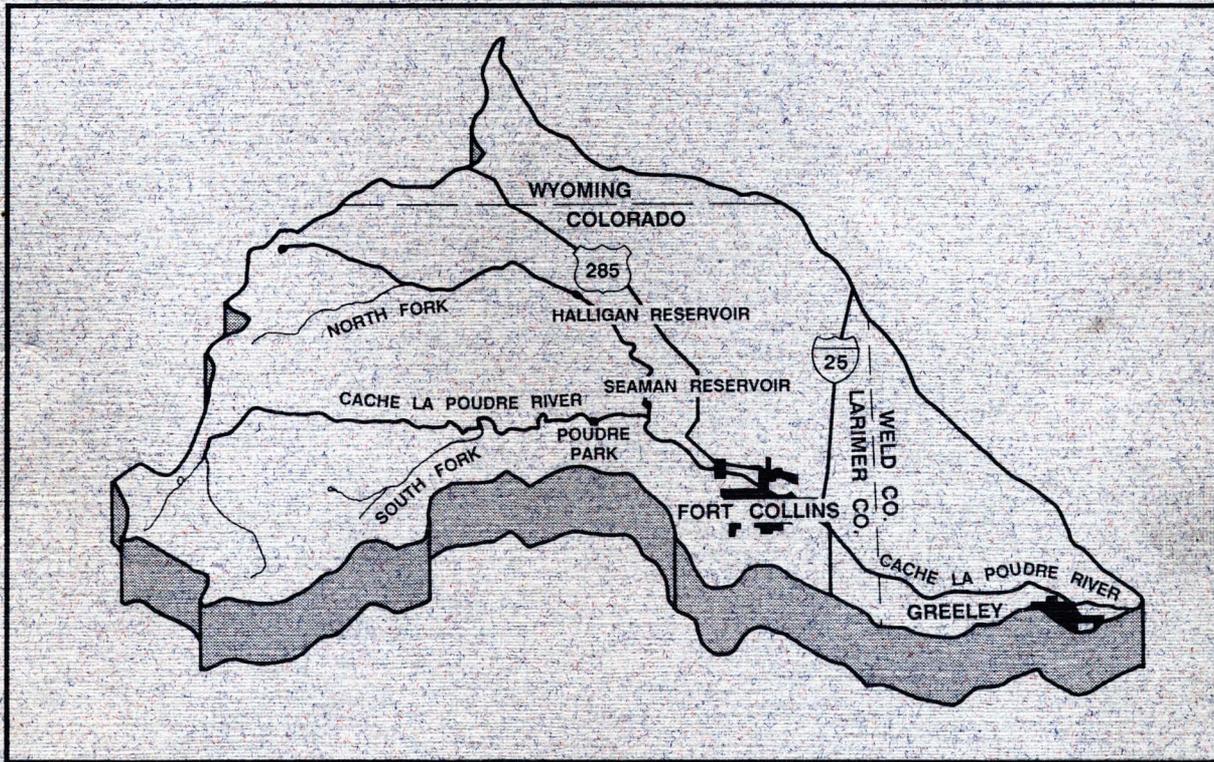


# Cache la Poudre Basin Study Extension

## Executive Summary



December 1990

**EXECUTIVE SUMMARY**

**CACHE LA POUFRE BASIN  
STUDY EXTENSION**

Prepared for:

**Colorado Water Resources & Power Development Authority**

Project Sponsor:

**Northern Colorado Water Conservancy District**

December, 1990

**Study Participants:**

- EBASCO Environmental  
formerly EnviroSphere Inc.  
and  
Aquatics Associates  
Centennial Archaeology, Inc.  
Outdoor Recreation Resources Associates  
Wildlife Management Consultants
- Harza Engineering Company  
and  
BBC, Inc.
- Northern Colorado Water  
Conservancy District

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## 1.0 INTRODUCTION

The Cache la Poudre Basin Study Extension was performed in response to an application submitted to the Colorado Water Resources and Power Development Authority (Authority) by the Northern Colorado Water Conservancy District (District). The purpose of the study was to refine the environmental, engineering, and economic analyses prepared during a basin-wide water resources investigation completed by the two agencies in January 1987. The initial basin study identified and evaluated potential structural and non-structural measures to provide for the efficient and environmentally sound development of water and hydroelectric power resources in the Cache la Poudre Basin. Following the completion of the study, it was determined that more definitive assessments were needed of the two alternative sites selected for a multiple-purpose reservoir on the mainstem of the Cache la Poudre River.

To facilitate implementation of the project, the District has proposed that the Cache la Poudre Project be divided into three separate and distinct stages. Each stage would be studied, evaluated, and implemented separately with the emphasis of the Basin Study Extension focused on Stage 1. The three stages are described as follows:

- Stage 1: The first stage would consist of a mainstem water storage reservoir to enhance water supplies for primarily municipal and industrial uses, and a conventional hydroelectric power plant. The mainstem reservoir would be located downstream of the community of Poudre Park and could be formed by constructing a dam two miles downstream of the confluence of the mainstem and North Fork of the Poudre River (the Grey Mountain Damsite), or by constructing a dam just below the confluence (the Poudre Damsite). When Stage 2 is implemented, the mainstem reservoir would also provide the means of diverting water by gravity through the Glade Reservoir Feeder Tunnel into storage in Glade Reservoir. When Stage 3 is implemented, the mainstem reservoir would also serve as the lowest of the two reservoirs needed for a pumped-storage hydroelectric power plant.
- Stage 2: The second stage would consist of Glade Reservoir which would be located in a natural depression known as the Hook and Moore Glade north of Ted's Place off the Poudre River. The facilities necessary to divert water from the Stage 1 mainstem reservoir, including the Glade Reservoir Feeder Tunnel, would also be incorporated in Stage 2.
- Stage 3: The third stage would consist of a pumped-storage hydroelectric project and associated transmission facilities. The power plant could be constructed at or below ground surface on the north shore of the

mainstem reservoir. As part of Stage 3, the Cache la Poudre Forebay Reservoir (up to 90,000 af of storage capacity) would be constructed near Grey Rock Mountain at an elevation about 1,400 feet higher than the mainstem reservoir, to serve as the upper reservoir for the pumped-storage project.

## 2.0 STUDY PROCESS

The Basin Study Extension was jointly managed by the Authority and the District. The Authority was responsible for contractual matters associated with the consultants' services and technical review of the consultants' work products. The District also provided technical review, performed hydrologic studies, and conducted the public involvement program.

The Basin Study Extension consisted of environmental, engineering, and economic assessments. Environmental investigations, conducted by Envirosphere Company, concentrated on the seven resource categories judged to have the greatest potential effect on overall project feasibility. The seven resource categories were aesthetic, aquatic, botanical, cultural, land use, recreational, and wildlife.

Engineering studies, conducted by Harza Engineering Company, concentrated on refining the previous engineering work. More specifically, the engineering consisted of reconfiguring the layout of Grey Mountain Dam as an arch dam structure, refining highway relocation layouts and costs, assessing flood control opportunities, evaluating conventional hydroelectric power generation, and updating construction cost estimates.

Hydrologic modeling performed by the District provided estimates of pre- and post-project flows in the Cache la Poudre Basin. It also included modeling potential water deliveries from the Colorado Big-Thompson (C-BT) and Windy Gap Projects which could be integrated with the proposed Stage 1 Cache la Poudre Project.

Economic assessments were prepared by BBC, Incorporated and provided information for consideration by potential project participants. The cost of the project was compared to the economic benefits of construction activities, enhanced water supplies, flood protection, hydroelectric power generation, and recreation.

Additionally, the feasibility of financing the proposed Stage 1 Project was evaluated.

### **3.0 ENGINEERING AND HYDROLOGIC ASSESSMENTS**

#### **3.1 ALTERNATIVE STAGE 1 RESERVOIR SITES**

Seven alternative plans for development of water supply and hydroelectric power in the Cache la Poudre River Basin were identified during the original Basin Study published in January 1987. These plans involved various water storage project locations, storage volumes, and configurations of pumped-storage hydroelectric power facilities. Alternative plans were evaluated in terms of technical and economic performance, as well as probable environmental effects and mitigation/enhancement opportunities. Based on these evaluations, two plans were recommended for further study. The primary difference between the two plans was that one plan included the Poudre Damsite and the other included the Grey Mountain Damsite for a multiple-purpose reservoir on the mainstem of the Cache la Poudre River.

The Basin Study Extension focused on Stage 1 of the project as discussed earlier. Therefore, all of the water supply alternatives from the Basin Study were re-evaluated in terms of their suitability to serve as part of a staged development for the overall Cache la Poudre Water and Power Project.

Figure 1, shows the potential water storage facilities identified in the Basin Study. The potential facilities were: Portal, Grey Mountain, Poudre, New Halligan, New Seaman, Rockwell, and Glade (with the Trailhead diversion dam on the river). Portal was included because it affords the maximum storage potential on the mainstem. Rockwell and New Seaman were included because a combination of storage at these two sites might eliminate the need for a dam on the mainstem of the Poudre River below Poudre Park. Similarly, Glade Reservoir (with the Trailhead diversion dam) was considered because of substantially smaller environmental effects on the mainstem of the Poudre River. New Halligan was included because of apparent low cost. However, a New Halligan Dam and Reservoir without another storage facility was not considered. The Halligan site is poorly located within the Basin from the standpoint of regional water management, because only regulation

of native storage flows on the North Fork can be achieved. Additionally, the estimated incremental yield of 7,000 af/yr is small in relation to the estimated yields provided by other alternatives.

Dredging existing plains reservoirs to recover storage capacity lost to sedimentation, was also considered. However, it was determined during the Basin Study that the cost of recovering lost storage capacity by dredging would exceed the cost of new reservoir storage by a factor of five or more, without including the costs to provide sufficient diversion capacity from the Poudre River to the enlarged plains reservoirs. Due to high cost, dredging is not a viable option.

Eight alternative plans were developed for a Stage 1 project, as shown in Table 3.1. Each plan includes a pumping station at Horsetooth Reservoir and a pipeline from Horsetooth to the proposed storage facility. In Plan 6, the pipeline extends from Horsetooth to New Seaman Reservoir and in Plans 7 and 8, from Horsetooth to Glade Reservoir. The pumping station and pipeline would convey water from the C-BT and Windy Gap Projects.

