UPPER GUNNISON-UNCOMPAHGRE BASIN

PHASE 1 - FEASIBILITY STUDY

SUMMARY REPORT

Prepared
For

THE COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

By
HDR Engineering, Inc.
May 1989

PREAMBLE

As graphically depicted on the cover, the water of the Upper Gunnison and Uncompahgre River Basins can be used to meet a variety of different and sometimes competing demands. These include recreational uses, irrigated agriculture, livestock production, and municipal and industrial uses. The basin is also confronted with the prospect of potential transmountain diversions.

This preliminary evaluation of the area's water resources was conducted in response to and in association with a large number of local, state, and Federal water interests. We are pleased to provide this report as the initial step in the identification, analysis, and financing of a balanced water management plan for the basin. We are confident that the data it contains will result in a more focused and informed discussion of the basin's complex water resource issues.

Colorado Water Resources and
Power Development Authority

SUMMARY REPORT
UPPER GUNNISON-UNCOMPAHGRE BASIN
PHASE 1 FEASIBILITY STUDY

Submitted to:

Colorado Water Resources and Power Development Authority
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Mr. Uli Kappus, P.E., Executive Director
Colorado Water Resources and
Power Development Authority
1580 Logan Street, Suite 620
Denver, CO 80203

Re: Summary Report for the Upper
Gunnison-Uncompahgre Basin
Phase 1 Feasibility Study

Dear Mr. Kappus:

H D R

We are pleased to submit this Summary Report as required by our contract dated June 5, 1987. Five interim Task Memoranda have been submitted previously, each reporting in detail on certain aspects of the study. A Final Report which discusses the study in a more detailed manner is submitted under separate cover.

The objective of this study was to identify and evaluate water resource management plans to enhance the water-based economy of the Study Area in an environmentally sound manner. Both structural and non-structural components have been examined, evaluated and utilized to formulate alternative plans which would meet in-basin needs. A recommended plan has been identified which meets the study objective.

Non-structural measures related to the municipal and industrial sector were found to have little potential for saving water in the context of this basin-wide study because the total consumptive use in this sector is less than two percent of the total consumptive use in the entire study area at present. Some of the measures identified should be considered for implementation at the local level in the future, however. Non-structural measures identified in the agricultural sector were determined to be either technically or economically infeasible except for water rights exchanges and/or transfers and drought leasing.

Six alternative development plans were evaluated as a means of meeting future water demands and enhancing water-based recreation in the Study Area. The preferred plan consists of the following: a 20,000 acre-foot multipurpose reservoir in the Ohio Creek basin; a 25,000 acre-foot multipurpose storage reservoir in the Tomichi Creek basin; and ten recreation enhancement components. The total capital cost of this plan is approximately $55 million (January 1989 price level).

The plan could be developed in stages. A financial analysis was performed on an initial stage which includes one storage reservoir and the ten recreation components. The total capital cost of Stage 1 would be approximately $32 million based on the Tomichi Creek Reservoir. The analysis showed that the total annual cost associated with Stage 1 would be about $1.25 million. The annual income from the project is estimated to be about $140,000 but the project would result in significant economic benefits to the Study Area through increased tourism (estimated to be about $4.45 million. Construction of Stage 1 will also result in year-round increased streamflows which would result in fish and wildlife benefits. Although the recommended plan is not financially feasible based solely on direct project income, its benefit-cost ratio is attractive when all project benefits are included. Therefore, several methods of generating income in addition to direct project income were investigated as a means of meeting annual project costs. These methods included the following: formation of a special recreation district with taxing powers; use of authorized, but as yet unappropriated Aspinall Unit mitigation funds; and the lease or sale of land adjacent to and in the vicinity of the proposed reservoirs. It was concluded that, if implemented, these methods could provide sufficient income to repay the annual debt service of the recommended plan.

The study also evaluated potential pumped-storage hydroelectric and transmountain diversion projects which, when combined with the preferred in-basin development plan, would result in a more comprehensive project. This was evaluated because it was thought that a more comprehensive development plan might be more financially attractive than an in-basin plan by itself provided that benefits and costs could be equitably shared between the project participants.

The study effort showed that numerous potential pumped-storage hydroelectric sites exist in the study area and that several of these sites appear to be economically attractive. These projects may adversely affect existing reservoirs that are included in the project and future studies, if conducted, should evaluate these potential impacts.

Transmountain diversion projects that would divert water from the headwaters of the Taylor River and from Blue Mesa Reservoir were investigated. There are significant institutional and environmental considerations involved with potential out-of-basin diversions. These may include: perfecting water rights, changing existing water rights or exchange agreements, changing operations of existing facilities, and a wide array of environmental issues. There may also be other potential constraints identified if the study proceeds into a more detailed phase. For purposes of analysis, preliminary evaluations were made of alternative export plans which might yield

up to 100,000 acre-feet of water annually. These export plans were analyzed without drawing conclusions regarding the issue of the legal availability of water. The estimated cost of implementing the alternatives studied are within the range of water development costs currently being experienced by municipal and industrial users along the front range.

We wish to express our appreciation for having had the opportunity to perform this study and also for the excellent support and guidance we received from Mr. Blaine Dwyer, the Authority's Project Manager. We also wish to acknowledge the valuable input and insights we received from the Technical Steering Committee and the Advisory Committee throughout the course of the study. We look forward to future opportunities to be of service to the Authority.

Very truly yours,

HDR ENGINEERING, INC.

Andrew Tczap, P.E.
Project Manager

AT:jb

Enclosure

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1.0 INTRODUCTION

This preliminary evaluation of alternative water management plans for the Upper Gunnison and Uncompahgre River Basins was conducted by the Colorado Water Resources and Power Development Authority (Authority) at the request of the Study's sponsors: the Upper Gunnison River Water Conservancy District (UGRWCD) and the Colorado River Water Conservation District (CRWCD). The purpose of this Summary Report is to present a concise overview of the Study. The Final Report for the Study presents these topics in greater detail.

The physical area investigated (the Study Area) in this Study includes the Upper Gunnison sub-basin (upstream of Crystal Dam) and the Uncompahgre sub-basin. Figure 1.1 shows the Gunnison River Basin and the Study Area boundary. Located in west-central Colorado, the Study Area is bordered by the Continental Divide to the east and southeast, the San Juan Mountains to the south, the town of Delta to the west, and the North Fork of the Gunnison and Roaring Fork watersheds to the north. The Study Area encompasses approximately 5120 square miles of land.

1.1 AUTHORIZATION

The Upper Gunnison-Uncompahgre Basin Phase I Feasibility Study (Study) was authorized on December 12, 1986, by the Authority's Board of Directors in response to an application submitted by the previously mentioned Study sponsors. The Authority entered into a contract with HDR Engineering, Inc. (HDR) on June 5, 1987, to provide consulting services for the Study. HDR subcontracted with three other organizations to provide specialty services: WBLA Inc., for hydrologic/water rights modeling; Woodward Clyde Consultants for geology and geotechnical engineering; and the CU Center for Economic Analysis for population projections and economic forecasting. The following individuals also participated as members of the Study Team: Dr. Hugo Ferchau for botany; Dr. Robert Behnke for aquatic biology; and Mr. Robert Rosette for waterfowl and stream access studies.

In addition, the Study has been performed with the aid of the U.S. Bureau of Reclamation (USBR) through their Technical Assistance to States Program. Their participation consisted of providing in-kind services and producing certain Study products as an adjunct to the Study Team. The USBR's participation included input to most of the study tasks, but concentrated on the areas of: collection and analysis of hydrologic data; preparation of agricultural water demand forecasts; identification and evaluation of structural components; and preparing environmental evaluations of components and plans. It has been the Authority's responsibility to promote coordination between HDR and the USBR as well as to make final decisions regarding the Study direction after considering input from Study sponsors, committees, and the general public.

1.2 STUDY OBJECTIVE

The objective of this Study was to identify and evaluate water resource management plans to enhance the water-based economy of the Study Area in an environmentally sound manner. Both structural and non-structural components have been examined. The purpose of the structural measures (such as dams, pipelines, and tunnels) is to develop additional water supplies consistent with the in-basin needs and the State's compact entitlements. The purpose of non-structural measures (such as enhanced water management through water exchange, reuse, and conservation) is to obtain greater environmental and economic benefits from the existing resource base.

Given the apparent inability of recreational and agricultural water users to pay for additional water development, other sources of revenue, including hydropower generation and potential out-of-basin water sales, were evaluated. This was done to identify very general options which, when combined with the preferred in-basin development plan, would result in a more comprehensive project with enhanced financial attractiveness. These options may require participation from electrical power entities or east slope water suppliers. This study has not speculated on the specific institutional relationships that might be involved. If these entities pursue a cooperative approach to project

development, further study would be required to arrive at an equitable sharing of project costs and benefits.

1.3 STUDY PROCESS

The Study was carried out in accordance with "The Plan of Study" (POS) contained in the consultant's contract. The POS identifies 16 individual work tasks comprising 45 subtasks. The 16 work tasks are listed in Table 1.1. This Phase I Feasibility Study (or prefeasibility study) is the first step in a complex process leading to the construction of a water resources project. The steps included in this process for a project which includes a storage reservoir are shown in Figure 1.2

This Study was conducted at a prefeasibility level of evaluation. This means that it was completed in sufficient detail to distinguish the major differences between alternatives, describe the viability of each alternative, and determine if more refined studies are warranted. If warranted, a full feasibility study would be the next phase of the process. Such a study would probably be carried out in discrete steps in order to minimize investment until such time that the project sponsors could be relatively certain that a financially feasible project has been identified. All steps of the feasibility study would be conducted at a level of detail suitable to support regulatory processes mandated under the National Environmental Policy Act (NEPA), including the acquisition of needed permits and licenses. The feasibility study would also provide the financial information that would serve as the foundation for project proponents and financing entities to make decisions regarding their future involvement in the project. To accomplish these goals, the feasibility study might include detailed geologic and geotechnical investigations. Final design for a selected project would be undertaken following the feasibility study phase.

The Study has been performed with the assistance of an Advisory Committee composed of 21 individuals representing a wide variety of interest groups, and a Technical Steering Committee.

The committees provided valuable direction throughout the course of the effort. Given the wide range of interests that were represented, it is not reasonable to expect that a unanimous consensus be obtained in an effort of this magnitude. However, the contribution of the individuals resulted in a comprehenseive evaluation of their viewpoints and their efforts are gratefully acknowledged.

In addition to the periodic committee and public meetings, the Study Team also met individually with more than 20 environmental, economic, and governmental entities. Their input is also gratefully acknowledged.

1.4 GENERAL DESCRIPTION OF THE GUNNISON RIVER BASIN

The Gunnison River Basin is located in West-Central Colorado. Its boundary encompasses an area of 8,020 square miles and includes all or major portions of Gunnison, Montrose, Delta and Ouray Counties and portions of Mesa, Hinsdale, Saguache and San Juan Counties. It is approximately 145 miles long east to west and 95 miles wide at its widest point north to south. The Gunnison River and its tributaries drain about eight percent of Colorado. Figure 1.1 shows the basin and the boundary of the Study Area within the basin.

The Gunnison River Basin was controlled by the Ute Indians until a large tract was opened for settlement in 1873, and the remainder of the basin was ceded in 1881. The first settlers were miners, many of whom turned to farming and ranching as their means of livelihood when the mining industry declined after 1893. Agriculture soon established itself as the basic industry in the area and extensive agricultural water supply systems were developed in the ensuing years. For the past century, agriculture has been the largest user of water within the Study Area.

More recently, recreation has become the other predominant sector in the local economy. The Study Area offers diverse recreational opportunities

throughout the four seasons of the year, with fishing the most popular activity in terms of visitor days.

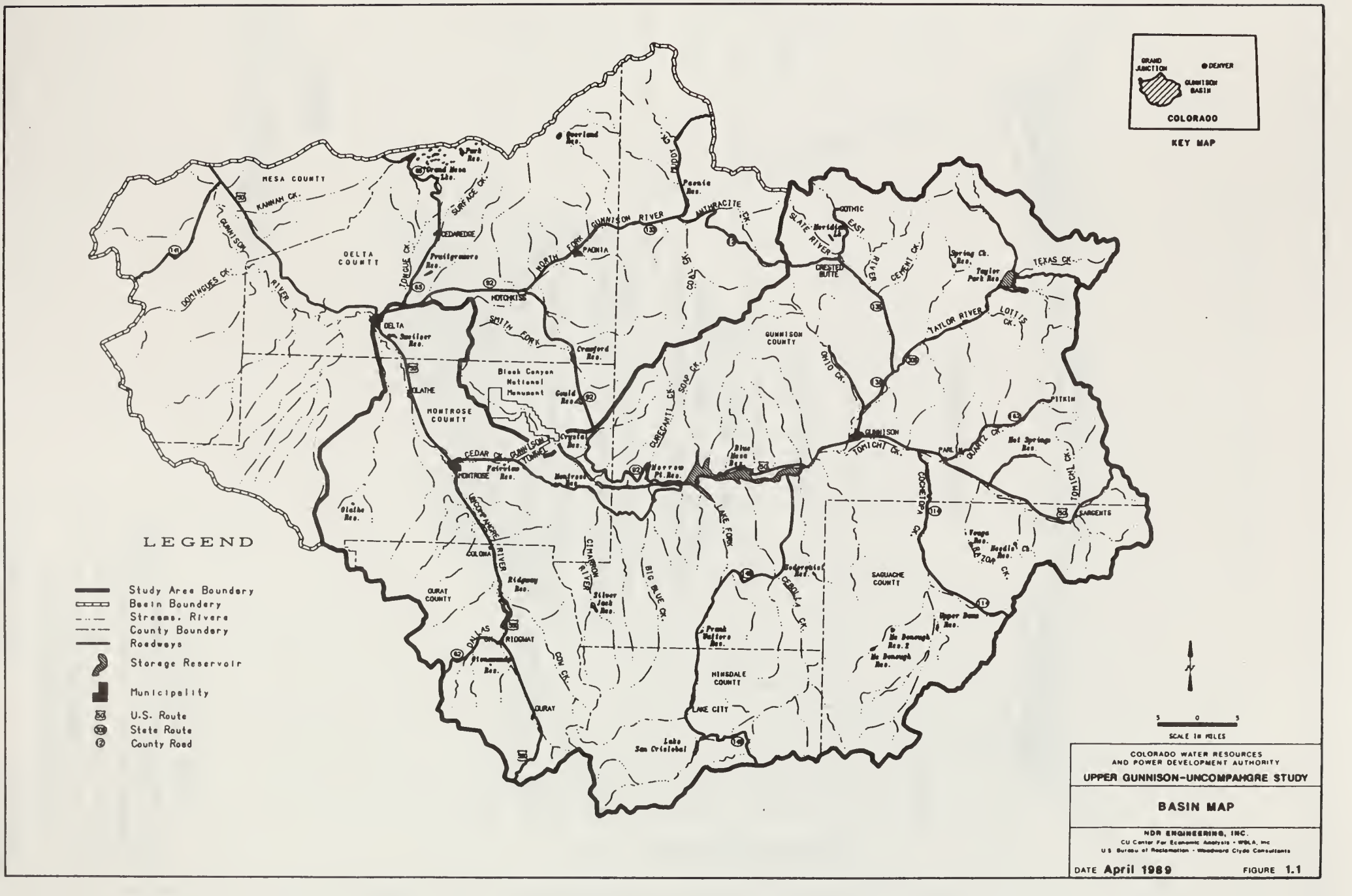
Water resources planning in the Upper Gunnison Basin began in the early 1900's and resulted in the construction of the second project ever undertaken by the U.S. Bureau of Reclamation (USBR), the Uncompahgre Project. The major features of this project are the Gunnison Tunnel, Taylor Park Reservoir, and 792 miles of canals, laterals, and drains. The Gunnison Tunnel diverts water from the Gunnison River for irrigation in the Uncompahgre Valley. Taylor Park Reservoir supplies water for irrigation, but is presently operated in a cooperative manner to enhance fisheries and recreation. It also provides flood protection on the Taylor River.

Public Law 485, approved in 1956, authorized the Department of the Interior to construct the Colorado River Storage Project consisting of the Curecanti (now called Aspinall), Flaming Gorge, Navajo and Glen Canyon Units. The Act also authorized a number of smaller projects to be constructed if technical and economic feasibility were demonstrated and other specified conditions were met. These projects were termed Participating Projects in the Act. Two CRSP participating projects located in the Study Area have been constructed by the USBR: the Dallas Creek Project and the Bostwick Park Project. Another potential CRSP participating project, the Upper Gunnison Project, was studied in detail, and several potential reservoir sites and conveyance systems were identified. The Concluding Report for the Upper Gunnison Project was published by the USBR in 1973. None of the proposed facilities have been constructed to date.

TABLE 1.1

Study Work Tasks

Task No.	Task Description
Task No. 1	Collect and Review Existing Data
Task No. 2	Describe Existing Water Resource Systems and Recreation Facilities
Task No. 3	Assess Basin Hydrology
Task No. 4	Project Demands
Task No. 5	Identify and Evaluate Recreational and Environmental Plan Components
Task No. 6	Compare Supply with Forecasted Demands and Instream Flows
Task No. 7	Select Plan Evaluation/Screening Criteria
Task No. 8	Non-Structural Plan Components
Task No. 9	Structural Plan Components
Task No. 10	Formulate and Evaluate Alternate Plan Combinations and Financing Strategies
Task No. 11	Identify Environmental Impacts and Potential Solutions
Task No. 12	Selection of Preferred Plan(s)
Task No. 13	Report Preparation
Task No. 14	Meetings and Public Involvement Program
Task No. 15	Prepare POS for Phase II Feasibility Study
Task No. 16	Preliminary Geotechnical Investigation (Optional)



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

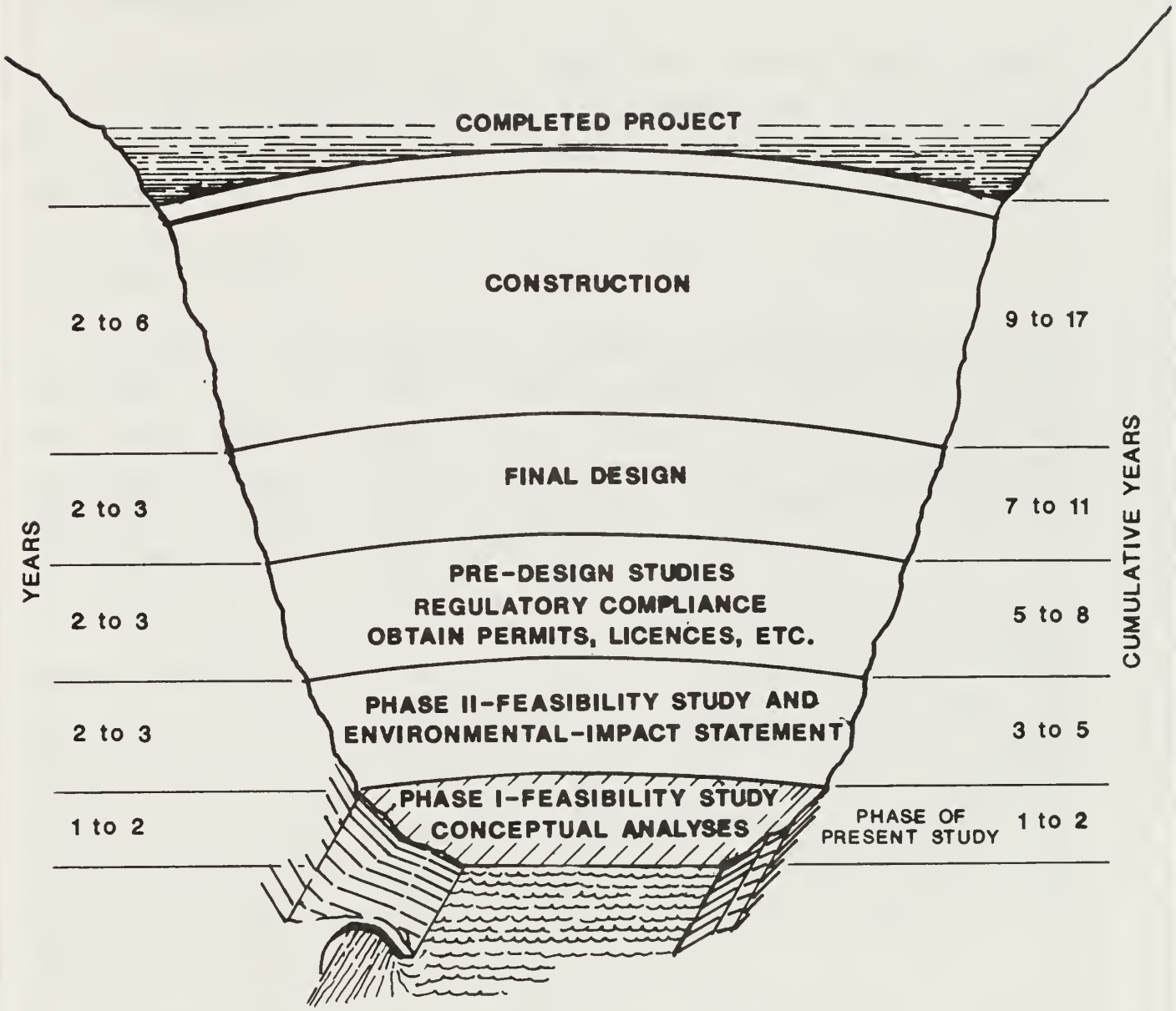
BASIN MAP

NDR ENGINEERING, INC.

