00	0.99	2.95	0.00	2.48	7.70	23.26	23.26	24.48
1971	7	100	100	0	100	0	100	0.00	0.00	1.39	0.00	7.15	3.63	10.82	22.18	17.05
1971	8	100	100	50	50	50	100	0.00	2.67	1.48	0.00	7.15	3.85	0.00	13.14	7.86
1971	9	100	100	100	0	100	100	0.00	2.59	1.16	0.00	6.94	3.04	0.00	12.69	6.14

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1972	10	67	100	100	100	100	100	5.73	5.73	2.71	14.16	14.16	7.22	24.00	24.00	11.74
1972	11	53	100	100	100	100	0	5.52	0.00	2.17	13.74	0.00	5.74	23.26	0.00	9.35
1972	12	100	100	100	100	100	50	5.73	2.98	4.11	14.16	7.76	10.12	24.00	12.92	17.24
1972	1	100	100	100	100	100	100	5.73	5.73	4.63	14.16	14.16	11.56	24.00	24.00	19.51
1972	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1972	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1972	4	100	53	100	100	100	100	2.56	5.52	3.09	6.82	13.74	7.98	11.05	23.26	13.36
1972	5	100	100	100	100	100	100	4.30	5.73	6.06	10.60	14.16	14.93	22.16	24.00	25.27
1972	6	100	100	100	100	100	100	5.26	3.89	5.85	13.03	9.67	14.46	23.26	23.26	24.48
1972	7	100	100	0	100	0	100	0.00	0.00	3.40	0.00	7.15	8.50	2.50	14.54	17.00
1972	8	100	100	50	50	50	100	0.00	2.67	2.47	0.00	7.15	6.41	0.00	11.60	10.46
1972	9	100	100	100	0	100	100	0.00	2.59	3.19	0.00	6.94	8.17	0.00	13.05	15.08
1973	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1973	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1973	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1973	1	100	100	100	100	100	100	5.73	5.73	5.12	14.16	14.16	12.61	24.00	24.00	21.40
1973	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1973	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1973	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1973	5	100	100	100	100	100	100	2.75	4.23	2.40	7.30	10.43	6.26	18.17	24.00	16.50
1973	6	100	100	100	100	100	100	0.74	1.07	3.65	1.88	2.77	9.11	23.26	23.26	24.48
1973	7	100	100	0	100	0	100	0.00	0.00	1.06	0.00	7.15	2.74	14.44	24.00	19.06
1973	8	100	100	50	50	50	100	0.00	2.67	1.77	0.00	7.15	4.56	0.00	14.21	10.23
1973	9	100	100	100	0	100	100	0.00	2.59	1.72	0.00	6.94	4.45	0.00	11.21	6.94

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1974	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1974	11	53	100	100	100	100	0	5.52	0.00	2.80	13.74	0.00	7.41	23.26	0.00	12.12
1974	12	100	100	100	100	100	50	5.73	2.98	4.92	14.16	7.76	12.15	24.00	12.92	20.63
1974	1	100	100	100	100	100	100	5.73	5.73	4.87	14.16	14.16	12.03	24.00	24.00	20.43
1974	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1974	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1974	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1974	5	100	100	100	100	100	100	5.62	5.62	5.96	13.94	13.94	14.72	24.00	24.00	25.27
1974	6	100	100	100	100	100	100	4.94	3.31	5.24	12.19	8.37	12.94	23.26	23.26	24.48
1974	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	6.39	18.55	25.27
1974	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1974	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48
1975	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1975	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1975	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1975	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1975	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1975	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1975	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1975	5	100	100	100	100	100	100	5.64	5.64	5.98	13.97	13.97	14.75	24.00	24.00	25.27
1975	6	100	100	100	100	100	100	3.48	1.75	3.71	8.66	4.51	9.31	23.26	23.26	24.48
1975	7	100	100	0	100	0	100	0.00	0.00	1.15	0.00	7.15	3.03	17.37	24.00	22.79
1975	8	100	100	50	50	50	100	0.00	2.67	3.08	0.00	7.15	7.97	0.00	14.21	15.44
1975	9	100	100	100	0	100	100	0.00	2.59	4.34	0.00	6.94	10.67	0.00	11.21	18.13

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1976	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1976	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1976	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1976	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1976	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1976	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1976	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1976	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1976	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1976	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	4.87	16.84	25.27
1976	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	12.17	25.27
1976	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.43	24.48
1977	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1977	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1977	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1977	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1977	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1977	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1977	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1977	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1977	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	22.32	24.48
1977	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1977	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1977	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1978	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1978	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1978	12	100	100	100	100	100	50	5.73	2.98	3.79	14.16	7.76	9.48	24.00	12.92	16.07
1978	1	100	100	100	100	100	100	5.73	5.73	0.71	14.16	14.16	1.72	24.00	24.00	2.73
1978	2	100	100	100	100	100	100	5.20	5.20	0.47	12.81	12.81	1.21	21.71	21.71	1.88
1978	3	100	67	100	100	100	100	5.73	5.73	0.49	14.16	14.16	1.27	24.00	24.00	1.96
1978	4	100	53	100	100	100	100	5.52	5.52	1.53	13.74	13.74	3.98	23.26	23.26	6.33
1978	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1978	6	100	100	100	100	100	100	4.19	2.53	4.51	10.31	6.63	11.03	23.26	23.26	24.48
1978	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	15.79	24.00	25.27
1978	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	12.89	25.27
1978	9	100	100	100	0	100	100	0.00	2.59	4.75	0.00	6.94	11.79	0.00	11.21	19.99
1979	10	67	100	100	100	100	100	5.73	5.73	2.99	14.16	14.16	7.78	24.00	24.00	12.95
1979	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1979	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1979	1	100	100	100	100	100	100	5.73	5.73	4.53	14.16	14.16	11.16	24.00	24.00	18.92
1979	2	100	100	100	100	100	100	5.20	5.20	5.26	12.81	12.81	13.04	21.71	21.71	22.11
1979	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1979	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1979	5	100	100	100	100	100	100	3.82	3.82	3.23	9.54	9.54	8.24	24.00	24.00	22.56
1979	6	100	100	100	100	100	100	3.85	2.21	3.88	9.59	5.83	9.66	23.26	23.26	24.48
1979	7	100	100	0	100	0	100	0.00	0.00	0.95	0.00	6.81	2.40	14.56	24.00	18.60
1979	8	100	100	50	50	50	100	0.00	2.67	1.05	0.00	7.15	2.70	0.00	15.41	8.87
1979	9	100	100	100	0	100	100	0.00	2.59	2.55	0.00	6.94	6.77	0.00	11.59	11.31

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1980	10	67	100	100	100	100	100	5.73	5.73	3.14	14.16	14.16	8.09	24.00	24.00	13.58
1980	11	53	100	100	100	100	0	5.52	0.00	2.23	13.74	0.00	5.86	23.26	0.00	9.56
1980	12	100	100	100	100	100	50	5.73	2.98	2.66	14.16	7.76	7.12	24.00	12.92	11.54
1980	1	100	100	100	100	100	100	5.73	5.73	4.68	14.16	14.16	11.65	24.00	24.00	19.70
1980	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1980	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1980	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1980	5	100	100	100	100	100	100	3.57	3.57	0.68	8.83	8.83	1.65	24.00	24.00	12.76
1980	6	100	100	100	100	100	100	0.71	0.00	0.59	1.72	0.00	1.48	23.26	23.26	24.48
1980	7	100	100	0	100	0	100	0.00	0.00	0.87	0.00	6.02	2.25	14.66	24.00	18.48
1980	8	100	100	50	50	50	100	0.00	2.67	1.59	0.00	7.15	4.12	0.00	13.22	8.58
1980	9	100	100	100	0	100	100	0.00	2.59	1.95	0.00	6.94	5.07	0.00	11.27	8.56
1981	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1981	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1981	12	100	100	100	100	100	50	5.73	2.98	4.81	14.16	7.76	11.91	24.00	12.92	20.22
1981	1	100	100	100	100	100	100	5.73	5.73	4.87	14.16	14.16	12.03	24.00	24.00	20.43
1981	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1981	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1981	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1981	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1981	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1981	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	2.50	14.54	25.27
1981	8	100	100	50	50	50	100	0.00	2.67	5.61	0.00	7.15	13.93	0.00	11.60	23.59
1981	9	100	100	100	0	100	100	0.00	2.59	5.29	0.00	6.94	13.15	0.00	11.21	22.31

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1982	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1982	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1982	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1982	1	100	100	100	100	100	100	5.73	5.73	5.39	14.16	14.16	13.42	24.00	24.00	22.76
1982	2	100	100	100	100	100	100	5.20	5.20	5.25	12.81	12.81	13.02	21.71	21.71	22.08
1982	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1982	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1982	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1982	6	100	100	100	100	100	100	5.52	3.89	5.33	13.74	9.67	13.27	23.26	23.26	24.48
1982	7	100	100	0	100	0	100	0.00	0.00	1.17	0.00	7.15	3.08	14.37	24.00	19.54
1982	8	100	100	50	50	50	100	0.00	2.67	1.19	0.00	7.15	3.12	0.00	15.69	9.84
1982	9	100	100	100	0	100	100	0.00	2.59	2.51	0.00	6.94	6.55	0.00	13.77	13.15
1983	10	67	100	100	100	100	100	5.73	5.73	2.55	14.16	14.16	6.75	24.00	24.00	10.95
1983	11	53	100	100	100	100	0	5.52	0.00	2.14	13.74	0.00	5.67	23.26	0.00	9.23
1983	12	100	100	100	100	100	50	5.73	2.98	2.66	14.16	7.76	7.13	24.00	12.92	11.56
1983	1	100	100	100	100	100	100	5.73	5.73	3.68	14.16	14.16	9.20	24.00	24.00	15.53
1983	2	100	100	100	100	100	100	5.20	5.20	5.34	12.81	12.81	13.31	21.71	21.71	22.57
1983	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1983	4	100	53	100	100	100	100	4.54	5.52	3.09	11.22	13.74	7.98	19.00	23.26	13.36
1983	5	100	100	100	100	100	100	1.46	5.08	1.40	3.80	12.51	3.65	9.46	24.00	9.25
1983	6	100	100	100	100	100	100	0.00	0.00	0.50	0.00	0.00	1.30	21.10	23.26	24.48
1983	7	100	100	0	100	0	100	0.00	0.00	0.78	0.00	0.00	2.03	24.00	24.00	25.27
1983	8	100	100	50	50	50	100	0.00	2.67	1.32	0.00	7.15	3.44	0.00	18.76	13.64
1983	9	100	100	100	0	100	100	0.00	2.59	1.30	0.00	6.94	3.40	0.00	11.91	6.02

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1984	10	67	100	100	100	100	100	5.73	5.73	1.49	14.16	14.16	3.88	24.00	24.00	6.08
1984	11	53	100	100	100	100	0	5.52	0.00	0.66	13.74	0.00	1.62	23.26	0.00	2.56
1984	12	100	100	100	100	100	50	5.73	2.98	1.63	14.16	7.76	4.21	24.00	12.92	6.54
1984	1	100	100	100	100	100	100	5.73	5.73	2.46	14.16	14.16	6.40	24.00	24.00	10.44
1984	2	100	100	100	100	100	100	2.40	5.20	3.95	6.25	12.81	9.79	10.20	21.71	16.66
1984	3	100	67	100	100	100	100	1.21	5.73	3.97	3.17	14.16	9.85	5.13	24.00	16.75
1984	4	100	53	100	100	100	100	2.50	5.52	3.09	6.52	13.74	7.98	10.63	23.26	13.36
1984	5	100	100	100	100	100	100	0.00	0.72	2.49	0.00	1.78	6.46	12.61	14.53	21.53
1984	6	100	100	100	100	100	100	0.74	0.74	3.38	1.85	1.85	8.48	22.01	22.01	24.48
1984	7	100	100	0	100	0	100	0.00	0.00	1.79	0.00	7.15	4.62	15.43	24.00	23.23
1984	8	100	100	50	50	50	100	0.00	2.67	1.08	0.00	7.15	2.82	0.00	16.40	10.04
1984	9	100	100	100	0	100	100	0.00	2.59	1.81	0.00	6.94	4.67	0.00	13.61	10.14
1985	10	67	100	100	100	100	100	5.73	5.73	3.14	14.16	14.16	8.08	24.00	24.00	13.55
1985	11	53	100	100	100	100	0	5.52	0.00	2.13	13.74	0.00	5.67	23.26	0.00	9.22
1985	12	100	100	100	100	100	50	5.73	2.98	4.90	14.16	7.76	12.10	24.00	12.92	20.55
1985	1	100	100	100	100	100	100	5.73	5.73	4.57	14.16	14.16	11.33	24.00	24.00	19.16
1985	2	100	100	100	100	100	100	5.20	5.20	5.32	12.81	12.81	13.24	21.71	21.71	22.47
1985	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1985	4	100	53	100	100	100	100	4.72	4.88	3.09	11.75	12.06	7.98	20.47	21.04	13.36
1985	5	100	100	100	100	100	100	3.58	3.58	5.42	8.87	8.87	13.50	21.89	21.89	25.27
1985	6	100	100	100	100	100	100	4.80	3.17	5.13	11.90	8.13	12.61	23.26	23.26	24.48
1985	7	100	100	0	100	0	100	0.00	0.00	2.70	0.00	7.15	7.19	5.23	17.27	17.36
1985	8	100	100	50	50	50	100	0.00	2.67	1.87	0.00	7.15	4.82	0.00	11.60	8.05
1985	9	100	100	100	0	100	100	0.00	2.59	2.59	0.00	6.94	6.94	0.00	11.21	11.21

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1986	10	67	100	100	100	100	100	5.73	5.73	2.38	14.16	14.16	6.20	24.00	24.00	10.12
1986	11	53	100	100	100	100	0	5.52	0.00	2.07	13.74	0.00	5.49	23.26	0.00	8.98
1986	12	100	100	100	100	100	50	5.73	2.98	4.29	14.16	7.76	10.57	24.00	12.92	17.95
1986	1	100	100	100	100	100	100	5.73	5.73	4.49	14.16	14.16	10.98	24.00	24.00	18.66
1986	2	100	100	100	100	100	100	5.20	5.20	5.26	12.81	12.81	13.03	21.71	21.71	22.10
1986	3	100	67	100	100	100	100	2.80	4.59	3.97	7.40	11.45	9.85	12.11	19.34	16.75
1986	4	100	53	100	100	100	100	2.48	2.48	3.09	6.46	6.46	7.98	11.84	11.84	13.36
1986	5	100	100	100	100	100	100	4.54	4.54	5.77	11.21	11.21	14.27	24.00	24.00	25.27
1986	6	100	100	100	100	100	100	0.56	0.52	2.48	1.43	1.34	6.45	23.26	23.26	24.48
1986	7	100	100	0	100	0	100	0.00	0.00	1.05	0.00	7.15	2.72	14.02	24.00	18.60
1986	8	100	100	50	50	50	100	0.00	2.67	1.41	0.00	7.15	3.69	0.00	13.70	8.36
1986	9	100	100	100	0	100	100	0.00	2.59	1.05	0.00	6.94	2.70	0.00	11.59	4.79
1987	10	67	100	100	100	100	100	5.73	5.73	1.68	14.16	14.16	4.34	24.00	24.00	6.72
1987	11	53	100	100	100	100	0	5.52	0.00	2.12	13.74	0.00	5.64	23.26	0.00	9.17
1987	12	100	100	100	100	100	50	5.73	2.98	3.80	14.16	7.76	9.51	24.00	12.92	16.11
1987	1	100	100	100	100	100	100	5.73	5.73	4.55	14.16	14.16	11.27	24.00	24.00	19.08
1987	2	100	100	100	100	100	100	5.01	5.20	5.32	12.34	12.81	13.25	20.96	21.71	22.49
1987	3	100	67	100	100	100	100	1.20	1.22	3.97	3.16	3.19	9.85	5.11	5.15	16.75
1987	4	100	53	100	100	100	100	2.78	2.78	3.09	7.35	7.35	7.98	13.36	13.36	13.36
1987	5	100	100	100	100	100	100	4.35	4.35	5.00	10.70	10.70	12.30	24.00	24.00	25.27
1987	6	100	100	100	100	100	100	4.48	3.00	4.96	10.97	7.80	12.22	23.26	23.01	24.48
1987	7	100	100	0	100	0	100	0.00	0.00	2.93	0.00	7.15	7.65	1.73	13.79	14.62
1987	8	100	100	50	50	50	100	0.00	2.67	1.47	0.00	7.15	3.82	0.00	11.60	5.99
1987	9	100	100	100	0	100	100	0.00	2.59	2.60	0.00	6.94	7.01	0.00	11.21	11.32