**TABLE 3.1**  
**Alternative Plans for Stage 1 Development**

<u>Plan No.</u>		<u>Dams and</u>
<u>Reservoirs</u>		<u>Active Storage</u> <sup>(1)</sup>
		(acre-feet)
1	Portal	265,000
2	Grey Mountain	187,000
3	Poudre	130,000
4A	Grey Mountain/Small New Halligan	187,000
4B	Grey Mountain/Large New Halligan	240,000
5	Poudre/New Halligan	183,000
6	Rockwell (Site C) and New Seaman	198,000
7	Glade with Trailhead	184,000
8	Glade with Trailhead/New Halligan	237,000

<sup>(1)</sup> Full storage at sites developed for water supply. No storage allocated for possible future pumped-storage addition.

The alternative plans described above were compared in terms of active storage, yield from native Cache la Poudre River flows and C-BT and Windy Gap imports, and estimated costs. A summary of the comparison of alternative plans is provided in Table 3.2.

**TABLE 3.2**  
**Comparison of Unit Yield Costs for Alternative Plans**

Plan	Unit Yield Cost <sup>(1)</sup> (\$/af)	Cost Rank <sup>(2)</sup>	Cost Factor <sup>(3)</sup>
1 Portal	853	4	1.14
2 Grey Mountain	800	2	1.07
3 Poudre	870	5	1.16
4A Grey Mountain/New Halligan	756 <sup>(4)</sup>	1	1.00
4B Grey Mountain/New Halligan	751 <sup>(4)</sup>	1	1.00
5 Poudre/New Halligan	839 <sup>(4)</sup>	3	1.12
6 Rockwell/New Seaman	871	6	1.16
7 Glade with Trailhead	1,560	8	2.08
8 Glade with Trailhead and New Halligan	1,380 <sup>(4)</sup>	7	1.84
9 Dredge Existing Reservoirs	ND	9	-

(1) Based on estimated annualized construction cost.

(2) Rank (low to high).

(3) Unit yield cost divided by unit yield cost for lowest cost plan (Plan 4B).

(4) Excludes cost of purchasing existing Halligan Dam and associated water rights.

All of the lowest cost plans (plans having a cost factor less than 1.10 in Table 3.2) involved a reservoir at the Grey Mountain site. After considering other factors as well as cost, further studies to define facility requirements and costs were concentrated on the Grey Mountain site. However, this does not preclude consideration of other potential sites during subsequent detailed feasibility studies. Also, certain of the engineering studies, particularly the Highway 14 relocation study, are directly applicable to any Stage 1 project involving storage on the mainstem Cache la Poudre River.

### 3.2 HYDROLOGIC MODELING

Stage 1 of the Cache la Poudre Project could store and deliver water from two primary sources: (1) native flows of the Cache la Poudre River and its tributaries, and (2) water from the C-BT and Windy Gap Projects. Therefore, accurate estimation of the individual and integrated yields from these water sources was an important aspect of the Basin Study Extension, along with estimation of pre- and post-project flows in the Poudre Basin.

The network simulation model MODSIM (MODSIMX, Version 2.51) developed at Colorado State University, was used for the hydrologic modeling for the Basin Study Extension. MODSIM operates on a monthly time step, but has the potential for analyzing weekly or daily time steps. It allocates water according to a priority list for meeting demands and filling storage for a system of reservoirs and river reaches.

Incorporation of the C-BT and Windy Gap water sources in the study required extensive geographical coverage for the hydrologic modeling. The modeled area included the Colorado River Basin from Grand Junction to the Continental Divide, and the Cache la Poudre and South Platte River Basins to the Nebraska state line. Figure 2 and its associated list of water demands illustrate the complexity of the computer model and the interrelated nature of the water supply systems in Colorado. The Final Report for the Basin Extension Study provides detailed documentation of the model's configuration, operating logic, input data, calibration, and output.

To determine the project's effects on river flows, it was necessary to first estimate the flows that would exist at various locations without the construction of the mainstem reservoir. To establish these preproject flows, computer simulations were prepared using 30 years (1954 through 1983) of historic flow data.

To estimate the safe annual yield from the proposed mainstem reservoir, and to establish maximum and minimum bounds for postproject flows, conservative assumptions were made regarding the development of conditional water rights in the Colorado River Basin. The safe annual yield for the Grey Mountain alternative under these conditions was estimated to be 41,000 acre-feet.

A separate postproject simulation for the Grey Mountain alternative using the MODSIM model was performed without the incremental contribution to safe annual yield due to diversions from the C-BT and Windy Gap Projects. This simulation resulted in a safe annual yield of 31,000 acre-feet from the Poudre River Basin only. Therefore, approximately 10,000 acre-feet of safe annual yield could be contributed by diversions from the C-BT and Windy Gap Projects.

### 3.3 PROJECT DESIGNS

Major features of a Stage 1 mainstem reservoir project would be similar regardless of the damsite considered. Further discussions in this section relate directly to the Grey Mountain alternative, although final selection of the damsite for the Stage 1 development has not been made.

Major features of the Grey Mountain alternative for the Stage 1 project would include:

1. Grey Mountain Dam (currently configured as a concrete arch dam, although other types of dams would also be feasible at this site);
2. Grey Mountain Reservoir with a surface area of about 1,600 acres at maximum normal water surface elevation (NWS) of 5630 feet (above mean sea level);
3. Multi-level outlet works to release water for downstream demands and to control river water temperatures;
4. Facilities to supply the existing North Poudre Irrigation Company system from the reservoir;
5. Conventional hydroelectric power plant and associated local electrical transmission facilities;
6. Facilities to convey water from Horsetooth Reservoir to Grey Mountain Reservoir;
7. Access roads to the project area; and
8. Relocated segment of Colorado Highway 14 around the reservoir.

Data for selected features of the Grey Mountain alternative are provided in Table 3.3.

**TABLE 3.3**

**Significant Data for Stage 1 Cache la Poudre Project  
(Grey Mountain Arch Dam Alternative)**

**Grey Mountain Dam and Reservoir**

Maximum Dam Height	415 ft
Crest Length	1580 ft
Crest Elevation	5655 ft
Diversion Works Capacity	9500 cfs
Spillway Capacity	122,000 cfs
Spillway Crest Elevation	5630 ft
Reservoir Area at Maximum	
Normal Water Surface	1600 acres
Selective Withdrawal System Capacity	850 cfs
Low-Level Outlet Works Capacity	1150 cfs
Anticipated Firm Yield	41,000 af/year

**Conventional Hydroelectric Power Plant**

Installed Capacity	18 to 24 MW
Average Annual Energy Production	39 to 52 GWh
Average Capacity Factor	25 %

**Horsetooth-Grey Mountain Facilities**

Pipeline Length	7.5 miles
Pipeline Capacity	170 cfs
Total Pumping Capacity	16,800 HP

Access Roads 4 miles

Highway 14 Relocation <sup>(1)</sup> 6 miles

<sup>(1)</sup> Length of the existing highway affected by mainstem reservoir construction.

**3.3.1 Type of Dam**

Preliminary investigations indicate that the Grey Mountain Damsite is topographically and geologically suitable for construction of an embankment dam, a concrete arch dam, or a concrete gravity dam. During the Basin Study, a comparison was made between an embankment dam (rockfill with central impervious core) and a concrete gravity dam constructed of roller compacted concrete (RCC). The RCC dam was found to be significantly less costly than the rockfill dam. If a damsite is suitable for arch dam construction, this type of dam usually is the least costly. Therefore, an arch dam alternative for the Grey Mountain site was

examined as part of the Basin Study Extension. It was determined that the arch dam alternative would be technically feasible and cost effective. A general layout for an arch dam at the Grey Mountain damsite is shown on Figure 3.

### **3.3.2 Facilities to Supply the North Poudre Irrigation System**

Grey Mountain Reservoir would inundate a portion of the facilities operated by the North Poudre Irrigation Company. If the dam and reservoir are constructed, continued supply to North Poudre facilities from the mainstem Cache la Poudre River will be provided by: (1) outlet works in the dam and new conveyance facilities from the dam to the existing North Poudre Irrigation facilities; or (2) modifications to the existing conveyance facilities to incorporate a submerged reservoir intake. Studies conducted as part of the Basin Study Extension indicate that the second option would be more cost effective.

### **3.3.3 Hydroelectric Power Facilities**

The proposed conventional hydroelectric powerhouse would be located at the base of the dam adjacent to the valve house, as indicated on Figure 3. The power plant could have an installed capacity in the range of 18 to 24 megawatts (MW) for the Grey Mountain alternative. The capacity range depends on how releases from the reservoir are made. Withdrawal of water directly from the reservoir via an intake/pipeline arrangement would result in lower installed capacity. If all reservoir releases, except extreme flood flows, could be passed through the hydroelectric power plant, installed capacity would be greater.

### **3.3.4 Horsetooth-Grey Mountain Conveyance**

Water from the C-BT and Windy Gap Projects, delivered through existing C-BT conveyance facilities to Horsetooth Reservoir, could be pumped approximately 7.5 miles to a mainstem reservoir on the Cache la Poudre River. The new mainstem reservoir would be approximately 200 feet higher in elevation than the existing Horsetooth Reservoir. A pipeline to deliver a peak flow of 10,000 af per month would require a diameter of 51 inches (4.25 feet) with two 8,400 HP pumping stations. One station would be located at Horsetooth Dam, the other about half-way between Horsetooth Dam and Grey Mountain Dam.

### **3.3.5 Highway Relocations**

Construction of any water storage reservoir on the mainstem Cache la Poudre River between Poudre Park and the mouth of the Poudre Canyon will require partial relocation of Colorado State Highway 14. This highway provides access to small towns including Poudre Park, Rustic and Idylwild, as well as access for recreational opportunities (camping, picnicking, hiking, fishing, river-based boating, etc.). Colorado Highway 14 is also the main alternate to U.S. Highway 34 for traveling between northern front range communities and northern west slope communities.

Cost estimates were developed for three Highway 14 relocation alternatives, as shown on Figure 4. Two of these alignments involve relocation within Poudre Canyon adjacent to a mainstem reservoir; the third alignment, the Rist Canyon alternative, involves a northerly access route from Fort Collins into Poudre Park.