CU Center For Economic Analysis - WPAA, Inc

U S Bureau of Reclamation - Woodward Clyde Consultants

DATE April 1989 FIGURE 1.1



LEGEND

CURRENT STATUS
OF GUNNISON STUDY

COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

TIME REQUIRED TO IMPLEMENT A WATER DEVELOPMENT PROJECT

HDR ENGINEERING, INC.
CU Center For Economic Analysis • WBLA, Inc.
U.S. Bureau of Reclamation • Woodward Clyde Consultants

DATE: April 1989 FIGURE: 1.2

2.0 DESCRIPTION OF EXISTING WATER USE

2.1 INTRODUCTION

This Study began by collecting existing data related to the Study Area in order to define historic water usage and shortages; to identify the water suppliers and their existing facilities; and to develop a data base for use in the Study.

2.2 DATA COLLECTION

This Study was built upon the large body of existing data including the following: reports of previous studies; topographic, geologic and land use maps; aerial photos; hydrologic data; climatologic data; water rights data; water diversion data; historical water use data; wildlife (including fishery) data; water quality data; data related to the environment in the Study Area; recreational use data; and demand forecasts.

The primary sources of information included the following: the U.S. Bureau of Reclamation (USBR); the U.S. Corps of Engineers (COE); the Colorado Water Conservation Board (CWCB); the U.S. Geological Survey (USGS); the Colorado State Engineers Office (SEO); the Colorado Division of Wildlife (CDOW); the U.S. Bureau of Land Management (BLM): the National Park Service (NPS): the U.S. Forest Service (USFS); the U.S. Fish and Wildlife Service (USFWS); the U.S. Department of Agriculture, Soil Conservation Service (SCS); and municipalities, recreational entities, environmental organizations, and agricultural water user groups within the Study Area.

2.3 INVENTORY OF WATER SUPPLY ENTITIES AND FACILITIES

For the purpose of this Study, water suppliers and users in the Study Area were categorized by their primary purpose as either regulatory, hydroelectric, agricultural, or municipal and industrial (M&I).

The term "regulatory" was coined to describe the Wayne N. Aspinall Unit (Aspinall Unit) of the Colorado River Storage Project (CRSP) which was constructed by the Federal government primarily to regulate Gunnison River flows. The Aspinall Unit is comprised of three storage reservoirs located on the main stem of the Gunnison River: Blue Mesa, Morrow Point and Crystal. Flows of the Gunnison River are largely controlled by Blue Mesa Reservoir, the largest and uppermost of the three. Each of the three reservoirs includes a hydroelectric generating facility for the purpose of project repayment. The total combined installed capacity of the three plants is 208,000 kilowatts (kW). The primary function of the Aspinall Unit, however, is to regulate streamflow so that water commitments to the Lower Colorado River Basin can be met in dry periods without curtailing the development of water allotted to the Upper Basin.

The only commercial hydroelectric power generating station in the Study Area other than the Aspinall Unit facilities, is the Ouray facility. The Ouray hydropower plant is a 700 kW run-of-river facility owned and operated by the Colorado Ute Electric Association. It is located on the Uncompahgre River within the town of Ouray.

Agriculture has historically been the largest user of water within the Study Area. Irrigated agriculture has been practiced in the area since the late 1800's. Three U.S. Bureau of Reclamation (USBR) projects which provide irrigation water from storage serve agricultural lands within the area. These projects are the Uncompahgre Project (Taylor Reservoir), Bostwick Park Project (Silver Jack Reservoir) and the Dallas Creek Project (Ridgway Reservoir). These projects are owned by the USBR but are operated and maintained by the Uncompahgre Valley Water Users Association (UVWUA), the Bostwick Park Water Conservancy District (BPWCD) and the Tri-County Water Conservancy District (Tri-County). Each of these organizations is also responsible for repayment of the project loans. The Uncompahgre Project irrigates 86,000 acres, the Bostwick Park Project irrigates 7000 acres, and the Dallas Creek Project provides 11,000 acre-feet (af) of supplemental supply to presently irrigated acreage in the Uncompahgre Valley.

In addition, there are many private irrigation ditches in the Study Area which are supplied by direct flow diversion water rights. Approximately 16,000 acres are irrigated by private ditches in the Uncompahgre sub-basin while more than 750 private ditches irrigate approximately 58,000 acres in the Upper Gunnison sub-basin.

Municipal and industrial (M&I) water use is relatively small in the Study Area in comparison to total water use. The primary M&I water suppliers within the Study Area are the Project 7 Water Authority; the municipalities of Gunnison, Crested Butte, Ouray and Ridgway; Mt. Crested Butte Water and Sanitation District; and the Lake City Area Water and Sanitation District. In addition, there are many small M&I water suppliers in the basin.

Project 7 Water Authority (Project 7) is by far the largest M&I water supplier in the Study Area. It was created for the purpose of having one treated water supplier to serve the Uncompahgre Valley area. Under the present operating arrangement, Project 7 treats raw water and delivers it to six water suppliers. Project 7 does not own water rights nor does it have taxing authority, but is reimbursed monthly by each entity for the cost of treating and delivering water. At present, raw water is purchased by each entity from Tri-County, who in turn purchases water from the UVWUA under an interim contract until Dallas Creek water supplies are available. Additionally, the City of Montrose obtains part of its raw water supply from the Cimarron Ditch and Reservoir Company and then delivers it to Project 7 for treatment.

The Tri-County Water Conservancy District is the sole purveyor of water from the USBR's Dallas Creek Project. Of the 39,400 af of water available from that project, 28,100 af is allocated for M&I use. Tri-County has commitments from Montrose, Delta and Olathe to purchase 14,000 af of Dallas Creek water.

The remaining M&I water suppliers within the Study Area rely mainly on ground water supplies, with springs and surface water diversions making up the remainder of their source of supply.

2.4 WATER-BASED RECREATION

The Upper Gunnison and Uncompahgre Basins offer diverse recreational opportunities throughout the four seasons of the year. The most popular water-based recreational activities are flatwater boating and fishing, stream fishing and camping. Activities which are rapidly growing in popularity include river rafting and boating, and wind surfing.

The majority of the land in the Study Area is public lands (70 percent) which are managed by the U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM). The National Park Service (NPS), the Colorado Division of Wildlife (CDOW) and the Colorado Division of Parks and Outdoor Recreation (CDPOR) operate recreation facilities within the Study Area on other public lands which encompass an additional two percent of the Study Area.

There are about 1.5 million acres of National Forest land within the Study Area, comprising approximately 46 percent of the Study Area. This National Forest land includes all or part of the following six wilderness areas: West Elk, Big Blue, Collegiate Peaks, La Garita, Mount Sneffles and Maroon Bells-Snowmass. Use figures for the National Forest lands were obtained from records kept by the USFS. In 1986, use of the National Forests within the Study Area for all recreation activities is estimated to have been 1,132,000 Recreational Visitor Days (RVD's). For the same period, water-based recreational activities within the forests amounted to 381,000 RVD's. The Taylor River and Taylor Park area receive some of the most intense recreational use that occurs on USFS lands within the Study Area. Major activities include fishing, boating, and camping. The 11 campgrounds located in the Taylor River drainage receive the highest utilization of all forest campgrounds located in the Study Area. They are full on weekends during the peak camping season and generally on many weekdays. In 1986, activities

within the six campgrounds located on the Taylor River below Taylor Park Reservoir accounted for approximately 37,000 RVD's of camping use. In addition, dispersed recreation activities in the undeveloped areas along the lower Taylor River such as fishing, rafting, hiking, roadside picnicking, and use of unimproved roads and pullouts amounted to an estimated 49,900 RVD's. The two forest campgrounds located on Taylor Park Reservoir received approximately 22,400 RVD's of camping use in 1986.

There are about 750,000 acres of BLM lands within the Study Area. The BLM manages large tracts of public land south of Gunnison in the Cochetopa Creek, Cebolla Creek and Lake Fork drainages. There are four special recreation management areas (SRMA) in the Study Area; the Cochetopa Canyon SRMA, the American Flats/Silverton and Lower Lake Fork SRMA, the Powderhorn SRMA, and the Gunnison Gorge SRMA. These SMRA's received approximately 405,000 Recreational User Days (RUD's) of use within the Study Area in 1986; 154,000 of which were for water-based activities (personal communication with BLM personnel). The Lake Fork drainage is BLM's most heavily used water-based recreation corridor in the Study Area and receives about 85 percent of the water-based recreational use cited above for the four SRMA's. Dispersed recreational use of BLM lands outside the SRMA's is roughly estimated at 430,000 RUD's and includes mostly big game hunting and automobile touring.

The National Park Service manages the Curecanti National Recreation Area which lies within the Study Area. Curecanti National Recreation Area was established under the authorization of the Colorado River Storage Act and covers more than 40,000 acres of land including the three Aspinall Unit reservoirs. This recreation area experienced approximately 1,115,000 visitations in 1986 (personal communication with NPS personnel). A visitation is defined as visitor usage regardless of time spent at the area up to one full day. Popular activities in 1986 included lake fishing (225,000 visitations), boating (165,000 visitations); and camping (127,000 visitations).

The Colorado Division of Wildlife manages multiple parcels of land for fishing and hunting access. They also own and operate three reservoirs which provide fishing and camping opportunities. These reservoirs are Spring Creek, Upper Dome and Lower Dome Reservoirs.

The Colorado Division of Parks and Outdoor Recreation (CDPOR) operates the Sweitzer Lake State Recreation Area near Delta which received approximately 100,000 visitor days of use between July 1, 1986 and June 30, 1987 (CDPOR records). The CDPOR will also operate the Ridgway State Recreation Area, which is presently under construction and scheduled for completion in 1989.

Three commercial rafting companies offer a variety of float trips and rafting experiences within the Study Area, excluding the Gunnison Gorge. Trips are conducted on the Taylor River between the confluence with Lottis Creek and the confluence with the East River; on the Gunnison River between the confluence with the Taylor River and Blue Mesa Reservoir; and on the Lake Fork of the Gunnison River between Ryan's Bridge (seven miles north of Lake City) and Blue Mesa Reservoir.

There are numerous private campgrounds located throughout the Study Area. These range from new resort communities such as Blue Mesa Recreation Ranch to traditional recreational vehicle, trailer and tent camping areas.

Crested Butte Mountain Resort (CBMR), located near the town of Crested Butte, is ranked eighth in skier days among Colorado's ski resorts. Approximately 385,000 skier days were recorded in 1987 (statistics compiled by Ski Country, USA). CBMR's growth rate is higher than the national average and plans are underway to increase its area by approximately 50 percent in the future.

The Black Canyon of the Gunnison National Monument is located outside of the Study Area immediately downstream of the Curecanti National Recreation

Area. This facility experienced approximately 289,000 visitations in 1986 (personal communication with NPS personnel).

2.5 NON-CONSUMPTIVE WATER USES

Several types of non-consumptive water rights exist in the Study Area which provide for minimum streamflows and minimum lake levels. These water rights are discussed in Chapter 3.0 in the context of their treatment in the hydrologic model.

3.0 BASIN-WIDE HYDROLOGIC MODEL

3.1 INTRODUCTION

Water availability in the Study Area was evaluated using a computerized model of the area's water resources and the existing water rights which affect usage of these resources. The geographic size of the basin, the complexity of Colorado water law, and the large number of existing water rights in the basin (approximately 5000 absolute decrees for consumptive use) made the use of a computer-based tool, or model, essential.

The model was developed to meet the following general objectives: 1) to simulate the historical hydrology of the basin, 2) to administer basin water rights in accordance with Colorado water law, and 3) to represent the operation of existing water development facilities in the basin.

The model identifies areas of major water shortages under alternative development assumptions and predicts future development that can be undertaken without impacting existing absolute water rights. The model can be utilized to identify geographical areas, legal considerations, and institutional issues to be evaluated in greater detail in future phases of the study, if undertaken.

The remainder of this chapter discusses the development of the model, the simplifying assumptions made, and the limitations of the model.

3.2 MODEL DESCRIPTION

The basin model was developed using a network optimization modeling system. This type of modeling system uses sophisticated mathematical relationships to allocate water in accordance with the seniority of the water rights modeled. The result is that the model operates more efficiently than models based on simple accounting methods. In the model, the basin is characterized as an interconnected network of reference lines called links

which represent streams, inflows (natural runoff), reservoirs and diversions that exist in the basin. The model simulates the amount of water flowing in each link (stream reach) and the amount of water contained in each reservoir while taking account of consumptive use by various water users. This is done on a monthly basis for each year being modeled. The selection of the years used in the modeling is discussed in the following section.

3.3 STUDY PERIOD HYDROLOGY

The first steps in developing the basin model were to select the historical period to be studied and to compute virgin flows (flows which would have occurred without the effects of stream regulation or diversions) for that study period. The study period consisted of 384 consecutive months from October 1952 through September 1983. This period was selected because it is statistically similar to the total period of record for three key streamflow gaging stations in the basin and includes a variety of hydrologic conditions. Nearly all the significant dry years in the period of record were included in the selected study period.

Separate data files of monthly virgin flows were derived for 59 locations in the basin. Virgin flows at gaged sites were derived from historical flow records corrected for upstream reservoir operations, basin imports and exports, and irrigation depletions. Historical irrigation depletions were estimated from climatic data, consumptive use calculations, diversion records, and detailed operating studies of selected ditches. Virgin flows at ungaged sites were developed from virgin flows at gaged sites corrected for area and elevation differences.

3.4 REPRESENTATION OF WATER RIGHTS

Gunnison basin water rights are represented in the model in one of two ways. "Select" water rights which significantly influence river administration or which transfer water from one sub-basin to another are

modeled individually. These water rights are modeled as diversions, consumptive use demands, and return flows.

Most small (in terms of quantity) irrigation water rights and a few small municipal and domestic rights are represented as aggregated depletions rather than as diversion and return flows (depletions are the difference between diversions and return flows). This was done because the large number of diversions in the Study Area dictated a simplified approach at this preliminary level of study. These rights were aggregated by geographical location and by relative water rights priority. Four priority classes were defined using the priorities of the major water rights to divide the smaller rights into the four classes. An agreement between the USBR and the CRWCD and the file documents supporting the agreement obligates the USBR to allow junior, in-basin, upstream appropriators the use of water in an amount not to exceed 60,000 af (U.S. Department of the Interior, 1984). This agreement is commonly referred to as the "Curecanti Subordination." The geographical distribution of the 60,000 af of depletions is as follows: 20,000 af in the drainage between Crystal and Blue Mesa Reservoirs and 40,000 af above Blue Mesa Reservoir within the Gunnison River Basin. The current junior upstream depletions are far less than these amounts. Issues surrounding the implementation of the agreement and its administration have not yet been fully resolved. However, the issues do not affect the study's hydrologic modeling of the agreement including the modeling of historic Aspinall Unit operations.

The direct-flow water rights for the Aspinall Unit were not modeled individually. In the past, there has been no need for full administration of these direct-flow decrees against upstream junior in-basin appropriators because of the "Curecanti Subordination." Therefore, only the Aspinall Unit storage decrees were modeled so that the hydrologic modeling could be calibrated with historic operations. If a situation arises in the future where in-basin depletions junior to the Aspinall Unit water rights are greater than 60,000 af or out-of-basin diversions are implemented, the USBR may require administration of both the direct-flow and storage decrees. This study has not addressed specific impacts of such administration. The

capacities of the Aspinall Unit direct flow decrees are: Blue Mesa, 3500 cfs; Morrow Point, 5450 cfs; and Crystal, 3000 cfs.

The depletions associated with each of these aggregated depletion demands were derived from consumptive use calculations, estimates of irrigated acreage served by specific ditches, diversion records, and detailed operating studies of selected ditches. The depletions are allocated between water rights priority classes at each aggregation point in proportion to the amount of decreed rights in each class at each point, and the assumption that diversions take place first under the more senior water rights.

3.5 INSTREAM FLOW DECREES MODELED

There are several reaches of the Gunnison River and its tributaries for which minimum stream flows have been proposed or decreed. There is also concern over instream flows for endangered species in the Colorado River. These instream flow issues fall generally into four categories: 1) instream flow decrees and recommendations of the Colorado Water Conservation Board (CWCB), 2) privately held instream flow decrees, 3) potential minimum stream flows associated with the proposed designation of the Gunnison River through the Black Canyon as a wild and scenic river, and 4) instream flow goals as stated in the Recovery Implementation Program For Endangered Fish Species in the Upper Colorado River Basin prepared by the U.S. Fish and Wildlife Service.

The CWCB administers Colorado's Instream Flow/Natural Lake Level Program pursuant to Section 37-92-102(3) of the Colorado Revised Statutes (C.R.S.). The CWCB is authorized to make applications in the Water Court for minimum streamflows and minimum lake levels which it determines to be necessary to preserve the natural environment to a reasonable degree. The CWCB presently holds or has applied for instream flow decrees on 180 stream reaches in the Gunnison River Basin.

All of the CWCB decrees located on stream reaches downstream of existing or proposed projects or downstream of existing diversions have been included

in the model. Decrees which are located on small headwaters streams where they would not have any impact on existing or proposed water development projects were not modeled.

There are several privately held instream flow decrees in the Upper Gunnison basin. The Rocky Mountain Biological Laboratory (RMBL) holds a group of non-consumptive instream flow and minimum lake level rights upstream of Gothic on the East River and its tributaries. The CWCB also holds instream flow rights on some of the same stream reaches. These rights were not modeled since they are located upstream of any existing or proposed developments considered in the study and therefore will not affect or be affected by potential development plans considered in the study.

The Taylor Park Pool Association (composed of local ranchers and landowners in the Taylor Park area) hold non-consumptive water rights on the Taylor River and its tributaries from Lottis Creek upstream. These water rights have been adjudicated but their legal status is somewhat unclear since C.R.S. 37-92-102(3) implies that only the State is empowered to appropriate water for instream flows. Furthermore, because these decrees are privately held, the possibility exists that they could be sold or abandoned. The legal issues involved in such a sale or abandonment are not well defined. Despite these uncertainties, it was decided that the privately held decrees located where future water development could be impacted should be included in the model since they have been adjudicated. The decrees included in the model are listed in Table 3.1.

TABLE 3.1

Taylor River Privately Held Instream Flow Decrees Included in the Model

Stream Name and Reach	Decreed Flow (cfs)	Adjudication Date	Division 4 Case Number
Lottis Creek	60.0	10-15-74	W-1987
Illinois Creek	27.5	10-15-74	W-1985
Taylor River to confluence of Lottis Creek	445.0	1-21-75	W-1991

In 1986 the Upper Gunnison River Water Conservancy District (UGRWCD) made two water rights filings in the Taylor River Drainage which included non-consumptive uses. In case No. 86CW202, the UGRWCD applied for an absolute right for 111,260 af of storage in Taylor Reservoir and releases therefrom for fishery and other recreational uses in and below the reservoir area. In case No. 86CW203, the UGRWCD applied for a conditional decree in the amount of 61,530 af and an absolute decree in the amount of 44,700 af, granting the right to refill Taylor Park Reservoir. Beneficial uses described for the stored water and for releases made to the Taylor and Gunnison Rivers include fish, wildlife, and recreational uses in addition to irrigation. These water rights were included in the model but were only operated when testing certain scenarios associated with an out-of-basin diversion project. This project is discussed in Chapter 8.

Proposed legislation to make the Black Canyon a national park and to confer Wild and Scenic status on the river through the Park would provide for instream flows in the reach below the Gunnison Tunnel. Quantification of that flow is under study at present by a committee under the auspices of Congressman Ben Nighthorse Campbell and various proposals have been put forth

by the committee members. In addition, The Nature Conservancy has proposed to donate a 300 cfs conditional water right to the CWCB to be used for instream flow purposes in that stream reach. Since the magnitude of this water right was not decided at the time of model development, discussions were held with the Technical Steering Committee and the Advisory Committee, and it was decided to adopt a year-round minimum flow of 300 cfs as the baseline instream flow regime for inclusion in the model. Furthermore, it was decided that for the purposes of this study only, this minimum flow would be supported by releases from storage in Blue Mesa Reservoir. The releases from the Blue Mesa Reservoir were modeled in a manner that the releases would meet both the senior Gunnison Tunnel decree requirements and the 300 cfs instream flows value as long as the Blue Mesa Reservoir level is above the minimum power pool It was assumed that the releases would be made with a priority date equal to the conditional water right that The Nature Conservancy is presently (1989) negotiating to donate to the CWCB, which is 1965. This assumption results in protecting the minimum streamflow release against potential diversions by downstream conditional water rights including the Mitex 1982 conditional hydropower decree. This modeling assumption was selected for the following reasons: 1) it reflects the manner in which the river would actually be administered downstream of the Aspinall Unit in the absence of an agreement between competing water interests or a ruling permitting the Federal government to retain dominion over releases made for instream flow purposes; and 2) it quantifies the maximum effect such releases would have on Blue Mesa storage. It should be noted that this was a modeling assumption only and as such has no legal implications. Resolution of this issue must be obtained outside of the study through appropriate negotiations and legal proceedings. The assumptions made in this study can not be construed as being legally binding on any affected parties including the USBR, the UVWUA, the CWCB, or The Nature Conservancy.