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1988	10	67	100	100	100	100	100	5.73	5.73	2.80	14.16	14.16	7.40	24.00	24.00	12.10
1988	11	53	100	100	100	100	0	5.52	0.00	2.09	13.74	0.00	5.57	23.26	0.00	9.07
1988	12	100	100	100	100	100	50	5.73	2.98	5.10	14.16	7.76	12.54	24.00	12.92	21.28
1988	1	100	100	100	100	100	100	5.73	5.73	4.63	14.16	14.16	11.56	24.00	24.00	19.53
1988	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1988	3	100	67	100	100	100	100	4.58	5.73	3.97	11.40	14.16	9.85	19.27	24.00	16.75
1988	4	100	53	100	100	100	100	2.44	2.81	3.09	6.36	7.42	7.98	10.73	12.57	13.36
1988	5	100	100	100	100	100	100	5.38	5.38	6.06	13.40	13.40	14.93	24.00	24.00	25.27
1988	6	100	100	100	100	100	100	5.30	3.89	5.85	13.19	9.67	14.46	23.26	23.26	24.48
1988	7	100	100	0	100	0	100	0.00	0.00	3.69	0.00	7.15	9.25	2.57	14.59	18.48
1988	8	100	100	50	50	50	100	0.00	2.67	3.01	0.00	7.15	7.83	0.00	11.60	13.06
1988	9	100	100	100	0	100	100	0.00	2.59	3.37	0.00	6.94	8.45	0.00	11.21	14.39
1989	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1989	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1989	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1989	1	100	100	100	100	100	100	5.73	5.73	6.00	14.16	14.16	14.80	24.00	24.00	25.05
1989	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1989	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1989	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1989	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1989	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1989	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	3.25	15.20	25.27
1989	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	12.80	25.27
1989	9	100	100	100	0	100	100	0.00	2.59	5.75	0.00	6.94	14.23	0.00	11.21	24.11

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1990	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1990	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1990	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1990	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1990	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1990	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1990	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1990	5	100	100	100	100	100	100	5.63	5.63	5.97	13.96	13.96	14.73	24.00	24.00	25.27
1990	6	100	100	100	100	100	100	5.25	3.64	5.53	13.01	9.04	13.76	23.26	23.26	24.48
1990	7	100	100	0	100	0	100	0.00	0.00	1.10	0.00	7.15	2.88	6.39	18.55	12.43
1990	8	100	100	50	50	50	100	0.00	2.67	0.95	0.00	7.15	2.39	0.00	11.92	4.11
1990	9	100	100	100	0	100	100	0.00	2.59	2.12	0.00	6.94	5.64	0.00	11.27	9.23
1991	10	67	100	100	100	100	100	5.73	5.73	2.69	14.16	14.16	7.17	24.00	24.00	11.64
1991	11	53	100	100	100	100	0	5.52	0.00	2.09	13.74	0.00	5.57	23.26	0.00	9.07
1991	12	100	100	100	100	100	50	5.73	2.98	2.74	14.16	7.76	7.28	24.00	12.92	11.85
1991	1	100	100	100	100	100	100	5.73	5.73	3.00	14.16	14.16	7.81	24.00	24.00	13.02
1991	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1991	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1991	4	100	53	100	100	100	100	4.76	5.52	3.09	11.82	13.74	7.98	20.03	23.26	13.36
1991	5	100	100	100	100	100	100	4.56	5.73	6.06	11.28	14.16	14.93	23.70	24.00	25.27
1991	6	100	100	100	100	100	100	4.93	3.30	5.23	12.17	8.35	12.92	23.26	23.26	24.48
1991	7	100	100	0	100	0	100	0.00	0.00	5.14	0.00	7.15	12.64	4.73	16.70	25.27
1991	8	100	100	50	50	50	100	0.00	2.67	1.37	0.00	7.15	3.58	0.00	12.80	6.63
1991	9	100	100	100	0	100	100	0.00	2.59	2.56	0.00	6.94	6.81	0.00	11.35	11.17

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1992	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1992	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1992	12	100	100	100	100	100	50	5.73	2.98	5.84	14.16	7.76	14.46	24.00	12.92	24.47
1992	1	100	100	100	100	100	100	5.73	5.73	4.56	14.16	14.16	11.28	24.00	24.00	19.10
1992	2	100	100	100	100	100	100	5.20	5.20	5.32	12.81	12.81	13.25	21.71	21.71	22.48
1992	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1992	4	100	53	100	100	100	100	5.23	5.52	3.09	12.92	13.74	7.98	22.93	23.26	13.36
1992	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1992	6	100	100	100	100	100	100	4.49	3.89	5.85	10.97	9.67	14.46	23.26	23.26	24.48
1992	7	100	100	0	100	0	100	0.00	0.00	2.65	0.00	7.15	7.10	3.25	15.20	15.11
1992	8	100	100	50	50	50	100	0.00	2.67	1.99	0.00	7.15	5.21	0.00	11.60	8.65
1992	9	100	100	100	0	100	100	0.00	2.59	2.41	0.00	6.94	6.28	0.00	11.21	10.24
1993	10	67	100	100	100	100	100	5.73	5.73	2.28	14.16	14.16	5.97	24.00	24.00	9.74
1993	11	53	100	100	100	100	0	5.52	0.00	2.21	13.74	0.00	5.82	23.26	0.00	9.49
1993	12	100	100	100	100	100	50	5.73	2.98	4.86	14.16	7.76	12.02	24.00	12.92	20.40
1993	1	100	100	100	100	100	100	5.73	5.73	4.49	14.16	14.16	10.98	24.00	24.00	18.66
1993	2	100	100	100	100	100	100	5.20	5.20	5.25	12.81	12.81	13.02	21.71	21.71	22.08
1993	3	100	67	100	100	100	100	3.96	5.73	3.97	9.82	14.16	9.85	16.71	24.00	16.75
1993	4	100	53	100	100	100	100	1.63	5.16	3.09	4.22	12.69	7.98	6.59	21.58	13.36
1993	5	100	100	100	100	100	100	3.92	3.92	6.06	9.73	9.73	14.93	24.00	24.00	25.27
1993	6	100	100	100	100	100	100	3.74	3.74	5.30	9.38	9.38	13.20	23.26	23.26	24.48
1993	7	100	100	0	100	0	100	0.00	0.00	1.27	0.00	7.15	3.34	11.87	23.26	17.67
1993	8	100	100	50	50	50	100	0.00	2.67	2.44	0.00	7.15	6.34	0.00	14.49	13.23
1993	9	100	100	100	0	100	100	0.00	2.59	2.23	0.00	6.94	5.86	0.00	12.24	10.54

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1994	10	67	100	100	100	100	100	5.73	5.73	3.04	14.16	14.16	7.87	24.00	24.00	13.14
1994	11	53	100	100	100	100	0	5.52	0.00	2.29	13.74	0.00	5.98	23.26	0.00	9.77
1994	12	100	100	100	100	100	50	5.73	2.98	3.40	14.16	7.76	8.50	24.00	12.92	14.49
1994	1	100	100	100	100	100	100	5.73	5.73	4.88	14.16	14.16	12.06	24.00	24.00	20.48
1994	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1994	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1994	4	100	53	100	100	100	100	2.58	2.72	3.09	6.90	7.24	7.98	12.34	13.05	13.36
1994	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1994	6	100	100	100	100	100	100	5.52	3.89	5.85	13.74	9.67	14.46	23.26	23.26	24.48
1994	7	100	100	0	100	0	100	0.00	0.00	6.06	0.00	7.15	14.93	0.00	12.90	25.27
1994	8	100	100	50	50	50	100	0.00	2.67	6.06	0.00	7.15	14.93	0.00	11.60	25.27
1994	9	100	100	100	0	100	100	0.00	2.59	5.85	0.00	6.94	14.46	0.00	11.21	24.48
1995	10	67	100	100	100	100	100	5.73	5.73	3.31	14.16	14.16	8.36	24.00	24.00	14.18
1995	11	53	100	100	100	100	0	5.52	0.00	3.09	13.74	0.00	7.98	23.26	0.00	13.36
1995	12	100	100	100	100	100	50	5.73	2.98	6.06	14.16	7.76	14.93	24.00	12.92	25.27
1995	1	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1995	2	100	100	100	100	100	100	5.20	5.20	5.41	12.81	12.81	13.47	21.71	21.71	22.84
1995	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1995	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1995	5	100	100	100	100	100	100	5.45	5.45	5.62	13.57	13.57	13.95	24.00	24.00	25.27
1995	6	100	100	100	100	100	100	0.00	0.00	0.47	0.00	0.00	1.22	23.26	23.26	24.48
1995	7	100	100	0	100	0	100	0.00	0.00	1.00	0.00	0.00	2.51	24.00	24.00	25.27
1995	8	100	100	50	50	50	100	0.00	2.67	1.92	0.00	7.15	4.97	0.00	17.19	14.29
1995	9	100	100	100	0	100	100	0.00	2.59	1.81	0.00	6.94	4.68	0.00	12.87	9.48

		Alts III & IV Plant Availability		Alt I Plant Availability		Alt II Plant Availability		Generation at Mary's PP			Generation at Estes PP			Generation at Pole Hill PP		
WY Year	Month	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Mary's (%)	Pole Hill (%)	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1996	10	67	100	100	100	100	100	5.73	5.73	2.60	14.16	14.16	7.00	24.00	24.00	11.30
1996	11	53	100	100	100	100	0	5.52	0.00	2.05	13.74	0.00	5.42	23.26	0.00	8.89
1996	12	100	100	100	100	100	50	5.73	2.98	3.16	14.16	7.76	8.12	24.00	12.92	13.64
1996	1	100	100	100	100	100	100	5.73	5.73	4.50	14.16	14.16	11.01	24.00	24.00	18.71
1996	2	100	100	100	100	100	100	5.20	5.20	5.26	12.81	12.81	13.04	21.71	21.71	22.12
1996	3	100	67	100	100	100	100	5.73	5.73	3.97	14.16	14.16	9.85	24.00	24.00	16.75
1996	4	100	53	100	100	100	100	5.52	5.52	3.09	13.74	13.74	7.98	23.26	23.26	13.36
1996	5	100	100	100	100	100	100	5.73	5.73	6.06	14.16	14.16	14.93	24.00	24.00	25.27
1996	6	100	100	100	100	100	100	4.79	3.24	5.20	11.87	8.26	12.81	23.26	23.26	24.48
1996	7	100	100	0	100	0	100	0.00	0.00	1.03	0.00	7.15	2.64	8.95	20.33	13.91
1996	8	100	100	50	50	50	100	0.00	2.67	1.62	0.00	7.15	4.21	0.00	13.06	8.56
1996	9	100	100	100	0	100	100	0.00	2.59	2.16	0.00	6.94	5.72	0.00	12.78	10.72

The following tables provide the monthly power generation calculations for Flatiron and Big Thompson powerplants, and the total CBT Project generation and the total revenue based on that generation.

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1950	10	27.61	27.61	16.59	0.41	0.41	0.41	71.92	71.92	42.86
1950	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1950	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1950	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1950	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1950	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1950	4	26.77	26.77	15.61	0.18	0.18	0.18	69.47	69.47	40.22
1950	5	27.61	27.61	29.05	0.26	0.26	0.26	71.77	71.77	75.58
1950	6	26.77	26.77	28.15	0.26	0.26	0.26	69.55	63.85	73.21
1950	7	5.16	19.51	29.05	0.60	0.60	0.60	10.09	43.58	75.92
1950	8	0.00	13.70	29.05	0.60	0.60	0.60	0.60	35.72	75.92
1950	9	0.00	13.29	21.09	0.53	0.53	0.53	0.53	34.55	53.84
1951	10	27.61	27.61	16.11	0.33	0.33	0.33	71.83	71.83	41.66
1951	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1951	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1951	1	27.61	27.61	23.33	0.00	0.00	0.00	71.51	71.51	59.59
1951	2	25.01	25.01	25.91	0.00	0.00	0.00	64.74	64.74	67.00
1951	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1951	4	26.77	26.77	15.61	0.16	0.16	0.16	69.45	69.45	40.20
1951	5	27.61	27.61	29.05	0.24	0.24	0.24	71.74	71.74	75.55
1951	6	26.77	26.77	28.15	0.24	0.24	0.24	69.53	63.83	73.18

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1951	7	20.16	27.61	28.13	2.73	2.73	2.73	39.75	61.49	61.55
1951	8	0.00	20.49	17.37	1.17	1.17	1.17	1.17	48.60	40.86
1951	9	0.00	14.01	16.50	0.60	0.60	0.60	0.60	36.03	42.34
1952	10	27.61	27.61	12.71	0.19	0.19	0.19	71.69	71.69	32.80
1952	11	26.77	0.00	11.10	0.00	0.00	0.00	69.29	0.00	28.48
1952	12	27.61	15.11	22.83	0.00	0.00	0.00	71.51	38.77	57.98
1952	1	27.61	27.61	23.00	0.00	0.00	0.00	71.51	71.51	58.49
1952	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1952	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1952	4	26.77	26.77	15.61	0.14	0.14	0.14	69.43	69.43	40.19
1952	5	27.61	27.61	26.55	0.60	0.60	0.60	65.34	65.34	60.71
1952	6	26.77	26.77	28.15	0.18	0.18	0.18	62.07	56.14	65.59
1952	7	9.99	23.35	13.82	2.00	2.00	2.00	20.46	52.37	30.09
1952	8	0.00	16.80	12.47	1.26	1.26	1.26	1.26	42.23	30.80
1952	9	0.00	13.85	8.92	0.61	0.61	0.61	0.61	35.73	22.86
1953	10	27.61	27.61	13.14	0.24	0.24	0.24	71.75	71.75	33.91
1953	11	26.77	0.00	11.09	0.00	0.00	0.00	69.29	0.00	28.46
1953	12	27.61	15.11	14.28	0.00	0.00	0.00	71.51	38.77	36.70
1953	1	27.61	27.61	22.88	0.00	0.00	0.00	71.51	71.51	58.11
1953	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1953	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1953	4	17.71	26.77	15.61	0.16	0.16	0.16	45.14	69.45	40.20
1953	5	24.26	27.61	29.05	0.22	0.22	0.22	61.20	71.72	75.54
1953	6	26.77	26.77	28.15	0.29	0.29	0.29	68.75	63.89	73.24
1953	7	7.50	21.94	17.41	2.43	2.43	2.43	16.11	49.86	40.91

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1953	8	0.00	17.07	11.68	0.90	0.90	0.90	0.90	42.33	28.11
1953	9	0.00	13.29	14.05	0.60	0.60	0.60	0.60	34.63	36.68
1954	10	27.61	27.61	16.59	0.41	0.41	0.41	71.92	71.92	42.86
1954	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1954	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1954	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1954	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1954	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1954	4	26.77	26.77	15.61	0.19	0.19	0.19	69.48	69.48	40.24
1954	5	27.61	27.61	29.05	0.60	0.60	0.60	72.11	72.11	75.92
1954	6	26.77	22.93	28.15	0.60	0.60	0.60	69.89	56.41	73.55
1954	7	0.00	14.89	29.05	0.64	0.64	0.64	0.64	35.40	75.96
1954	8	0.00	13.70	29.05	0.68	0.68	0.68	0.68	35.80	76.00
1954	9	0.00	13.29	25.98	0.50	0.50	0.50	0.50	34.53	67.69
1955	10	27.61	27.61	16.59	0.50	0.50	0.50	72.01	72.01	42.95
1955	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1955	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1955	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1955	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1955	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1955	4	26.77	26.77	15.61	0.19	0.19	0.19	69.48	69.48	40.24
1955	5	27.61	27.61	29.05	0.49	0.49	0.49	71.99	71.99	75.80
1955	6	26.77	26.77	28.15	0.28	0.28	0.28	69.57	63.87	73.23
1955	7	4.55	18.97	29.05	0.90	0.90	0.90	9.32	42.86	76.22
1955	8	0.00	15.18	29.05	0.61	0.61	0.61	0.61	38.59	75.92