The cost estimates for Highway 14 relocation are based on meeting Colorado Department of Highways (CDOH) requirements as provided to the District. If the 45 mph design speed requirement could be reduced at selected locations along the alternate alignments within the Poudre Canyon, the costs for the Poudre Canyon routes could be reduced. Otherwise, the cost for the Rist Canyon alternative is estimated to be approximately half the cost of either Poudre Canyon alternative.

### **3.4 UPDATED CONSTRUCTION COST ESTIMATE**

Construction, operation, and maintenance costs for the Grey Mountain Project were estimated at January 1988 price levels. A contingency allowance of 25 percent or more is applied to all items. The cost of engineering and owner's overhead is estimated to be 15 percent of direct costs plus contingencies.

Construction of Grey Mountain Dam is estimated to cost about \$164 million, as shown in Table 3.4. This cost excludes facilities for conventional hydroelectric power generation, Horsetooth conveyance facilities, access roads, and the Route 14 relocation which were estimated separately.

TABLE 3.4

Cost Estimate for Grey Mountain Dam and Reservoir<sup>(1)</sup>

Major Item	Cost
Diversion and Care of Water	\$ 3,570,000
Dam and Spillway	
Excavation	4,300,000
Foundation Treatment	880,000
Grout Curtain	4,000,000
Drainage Curtain	470,000
Arch Dam Concrete	87,400,000
Spillway, Pier and Beam Concrete	1,740,000
Plunge Pool Concrete Slab	1,000,000
Outlet Works	
North Poudre Supply Facilities	1,480,000
Low-Level Outlet	520,000
Selective Withdrawal System	1,700,000
Valves and Valvehouse	3,550,000
Reservoir Clearing	1,600,000
Land Acquisition	1,600,000
Powerline and Telephone Line Relocations	<u>210,000</u>
Sub-Total (Direct Cost)	114,020,000
Contingency (25%)	<u>28,500,000</u>
Sub-Total	\$ 142,520,000
Engineering and Administration (15%)	<u>21,280,000</u>
Construction Cost (January 1988)	\$ 163,900,000

(1) Excludes costs for environmental mitigation and enhancement, road relocations and access road construction, dwelling and business relocations, conventional hydroelectric powerplant, and facilities to convey water from Horsetooth Reservoir to Grey Mountain Reservoir.

Implementation of all components of the Stage 1 development based on the Grey Mountain alternative is estimated to have a construction cost of \$230 million in January 1988 dollars, as shown in Table 3.5.

**TABLE 3.5**  
**Total Construction Cost for Stage 1 Development<sup>(1)</sup>**  
**(Grey Mountain Alternative)**

Component	January 1988 Construction Cost (\$ Million)
Grey Mountain Dam and Reservoir	163.9
Conventional Hydroelectric Plant <sup>(2)</sup>	13.9
Horsetooth-Grey Mountain Conveyance	29.0
Access Roads	1.9
Route 14 Relocation <sup>(3)</sup>	<u>21.4</u>
<b>Total</b>	<b>230.1</b>

- (1) Excludes costs for environmental mitigation and enhancements.
- (2) Based on 24 MW installation.
- (3) Based on the Rist Canyon alternative.

The total cost in Table 3.5 does not include costs that may be incurred for mitigating environmental effects or providing environmental enhancements as discussed later. Preliminary cost estimates for potential mitigation components are presented in the Final Report. The overall sensitivity of project economics to potential mitigation costs was considered during economic assessments.

#### 4.0 ENVIRONMENTAL ASSESSMENTS

The environmental assessments quantified existing resources in the project area, evaluated the type and magnitude of project effects on those resources, and identified potential measures to mitigate the effects or to enhance current conditions. Comparisons were made between environmental effects and potential mitigation measures for alternative mainstem reservoirs formed by constructing

a dam at either the Grey Mountain Damsite or the Poudre Damsite. The overall objective was to provide preliminary conclusions regarding the environmental feasibility of the project with respect to the seven key resources considered. Feasibility was addressed in terms of whether opportunities exist to fully mitigate project effects, whether project effects would jeopardize the survival of threatened or endangered species, and whether mitigation costs would compromise the economic viability of the project.

Mitigation measures identified during the study are intended to provide a starting point for the development of a comprehensive mitigation plan for the project. The mitigation plan will be developed in consultation with appropriate local, state, and federal agencies; special interest groups; and project participants as the multiple-purpose project is refined to meet the specific needs of the participants. The Authority and the District both recognize that the studies performed during the Basin Study Extension do not constitute all of the environmental studies that will be needed before a feasible project can be licensed and permitted. However, the environmental studies conducted to date are those requiring the most extensive field work, and they address the most critical issues affecting the overall feasibility of the project. Summaries of the studies are presented below. Recreation, land use, and aesthetic resources are discussed in a single section due to their interrelated nature.

#### **4.1 AQUATIC RESOURCES**

Eleven fish species were identified in the project area on the mainstem and on the North Fork of the Cache la Poudre River using fish capture techniques selected in consultation with the Colorado Division of Wildlife (CDOW), the U.S. Fish and Wildlife Service (FWS), and the U.S. Forest Service (USFS). Particular emphasis was placed on assuring consistency with similar studies conducted previously along the Poudre River by the CDOW.

In the mainstem, brown and rainbow trout were dominant. In the North Fork, those trout species were accompanied by high densities of yellow perch and white suckers at various locations. The average biomass of trout populations in the mainstem ranged from 33 to 106 lb/ac with few fish longer than 12 inches. For comparison purposes, CDOW requires that for a fishery to be considered for

designation as "Gold Medal", it must contain a biomass of at least 40 lb/ac and have at least 12 fish per acre that are longer than 14 inches. Most of the Cache la Poudre locations sampled meet the biomass criteria but they do not meet the size criteria due to cold water temperatures, overwinter mortality, and relatively large harvest by fishermen. The lowest density and biomass were sampled at the downstream end of the study area (1/2 mile east of Taft Hill Road near Fort Collins), where flow depletion and habitat degradation are presently significant.

The johnny darter, a fish species designated by the CDOW as a "species of special concern", was found only in the North Fork and represented eight to ten percent of the fish sampled in the North Fork. Special concern status is a designation applied to species which have recently been eligible for threatened or endangered listing or could become eligible in the near future, require additional information to accurately define their status, or engender high public interest. The johnny darter was originally listed as a Colorado State threatened species, but was removed from the threatened species list in 1985. Johnny darters have been determined to be more common than was originally believed, but continue to be listed as a species of special concern in recognition of their general decline in range and abundance over the past century, as well as their dependence upon a narrow range of habitat conditions.

The primary effects on fish distribution and abundance from construction of the Stage 1 mainstem reservoir would be inundation of approximately 7.5 miles of existing stream habitat on the mainstem and 7.5 miles of habitat on the North Fork. Johnny darter populations would remain in the North Fork upstream of the proposed reservoir and could become established around the edges of the reservoir where shallow, sandy areas would exist.

A fisheries habitat evaluation was conducted to characterize the existing fish habitat in the study area and to provide information to quantify project-related changes in habitat. Four evaluation methods were used depending on the type of effect to be addressed:

- Instream Flow Incremental Methodology (IFIM);
- Habitat Quality Index;
- Stream Temperature Modeling; and
- Reservoir Quality Index.

The IFIM and temperature studies were conducted to assess effects of the proposed project on flow and temperature-related habitat downstream from the proposed Stage 1 mainstem reservoir. The Habitat Quality Index was utilized at the request of resource agencies to characterize the habitat of stream reaches that would be inundated. The Reservoir Quality Index was calculated at the request of CDOW to provide an estimate of reservoir carrying capacity and to aid in future evaluations of reservoir stocking.

It is not known at present whether water deliveries to project participants would be made through a pipeline from the reservoir or delivered to the Cache la Poudre River for subsequent diversion at undetermined downstream locations. Therefore, two release scenarios for post-project flows were evaluated to place bounds on the maximum and minimum post-project flows in the river. The maximum bound assumed all municipal deliveries would be made to the river, and the minimum bound assumed all municipal deliveries would be made through a pipeline from the reservoir.

For reservoir releases associated with the minimum bound of post-project river flows, overall fish habitat increased moderately during May and June because of reductions in peak flow. For the maximum release scenario, overall fish habitat increased significantly during March, April, September, and October. Comparisons between post-project habitat under the maximum bounding reservoir releases were consistently greater when the mainstem reservoir was assumed to be formed at the Grey Mountain Dam site rather than the Poudre Dam site. This occurred because the larger reservoir storage capacity associated with the Grey Mountain alternative afforded the potential for larger releases from the reservoir.

River water temperature studies indicated that pre-project mean monthly water temperatures in the Poudre River were not generally detrimental to trout survival under most hydrologic and meteorologic conditions. However, for short periods during summer months temperatures were significantly higher than optimum for either brown or rainbow trout.

With-project summer water temperatures were predicted to be lower than pre-project conditions, and winter river water temperatures were predicted to be higher than pre-project temperatures. Predicted with-project river water temperatures

during July and August of hot dry years were significantly improved over pre-project conditions.

Potential mitigation measures for trout and species of special concern were considered in three categories: (1) in-kind mitigation, (2) land or access acquisition, and (3) biomass or standing crop replacement. In-kind mitigation was considered for effects due to inundation and in association with predicted habitat changes downstream of the mainstem reservoir. Loss of stream habitat through inundation could be partially offset by habitat increases downstream resulting from reservoir releases. Mitigation for the remaining loss of stream habitat could potentially be provided through flow modifications upstream of the proposed mainstem reservoir to reduce summer flows and increase winter flows. Upstream flow modifications would be achieved through changes in the operation of existing upstream reservoirs.

Mitigation to offset loss of trout biomass in inundated reaches of the Cache la Poudre River could be provided by stocking trout in the reservoir. Potential mitigation for water temperature effects would vary, depending on the downstream reaches evaluated. Below Taft Hill Road, expected reservoir water releases at temperatures between 5 and 10°C could provide substantial relief from high river water temperatures during summer months below the Larimer County Canal diversion.

## **4.2 BOTANICAL RESOURCES**

The botanical resources study area was defined in consultation with state and federal natural resource agencies and consisted of 39,489 acres. The study area was contiguous and incorporated the potential inundation areas for all three stages of the Cache la Poudre Project and substantial border areas for use as buffer zones or potential mitigation. The proposed mainstem reservoir would affect up to 5.2 percent of the study area (2,037 acres) containing mountain shrub (972 acres), upland forest (630 acres), grassland (334 acres), and riparian vegetation (101 acres).