The U.S. Fish and Wildlife Service (USFWS) is in the process, with the cooperation of a number of other entities, of addressing the flow requirements for endangered fish species in the Westwater Canyon area of the Colorado River downstream of its confluence with the Gunnison River. These flows are

intended to be maintained primarily by releases from Green Mountain and Ruedi Reservoirs. Blue Mesa Reservoir is being discussed as an additional source of water if the supply from the other reservoirs is insufficient. The instream flow requirement at Westwater is still under study. It was therefore considered premature to model releases from Blue Mesa Reservoir for this purpose and this potential demand on Gunnison Basin water was not modeled.

3.6 TREATMENT OF CONDITIONAL WATER RIGHTS DECREES

A large number of conditional water rights decrees have been adjudicated in the Gunnison Basin. It is reasonable to assume that some of these decrees will be perfected to some degree in the future, but that others will not. Based on the future water demand forecasts developed during the study, on discussions with members of the Technical Steering and Advisory Committees, and on professional judgement, a list of conditional decrees to be included in the model was developed. Omission of conditional water rights from the list carries no legal implication regarding those rights. In fact, there are many reasons why a water supplier might legitimately maintain diligence on conditional water rights in amounts greater than included in this study's model. These reasons include but are not limited to the following:

- The water supplier may not have confidence in the reliability or longevity of its present water supply system and may be considering the implementation of a new type of system. Furthermore, it may be difficult to obtain changes in its present decrees to support the new system. An example would be the conversion of a groundwater system that is presently experiencing water quality or water table drawdown problems to a surface water storage system.

- The water supplier could have conditional decrees that may prove difficult to perfect in their present form but the possibility of transferring them to some other project, other uses, or other purpose may be feasible.

- The water supplier may have obtained conditional reservoir storage decrees in amounts greater than needed for their primary purpose of water supply in order to construct reservoirs large enough to allow other project purposes including reservoir recreation and enhancement of downstream flows.

- The water supplier may be anticipating a higher growth in water demand than was forecasted in this study. The forecasts prepared for this study are believed reasonable for the Study Area as a whole. However, there may be higher growth rates in individual areas. Local water suppliers are ultimately responsible for meeting those demands and may therefore choose to adopt more conservative approaches to meet future needs.

The list of conditional decrees included in the model is presented in Table 3.2. Certain other conditional decrees not included in the basin model were used when evaluating alternative in-basin development plans and transmountain diversion projects. These decrees were inserted to serve as the supporting water right for those potential developments. These decrees are discussed in later chapters where the two types of development are discussed.

3.7 OPERATION OF EXISTING FACILITIES

The operating procedures of major existing water supply facilities are represented in the basin model. Specific facilities and systems modeled in detail include the Aspinall Unit, the Uncompahgre Project, the Bostwick Park Project, the Dallas Creek Project, and the Project 7 Water Authority. Smaller municipal and domestic systems, such as the City of Gunnison and the Town of Crested Butte, were modeled as depletions because of the proximity of their diversion and return flow points.

3.8 MODEL CALIBRATION

The model was calibrated against historical data for the years 1979 through 1983. Comparisons were made between historical streamflows and reservoir contents and those predicted by the model. Model parameters relating to simulation of operating procedures and to calculation of return flows were adjusted as required to achieve closer agreement between modeled and historical results. The final model calibration showed a good correlation between historical and modeled results.

TABLE 3.2

Conditional Decrees Operated in Basin Model[1]

Water District	Project/Decree Name	Source	Decreed Amount	Adjudication Date	Operated Amount[2]	Use Type
40	Snowshoe Dam	Anthracite Cr.	75,000 af	08/11/69	61,600 af	Industrial
40	Lamm Reservoir	Gunnison River	162,700 af	08/11/69	22,000 af	M & I
40	Paonia Refill	Muddy Cr.	2,576 af	12/31/70	2,756 af	Irrigation
40	Fruitland Mesa Project	Crystal Cr.	600 cfs	01/31/64[3]	50 cfs	Irrigation
41	Uncompahgre Valley Hydro	Gunnison River	900 cfs	12/31/81	900 cfs	Commercial
			235 cfs	12/22/87[4]	235 cfs	Commercial
42	Grand Junction Pipeline	Gunnison River	120 cfs	07/21/59	60 cfs	Municipal
59	City of Gunnison	Gunnison River	10 cfs	06/20/57	10 cfs	M & I
59	North Village Reservoir	East River	700 af	12/31/83[3]	700 af	M & I
50	Crested Butte Mountain Resort	East River	6 cfs	12/31/81[3]	6 cfs	Snowmaking

(1) These decrees were included in the basin model for study purposes only. See Section 3.6 for additional clarification.
(2) Typical monthly diversion and depletion patterns have been derived for each decree based on anticipated use.
(3) Benefits from Curecanti subordination.
(4) Application date, water right not yet adjudicated.

4.0 FORECAST OF FUTURE DEMANDS AND WATER AVAILABILITY

4.1 INTRODUCTION

Future water demands within the Study Area were forecasted. Forecasts were prepared for municipal, industrial and agricultural use through the year 2035. Three separate forecasts were prepared for each water use sector to reflect Baseline, Moderate and High economic growth scenarios which are discussed below. The basin model was then operated to assess the ability of current water supplies to meet the future demands.

4.2 FORECAST OF FUTURE MUNICIPAL AND INDUSTRIAL DEMAND

The methodology adopted in this study to forecast future municipal and industrial water demand consisted of preparing an estimate of future population growth and applying the historical average consumptive use figures to the population projection.

Population forecasts were prepared based on three growth scenarios. The baseline scenario assumes that economic growth in the Study Area will have the same relationship to national and world economic conditions as in the past and that the net natural increase in population follows the U.S. Census Bureau's Middle Series projection. The moderate scenario assumes slightly higher economic growth due to higher energy prices and uses the average of the Census Bureau's Middle and High projections of net natural increase in population. The high scenario assumes a higher rate of economic growth, mainly due to growth in the energy sector and uses the Census Bureau's high projection of net natural increases in population.

Historic water use data combines municipal and light industrial uses and therefore these categories were retained as a combined M&I demand forecast. Other industrial water usage was determined separately by evaluating the potential for increased mining development and adding that demand to the present mining demand in the study area.

4.3 FORECAST OF FUTURE AGRICULTURAL WATER DEMAND

Agriculture, as treated in this study, consists of irrigated agriculture and livestock production. Separate forecasts were made for these two segments.

The forecasts of irrigated agricultural demand were prepared based on three scenarios of projected growth. The baseline condition for irrigated agriculture assumes continued cultivation of currently irrigated lands with associated historical cropping patterns and water shortages, which is the present situation with no change. The moderate growth scenario assumes providing a full irrigation water supply to all currently irrigated lands. The high growth scenario assumes providing a full water supply to all currently irrigated lands as well as to all other arable lands that are presently not irrigated. This entails bringing 30,235 acres of new land under irrigation. The probability of market changes occurring which would make this level of development economical is low, but it illustrates the potential maximum growth condition in the agricultural sector and the associated water demand.

The forecast of livestock water demand was based on consumptive use figures for the particular animals raised in the area and livestock population projections. The livestock population projection was based on maintaining the historic ratio of population per irrigated acre in the study area.

4.4 SUMMARY OF WATER DEMAND FORECASTS

Table 4.1 summarizes projected future water demands for the study area in the year 2035.

TABLE 4.1

Summary of Study Area Water Demands

(af/yr to nearest 50)

		Year 2035 Diversion Requirement		
Use Sector	Present	Baseline	Moderate	High
Agriculture:				
Irrigated Agriculture	706,000	706,000	783,000	901,000
Livestock Production	1,900	1,900	2,000	2,200
Municipal & Industrial:				
M&I	10,250	16,300	21,500	27,700
Mining	250	550	1,300	48,950
Total	718,400	724,750	807,800	979,850

		Year 2035 Consumptive Use		
Use Sector	Present	Baseline	Moderate	High
Agriculture:				
Irrigated Agriculture	229,000	229,000	250,000	283,000
Livestock Production	1,100	1,100	1,200	1,300
Municipal & Industrial:				
M&I	3,100	4,900	6,450	8,300
Mining	50	50	150	6,100
Total	233,250	235,050	257,800	298,700

4.5 FUTURE WATER AVAILABILITY WITH NO DEVELOPMENT

The hydrologic model discussed previously was operated to evaluate the ability of the Study Area's current water supplies to meet forecasted water demands. The Moderate Demand Scenario was used to investigate this "No-Action Alternative."

Municipal and industrial (M&I) demands for very small systems in the basin were not explicitly modeled. Of the 12 M&I demands explicitly represented in the basin model, shortages occurred to only one; a mining demand of 120 af per year located near Crested Butte. Occasional shortages to this demand occur because of a combination of limited physical supply and the fact that its water right has a very junior priority.

Agricultural demands in this No-Action Alternative are those associated with providing a full water supply to currently irrigated lands; no new lands are assumed to be brought into production. Shortages to these irrigation demands are summarized in Table 4.2. The shortages shown in the table are shortages to depletion demands; shortages to headgate diversion demands may be up to four times the shortages shown in the table and diversion shortages would occur more frequently than indicated in the table.

Further evaluation of these agricultural shortages indicated that the predicted Blue River sub-basin shortage may be overstated. Records of irrigated acreage in this sub-basin are poor to non-existent and could be the cause of overstating the demands. Also, the level of detail of the model makes verification of the adequacy of water supply in this particular sub-basin difficult. It was also determined subsequent to modeling that recent purchases of large tracts of land in the sub-basin have resulted in significant amounts of land being taken out of production. In addition, discussions with the Water Commissioner of that District revealed that significant shortages have not occurred historically in the Blue River service area. For the purposes of this study, therefore, the Blue River sub-basin was not considered to be an area with significant agricultural water shortages.

TABLE 4.2

Shortages to Agricultural Demands
No-Action Alternative
(af)

Sub-Basin	No. of Years w/Shortages	Maximum Annual Shortage	Average Annual Shortage[1]	Monthly Distribution
Ohio Creek	5	1831	793	June and July
Tomichi	6	3145	1413	May through August
Cochetopa Creek	3	721	469	May through July
Blue River	20	920	243	June through September
Cow Creek	3	756	394	April
Bostwick Park	1	420	420	August-September
Upper Spring Creek	32	167	72	July through September
Happy Canyon Creek	32	143	89	July through September
Horsefly Creek	32	118	53	May through September

1) Average annual shortages for years when shortage occurs.

Instream flow demands were represented in this evaluation by the decreed CWCB and private instream flow water rights in the basin. Whenever the streamflow in a reach was less, on an average monthly basis, than the decreed instream flow rate, a deficiency was said to exist. Such deficiencies were observed on many of the stream reaches covered by existing CWCB instream flow decrees, but most were minor. The most severe of these deficiencies were found on lower Ohio Creek, lower Tomichi Creek, and on Cochetopa Creek upstream of the confluence with Los Pinos Creek. Large deficiencies to the relatively junior private instream flow decree below Taylor Park Dam are frequent, but flow conditions regularly satisfy the CWCB decree in that reach.

An instream flow target of 300 cfs was included in the model for the Gunnison River through the Black Canyon. As discussed in Section 3.5, this water was assumed to be supplied by Blue Mesa releases whenever normal Blue Mesa operations did not provide the minimum flow level. The 300 cfs minimum was met in all months of the 32-year study period, requiring an annual average Blue Mesa storage release of 22,000 af specifically for that purpose. Blue Mesa Reservoir levels never went below minimum power pool for the No-Action Alternative.

5.0 IDENTIFICATION AND EVALUATION OF PLAN COMPONENTS

5.1 INTRODUCTION

Potential plan components were identified to meet the target objectives of the study. These target objectives are:

1. Satisfy projected future municipal and industrial water demands within the study area.
2. Provide high quality recreation opportunities that will result in increased tourism and related economic benefits to the study area and to the State of Colorado.
3. Assure that an adequate water supply will be available to support the recreational opportunities proposed as a result of meeting Objective 2 above.
4. Satisfy projected future agricultural water demands in the study area.
5. Preserve the critical aspects of the environment, such as water quality, to the maximum practicable extent consistent with the other target objectives.

Potential components consisted of both structural and non-structural measures. Non-structural components include: conservation measures which reduce water demand; water management techniques such as water right transfers; and recreation improvement components. Structural components considered include water storage and conveyance facilities.

The possibility of taking land out of production as a means of increasing streamflow for fishery and recreational purposes was not considered as it is contrary to Target Objective No. 4. Also, taking significant amounts of land out of production might result in adverse environmental effects and the effort required to evaluate that possibility is outside of the scope of the present study.

5.2 NON-STRUCTURAL COMPONENTS

5.2.1 Water Management and Conservation Measures

A number of water management and conservation measures were evaluated as potential non-structural means of satisfying future water demands. Although it may seem that agricultural demands can be reduced through more efficient irrigation practices, most of the water that appears to be unnecessarily diverted actually returns to the stream within a short period of time and is available for other uses. It was also determined that most other non-structural measures related to the agricultural sector were generally not practical because of economic or legal considerations.

The M&I sector in the study area presently accounts for less than 1.5 percent of the total consumptive use in the study area. Any savings achieved through conservation and/or improved management of M&I water supplies would therefore have practically no impact on reducing the overall future demands in the Study Area.

The two measures which were judged to have potential for implementation are: drought insurance whereby the owner of an agricultural water right agrees to lease his water during drought periods for other purposes; and water rights transfers, exchanges, and/or purchase.

Table 5.1 identifies the water management and conservation measures that were evaluated and the results of screening them.

TABLE 5.1

Summary of Screening Results
Water Management and Conservation Measures

Component	Screening Results	Remarks
Pheatophyte Control	Eliminated	Adverse environmental impact and high cost.
Ditch Lining	Eliminated	High cost relative to benefit.
On-farm Efficiency Improvements	Eliminated	High cost relative to benefit.
Reservoir Evaporation Suppression	Eliminated	Technically and financially not feasible.
M&I Water Conservation	Eliminated	Insignificant potential savings.
Water Rights Purchase, Exchange and Transfer	Retained	Potential benefit for instream flows and transmountain diversions.
Drought Insurance	Retained	Potential benefit for instream flows and transmountain diversions.
Conjunction Use of Ground and Surface Water Supplies	Eliminated	Technically not feasible.

TABLE 5.2

Recreation Components Recommended for Inclusion in Alternative Plans

TARGET OBJECTIVE: UNIQUE/TROPHY FISHERY

Water Body	Component	Proposed Action
Gunnison River - Almont to Blue Mesa Reservoir	Trophy-size, wild rainbow trout stream fishery	Manage instream flows, improve access on public sections and improve irrigation diversions
Taylor River	Trophy-size, wild rainbow trout stream fishery	Manage instream flows, institute special regulations and provide public access to 1/4 mile reach below the dam.
Blue Mesa Reservoir	Study potential for introduction of large-size trout species	Research the desirability of introducing Kamloops trout on a trial basis and implement if results warrant.
Uncompahgre River below Ridgway Reservoir	Develop trout fishery	Monitor conditions and implement appropriate plan when conditions warrant.

TARGET OBJECTIVE: IMPROVE ACCESS EXISTING GOOD QUALITY FISHERIES

Water Body	Component	Proposed Action
East River	Provide public access	Arrange for public access to 3 miles of present private property through short term leases.
Tomichi Creek (Marshall Creek to Gunnison River)	Provide public access	Arrange for public access to 8 miles of present private property through short term leases
Quartz Creek	Provide public access	Arrange for public access to 3 miles of presently private property through short term leases.

TARGET OBJECTIVE: PROVIDE IMPROVED STREAM BOATING OPPORTUNITIES

Water Body	Component	Proposed Action
Taylor River	Improve put-in and take-out points	Provide 2 raft and boat access points.
Taylor River	Improve low flow rafting potential	Modify selected reaches of streambed and manage Taylor Reservoir releases to improve rafting.
Gunnison River - Almont to Blue Mesa Reservoir	Improve put-in and take-out points	Provide 3 raft and boat access points.

TARGET OBJECTIVE: IMPROVE WATERFOWL HABITAT AND WETLAND AREAS

Waterbody	Component	Proposed Action
No Economically Beneficial Components Identified (Will Not Draw Out-of-Basin Visitors)		

TARGET OBJECTIVE: IMPROVE CAMPING AND HIKING OPPORTUNITIES

Waterbody	Component	Proposed Action
Gunnison River - Almont to Blue Mesa Reservoir	Provide campgrounds	Develop 25 campsites
East River	Provide campgrounds and trails	Develop 10 campsites and 18 miles of trail between Almont and Crested Butte.
Taylor River	Provide campgrounds	Develop 25 campsites.
Taylor Park Reservoir	Provide campgrounds	Develop 30 RV campsites.
Tomichi Creek	Provide trail	Develop 4 miles of streamside trail through City of Gunnison, 3-acre park and 20 picnic sites.
Cochetopa Creek within Cochetopa Canyon	Improve existing campgrounds	Improve 32 existing primitive campsites.
Uncompahgre River	Provide trails	Develop 17 mile trail from Montrose to Ridgway Reservoir.

Irrigation water supply shortages, instream flow deficiencies, water quality improvement, and flood control were all identified as needs to be met in a potential water resource development plan. These needs are summarized below:

Study Area Water Shortages/Deficiencies

Sub-basin	Irrigation Shortage	Streamflow Deficiency(1)	Flood Control Desirable	Water Quality Deficiency
East River		X	X	
Slate River		X		X
Ohio Creek	X	X	X	X
Tomichi Creek	X	X	X	X
Cochetopa Creek	X	X	X	X
Quartz Creek		X	X	X
Soap Creek		X		
Cimarron River		X		
Taylor River (Below Spring Ck.)		X		
Cow Creek	X			
Upper Spring Creek	X			
Happy Canyon Creek	X			
Horsefly Creek	X			

(1) Measured against CWCB decrees.

These needs were reviewed from the standpoint of identifying a practical, economical means of satisfying the particular need. It was decided that structural measures to satisfy only streamflow deficiencies, only flood control, or only these two in combination would not be warranted from an economic and environmental perspective. Therefore, the sub-basins experiencing irrigation shortages, as well as other needs, and the Slate River which experiences significant water quality problems were selected as the sub-basins to be studied for potential multipurpose structural components. This resulted in eight sub-basins being investigated for potential structural components.

Several storage reservoirs were investigated to mitigate the water quality problems on the Slate River by providing dilution releases. These reservoirs were eliminated from further consideration on the basis of high cost and their locations in environmentally sensitive areas.

Two types of structural components were identified to meet future agricultural demands: conveyance systems to transfer water from one sub-basin to another, and storage reservoirs. These were evaluated, and it was determined that conveyance systems were not economically feasible and that storage reservoirs provided the only practical means of meeting projected future agricultural water demands.

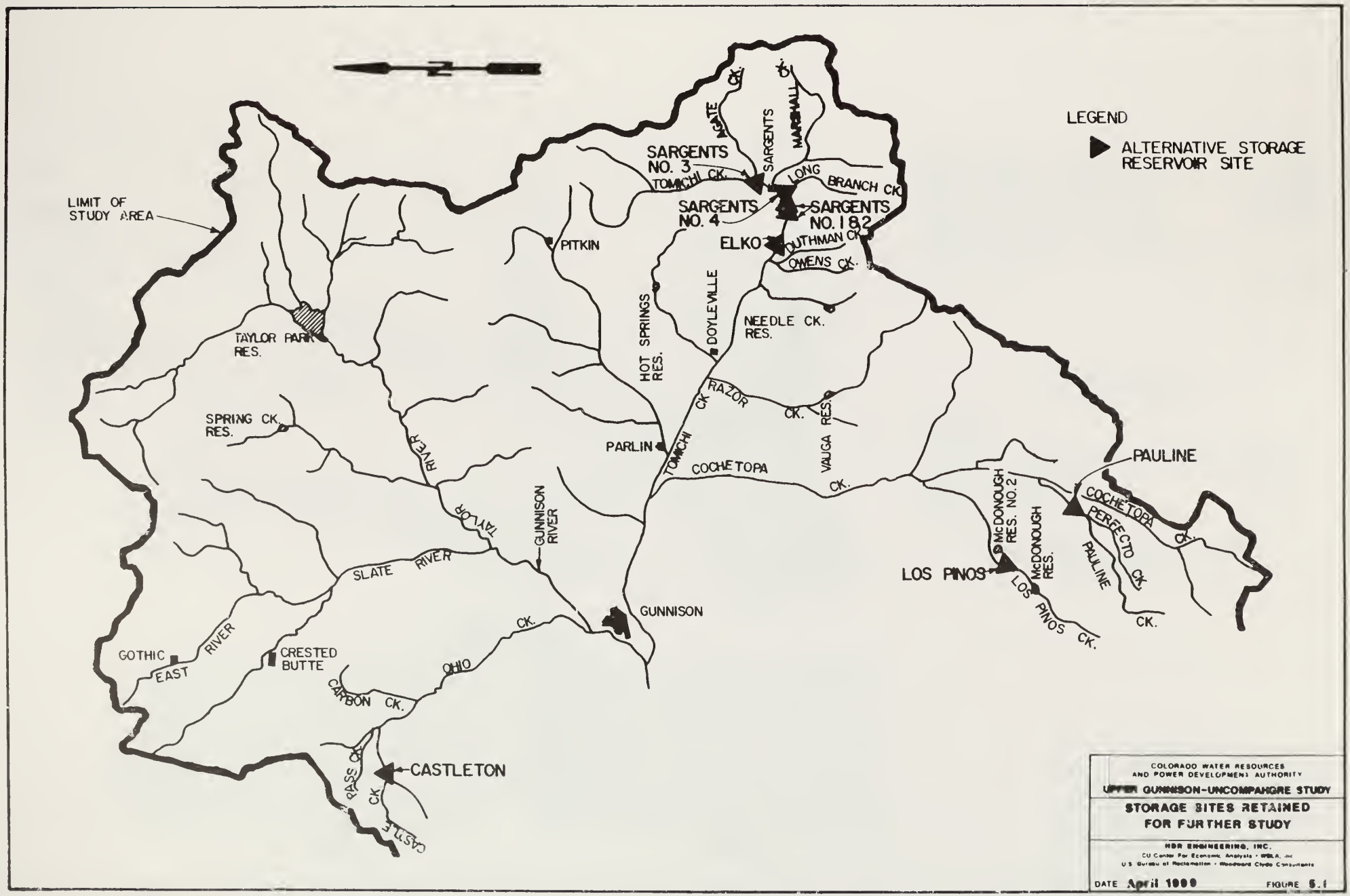
A total of 57 potential reservoir sites were identified in the seven sub-basins identified as having irrigation shortages. A preliminary screening of these 57 sites resulted in retaining eight alternative sites located in three different sub-basins. Four of the seven sub-basins were eliminated from further consideration because the shortages in these sub-basins were very small in magnitude and the structural measures identified to satisfy the shortages were found to be very costly. Eight reservoir sites were retained for further study. These were: the Los Pinos and Pauline sites in the Cochetopa Creek sub-basin; the Castleton site in the Ohio Creek sub-basin; and the Elko and Sargents No. 1, 2, 3 and 4 sites in the Tomichi Creek sub-basin. The locations of these potential reservoir sites are shown on Figure 5.1.