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1955	9	0.00	13.29	28.15	0.79	0.79	0.79	0.79	34.82	73.74
1956	10	27.61	27.61	16.59	0.40	0.40	0.40	71.91	71.91	42.85
1956	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1956	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1956	1	27.61	27.61	10.21	0.00	0.00	0.00	71.51	71.51	26.10
1956	2	25.01	25.01	1.92	0.00	0.00	0.00	64.74	64.74	4.96
1956	3	27.61	27.61	1.64	0.00	0.00	0.00	71.51	71.51	4.13
1956	4	26.77	26.77	6.48	0.13	0.13	0.13	69.42	69.42	16.48
1956	5	27.61	27.61	29.05	0.17	0.17	0.17	71.67	71.67	75.49
1956	6	26.77	26.77	28.15	0.26	0.26	0.26	69.55	63.85	73.20
1956	7	3.11	17.35	29.05	0.76	0.76	0.76	6.58	39.95	76.08
1956	8	0.00	14.38	29.05	0.44	0.44	0.44	0.44	36.91	75.76
1956	9	0.00	13.29	28.15	0.50	0.50	0.50	0.50	34.53	73.45
1957	10	27.61	27.61	16.59	0.56	0.56	0.56	72.07	72.07	43.01
1957	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1957	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1957	1	27.61	27.61	25.20	0.00	0.00	0.00	71.51	71.51	65.20
1957	2	25.01	25.01	12.88	0.00	0.00	0.00	64.74	64.74	33.03
1957	3	27.61	27.61	0.00	0.00	0.00	0.00	71.51	71.51	0.00
1957	4	26.77	26.77	3.62	0.13	0.13	0.13	69.42	69.42	9.52
1957	5	27.61	27.61	29.05	0.15	0.15	0.15	68.33	68.33	72.10
1957	6	26.77	26.77	28.15	0.16	0.16	0.16	53.16	50.20	56.67
1957	7	27.61	27.61	29.05	4.00	4.00	4.00	55.62	61.22	61.06
1957	8	0.00	21.03	12.84	1.72	1.72	1.72	1.72	50.16	29.05
1957	9	0.00	14.09	8.20	0.70	0.70	0.70	0.70	36.30	20.96

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1958	10	27.61	27.61	16.59	0.50	0.50	0.50	72.01	72.01	42.95
1958	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1958	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1958	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1958	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1958	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1958	4	26.77	26.77	15.61	0.18	0.18	0.18	69.48	69.48	40.23
1958	5	27.61	27.61	29.02	0.86	0.86	0.86	61.75	61.75	62.20
1958	6	26.77	26.77	28.15	0.35	0.35	0.35	63.73	58.33	67.33
1958	7	2.24	16.36	17.36	1.46	1.46	1.46	5.64	38.97	44.01
1958	8	0.00	13.70	22.72	0.96	0.96	0.96	0.96	36.08	58.59
1958	9	0.00	13.29	28.15	0.55	0.55	0.55	0.55	34.57	73.49
1959	10	27.61	27.61	16.59	0.59	0.59	0.59	72.10	72.10	43.04
1959	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1959	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1959	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1959	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1959	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1959	4	26.77	26.77	15.61	0.16	0.16	0.16	69.45	69.45	40.20
1959	5	27.61	27.61	29.05	0.21	0.21	0.21	69.80	69.80	73.50
1959	6	26.77	26.77	28.15	0.22	0.22	0.22	68.39	62.81	71.99
1959	7	5.97	20.23	17.86	1.85	1.85	1.85	12.75	46.13	42.83
1959	8	0.00	15.08	14.60	0.91	0.91	0.91	0.91	38.71	37.50
1959	9	0.00	13.29	21.39	0.50	0.50	0.50	0.50	34.53	54.61
1960	10	27.61	27.61	16.37	0.41	0.41	0.41	71.91	71.91	42.34

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1960	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1960	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1960	1	27.61	27.61	22.99	0.00	0.00	0.00	71.51	71.51	58.48
1960	2	25.01	25.01	25.88	0.00	0.00	0.00	64.74	64.74	66.92
1960	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1960	4	26.77	26.77	15.61	0.14	0.14	0.14	69.43	69.43	40.19
1960	5	27.61	27.61	29.05	0.20	0.20	0.20	71.31	71.31	75.14
1960	6	26.77	26.77	28.15	0.22	0.22	0.22	68.70	63.12	72.37
1960	7	7.33	21.76	15.54	1.94	1.94	1.94	15.31	49.04	35.79
1960	8	0.00	13.70	12.81	0.67	0.67	0.67	0.67	35.79	33.54
1960	9	0.00	13.29	16.36	0.51	0.51	0.51	0.51	34.53	42.42
1961	10	27.61	27.61	14.20	0.30	0.30	0.30	71.81	71.81	36.81
1961	11	26.77	0.00	11.00	0.00	0.00	0.00	69.29	0.00	28.22
1961	12	27.61	15.11	20.57	0.00	0.00	0.00	71.51	38.77	51.92
1961	1	27.61	27.61	22.99	0.00	0.00	0.00	71.51	71.51	58.48
1961	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1961	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1961	4	26.77	26.77	15.61	0.12	0.12	0.12	69.41	69.41	40.17
1961	5	27.61	27.61	27.06	0.50	0.50	0.50	68.96	68.96	65.47
1961	6	23.21	25.61	28.15	0.90	0.90	0.90	43.78	48.74	55.40
1961	7	6.85	21.22	12.26	1.61	1.61	1.61	14.08	47.72	27.40
1961	8	0.00	15.45	8.56	0.90	0.90	0.90	0.90	39.40	21.40
1961	9	0.00	17.59	11.29	1.24	1.24	1.24	1.24	43.18	26.70
1962	10	27.61	27.61	11.33	0.60	0.60	0.60	72.11	72.11	29.63
1962	11	26.77	0.00	10.90	0.00	0.00	0.00	69.29	0.00	28.00

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1962	12	27.61	15.11	16.29	0.00	0.00	0.00	71.51	38.77	41.74
1962	1	27.61	27.61	22.90	0.00	0.00	0.00	71.51	71.51	58.20
1962	2	25.01	25.01	26.11	0.00	0.00	0.00	64.74	64.74	67.53
1962	3	22.42	27.61	20.03	0.00	0.00	0.00	56.65	71.51	50.60
1962	4	13.70	26.77	15.61	0.14	0.14	0.14	32.70	69.43	40.18
1962	5	27.61	27.61	29.05	0.24	0.24	0.24	67.19	71.75	75.56
1962	6	26.77	26.77	28.15	0.21	0.21	0.21	64.71	62.85	72.05
1962	7	14.21	27.01	27.69	1.84	1.84	1.84	28.17	59.47	63.92
1962	8	0.00	15.27	13.42	0.90	0.90	0.90	0.90	39.06	34.17
1962	9	0.00	13.29	16.32	0.52	0.52	0.52	0.52	34.55	42.33
1963	10	27.61	27.61	16.59	0.50	0.50	0.50	72.01	72.01	42.95
1963	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1963	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1963	1	27.61	27.61	25.16	0.00	0.00	0.00	71.51	71.51	65.10
1963	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1963	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1963	4	26.77	26.77	15.61	0.20	0.20	0.20	69.49	69.49	40.24
1963	5	27.61	27.61	29.05	0.93	0.93	0.93	72.44	72.44	76.25
1963	6	26.77	26.77	28.15	0.41	0.41	0.41	69.70	64.00	73.36
1963	7	3.03	17.26	29.05	0.50	0.50	0.50	6.17	39.55	75.82
1963	8	0.00	16.98	29.05	0.55	0.55	0.55	0.55	41.84	75.87
1963	9	0.00	15.25	28.15	0.60	0.60	0.60	0.60	38.42	73.51
1964	10	27.61	27.61	16.59	0.60	0.60	0.60	72.11	72.11	43.05
1964	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1964	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1964	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1964	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1964	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1964	4	26.77	26.77	15.61	0.17	0.17	0.17	69.47	69.47	40.22
1964	5	27.61	27.61	29.05	0.29	0.29	0.29	71.79	71.79	75.60
1964	6	26.77	26.77	28.15	0.25	0.25	0.25	69.55	63.85	73.20
1964	7	7.25	21.67	29.05	0.63	0.63	0.63	13.86	47.58	75.95
1964	8	0.00	13.70	14.17	0.76	0.76	0.76	0.76	35.88	37.19
1964	9	0.00	13.29	21.11	0.56	0.56	0.56	0.56	34.59	53.93
1965	10	27.61	27.61	16.59	0.32	0.32	0.32	71.83	71.83	42.77
1965	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1965	12	27.61	15.11	27.67	0.00	0.00	0.00	71.51	38.77	71.66
1965	1	27.61	27.61	22.35	0.00	0.00	0.00	71.51	71.51	56.48
1965	2	25.01	25.01	25.44	0.00	0.00	0.00	64.74	64.74	65.79
1965	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1965	4	26.77	26.77	15.61	0.13	0.13	0.13	69.43	69.43	40.18
1965	5	27.61	27.61	29.05	0.20	0.20	0.20	71.71	71.71	75.52
1965	6	26.77	26.77	28.15	0.19	0.19	0.19	62.21	56.31	65.71
1965	7	23.85	27.61	28.51	4.00	4.00	4.00	48.34	62.21	60.64
1965	8	0.00	21.39	14.99	1.98	1.98	1.98	1.98	51.10	34.68
1965	9	0.00	15.34	9.79	0.79	0.79	0.79	0.79	38.78	24.07
1966	10	27.61	27.61	16.54	0.30	0.30	0.30	71.81	71.81	42.63
1966	11	26.77	0.00	11.38	0.00	0.00	0.00	69.29	0.00	29.16
1966	12	27.61	15.11	18.27	0.00	0.00	0.00	71.51	38.77	46.27
1966	1	27.61	27.61	23.84	0.00	0.00	0.00	71.51	71.51	61.26

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1966	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1966	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1966	4	26.77	26.77	15.61	0.17	0.17	0.17	69.47	69.47	40.22
1966	5	27.61	27.61	29.05	0.29	0.29	0.29	71.79	71.79	75.60
1966	6	26.77	25.55	28.15	0.38	0.38	0.38	69.67	61.67	73.32
1966	7	2.63	16.81	29.05	1.26	1.26	1.26	6.18	39.56	76.58
1966	8	0.00	13.78	29.05	0.91	0.91	0.91	0.91	36.20	76.23
1966	9	0.00	13.29	28.15	0.50	0.50	0.50	0.50	34.53	73.45
1967	10	27.61	27.61	16.59	0.51	0.51	0.51	72.02	72.02	42.96
1967	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1967	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1967	1	27.61	27.61	27.22	0.00	0.00	0.00	71.51	71.51	70.48
1967	2	25.01	25.01	25.87	0.00	0.00	0.00	64.74	64.74	66.89
1967	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1967	4	26.77	26.77	15.61	0.13	0.13	0.13	69.42	69.42	40.17
1967	5	27.61	27.61	29.05	0.17	0.17	0.17	71.67	71.67	75.49
1967	6	26.77	26.77	28.15	0.20	0.20	0.20	67.12	61.71	70.80
1967	7	12.51	16.01	17.05	0.58	0.58	0.58	23.70	31.97	35.08
1967	8	0.00	13.70	10.26	0.90	0.90	0.90	0.90	36.03	27.14
1967	9	0.00	14.66	11.77	0.50	0.50	0.50	0.50	37.19	29.57
1968	10	27.61	27.61	15.29	0.49	0.49	0.49	71.99	71.99	39.72
1968	11	26.77	0.00	10.21	0.00	0.00	0.00	69.29	0.00	26.08
1968	12	27.61	15.11	19.97	0.00	0.00	0.00	71.51	38.77	50.46
1968	1	27.61	27.61	22.35	0.00	0.00	0.00	71.51	71.51	56.48
1968	2	25.01	25.01	25.44	0.00	0.00	0.00	64.74	64.74	65.81

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1968	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1968	4	26.77	26.77	15.61	0.11	0.11	0.11	69.40	69.40	40.16
1968	5	27.61	27.61	27.76	0.16	0.16	0.16	71.62	71.62	72.00
1968	6	26.77	26.77	28.15	0.66	0.66	0.66	68.63	63.04	69.62
1968	7	6.93	21.31	16.78	1.87	1.87	1.87	14.50	48.16	39.32
1968	8	0.00	15.54	7.60	0.60	0.60	0.60	0.60	39.27	18.61
1968	9	0.00	13.29	12.33	0.52	0.52	0.52	0.52	34.55	32.17
1969	10	27.61	27.61	15.17	0.35	0.35	0.35	71.86	71.86	39.27
1969	11	26.77	0.00	10.97	0.00	0.00	0.00	69.29	0.00	28.16
1969	12	27.61	15.11	13.76	0.00	0.00	0.00	71.51	38.77	35.29
1969	1	27.61	27.61	22.79	0.00	0.00	0.00	71.51	71.51	57.84
1969	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1969	3	22.79	27.61	20.03	0.00	0.00	0.00	57.83	71.51	50.60
1969	4	13.02	26.77	15.61	0.15	0.15	0.15	33.50	69.45	40.20
1969	5	21.65	27.61	29.05	0.19	0.19	0.19	43.56	66.14	69.82
1969	6	23.37	25.69	28.15	1.25	1.25	1.25	44.51	49.25	56.57
1969	7	13.05	25.12	18.26	2.63	2.63	2.63	26.71	56.31	39.53
1969	8	0.00	14.48	11.75	1.15	1.15	1.15	1.15	37.81	30.69
1969	9	0.00	13.53	6.73	0.46	0.46	0.46	0.46	34.93	17.32
1970	10	27.61	27.61	16.59	0.50	0.50	0.50	72.01	72.01	42.95
1970	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1970	12	27.61	15.11	21.00	0.00	0.00	0.00	71.51	38.77	53.07
1970	1	27.61	27.61	22.99	0.00	0.00	0.00	71.51	71.51	58.48
1970	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1970	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1970	4	22.90	26.77	15.61	0.13	0.13	0.13	58.32	69.43	40.18
1970	5	22.65	27.61	29.05	0.51	0.51	0.51	50.44	71.66	73.44
1970	6	21.10	26.58	28.15	0.68	0.68	0.68	39.41	50.36	57.16
1970	7	14.05	26.30	18.74	2.78	2.78	2.78	28.78	58.80	40.15
1970	8	0.00	15.99	10.17	0.90	0.90	0.90	0.90	40.42	25.03
1970	9	0.00	14.56	7.93	0.60	0.60	0.60	0.60	37.10	19.82
1971	10	27.61	27.61	7.31	0.35	0.35	0.35	71.86	71.86	19.01
1971	11	26.77	0.00	11.15	0.00	0.00	0.00	69.29	0.00	28.61
1971	12	27.61	15.11	13.87	0.00	0.00	0.00	71.51	38.77	35.58
1971	1	27.61	27.61	22.65	0.00	0.00	0.00	71.51	71.51	57.38
1971	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1971	3	17.40	27.61	20.03	0.00	0.00	0.00	44.29	71.51	50.60
1971	4	12.04	26.77	15.61	0.13	0.13	0.13	30.49	69.43	40.18
1971	5	12.15	27.61	14.71	0.17	0.17	0.17	27.06	68.01	33.91
1971	6	26.77	26.77	28.15	0.17	0.17	0.17	50.21	53.67	63.45
1971	7	12.78	25.55	20.41	0.90	0.90	0.90	24.50	55.78	43.38
1971	8	0.00	15.36	9.36	0.80	0.80	0.80	0.80	39.13	23.34
1971	9	0.00	14.86	7.46	0.55	0.55	0.55	0.55	37.62	18.34
1972	10	27.61	27.61	13.84	0.50	0.50	0.50	72.01	72.01	36.01
1972	11	26.77	0.00	11.02	0.00	0.00	0.00	69.29	0.00	28.28
1972	12	27.61	15.11	20.64	0.00	0.00	0.00	71.51	38.77	52.12
1972	1	27.61	27.61	23.08	0.00	0.00	0.00	71.51	71.51	58.78
1972	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1972	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1972	4	13.08	26.77	15.61	0.15	0.15	0.15	33.65	69.44	40.19

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1972	5	25.52	27.61	29.05	0.21	0.21	0.21	62.79	71.72	75.53
1972	6	26.77	26.77	28.15	0.24	0.24	0.24	68.57	63.84	73.19
1972	7	2.87	17.08	20.35	1.33	1.33	1.33	6.70	40.10	50.59
1972	8	0.00	13.70	12.34	0.60	0.60	0.60	0.60	35.72	32.28
1972	9	0.00	15.25	18.00	0.80	0.80	0.80	0.80	38.63	45.24
1973	10	27.61	27.61	16.59	0.47	0.47	0.47	71.97	71.97	42.91
1973	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1973	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1973	1	27.61	27.61	24.70	0.00	0.00	0.00	71.51	71.51	63.83
1973	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1973	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1973	4	26.77	26.77	15.61	0.15	0.15	0.15	69.44	69.44	40.20
1973	5	21.71	27.61	19.70	0.19	0.19	0.19	50.12	66.46	45.05
1973	6	26.77	26.77	28.15	0.19	0.19	0.19	52.84	54.06	65.59
1973	7	16.92	27.61	22.71	1.08	1.08	1.08	32.44	59.84	46.65
1973	8	0.00	16.62	12.08	1.19	1.19	1.19	1.19	41.84	29.82
1973	9	0.00	13.29	8.44	0.53	0.53	0.53	0.53	34.56	22.07
1974	10	27.61	27.61	16.59	0.30	0.30	0.30	71.80	71.80	42.74
1974	11	26.77	0.00	14.22	0.00	0.00	0.00	69.29	0.00	36.55
1974	12	27.61	15.11	23.97	0.00	0.00	0.00	71.51	38.77	61.66
1974	1	27.61	27.61	23.80	0.00	0.00	0.00	71.51	71.51	61.12
1974	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1974	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1974	4	26.77	26.77	15.61	0.19	0.19	0.19	69.48	69.48	40.24
1974	5	27.61	27.61	29.05	0.29	0.29	0.29	71.48	71.48	75.30