In a regional context, the most significant effects of the project on vegetation would be the inundation of up to 101 acres of riparian area. Regionally, rivers and riparian cover types comprise a small amount of area and

are relatively scarce. Due to their proximity to water, riparian cover types are valuable to wildlife in that they are conducive to high productivity and species diversity. However, the riparian vegetation in the project areas has been significantly degraded due to heavy grazing, development, recreational activities, and proximity to Highway 14.

Five plant species of special concern were identified by the Colorado Natural Areas Program as potentially occurring in or near the study area. These species included Colorado butterfly weed (Guara neomexicana), Bell's twinpod (Physaria bellii), Larimer aletes (Aletes humilis), purple-stem cliffbreak (Pellaea atropurpurea), and prairie goldenrod (Solidago ptarmicoides). All potential habitats for these species in the study area were searched, but only the Larimer aletes was located. In addition to the known population of this species at the summit of Grey Rock Mountain, Larimer aletes was also found at the base of some massive granite boulders on Grey Rock Mountain. Construction of either mainstem reservoir alternative would not affect this species. No plant associations of special concern or natural nonriverine wetlands were identified in the study area.

Mitigation for riparian vegetation losses could include creation of wetland areas with seepage or spill water from irrigation or from other sources. Losses of upland cover types could also be mitigated through reclamation of other areas. All of the mitigation measures required for botanical resources could be accomplished in conjunction with wildlife mitigation measures.

#### **4.3 CULTURAL RESOURCES**

Two basic types of cultural resource studies were undertaken. Class I investigation consisted of researching existing records to ascertain if portions of the current project area have been inventoried previously and to determine the location, nature, and significant qualities of known cultural resources. Class III investigation consisted of intensive pedestrian inventory conducted for the purpose of discovering, recording, and evaluating sites within a more limited area. Class I investigation was conducted for a contiguous 82-square-mile (52,480 acres) area encompassing facilities associated with all three of the proposed project stages. The Class III investigation covered 6390 acres within the mainstem reservoir inundation area and an associated buffer zone.

Class I investigation indicated that 39 previously recorded prehistoric and historic sites exist in the general project vicinity. Thirty of these sites were located within the Class III investigation area, of which 10 are prehistoric and 20 are historic. Six of the sites evaluated in the field during the Class III investigation were assessed as eligible for inclusion in the National Register of Historic Places (NRHP). All 6 significant (NRHP eligible) sites would be partially or wholly inundated by the proposed mainstem reservoir (at NWS El. 5630 feet) regardless of which alternative damsite is chosen.

Mitigation in the form of data retrieval is recommended at all 6 significant sites. For the 4 prehistoric sites, recommended mitigation measures consist of partial excavation. Mitigation at one historic site, a homestead, should consist of small-scale excavation in combination with mapping, photodocumentation, and additional archival research. At the remaining historic site, an inactive water filtration facility, mitigation should consist of full recording to Historic American Engineering Record (HAER) standards accompanied by photodocumentation and production of a complete narrative.

#### **4.4 RECREATION, AESTHETIC, AND LAND USE RESOURCES**

The recreation, aesthetic, and land use studies were conducted within a primary study area and a larger surrounding area, termed the secondary study area. The primary study area encompassed approximately 34,000 acres in the immediate vicinity of the proposed project facilities. The larger secondary study area, consisting essentially of all of Larimer County, was used to provide a regional perspective for the recreation studies. Recreation resources beyond the boundaries of the secondary study area were also considered where necessary for providing proper context in the evaluation process.

##### **4.4.1 Recreation**

The Cache la Poudre Canyon is surrounded by lands and waters of the Arapahoe-Roosevelt National Forest that offer many opportunities for hiking, angling, sightseeing, and other forms of dispersed recreation opportunities. Forest Service camping and picnicking facilities within the primary study area receive approximately 4,000 annual visits. Two existing river access sites near the canyon mouth, operated by the Colorado Division of Parks and Outdoor Recreation (CDPOR),

provide additional facilities for day-use activities. Use of these sites totals over 50,000 visits per year.

By volume, the most popular recreational activity within the study area is sightseeing, which accounts for an estimated 207,000 visits per year. Other major activities include hiking on the Greyrock Mountain National Recreation Trail (19,500 annual visits), whitewater boating on several sections of the Poudre River (6,000 visits), and stream angling (4,700 visits).

Without mitigation, the Grey Mountain alternative for the mainstem reservoir would displace a total of 9,460 user visits each year, excluding temporary hiking displacements. Loss of an estimated 5,050 whitewater boating visits would account for most of the displaced visits. Projected angling losses amount to 2,600 annual visits. Indirect effects of the Grey Mountain alternative through downstream flow changes might increase the whitewater boating loss slightly, but would probably not have an adverse effect on desired flow levels for angling.

The Poudre alternative for the mainstem reservoir would displace less than half the number of long-term annual visits predicted for the Grey Mountain alternative. The primary difference in displacement effects relates to whitewater boating. Although the Poudre alternative, like the Grey Mountain alternative, would inundate the Bridges whitewater run, the Poudre alternative would leave the more heavily used Filter Plant run essentially intact and floatable. The total number of recurring losses projected for the Poudre alternative, without mitigation, is 4,380 annual visits. Angling would be most affected, with an estimated 1,900 visits per year displaced to other locations. Altered streamflows associated with the Poudre alternative could indirectly lead to an additional annual loss of about 50 whitewater boating visits.

Potential options to mitigate recreation losses and to take advantage of recreation opportunities provided by the mainstem reservoir include relocation of the Greyrock Mountain Trailhead, new and replacement river access sites for whitewater boating and fishing, boat chutes at diversion dams to provide a new whitewater run, and facilities at or near the proposed reservoir to support flatwater boating, angling, camping, and picnicking. Based on estimates of potential use of these new facilities, either alternative could result in a net

increase in projected annual recreation visits in the study area. The additional whitewater boating opportunities proposed would fully mitigate the lost activity on the Bridges and/or Filter Plant runs. Overall, the projected net change for the Grey Mountain alternative could be a gain of nearly 17,600 annual visits. A net increase of over 21,100 visits could be associated with the Poudre alternative.

#### **4.4.2 Aesthetics**

Existing visual resources were characterized on the basis of Forest Service inventory data, slope and landform information from topographic maps, vegetation mapping conducted for other study tasks, and preliminary field observations and photography. Expected project effects from the Grey Mountain and Poudre alternatives were assessed according to the degree of landscape change that would occur and the visibility of this change. The compatibility of the appearance of project features with the visual management objectives of the Forest Service were also evaluated.

Highway 14, which parallels the Cache la Poudre River, is the primary viewing location. The sensitivity of viewers using the highway and other recreation user groups to visual change is presumed to be high, as indicated by the assignment of sensitivity Level 1 to virtually all Forest Service lands within the primary study area. Motorists traveling up the canyon would view the Grey Mountain Dam for a distance of approximately 0.5 mile immediately south of the damsite. Travelers in the opposite direction would probably be able to view the dam at a distance of 0.5 to 1 mile. In addition to views from the highway, dispersed recreationists on and along the river would be able to view the dam for up to about 0.5 mile downstream. The visual change created by the Grey Mountain Reservoir would be larger in area, extending approximately 6 miles upstream from the damsite to near Poudre Park. The portions of the reservoir visible from Highway 14 would appear as a narrow lake flanked by steep canyon walls. The reservoir would increase the visual diversity of the study area, although viewers would likely have divided preferences for lake versus river settings. The visual effects of the Poudre alternative would be very similar to those of the Grey Mountain alternative.

#### **4.4.3 Land Use**

Approximately 40 percent of the study area is national forest land and 43 percent is privately owned. Other land owners with river frontage include the CDOW, City of Fort Collins, and City of Greeley. There are four subdivisions in the study area, most of which are only partially developed.

Either of the two alternative damsites considered for the mainstem reservoir would inundate developed properties on the flatter riverside areas in the canyon. These alternatives would require acquisition or easements for approximately 1,800 to 2,200 acres of land. Most of the land required for the mainstem reservoir is presently used for grazing. Approximately one-third of the land needed for project development would consist of Forest Service lands, one-third would be State Land Board holdings, and the remainder would be divided between municipal lands and private holdings. Most of the municipal land is at the site of an inactive water treatment facility owned by the City of Fort Collins. Two of the four existing subdivisions would be inundated along with an estimated 60 to 70 homes, cabins, and outbuildings. The two project alternatives differ very little with respect to displacement of developed land uses. However, the Poudre alternative would not require acquisition of one of the two ranch/farmstead properties located between the two damsites. Several utilities and Colorado Highway 14 would require relocation.

The proposed project would shift some dispersed recreational activity onto some lands not currently managed for that purpose, but would not require significant changes in land management. Little change in access patterns would occur because of the reservoir, and new access resulting from the proposed project would not be significant. Therefore, no significant indirect land use effects are expected.

#### **4.5 WILDLIFE RESOURCES**

The wildlife resources study area covered 39,489 acres and was coincident with the study area used for botanical resources. The studies consisted largely of a habitat evaluation using the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP) for seven evaluation species. Each evaluation species represented a broader group of species characteristic of a specific habitat type.

The HEP was used to determine project effects and to estimate the effectiveness of potential mitigation measures.

Both the Poudre and the Grey Mountain alternatives would affect the seven wildlife evaluation species studied as part of the HEP. Habitat losses would be highest for mule deer; intermediate for black-capped chickadee, Abert squirrel, and western meadowlark; and lowest for song sparrow, great blue heron, and beaver. Specialists, such as the beaver, song sparrow, and Abert squirrel, depend on specific habitats to meet their life requisites and would be more affected by the proposed project than generalists, even though the acreage of lost habitat is less. This is due to the presence of high-quality habitat for the specialists in the project area and the heavy reliance of the specialists on that habitat.

One federally-listed endangered species, the bald eagle, was observed in the project area. The proposed mainstem reservoir would inundate trees presently used by bald eagles for perching and intermittent roosting at night. The loss of these trees could affect the seven bald eagles observed wintering in the project area, which represent about one percent of the population of bald eagles wintering in Colorado. A Biological Assessment and close coordination with the U.S. Fish and Wildlife Service will be required for this species under Section 7(c) of the Endangered Species Act.

