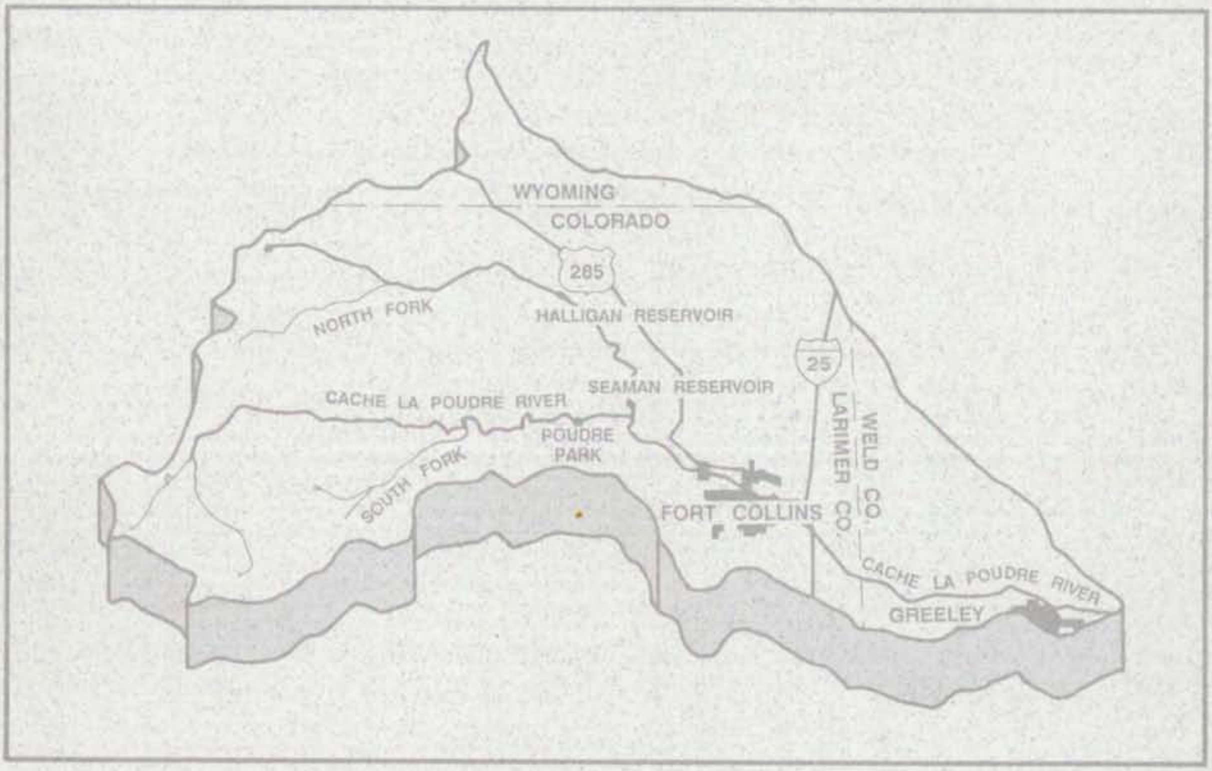
Cache la Poudre Basin Study Extension

Final Report | Volume I



COLORADO WATER RESOURCES & POWER DEVELOPMENT AUTHORITY

December 1990

MAIN REPORT
VOLUME I

CACHE LA POUDRE BASIN
STUDY EXTENSION

Prepared for:

Colorado Water Resources & Power Development Authority

Project Sponsor:

Northern Colorado Water Conservancy District

December, 1990

Study Participants:

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

HARZA ENGINEERING COMPANY CONSULTING ENGINEERS

December 10, 1990

Mr. Dan Law
Executive Director
Colorado Water Resources and Power
Development Authority
Logan Tower Building, Suite 620
1580 Logan Street
Denver, CO 80203

Subject: Transmittal of Final Report --
Cache la Poudre Basin Study Extension

Dear Dan:

Harza Engineering Company is pleased to submit the Final Report on the Cache la Poudre Basin Study Extension. The report includes three volumes -- Executive Summary, Main Report - Volume I, and Main Report - Volume II. A set of microfiche films are bound at the end of Volume II. These films contain the many appendices to the Main Report, which mainly comprise basic data and computer analyses that support various aspects of the Basin Study Extension.

The Cache la Poudre Basin Study Extension was carried out under two separate contracts with the Authority. Harza Engineering Company, with subconsultant BBC, Inc., was responsible for the engineering and economic investigations. EBASCO Environmental (formerly Envirosphere), with subconsultants Aquatic Associates, Centennial Archaeology, Inc. and Outdoor Recreation Resources Associates, was responsible for environmental studies. Hydrologic modeling was performed by the Northern Colorado Water Conservancy District.

The Study Extension concentrated on a mainstem water supply development on the Cache la Poudre River at the Grey Mountain site, following a review of potential alternatives identified in the Basin Study completed in 1987.

The Extension Study represents a significant advancement in the status of a water resources development project on the Cache la Poudre River in terms of refining project cost estimates, economic and financial analyses and, particularly, in terms of environmental investigations.

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A reservoir with storage capacity of 195,000 acre-feet (af) at the Grey Mountain site can provide a safe yield of 41,000 af per year, based on hydrologic modeling results. Grey Mountain Dam and Reservoir has an estimated construction cost of about $230 million (January 1988 price level). This cost includes appurtenant facilities and road relocation. A conventional hydroelectric power plant in the 18 to 24 MW capacity range could be provided at the dam. Flood control benefits have yet to be quantified but they are expected to be substantial.

Studies were made of aquatic, botanical, and wildlife resources, cultural resources, and recreation, aesthetics, and land use that could be affected by the project. While potential environmental effects may be substantial in certain resource categories, extensive measures have been identified to provide mitigation for these effects. Opportunities appear to exist for implementing certain environmental enhancements during project construction and operation. These enhancement opportunities and mitigation plans will need to be refined in subsequent feasibility-level studies.

The Grey Mountain Project appears to be economically viable, based on a benefit-cost analysis. The project appears financially feasible assuming new water tap fees are increased by $1,000 per single family tap equivalent and user charges are increased by $0.15 per 1,000 gallons.

Recommendations contained in the report call for review of study results and findings with regulatory agencies and potential purchasers of water supply developed by the project.

Harza is pleased to have been associated with the Cache la Poudre Basin Study Extension. We gratefully acknowledge the encouragement and extensive contributions provided throughout the study by Mr. Karl Dreher of the Northern District and Mr. Blaine Dwyer (formerly Project Manager for the Authority). We look forward to future opportunities to be of service to the Authority.