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1974	6	26.77	26.77	28.15	0.28	0.28	0.28	67.44	61.99	71.09
1974	7	7.77	22.21	29.05	0.84	0.84	0.84	15.00	48.74	76.16
1974	8	0.00	13.70	29.05	0.90	0.90	0.90	0.90	36.02	76.22
1974	9	0.00	13.29	28.15	0.90	0.90	0.90	0.90	34.93	73.85
1975	10	27.61	27.61	16.59	0.34	0.34	0.34	71.85	71.85	42.79
1975	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1975	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1975	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1975	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1975	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1975	4	26.77	26.77	15.61	0.16	0.16	0.16	69.45	69.45	40.20
1975	5	27.61	27.61	29.05	0.25	0.25	0.25	71.48	71.48	75.31
1975	6	26.77	26.77	28.15	0.22	0.22	0.22	62.39	56.51	65.87
1975	7	20.79	27.61	26.23	4.00	4.00	4.00	42.16	62.77	57.21
1975	8	0.00	16.62	18.47	1.30	1.30	1.30	1.30	41.95	46.27
1975	9	0.00	13.29	21.67	0.77	0.77	0.77	0.77	34.80	55.58
1976	10	27.61	27.61	16.59	0.30	0.30	0.30	71.81	71.81	42.75
1976	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1976	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1976	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1976	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1976	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1976	4	26.77	26.77	15.61	0.19	0.19	0.19	69.48	69.48	40.24
1976	5	27.61	27.61	29.05	0.29	0.29	0.29	71.79	71.79	75.61
1976	6	26.77	26.77	28.15	0.42	0.42	0.42	69.71	64.02	73.37

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1976	7	5.89	20.14	29.05	0.68	0.68	0.68	11.44	44.81	76.00
1976	8	0.00	14.28	29.05	0.61	0.61	0.61	0.61	36.89	75.93
1976	9	0.00	13.53	28.15	1.02	1.02	1.02	1.02	35.50	73.97
1977	10	27.61	27.61	16.59	0.36	0.36	0.36	71.86	71.86	42.80
1977	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1977	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1977	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1977	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1977	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1977	4	26.77	26.77	15.61	0.17	0.17	0.17	69.46	69.46	40.22
1977	5	27.61	27.61	29.05	0.54	0.54	0.54	72.04	72.04	75.86
1977	6	26.77	25.71	28.15	0.60	0.60	0.60	69.89	62.19	73.55
1977	7	0.00	13.70	29.05	0.73	0.73	0.73	0.73	33.18	76.05
1977	8	0.00	13.70	29.05	0.58	0.58	0.58	0.58	35.70	75.90
1977	9	0.00	13.29	28.15	0.72	0.72	0.72	0.72	34.75	73.67
1978	10	27.61	27.61	16.59	0.45	0.45	0.45	71.96	71.96	42.90
1978	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1978	12	27.61	15.11	19.21	0.00	0.00	0.00	71.51	38.77	48.55
1978	1	27.61	27.61	3.14	0.00	0.00	0.00	71.51	71.51	8.30
1978	2	25.01	25.01	2.18	0.00	0.00	0.00	64.74	64.74	5.74
1978	3	27.61	27.61	2.26	0.00	0.00	0.00	71.51	71.51	5.98
1978	4	26.77	26.77	7.69	0.12	0.12	0.12	69.41	69.41	19.65
1978	5	27.61	27.61	29.05	0.15	0.15	0.15	71.66	71.66	75.47
1978	6	26.77	26.77	28.15	0.18	0.18	0.18	64.71	59.37	68.35
1978	7	18.90	27.61	29.05	0.37	0.37	0.37	35.06	59.14	75.69

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1978	8	0.00	15.08	29.05	0.63	0.63	0.63	0.63	38.42	75.95
1978	9	0.00	13.29	23.44	0.37	0.37	0.37	0.37	34.39	60.34
1979	10	27.61	27.61	15.14	0.24	0.24	0.24	71.75	71.75	39.09
1979	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1979	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1979	1	27.61	27.61	22.59	0.00	0.00	0.00	71.51	71.51	57.21
1979	2	25.01	25.01	25.47	0.00	0.00	0.00	64.74	64.74	65.88
1979	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1979	4	26.77	26.77	15.61	0.12	0.12	0.12	69.41	69.41	40.17
1979	5	27.61	27.61	25.98	0.27	0.27	0.27	65.25	65.25	60.27
1979	6	26.77	26.77	28.15	0.32	0.32	0.32	63.79	58.40	66.49
1979	7	17.10	27.61	22.27	3.47	3.47	3.47	35.13	61.90	47.68
1979	8	0.00	18.42	10.44	1.18	1.18	1.18	1.18	44.83	24.24
1979	9	0.00	13.69	13.41	0.73	0.73	0.73	0.73	35.52	34.76
1980	10	27.61	27.61	15.85	0.45	0.45	0.45	71.96	71.96	41.11
1980	11	26.77	0.00	11.29	0.00	0.00	0.00	69.29	0.00	28.94
1980	12	27.61	15.11	13.64	0.00	0.00	0.00	71.51	38.77	34.97
1980	1	27.61	27.61	23.23	0.00	0.00	0.00	71.51	71.51	59.25
1980	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1980	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1980	4	26.77	26.77	15.61	0.15	0.15	0.15	69.44	69.44	40.20
1980	5	27.61	27.61	14.93	0.19	0.19	0.19	64.20	64.20	30.20
1980	6	26.77	26.77	28.15	0.49	0.49	0.49	52.95	50.53	55.19
1980	7	17.28	27.61	22.12	3.04	3.04	3.04	34.98	60.68	46.76
1980	8	0.00	15.45	10.11	0.85	0.85	0.85	0.85	39.35	25.25

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1980	9	0.00	13.36	10.09	0.68	0.68	0.68	0.68	34.84	26.36
1981	10	27.61	27.61	16.59	0.60	0.60	0.60	72.10	72.10	43.05
1981	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1981	12	27.61	15.11	23.62	0.00	0.00	0.00	71.51	38.77	60.55
1981	1	27.61	27.61	23.80	0.00	0.00	0.00	71.51	71.51	61.12
1981	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1981	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1981	4	26.77	26.77	15.61	0.19	0.19	0.19	69.48	69.48	40.24
1981	5	27.61	27.61	29.05	0.25	0.25	0.25	71.76	71.76	75.57
1981	6	26.77	26.77	28.15	0.39	0.39	0.39	69.68	63.98	73.34
1981	7	2.87	17.08	29.05	0.71	0.71	0.71	6.08	39.48	76.03
1981	8	0.00	13.70	27.15	0.79	0.79	0.79	0.79	35.91	71.08
1981	9	0.00	13.29	25.70	0.70	0.70	0.70	0.70	34.72	67.15
1982	10	27.61	27.61	16.59	0.51	0.51	0.51	72.02	72.02	42.96
1982	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1982	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1982	1	27.61	27.61	26.20	0.00	0.00	0.00	71.51	71.51	67.77
1982	2	25.01	25.01	25.44	0.00	0.00	0.00	64.74	64.74	65.79
1982	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1982	4	26.77	26.77	15.61	0.14	0.14	0.14	69.43	69.43	40.19
1982	5	27.61	27.61	29.05	0.22	0.22	0.22	71.72	71.72	75.54
1982	6	26.77	26.77	28.15	0.50	0.50	0.50	69.79	64.09	71.74
1982	7	16.83	27.61	23.10	2.00	2.00	2.00	33.20	60.77	48.90
1982	8	0.00	18.78	11.65	1.07	1.07	1.07	1.07	45.36	26.87
1982	9	0.00	16.06	15.36	0.64	0.64	0.64	0.64	39.99	38.21

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1983	10	27.61	27.61	12.95	0.45	0.45	0.45	71.96	71.96	33.65
1983	11	26.77	0.00	10.87	0.00	0.00	0.00	69.29	0.00	27.90
1983	12	27.61	15.11	13.66	0.00	0.00	0.00	71.51	38.77	35.01
1983	1	27.61	27.61	18.58	0.00	0.00	0.00	71.51	71.51	47.00
1983	2	25.01	25.01	26.00	0.00	0.00	0.00	64.74	64.74	67.22
1983	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1983	4	22.66	26.77	15.61	0.11	0.11	0.11	57.53	69.40	40.16
1983	5	11.16	27.61	10.90	0.13	0.13	0.13	26.00	69.34	25.33
1983	6	24.40	26.77	28.15	0.34	0.34	0.34	45.85	50.37	54.77
1983	7	27.61	27.61	29.05	1.08	1.08	1.08	52.70	52.70	58.22
1983	8	0.00	22.45	15.92	0.60	0.60	0.60	0.60	51.63	34.91
1983	9	0.00	14.01	7.31	0.53	0.53	0.53	0.53	35.97	18.57
1984	10	27.61	27.61	7.37	0.48	0.48	0.48	71.98	71.98	19.31
1984	11	26.77	0.00	2.95	0.00	0.00	0.00	69.29	0.00	7.79
1984	12	27.61	15.11	7.97	0.00	0.00	0.00	71.51	38.77	20.35
1984	1	27.61	27.61	12.32	0.00	0.00	0.00	71.51	71.51	31.63
1984	2	12.05	25.01	19.91	0.00	0.00	0.00	30.91	64.74	50.31
1984	3	6.23	27.61	20.03	0.00	0.00	0.00	15.74	71.51	50.60
1984	4	12.54	26.77	15.61	0.14	0.14	0.14	32.33	69.43	40.19
1984	5	14.77	17.05	24.83	0.30	0.30	0.30	27.67	34.38	55.60
1984	6	25.36	25.36	28.15	0.22	0.22	0.22	50.18	50.18	64.72
1984	7	18.45	27.61	26.74	1.61	1.61	1.61	35.50	60.38	57.99
1984	8	0.00	19.59	11.87	0.75	0.75	0.75	0.75	46.57	26.55
1984	9	0.00	15.88	11.99	0.90	0.90	0.90	0.90	39.91	29.52
1985	10	27.61	27.61	15.82	0.40	0.40	0.40	71.90	71.90	40.98

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1985	11	26.77	0.00	10.85	0.00	0.00	0.00	69.29	0.00	27.88
1985	12	27.61	15.11	23.90	0.00	0.00	0.00	71.51	38.77	61.44
1985	1	27.61	27.61	22.80	0.00	0.00	0.00	71.51	71.51	57.86
1985	2	25.01	25.01	25.88	0.00	0.00	0.00	64.74	64.74	66.90
1985	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1985	4	23.83	24.34	15.61	0.20	0.20	0.20	60.96	62.52	40.25
1985	5	25.22	25.22	29.05	0.19	0.19	0.19	59.76	59.76	73.45
1985	6	26.77	26.77	28.15	0.46	0.46	0.46	67.19	61.79	70.84
1985	7	6.37	20.68	20.78	0.66	0.66	0.66	12.26	45.76	48.69
1985	8	0.00	13.70	9.55	0.54	0.54	0.54	0.54	35.66	24.82
1985	9	0.00	13.29	13.29	0.44	0.44	0.44	0.44	34.46	34.46
1986	10	27.61	27.61	11.95	0.16	0.16	0.16	71.66	71.66	30.80
1986	11	26.77	0.00	10.56	0.00	0.00	0.00	69.29	0.00	27.10
1986	12	27.61	15.11	21.44	0.00	0.00	0.00	71.51	38.77	54.25
1986	1	27.61	27.61	22.35	0.00	0.00	0.00	71.51	71.51	56.48
1986	2	25.01	25.01	25.46	0.00	0.00	0.00	64.74	64.74	65.85
1986	3	14.21	22.94	20.03	0.00	0.00	0.00	36.52	58.32	50.60
1986	4	13.94	13.94	15.61	0.50	0.50	0.50	35.23	35.23	40.55
1986	5	27.61	27.61	29.05	0.26	0.26	0.26	67.63	67.63	74.63
1986	6	26.77	26.77	28.15	0.18	0.18	0.18	52.20	52.07	61.74
1986	7	16.38	27.61	22.27	0.38	0.38	0.38	30.78	59.14	45.02
1986	8	0.00	15.99	9.87	0.63	0.63	0.63	0.63	40.15	23.97
1986	9	0.00	13.69	5.78	0.27	0.27	0.27	0.27	35.07	14.60
1987	10	27.61	27.61	8.19	0.18	0.18	0.18	71.68	71.68	21.10
1987	11	26.77	0.00	10.79	0.00	0.00	0.00	69.29	0.00	27.72

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1987	12	27.61	15.11	19.26	0.00	0.00	0.00	71.51	38.77	48.68
1987	1	27.61	27.61	22.73	0.00	0.00	0.00	71.51	71.51	57.63
1987	2	24.26	25.01	25.90	0.00	0.00	0.00	62.57	64.74	66.96
1987	3	6.22	6.27	20.03	0.00	0.00	0.00	15.70	15.83	50.60
1987	4	15.60	15.60	15.61	0.50	0.50	0.50	39.58	39.58	40.55
1987	5	27.61	27.61	29.05	0.42	0.42	0.42	67.09	67.09	72.04
1987	6	26.77	26.49	28.15	0.24	0.24	0.24	65.73	60.54	70.06
1987	7	2.03	16.09	17.22	0.93	0.93	0.93	4.69	37.96	43.34
1987	8	0.00	13.70	7.28	0.35	0.35	0.35	0.35	35.47	18.92
1987	9	0.00	13.29	13.42	0.38	0.38	0.38	0.38	34.40	34.72
1988	10	27.61	27.61	14.20	0.25	0.25	0.25	71.76	71.76	36.74
1988	11	26.77	0.00	10.67	0.00	0.00	0.00	69.29	0.00	27.40
1988	12	27.61	15.11	24.58	0.00	0.00	0.00	71.51	38.77	63.50
1988	1	27.61	27.61	23.09	0.00	0.00	0.00	71.51	71.51	58.82
1988	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1988	3	22.88	27.61	20.03	0.00	0.00	0.00	58.13	71.51	50.60
1988	4	12.67	14.72	15.61	0.16	0.16	0.16	32.36	37.69	40.21
1988	5	27.61	27.61	29.05	0.50	0.50	0.50	70.89	70.89	75.82
1988	6	26.77	26.77	28.15	0.26	0.26	0.26	68.78	63.85	73.20
1988	7	2.95	17.17	22.12	0.82	0.82	0.82	6.34	39.73	54.36
1988	8	0.00	13.70	15.27	0.90	0.90	0.90	0.90	36.02	40.07
1988	9	0.00	13.29	16.85	0.50	0.50	0.50	0.50	34.53	43.56
1989	10	27.61	27.61	16.59	0.51	0.51	0.51	72.02	72.02	42.96
1989	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1989	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1989	1	27.61	27.61	28.80	0.00	0.00	0.00	71.51	71.51	74.64
1989	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1989	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1989	4	26.77	26.77	15.61	0.26	0.26	0.26	69.55	69.55	40.31
1989	5	27.61	27.61	29.05	0.54	0.54	0.54	72.04	72.04	75.86
1989	6	26.77	26.77	28.15	0.49	0.49	0.49	69.78	64.08	73.43
1989	7	3.83	18.16	29.05	0.83	0.83	0.83	7.91	41.34	76.15
1989	8	0.00	14.98	29.05	0.51	0.51	0.51	0.51	38.11	75.82
1989	9	0.00	13.29	27.74	0.50	0.50	0.50	0.50	34.53	72.33
1990	10	27.61	27.61	16.59	0.60	0.60	0.60	72.11	72.11	43.05
1990	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1990	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1990	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1990	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1990	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1990	4	26.77	26.77	15.61	0.11	0.11	0.11	69.40	69.40	40.16
1990	5	27.61	27.61	29.05	0.15	0.15	0.15	71.35	71.35	75.18
1990	6	26.77	26.77	28.15	0.18	0.18	0.18	68.48	62.90	72.11
1990	7	7.77	22.21	14.56	1.98	1.98	1.98	16.14	49.88	32.95
1990	8	0.00	14.02	4.85	0.23	0.23	0.23	0.23	36.00	12.53
1990	9	0.00	13.36	10.87	0.40	0.40	0.40	0.40	34.56	28.26
1991	10	27.61	27.61	13.74	0.22	0.22	0.22	71.72	71.72	35.46
1991	11	26.77	0.00	10.67	0.00	0.00	0.00	69.29	0.00	27.40
1991	12	27.61	15.11	13.95	0.00	0.00	0.00	71.51	38.77	35.82
1991	1	27.61	27.61	15.22	0.00	0.00	0.00	71.51	71.51	39.05