Mitigation for project effects should concentrate on improving the habitat quality to increase the capacity of the remaining habitat to support wildlife. Potential improvements for habitat quality were developed for the seven evaluation species, thereby reflecting overall wildlife use of improved habitat in the study area.

## **5.0 ECONOMIC ASSESSMENTS**

### **5.1 INTRODUCTION**

The economic assessments prepared for the Basin Study Extension consisted of three components based on the Grey Mountain alternative: assessment of economic effects; estimation of benefits and costs; and determination of financial feasibility. The economic effects component identified tangible monetary impacts and demographic effects directly and indirectly attributable to the project. The

benefit-cost element included the tangible economic effects plus intangible benefits and costs. The financial feasibility assessment compared direct project revenues with annual revenue requirements assuming debt financing of the project.

## **5.2 ECONOMIC EFFECTS ASSESSMENT**

The economic effects assessment included an identification of the economic attributes of the Grey Mountain alternative, a description of the current economic and demographic nature of the area, and an estimation of the project's economic impacts.

### **5.2.1 Economic Attributes of the Grey Mountain Alternative**

The area of economic influence is the Larimer-Weld County Region. A large majority of the workers needed to construct the proposed project are expected to reside in the cities of Fort Collins and Greeley, and to a lesser extent in other nearby urban areas.

The employment and remuneration levels associated with the construction of Grey Mountain Dam and associated facilities would be substantial. Average annual employment would reach its highest level in the third year of the five-year project construction period with an estimated 510 workers. Direct wages and salaries from construction would amount to more than \$33 million over the five-year period, excluding fringe benefits and payroll burden. To the extent possible, construction materials, supplies, and contract services would be purchased in northern Colorado.

### **5.2.2 Economic Effects of the Project**

Economic effects of the Stage 1 project on the Larimer-Weld County Region would stem from construction employment and disposition of wage and salary income, purchases of local goods and services, and direct effects as those purchases circulate through the local economy. Beneficiaries would include private individuals, businesses, and local political jurisdictions. Effects on existing and future recreational activities would be evident during both construction and operation of the project. The economic effects presented in the following paragraphs are expressed in terms of 1988 dollars.

### 5.2.2.1 Employment Effects

Primary and induced employment effects related to the construction of the project are estimated to total approximately 1,600 jobs. This includes approximately 610 induced job opportunities as construction workers spend wage and salary income creating a need for other retail and service employees. In addition, about 280 jobs would be created through the purchase of construction related materials. Approximately 70 percent of the new jobs would be evident in the Fort Collins area, 20 percent in the Greeley area, and the remainder throughout the Larimer-Weld Region. These jobs would be largely for existing residents; few new people are expected to migrate to the area directly or indirectly as a result of the project.

### 5.2.2.2 Personal Income Effects

The construction of the project would generate nearly \$74 million in direct and secondary personal income in the Larimer-Weld Region. This includes \$33 million in direct worker compensation, as well as \$41 million in secondary earnings.

### 5.2.2.3 Effects on Retail and Service Sales

As shown below, the commercial base in the Larimer-Weld Region would be positively affected by the construction of the Grey Mountain alternative:

**TABLE 5.1**  
**Increases in Direct and Secondary**  
**Retail and Service Sales**

(Millions)

	<u>Retail Sales</u>	<u>Services Sales</u>
Fort Collins	\$ 21.47	\$ 20.36
Greeley	5.93	5.82
Other Region	<u>2.96</u>	<u>2.91</u>
Total	\$ 30.36	\$ 29.09

These increases in business revenues would stem from personal consumption expenditures by direct and secondary employment and by expenditures made by other businesses in the region.

#### **5.2.2.4 Fiscal Impacts on Municipalities**

Positive impacts will accrue primarily to the region's largest incorporated communities, Fort Collins and Greeley. During the construction of the project, Fort Collins is projected to receive \$590,000 in additional sales tax revenues, while Greeley is projected to receive \$178,000 in additional sales tax revenues. These monies will be forthcoming in large part from retail purchases made by direct and secondary employees. Other minor tax revenues are also possible, as well as modest revenue increases for other local governments.

#### **5.2.2.5 Other Economic Effects**

During construction and operation of the Grey Mountain Project, there would be certain positive and negative effects, without mitigation, on the area's recreational resources which in turn produce economic effects. In addition, an estimated 60 to 70 residential structures would be affected by the project. Assuming fair compensation for these losses by the project sponsors, there should be no dollar loss to the property owners or taxing jurisdictions. Recreational cabin use within the inundation area would be lost, although regional economic effects would be negligible since associated expenditures would occur elsewhere within the Larimer-Weld Region.

Operation of the Grey Mountain Project would produce several beneficial effects for the region. The increase in water resource availability would have a positive effect on northern Colorado since municipal providers could avoid the cost of more expensive water development alternatives resulting in more discretionary dollars to spend by area households and businesses. Farmers in the region would benefit from greater water availability during drought periods. Hydroelectric generation would have a similarly positive, but more limited, effect on the region. Businesses and households may benefit from hydroelectric power generation to the extent that utilities may incur lower costs for energy production. Flood control benefits would also improve the economic base of the region in the form of reduced flood insurance rates, increased property values, higher business revenues, and gains in employment. Although substantial, these

regional economic benefits attributable to the project have not yet been quantified in dollar terms.

### **5.3 BENEFIT COST ANALYSIS OF THE GREY MOUNTAIN ALTERNATIVE**

The economic feasibility, or benefit-cost, analysis of the Grey Mountain alternative incorporated the economic effects described above plus non-dollar and intangible effects of the project. In performing the analysis, the following assumptions were made:

The benefits and costs accrued to existing and future inhabitants of northern Colorado;

The time horizon for consideration of benefits and costs was through the 60th year following the start of construction;

The benefit-cost analysis was performed in constant 1988 dollars;

A discount rate of 8 percent, composed of a 5 percent inflation rate and a 3 percent real interest rate, was used; and

Although attempts were made to quantify all benefits and costs, a number of tangible and potentially significant benefits and costs were not quantified due to lack of supporting data.

#### **5.3.1 Economic Benefits of the Grey Mountain Alternative**

Quantified project benefits include the safe water supply yield, hydroelectric power generation, lake-oriented recreation, and gains in personal and business income. Most of these benefits would not be realized until construction is completed, but they would continue indefinitely.

##### **5.3.1.1 Safe Yield**

The Grey Mountain alternative was estimated to provide 41,000 af of safe annual yield. The value of this safe yield was assumed to be approximated by the per acre-foot cost of comparable municipal and industrial (M&I) water supply alternatives. Although closely comparable water supplies were limited in number, several alternative sources of water were evaluated including the C-BT and Windy Gap Projects, Thornton's proposed Northern Water Supply Project, and enlargement of Halligan Reservoir. This analysis resulted in cost estimates ranging from \$1,400 to \$6,100 per acre-foot of safe yield. A value of \$3,500 per acre-foot

for the Grey Mountain Project was used, resulting in a total benefit to the region of \$143.5 million for water supply.

### 5.3.1.2 Hydroelectric Power

Based upon projected load factors, power values, and energy requirements for pumping water from Horsetooth Reservoir to Grey Mountain Reservoir, annual net hydroelectric benefits were estimated to be \$1.65 million for a 24 MW powerplant.

### 5.3.1.3 Lake-Oriented Recreation

Existing reservoirs in the region are currently used to capacity during peak summer months. Assuming a limited amount of development around the reservoir, annual visitations by activity are projected as shown in Table 5.2.

**TABLE 5.2**  
**Projected Annual Recreation Visits**  
**Grey Mountain Reservoir**

<u>Activity</u>	<u>Utilization (Annual Visits)</u>	
	<u>Initial</u>	<u>Maximum Capacity</u>
Power Boating	12,860	42,880
Wakeless boating	6,340	21,120
Camping	2,400	12,000
Picnicking	2,400	12,000
Shoreline angling	<u>1,000-2,000</u>	<u>10,000</u>
Total	25,000-26,000	98,000

Based on the estimated number of annual visits to Grey Mountain Reservoir and the benefit per visit, total annual flatwater recreation benefits were estimated to be approximately \$640,000 when project construction is completed. Annual recreational benefits were projected to increase to \$2.4 million when maximum capacity was attained.

### 5.3.1.4 Personal Income and Business Net Income Benefits

Individual and business establishments in northern Colorado would benefit from the project to the extent that new personal and business income would be

generated within the regional economy. A total of \$74 million in personal income could be added to the region, directly and indirectly attributable to the Grey Mountain Project. Business net income, assuming 10 percent profit on pre-tax revenue, would amount to roughly \$6.2 million.

#### **5.3.1.5 Local Tax Revenue Benefits**

Local governments would benefit by an estimated \$770,000 in additional sales tax revenues as a result of constructing the Grey Mountain Project. Additional costs or other revenues are likely to be quite modest since little or no immigration of people is anticipated.

#### **5.3.1.6 Flood Control Benefits**

According to the Army Corps of Engineers (COE), there have been 30 major floods on the Cache la Poudre River during the past 100 years. As currently planned, the Grey Mountain Project could simply store the entire flood expected to occur once in every 100 years without reducing the project's estimated safe annual yield. Principal beneficiaries would be Fort Collins, the Town of La Porte, and unincorporated areas in Larimer County.

Although potential flood control benefits are considered to be substantial, such benefits could not be quantified for this study. Earlier COE estimates of average damages equal to \$1.2 million per year are believed to considerably understate the potential damages, in part because damages to streets and utilities, emergency costs, agricultural losses, and other considerations were excluded. In addition, flood control would protect more highly valued uses of the floodplain which could provide substantial benefits to the City of Fort Collins.

The City of Fort Collins, in cooperation with other entities, is planning a Heritage Corridor along the river wherein a variety of amenities are contemplated for increasing the overall contribution derived from activities along the river. Property values, job opportunities, income levels, and the commercial base of the area could all improve with flood protection such as would be provided by the Grey Mountain Project.