Very truly yours,

R. A. Westmore

Richard A. Westmore, P.E.
Project Manager

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CHAPTER 1.0

INTRODUCTION

1.0 INTRODUCTION

This Final Report for the Cache la Poudre Basin Study Extension presents work performed over a three-year period from 1987 through 1990. In addition to this Final Report, there is also a Summary Report of approximately fifty pages that presents the key findings of the work.

1.1 BACKGROUND AND PERSPECTIVE

The Cache la Poudre River Basin is located in north central Colorado and is bordered by the Laramie and Medicine Bow Mountain Ranges to the west, and the confluence of the Cache la Poudre River and the South Platte River near the City of Greeley to the east. The Cache la Poudre River drains an area of almost 1,900 square miles consisting of two distinct components. The mountainous upper basin yields the major portion of the surface water runoff which results from annual snowmelt. The lower basin plains area contains the majority of those in agriculture, municipalities, and industry who depend on the Cache la Poudre River for a significant portion of their water supplies. In particular, extensive agricultural water supply systems have been developed to utilize the water resources of the Cache la Poudre River. To augment the water supply in the Cache la Poudre Basin, other water supply projects, most notably the Colorado-Big Thompson (C-BT) Project, provide supplemental water supplies in the lower basin.

Proposals for constructing water storage projects on the Cache la Poudre River have been considered for many years. The U.S. Bureau of Reclamation (USBR) conducted investigations in 1928, 1954, 1959, and 1963. During the 1970s and early 1980s, designation of the Poudre River as part of the National Wild and Scenic River System upstream from the Poudre Canyon mouth was proposed. This would have precluded the construction of any water projects in the future. In 1983, at the urging of Congressman Hank Brown, representatives from the Northern Colorado Water Conservancy District (District) and other community leaders began meeting to explore the potential for a compromise which would designate a major portion of the river, yet allow water storage projects on the short sections left undesignated. This resulted in federal legislation to designate segments of the Poudre River as either Wild or Recreational for 75 miles of the river's 83 miles above the mouth of the canyon. The legislation was enacted and became law on October 30, 1986.

As a result of the compromise and subsequent Wild and Scenic Legislation, segments comprising over 90 percent of the Cache la Poudre River above the canyon mouth will be managed by the U.S. Forest Service as either Wild or Recreational. The 8 miles of river between the community of Poudre Park and the canyon mouth, along with a short segment on the Poudre's South Fork, remain undesignated and potentially available for future water projects. After considering various alternatives for developing water storage in the undesignated sections of the river, the District applied for and was granted a Preliminary Permit from the Federal Energy Regulatory Commission (FERC) to investigate the feasibility of including hydroelectric power generating components in the configuration of a proposed multiple-purpose project (FERC Project No. 9290).

As described in the District's Preliminary Permit Application to FERC, the proposed project configuration consisted of three reservoirs; Glade Reservoir, the Cache la Poudre Afterbay (Grey Mountain Reservoir), and the Cache la Poudre Forebay (Greyrock Mountain Reservoir). Glade Reservoir was conceptually planned to provide the largest water storage component of the multiple-purpose project. Glade Reservoir could provide up to 500,000 acre-feet (af) of water storage at an off-channel location north of Ted's Place. Water would be delivered for storage in Glade Reservoir from a diversion dam on the Cache la Poudre River through the Glade Reservoir feeder tunnel.

The second largest water supply feature was conceptually planned on the mainstem of the Cache la Poudre River. The mainstem reservoir (Grey Mountain Reservoir) could provide approximately 200,000 af of water storage. In addition to water supply storage, the mainstem reservoir would provide: the diversion for delivering water by gravity from both the mainstem and North Fork of the Cache la Poudre River through the Glade Reservoir Feeder Tunnel for storage in Glade Reservoir; flood protection for the City of Fort Collins; power generation from releases to the Poudre River through a conventional hydroelectric power plant; and the afterbay reservoir for a separate pumped-storage hydroelectric power plant situated either above or below ground on the north shore of the reservoir.

The third reservoir, the Cache la Poudre Forebay, was conceptually sited west of Greyrock Mountain. This reservoir could provide up to 90,000 af of storage at an elevation approximately 1,400 ft above Grey Mountain Reservoir for operating the pumped-storage hydroelectric plant.

In 1985, the District submitted an application to the Colorado Water Resources and Power Development Authority (Authority) for a basin-wide study to evaluate all potentially viable alternatives to the above plan that would provide for the efficient and environmentally sound development of water and hydroelectric power resources in the Cache la Poudre Basin. It was the specific intent of this basin-wide study to identify and evaluate any alternative measures, including non-structural and water conservation measures, that would provide the water supplies needed for the future and might be less costly or have less environmental effects than the project configuration initially proposed by the District. The Authority accepted the District's application and initiated the Cache la Poudre Basin Study during the summer of 1985.

The Authority's Cache la Poudre Basin Study was completed in 1986 and verified a number of the conclusions the District had previously determined concerning water supply storage and the potential for hydroelectric power generation in the Poudre Basin. First, the Basin Study confirmed the need for additional water supply storage in northeastern Colorado to minimize the economic consequences of a major drought. Secondly, although 32 nonstructural, water conservation and water management measures were identified and evaluated, the Basin Study demonstrated that even if all of the viable nonstructural measures were implemented, the need for a large increment of additional water supply storage could not be eliminated. Third, the configuration of the recommended project was very similar to the project configuration proposed by the District in its application to FERC for a Preliminary Permit. The preferred configuration for a multiple-purpose water supply project was recommended based on consideration of pertinent economic, environmental, and engineering factors. The preferred configuration was selected based on prefeasibility evaluation of 5 damsites on the mainstem of the Cache la Poudre River below Poudre Park, one damsite on the South Fork, 3 damsites on the North Fork (including replacement or modification of 2 existing dams), and one off-channel damsite.

The main difference between the project configuration proposed by the District and the alternative configuration identified during the Authority's Basin Study was the location of the damsite for the mainstem reservoir. The damsite for the mainstem reservoir identified during the Basin Study, as being potentially preferable mainstem reservoir identified during the Basin Study, as being potentially preferable to the Grey Mountain Damsite proposed by the District in its FERC application, was immediately below the confluence of the mainstem and North Fork of the Cache la Poudre River (Poudre site). This site was approximately 2 miles upstream of the Grey Mountain Damsite and was considered to be potentially the preferable damsite because inundating 2 miles less of the mainstem Cache la Poudre River may be more environmentally acceptable and because the lost storage on the mainstem could be provided off-channel at the Glade site. However, insufficient data existed to warrant an unreserved recommendation of this site, and the Basin Study included the Grey Mountain Damsite as an alternative damsite for the mainstem reservoir in the recommended project configuration.