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1991	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1991	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1991	4	23.48	26.77	15.61	0.14	0.14	0.14	60.23	69.43	40.19
1991	5	27.28	27.61	29.05	0.22	0.22	0.22	67.04	71.73	75.54
1991	6	26.77	26.77	28.15	0.24	0.24	0.24	67.38	61.93	71.03
1991	7	5.71	19.96	29.05	1.78	1.78	1.78	12.22	45.59	73.88
1991	8	0.00	14.98	8.08	0.60	0.60	0.60	0.60	38.20	20.26
1991	9	0.00	13.45	13.23	0.57	0.57	0.57	0.57	34.88	34.34
1992	10	27.61	27.61	16.59	0.22	0.22	0.22	71.72	71.72	42.67
1992	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1992	12	27.61	15.11	28.14	0.00	0.00	0.00	71.51	38.77	72.92
1992	1	27.61	27.61	22.74	0.00	0.00	0.00	71.51	71.51	57.67
1992	2	25.01	25.01	25.88	0.00	0.00	0.00	64.74	64.74	66.93
1992	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1992	4	26.40	26.77	15.61	0.13	0.13	0.13	67.61	69.42	40.17
1992	5	27.61	27.61	29.05	0.43	0.43	0.43	71.93	71.93	75.75
1992	6	26.77	26.77	28.15	0.25	0.25	0.25	65.74	63.84	73.20
1992	7	3.83	18.16	18.04	1.16	1.16	1.16	8.24	41.67	44.05
1992	8	0.00	13.70	10.20	0.50	0.50	0.50	0.50	35.62	26.55
1992	9	0.00	13.29	12.10	0.50	0.50	0.50	0.50	34.53	31.53
1993	10	27.61	27.61	11.52	0.15	0.15	0.15	71.65	71.65	29.66
1993	11	26.77	0.00	11.20	0.00	0.00	0.00	69.29	0.00	28.72
1993	12	27.61	15.11	23.77	0.00	0.00	0.00	71.51	38.77	61.05
1993	1	27.61	27.61	22.35	0.00	0.00	0.00	71.51	71.51	56.48
1993	2	25.01	25.01	25.44	0.00	0.00	0.00	64.74	64.74	65.79

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1993	3	19.97	27.61	20.03	0.00	0.00	0.00	50.47	71.51	50.60
1993	4	8.03	24.88	15.61	0.11	0.11	0.11	20.59	64.43	40.16
1993	5	27.61	27.61	29.05	0.20	0.20	0.20	65.47	65.47	75.52
1993	6	26.77	26.77	28.15	0.44	0.44	0.44	63.59	63.59	71.58
1993	7	13.97	26.77	21.13	2.77	2.77	2.77	28.61	59.94	46.17
1993	8	0.00	16.98	15.46	1.14	1.14	1.14	1.14	42.43	38.60
1993	9	0.00	14.36	12.43	0.56	0.56	0.56	0.56	36.68	31.62
1994	10	27.61	27.61	15.36	0.21	0.21	0.21	71.72	71.72	39.62
1994	11	26.77	0.00	11.56	0.00	0.00	0.00	69.29	0.00	29.60
1994	12	27.61	15.11	16.99	0.00	0.00	0.00	71.51	38.77	43.38
1994	1	27.61	27.61	23.84	0.00	0.00	0.00	71.51	71.51	61.27
1994	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1994	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1994	4	14.47	15.25	15.61	0.17	0.17	0.17	36.46	38.42	40.22
1994	5	27.61	27.61	29.05	0.50	0.50	0.50	72.01	72.01	75.82
1994	6	26.77	26.77	28.15	0.43	0.43	0.43	69.72	64.02	73.38
1994	7	0.00	15.09	29.05	0.95	0.95	0.95	0.95	36.08	76.27
1994	8	0.00	13.70	29.05	0.75	0.75	0.75	0.75	35.87	76.07
1994	9	0.00	13.29	28.15	0.76	0.76	0.76	0.76	34.79	73.71
1995	10	27.61	27.61	16.59	0.19	0.19	0.19	71.69	71.69	42.63
1995	11	26.77	0.00	15.61	0.00	0.00	0.00	69.29	0.00	40.05
1995	12	27.61	15.11	29.05	0.00	0.00	0.00	71.51	38.77	75.32
1995	1	27.61	27.61	29.05	0.00	0.00	0.00	71.51	71.51	75.32
1995	2	25.01	25.01	26.29	0.00	0.00	0.00	64.74	64.74	68.01
1995	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60

		Generation at Flatiron PP			Generation at Big Thompson PP			Total Generation		
WY Year	Month	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV	Alt I	Alt II	Alt III+IV
1995	4	26.77	26.77	15.61	0.15	0.15	0.15	69.45	69.45	40.20
1995	5	27.61	27.61	29.05	0.18	0.18	0.18	70.82	70.82	74.08
1995	6	26.77	26.77	28.15	0.20	0.20	0.20	50.24	50.24	54.53
1995	7	27.61	27.61	29.05	1.71	1.71	1.71	53.32	53.32	59.55
1995	8	0.00	20.58	16.74	1.74	1.74	1.74	1.74	49.33	39.66
1995	9	0.00	15.06	11.19	0.96	0.96	0.96	0.96	38.42	28.13
1996	10	27.61	27.61	13.40	0.16	0.16	0.16	71.67	71.67	34.46
1996	11	26.77	0.00	10.46	0.00	0.00	0.00	69.29	0.00	26.82
1996	12	27.61	15.11	15.92	0.00	0.00	0.00	71.51	38.77	40.83
1996	1	27.61	27.61	22.41	0.00	0.00	0.00	71.51	71.51	56.64
1996	2	25.01	25.01	25.48	0.00	0.00	0.00	64.74	64.74	65.91
1996	3	27.61	27.61	20.03	0.00	0.00	0.00	71.51	71.51	50.60
1996	4	26.77	26.77	15.61	0.11	0.11	0.11	69.40	69.40	40.16
1996	5	27.61	27.61	29.05	0.52	0.52	0.52	72.03	72.03	75.84
1996	6	26.77	26.77	28.15	0.27	0.27	0.27	66.96	61.81	70.91
1996	7	10.53	23.71	16.25	0.47	0.47	0.47	19.95	51.66	34.30
1996	8	0.00	15.27	10.09	0.50	0.50	0.50	0.50	38.66	24.98
1996	9	0.00	14.96	12.66	0.29	0.29	0.29	0.29	37.55	31.55

APPENDIX

Senate Document 80

C-BT Project Maps

Alternatives Analysis Meeting Notes

Existing Watershed and Best Management Practices

Operations Summary

Literature Review and Water Quality Studies

Final Report of the External Review Panel

LITERATURE REVIEW

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(Northern Water) Colorado-Big Thompson Nutrient Project:
http://nw.ncwcd.org/environment/nutrientproject.aspx

(Northern Water) Colorado-Big Thompson Water Quality Program:
http://www.ncwcd.org/environment/waterquality.asp

(Northern Water) West Slope Water Quality Monitoring Sites:
http://www.ncwcd.org/environment/wq_westmap.asp

(Northern Water) Three Lakes Nutrient Study FTP Site (secure): ftp://ftp.ncwcd.org/

Login: LakesStudy

Password: nw@3LakesPW

(Northern Water) Colorado-Big Thompson Water Quality Data: ftp://ftp.ncwcd.org/ (Data Folder)

(Grand County) Grand County: http://www.co.grand.co.us

(Grand County) Grand County Stream Management Plan: http://www.co.grand.co.us/WRM.html

(Grand County) Grand Ditch Breach EIS:
http://www.nps.gov/romo/parkmgmt/grand_ditch_breach_rest_eis.htm

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Password: grand

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Colorado Water Quality Forum (Nutrient Standard Information): http://www.cwqf.org/

Colorado Water Quality Control Commission 2008 Grand Lake Clarity Standard (page 89):

http://www.cdphe.state.co.us/regulations/wqccregs/100233uppercoloradoandnorthplatteriverbasinnew.pdf

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	Study Title	Author	Year	Feature	Keywords	Electronic Copy	Category
1	Progress Report on Copper Study	John Stednick	1993	East Slope Canals	Algae Control, Copper Sulfate	N	Algae Control
2	A Review of Copper Sulfate Usage on Reclamation's Colorado Big Thompson (C-BT) Project	David Sisneros, Technical Service Center, USBR	2006	East Slope Canals	Algae Control, Copper Sulfate	Y	Algae Control
3	Aquatic Weed Management Control Methods	James Shleton, Tim Murphy SRAC	1989		Alage Control	Y	Algae Control
4	Toxicity of Copper Sulfate and Cutrine to Rainbow Trout under Acute, Chronic, and Episodic Exposures	Patrick Davies, Stephen Brinkman	1994		Aquatic Life, Copper Sulfate, Fish Kill	Y	Algae Control
5	Effect of Copper Sulphate Pentahydrate on Cladophora Glomerata at Different Temperatures	Maria Angelica Echeverria Caceres, CSU	1995		Algae Control, Copper Sulfate	Y	Algae Control
6	Toxicity and Bioavailability of Copper Herbicides (Clearigate, Cutrine Plus and Copper Sulfate) to Freshwater Animals	Mastin, Rodgers	2000		Algae Control, Copper Sulfate	Y	Algae Control
7	Review of Alternative Aquatic Pest Control Methods for California Waters	Ben Greenfield, Nicole David, Jennifer Hunt, Marion Wittmann, Geoffrey Siemering	2004		Aquatic Weed, Algae Control	Y	Algae Control
8	Aquatic Pest Management - Chap 6 Non Chemical Vegetation Management Techniques	Julie A. Stachecki, Carolyn J. Randall	2006		Algae Control	Y	Algae Control
9	Report on the Big Thompson River Fish Kill	Andrew Archuleta	1992	Big Thompson Watershed	Aquatic Life, Copper Sulfate, Fish Kill	Y	Big Thompson Watershed
10	Chemical Kinetics and Toxicity of Copper Sulfate	John Stednick, Pat Davies	1993	Big Thompson Watershed	Aquatic Life, Copper Sulfate, Fish Kill	Y	Big Thompson Watershed
11	Status and Trends of the Fish Community at Four Sites in the Big Thompson River near Loveland, Colorado 1979-1992	Kevin Bestgen, Kurt Fausch	1993	Big Thompson Watershed	Aquatic Life	Y	Big Thompson Watershed
12	Big Thompson River Fish Kill Report	Richard Arber Associates	Aug 1, 1993	Big Thompson Watershed	1990 and 1992 Fish kills in relation to copper applications	Y	Big Thompson Watershed
13	Comprehensive Design of a Water Quality Monitoring Network for the Big Thompson Watershed (Volume 1 and Volume 2)	Jim Loftis, Rob Buirgy, Ben Alexander, David Dubois	May 1, 2000	Big Thompson Watershed	Monitoring Design	Y	Big Thompson Watershed
14	Water Quality of the Upper Big Thompson Watershed	Alan Jassby, Charles Goldman	Nov 1, 2003	Big Thompson Watershed	Assessment of General Chemistry, Organic Compounds, Microorganisms, Nutrients, Trace Metals, Major Ions	Y	Big Thompson Watershed
15	Retrospective Analysis of Water Quality Data in the Big Thompson Watershed (2001-2006)	Paul Haby, Jim Loftis, CSU	Aug 1, 2007	Big Thompson Watershed	Nutrients, General Chemistry, Metals, Microbiology, Total Organic Carbon	Y	Big Thompson Watershed
16	Big Thompson Watershed Management Plan	Rob Buirgy	December-07	Big Thompson Watershed	Nutrients, Algae Blooms, Secchi	Y	Big Thompson Watershed
17	Cooperative Design of a Water Quality Monitoring System for the Big Thompson River Watershed, Colorado	Adrienne Greve, CSU	Fall 1999	Big Thompson Watershed	Monitoring Design	Y	Big Thompson Watershed
18	Evaluation of the Cooperative Water Quality Monitoring Program in Colorado's Big Thompson Watershed	Michael Giardullo	Summer 2006	Big Thompson Watershed	Nutrients, Bacterial, General Chemistry	Y	Big Thompson Watershed
19	Analysis of Data Similarity among Sites within the Cooperative Monitoring Program	Jeffrey Boring	Summer 2006	Big Thompson Watershed	Monitoring Design	Y	Big Thompson Watershed
20	Upper Big Thompson River Watershed Study - Needs Assessment Final Report	Jeff Writer	1996		Water Quality Monitoring, Watershed Management	Y	Big Thompson Watershed

	Study Title	Author	Year	Feature	Keywords	Electronic Copy	Category
21	Comprehensive Water Quality of the Boulder Creek Watershed, Colorado, During High-Flow and Low-Flow Conditions, 2000	USGS	2003	Boulder Creek Watershed	General Water Quality	Y	Boulder Creek Watershed
22	Boulder Feeder Canal Trail Proposal - Health and Safety Analysis	Brown and Cladwell	2005	Boulder Creek Watershed	Drinking Water, Water Treatment, Water Quality Protection	Y	Boulder Creek Watershed
23	Water Quality Conditions, Hydrologic Budget, and Sources and Fate of Selected Trace Elements and Nutrients in Boulder Reservoir, Boulder, Colorado, 1997-98	USGS	1999	Boulder Reservoir	Metals, General Water Quality	N	Boulder Creek Watershed
24	Analysis of Modeling Results for Boulder Reservoir, 2003	Wiliam Lewis	2004	Boulder Reservoir	Drinking Water Supply, Water Treatment	Y	Boulder Creek Watershed
25	Studies of Travel Time, Short-Circuiting, Mixing, and Withdrawal Depth for Water of the Boulder Feeder Canal and Boulder Reservoir	William Lewis, James Saunders	2004	Boulder Reservoir, Boulder Feeder Canal	Drinking Water Supply, Water Treatment	Y	Boulder Creek Watershed
26	Eutrophication of Reservoir on the Colorado Front Range	Biran Gelder, Jim Loftis, Marci Koski, Brett Johnson, Laurel Saito	2003	Horsetooth Reservoir, Carter Lake	Nutrients, Algal Productivity, Trophic Status	Y	CBT General
27	Water Quality and Trend Analysis of Colorado-Big Thompson System Reservoirs and Related Conveyances, 1969 through 2000	USGS	2003	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir	General Chemistry, Nutrients, Metals	Y	CBT General
28	Physical, Chemical and Biological Attributes of Western and Eastern Slope Reservoir, Lake and Flowing Water Sites on the C-BT Project 2005-2007: Lake Granby, Grand Lake, Shadow Mountain Reservoir, Horsetooth Reservoir, Carter Lake	Davine Lieberman, USBR	2008	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir	Nutrients, Algae Blooms, Secchi, Operations	Y	CBT General
29	Analysis of Water Quality Data and Sampling Programs at Selected Sites in Northern-Central Colorado	USGS	1990	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Upper Colorado River	Water Quality Monitoring	Y	CBT General
30	Summary Report Benthic Macroinvertebrate Biomonitoring Program, Fall 2008	David Rees	2009	Upper Colorado River, South Platte Tributaries	Aquatic Life, Macroinvertebrates	Y	CBT General
31	Northern Water 2007 Water Quality Report	Esther Vincent	2007		Nutrients, metals, general chemistry	Y	CBT General
32	Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring and Management	WHO	1999		Cyanobacteria	Y	Cyanobacteria
33	Assessment of Blue-Green Algal Toxins in Raw and Finished Drinking Water	AWWARF	2001		Cyanobacteria	N	Cyanobacteria
34	Determination and Significance of Emerging Algal Toxins (Cyanotoxins)	AWWARF	2007		Cyanobacteria	N	Cyanobacteria
35	Scientific Assessment of Freshwater Harmful Algal Blooms	Interagency Working Group	Unknown		Cyanobacteria	Y	Cyanobacteria
36	Water Quality of the Boulder Creek Watershed, Colorado	USGS	2003	Boulder Creek	General Water Quality, Emerging Contaminants	Y	Emerging Contaminants
37	Anthropogenic Organic Compounds in Source Water of Nine Community Water Systems that Withdraw from Streams, 2002-05	USGS	2008		Emerging Contaminants	N	Emerging Contaminants
38	Aquatic Life Criteria for Contaminants of Emerging Concern - Part I General Challenges and Recommendations	OW/ORD Emerging Contaminants Workgroup	2008		Emerging Contaminants	Y	Emerging Contaminants
39	Endocrine-Disrupting Chemicals	The Endocrine Society	2009		Emerging Contaminants	Y	Emerging Contaminants