### 5.3.2 Economic Costs of the Grey Mountain Alternative

Economic costs consist mostly of direct construction costs (\$230.1 million in 1988 dollars) and the displacement of certain existing recreational activities, assuming no mitigation. Construction costs are short term in nature, while displaced recreation could represent a long-term loss if not fully mitigated. Construction costs would amount to \$182 million in present value terms. Displaced annual recreation costs without mitigation are summarized in the following table:

**TABLE 5.3**  
**Estimated Displaced Recreation Costs**  
**Grey Mountain Reservoir**

<u>Activity</u>	<u>Annual Costs (\$1,000's) <sup>(1)</sup></u>
Recreation cabins	4
Fishing	41
Hiking	324
Hunting	- <sup>(2)</sup>
Picnicking	8
Whitewater boating	101

(1) Not additive because certain costs occur in a single year, while others would occur every year.

(2) Less than \$1,000.

Hiking losses would be temporary if access to the Grey Mountain Trailhead is disrupted only during the construction period.

Whitewater boating losses represent the largest potential recreational loss, since more than 5,000 annual visits could be permanently lost if not mitigated.

Without mitigation, reductions in expenditures made by recreationists could lead to losses in personal income and net business income within the region. Personal income losses could amount to approximately \$820,000 annually and net regional business income reductions could approximate \$88,000.

The reimbursement of 60 to 70 residential property owners would cost approximately \$4.2 million based on estimated fair market values for the properties.

### 5.3.3 Conclusions from the Benefit-Cost Analysis

Annual benefits and costs were discounted using a real interest rate of 3 percent. The present value of costs and benefits and the benefit-cost ratio are presented in Table 5.3. Present value benefits exceed costs by about \$45 million, producing a benefit-cost ratio of 1.22.

A sensitivity analysis was performed by decreasing project benefits by 10 percent and increasing costs by 10 percent. The analysis indicated that the Grey Mountain Project would still be economically feasible. Another sensitivity analysis with a real discount rate of 5 percent (corresponding to a nominal rate of approximately 10 percent) also indicated that the project would remain feasible.

TABLE 5.3

Present Value of Benefits and Costs  
for the Grey Mountain Alternative <sup>(1)</sup>

	<u>Millions</u>
BENEFITS	
M&I Water Supply	\$ 100.65
Conventional Hydropower	43.54
Flat Water Recreation	40.56
Personal Income	55.93
Business Income	4.69
Local Tax Revenue	<u>0.57</u>
Sub-Total	\$ 245.94
COSTS	
Construction	\$ 182.10
O&M	7.28
Inundation	3.52
Lost Recreation	7.25
Personal Income	0.60
Business Income	<u>0.06</u>
Sub-Total	\$ 200.81
NET PRESENT VALUE	\$ 45.13

(1) Flood control benefits and mitigation costs have not been included.

## **5.4 FINANCIAL FEASIBILITY OF THE PROJECT**

The financial feasibility analysis focused upon project construction costs and potential revenue streams to offset annual repayment obligations.

### **5.4.1 Annual Revenue Requirements**

Estimated annual revenue requirements were composed of capital and operating costs. An annual schedule of dollar requirements was prepared using a total project construction cost of \$230.0 million expended over a 5-year period. Annual O&M costs were estimated to be \$360,000. Capital costs were assumed to be fully met through a single bond issue with a 30-year term and a 3 percent real interest rate (equivalent to an 8 percent nominal rate). The estimated revenue requirements are intended to be realistic but conservative, since other more favorable financing alternatives could help support the project.

### **5.4.2 Projected Revenues for Repayment**

Although a number of project benefits were identified to result from construction of the Grey Mountain alternative, only water sales to municipal and industrial (M&I) users and hydroelectric power generation were presumed to be vendable and, therefore, relevant to project repayment. Water tap fees and user charges represent a logical vehicle for repayment from the M&I sector.

Tap fee and user charge requirements could not be estimated with certainty at the time this study was completed since no attempt has been made thus far to identify specific water suppliers who may participate in construction of the Grey Mountain Project. As an indication of reasonable tap fees and user charges, a brief examination of prevailing rates within the Cache la Poudre River Basin found wide range within this region. For example, tap fees for single family homes in Fort Collins and Greeley ranged from \$1,600 to \$2,300, respectively. In contrast, the town of Mead charged \$4,500 for a single family tap. User charges ranged from \$0.80 per 1,000 gallons to \$1.40 per 1,000 gallons.

Based upon the foregoing, the revenue repayment projections in 1988 dollars were estimated to require an additional \$1,000 per new single family tap equivalent and a \$0.15 per thousand gallons user charge to fund project repayment. These estimates were considered reasonable in comparison with present rates and fees.

Revenue generated (in 1988 dollars) from user charges and tap fees in the initial year of water supply operation is estimated to be approximately \$13.1 million.

Net revenues from the sale of power from the 24 MW conventional hydroelectric power plant were estimated to total \$1.65 million annually. This revenue estimate was based on the assumption that current market conditions would continue in the future.

#### **5.4.3 Financial Feasibility Determination**

Based on water tap fees of \$1,000 per new single family equivalent and user charges of \$0.15 per 1,000 gallons (both in addition to current charges), the Gray Mountain alternative for Stage 1 of the Cache la Poudre Project is financially feasible. Water tap fees are based on basin-wide projections of new households from the previous Basin study. User charge revenues are calculated from annual basin-wide water demand forecasts for the M&I sector.

If annual power sales revenues are added to water revenues from the M&I sector, the total project revenues will exceed the revenue requirements for the bond issue and O&M costs. This conclusion is further supported by a sensitivity analysis in which the interest was increased by two percentage points.

## **6.0 CONCLUSIONS AND RECOMMENDATIONS**

The Cache la Poudre Basin Study Extension evaluated engineering and hydrologic, environmental and economic aspects of developing a water supply reservoir on the mainstem of the Cache la Poudre River downstream of the confluence with its North Fork. Conclusions reached in relation to the engineering and hydrologic, environmental, and economic assessments are summarized below.

### **6.1 ENGINEERING AND HYDROLOGIC CONCLUSIONS**

Hydrologic assessments indicate that a safe yield of 41,000 af/yr could be provided from a 195,000 af reservoir assuming an initial storage volume of 150,000 af. Reservoir releases would support a hydroelectric powerplant at the dam with an installed capacity of 18 to 24 MW, depending on whether municipal water

deliveries are passed through the powerplant. Flood routing studies demonstrate that an 82 percent reduction (17,400 cfs to 3,100 cfs) in the 1-in-100-year flood at the mouth of Poudre Canyon would be accomplished with only 10,000 af of reservoir storage allocated to flood control. A 50 percent reduction (to 8,700 cfs) could be accomplished without any storage specifically allocated to flood control.

Alternatives for relocating Colorado Highway 14 in the vicinity of the project were evaluated. The cost of the alternatives (including contingencies and engineering and administrative costs) ranged from \$21.4 to \$43.1 million depending primarily on whether relocated highway access would have to remain within the Poudre Canyon or whether it could be provided through the Rist Canyon.

Using the Rist Canyon alternative (\$21.4 million), the total construction cost of the Grey Mountain alternative was estimated to be approximately \$230 million at January 1988 price levels. The major cost components of the project are as follows:

	Cost (\$ Million - Jan. 1988)
Grey Mountain Dam and Reservoir	\$ 163.9
Hydroelectric Powerplant (24 MW)	13.9
Horsetooth-Grey Mountain Conveyance	29.0
Access Roads	1.9
Route 14 Relocation	<u>21.4</u>
Total	\$ 230.1

## 6.2 ENVIRONMENTAL CONCLUSIONS

Based on the environmental assessments performed for the seven resources judged to be the most critical in terms of potentially affecting project feasibility, the environmental effects of constructing either the Poudre or Grey Mountain alternative to form a mainstem reservoir will obviously be significant. However, while the environmental effects may be substantial, none appear to represent fatal flaws in terms of proceeding with plans for constructing a mainstem reservoir. This is demonstrated by the fact that there are a number of positive environmental effects, or environmental enhancements, that would result from

construction and operation of the proposed mainstem reservoir, and all of the negative environmental effects identified thus far can be adequately offset through reasonable levels of mitigation. Therefore, there are no indications at this time that the feasibility of Stage 1 of the Cache la Poudre Project will be solely dependent on any environmental factors.

#### **6.2.1 Aquatic Resources**

The primary effects on fish distribution and abundance would result from transforming up to 15 miles of stream habitat to reservoir habitat. Habitat downstream of the project could be improved by scheduled reservoir releases to mitigate a portion of the lost stream habitat. Potential flow modifications upstream of the project could offset the remainder of the project's effect on habitat availability.

#### **6.2.2 Botanical Resources**

The most important effect on botanical resources would be loss of riparian vegetation in the reservoir area. Potential mitigation measures involve the creation of new areas. Project construction would not affect any threatened or endangered plant species or species of special concern.

#### **6.2.3 Cultural Resources**

Six cultural resource sites were assessed as eligible for inclusion in the National Register of Historic Places. Mitigation for all six sites would include data retrieval. Five of the sites should receive partial excavation.

#### **6.2.4 Recreation**

Without mitigation, the recreational effects of project development would include the displacement of up to 8,460 user visits each year. The Poudre alternative would displace less than half the number of visits as the Grey Mountain alternative, with the primary difference attributable to effects on whitewater boating. Mitigation measures could include trailhead relocation; new river access sites for whitewater boating; boat chutes at diversion dams; and new boating, camping, and picnicking facilities. With these facilities, a net increase of nearly 17,600 annual visits could result.

### **6.2.5 Aesthetics**

Primary effects of the project on the aesthetics of the study area were assessed according to the degree of landscape change and the visibility of the change. Selection of appropriate mitigation measures will depend on site-specific simulation of project appearance when a project alternative is chosen.

### **6.2.6 Land Use**

The project would shift some dispersed recreational activity onto other lands and would require acquisition of up to 2,200 acres of land. This land is presently held in approximately equal portions by the federal government, the State Land Board, and municipal and private entities.

### **6.2.7 Wildlife Resources**

Project effects on wildlife resources were analyzed using a Habitat Evaluation Procedure in accordance with local, state, and federal agency input. Potential mitigation measures for habitat losses were generally based on improving the habitat quality of remaining habitat in the study area. One federally-listed endangered species, the bald eagle, was observed. A biological assessment and close coordination with federal agencies will be required in addressing project effects on this species.