Following the completion of the Basin Study, it was clear that more definitive environmental assessments were required to adequately evaluate the feasibility of the recommended project identified during the Basin Study and compare the environmental effects of the two alternative damsites for the mainstem reservoir. Consequently, the District applied to the Authority for funding to extend the Basin Study. The Authority agreed to extend the Basin Study to complete key environmental studies and to refine engineering and economic analyses.

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

Stage 1: The first stage would consist of a mainstem water storage reservoir and a small conventional hydroelectric plant for power generation from reservoir releases to the Poudre River. The mainstem reservoir would be located downstream of the community of Poudre Park and could be formed by constructing a dam at the Grey Mountain site two miles downstream of the confluence of the mainstem and North Fork of the Poudre River, or by constructing a dam just below the confluence at the Poudre site. When Stage 2 is implemented, the mainstem reservoir would also provide the means of diverting water by gravity through the Glade Reservoir Feeder Tunnel into storage in Glade Reservoir.

When Stage 3 is implemented, the mainstem reservoir would also serve as the afterbay for the pumped-storage hydroelectric plant.

Stage 2: The second stage would consist of Glade Reservoir which would provide water storage in a natural depression known as the Hook and Moore Glade north of Ted's Place off the Poudre River. The facilities necessary to divert water from the Stage 1 mainstem reservoir, including the Glade Reservoir Feeder Tunnel, would also be incorporated in Stage 2.

Stage 3: The third stage would consist of a pumped-storage hydroelectric power plant and the necessary transmission facilities. The power plant could be constructed at or below ground surface on the north shore of the mainstem reservoir. The third stage would also include the Cache la Poudre Forebay Reservoir for the operation of the pumped-storage hydroelectric plant.

1.2 PURPOSE OF STUDY EXTENSION

The purpose of the Basin Study Extension is to preform key environmental studies and additional engineering and economic analyses in order to assess, at a preliminary level of detail, the feasibility of the Stage 1 water storage project. The effort is focused primarily on the Stage 1 project described above, without pumped-storage hydroelectric components, although portions of the environmental studies are applicable to stages 2 and 3. As explained in Chapter 7.0, the reason for focusing on the Stage 1 mainstem reservoir is that data available to date indicate that a mainstem reservoir offers the most economical potential for a large increment of water supply storage among all the alternatives that have been identified.

The key environmental studies completed during the Basin Study Extension are intended to: quantify existing aesthetic, aquatic, botanical, cultural, land use, recreation, and wildlife resources; assess the potential effects of the proposed Stage 1 project on these resources; and identify possible mitigation measures. The Authority and the District both recognize that these studies do not constitute all of the environmental studies that will need to be completed before a feasible project can be licensed and permitted. However, these environmental studies are the ones requiring the most extensive field work. They also address the most critical environmental issues affecting project feasibility.

The engineering and economic studies conducted during the Basin Study Extension are intended to better define the location and design of project features, proposed project operations, road relocations, and project costs and benefits.

1.3 AUTHORIZATION

The Authority, which was created by the Colorado General Assembly in 1981 as a political subdivision of the State, has the statutory capacity to finance water and hydroelectric projects through the issuance of revenue bonds. In addition to financing, the Authority is authorized to assist regional or local entities in the planning, design, and construction of water and hydropower projects.

The Cache la Poudre Basin Study Extension was authorized in June 1987 by the Authority's Board of Directors in response to an application submitted by the District. The Authority entered into contracts with Harza Engineering Company and Envirosphere Company to provide consulting services for the Study.

1.4 ROLES OF THE PARTICIPANTS

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

Harza Engineering Company and their subconsultant, BBC, Inc. in Denver, Colorado prepared the engineering and socio-economic assessments. Envirosphere Company prepared the environmental evaluations with the assistance of the following subconsultants:

- Aquatic Management Associates - Fort Collins, Colorado
- Centennial Archaeology Incorporated - Fort Collins, Colo-rado

- Outdoor Recreation Resources Associates - Fort Collins, Colorado.

1.5 STUDY APPROACH

The Basin Study Extension consisted of 9 work tasks. Since there were 10 work tasks completed during the Basin Study, the tasks for the Basin Study Extension began with Task 11 and were as follows:

Task 11	-	Aquatic Resource Studies
Task 12	-	Botanical Resource Studies
Task 13	-	Cultural Resource Studies
Task 14	-	Recreation, Land Use, and Aesthetic Resource Studies
Task 15	-	Wildlife Resource Studies
Task 16	-	Engineering Studies
Task 17	-	Hydrologic Modeling
Task 18	-	Socio-Economic Evaluation
Task 19	-	Final Report Preparation

The environmental studies concentrated on those resources and issues judged to have the greatest overall effect on project feasibility. The engineering studies concentrated on refining selected aspects of the previous work and on providing technical information associated with dividing the project into three stages. More specifically, the engineering evaluations addressed the following aspects of the project:

- Reassess alternatives for Stage 1 water supply facilities
- Refine highway relocation layouts and costs
- Provide topographic mapping of the selected Stage 1 water storage site and the highway relocation, and
- Assess flood control opportunities.

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

The socio-economic evaluation provided additional information for consideration by potential project participants. The evaluation included an estimation of the economic and social benefits of construction activities, enhanced water supplies, flood protection, hydroelectric power generation, and recreation.

CHAPTER 2.0

AQUATIC RESOURCES STUDIES

2.0 AQUATIC RESOURCES

2.1 INTRODUCTION

The 1987-88 aquatic resource studies constituted the second year of aquatic resource studies associated with the proposed Cache la Poudre Water and Power Project. Studies from the previous year were documented by Aquatic Management Associates (1986a,b; 1987a,b,c) and Aquatics Associates (1987). The 1987-88 aquatic resource study program was Task 11 of the Cache la Poudre Basin Study Extension funded by the Colorado Water Resources and Power Development Authority (Authority). These studies were designed to support effects assessments and identify potential mitigation measures as part of a preliminary environmental feasibility assessment.