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40	Food Web Changes over Fourteen Years Following Introduction of Rainbo Smelt in to a Colorado Reservoir	Brett Johnson, John Goettl, CSU	1999	Horsetooth Reservoir	Foodweb, Aquatic Life	Y	Fisheries and Foodweb
41	Fish and Fisheries Management in Lakes and Reservoirs	USEPA	1993		Foodweb, Aquatic Life	Y	Fisheries and Foodweb
42	Ecological Integrity and Western Water Management: A Colorado Perspective	Alan Covich, William Clements, Kurt Fausch, John Stednick, John Wilkings-Wells, Steven Abt, CSU	1995		Foodweb, Aquatic Life	Y	Fisheries and Foodweb
43	Stocking Piscivores to improve Fishing and Water Clarity: a Synthesis of the Lake Mendota Biomanipulation Project	Lathrop, Johnson, Gelsgang, Carptenter, Hrabik, Kitchell, magnuson, Rustam, Stewart	2002		Foodweb, Aquatic Life	Y	Fisheries and Foodweb
44	Fraser River Watershed, Colorado - Assessment of Available Water-Quantity and Water-Quality Data through Water Year 1997	USGS	1999	Fraser River	General Chemistry, Nutrients, Organic Compounds, Metals	Y	Fraser River
45	Streamwater Quality at Selected Sites in the Fraser River Basin, Grand County, Colroado, Water Years 1991-2000	USGS	2003	Fraser River	General Water Quality	Y	Fraser River
46	Groundwater Quality Assessment of Selected Wells in the Fraser River Watershed, Colorado, August 1998	USGS	Jan 1, 2000	Fraser River	General Chemistry	Y	Fraser River
47	Erosion and Sediment Control for Construction Activities - Guidance Manual	Kevin Vecchiarelli	Spring 2005	Fraser River	Erosion, Sedimentation, Mitigation	Y	Fraser River
48	Water Quality Characteristics and Ground Water Quantity of the Fraser River Watershed, Grand County, Colorado, 1998-2001	USGS	Unknown	Fraser River	General Chemistry, Radon	Y	Fraser River
49	The Cache La Poudre River, Colorado, as a Drinking-Water Sources	USGS	2005	Cache La Poudre River	General Water Quality, Emerging Contaminants	Y	General Water Quality
50	Trace Elements in Streambed Sediment and Fish Liver at Selected Sites in the Upper Colorado River Basin, Colorado, 1995-96	USGS	1998	Colorado River	Metals, Sediments	Y	General Water Quality
51	Analysis of Ground-Water-Quality Data of the Upper Colorado River Basin, Water Yeasr 1972-92	USGS	1998	Colorado River	Groundwater	Y	General Water Quality
52	Water Quality in the Upper Colorado River Basin 1996-98	USGS	2000	Colorado River	General Water Quality	Y	General Water Quality
53	Water Quality at Basic Fixed Sites in the Upper Colorado River Basin National Water Quality Assessment Study Unit, Cotober 1995-September 1998	USGS	2000	Colorado River	General Water Quality	Y	General Water Quality
54	Algal Data from Selected Sites in the Upper Colorado River Basin, Colorado, Water Years 1996–97	USGS	2001	Colorado River	Algae Productivity	Y	General Water Quality
55	Probable Effects of the Proposed Sulphur Gulch Reservoir on Colorado River Quantity and Quality near Grand Junction, Colorado	USGS	2004	Colorado River	General Water Quality	Y	General Water Quality
56	Forests and Water: A State-of-the Art Review for Colorado	Lee H. MacDonald, John Stednick, CSU	2003	Fraser River	Forest Management, Erosion, Water Yield, Water Quality	Y	General Water Quality
57	Collaborative Approach to Selenium Issues in Western Colorado	Mike Baker, USBR	Jun 1, 2004	Lower Colorado River	Selenium	N	General Water Quality
58	Selenium in Western Colorado - Why Should You Care?	Unknown	Unknown	Lower Colorado River	Selenium	N	General Water Quality

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59	Water Quality and Best Management Practices in the Lower South Platte River Basin	Mahdi Al Kaisi	1998	Lower South Platte	Agricultural BMPs, Salinity, Fertilizer	Y	General Water Quality
60	Water Quality in Alluvial Aquifers of the Southern Rocky Mountain Physiographic Province, Upper Colorado River Basin, Colroado, 1997	USGS	2000	Rocky Mountains	Groundwater	Y	General Water Quality
61	Water Quality Assessment of the South Platte River Basin, Colorado, Nebraska and Wyoming - Analysis of Available Nutrient, Suspended-sediment, and Pesticide Data, Water Years 1980-82	USGS	1995	South Platte River	Nutrients, Suspended Sediments, Pesticides	Y	General Water Quality
62	Effect of Urban Development on Stream Ecosystems along the Front Range of the Rocky Mountains, Colorado and Wyoming	USGS	2006	South Platte Tributaries	General Water Quality	Y	General Water Quality
63	Water Quality Assessment of the South Platte River Basin, Colorado, Nebraska and Wyoming - Environmental Setting and Water Quality of Fixed Sites, 1992-95	USGS	1998	South Platte River	General Water Quality	Y	General Water Quality
64	Water Quality in the South Platte River Basin, Colorado, Nebraska and Wyoming, 1992-95	USGS	1998	South Platte River	General Water Quality	Y	General Water Quality
65	Methods to Identify Changes in Background Water-Quality Conditions Using Dissolved-Solids Concentrations and Loads as Indicatoirs, Arkansas River and Fountain Creek, in the Vicinity of Pueblo, Colorado	USGS	2004		General Water Quality, Dissolved-Solids	Y	General Water Quality
66	ARNF Watershed Assessment	USFS	2009		Forest Management	Y	General Water Quality
67	Memo on Foodweb dynamics in Horsetooth and Carter Reservoir and Water Quality Parameters	Unknown (Possibly Brett Johnson)	2000	Horsetooth	Foodweb, Zooplankton	N	Horsetooth and Carter Lake
68	Horsetooth Reservoir Preliminary Limnological Assessment	Ecological Research Associates	Jan 1, 1995	Horsetooth	Dissolved Oxygen, Manganese, Monitoring	Y	Horsetooth and Carter Lake
69	Horsetooth Reservoir 1996 Water Quality Conditions	Ecological Research Associates	Jul 1, 1998	Horsetooth	Foodweb,Total Organic Carbon, Natural Oprganic Matter, Turbidity, Nutrients, Trophic Status, Operation, Dissolved Oxygen	Y	Horsetooth and Carter Lake
70	Final Report: Ecosystem Monitoring during Horsetooth Reservoir Refilling	Brett Johnson,Justin Butteris, Michael Dodrill, CSU	Feb 1, 2005	Horsetooth	Foodweb, Zooplankton, Operations, Phytoplankton, Aquatic Life	Y	Horsetooth and Carter Lake
71	Physical, Chemical and Biological Characteristics of Horsetooth Reservoir, Fort Collins, Colorado (2004-2005)	Davine Lieberman, USBR	Apr 1, 2005	Horsetooth	Phytoplankton, Zooplankton, Algae Blooms, Dissolved Oxygen, Total Organic Carbon, Operations	Y	Horsetooth and Carter Lake
72	Horsetooth Reservoir Water Balance and TOC Evaluation: Data Inventory and Modeling Assessment	Al Paquett, CH2MHill, Trent Biggs and Alaa Aly, Intera	Nov 1, 2006	Horsetooth	Modeling, Total Organic Carbon, Operations	Y	Horsetooth and Carter Lake
73	Technical Memo: 2008 Horsetooth Reservoir Geosmin Episode	Judy Billica, Fort Collins Water Utility	May 1, 2009	Horsetooth	Geosmin, Water Treatment	N	Horsetooth and Carter Lake
74	Potential Effects of Low Dissolved Oxygen Levels on the Foodweb of Horsetooth Reservoir	Benjamin Felt, CSU	Summer 2006	Horsetooth	Dissolved Oxygen, Aquatic Life, Zooplankton	N	Horsetooth and Carter Lake
75	Top-down Influences on Water Quality in Front Range Reservoirs	Brett Johnson, Joshua Hobgood, CSU	2000	Horsetooth, Cache La Poudre	Foodweb, Zooplankton, Operations, Nutrients	Y	Horsetooth and Carter Lake

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76	Characterization of Dissolved Organic Matter in Colorado Drinking Water Sources and Treatment Plants of the Upper Cache La Poudre River, Horsetooth Reservoir and Associated Components of the Colorado-Big Thompson Project - Study Plan	Mel Suffet	Aug 1, 2007	Horsetooth, Cache La Poudre	Dissolved Organic Matter, Dinsinfection Byproducts	N	Horsetooth and Carter Lake
77	Zooplankton Dynamics at Horsetooth and Carter Reservoirs	Brett Johnson, brian Graeb, CSU	2000	Horsetooth, Carter Lake	Foodweb, Zooplankton, Operations, Nutrients	N	Horsetooth and Carter Lake
78	Horsetooth and Carter Lake Reservoirs Water Quality Comparisons	Alan Jassby and Charles Goldman, Ecological Research Associates	Oct 1, 1999	Horsetooth, Carter Lake	Operations, Algae Blooms, Phytoplankton, Zooplankton, Dissolved Oxygen, Manganese, Iron, Total Organic Carbon, Natural Organic Matter, Aquatic Life, Foodweb	Y	Horsetooth and Carter Lake
79	Summary of Manganese Control Issues Associated with Treatment of Horsetooth Reservoir Water	William Knocke, W. Curtis, Virginia Tech	1993	Horsetooth	Water Treatment, Manganese	N	Horsetooth/Cache La Poudre Water Treatment
80	In-Plant Experience with Chlorine Dioxide and Manganese Removal: A Case Study at Soldier Canyon Water Treatment Plant	Thomas Ulman, Bob Reed	Apr 1, 1996	Horsetooth	Manganese, Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
81	The Use of CO2 and Lime for Corrosion Control: Practical Aspects of Operations	Kevin Gertig, Ken Carlson, Fort Collins Water Utility	1994	Horsetooth, Cache La Poudre	Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
82	Getting a Jump on the Information Collection Rule: Plant Scale Characterization of NOM and the Relationship to DBP Formation	Ken Carlson, Keith Elmund, Kevin Gertig	1994	Horsetooth, Cache La Poudre	Total Organic Carbon, Water Treatment, Disinfection Byproducts, Natural Organic Matter	N	Horsetooth/Cache La Poudre Water Treatment
83	The Relationship of Speciation to Iron and Manganese Removal Strategies	Ken Carlson, Kevin Gertitg, Fort Collins Water Utility, William Knocke, Virginia Tech	1994	Horsetooth, Cache La Poudre	Water Treatment, Manganese	N	Horsetooth/Cache La Poudre Water Treatment
84	Oxidation of Dissolved Manganese in Natural Waters	Dean Gregory, Ken Carlson, Fort Collins Water Utility	1996	Horsetooth, Cache La Poudre	Water Treatment, Manganese, Total Organic Carbon	N	Horsetooth/Cache La Poudre Water Treatment
85	The Efficacy of Pre Ozonation and Enhanced Coagulation for the Treating Low Alkalinity, High Color Water	Ken Carlson, Dean Gregory, Sarah MacMillan, Fort Collins Water Utility	1996	Horsetooth, Cache La Poudre	Water Treatment, Total Organic Carbon	N	Horsetooth/Cache La Poudre Water Treatment
86	Manganese Oxidation with Chlorine Dioxide	Rovert Hoehn, Virginia Tech, Kevin Gertig, Dean Gregory, Fort Collins Water Utility, Aaron Rosenblatt, CDG Technology	1998	Horsetooth, Cache La Poudre	Water Treatment, Manganese	N	Horsetooth/Cache La Poudre Water Treatment
87	A Pilot Plant Study to Compare the Performance of Dual and Mixed Media Declining Rate Filters	Judy Billica, Dean Gregory, Kevin Gertig, Fort Collins Water Utility	1999	Horsetooth, Cache La Poudre	Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
88	Optimization of a Coagulation Process to Treat High TOC Low Alkalinity Water and its impact on Filtration Performance	Judy Billica, Kevin Gertig, Fort Collins Water Utility	2000	Horsetooth, Cache La Poudre	Total Organic Carbon, Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
89	Carbon Dioxide-enhanced Alum Coagulation	Kevin Gertig, Ben Alexander, Keigh Elmund, Grant Jones, Fort Collins Water Utility	Sep 1, 1993	Horsetooth, Cache La Poudre	Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
90	A Utility's Experience Using a Pilot Plant to Meet the Challenges of the 90's	Kevin Gertig, Michael Smith, Keith Elmund, Ken Carlson, Fort Collins Water Utility	Sep 1, 1996	Horsetooth, Cache La Poudre	Water Treatment, Manganese	N	Horsetooth/Cache La Poudre Water Treatment
91	Optimizing Treatment through Iron and Manganese fractionation	Ken Carlson, kevin Gertitg, Fort Collins Water Utility, William Knocke, Virginia Tech	Apr 1, 1997	Horsetooth, Cache La Poudre	Water Treatment, Manganese	N	Horsetooth/Cache La Poudre Water Treatment

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92	Forms and Sources of Total Organic Carbon	Kevin Gertig, Judy Billica	May 1, 2000	Horsetooth, Cache La Poudre	Total Organic Carbon, Water Treatment	N	Horsetooth/Cache La Poudre Water Treatment
93	1999 Drinking Water Quality Policy Annual Report	Lois Rellergert, Fort Collins Water Utility	May 1, 2000	Horsetooth, Cache La Poudre	Source Water Protection	N	Horsetooth/Cache La Poudre Water Treatment
94	Zebra Mussel Control Handbook for Facility Operators. First Edition	Shawn Boelman, Frank Neilson, Elba Dardeau, Thomas Cross	1997		Mussels	Y	Mussels
95	Assessment of the Potential Impact of Invasive Mussels to Water and Power System Facilities and Structures of the following Facilities: East Portal Reservoir, Marys Lake and Powerplant, Pole Hill Afterbay and Powerplant, Pinewood Reservoir, Carte Lake, Horsetooth Reservoir and Green Mountain Reservoir of the Colorado-Big Thompson	Renata Claudi, Tom Prescott	2009		Mussels	Y	Mussels
96	Assessment of the Potential Impact of Invasive Mussels to Water and Power System Facilities and Structures and Recommendations for Control - Willow Creek Reservoir, Granby Reservoir, Shadow Mountain Reservoir, Grand Lake and Lake Estes,	Renata Claudi, Tom Prescott	2009		Mussels	Y	Mussels
97	Sources and Loads of Nutrients in the South Platte River, Colorado and Nebraska, 1994-95	USGS	1996	South Platte River	Nutrients	N	Nutrients General
98	Nitrogen Concentrations in River Draining Native, Urban and Agricultural Ecosystems in the Front Range of Colorado	Laura Stroup, Jason Kaye, CSU	2001	South Platte Tributaries	Nutrients	N	Nutrients General
99	Typical Water Quality Values for Florida's Lakes, Streams ans Estuaries	Mark Friedemann, Joe Hand	1989		Nutrient Criteria	Y	Nutrients General
100	Environmental Thresholds for Nutrients in Streams and Rivers of the Colorado Mountain and Foothills	William Lewis, James McCutchan, USEPA	2005		Nutrient Criteria	Y	Nutrients General
101	Application of Nutrient-Saturation Concept to the Control of Algal Growth in Lakes	William Lewis, James Saunders and James McCutchan	2007		Nutrients, Algal Productivity	Y	Nutrients General
102	Nutrient and Suspended-Sediment Trends in the Missouri River Basin, 1993-2003	USGS	2007		Nutrients	Y	Nutrients General
103	Agricultural Practices in 9 States Contribute Majority of Excessive Nutrients to the Northern Gulf of Mexico	USGS	2008		Nutrients	Y	Nutrients General
104	Nutrient Trends in Streams and Rivers of the united States, 1993-2003	USGS	2009		Nutrients	Y	Nutrients General
105	Clean Water Act Nutrient Standards	Environment Reporter	2009		Nutrient Criteria	Y	Nutrients General
106	Incorporating Uncertainty into the Ranking of Sparrow Model Nutrient Yields from Mississippi/Atchaefalaya River Basin Watersheds	Dale Robertson, Gregory Schwarz, David Saad, Richard Alexander	2009		Nutrients	Y	Nutrients General
107	Taste and Odor Algae Impacts on the City of Loveland	USBR	2004		Algal Productivity, Taste and Odor	Y	Taste and Odor
108	Water Quality Monitoring Technical Guidebook	The Oregon Plan for Salmon and Watersheds	1999		Temperature Monitoring	Y	Temperature
109	Protocol for Placement and Retrieval of Temperature Data Loggers in Idaho Streams	Donald Zaroban	2000		Temperature Monitoring	Y	Temperature