## **6.3 ECONOMIC CONCLUSIONS**

The calculated benefit-cost ratio for the Grey Mountain alternative was 1.22 based on a real discount rate of 3 percent. Flood control benefits, while substantial, were not included because of a lack of available data. Mitigation costs were also not included in the benefit-cost analysis because potential mitigation measures have not been combined into an overall plan with the concurrence of regulatory agencies. The flood control benefits and the mitigation costs tend to offset each other in the benefit-cost computation.

Sensitivity analyses were prepared to reflect variations in benefits and costs. Costs could increase by 20 percent and, with no increases in project benefits, the benefit-cost ratio would still be greater than 1.0.

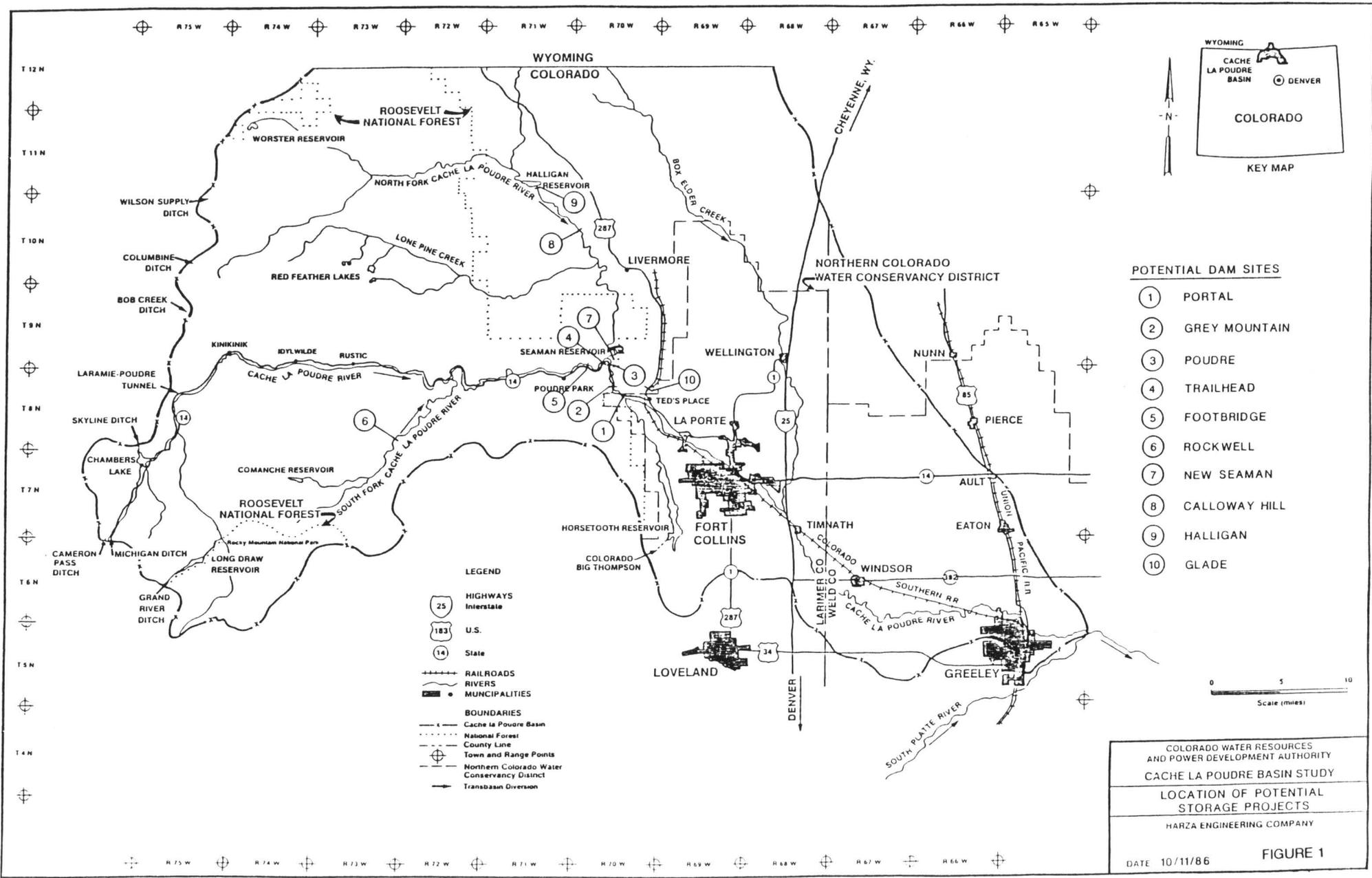
The Grey Mountain alternative is financially feasible assuming new water tap fees are increased by \$1,000 per single family equivalent and user charges are increased by \$0.15 per 1,000 gallons.

#### 6.4 RECOMMENDATIONS

The conclusions in the preceding sections indicate that either of the two alternatives for a water supply project on the mainstem of the Cache la Poudre River is feasible based on the engineering and hydrologic, environmental, and economic evaluations performed. Although the Grey Mountain alternative was selected to evaluate project costs, considerable information has been developed on the relative effects of both the Poudre and Grey Mountain alternatives.

It is recommended that the results of the Basin Study Extension be reviewed with regulatory agencies and with potential purchasers of the water supply developed by the project. The report should also be reviewed with entities that may be interested in other project benefits, such as flood control and hydropower benefits.

Potential measures to mitigate project effects are discussed in the preceding sections for each of the seven natural resources that are considered to be the most sensitive in terms of project feasibility. The measures cannot, however, be refined and evaluated in the context of a single comprehensive mitigation plan until additional information is available regarding detailed operation of the project to meet the specific needs of the entities purchasing the water supply of the project. Therefore, an iterative approach to project refinement is needed. Potential participants in the project should be surveyed regarding their needs, the project refined accordingly, and then regulatory agencies consulted regarding the mitigation of project effects. In addressing these issues, specific environmental and technical analyses may be needed to adequately distinguish between the effects, costs, and benefits of the project alternatives. Many of these potential study refinements are discussed in the main body of the report.



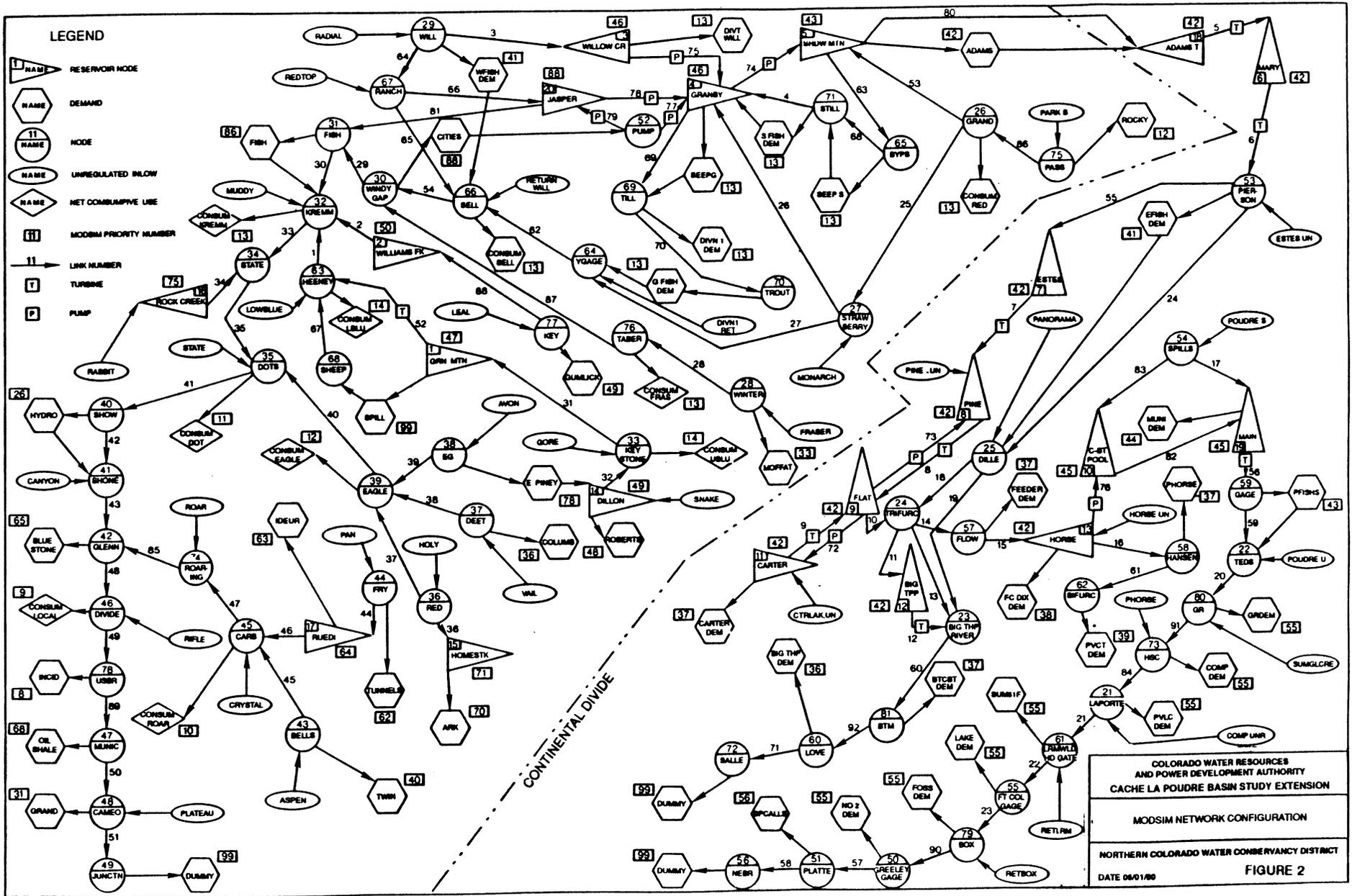
**POTENTIAL DAM SITES**

- ① PORTAL
- ② GREY MOUNTAIN
- ③ POUDBRE
- ④ TRAILHEAD
- ⑤ FOOTBRIDGE
- ⑥ ROCKWELL
- ⑦ NEW SEAMAN
- ⑧ CALLOWAY HILL
- ⑨ HALLIGAN
- ⑩ GLADE