2.1.1 Study Objectives and Aquatic Resources Scope of Work

The following were the objectives of the aquatic resource studies:

(1) conduct a literature review of data on the fish and macroinvertebrate populations in the study area;

(2) conduct agency consultations on the scope and methods of the aquatic resource studies;

(3) survey the Cache la Poudre River (Poudre River) and the North Fork of the Cache la Poudre River (North Fork) for existing fish and macroinvertebrate populations;

(4) conduct instream flow and stream temperature studies utilizing the Instream Flow Incremental Methodology (IFIM) (Bovee, 1982);

(5) assess the effects of the proposed project in terms of instream flow and temperature;

(6) estimate reservoir habitat units that could be created through project implementation and determine appropriate trout stocking densities;

(7) identify potential mitigation measures applicable to project effects;

(8) assess the feasibility of the proposed project in terms of its effect on aquatic resources;

(9) prepare a final study report documenting all phases of the study.

In addition to the fishery, instream flow, and temperature studies, it was determined during resource agency consultation that two other studies would be conducted and reported: (1) an evaluation of the habitat quality of the stream reaches to be inundated using the Habitat Quality Index (HQI); and (2) an estimate of the relative trout carrying capacity of the proposed reservoir using the Reservoir Quality Index (RQI).

As presently envisioned, Stage 1 of the proposed Cache la Poudre Water and Power Project would consist of a water storage reservoir on the mainstem of the Cache la Poudre River. Based on a preliminary screening of alternatives, there are two preferred damsite alternatives for the mainstem reservoir:

(1) Poudre Damsite, located less than 0.5 mile downstream of the Poudre-North Fork confluence; and

(2) Grey Mountain Damsite, located approximately 2 miles downstream from the Poudre Damsite.

Instream flow and temperature analyses in this report are based on an assumed Grey Mountain Damsite. Where differences exist between effects relative to the two alternative damsites, distinctions are made with the objective of assisting in the final damsite selection.

2.1.2 Task Organization

Aquatic resource studies were performed by Aquatics Associates (formerly Aquatic Management Associates) of Fort Collins, Colorado, under subcontract to Envirosphere Company of Bellevue, Washington. Field and laboratory work for fish and macroinvertebrate studies were performed by David B. Robinson and Tami L. Schneck of Aquatics Associates. Instream flow and temperature studies were performed under the direction of W.J. Miller and Associates of Denver, Colorado. Project scoping and field support for the instream flow and temperature studies were provided by Aquatics Associates, W.J. Miller and Associates, the Colorado Division of Wildlife

(CDOW), U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (FS), and the Northern Colorado Water Conservancy District (NCWCD).

The 1987-88 aquatic resources study period extended from June 1987 to November 1988. Field studies were conducted from June through November 1987, and analysis and reports were completed in the remaining time.

2.2 STUDY AREA

The aquatic resources study area included areas potentially inundated by the proposed mainstem reservoir and sections of the Poudre River where significant changes in stream flows might occur due to project operations (Figure 2.1). The upstream study area boundary on the Poudre River was established at the river's confluence with Joe Wright Creek. The upstream study area boundary on the North Fork was established at an elevation of 5680 feet. This elevation provided a 40 foot buffer in elevation between the water surface elevation of the proposed reservoir at flood stage (5640 feet) and the study area boundary. Although no project-related flow changes have been proposed upstream from the reservoir, upstream reaches of the Poudre River were included in the study area to document existing conditions and to provide data for potential beneficial flow changes in the future.

The downstream boundary of the study area was defined as the western limit of the Fort Collins Urban Growth Area (Larimer-Weld Council of Governments, 1985), located 0.5 miles east of Taft Hill Road. Placement of the boundary at this point was based on irrigation water delivery patterns.

2.3 METHODS

Study methods are described in this section relative to field techniques and data analysis for the following:

(1) fish population inventories consisting of standard surveys and those for species of special concern;

(2) macroinvertebrate population inventories;

(3) fish habitat evaluations consisting of Instream Flow Incremental Methodology, Habitat Quality Index, Reservoir Quality Index, and stream temperature studies.

River mile (RM) locations of key features, study sites, and segment boundaries used in the analysis are shown in Table 2.1. Locations on the Poudre River are based on river distances measured upstream from the confluence with the South Platte River, and locations on the North Fork are based on river distances measured upstream from the confluence with the mainstem of the Poudre River.

2.3.1 Fish Population Inventories

Fish population sampling was conducted to provide:

(1) a basis for describing existing fish species composition and population levels, and evaluating project effects on those parameters; and

(2) information on timing of spawning and rearing for use in assessment of project effects on habitats within and downstream from the proposed inundation area.

Fish population inventories consisted of capturing fish by electroshocking at selected study sites on the Poudre and North Fork. After measuring and weighing the specimens captured, population estimates were calculated. Fish capture techniques were designed during consultation with the CDOW, FWS, and FS. Particular emphasis was placed on assuring consistency with similar studies conducted previously by CDOW (CDOW, 1987). Fish sampling was conducted during the fall of 1986 and during the spring and fall of 1987.

TABLE 2.1

Locations of Key Features, Study Sites, and Segment Boundaries for Aquatic Resource Studies

Identification Number[1]	River Mile[2]	Locations and Key Features	Study Site[3]
	0	CACHE LA POUDRE RIVER (at confluence with South Platte River)	
1	45.9	Larimer-Weld Canal, downstream study area boundary	T
2	48.1	Overland Trail Road, IFIM segment boundary	
3	52.2	Larimer County Canal, IFIM segment boundary	
4	52.7	Anderson Ranch, 0.9 miles downstream from the Hansen Canal (sample site CLP-3)	F, M, H
5	53.8	Horsetooth Reservoir outfall (Hansen Canal), IFIM segment boundary	T
6	54.9	Gage at the mouth of the canyon	T
7	57.9	Grey Mountain Damsite	
8	58.1	1.1 miles downstream from the North Fork confluence (sample site CLP-2)	M, H
9	59.0	Poudre Damsite	
10	59.2	North Fork confluence, IFIM segment boundary	
11	60.7	Lower Wild Trout Water boundary, 0.1 miles downstream from the Munroe Diversion (sample site CLP-1)	F, M, H
12	60.9	Upstream from the Munroe Diversion	F
13	65.5	5,680 feet near Poudre Park, IFIM segment boundary	
14	78.5	Kelly Flats Campground	F
15	81.8	Indian Meadows, 1.0 mile downstream from Highway 14 bridge (Middle Wild Trout Water, sample site CLP-4)	F, M, H
16	87.1	Lower Control, 2.0 miles upstream from Rustic	F
17	90.1	Upper Wild Trout Water boundary, 5.0 miles upstream from Rustic	F
18	93.3	0.3 miles downstream from the CDOW Fish Rearing Unit (sample site CLP-5)	H
19	96.0	Big Bend Campground	F
20	104.3	Joe Wright Creek, upstream study area boundary	