Preliminary evaluation of these components resulted in retaining the Ohio Creek site, the two Cochetopa sub-basin sites, and two of the five sites in the Tomichi sub-basin; Sargents No. 3 and Elko. The two Cochetopa sites and the two Tomichi sites that were retained for further study exhibit advantages and disadvantages that make a definite choice between them very difficult at this level of study.

The major project features and preliminary cost estimates for each of these five potential storage reservoirs is presented in Table 5.3. All of these potential reservoirs would be formed by earthfill embankment dams with ungated spillways and multilevel outlet works. Preliminary project layout drawings are shown in Figures 5.2 through 5.6.

Table 5.3
Summary of Potential Storage Reservoirs

FEATURES	Los Pinos	Pauline	Castleton	Elko	Sargents #3
Total Storage	12,000 af	10,000 af	20,000 af	30,000 af	25,000 af
Surface Area	300 ac	206 ac	286 ac	540 ac	474 ac
Dam Height	119 ft	189 ft	199 ft	121 ft	143 ft
Dam Volume	241,000 cy	640,000 cy	599,000 cy	492,000 cy	771,000 cy
COST ESTIMATE ($1000's)					
Mobilization, Land, and Access	755	958	1,917	1,357	1,342
Dam, Spillway and Outlet Works	6,250	10,987	11,300	9,268	11,635
Relocations	980	385	0	3,600	3,425
Miscellaneous Items (10%)	799	1,233	1,322	1,423	1,640
Subtotal Direct Cost	8,784	13,563	14,539	15,648	18,042
Contingencies (25%)	2,196	3,391	3,635	3,912	4,511
Total Direct Cost	10,980	16,954	18,174	19,560	22,553
Engr., Legal, & Admin.(15%)	1,647	2,543	2,726	2,934	3,383
Total Construction Cost	12,627	19,497	20,900	22,494	25,936
Interest During Construc (8%, 3yrs)	1,573	2,429	2,603	2,802	3,231
Total Capital Cost	14,200	21,926	23,503	25,296	29,167
Debt Serv. Rsrv.(1 yr. debt serv)	1,430	2,208	2,367	2,547	2,937
Financing Expenses (3%)	469	724	776	835	963
Total Investment Cost	16,099	24,858	26,646	28,678	33,067
Annual Debt Service (8%, 30yrs)	1,430	2,208	2,367	2,547	2,937
Annual O&M Cost	49	46	59	68	63
Total Annual Cost	1,479	2,254	2,426	2,615	3,000



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

STORAGE SITES RETAINED FOR FURTHER STUDY

HDR ENGINEERING, INC.

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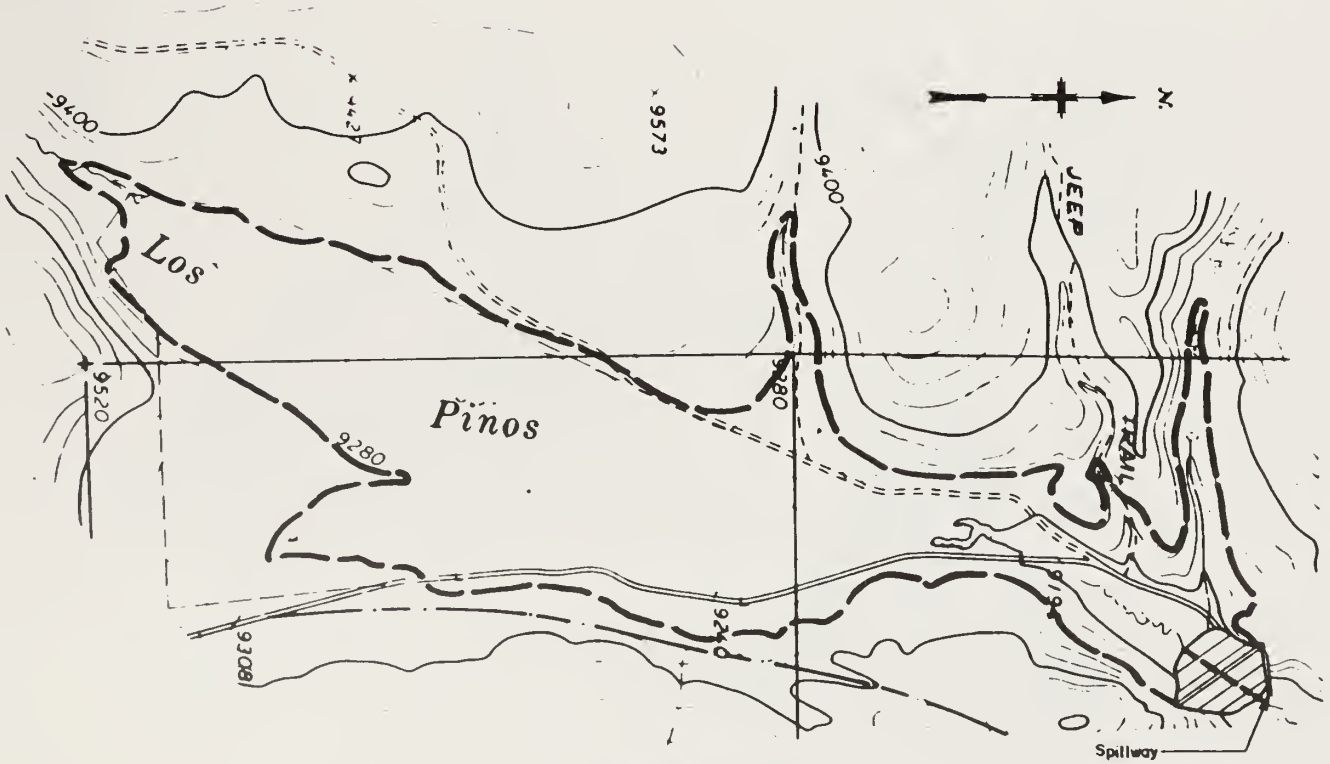
U.S. Bureau of Reclamation · Woodward Clyde Consultants

DATE April 1999 FIGURE 5.1



SITE PLAN

DAM CREST LENGTH	800
DAM CREST ELEVATION	9, 299
SPILLWAY ELEVATION	9, 289
NORMAL WATER SURFACE ELEVATION	9, 289

LEGEND

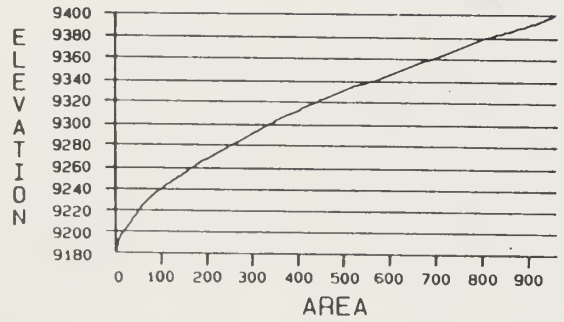
NORMAL WATER SURFACE ELEVATION

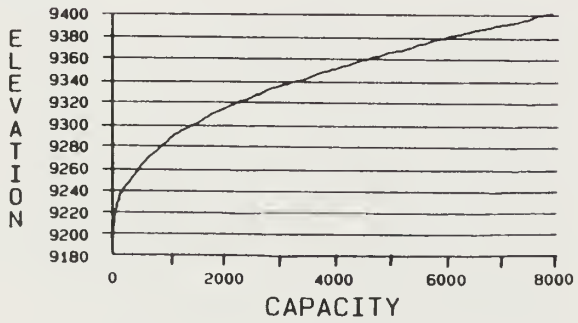
RESERVOIR OUTLET

ROAD RELOCATION

0 1000 2000 3000

SCALE IN FEET





COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

LOS PINOS PROJECT LAYOUT

HDR ENGINEERING, INC.

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U.S. Bureau of Reclamation · Woodward Clyde Consultants

DATE April 1989 FIGURE 5.2

SITE PLAN

DAM CREST LENGTH	2, 100
DAM CREST ELEVATION	10, 069
SPILLWAY ELEVATION	10, 059
NORMAL WATER SURFACE ELEVATION	10, 059

LEGEND

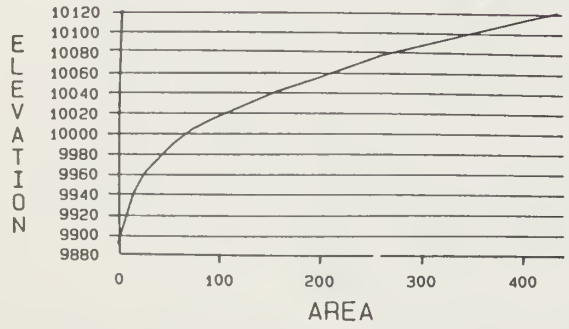
NORMAL WATER SURFACE ELEVATION

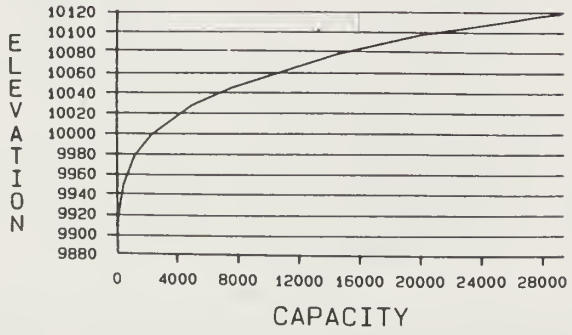
RESERVOIR OUTLET

ROAD RELOCATION

0 1000 2000 3000

SCALE IN FEET





COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

PAULINE PROJECT LAYOUT

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CU Center For Economic Analysis • WBLA Inc
U S Bureau of Reclamation • Woodward Clyde Consultants

DATE April 1989 FIGURE 5.3

N.

DAM CREST LENGTH	1,550
DAM CREST ELEVATION	8,399
SPILLWAY ELEVATION	8,389
NORMAL WATER SURFACE ELEVATION	8,389

LEGEND

NORMAL WATER SURFACE ELEVATION

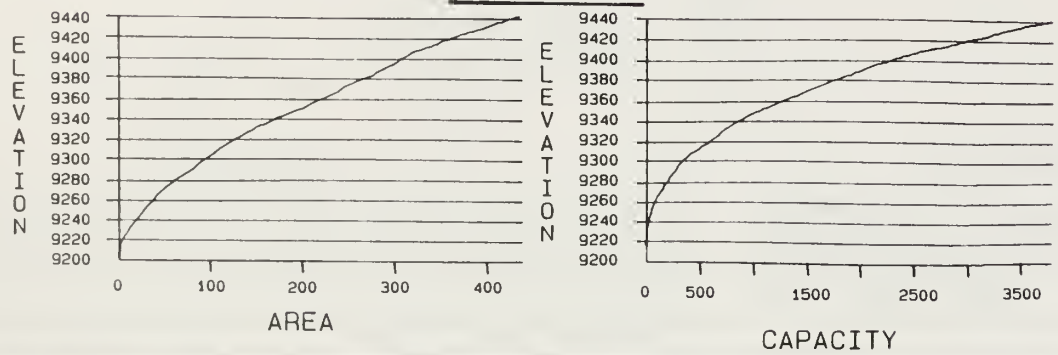
RESERVOIR OUTLET

ROAD RELOCATION

0 1000 2000 3000

SCALE IN FEET

SITE PLAN



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

CASTLETON PROJECT LAYOUT

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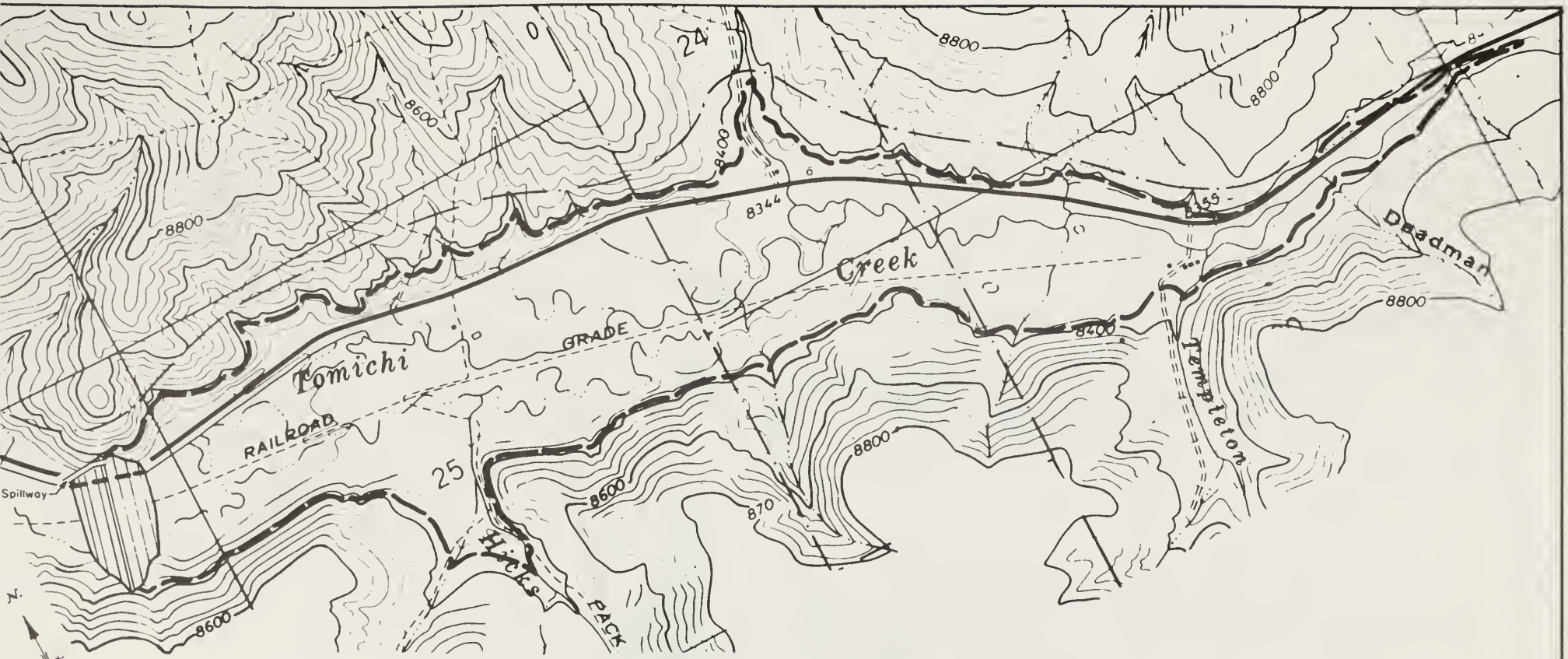
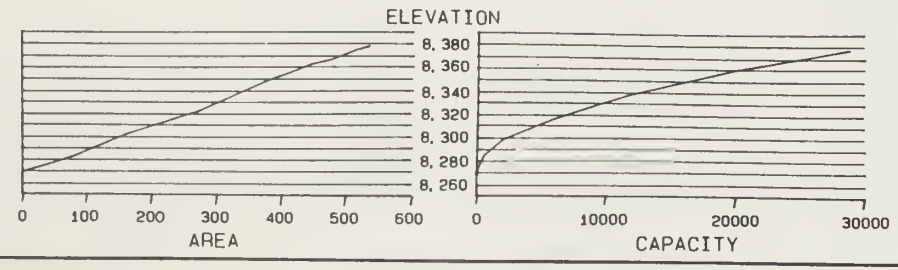
DATE April 1989 FIGURE 5.4



SITE PLAN

DAM CREST LENGTH	1, 350
DAM CREST ELEVATION	8, 391
SPILLWAY ELEVATION	8, 381
NORMAL WATER SURFACE ELEVATION	8, 381



LEGEND

NORMAL WATER SURFACE ELEVATION

RESERVOIR OUTLET

ROAD RELOCATION

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

ELKO PROJECT LAYOUT

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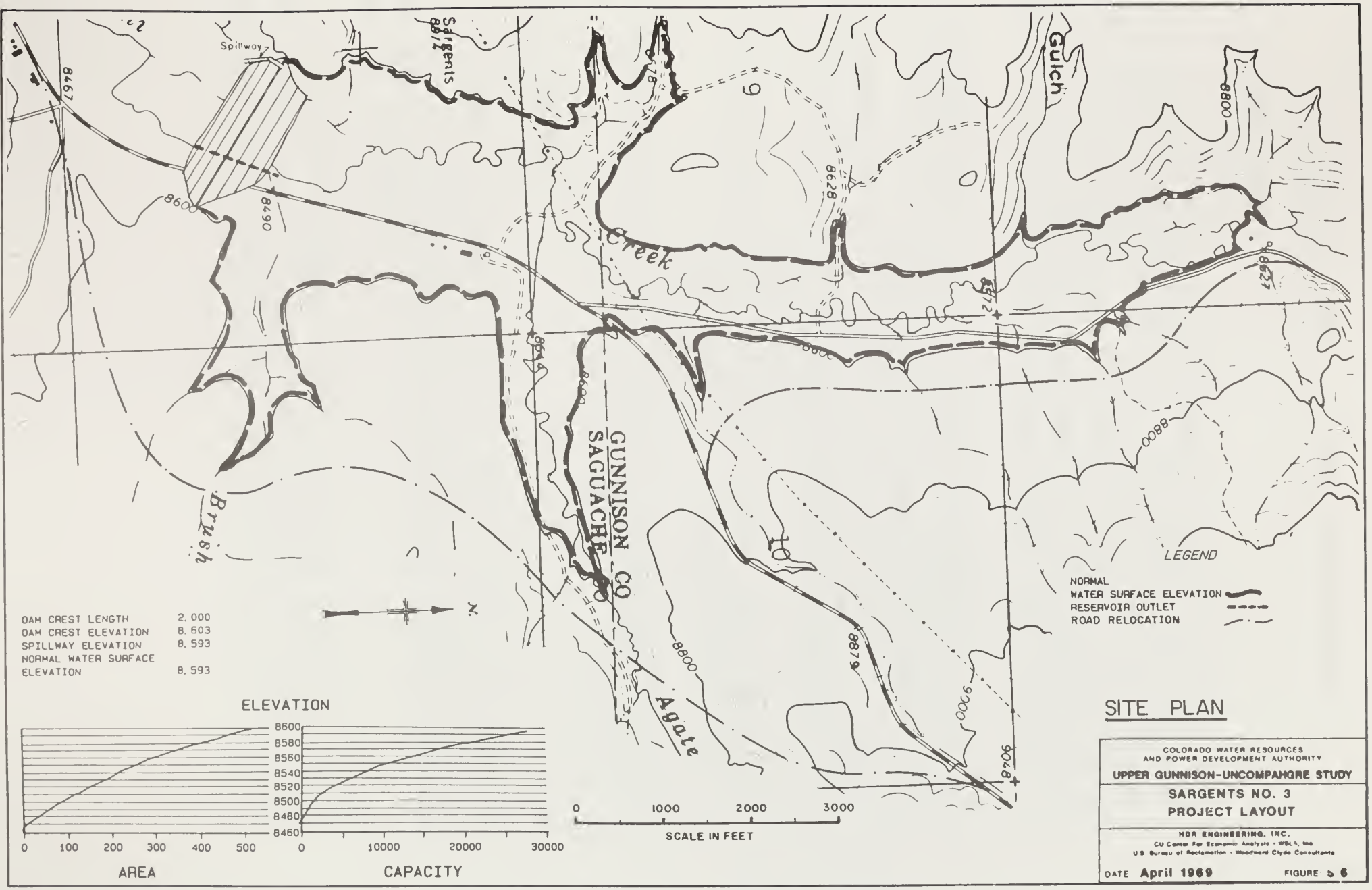
U.S. Bureau of Reclamation • Woodward Clyde Consultants

DATE **April 1989** FIGURE **5.5**



SITE PLAN

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

SARGENTS NO. 3
PROJECT LAYOUT

HDR ENGINEERING, INC.
CU Center For Economic Analysis · WBLA, Inc
U.S. Bureau of Reclamation · Woodward Clyde Consultants

DATE April 1969 FIGURE 5.6

6.0 IN-BASIN DEVELOPMENT PLAN FORMULATION AND EVALUATION

6.1 PLAN FORMULATION

The components retained after screening the alternatives discussed in the previous chapter are listed in Table 6.1. These components were combined into six alternative development plans to meet projected in-basin water demands. The six plans were formulated with the intent of presenting a broad range of development possibilities which would meet the target objectives to some degree. These alternative plans are defined in general terms as follows:

Alternative No. 1 - a group of 17 recreational components.
Alternative No. 2 - three storage reservoirs, one each in the Ohio Creek, Tomichi Creek and Cochetopa Creek sub-basins.
Alternative No. 3 - a combination of alternatives 1 and 2.
Alternative No. 4 - three storage reservoirs of Alternative 2 combined with ten recreation components selected from Alternative No. 1.
Alternative No. 5 - storage reservoirs on Tomichi Creek and Ohio Creek combined with the ten recreation components from Alternative No. 4
Alternative No. 6 - one storage reservoir on Tomichi Creek combined with ten recreation components from Alternative No. 4.