- LEGEND**
- 25 HIGHWAYS Interstate
  - 183 U.S.
  - 14 State
  - RAILROADS
  - RIVERS
  - MUNICIPALITIES
  - BOUNDARIES
  - Cache la Poudre Basin
  - National Forest
  - County Line
  - Town and Range Points
  - Northern Colorado Water Conservancy District
  - Transbasin Diversion

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY  
 CACHE LA POUDBRE BASIN STUDY  
 LOCATION OF POTENTIAL STORAGE PROJECTS  
 HARZA ENGINEERING COMPANY  
 DATE 10/11/86

**FIGURE 1**



**LEGEND**

- NAME RESERVOIR NODE
- NAME DEMAND
- NAME NODE
- NAME UNREGULATED INFLOW
- NAME NET CONSUMPTIVE USE
- MODSIM PRIORITY NUMBER
- LINK NUMBER
- TURBINE
- PUMP

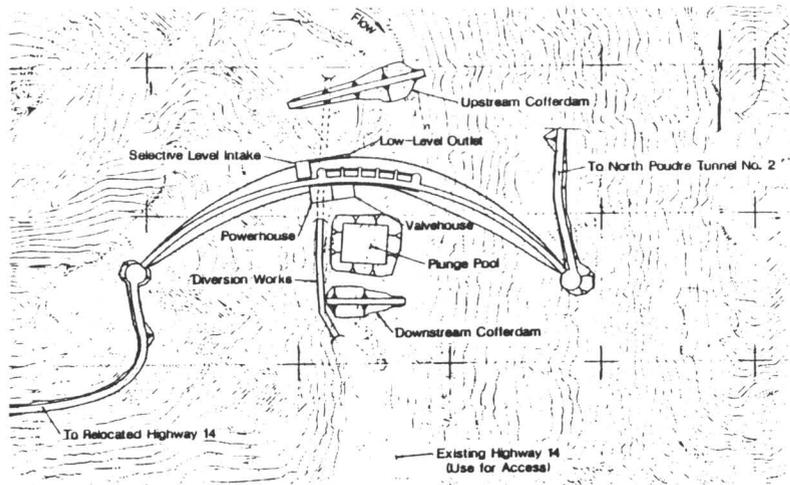
COLORADO WATER RESOURCES  
AND POWER DEVELOPMENT AUTHORITY  
CACHE LA POUDRE BASIN STUDY EXTENSION

MODSIM NETWORK CONFIGURATION

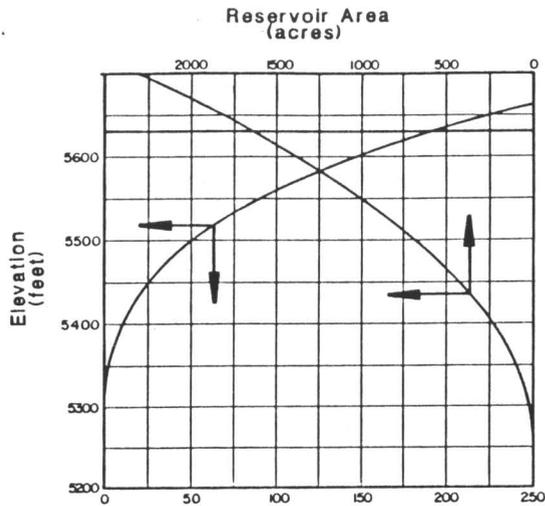
NORTHERN COLORADO WATER CONSERVANCY DISTRICT

DATE 06/01/80

**FIGURE 2**

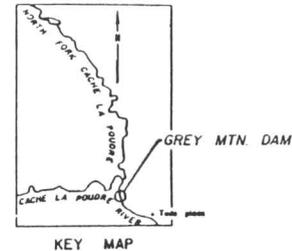


**PLAN**  
1" = 400'

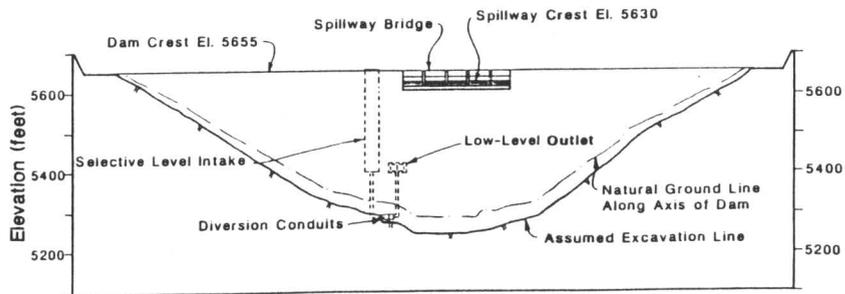


**AREA-VOLUME CURVE**

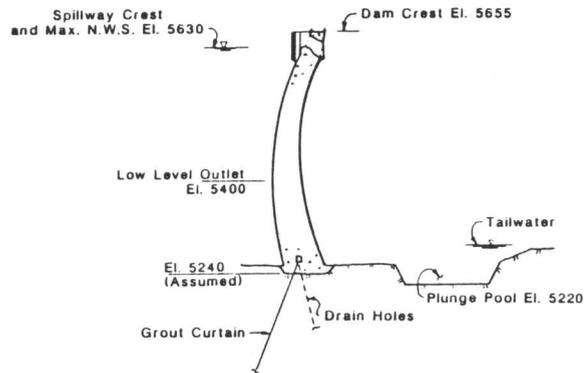
Max N.W.S. El. 5630



**KEY MAP**



**PROFILE**  
1" = 300'



**SECTION THROUGH CROWN**  
1" = 200'

COLORADO WATER RESOURCES  
& POWER DEVELOPMENT AUTHORITY  
CACHE LA POUDRE PHASE I EXTENSION STUDY

**GREY MOUNTAIN DAM**  
**PLAN PROFILE AND SECTION**

HARZA ENGINEERING COMPANY

DATE 3/4/88

FIGURE 3



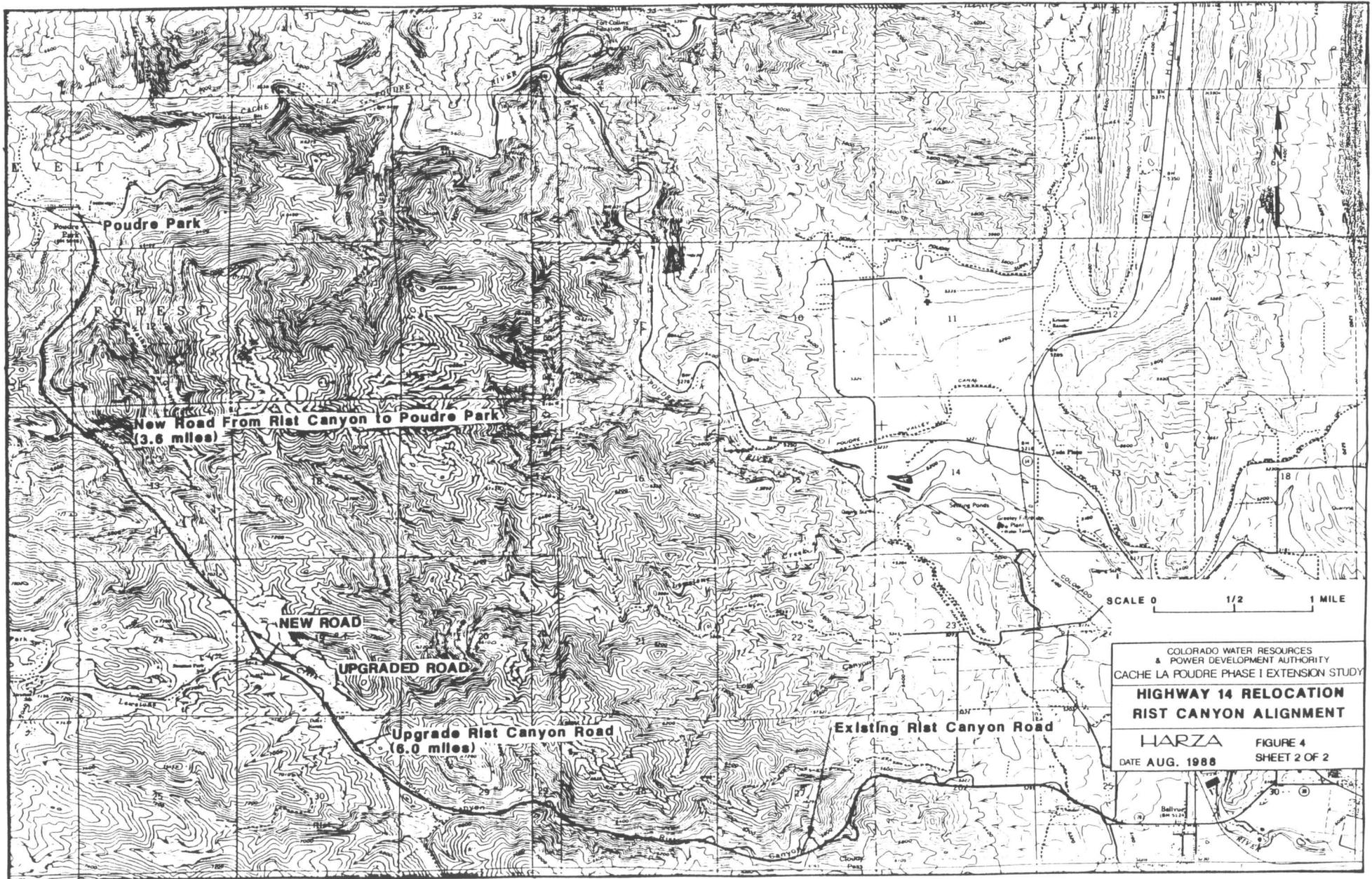
COLORADO WATER RESOURCES  
 & POWER DEVELOPMENT AUTHORITY  
 CACHE LA POUDE PHASE I EXTENSION STUDY

**HIGHWAY 14 RELOCATION  
 POUDE CANYON  
 ALIGNMENTS A AND B**

**HARZA**

DATE 4/18/88

FIGURE 4  
 SHEET 1 OF 2



COLORADO WATER RESOURCES  
& POWER DEVELOPMENT AUTHORITY  
CACHE LA POUDBRE PHASE I EXTENSION STUDY

**HIGHWAY 14 RELOCATION  
RIST CANYON ALIGNMENT**

**HARZA** FIGURE 4  
DATE AUG. 1988 SHEET 2 OF 2