TABLE 2.1 (Continued)

Locations of Key Features, Study Sites, and Segment Boundaries for Aquatic Resource Studies

Identi-fication Number(1)	River Mile(2)	Locations and Key Features	Study Site(3)
	0	NORTH FORK OF THE CACHE LA POUDRE RIVER	
21	0.6	0.6 miles downstream from Seaman Reservoir (sample site NFCLP-2)	F, M, H
22	1.3	Seaman Reservoir dam, IFIM segment boundary	
23	2.9	Inlet to Seaman Reservoir, IFIM segment boundary	
24	3.6	0.7 miles upstream from Seaman Reservoir (sample site NFCLP-1)	M, H
25	6.3	2.9 miles upstream from Seaman Reservoir (sample site NFCLP-3)	F
26	9.4	5680 feet, IFIM segment boundary and upstream study area boundary	

(1)For Figure 2.1.

(2)River mile (RM) is the distance in miles measured upstream from the confluence of the Poudre and South Platte Rivers near Greeley, Colorado.

(3)Study sites for fish populations, macroinvertebrates, habitat, and stream temperature are denoted by F, M, H, and T, respectively.

Tributary streams were located on 7.5-minute U.S. Geological Survey (USGS) topographic maps, and site visits to tributaries were made during the low flow period in August and September of 1986 to determine the importance of tributaries to fish populations in the Poudre River and North Fork. Although fish population inventories were not performed in Seaman Reservoir, the only existing impoundment within the study area, historic data were compiled to provide a general description of the fish species present.

2.3.1.1 Study Locations

A review of the existing data indicated that intensive fish inventories have been conducted on the Poudre River within Poudre Canyon. However, it was determined that more study would be required on the Poudre River below Poudre Canyon. On the North Fork, there was a need for additional study in the reaches below and above Seaman Reservoir. Stream segments were selected to best characterize stream sections that represented the general habitat characteristics of the reach below Poudre Canyon and the two North Fork reaches. Sampling stations were chosen in these stream segments to characterize fish populations within the segments. Each sampling station included at least one complete habitat sequence (e.g., beginning at the head of a riffle and extending upstream through a run and pool to the head of the next riffle).

One study site was sampled below Poudre Canyon. Fish sampling station CLP-3 (No. 4 in Table 2.1 and Figure 2.2) was located on the Poudre River 0.9 miles downstream from the outfall of the Charles Hansen Canal, which delivers water to the Poudre River from Horsetooth Reservoir. Two study sites were sampled on the North Fork. Station NFCLP-3 (No. 23 in Table 2.1 and Figure 2.2) was located 2.9 miles upstream from Seaman Reservoir, and station NFCLP-2 (No. 21 in Table 2.1 and Figure 2.2) was located 0.6 miles downstream from Seaman Reservoir.

In addition to sampling at the three stations mentioned above, existing data on fish populations in the study area were compiled for use in the description of the existing environment (Aquatic Management Associates, 1986a). Although studies performed on the mainstem Cache la Poudre River as far back as 1962 were reviewed, more recent studies conducted by CDOW from 1980 to 1987 (Nehring and Anderson, 1981, 1982, 1983, 1984, 1985, 1986; CDOW, 1987) were used to characterize fish populations in the study area. Seven sites were selected to evaluate the effects of existing special regulation management. Three sites were chosen in special regulation areas located in the upper wild trout water (UWTW), at Indian Meadows in the middle wild trout water (MWTW), and in the lower wild trout water (LWTW). Wild trout waters are areas regulated for natural (not stocked) trout production. Four sites were chosen in standard regulation areas including Big Bend Campground, Kelly Flats Campground, and upstream from the Munroe Diversion (Figure 2.2). The consistency of data from these studies allowed for the averaging of population statistics for the purpose of preparing a general characterization of fish populations.

2.3.1.2 Capture Techniques

Fish populations were sampled using a Model VVP-2C electroshocker (Coffelt Electronics, Inc.) powered by a 2200 watt gasoline generator. One stationary negative electrode and three to five mobile positive electrodes were used, depending on stream width and water volume at the time of sampling. The number of field personnel ranged from 7 to 12 individuals. All areas within the stream were electroshocked by moving in a downstream to upstream direction. Stunned fish were transferred to a live cage anchored in the stream.

All collected fish were identified to species, counted, weighed, and measured for total length prior to being returned to the stream. Data on streamflow, water temperature, average stream width, and duration of sampling effort were also recorded.

2.3.1.3 Population Estimates

Population density was calculated for the mainstem Poudre River fish sampling stations using the Peterson mark and recapture method (Everhart et al., 1975). This method was previously used by CDOW for studies on the Poudre River and was used in this study to maintain methodological consistency.

The Peterson population estimation technique is based on the assumption that marked fish returned to the population are a portion of the total population that can be measured by determining the ratio of recaptured fish to the sample size at some later date. In other words, the technique assumes that future sampling programs will recapture marked fish in proportion to the number of marked fish in the total fish population. The concept is expressed mathematically as:

$$N = \frac{MC}{R}$$

where,

N = Total fish population;

M = Total number of marked fish in the population;

C = Total number of fish captured in second sample;

R = Number of marked fish captured in second sample.

If R is less than 10, the formula is modified to account for potential bias in small samples as follows (Everhart et al., 1975):

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1 \quad .$$

Population density was calculated for the two North Fork sections using the Seber-LeCren method (Everhart et al., 1975). This method was used rather than the Peterson method because it is more precise (i.e., has a narrower 95 percent confidence interval) and requires only one field trip per sampling. The Seber-LeCren population estimation technique assumes that in a closed population, the chance of capture remains the same from sample to sample. That is, when equal effort is expended to obtain two separate samples and individual fish are removed from the population after the first sample, a relationship exists between the number of fish captured in the first and second samples that can be used to estimate total population numbers. This method is generally more accurate than the Petersen method when at least 50 percent of the population is captured during the first sample. The concept is expressed mathematically as:

$$N = \frac{C_1^2}{(C_1 - C_2)}$$

where,

C_1 = Total number captured in first sample;

C_2 = Total number captured in second sample.