6.2 PLAN EVALUATION

The hydrologic computer model was used to evaluate the effects of developing alternative plans. This allowed plans to be compared relative to each other and also to the results of the No-Action Alternative discussed previously in Chapter 4.

The recreation components included in alternative plans do not consume water, although several of them may require management of streamflow through changes in reservoir release patterns. When modeling alternative plans, these

components were not included since they do not consume water, and because modifications to reservoir release patterns to accommodate recreation needs will ultimately be established such that downstream water users will not be adversely impacted. Therefore, only alternatives which include storage reservoirs were modeled. In evaluating potential in-basin reservoirs, only one alternative was modeled explicitly; namely, the development of three reservoirs, one each on Ohio, Tomichi, and Cochetopa Creeks. Alternatives representing development of a single reservoir or combinations of two of the three reservoirs were not modeled.

Because of the Curecanti Subordination, which insures that in-basin depletions under junior water rights are not called out by Blue Mesa Reservoir, the hydrologic effects of individual reservoirs are largely confined to the streams on which those reservoirs are located. Increased in-basin storage and water use on any one tributary above Blue Mesa generally does not affect yields to in-basin water rights on other tributaries. Therefore, the modeling of individual in-basin storage projects would not add significantly to the information that could be obtained from modeling all three reservoirs together.

The principal effect of developing all three in-basin storage projects for irrigation use and streamflow enhancement is to correspondingly increase late season inflow to Blue Mesa. This, in turn, increases the late season physical supply available to the senior Gunnison Tunnel direct flow decree and decreases late season dependence by the Tunnel on Taylor Park Exchange water stored in Blue Mesa.

Five alternative in-basin reservoirs in three sub-basins were evaluated using the basin model. These reservoirs include Castleton in the Ohio Creek sub-basin, Elko and Sargents No. 3 on Tomichi Creek, and Los Pinos and Pauline in the upper Cochetopa drainage.

Scenario (model run) 2A evaluated a combination of Castleton, Elko, and Los Pinos reservoirs. Results of this scenario showed that certain

agricultural shortages and instream flow deficiencies still remained with the reservoirs assumed to be in place. The results also suggested that the shortages could be eliminated or reduced by moving to storage sites further upstream on Tomichi and Cochetopa Creeks. Therefore, Scenario 2B evaluated a combination of Castleton, Sargents No. 3, and Pauline reservoirs.

The storage of water in these reservoirs was assumed to occur under conditional decrees held by the Upper Gunnison River Water Conservancy District, assuming they could be transferred to the proposed reservoir site if required. The reservoirs were operated to alleviate agricultural supply shortages and to meet enhanced instream flow targets. Releases were made on demand to satisfy both water uses. Otherwise the reservoirs were allowed to store water in priority and to spill when full.

The enhanced instream flow targets were developed from statistics of natural flow on Ohio, Tomichi, and Cochetopa Creeks and are based on fishery and recreational considerations. On all streams the enhanced instream flow targets are equal to or higher than the CWCB decreed values. Enhanced instream flow targets were developed for each modeled reach on each of the three tributaries. However, usually only one reach on each tributary acted as the controlling reach, calling instream flow water through the other reaches and satisfying them in the process. The controlling reaches and their associated flow targets are:

Ohio Ck. at Mouth	29 cfs year-round
Tomichi Ck. Above Razor Ck.	18 cfs Oct-Mar, 31 cfs Apr-Sep
Cochetopa Ck. Above Los Pinos Ck.	9 cfs Oct-Mar, 15 cfs Apr-Sep

The hydrologic performance of each in-basin reservoir was evaluated mainly by assessing agricultural shortages and instream flow conditions on the respective streams. Recreation potential of the reservoirs was evaluated by examining reservoir level fluctuations. Basin-wide effects were identified by evaluating conditions at several other key stream reaches, storage reservoirs, and points of diversion in the basin.

The three reservoirs modeled in Scenario 2B were able to eliminate shortages to agricultural depletion demands that were identified in the No-Action Alternative. Enhanced instream flow targets were met or exceeded throughout the 32-year study period (1952-1983) on Ohio and Tomichi Creeks, but not on upper Cochetopa and Pauline Creeks, where insufficient physical supply caused infrequent deficiencies. Tables 6.2 through 6.4 summarize the monthly instream flows predicted by the model in specified locations on Ohio, Tomichi, and Cochetopa Creeks with the three reservoirs in place.

The recreation potential of Castleton and Sargents No. 3 reservoirs appear good. As shown on Figures 6.1 and 6.2, these reservoirs fill regularly and are substantially full most of the time. Pauline Reservoir, shown on Figure 6.3, is often very low or near empty because of the lack of physical supply. Blue Mesa Reservoir storage levels under this scenario differ from the No-Action Alternative as depicted in Figure 6.4.

The Taylor Park Exchange Agreement stipulates that the UVWUA be given a credit to draw on Blue Mesa storage in direct proportion to Taylor Park Reservoir releases made in excess of Gunnison Tunnel diversions, up to an amount equal to their Taylor Park storage decree. Flows downstream of Taylor Park Dam, Blue Mesa Reservoir inflows, and tunnel diversions were all monitored in the model to keep track of credits and debits to the "exchange account." As mentioned previously, the late season releases from the three reservoirs increase late season inflows to Blue Mesa, which reduces the need for Gunnison Tunnel diversions to draw on Blue Mesa storage during the latter part of the growing season. This reduces the draw on UVWUA's storage credit in Blue Mesa and results in the Taylor Park Exchange Account showing a higher average storage credit than in the No-Action Alternative. The average monthly exchange credit under Scenario 2B is 5228 af/mo, compared to 4857 af/mo in the No-Action Alternative. This indicates that construction of the three in-basin reservoirs increases the dependability of the UVWUA water supply from Taylor Park Reservoir.

Gunnison Tunnel diversion demands are consistently met and Blue Mesa Reservoir releases are able to maintain the target 300 cfs minimum instream flow in the Black Canyon under Scenario 2B.

6.3 SCREENING OF ALTERNATIVE PLANS

The six alternative plans were screened by the Study Team and reviewed by the Authority, the project sponsors, the Technical Steering Committee, and the Advisory Committee. The following screening factors were used: ability to meet target objectives; environmental effects; potential benefits; institutional/ social factors; and cost. Table 6.5 presents a summary of the screening results. The relative rank assigned to each alternative plans is presented below:

Plan	Rank
Alternative 5	1
Alternative 6	2
Alternative 1	3
Alternative 3	4
Alternative 4	5
Alternative 2	6

Alternative 5 was selected as the top ranked plan mainly because it meets the target objectives in a balanced manner with relatively few adverse environmental impacts. The two reservoirs included in this alternative would be able to reduce the total average annual irrigation depletion shortage in the Study Area by about 60 percent. Furthermore, the hydrologic model results indicate that the reservoirs can provide releases to meet enhanced streamflow targets below each dam and would have reservoir fluctuations which would allow the development of a flatwater recreation facility at each reservoir. Both reservoirs could alleviate flooding which takes place periodically. Although the No-Action scenario did not identify any M&I shortages in the study area, the water that is stored for the purpose of instream flow enhancement could possibly be stored under a transferred City of Gunnison storage decree. This

would provide for municipal water storage and instream flow releases, if an arrangement could be made, whereby the City would utilize these reservoirs to convert its groundwater system to a surface water system in the future. It should be noted that this possibility may or may not be in accordance with the City's present or future plans regarding their water rights.

The ten recreation components cover a variety of activities including: fishery enhancement, boating, camping, hiking and bicycling. If implemented as a group, the following economic benefits are expected: national publicity, a significant increase in visitor days with associated economic benefits, and a significantly enhanced recreational environment for the local population.

Additionally, Alternative 5 can be staged in a variety of ways; for example, the recreation components could be phase one, one reservoir could be phase two, and the second reservoir could comprise the last stage. This sequence could be reversed or the recreation components could also be phased.

The estimated total capital cost to implement Alternative 5 is approximately $55.5 million. A breakdown of that cost is presented in Table 6.6.

TABLE 6.1

Components Recommended for Consideration in Plan Formulation

<u>In-Basin Reservoirs</u>

Storage Reservoir in the Ohio Creek Basin

Storage Reservoir in the Upper Cochetopa Basin

Storage Reservoir in the Upper Tomichi Basin

<u>Recreation Components</u>

Campsites along Gunnison
Trail and campsites along East River
*Campsites along Taylor River
Campsites at Taylor Park Reservoir
Streamside trail and park along Tomichi Creek
*Campsites in Cochetopa Canyon
*Trail from Montrose to Ridgway Reservoir
Boat Access points on Taylor River
*Improve Taylor River low flow boating
*Boat access points on Gunnison River
*Improve access to East River
*Improve access to Tomichi Creek
Improve access to Quartz Creek
*Trophy fishery on Gunnison River
*Study of trophy fishery in Blue Mesa
*Trophy fishery on Taylor River
Monitor fishery on Uncompahgre River

<u>Water Management and Conservation Measures</u>

Water Rights Purchases, Exchanges and Transfers
Drought Insurance

---

*Denotes first priority items.

TABLE 6.2

Ohio Creek at Mouth, Modeled
Average Monthly Flow with Castleton Reservoir (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Average	34	32	30	29	29	29	81	227	291	100	39	33	77
Std.Dev	7	3	1	0	1	1	20	98	153	92	17	8	26
Maximum	53	43	36	31	33	32	114	446	652	445	109	80	140
Minimum	29	29	29	29	29	29	33	38	29	29	29	29	32
CWCB													
DECREE	12	12	12	12	12	12	12	12	12	12	12	12	
ENHANCED ISF													
TARGET	29	29	29	29	29	29	29	29	29	29	29	29	

TABLE 6.3

Tomichi Creek Above Razor Creek, Modeled
Average Monthly Flow with Sargents No. 3 Reservoir (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Average	29	24	23	23	24	27	50	110	119	53	38	40	47
Std.Dev	18	8	5	8	6	11	24	100	103	41	12	17	21
Maximum	79	44	37	48	38	59	104	417	457	232	84	109	100
Minimum	20	20	20	20	20	18	31	31	31	33	31	33	28
CWCB													
DECREE	18	18	18	18	18	18	18	18	18	18	18	18	
ENHANCED ISF													
TARGET	18	18	18	18	18	18	31	31	31	31	31	31	

TABLE 6.4

Cochetopa Creek Above Los Pinos Creek, Modeled
Average Monthly Flow with Pauline Reservoir (cfs)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Average	18	19	16	15	15	19	33	40	47	25	24	20	24
Std.Dev	6	3	3	3	3	4	10	25	34	15	10	7	7
Maximum	31	25	22	22	19	28	64	113	153	85	53	41	41
Minimum	7	12	8	7	7	11	17	12	3	0	11	5	12
CWCB													
DECREE	9	9	9	9	9	9	9	9	9	9	9	9	
ENHANCED ISF													
TARGET	9	9	9	9	9	9	15	15	15	15	15	15	

TABLE 6.5

Alternative Plan Comparison Table

Alternative Plan	Overall Ranking: Tech.	Envir.	Institutional/ Social	Cost[1]	Comments
1	Low	High	High	7.8 0.9 NA	Single purpose development plan benefits only recreation. Reliability of projected direct economic benefits is low to moderate at this stage of study therefore financing will be relatively difficult to obtain except for grants.
2	Low	Mod.	Mod.	83.2 7.5 137.0	Multipurpose development plan but benefits to recreation and flood control are relatively low, most of benefits are agricultural water supply. Includes three dams, one of which will have limited recreation benefit. Public resistance is expected to be severe.
3	Mod.	Mod.	Mod.	91.4 7.5 153.0	This plan combines alternatives 1 and 2. Weaknesses, except single purpose weakness, noted above exist in this plan also. Plan provides a relatively good balance of benefits.
4	Mod.	Mod.	Mod.	86.4 7.9 144.0	This plan reduces the number of recreation components included in Alt. No. 3 but is the same otherwise. Some reduction of recreation benefit obviously results, but a good balance of benefits is still obtained.
5	High	Mod.	High	62.0 5.7 126.0	This plan includes all the recreation components of Alt. No. 4 but only two of the reservoirs. The reservoirs satisfy about 60% of identified irrigation shortages. Both reservoirs provide instream flow enhancement and both are potentially good flatwater recreation facilities because reservoir fluctuations are acceptable. This plan provides a good balance of potential benefits.
6	Mod.	Mod.	Mod.	35.8 3.3 132.0	This plan includes all the recreation components of Alts. 4 and 5 but includes only one reservoir. The reservoir satisfies 40 percent of the identified irrigation shortage and provides streamflow enhancement and good flatwater recreation potential.

(1) Cost shown are as follows: top number is total investment cost expressed in millions of dollars, second number is annualized investment cost also in millions, third number is unit cost of storage expressed in $/af. All costs are in January 1989 prices.

TABLE 6.6

Preliminary Cost Estimate - Alternative No. 5

INVESTMENT COST :	
Total Construction Cost of Recreation Components	$2,580,000
Total Construction Cost of Ohio Creek Reservoir	$20,900,000
Total Construction Cost of Tomichi Creek Reservoir	$25,936,000
Total Plan Construction Cost	$49,416,000
Interest During Construction (8% over three years)	$6,157,000
Total Plan Capital Cost	$55,573,000
Debt Service Reserve Fund (1 year debt service)	$5,507,000
Financing Expenses (1 1/2% of capital cost plus debt service reserve)	$916,000
Total Investment Cost	$61,996,000
ANNUAL COST :	
Annual Debt Service (8% over 30 years)	$5,507,000
Annual Lease and/or O&M Cost	$179,000
Total Annual Cost	$5,686,000