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110	New approaches for monitoring stream temperature: airborne thermal infrared remote sensing	Russell Faux, Henry Lachowski and Paul Maus, Christian Torgersen, Mattew Boyd	2001		Temperature Monitoring	Y	Temperature
111	Measuring Stream Temperature with Digital Data Loggers: A User's Guide	Jason Dunham, Gwynne Chandler, Bruce Rieman, Don Martin	2005		Temperature Monitoring	Y	Temperature
112	Stream Temperature Protocol Water Quality Monitoring Guidebook				Temperature Monitoring	Y	Temperature
113	An Introduction to the Limnology of Northern Colorado	Robert Pennak	1941	Grand Lake	Clarity, trophic status, nutrients, algal productivity	Y	Three Lakes
114	Diurnal Movements of zooplankton Organisms in Some Colorado Mountain Lakes	Robert Pennak	1944	Grand Lake	Clarity, Zooplankton	Y	Three Lakes
115	Grand Lake 104(b) (3) Stormwater Project 1999-2001 Report	Joni Nuttle, WQCD	2002	Grand Lake	Stormwater, General Water Quality	Y	Three Lakes
116	Comparative Limnology of Eight Colorado Mountain Lakes	Robert Pennak	Jul 1, 1955	Grand Lake	Secchi, Algal Productivity, Dissoled Oxygen, Trophic Status	Y	Three Lakes
117	Identification of Potential Sediment Sources in the Kawuneeche Valley Using a Geographic Information System	Terrence Toy, Donna Ryder, David Longbrake, AWRA	Mar 1, 1993	North Fork of the Colorado River	Erosion, Sedimentation, Shadow Mountain Reservoir Delta	Y	Three Lakes
118	2008 Shadow Mountain Reservoir Aquatic Weed Ground Truthing Survey	David Sineros	2008	Shadow Mountain Reservoir	Aquatic Weeds	Y	Three Lakes
119	2009 Shadow Mountain Reservoir Aquatic Weed Ground Truthing Survey	David Sisneros	2009	Shadow Mountain Reservoir	Aquatic Weeds	Y	Three Lakes
120	Sedimentation Study of Araphao National Recreation Area and Vicinity	Dave Rosgen, USFS	Apr 1, 1983	Shadow Mountain Reservoir	Shadow Mountain Reservoir Delta, Sedimentation Transport and Mitigation, Aquatic Weeds	Y	Three Lakes
121	Wetland Delineation Report - Shadow Mountain Lake Pine Beach Recreation Area Grand County, CO	Darcy Tiglas, Pinyon Environmental Engineering Resources	Nov 1, 2000	Shadow Mountain Reservoir	Shadow Mountain Reservoir Delta, Aquatic Weeds, Wetlands	N	Three Lakes
122	Biological Baseline Report - Shadow Mountain lake Pine Beach Recreation Area Grand County	Darcy Tiglas, Pinyon Environmental Engineering Resources	Nov 1, 2000	Shadow Mountain Reservoir	Aquatic Life, Wildife Habitat, Sedimentation Mitigation	Y	Three Lakes
123	Shadow Mountain Lake Delta Analysis, CB470 Senior Project	Caleb Barclay, Dr Luis Garcia	Nov 1, 2000	Shadow Mountain Reservoir	Delta Mapping, Sedimentation Rate and Mitigation	Y	Three Lakes
124	Shadow Mountain Lake Restoration Project	CDPHE, HDR	Jun 1, 2003	Shadow Mountain Reservoir	Shadow Mountain Reservoir Delta, Restoration, Sedimentation, Mitigation	Y	Three Lakes
125	A Survey of Aquatic Plants in Shadow Mountain Reservoir	David Sisneros and Chris Holdren, Technical Service Center, USBR	Mar 1, 2005	Shadow Mountain Reservoir	Aquatic Weeds assessment, Aquatic Weed Control recommendations	Y	Three Lakes
126	Impact of the 2006 Shadow Mountain Drawdown to Control Aquatic Plants	David Sisneros, Technical Service Center, USBR	Feb 1, 2008	Shadow Mountain Reservoir	Aquatic Weeds, assessment of drawdown	Y	Three Lakes
127	Algae Control Cooperation Memo	C.N. Feast II	1954	Shadow Mountain Reservoir, Grand Lake	Algae blooms, Taste and Odor, Algae Control, Aquatic Life	Y	Three Lakes
128	Algae Control in the Grand Lake Area, Report of the Technical Subcommittee to the Algae Committee	John Maletic, USBR, Robert Massey, Greeley Water Works, W.D. Klein, Colorado Game and Fish Commission	Jun 1, 1954	Shadow Mountain Reservoir, Grand Lake	Algae Blooms, Algae Control, Aquatic Life	Y	Three Lakes
129	Report on Grand Lake and Shadow Mountain Lake, Grand County Colorado, Working Paper No 770	USEPA Region VIII	Jul 1, 1977	Shadow Mountain Reservoir, Grand Lake	Nutrient loading, Trophic Status, Point Source discharge, Non Point Source, Nutrient Control	Y	Three Lakes

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130	Three Lakes Water Quality Assessment	Robert Ray, NWCCOG	1998	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrients, Algal Productivity, Trophic Status	Y	Three Lakes
131	Atmospheric Deposition of Nutrients, Pesticides and Mercury in Rocky Mountain National Park, Colorado, 2002	USGS	2002	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nitrogen Deposition, Nutrients	Y	Three Lakes
132	Three Lake Water-Quality Model Documentation	Hydrosphere Resource Consultants	2008	Shadow Mountain Reservoir, Grand Lake, Lake Granby	General Water Quality, nutrients, algal productivity, trophic status, clarity, dissolved oxygen	Y	Three Lakes
133	Water Quality Conditions in Grand Lake, Shadow Mountain Lake and Lake Granby	USEPA Pacific Northwest Region	Dec 1, 1970	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Pollution Prevention, Water Quality Assessment in lakes and tributaries, Nutrient Loading, Dissolved Oxygen, Secchi, Algal Productivity	Y	Three Lakes
134	Water Quality Study Grand Lake, Shadow Mountain Lake and Lake Granby	USEPA Region VIII	Jul 1, 1977	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrient loading, Point Source discharge, Non Point Source, Nutrient Control, Algae Blooms, Dissolved Oxygen, Trophic Status, Aquatic Weeds, Bacterial Contamination	Y	Three Lakes
135	Analysis of Water Quality Effects on Three Lakes Windy Gap Project	Dames & Moore	Nov 1, 1977	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrients Loading	Y	Three Lakes
136	Potential Impact of Windy Gap Diversions on the Productivity of the Three Lakes System	J.W. Yahnke, USBR	Oct 1, 1978	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Algae blooms, Secchi, Nutrient Loading, Trophic Status	Y	Three Lakes
137	Report Water Quality Impact Study Windy Gap Project	Dames & Moore	Oct 1, 1979	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrients, Point Source Discharges, Trophic Status	Y	Three Lakes
138	Potential Impact on Trophic State and Algal Standing Crop of the Three Lakes System due to Windy Gap diversions	J.W. Yahnke, USBR	Feb 1, 1981	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrient loading, Trophic Status, Algae Blooms, Operations	Y	Three Lakes
139	An Assessment of Information on Water Quality in Lake Granby, Shadow Mountain Reservoir and Grand Lake	William Lewis, Jr	Apr 1, 1992	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrient Loading, Sediment Transport, Operations, Drawdowns, Aquatic Life	Y	Three Lakes
140	Three Lakes Clean Lakes Watershed Assessment Final Report	Hydrosphere Resource Consultants	Dec 1, 2003	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrients, Algae Blooms, Secchi, Trophic Status, Nutrient Sources, Mitigation, Recommendations	Y	Three Lakes
141	Scoping Study Three Lake Water Quality, Grand County Colorado	McLaughling Rincon	May 1, 2006	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Mitigation, Bypass Flows, Pipeline	Y	Three Lakes
142	Grand County Zoning Regulations, Section 14.5	Grand County Zoning and Planning	May 1, 2009	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Planning and Zoning Regulations specific to Three Lakes area	Y	Three Lakes
143	Preliminary Assessment of Nutrients and Nutrient-Related Concerns in the C-BT Watershed	Ben Alexander	May 1, 2004	Shadow Mountain Reservoir, Grand Lake, Lake Granby	Nutrients, Total Organic Carbon, Taste and Odor, Cyanobacteria, Operations	Y	Three Lakes

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144	Comparative Limnology of Colorado-Big Thompson Project Reservoirs and Lakes	Wesley Nelson	1971	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir	Algae Blooms, Phytoplankton, Trophic Status, Secchi, Zooplankton, General Chemistry	Y	Three Lakes
145	Phytoplankton Nutrient Limitation in Colorado Mountain Lakes	Donald Morris, William Lewis	1988		Nutrients, phytoplankton, algal produtivity	Y	Three Lakes
146	Secchi Disk Science" Visual Optics of Natural Waters	Rudolph Preisendorfer	1986		Clarity, Secchi	Y	Transparency
147	Limnology and Trophic Status of Lower Echo Lake, Upper Lake, and Fallen Leaf Lake	John Reuter, Mark Palmer, Charle Goldman	1996		Clarity, Nutrients	Y	Transparency
148	A Quantitative Evaluation of Factors Controlling Transparency in Lake Dillon, Colorado	William Lewis, James Saunders	1999		Clarity	Y	Transparency
149	Use of Viewer Box in Secchi Disk Measurements	David Smith, Creighton Hoover	1999		Clarity, Secchi	Y	Transparency
150	Comparison of Methods for mMeasuring Visual Water Clarity	Ashley Steel, Steve Neuhausser	2002		Clarity, Secchi	Y	Transparency
151	Nutrient Concentrations in Upper and Lower Echo Fallen Leaf, Spponer and Marlette Lakes and Associated Outlet Streams, California and Nevada, 2002-03	USGS	2004		Clarity, Secchi, nutrients	Y	Transparency
152	Scientists See Progress in Reintroduction of Lahontan Cutthroat Trout to Fallen Leaf Lake	John Cobourn, Heather Segale	2005		Clarity, Aquatic Life	Y	Transparency
153	A Simulation Model of Land-Use Change in the Lake Tahoe Basin of California and Nevada, as Used in a Decision-Support System	Mark Hessenflow, David Halsing	2008		Clarity, nutrients, sediments	Y	Transparency
154	The Secchi Dist and Our Eyes - Working Together to Measure Clarity of Our Lakes				Clarity, Secchi	Y	Transparency
155	2002 NWCCOG Regional Water Quality Management Plan - Volume 1 Policy Plan	NWCCOG	2002	Colorado River	Point Source Discharges, Non Point Source, Remediation, Standards, Land Use	Y	Upper Colorado River
156	2002 NWCCOG Regional Water Quality Management Plan - Volume 2 Water Quality Program Development	NWCCOG	2002	Colorado River	Point Source Discharges, Non Point Source, Salinity, SWAP, Land Use	Y	Upper Colorado River
157	Water Quality Protection Standards	NWCCOG	2002	Colorado River	Erosion, Sedimentation, Urban Runoff, Stormwater, Mitigation	Y	Upper Colorado River
158	Grand County Stream Management Plan Phase II Draft Report - Environmental and Water Users Flow Recommendations	Tetratech	Apr 1, 2008	Colorado River	Streamflow, Temperature, Aquatic Life, Attached Algae	Y	Upper Colorado River
159	NWCCOG 2002 Regional Water Quality Management Plan	NWCCOG	2002	Upper Colorado River	General Water Quality	Y	Upper Colorado River
160	Range Wide Status of Colorado River Cutthroat Trout, 2005	Christine Hirsch, Shannon Albeke, Thomas Nesler	2006	Upper Colorado River	Aquatic Life	Y	Upper Colorado River
161	A Review of Aquatic Invertebrate Studies and Fish Population Survey Data for the Colorado River in Middle Park, Colorado from 1980 through 2009: What Does It Tell Us?	Barry Nehring, John Ewert, Sherman Hebein, CDOW	2010	Upper Colorado River	Aquatic Life, Macroinvertebrates	Y	Upper Colorado River
162	Response to Concerns on Aquatic Systems Potentially Affected by the Construction and Operation of Windy Gap	Robert Erikson	Oct 1, 1980	Upper Colorado River	Macroinvertebrates	Y	Upper Colorado River
163	Benthic Field Studies for the Windy Gap Study Reach, Colorado River	Robert Erikson	Jun 1, 1983	Upper Colorado River	Macroinvertebrates	Y	Upper Colorado River

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164	Benthic Field Studies for the Azure Study Reach, Colorado River	Robert Erikson	Feb, 1983	Upper Colorado River	Macroinvertebrates	Y	Upper Colorado River
165	Aquatic Habitat Studies for the Azure Study Reach, Colorado River	Robert Erikson	Mar, 1983	Upper Colorado River	Macroinvertebrates, Aquatic Life	Y	Upper Colorado River
166	NWCCOG Water Quality Protection Standards	NWCCOG		Upper Colorado River	Erosion, Sediment	Y	Upper Colorado River
167	Windy Gap Firming Project - Lake and Reservoir Water Quality Technical Report	USBR, Great Plains Region	Aug 1, 2008	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir	Nutrients, Algae Blooms, Secchi, Trophic Status, Dissolved Oxygen, Mitigation, Nutrient Sources, Aquatic Life	Y	Windy Gap Firming Project
168	Windy Gap Firming Project Draft EIS - Executive Summary	USBR, Great Plains Region	Aug 1, 2008	Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir, Upper Colorado River	Nutrients, Algae Blooms, Secchi, Trophic Status, Dissolved Oxygen, Mitigation, Nutrient Sources, Aquatic Life, Temperature	Y	Windy Gap Firming Project
169	Windy Gap Firming Project - Stream Water Quality Modeling and Methods Report	USBR, Great Plains Region	May 1, 2008	Upper Colorado River, Willow Creek, South Platte Tributaries	Nutrients, Sediments, Attached Algae, Temperature	Y	Windy Gap Firming Project
170	Windy Gap Firming Project - Stream Water Quality Technical Report	USBR, Great Plains Region	May 1, 2008	Upper Colorado River, Willow Creek, South Platte Tributaries	Nutrients, Sediments, Attached Algae, Temperature	Y	Windy Gap Firming Project
171	Windy Gap Firming Project - Aquatic Resources Technical Report	USBR, Great Plains Region	Jan 1, 2010	Upper Colorado River, Willow Creek, South Platte Tributaries	Aquatic Life, Macroinvertebrates	Y	Windy Gap Firming Project
172	Factors Controlling Transparency in Grand Lake, Colorado	James McCutchan, CU	Apr 2, 2010	Grand Lake, Shadow Mountain	Transparency, Algae Blooms, Secchi, Sediments	Y	Three Lakes
173	A cost-benefit analysis of preventative management for Zebra and Quagga Mussels in the Colorado-Big Thompson System	Catherine Thomas	Jul 1, 2010	Willow Creek Reservoir, Windy Gap Reservoir, Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir, Boulder Reservoir	Mussels	Y	Mussels
174	Uncertainties in Data and Spurious Correlations Related to the Redfield Ratio	Lars Hakanson and Maria I. Stenstrom-Khalili	Jul 2, 1909		Nutrients, Nutrients Ratios	Y	Nutrients General
175	Water Quality of Willow Creek as affected by beetle-killed forests	J.D. Stednick, K.E. Condon and F. Ginter, Watershed Science Program Colorado State University	Jun 7, 2010	Willow Creek, Willow Creek Reservoir	Nutrients, Pine Beetle, TOC, THM	Y	Three Lakes
176	Report of Refined Analysis on Grand Lake Water Clarity	Mark Coleman	Apr 28, 2008	Grand Lake, Shadow Mountain	Transparency, Secchi, Chlorophyll a, Nutrients, Algae Blooms	Y	Three Lakes
177	Dr Boyer's comments on McCutchan's report	Dr Jean Marie Boyer, Hydros Consultants	Jul 3, 1909	Grand Lake, Shadow Mountain	Transparency, Secchi, Chlorophyll a, Nutrients, Aglae Blooms	Y	Three Lakes
178	An Assessment of Correlation Between Secchi Depth and Selected Water Quality Parameters in Grand Lake, Colorado	Rob Buirgy	Feb 20, 2008	Grand Lake, Shadow Mountain	Transparency, Secchi, Chlorophyll a, Nutrients, Aglae Blooms	Y	Three Lakes
179	2009 Horsetooth Reservoir Water Quality Monitoring Program Report	Judy Billica, Jill Oropeza	Sep, 2010	Horsetooth Reservoir	Dissolved Oxygen, Total Organic Carbon, General Chemistry	Y	Horsetooth and Carter Lake
180	Stream Management Plan Grand County, Colorado, Phase 3	Tetra Tech, Inc., Habitech, Inc, Walsh Aquatic Consultatns, Inc.	Aug, 2010	Upper Colorado River	Temperature, Aquatic Life, Periphyton	Y	Upper Colorado River