Both the Peterson and Seber-LeCren methods were used to estimate populations with a 95 percent confidence interval (95 percent CI).

Length-weight relationships were determined by linear regression techniques for each fish species using the total length in centimeters (cm) and weight in grams (g) (Carlander, 1969). The length-weight relationship and population estimates were used to calculate biomass in kilograms per hectare (kg/ha) using the following formula:

$$\text{Biomass (kg/ha)} = \frac{(L_i)\ (g_i)\ (N/ha)}{1000}$$

where,

L_i = Percentage of population distributed in the ith cm length interval;

g_i = Predicted weight in grams of individuals in the ith cm length interval (from the length-weight relationship);

N = Estimated population in the sample reach;

ha = Water surface area of the sample reach in hectares.

Population and biomass estimates were calculated for two size classifications for each fish species: fish less than 15 cm in length; and fish greater than 15 cm in length. Total population and biomass (summed total) were also calculated.

At all locations within the study area where data on trout populations from previous studies were available, summary statistics were calculated in order to characterize the existing environment. Average percent composition, density, and biomass estimates were calculated for trout greater than 15 cm.

2.3.2 Species of Special Concern

Special concern status is a designation of CDOW that is applied to species which have recently been eligible for threatened or endangered listing or could become eligible in the near future, require additional information to accurately define their status, or engender high public interest (CDOW, 1985). The johnny darter is currently designated as a species of special concern. This species was originally listed as a Colorado State threatened species, but was removed from the threatened species list in 1985 (CDOW, 1985). Johnny darters have been found to be more common than was originally believed (Propst, 1982a), but continue to be listed as a species of special concern in recognition of the general decline in range and abundance over the past century (Aquatic Management Associates, 1987a) as well as their dependence upon a narrow range of habitat conditions (Propst, 1982b).

Johnny darters were found within the North Fork portion of the study area during 1986 and 1987 while conducting surveys of trout populations. Once their presence in the region was established, a program was designed to survey the distribution of the species in the study area. Study sites were selected within the inundation area of the proposed mainstem reservoir based on physical characteristics known to provide johnny darter habitat. Four sites on the mainstem of the Poudre River and one site on the North Fork were sampled (Figure 2.3).

Sampling gear included seines, a modified kick net specifically designed for the sampling effort, and electroshocking equipment. The electroshocking equipment used in combination with the kick net was found to provide the most efficient sampling. Lengths of all johnny darters intercepted were measured, and weights were determined for a subsample of the catch. Additionally, the area of the site was estimated, and substrate type was noted. Wherever johnny darters were found, further observations on the habitat conditions were made including approximate flow, water depth, and presence of macrophytes.

Collected data were summarized in terms of catch per hour of electroshocking. Length-frequency histograms and length-weight relationships were also generated. A comparison of data at all sampling stations was made relative to data collected previously in and near the study area (Aquatic Management Associates 1986a,b; 1987a,b; Aquatics Associates 1987). All available data were used to estimate the distribution of johnny darters in the proposed inundation area and to assess potential project effects.

2.3.3 Macroinvertebrate Population Inventories

Six areas were identified where additional information on macroinvertebrate populations was needed (Aquatic Management Associates, 1986a). Four sampling locations were selected on the Poudre River: sampling site CLP-4 was located 0.3 miles downstream from Rustic, Colorado; site CLP-1 was located 0.1 miles downstream from the Munroe Diversion; site CLP-2 was located 1.1 miles downstream from the confluence of the Poudre River and the North Fork; and site CLP-3 was located 0.9 miles downstream from the outlet of the Charles Hansen Supply Canal from Horsetooth Reservoir (Figure 2.4). Two sampling locations were selected on the North Fork: sampling site NFCLP-1 was located 0.7 miles upstream from Seaman Reservoir, and site NFCLP-2 was located 0.6 miles downstream from Seaman Reservoir (Figure 2.4). Spring and fall samplings were performed in 1986. Subsequent sampling was performed in the spring and fall of 1987. Sites were selected to correspond with areas where fish population or habitat data were available.

Triplicate 0.1 square meter samples were collected at each sample site using a modified Hess sampler. All macroinvertebrates collected were classified to the genus level and where possible, to the species level, except for chironomids which were classified to the family level. The total number of individuals in each classified group were counted and the groups averaged to determine population densities, which were reported as the average number per square meter. Species diversity was calculated using the Shannon formula (Lloyd et al., 1968). The ecological concept of species diversity is a means of characterizing biotic communities according to species richness or variety and proportional numbers of individuals among species or other taxonomic groups. Species diversity indices are mathematical expressions of the ratio between the number of taxa and numbers of individuals per taxon. Diversity indices increase with increased variety and nearly equal numbers of individuals per taxon, and decrease in communities with smaller numbers of taxa or where large disparities among numbers within taxa exist. Rigorous environmental conditions, pollution, and other stresses tend to reduce diversity relative to that found in more pristine conditions (Odum, 1979). The mathematical formula used to determine macroinvertebrate species diversity is (Lloyd et al., 1968):

$$d = C / N \, (N \log_{10} N \quad - \quad n_i \log_{10} n_i),$$

where,

- d = Diversity index;
- C = 3.321928;
- N = Total number of individuals;
- n_i = Total number of individuals in the ith taxon.

2.3.4 Fisheries Habitat Evaluation

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

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

The IFIM and temperature studies were conducted to assess effects of the proposed project on flow and temperature-related habitat downstream from the proposed Poudre or Grey Mountain damsites. The Habitat Quality Index was conducted at the request of resource agencies to characterize the habitat of stream reaches to be inundated. This index can be used for future evaluations of stream versus reservoir habitat and mitigation. Similarly, the Reservoir Quality Index was calculated at the request of CDOW to provide an estimate of reservoir carrying capacity and aid in future evaluations of trout stocking rates.

2.3.4.1 Instream Flow Incremental Methodology

The Instream Flow Incremental Methodology described by Bovee (1982) was used to quantify physical stream habitat in the study area and to determine the effects of changes in the flow regime on physical habitat downstream from the proposed project. The IFIM utilizes computer-based simulation techniques based on the assumption that stream depth, water velocity, and substrate are primary fish habitat variables. The method compares these variables to fish preferences (as expressed by habitat preference or suitability curves) in order to quantify habitat conditions in a given stream for selected fish species and life stage at a given flow or range of flows. Simulation of stream habitat includes the following:

(1) a hydraulic component whereby simulation modeling is used to predict water depth, water velocity, and submerged substrate over a range of flows based on stream measurements at one or a limited number of flows;

(2) a habitat component which involves development of habitat preference curves for depth, velocity, and substrate;

(3) computer linkage of habitat curves with output from the hydraulic modeling component.