FIGURE 6.1

CASTLETON RESERVOIR
Scenario 2B Reservoir Level

FIGURE 6.2

SARGENTS RESERVOIR NO. 3
Scenario 2B Reservoir Level

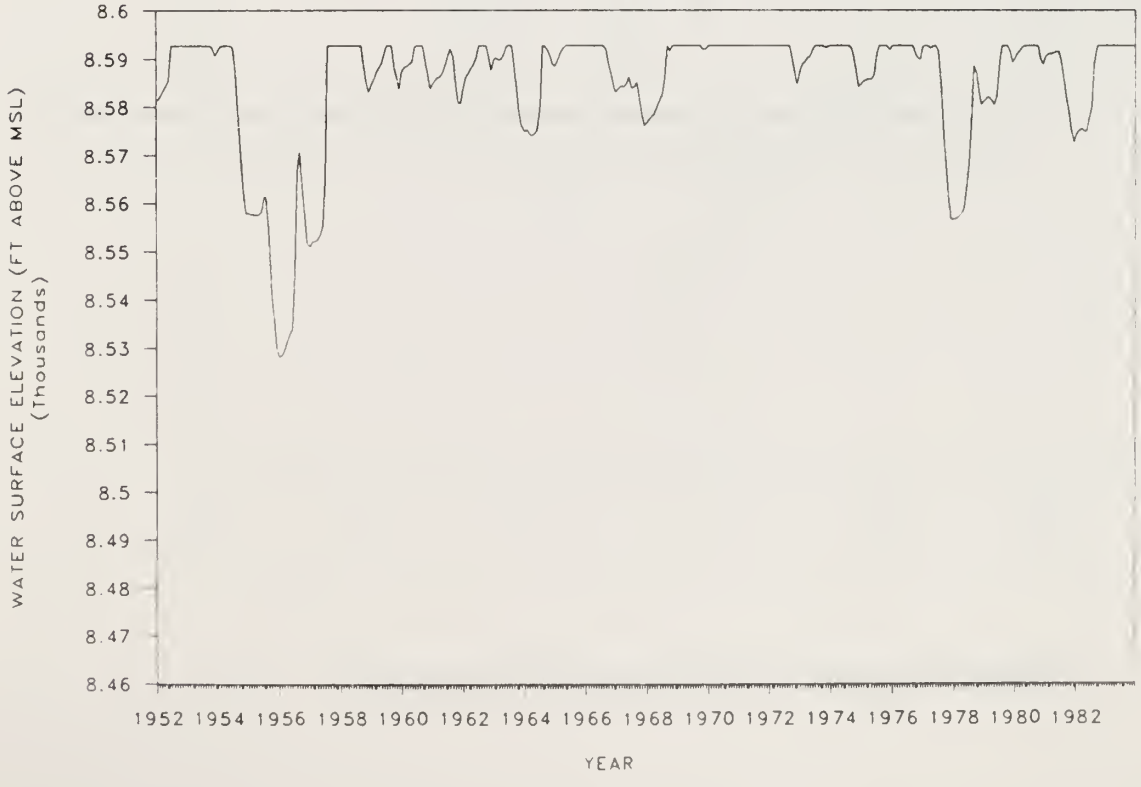


FIGURE 6.3

PAULINE RESERVOIR
Scenario 2B Reservoir Level

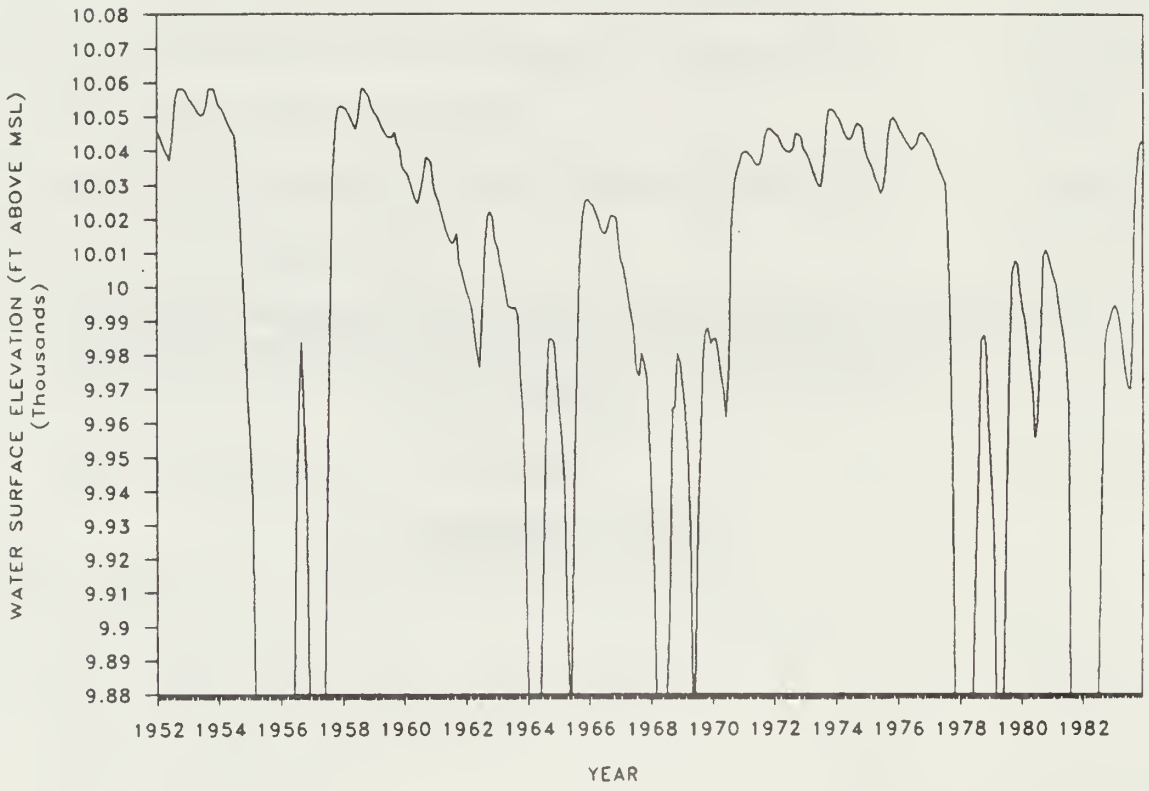
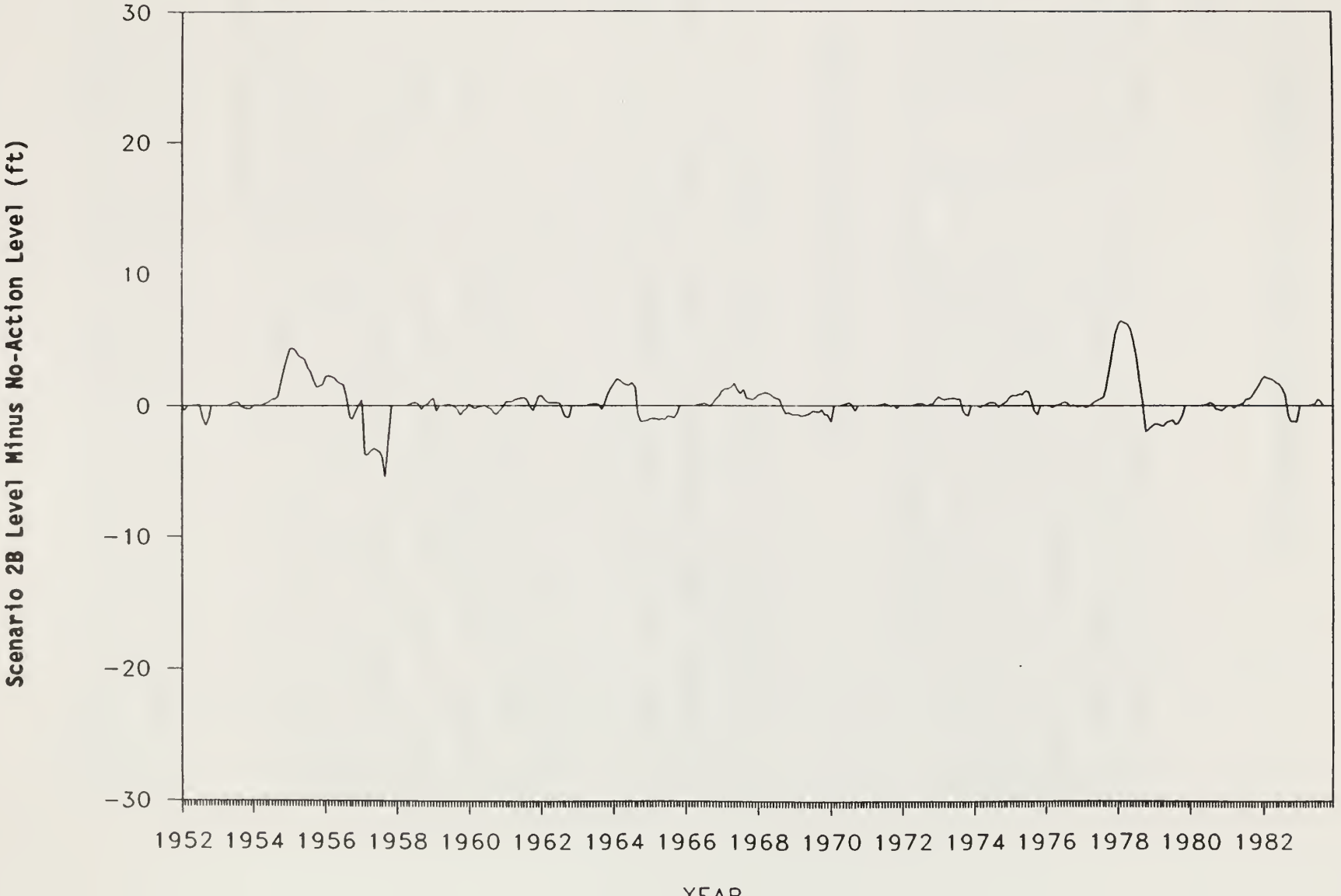


FIGURE 6.4

BLUE MESA RESERVOIR LEVEL
No-Action versus Scenario 2B



7.0 FINANCIAL EVALUATION OF PREFERRED PLAN

7.1 INTRODUCTION

A preliminary financial evaluation of the preferred plan was prepared in order to provide an indication of the financial viability of that plan. For the purpose of this study, a staged version of Alternative No. 5 which includes one storage reservoir on Tomichi Creek and all ten recreation components was evaluated. This was done because certain sources of financing are only available for "small" projects, and Alternative No. 5 does not qualify unless the scope of the project is reduced through phasing.

7.2 SOURCES OF FUNDING AND RESULTING ANNUAL COSTS

A broad list of potential funding sources for implementation of Alternative No. 5 was prepared and reviewed. After evaluating the list of potential sources, a financing strategy was developed which identified a potential source of funds for each component included in the plan. Table 7.1 defines the financing strategy used for the analysis.

The required project funding is assumed to come from: USBR Small Projects Program Grant, State environmental mitigation grant (HB 1158), low interest state and Federal loans, and the sale of revenue bonds. Therefore, the only funds included in the financing strategy which require up-front financing costs and interest during construction is the amount assumed to be derived from the sale of revenue bonds, $2,851,000. When interest during construction, debt service reserve funds and financing expenses are added to the construction amount allocated to revenue bonds, the total amount of bonds that are required is $3,635,000.

Table 7.2 presents a breakdown of project funding by source along with the annual debt service associated with repayment of each source. This table is based on preliminary discussions with key personnel at the potential

funding agencies involved. The total annual cost associated with Alternative No. 5, Phase 1, based on the assumed financing strategy is $1,247,000.

It should be noted that the total annual cost can be reduced somewhat by eliminating the need to include interest during construction, debt service reserve funds, and financing expenses. This can be accomplished by establishing a fund with relatively small annual payments (approximately $39,000 per year over 15 years) made into the fund during the permitting and final design phase of the project. Considering the lead time required to implement a project such as this, the project sponsors may be able to accumulate sufficient funds to cover these up-front costs. If this were done, the total annual project cost could be reduced by about $70,000 to $1,177,000 per year.

7.3 SOURCES AND AMOUNT OF DIRECT PROJECT INCOME

Alternative No. 5, if implemented, will generate direct income from the sale of agricultural water and from campground user fees. The average annual sale of agricultural water has been estimated to be 7800 af, while annual campground use has been estimated at approximately 8000 campsite days. The resulting direct project income is as follows:

7800 af per year of agricultural water at $10 per af	=	$78,000 per year
8000 campsite-days at $8	=	64,000 per year
Total		$142,000 per year

The direct agricultural benefits are the result of the $10 per af charge for the water. Quantifying increased agricultural production and including the market value of the crops would constitute a double counting of the direct benefits and, therefore, has not been included in the study.

7.4 OTHER PROJECT BENEFITS

7.4.1 Economic Impact of Increased Tourism

The increased visitation estimated to result from implementation of Alternative No. 5, Phase I is estimated to be 62,000 visitor days annually. The economic impact to the region resulting from this increased tourism was estimated using data available from various studies of tourist and visitor spending patterns. Based on the breakdown of expected visitation by the type of recreation component, the total estimated incremental visitor days was estimated to consist of 54 percent campers and 46 percent commercial lodgers. The estimate of economic benefit was prepared on the basis of direct expenditures and induced benefits. Direct expenditures represent spending by the additional visitors on all goods and services purchased in the area including: food, beverages, retail shopping, supplies, lodging and other rentals, restaurant meals, gasoline and other transportation expenses that would accrue to the region. Induced benefits are represented by transactions among local businesses and spending resulting from local resident consumption, local government spending and other forms of local spending that will result from the increased visitation. The results of this analysis are summarized as follows:

Direct Expenditures	$2,610,000
Induced Benefits	$1,840,000
Total Economic Output	$4,450,000
Direct Employment Generated	64
Total Employment Generated	94

7.4.2 Environmental Indirect Benefits

Implementation of the preferred alternative will result in other indirect benefits to the environment, fish and wildlife, and to the general public

living in the area. No attempt has been made to quantify the economic impact of these indirect benefits; however, they are discussed briefly below for informational purposes.

Instream Flow. The preferred alternative includes one storage reservoir located in the Upper Tomichi Creek basin. This reservoir was sized to provide releases to enhance the natural streamflow in Tomichi Creek. For example, in the No-Action Alternative, minimum summer flows in Tomichi Creek above Razor Creek reach zero in six years of the 32-year period investigated, whereas the minimum summer flow under Alternative No. 5, Phase 1, is 31 cfs as a result of the proposed storage reservoir on Upper Tomichi Creek. The expected flow regime in Tomichi Creek with the proposed reservoir in place is expected to be highly beneficial to the existing fishery.

7.4.3 Flood Protection Benefits

A reservoir on Upper Tomichi Creek has the potential of providing flood protection to the Tomichi valley. The economics of constructing the reservoir large enough to do this has not been investigated in this phase of the study.

7.5 POTENTIAL SOURCES OF SUPPLEMENTAL INCOME

Sections 7.2 and 7.3 demonstrated that direct project income is not sufficient for project debt repayment. However, the project also generates significant indirect benefits which would accrue to the general population of the Study Area as defined in Section 7.4. Potential sources of supplemental income for use in project debt repayment not included in the financing strategy were identified for consideration, if the project sponsors believe that the indirect benefits warrant proceeding with project implementation. These potential sources are discussed below.

- Formation of Special District. A special Recreation and Economic Development District could be formed in the Study Area for the

purpose of providing economic development through the construction of water and recreation facilities. Such a district would require state legislative authorization and local voter approval. If such a district were formed and could levy a one mill property tax and half cent sales tax, it is estimated that approximately $1,200,000 could be raised annually.

If the district were formed to encompass the Upper Gunnison River Water Conservancy District (UGWCD) boundaries only, the annual tax income is estimated to be $550,000.

- Increase UGRWCD Mill Levy. If the present UGRWCD mill levy were increased by one mill, it is estimated that approximately $170,000 additional per year would be raised. That money could possibly be used for the purpose of project debt service on the basis of the indirect benefit to the community at large.

- Water Sales. The UGRWCD, or a newly created entity, could develop a water export project which may have the potential to subsidize the debt service associated with development of an in-basin development plan. This would be a significant undertaking for a local entity; however, they could implement such a project on a turnkey, design-build basis which would make it a manageable undertaking.

- Power Sales. The UGRWCD, or a newly created entity, could potentially develop a pumped-storage project that might generate income in excess of its debt service that may have the potential to assist with debt service of in-basin development.

- Aspinall Mitigation Funds. The Federal government has authorized, but not appropriated, approximately $820,000 to be used to obtain access to streams for fishing as a replacement measure for the stream fishery that was lost as a result of constructing Blue Mesa Reservoir. Obtaining these funds may take a coordinated and

concerted effort on the part of the local citizens, the CDOW and Colorado congressional delegation. Use of these funds for this project would also require approval of the CDOW.

- Land Sales. The sale of property around the proposed Tomichi Creek Reservoir and/or collection of lease fees from landowners near the reservoir offers another potential source of funds for project development. This has not been evaluated in this study.

- Federal Funding Although not considered as a source of financing in this phase of the Study, a potential source of project funding that should be considered in future phases of this phase of the Study is appropriated Federal funds. Such funds may be available for a project that is regional in nature such as an east-west slope cooperative development to provide water to a variety of users and also that provides outdoor recreation opportunities.

TABLE 7.1

Financing Strategy for
Alternative No. 5, Phase I

Plan Component	Construction Cost ($)	Annual Cost ($)	Funding Source
Gunnison River Trophy Fishery	150,000		CWCB [1] Construction Loan
		3,000	Project Income or Taxes
Taylor River Trophy Fishery	25,000		DOW
		6,000	Project Income or Taxes
Gunnison River Boat Access	90,000		State Lottery Funds
		3,000	Project Income or Taxes
Taylor River Campgrounds	250,000		Revenue Bonds
		5,000	User Fees
Cochetopa Creek Campgrounds	215,000		Revenue Bonds
		6,500	User Fees
Uncompahgre River Trail	1,700,000		State Lottery ($500,000) Funds and Revenue Bonds ($1,200,000)
		17,000	Project Income or Taxes
Tomichi Creek Reservoir	25,936,000		USBR[2] grant ($5,000,000) and Loan ($8,500,000); CWCB Loan ($10,000,000); State Environmental Mitigation Funds ($1,250,000) Revenue Bonds ($1,186,000)
		63,000	Project Income or Taxes
Taylor Riverbed Mod. for Rafting	150,000	-	State Lottery Funds
East River Access	-	4,500	Project Income or Taxes
Tomichi Creek Access	-	12,000	Project Income or Taxes
TOTAL	$28,516,000	$120,000	

[1] Colorado Water Conservation Board.

[2] USBR grant and loan refers to funds available under the Small Reclamation Projects Act of 1956.

TABLE 7.2

Breakdown of Total Annual Cost
Alternative No. 5, Phase 1

Funding Source	Amount	Annual Debt Service
DOW Grant	$ 25,000	-
USBR Grant (Small Projects Loan Program)	5,000,000	-
Lottery Funds Grant	740,000	-
State Envir. Mitigation Funds (grant)	1,250,000	-
USBR Loan (0 int. over 40 years)	8,500,000	$ 212,500
CWCB Loan (5% int. over 40 years	10,150,000	591,540
Revenue Bonds (8% over 30 years)	3,635,000	322,985
	Total Annual Debt Service	$1,127,025
	Annual Lease, O&M Cost	120,000
Total Annual Cost		$1,247,025

8.0 POTENTIAL FINANCIAL ENHANCEMENT

8.1 INTRODUCTION

In addition to defining and evaluating potential water resource development plans to serve in-basin needs, this study also identified and evaluated potential projects which, when combined with the preferred in-basin development plan, may result in a more comprehensive project with enhanced financial attractiveness. Specifically, two options were studied: pumped-storage hydroelectric generating facilities, and sale of water out of the basin. These options may require participation from electrical power entities or east slope water suppliers. This study has not speculated on the specific institutional relationships that might be involved. If these entities pursue a cooperative approach to project development, further study would be required to arrive at an equitable sharing of project costs and benefits.

8.2 PUMPED STORAGE HYDROELECTRIC POWER GENERATION

Pumped-storage electric generating plants are a special type of hydroelectric plant designed specifically to generate peaking capacity. Such developments involve pumping water from a lower reservoir to an upper reservoir with low cost off-peak power and later releasing the water from the upper reservoir back to the lower reservoir during peak power demand periods to generate high value peaking power. Most pumped-storage projects recirculate the same water and after initial reservoir filling, only require additions to the water supply to make up for evaporation and seepage losses.

A review of existing reports and a preliminary evaluation of the basin topography resulted in the identification of 30 potential pumped-storage sites in the study area. These sites were screened on the basis of the ratio of water conductor length to gross head, which is an indicator of a potential project's economic attractiveness. Two projects: the 720 MW Needle Point No. 3 and 1000 MW Rocky Point No. 2, were selected as potentially attractive sites

and were evaluated in greater detail. Preliminary layouts and cost estimates were prepared for these two projects.

The Needle Point No. 3 project is located on the north side of Morrow Point Reservoir and about one mile west of Curecanti Creek. It has an average gross head of about 1930 feet which can support an installed capacity of 720 MW. As shown on Figure 8.1, this project utilizes the existing Morrow Point Reservoir for the lower reservoir. The estimated total capital cost of the project is approximately $577 million. This results in a unit capital cost of about $800 per installed kilowatt.

The Rocky Point pumped-storage project, located on the north side of Taylor Park Reservoir, uses that existing reservoir as its lower reservoir. As presently proposed by the project proponent, Natural Energy Resources Company (NECO), this project has an installed capacity of 1000 MW computed on the basis of generating power about eight hours per day, five days per week. In order to put this project on the same basis as all the other projects considered, it was necessary to increase the size of the upper reservoir to provide sufficient storage to generate power 10 hours per day, five days per week, which is the criteria established in this study. The general project configuration is shown on Figure 8.2. The estimated cost is the same as presented in NECO's Federal Energy Regulatory Commission license application with a modification to the upper reservoir cost. The estimate has also been updated to the January 1989 price level. The estimated total capital cost for this project is approximately $920 million. This results in a unit capital cost of about $920 per installed kilowatt.

Comparisons between these two projects on the basis of the data presented herein should be avoided since they have been studied to different levels of detail. The Rocky Point project has been studied to full feasibility level of detail, including geotechnical field and laboratory investigations. As a result, the cost estimate for that project has a much lower risk of error due to unknown or unforeseen conditions than the Needle Point No. 3 project, which has been studied at a prefeasibility level.

Results of a peaking power study which was recently (January 1989) completed for the Authority indicate that a total installed peaking capacity of 450 MW (medium growth) to 825 MW (high growth) may be economically attractive within the State of Colorado by the year 2007, if the cost of that capacity is in the range of $1000/kW to $1200/kW. It appears, therefore, that both of the pumped-storage projects evaluated in this study may be financially feasible and could possibly serve as a method for enhancing the financial attractiveness of an in-basin water resource development plan, provided that the economic benefits of the project are shared in an equitable manner between the water supply function and the power supply function of a combined project.

8.3 OUT-OF-BASIN WATER SALES

8.3.1 Introduction

The possibility of exporting water from the study area to the Front Range was investigated as a potential method of enhancing the financial feasibility of an in-basin development plan. The purpose of the investigation was to determine if the potential for an export project exists; and if so, to make a preliminary determination as to whether such a project appears to be financially feasible and therefore would warrant further, more detailed study. Water sales to downstream states was not investigated due to institutional constraints associated with such an arrangement.

A review of existing data and reports identified three previously studied projects which would divert water from the Upper Taylor River basin to either the Arkansas River basin or the South Platte River basin. These projects are:

- the Collegiate Range Project as proposed by the City of Aurora;
- the Union Park Water Supply Project as proposed by Arapahoe County; and
- the Central Colorado Project as evaluated by the Central Colorado Water Conservancy District.

In addition, the concept of diverting Upper Taylor River water from the existing Taylor Park Reservoir to either the Arkansas or South Platte Basins was evaluated (Taylor Park Project). These four potential projects are illustrated schematically in Figure 8.3.

8.3.2 Methodology and Assumptions

The methodology and simplifying assumptions which formed the basis of this investigation are as follows:

- In cases where proposed export projects affect the operation of existing facilities, require purchases of Blue Mesa Reservoir water to replace water diverted upstream, or involve contractual arrangements with holders of senior water rights, it was assumed that the necessary agreements could be reached.

- The project configurations reported in published literature for previously studied projects were accepted. In the case of the Collegiate Range Project, the project proponent has stated that additional front range storage is not a required element of the project (personal communication with Mr. Doug Kemper, Manager of Water Resources, City of Aurora).

- Independent cost estimates were developed for each project.

- Preliminary engineering studies were carried out for new projects in order to size the project features and to estimate construction quantities for use in preparing cost estimates.

- Front range storage requirements to accommodate the Taylor Park Project water deliveries were estimated based on a uniform inflow rate to a hypothetical east slope storage reservoir. Releases from the east slope reservoir matched a typical municipal demand pattern. A ten percent dead storage allowance and a 25 percent contingency

allowance were added to the estimated storage requirement. Since the location of such a facility is unknown, its cost was estimated using a direct cost of $1250 per af of total storage provided. This figure is based on a review of the actual cost of recently constructed front range storage facilities and cost estimates of proposed front range storage reservoirs of a comparable size.

- Sensitivity analyses were conducted to test the effect of water rights and instream flow considerations on the potential attractiveness of front range water delivery projects. The Taylor Park Project was used for these analyses because it is the only project under consideration which lends itself to the preliminary analysis appropriate for the present level of study. This project does not require the modeling of additional west slope reservoirs. Equally important, this project does not require modeling of the physical facilities needed to collect and deliver the water to the new west slope reservoirs. The model results obtained from the Taylor Park Project analysis can be used to infer conclusions related to the other projects.

8.3.3. Modified Central Colorado Project

As configured in this study, the Modified Central Colorado Project would export only uncommitted Blue Mesa Reservoir water (up to 180,000 af per year) and only to the Arkansas River basin. Delivery to the South Platte River basin was found to be uneconomical for this project. No storage facilities in the Arkansas basin were included in this project configuration. It was determined that, at an average annual yield of 60,000 af, the unit cost of the water is approximately $6125 per af based on a project capital cost of about $367 million. At a yield of 150,000 af, the unit cost reduces to about $2950 per af. This project is not considered economically attractive at the lower yield, while higher yields appear to adversely impact Blue Mesa Reservoir levels.

8.3.4 Taylor Park Project

A yield analysis of the Taylor Park Project was carried out using various assumptions regarding water rights, instream flow requirements in the Taylor River below Taylor Park Dam, and minimum allowable water levels for Taylor Park Reservoir.