	Study Title	Author	Year	Feature	Keywords	Electronic Copy	Category
181	Ecological responses to nutrients in streams and rivers of the Colorado mountains and foothills	William M. Lewis, jr. and James H. Mccutchan, jr.	Aug, 2010		Nutrients, attached algae, periphyton, eutrophication, herbivory/grazing, invertebrates, nuisance algae	Y	Nutrients General
182	Memo on Review of Research Proposals on Whirling Disease from the Colorado Division of Wildlikfe and the Colorado Cooperative Fish and Wildlife Research Units	Bill Miller	Mar 1, 1997	Upper Colorado River	Whirling Disease	Y	Whirling Disease
183	Comments on Nehring et al. 2010	Bill Miller	Feb 1, 2010	Upper Colorado River	Aquatic Life, Macroinvertebrates	Y	Upper Colorado River
184	Analysis of Aggradation and Degradation below Proposed Windy Gap Reservoir, Colorado	Timothy J. Ward	May 1, 1981	Upper Colorado River	Sedimentation, sediment transport	Y	Upper Colorado River
185	Nutrients in the Nation's Streams and Groundwater: National Findings and Implications	Neil M. Dubrovsky and Pixie A. Hamilton	Sep, 2010		Nutrients	Y	Nutrients General
186	Technical Approaches for Setting Site-Specific Nutrient Criteria	William Warren-Hicks, Benjamin Parkhurst, Steven Bartell, Miles Smart, Water Environmnent Research Foundation	Jan 1, 2005		Nutrient Criteria	Y	Nutrients General
187	Guidance on Developing Nutrient Standards for Protecting Designated Uses of Water Bodies	Benjamin Parkhurst, William Warren-Hicks, Miles Smart	March, 2005		Nutrient Criteria	Y	Nutrients General
188	Disinfection By-Product/Algal Toxin Study	Clifford W. Callinan, P.E.	Sep, 2009		Algal Toxin, Disinfection By-Products	Y	General Water Quality
189	Estrogenic activity of US drinking waters: A relative exposure comparison	Benjamin Stanford, Shane Snyder, Rebecca Trenholm, Janie Holady, Brett Vanderford, AWWA	Dec 1, 2011		Emerging Contaminants	Y	Emerging Contaminants
190	The Effect of the Grand Ditch on the abundance of benthic invertebrates in the Colorado River, Rocky Mountain National Park	Jordan Clayton, Cherie Westbrooks, Georgia University	Apr 1, 2008	Colorado River	Macroinvertebrates, Sediments	Y	Three Lakes
191	Characterizing Temporal and spatial variability of watershed dissolved organic matter and disinfection byproduct formation with fluorescence spectroscopy	Katherine Morven , Helen Beggs	Jul, 2010	Horsetooth	Dissolved Organic Matter, Disinfection Byproducts	Y	Horsetooth and Carter Lake
192	Guidelines for Design and Sampling for Cyanobacterial Toxin and Taste-and-Odor Studies in Lakes and Reservoirs	Jennifer L. Graham, Keith A. Loftin, Andrew C. Ziegler, and Michael T. Meyer	2008		Cyanobacteria, Taste and Odor	Y	Cyanobacteria
193	Fort Collins Northern Integrated Supply Project ; Potential impacts to Water Treatment Operation	CH2MHill	Sep, 2006	Horsetooth, Glade	treatment, TOC, TTHMs, HAAs	Y	Horsetooth and Carter Lake
194	Fort Collins Northern Integrated Supply Project ; Water Quality Project - Operational Plan Overview	CH2MHill	Aug, 2006	Horsetooth, Glade	treatment, TOC	Y	Horsetooth and Carter Lake
195	Northern Integrated Supply Project: Glade Reservoir Water Quality Technical Memorandum (FINAL DRAFT)	CH2MHill	Sep, 2006	Horsetooth, Glade	treatment, TOC	Y	Horsetooth and Carter Lake
196	Responses of soil and water chemistry to mountain pine beetle induced tree mortality in Grand County, Colorado, USA	David W. Clow, Charles Rhoades, Jennifer Briggs, Megan Caldwell, William M. Lewis Jr.	May, 2011	Grand Lake, Shadow Mountain, Lake Granby	Pine beetle, nutrients, DOC	Y	Three Lakes
197	Monitoring to Determine Geosmin Sources and Concentrations in a Northern Colorado Reservoir	Judy Billica, Jill Oropeza, Keith Elmund	Aug, 2010	Horsetooth	geosmin, Water Treatment, algal productivity	Y	Horsetooth and Carter Lake
198	A Quantitative Evaluation of Factors Controling Transparency in Lake Dillon	Lewis, Saunders	Jul, 1999		transparency, clarity, suspended solids	Y	Transparency

	Study Title	Author	Year	Feature	Keywords	Electronic Copy	Category
199	Colorado-Big Thompson Nutrient Project Phase 1 Report	Nicole Seltzer, Tom Pitts	Dec, 2007	Windy Gap Reservoir, Shadow Mountain Reservoir, Grand Lake, Lake Granby, Carter Lake, Horsetooth Reservoir	Nutrients, algal productivity, cyanobacteria, algae control, taste and odor, sedimentation, transparency, water treatment, nutrient criteria	Y	CBT General
200	2010 Shadow Mountain Reservoir Aquatic Weed Ground Truthing Survey	David Sisneros	2010	Shadow Mountain Reservoir	Aquatic Weeds	Y	Three Lakes

APPENDIX

Senate Document 80

C-BT Project Maps

Alternatives Analysis Meeting Notes

Existing Watershed and Best Management Practices

Operations Summary

Literature Review and Water Quality Studies

Final Report of the External Review Panel

Grand Lake Operations and Management Study:

Final Report of the External Review Panel on the Draft Preliminary Alternatives Development Report for the Colorado-Big Thompson Project West Slope Collection System

On June 28, 2012, the three-member External Review Panel (Review Panel) participated in a teleconference with representatives of the Bureau of Reclamation, Grand County, the Northern Colorado Water Conservancy District (the Northern District), and TetraTech. The purpose of the teleconference was to discuss the July 2012 Draft Preliminary Alternatives Development Report (July Draft), which was prepared by the Eastern Colorado Area Office of the Bureau of Reclamation in consultation with Grand County, the Northern District, and TetraTech. Grand County, the Northern District, and the three members the Review Panel also provided comments on the July Draft. The purpose of this report is to summarize the final comments of the Review Panel, including comments on the four recommended alternatives.

1. *Main conclusions about the draft report*

The primary purpose of the July Draft is to determine whether it is appropriate to continue with development of alternatives for improvement of water clarity in Grand Lake, Colorado. Alternatives under consideration are subject to various constraints, including those related to water yield and power generation for the Colorado-Big Thompson (C-BT) Project, protection of aquatic life, and public acceptance. In the July Draft, four alternatives are recommended for further consideration: Alternative I (no Farr pumping, June – September), Alternative II (reduced Farr pumping, July – September; possibly in combination with Alternative I), Alternative III (bypass Grand Lake), and Alternative IV (bypass Grand Lake and Shadow Mountain Reservoir). The July Draft also lists potential solutions that are not evaluated

now but could be evaluated in the future, including modifications to the recommended alternatives (e.g., a floating pipeline) and options that could be used in combination with one of the recommended alternatives (e.g., oxygenation of Shadow Mountain Reservoir). In addition, potential solutions that have not yet been considered also could be evaluated in the future. The Review Panel believes that the overall conclusions presented in the July Draft are appropriate. Among the potential solutions now under consideration and based on available information, Alternative III is most likely to result in attainment of the proposed clarity standard for Grand Lake while also allowing for sufficient control over diversions, maintaining power generation, and meeting public acceptance. Alternatives I, II, and IV remain under consideration, but Alternatives I and II are less likely than Alternative III to meet the clarity goals for Grand Lake and Alternative IV may not offer sufficient operational flexibility due to the loss of storage capacity of Shadow Mountain Reservoir. Alternative IV also poses water quality problems that could be avoided with Alternative III (see below).

2. *Additional comments of the review panel*

For each of the alternatives that is considered in the July Draft, there is some uncertainty with respect to improvements in clarity, and some of the alternatives could have unwanted consequences for water quality in Grand Lake or elsewhere in the C-BT system. Maintenance of high water quality for deliveries to the East Slope is of particular concern, but some of the alternatives could have unanticipated effects on water quality in Grand Lake due to interactions between nutrient supply and water residence time.

Alternatives I and II: Alternatives I and II seek improvements in water clarity of Grand Lake through operational changes (no pumping or low rates of pumping, July - September). Compared with current operations conditions, these alternatives might produce slight

improvements in water clarity of Grand Lake during the summer months, but these alternatives may not result in attainment of the proposed clarity standard. Furthermore, increased water residence time during the growing season combined with nutrient enrichment from the reservoirs prior to the growing season could lead to more algal biomass during the summer months than currently is characteristic of Grand Lake. In order to meet the requirements for East Slope diversions, rates of pumping October – June would be higher than under current operations conditions. Thus, either of these alternatives could have unwanted effects on water quality for Grand Lake and diversions to the Adams Tunnel at some times of year.

Uncertainty in the effects of Alternatives I and II on clarity or other aspects of water quality originates partly from complex linkages between abiotic factors (e.g., nutrient concentrations, temperature, hydrologic residence time) and growth of phytoplankton in Grand Lake. During the summer months, pumping has been stopped experimentally for periods of a few weeks, and in 2011, abnormal hydrologic conditions resulted in no pumping from mid May through early September. Studies of water quality during these experimental stoppages and during 2011 have provided some information relevant to expected conditions with low pumping or no pumping for the summer months, but conditions during the brief stop-pump experiments and during 2011 are not fully analogous to the range of conditions that might occur across multiple years under Alternatives I or II. The effects of Alternatives I or II could be tested experimentally, however, through stop-pump or low-pump experiments that extend from July through September in multiple years (e.g., including wet and dry years). Although available information suggests that Alternative III is more likely to meet the proposed clarity standard than other alternatives under consideration, additional stop-pump experiments could demonstrate the viability of Alternatives I and II.

Alternatives III and IV: Alternatives III and IV would allow water from Granby Reservoir to bypass Grand Lake (III) or Shadow Mountain Reservoir and Grand Lake (IV) and would require diversion of water from the reservoirs to the Adams Tunnel through Grand Lake under unusual circumstances (e.g. supply canal failure).

Routing of water from Grand Lake: Routing of water from Grand Lake is important for Alternatives III and IV. Some variations on Alternatives III and IV would call for Grand Lake water outflow to be mixed with water from one or both reservoirs before being sent to the Adams Tunnel (e.g., via the channel between Grand Lake and Shadow Mountain Reservoir). Especially for algal biomass, this practice might offset the potential for Grand Lake water to sustain the current quality characteristics for water passing through the Adams Tunnel. The addition of water from Grand Lake to the two reservoirs probably would not reduce the amount of algal biomass through dilution in the blended Grand Lake/reservoir water. For example, residence times for water in Shadow Mountain Reservoir would at times allow full algal biomass development for the Grand Lake water, which presently does not occur because Grand Lake is rapidly flushed during the growing season. In other words, algal biomass in these lakes cannot be treated as a conservative characteristic for which calculations can be made easily for quality of blended water sources. Blending may cause the present biomass dilution in Grand Lake to disappear.

The best operational mode for disposition of water from Grand Lake is to ensure is that it is a discrete supply when it reaches the Adams Tunnel, i.e., it is not mixed with other water until it enters the tunnel. In this way, monitoring of the supply water for the Adams Tunnel will show the full benefit of the Grand Lake component of supply.

Hydraulic isolation of Grand Lake: Hydraulic separation of Grand Lake from out of

basin water sources is important. Entry of water through the connecting channel or by other means from sources outside the Grand Lake watershed could have surprisingly adverse effects on Grand Lake even though the quantities of water diverted in this manner might be minor from a hydrologic standpoint. When not used for large throughflow volumes, Grand Lake will be more sensitive to external nutrient supply than it is at present because its hydraulic residence time will be much longer. Residence time is relevant to potential for algal accumulation. Under present operations, short hydraulic residence times during the growing season caused by pumping suppress algal accumulation by stripping algae from the upper water column. For this reason, under present conditions the main contributor to suppression of transparency in Grand Lake is non-living particulate matter rather than algae. Separation of Grand Lake from the large throughflows of water from Shadow Mountain Reservoir (and Granby) will greatly reduce the influence of suspended non-living particulate matter on transparency. At the same time, however, the beneficial suppression of algal accumulation caused by rapid water removal from the surface of Grand Lake will no longer occur. Grand Lake is more likely to produce algal populations that use all of the available nutrients rather than being stripped from the water column before they have the opportunity to reach maximum abundance. Therefore, if Grand Lake is bypassed (Alternative III or IV), the dominant factor in the future for transparency for Grand Lake is likely to be algal biomass rather than non-living suspended particulate matter. In this case, the addition of even seemingly small amounts of water richer in nutrients than Grand Lake itself must be avoided, because the lake will respond fully to any such additions. Although any effect of watershed control of nutrients on algal growth in Granby and Shadow Mountain Reservoirs is likely to be small because of natural sources of phosphorus, control of nutrient sources within the Grand Lake watershed may have measurable benefits if Grand Lake is

bypassed. However, the lake also will need to be shielded from flows that might enter from the two reservoirs, unless some temporary and unusual emergency requires that this restriction be lifted.

Capture of water from North and East Inlets: Implementation of any operational scheme that involves direct capture of water from East Inlet or North Inlet for water en route to the Adams Tunnel (e.g. some versions of Alternative IV) may adversely change the water quality characteristics of Grand Lake. With its natural supplies intact and no pumping or diversions, the Grand Lake water balance will be dominated by flows originating from East Inlet and North Inlet. Water quality sampling shows that the water in these two streams is exceptionally free of nutrients and suspended solids. Nutrient supplies for these streams are near the minimum of all waters in Colorado. Other water will enter Grand Lake directly through much smaller streams or through subsurface flow. This water, which comes from low elevation and therefore has more contact with soil than the North and East Inlets, likely has higher concentrations of nutrients. The distinctions here are small because all of these water sources for Grand Lake are low in nutrients, but the higher elevation source likely is significantly lower in nutrients than the lower elevation source. In addition, human presence, although not grossly polluting the lake, likely produces small amounts of additional nutrients and suspended solids that reach the lake. With a natural hydrologic regime these effects will be greatly diminished by the entry of large amounts of water from the North and East Inlet. The North and East Inlets provide a large amount of dilution that counterbalances slightly richer sources of nutrients or suspended solids that originate naturally or from anthropogenic sources at lower elevation. Therefore, direct diversion of the North and East Inlet waters is undesirable and could undermine the goal of the clarity improvement project.

Potential for improvement in clarity: The clarity of Grand Lake with successful

execution of modified operations that isolate it hydrologically from other water sources and allow its natural water sources to remain intact is not entirely certain. An improvement in water quality is highly likely, but the lake will be operating under a new regime that involves algal populations and non-living suspended solids that are dictated by conditions in the Grand Lake watershed rather than by the large volumes of pumped water that now control conditions in the lake. Return to transparencies as high as nine meters as measured by Secchi depth, for example, cannot be confidently predicted. Nutrient sources in the watershed involving human activity are likely small but the relative importance of these sources will be magnified by increased hydraulic residence time. At present the local sources are insignificant because they are overwhelmed by external sources. In the future, they may be a significant part of the overall nutrient budget of the lake, even though they are small in a quantitative sense. If the transparency that ensues from hydrologic isolation of Grand Lake is unsatisfactory, analysis of small anthropogenic nutrient sources would be the logical first place to seek further improvement. The same would apply to suspended solids, which are mobilized by human activities.

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July 9, 2012