Results of this linkage are expressed as square feet of Weighted Usable Area (WUA) per 1000 feet of stream, which represents the quantity and quality of fish species- and life stage-specific habitat in the stream reach at a given flow.

Field measurements for IFIM are conducted at sites selected to represent larger homogeneous reaches or unique areas that may be critical to fish spawning or rearing. The types of field measurements taken are based on hydraulic and habitat variables that have been shown to be important to selected target species.

Target Species Selection

During agency consultation, brown trout and rainbow trout were selected as target species for this study. These species were selected because of their sport fishery recreational value and because of their potential sensitivity to project-related changes in streamflow.

Study Site Selection

River segments within the study area downstream from elevation 5680 feet (the water surface elevation of the proposed reservoir at flood stage plus 40-foot elevation buffer) were divided into relatively homogeneous segments based on flow regime, channel stability, sinuosity, gradient, temperature, and water quality. Each segment was then divided into reaches that were approximately 10 channel widths in length. Five randomly selected reaches within each segment were visited by the study team, and study sites were selected in the reach that best characterized overall habitat conditions within the segment. Consulting resource agency personnel were provided with a detailed description of study site locations and site selection procedures.

Similar river segmentation procedures were used in determining study site locations along the Poudre River upstream from elevation 5680 feet. Although no flow changes have been proposed upstream from the proposed mainstem reservoir, study sites were selected in areas managed with special regulations by CDOW in order to assess future beneficial flow changes in the upstream segments.

Four study sites were sampled on the Poudre River and two were sampled on the North Fork. Existing CDOW data for a fifth site on the Poudre River (CLP-1) was obtained for use in the analysis.

Study site CLP-1 was located 0.1 miles downstream from the Munroe Diversion. The site represented a 6.3-mile segment of the Poudre River from elevation 5680 feet (approximately Poudre Park) downstream to the confluence with the North Fork (Figure 2.5). The upstream segment boundary was selected at 40 feet above the maximum pool elevation of the proposed reservoir at flood stage, and the downstream boundary was selected based on changes in flow regime. Throughout the segment, the stream channel was sinuous and confined by mountainous canyon walls. Substrate was predominantly cobble with some boulders and areas of gravel and sand. The gradient in this segment was steeper than found in lower segments. The stream habitat types were generally limited to riffles and long runs. Six transects were used to characterize hydraulic and habitat conditions. Flows ranging from 25 to 1000 cfs were used to simulate hydraulic conditions.

Site CLP-2 was located 1.1 miles downstream from the confluence of the Poudre River and the North Fork. The site represented a 4.9-mile segment of the Poudre River from the confluence with the North Fork downstream to the outlet of the Charles Hansen Supply Canal from Horsetooth Reservoir (Figure 2.5). Selection of segment boundaries was primarily based on changes in flow regime. Throughout the segment, the river remained sinuous and confined by mountainous canyon walls. Substrate was similar to that found in Segment CLP-1. Segment CLP-2 had a lower gradient than found upstream in Segment CLP-1. The general stream habitat types in this segment included pools, runs, and riffles. Six transects were used to characterize hydraulic and habitat conditions. Flows ranging from 20 to 1100 cfs were used to simulate hydraulic conditions.

Site CLP-3 was located 0.9 miles downstream from the outlet of the Charles Hansen Supply Canal from Horsetooth Reservoir. The site represented a 5.1-mile segment of the Poudre River from the outlet of the Charles Hansen Supply Canal downstream to Overland Trail Road in LaPorte, Colorado (Figure 2.5). The upstream segment boundary was selected to correspond with substantial changes in flow regime. The downstream boundary was selected at the limit of the channelization that has occurred between Overland Trail Road and the lower study area boundary. Throughout the segment, the local topography changed from a confined canyon to an open valley. The channel remained sinuous and the gradient was similar to that found in Segment CLP-2. Substrate in this segment was predominantly large cobble and small boulders. The channel in most sections was uniformly armored.

Site CLP-4 was located 3.3 miles downstream from Rustic, Colorado. The site represented an approximately 38-mile segment of the Poudre River upstream from the proposed mainstem impoundment (Figure 2.5). Within this reach, two types of homogeneous habitat characterized by low and high gradients were identified. The site sampled to represent this segment was typical of the steep gradient habitat. The average slope for the Poudre River from Joe Wright Creek downstream to Poudre Park was 69.3 feet per mile. The slope for this segment was 66.3 feet per mile. The stream channel was sinuous and generally confined by mountainous canyon walls. Substrate was predominantly cobble and gravel with some boulders and areas of sand. The general habitat types included riffles, long runs, and pools. Five transects were used to characterize hydraulic and habitat conditions. Flows ranging from 20 to 2000 cfs were used to simulate hydraulic conditions.

Site CLP-5 was located 0.3 miles downstream from the CDOW Fish Rearing Unit. The site represented an approximately 8-mile segment of the Poudre River upstream from the proposed mainstem impoundment (Figure 2.5). The site sampled to represent this segment was typical of the low gradient meadow habitat found in the upper Poudre River. The average slope for the meadow reach was approximately 26.5 feet per mile. The slope for this segment was 26.5 feet per mile. Substrate was predominantly cobble and gravel with some areas of sand.

Site NFCLP-1 was located 0.7 miles upstream from Seaman Reservoir. The site represented a 6.3-mile segment of the North Fork from elevation 5680 feet downstream to the inlet of Seaman Reservoir (Figure 2.5). The upstream boundary was selected based on the proposed reservoir pool elevation at flood stage plus a 40-ft elevational buffer zone, and the downstream boundary was selected based on changes in flow regime. The stream channel was sinuous in this segment and had a moderate slope. Substrate was predominantly cobble and gravel with some sand. The general habitat types included long deep runs and riffles. Six transects were used to characterize hydraulic and habitat conditions. Flows ranging from 5 to 350 cfs were used to simulate hydraulic conditions.

Site NFCLP-2 was located 0.6 miles downstream from Seaman Reservoir (Figure 2.5). The site represented a 1.2-mile segment of the North Fork from the outlet of Seaman Reservoir downstream to the confluence with the Poudre River (Figure 2.5). Both segment boundaries were selected based primarily on changes in flow regime. The river remained sinuous in this segment with substrate material similar to that found in segment NFCLP-1. Flow regime was controlled by releases from Seaman Reservoir. The general habitat types included riffles, runs, and pools. Six transects were used to characterize hydraulic and habitat conditions. Flows ranging from 5 to 350 cfs were used to simulate hydraulic conditions.