Regarding the water right assumption, an export from Taylor Park Reservoir could possibly be supported by existing rights such as the Uncompahgre Valley Water Users Association's (UVWUA) Taylor Park storage decree with replacement water purchased from Blue Mesa Reservoir; by transfer of the Upper Gunnison River Water Conservancy District's (UGWCD) conditional storage decrees; by transfer of some other existing conditional storage decrees; or by a new storage decree. Implementation of any purchase agreement for water from Blue Mesa Reservoir would be subject to the terms of the assignment of the Blue Mesa Reservoir storage and direct-flow water rights from the Colorado River Water Conservation District (CRWCD) to the United States. Use of Blue Mesa water in export projects is conditioned upon prior consent of the parties to that agreement. There may also be other legal or institutional constraints regarding purchase of Blue Mesa water; this study has not analyzed such constraints.

Important considerations in assessing the yield of a new water right include the effect of privately held instream flow decrees on the Taylor River below Taylor Park Dam, and the potential for full administration of the Aspinall Unit power rights by the State Engineer's office. The privately held decrees for up to 445 cfs year-around have the potential to severely limit the yield of junior upstream appropriations or changes of use by senior upstream rights, regardless of whether replacement storage is constructed elsewhere in the basin. Scenario 13 assessed the storable flow yield of a new right for transbasin diversion assuming this privately held instream decree is maintained and exercised.

Potential increased demand by Aspinall Unit hydropower rights in the basin may result if these direct flow decrees are fully utilized to support power production. The hydrologic model was calibrated using only Aspinall Unit storage decrees to support the power generation. As discussed in Section 3.4, this was done to calibrate the model with historical reservoir operations. The study has not addressed full administration of these existing hydropower rights against upstream junior diversions. However, in the March 1989 issue of Colorado Stream Lines, Keith Kepler, Assistant Division IV Engineer stated that, in his opinion, export of water from Taylor Park would not be feasible if hydroelectric power rights are fully exercised in the future.

For the purpose of this study, the yield was estimated using both the UVWUA storage decree and a new storage decree because this approach provides an upper and lower limit, respectively, for the range of export yields. The UVWUA storage decree was used in the analysis to illustrate the effects of using an existing senior water right to support transmountain exports and does not imply that the Board of Directors of the UVWUA anticipates or supports such an arrangement. It should also be noted that several significant institutional factors, such as changing the decreed use of the water, would have to be resolved before this right could be used to support an export project.

Three different Taylor River instream flow regimes were used to evaluate potential effects on export yields. Regime I assumes that streamflows below Taylor Park Dam will not be allowed to go below the CWCB's instream flow decree. Regime II assumes a higher streamflow which simulates the present target releases under the Taylor Park Exchange Agreement. Regime III is identical to Regime II with the exception that flows during two summer months of the year are increased to 300 cfs from the 150 cfs of Regime II.

The minimum target storage level assumed for Taylor Park Reservoir was 23,400 af (elevation 9268) which corresponds to a drawdown of approximately 62 feet below full normal pool. The historic lowest level reached was 8780 af

(about elevation 9241) in 1956. It should be noted that no conservation pool presently exists at this reservoir and, therefore, no minimum storage level is legally required by the Taylor Park Reservoir storage decree.

The operation study assumed that instream flow releases would have the highest priority, minimum reservoir level would have the next highest, and the export project would have the lowest priority. This assumption was made because it is expected that before an export project is implemented, such conditions would be imposed by the permitting agencies. The operation study also assumed that transmountain diversions would take place at a uniform rate which understates the export yield potentially available during high flow periods. Finally, present Taylor Park Reservoir operating rules were modified by eliminating forecast rules which tend to draw down the reservoir in anticipation of the next spring runoff. Instead, the export project performs the same function.

The yield analysis was carried out for the 32-year hydrologic period of 1952-1983. Figure 8.4 presents the yield study results. The average of the annual yields obtained during the 32-year period modeled is plotted against instream flow assumption for the case of using the existing UVWUA water right and for using a new junior decree. For the purpose of sizing this project, an average annual yield of 42,000 af corresponding to instream flow Regime II and the use of an existing water right was selected as the Taylor Park Project yield.

A detailed evaluation of the hydrologic model output indicates that construction of this project will not adversely affect existing downstream water rights, except for the privately held instream flow decree downstream of Taylor Park Dam. This relatively junior decree is seldom met under present conditions or under the No-Action Alternative, but the magnitude of the deficiency is increased with the Taylor Park project in place.

Preliminary engineering layouts were prepared for the 42,000 af yield project configuration and the cost of that project was estimated. A variation

of that project which adds 58,000 af of yield from a pumpback facility from Blue Mesa Reservoir to Taylor Park Reservoir was also evaluated. The unit cost of the base project (42,000 af) was determined to be about $7150 per af of average yield based on the project capital cost of about $300 million. The corresponding figure for the 100,000 af project variation is $5310 per af.

8.3.5 Collegiate Range Project

The average annual yield of this project identified in the 1985 report titled Collegiate Range Project prepared by the David E. Fleming Company is 73,000 af. The project configuration and sizing presented in that report and in preliminary project drawings supplied by the City of Aurora was reviewed by the Study Team. An independent cost estimate was then prepared based on that configuration. The total capital cost of the project was estimated to be about $512 million.

8.3.6 Union Park Project

This project would divert water from Taylor Park Reservoir into the proposed Union Park Reservoir located on Lottis Creek, south of Taylor Park Reservoir. The project as proposed by NECO is intended to supply water to the Denver Metro area during dry years only. This concept is different from the other alternatives evaluated. In order to evaluate the yield under this dry year delivery concept, an end user must be identified and an integrated system operation study performed. Such a study has not been reported on by NECO but was done by the Corps of Engineers when they evaluated the Union Park Project (Metropolitan Denver Water Supply System EIS, Volume VIII, 1988). The results showed a "safe yield" ranging from 63,000 af to 111,000 af when operated as a component of the Denver Water Department (DWD) system.

The project configuration and sizing of individual features presented in the 1988 report titled Union Park Water Supply Project Reconnaissance Evaluation Study prepared by Ebasco Services, Incorporated, was used by the

Study Team to prepare an independent cost estimate. The estimated capital cost of this project is approximately $721 million.

8.3.7 Value of Water

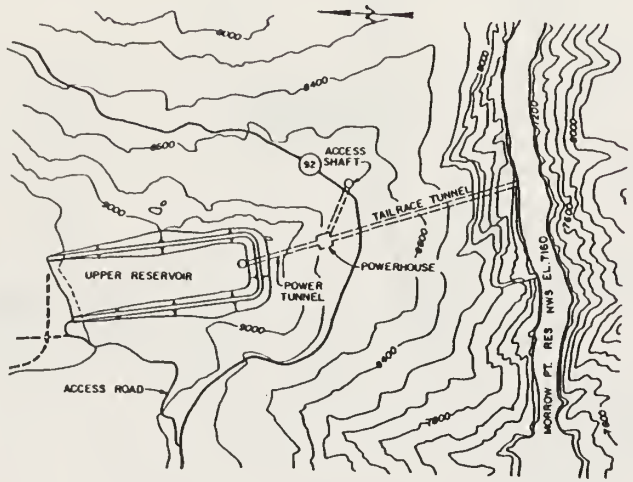
Based on a brief review of recent water transactions and estimated costs for projects currently being considered, front-range metropolitan areas are currently paying an up-front cost of $2000 to $10,000 per af of firm yield. This broad range in cost is largely attributable to variations in the definition of firm yield, the location of and alternatives available to specific water users, and the immediacy of the need for the water. Because transactions at either extreme of this cost range are relatively infrequent, it appears that a reasonable value of new sources of municipal water is in the range of $3000 to $9000 per af.

8.3.8 Conclusion

The Upper Taylor River Basin has the hydrologic potential to be the source of a transmountain diversion project that could deliver water to the South Platte River Basin or the Arkansas River Basin. The hydrologic yield of such projects depends on many technical and institutional considerations including, but not limited to, the water right used for the export and the instream flow requirements in the Taylor River drainage. A potential export project entails many conflicts with the holders of other water rights and with the operators of existing facilities.

Using the Taylor Park Project as an example, the total capital cost ($300 million including east slope regulating storage) divided by an average annual yield of approximately 42,000 af results in a unit capital cost of about $7150 per af. This same project with the addition of 58,000 af of average yield from the Blue Mesa pumping variation (100,000 af total average yield) results in a unit cost of about $5310 per af based on a capital cost of $531 million. These costs are within the range of costs being experienced by municipal and industrial users along the front range and indicate that a project with

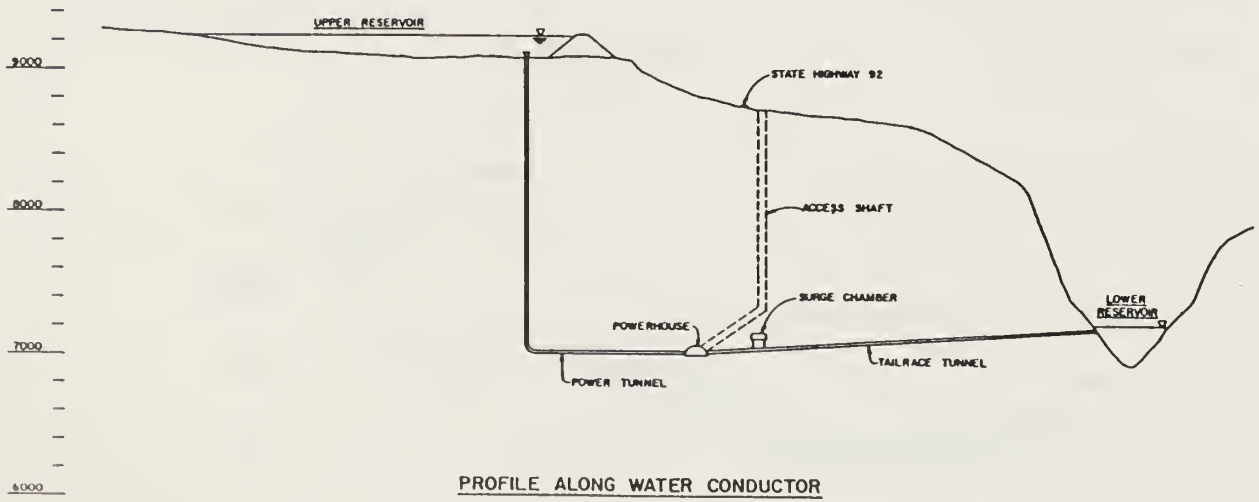
out-of-basin water sales component may enhance the financial attractiveness of an in-basin development plan.



SITE PLAN

1000 0 1000

SCALE IN FEET



PROFILE ALONG WATER CONDUCTOR

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

NEEDLE POINT NO. 3

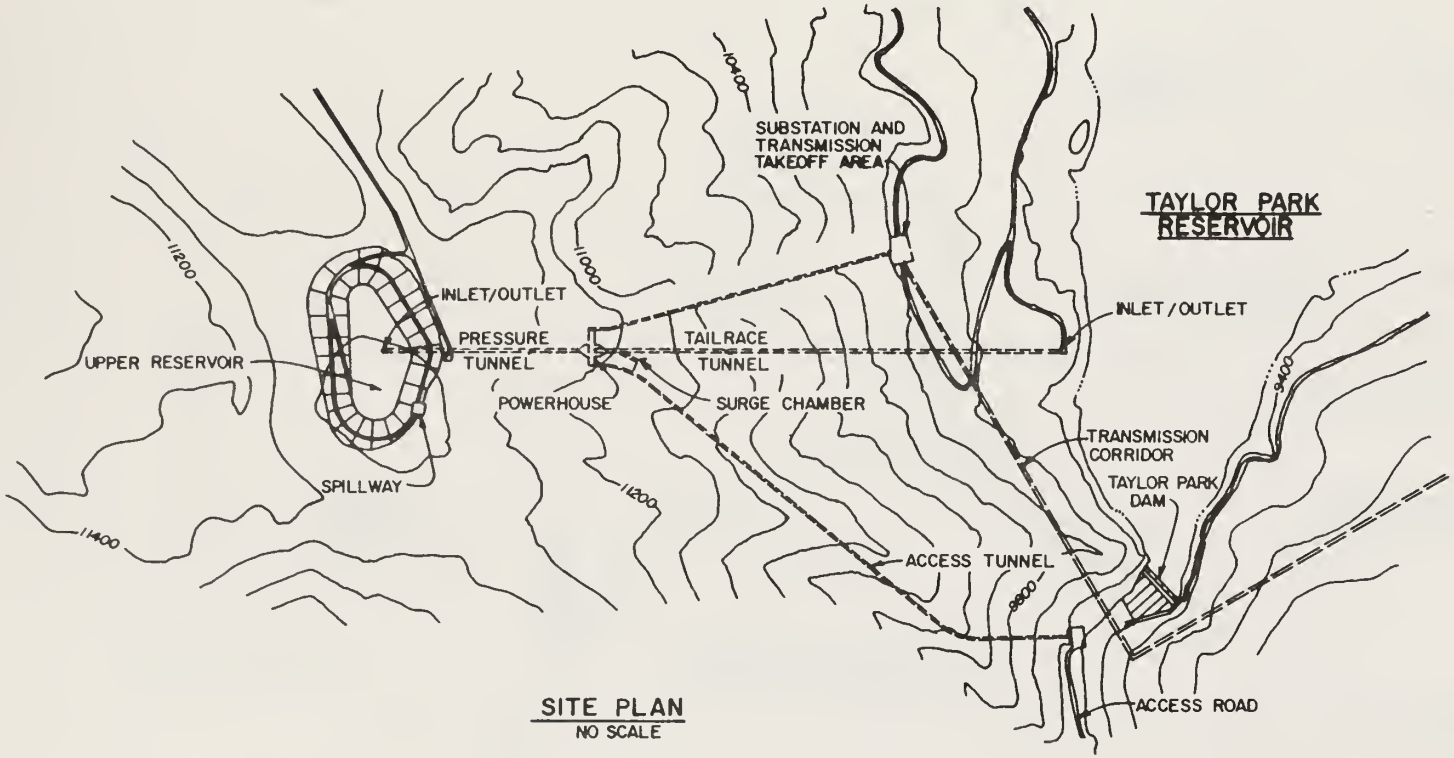
PUMPED-STORAGE PROJECT

HDR ENGINEERING, INC.

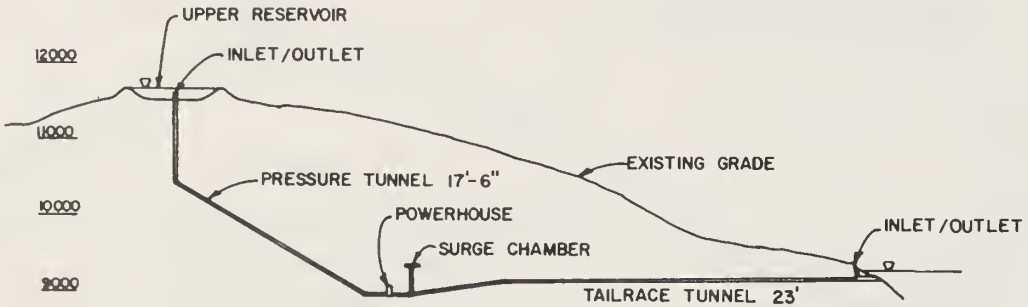
CU Center For Economic Analysis • WBLA, Inc.

U.S. Bureau of Reclamation • Woodward Clyde Consultants

DATE April 1989 FIGURE 8.1



SITE PLAN
NO SCALE



PROFILE ALONG POWER TUNNEL

NOTE: DATA PRESENTED HEREIN TAKEN FROM APPLICATION FOR MAJOR UNCONSTRUCTED PROJECT FOR THE ROCKY POINT PUMPED STORAGE PROJECT (FERC PROJECT NO. 7802) PROPOSED BY NATURAL ENERGY RESOURCES COMPANY WITH THE EXCEPTION OF THE UPPER RESERVOIR WHICH IS SHOWN ENLARGED.

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

UPPER GUNNISON-UNCOMPAHGRE STUDY

ROCKY POINT PUMPED-STORAGE PROJECT

NBR ENGINEERING, INC.
CU Center For Economic Analysis - WBLA, Inc.
U.S. Bureau of Reclamation - Woodward Clyde Consultants

DATE April 1989 FIGURE 8.2

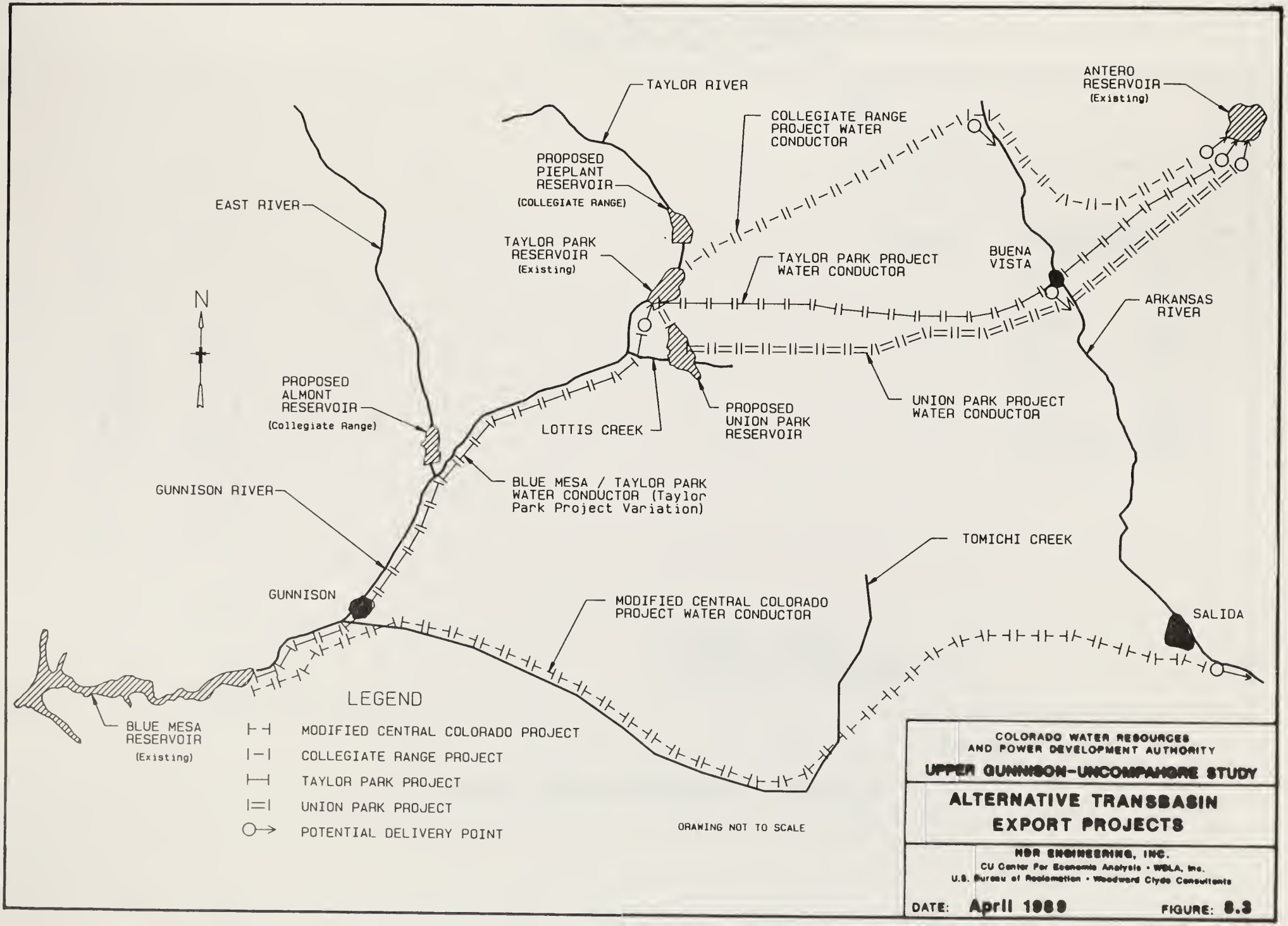
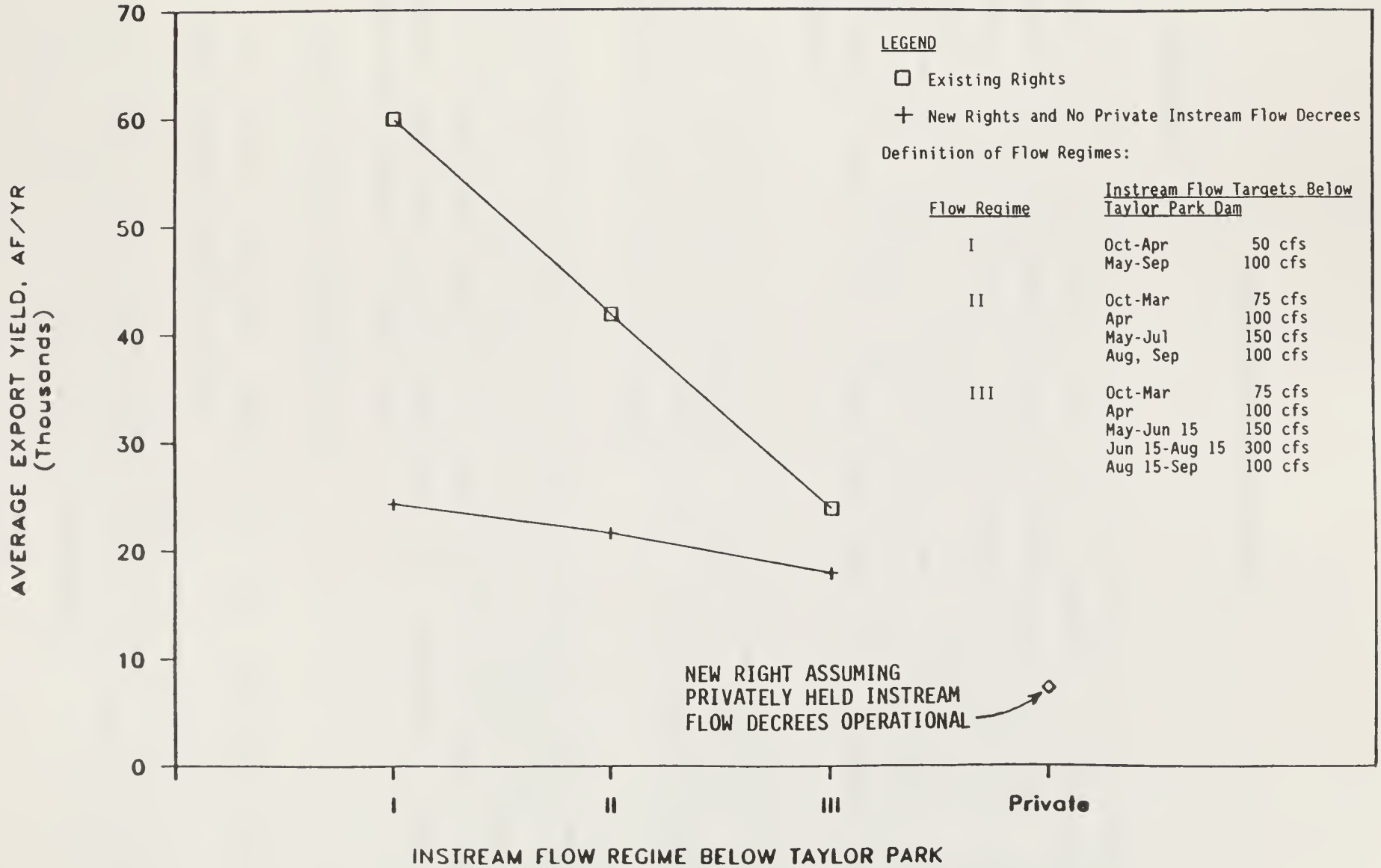

TAYLOR RIVER
ANTERO RESERVOIR (Existing)
COLLEGIATE RANGE PROJECT WATER CONDUCTOR
PROPOSED PIEPLANT RESERVOIR (COLLEGIATE RANGE)
EAST RIVER
TAYLOR PARK RESERVOIR (Existing)
TAYLOR PARK PROJECT WATER CONDUCTOR
BUENA VISTA
ARKANSAS RIVER
N
PROPOSED ALMONT RESERVOIR (Collegiate Range)
LOTTIS CREEK
PROPOSED UNION PARK RESERVOIR
UNION PARK PROJECT WATER CONDUCTOR
BLUE MESA / TAYLOR PARK WATER CONDUCTOR (Taylor Park Project Variation)
GUNNISON RIVER
TOMICHI CREEK
GUNNISON
MODIFIED CENTRAL COLORADO PROJECT WATER CONDUCTOR
SALIDA
BLUE MESA RESERVOIR (Existing)
LEGEND
MODIFIED CENTRAL COLORADO PROJECT
COLLEGIATE RANGE PROJECT
TAYLOR PARK PROJECT
UNION PARK PROJECT
POTENTIAL DELIVERY POINT
DRAWING NOT TO SCALE
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
UPPER GUNNISON-UNCOMPAHGRE STUDY
ALTERNATIVE TRANSBASIN EXPORT PROJECTS
HDR ENGINEERING, INC.
CU Center For Economic Analysis • WDLA, Inc.
U.S. Bureau of Reclamation • Woodward Clyde Consultants
DATE: April 1989
FIGURE: 8.3

FIGURE 8.4

EXPORT YIELD VERSUS INSTREAM FLOW
Existing and New Water Rights



9.0 ENVIRONMENTAL CONSIDERATIONS

9.1 INTRODUCTION

This chapter presents an appraisal-level evaluation of environmental effects that may result from the construction and operation of the potential alternative plans and financing mechanisms evaluated during the study. The purpose of the evaluations was to identify environmental effects which could materially influence the configuration of the alternative plan. The evaluations were based on literature reviews and on input solicited from resource agency personnel, other professionals and lay people. No site-specific field data was collected other than visual inspections by the Study Team.

The alternative plans containing storage reservoirs were evaluated on the basis of selecting one representative reservoir in each basin where alternative sites are still under consideration. This was done to illustrate the types of impacts that can be expected.

An evaluation was prepared on one example pumped-storage project (Needle Point No. 3). The Rocky Point Project was not evaluated because this appraisal-level evaluation would add little to the more detailed evaluations that have already been prepared on the project as part of the Federal Energy Regulatory Commission license application. All transmountain diversion projects were evaluated in general terms.

9.2 POTENTIAL IN-BASIN DEVELOPMENT PLANS

The following paragraphs summarize the most significant effects associated with each alternative plan.

Alternative No. 1 is a non-structural plan consisting of 17 recreation components. The primary concern which must be addressed in future studies is the ecological impacts associated with increased human use.

Alternative No. 2 consists of constructing three water storage reservoirs; one each in the Upper Ohio Creek, Upper Tomichi and Upper Cochetopa Creek sub-basins. All of these reservoirs have potential impacts to big game range. The most serious potential impact in this regard is at the Upper Tomichi site where the availability of winter range is reported by the CDOW to limit deer and elk populations. Both Tomichi Creek and Cochetopa Creek are good stream fisheries at present and short reaches of these streams will be affected. Ohio Creek is a poor fishery at present; however, the proposed storage site is on the Castle Creek tributary which is a good brook trout fishery at present. The reservoirs proposed for the Tomichi and Ohio Creek sub-basins should develop into good fisheries and the proposed streamflow enhancement downstream of these reservoirs should result in an improved stream fishery below the dams. The Cochetopa basin facility, on the other hand, is projected to experience fluctuations of a magnitude that may not produce a good fishery. This facility does have sufficient hydrologic yield to meet target streamflow enhancement but does improve historical streamflow significantly. The ecological impacts of constructing these reservoirs have not been studied in detail and should be undertaken in future phases.

Alternative No. 3 is a combination of Alternatives 1 and 2 and will exhibit the positive and negative impacts of both alternatives.

Alternative No. 4 combines ten of the recreation components of Alternative 1 with the three in-basin reservoirs of Alternative No. 2. Environmental impacts of this alternative would be very similar to those of Alternative 3, except that the recreation benefits would be reduced because fewer recreation components are included.

Alternative No. 5 is similar to 4, except the Upper Cochetopa Reservoir has not been included. The Upper Cochetopa Reservoir has a relatively high potential impact on stream fisheries and relatively low recreation potential. Therefore, this plan should have similar benefits and fewer environmental problems than Alternative 4.

Alternative No. 6 is similar to 4, except only one in-basin reservoir located in the Upper Tomichi area would be constructed. Fishery and recreation benefits associated with the Ohio Creek facility would be foregone. Of most significance would be the loss of the opportunity to improve Ohio Creek streamflows.

9.3 POTENTIAL FINANCING MECHANISMS

9.3.1 Pumped-Storage

The Needle Point No. 3 project was selected for a brief environmental evaluation and discussion of typical concerns associated with a pumped-storage project. This project utilizes the existing Morrow Point Reservoir as its lower reservoir and would include the construction of an upper reservoir on the north canyon rim with a tunnel connecting the two reservoirs. The powerhouse would be located underground. This project would result in daily fluctuations of about 10 feet in Morrow Point Reservoir. This would adversely affect both the present recreation use of the reservoir and aesthetics. Fishing is not a significant activity at this reservoir at present but it is growing. Long-term impacts to the fishery require further study and may be significant. The upper reservoir, project access roads and transmission lines associated with this project would reduce habitat as the areas involved are used by both deer and elk, but the extent to which this may occur has not been quantified. Construction of these facilities may also have a significant impact on the scenic viewshed along the north side of Morrow Point Reservoir which is heavily used by sightseers.

9.3.2 Potential Transmountain Diversion Projects

Three transmountain diversion projects were studied that would divert Gunnison Basin water to the South Platte River Basin (Collegiate Range, Union Park and Taylor Park Projects). One project that can only divert economically to the Arkansas River Basin (Modified Central Colorado Project) was also studied but was dropped from further consideration because it was found to be

economical only at relatively high yields (over about 100,000 af). It is doubtful that a demand will exist in the Arkansas River Basin for that level of yield in the near to mid-term.

Two of the projects evaluated, Collegiate Range and Union Park, require the construction of major storage reservoirs in the Study Area and a water conveyance system to the east slope. The Taylor Park Project requires a water conveyance system to the east slope and relatively minor east slope storage, but no new west slope storage facilities. Thus, potential environmental impacts are considered to be greater for the Collegiate Range and Union Park Projects than for the Taylor Park Project.

The Collegiate Range Project includes two mainstem reservoirs located in heavily used and relatively sensitive areas, one on the Upper Taylor River above the existing Taylor Park Reservoir and one on the East River near Almont. The proposed Almont site would inundate the existing Roaring Judy fish hatchery which is considered by the CDOW to be unique, and sections of the East and Lower Taylor River. Both of these areas are popular, heavily used recreation corridors. The Collegiate Range Project configuration appears to be potentially more environmentally damaging than the Union Park Project which includes one off-stream reservoir located on Lottis Creek, a tributary of the Upper Taylor River. However, it should be noted that the level of the present study only allows a subjective comparison to be made and specific impacts must be studied in future study phases before a quantitative comparison of projects can be made.

All three of the South Platte delivery projects will impact Taylor River flows below Taylor Park dam. At present, Taylor Park Reservoir is operated in a manner to ensure that minimum streamflows below the dam are suitable for the high quality fishery that presently exists in Taylor River. Flow in the river normally exceeds the minimum target values at present. The establishment of instream flow requirements downstream of a potential transbasin diversion project requires careful study and consideration before project implementation takes place.

The Taylor Park Project was evaluated using the hydrologic model to study downstream environmental effects associated with project implementation. The Taylor Park Project assuming downstream flow regime II (minimum downstream flows equal to present target minimums); a minimum pool in Taylor Park Reservoir of elevation 9268 ft (23,400 af) and the existence of the three in-basin reservoirs is discussed below as an example of the downstream effects of a transmountain diversion project that exports approximately 42,000 af per year on the average combined with in-basin development. If higher levels of export are considered, the resulting impacts will be greater.

The streamflow downstream of the dam under this plan would be reduced from what is experienced at present and what has been predicted under the No-Action Alternative. This will have an adverse impact on rafting on the Taylor River. Although the impact of the new flow regime on the Taylor River fishery has not been studied in detail, it is believed that the flow regime is adequate to maintain the present fishery assuming that periodic reservoir releases will be made to provide flushing flows as required.

The Taylor Park Reservoir actually experiences less fluctuation under this proposed operation than predicted under the No-Action Alternative. This would be beneficial to recreation use and perhaps to the existing lake fishery. This project was operated to require a minimum level in Taylor Park Reservoir. This would be beneficial to the lake fishery and recreation considering that no minimum pool requirement presently exists.

Blue Mesa Reservoir would operate at lower levels than in the No-Action Alternative with the transmountain diversion project and the three in-basin reservoirs in place as shown in Figure 9.1. The results indicate that Blue Mesa Reservoir will operate at levels five feet or more lower than under the No-Action Alternative approximately 50 percent of the time. The effect on Blue Mesa Reservoir levels would be even greater if export levels higher than 42,000 af per year are contemplated. This may affect recreation and the fishery at Blue Mesa adversely and requires additional detailed study and evaluation. Modification of present Blue Mesa operating rules may mitigate

this effect. However, the information presented in Figure 9.1 demonstrates that the potential impacts of transmountain exports from the basin headwaters in combination with in-basin development extends far beyond the immediate area of the diversion point, and those impacts require careful study when planning a transmountain export project.

9.4 MITIGATION POTENTIAL

Mitigation measures are designed to reduce adverse environmental impacts of developments. For example, the effect of inundating big game range can be reduced by improving the carrying capacity of range in the near-by vicinity.

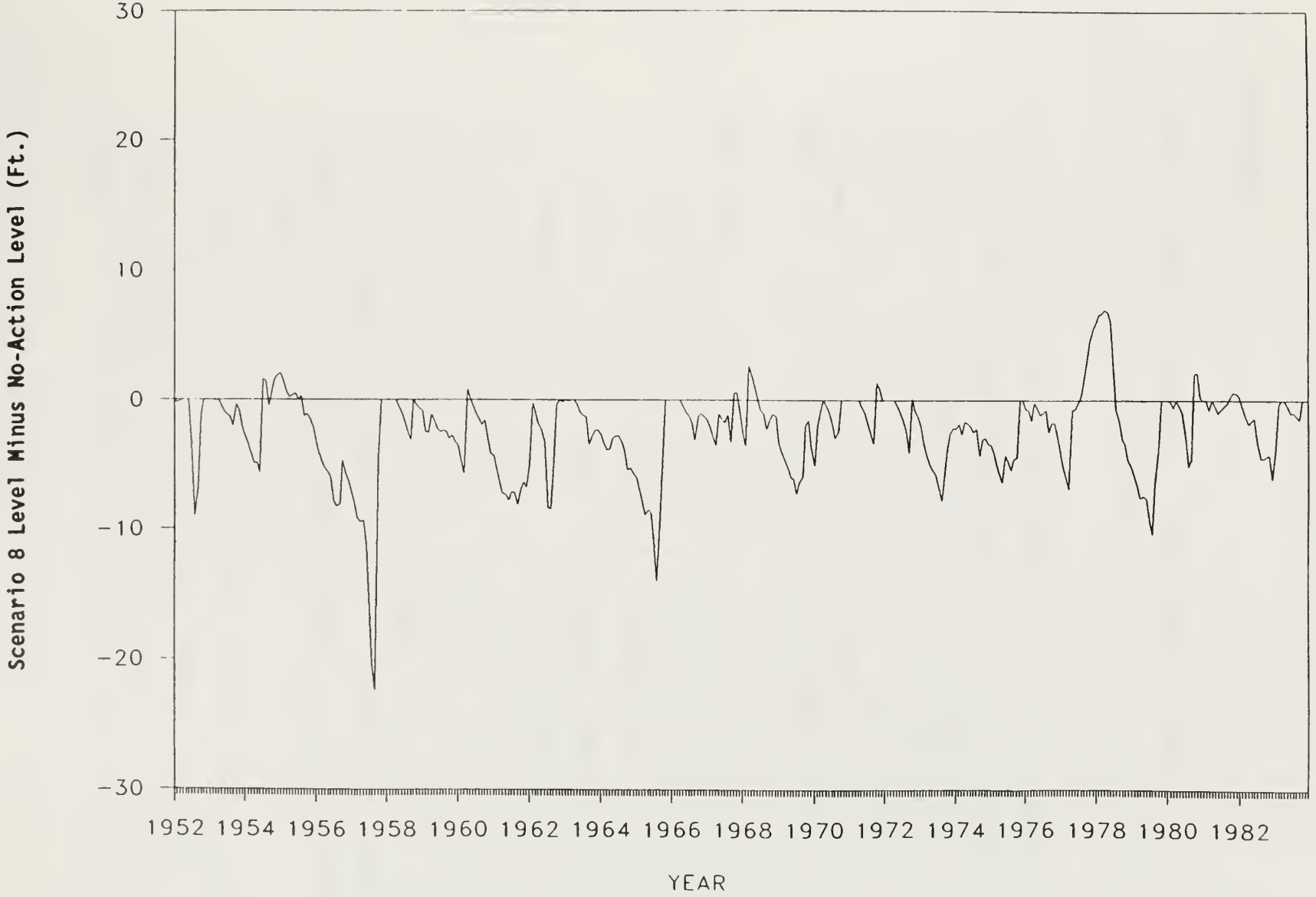
Specific mitigation measures for alternatives would be developed in later studies in consultation with government agencies and private organizations. The types of proposals that would be analyzed for different type impacts are listed below:

Impact	Potential Mitigation Measure
Big game range inundation	Acquisition and improvement of nearby ranges
Highway relocation in big game range	Road design, fencing, signing
Human disturbance to wildlife	Seasonal closures, road closures, reservoir zoning
Wetland losses	Creation of new wetlands or improvement of existing wetlands
Inundation of stream fishery	Improved flows downstream, outlet works design, reservoir operation plans, access to other streams

Increased recreation and human activity	Facilities to direct and control traffic, off-road activities, sanitation.
Blue Mesa Reservoir Fluctuations	Revise present operating rules to minimize increased drawdown due to transmountain diversions

FIGURE 9.1

BLUE MESA RESERVOIR LEVEL
No-Action Versus Scenario 8



10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The Upper Gunnison-Uncompahgre Basin Phase 1 Feasibility Study accomplished the objectives established in the Plan of Study. The key findings are summarized below:

- Although the Study Area has sufficient water on an average annual basis to meet projected demands over the 50-year planning horizon, shortages will exist unless additional development and/or improved management of the existing supply is undertaken to effectively utilize the existing water supplies. Non-structural water management and conservation measures as well as structural means were investigated as a way of meeting the projected shortages.

- Non-structural measures related to the municipal and industrial sector were found to have little potential in the context of this basin-wide study because the total consumptive use in this sector is less than two percent of the total consumptive use in the entire Study Area at present. Some of the measures should be considered for implementation at the local level in the future, however. Non-structural measures identified in the agricultural sector were found to be either technically or economically infeasible except for water rights exchanges and/or transfers and possibly drought leasing. The first two measures were used in the identification of potential financing mechanisms. Drought leasing was not used as a component in this study but should be considered in future phases of the study as a potential means of enhancing instream flows.

- Six alternative development plans were identified and evaluated for their ability to meet future water demands and enhancing the existing recreation sector of the local economy. The preferred plan consists of the following: a 20,000 acre-foot multipurpose

reservoir in the Ohio Creek Sub-basin; a 25,000 acre-foot multipurpose storage reservoir in the Tomichi Creek Sub-basin; and ten recreation enhancement components. The total capital cost of this plan is approximately $55,500,000 (January 1989 price level). This plan can be developed in stages, and a financial analysis was performed on a Phase 1 concept which includes the Tomichi Creek storage reservoir and the ten recreation components. The total capital cost of Phase I is approximately $32,000,000. The analysis showed that the total annual cost associated with Phase 1 would be about $1,250,000. The direct project annual income would only be about $140,000, but the project would result in significant indirect economic benefits to the Study Area through increased tourism (estimated to be $4,450,000 annually). Construction of Phase I will also result in year-round increased streamflow below the reservoir which would result in an enhanced stream fishery.

- The study effort indicates that numerous potential pumped-storage sites exist in the Study Area and that several of these sites appear to be economically attractive.

- Out-of-basin diversion from the headwaters of the Taylor River was also investigated. The hydrologic yield of such projects depends on many technical and institutional considerations including, but not limited to, the water right used for the export and the instream flow requirements in the Taylor River drainage. A potential export project entails many conflicts with the holders of other water rights and with the operators of existing facilities. Using the Taylor Park Project and a senior water right to support the diversion, the average annual yield would range from about 24,000 af to 60,000 af depending on Taylor River instream flow requirements. The same project using new water rights would have an average annual yield ranging from about 18,000 af to 24,000 af, again, depending on Taylor River instream flow requirements. If the existing privately-held instream flow water rights are enforced and junior

water rights are used in conjunction with the export, the average annual yield would be about 7,200 af. The export yield could be enhanced for any of the situations discussed above by pumping water from Blue Mesa Reservoir. A project arrangement where an additional 58,000 af per year would be pumped from Blue Mesa Reservoir was evaluated and resulted in 25 percent cost savings per af of yield. The potential environmental effects of transmountain diversions on instream flows and water levels at Blue Mesa Reservoir become significant above certain levels of export. These effects may adversely affect the recreation-based economy of the Study Area, but this has not been evaluated in detail in this study.

10.2 RECOMMENDATIONS

The preferred in-basin development plan consisting of storage reservoirs and recreation components provides a relatively wide range of benefits; however, the project is not financially feasible on its own. The indirect benefits generated by the project indicate that further evaluation of the project may be warranted. It is recommended that the following be included in future study phases: refinement of project costs and benefits; performance of a more detailed assessment of the possibility of raising income to pay project debt service by other means than through direct project income; and perform a refined financial analysis.

Based on the results of this preliminary level study, it appears that financially feasible pumped-storage sites may exist in the Study Area. This potential should be studied in more detail in the future to identify a preferred site and to quantify the potential economic benefits associated with such a development.

It is recommended that further study of potential transmountain diversion projects be undertaken in order to: define the amount of water available for diversion under various assumptions; define the downstream economic and environmental impacts of diversion; prepare a detailed comparison of

alternative projects; and prepare a detailed cost estimate and refined financial analysis of the preferred alternative.