<u>Field Data Collection</u>

Field measurements were made at sites CLP-2, CLP-3, NFCLP-1, and NFCLP-2 in the summer of 1986 and at sites CLP-4 and CLP-5 in the summer of 1987. At each study site, transects were positioned across the river in different habitat types in order to represent the available physical habitat diversity including pools, runs, riffles, and other features common to the reach. The first transect, located at the downstream end of each study site, was placed across a hydraulic control (usually located at the top of a riffle or at a channel constriction). Additional transects were placed across all hydraulic controls located in the study site. Measuring tapes were strung across each transect, and permanent head and tail pins were established on the bank as reference points at the ends of the tape to provide consistency between field measurements taken during low-, mid-, and high-flow conditions. Along each transect, measurement points (verticals) were placed at locations where abrupt changes in substrate, water velocity, or ground surface elevations were observed. Where substrate, water velocity, and bottom profile were consistent, verticals were placed at equal intervals ranging from 2 to 4 feet.

During low- and mid-flow conditions, distance from the left (looking downstream) headpin, ground elevation, water depth, and average velocity were determined at all verticals along each transect. Water surface elevations were also measured at each transect. Depth and velocity were determined using a top-setting wading rod and direct readout electromagnetic flow meter. Velocity measurements were made at a depth of 0.6 times the total depth in water when less than or equal to 2.5 feet deep. In water greater than 2.5 feet deep, velocity was measured at depths of 0.2 and 0.8 times the total depth and averaged. Streamflow was calculated using depth and velocity data at each transect. In order to determine elevations, a nearby permanent object was selected as a benchmark and assigned an artificial elevation of 100.0 feet. Headpin, ground surface, and water surface elevations were determined using an automatic level and stadia rod with reference to the benchmark. The distances between headpins along each streambank were measured to determine transect stationing and total length.

During high-flow conditions, only water surface elevations were measured at all transects. Flow data from stream gaging stations and, if necessary, data from diversion structures and reservoir outlets were used to determine streamflows at some stations during the time high-flow sampling occurred. Flow data from gages and diversion structures were used for high flows due to the hazards and large time commitment of taking depth and velocity measurements. Where gage data were not available, stream flow was calculated from depth and velocity measurements taken across the transect within the study site judged to have the most uniform flow and substrate characteristics.

Habitat Preference Curves

The habitat preference curves for brown trout presented in Figure 2.6 (Raleigh et al., 1984a) and those for rainbow trout presented in Figure 2.7 (Raleigh et al., 1984b) were used in the IFIM analyses. These curves were agreed upon during consultation with resource agencies.

Computer Simulations

Hydraulic Models

Field data were entered into the Colorado State University CYBER computer system for analysis using the Physical Habitat Simulation System (PHABSIM) programs maintained by the FWS Instream Flow Group. At all stations, velocity data collected during low-flow or mid-flow conditions and water surface elevation data collected at all flows were used to simulate hydraulic relationships using the IFG-4A methodology described by Milhous (1984). Hydraulic relationships were simulated for conditions ranging from near base flow to near peak flow. The output of these hydraulic simulations was then coupled with preference curves for the target species using the HABTAT computer program (Milhous et al., 1984). Output from the HABTAT program (WUA versus discharge) provided the WUA value calculated for each species and life stage over the range of simulated flows.

To maintain the reliability of modeling results over the full range of flows, the hydraulic simulations were performed using two separate sets of velocity calibration data: a low-flow set that utilized water velocity data collected under low-flow conditions; and a mid-flow set that utilized water velocities measured at intermediate flows. Both data sets utilized water surface elevation and discharge data from low, middle, and high flows. Hydraulic simulation output for each flow of interest was based on one of these two sets of velocity calibration data and the full range of water surface and discharge data. The final WUA versus discharge relationship for each species and life stage over the full range of flows was developed by combining simulation output from both the low- and mid-flow velocity calibration data sets. Weighted usable area versus discharge values generated using low-flow velocity calibration data were used for hydraulic conditions ranging from near base flow to a point approximately midway between actual flows measured during low- and mid-flow conditions. Weighted usable area versus discharge values for hydraulic conditions ranging from midway between actual flows measured during low-and mid-flow conditions to near peak flow were taken from the output of simulations using mid-flow velocity calibration data.

Hydrologic Simulations

To address the effects of the proposed project on stream flows and fish habitat, a time series approach based on historic hydrologic records was used. Mean monthly pre- and with-project flow data needed for this analysis were provided by NCWCD (1987a,b). Computer simulations of project hydrology were performed using MODSIMX Version 2.51 (Labadie, 1987). MODSIMX (commonly referred to as MODSIM) was developed by modifying a mass-balance network model devised by the Texas Water Development Board (1972). Application of the network model for the proposed Stage 1 Cache la Poudre Project began by defining the characteristics and spatial distribution of the influential elements within the project-affected river basins, and included the following:

(1) reservoirs with their corresponding area-capacity, relative priority under Colorado water law, and rule curve data;

(2) links representing conveyances, canals, and river reaches with defined capacities;

(3) nodes representing points on conveyances or confluences;

(4) demands including municipal, irrigation, fish flows, etc., and their relative priorities under Colorado water law;

(5) inflows of all water sources, usually unregulated natural inflow.

Following network development, calibration and validation runs were performed to identify and correct potential problems with model configuration and data, and to demonstrate that the model properly simulated the system. With a calibrated and verified model, pre-project hydrology was simulated for a 30-year period of record from October 1954 through September 1983.

With-project hydrology consisted of two separate bounding conditions. The first, referred to as the "minimum bounding condition," was based on the assumption that all water available for use from the reservoir would be delivered by pipeline from the reservoir, and therefore would not contribute to downstream flow quantities. The second, referred to as the "maximum bounding condition," was based on the assumption that all water available for use from the reservoir would be released from the reservoir and carried in the stream channel to points downstream of the study area boundary.

Instream Flow Analysis

Analysis of pre- and with-project simulated streamflows was based on a standardized procedure agreed upon by the consulting resource agencies. This procedure, generally termed "time series" analysis, was based on mean monthly flows predicted for a simulated (in this case 30-year) period of record. For each month of the year, a "time series" of flows was simulated, one to represent conditions in each of the 30 simulated years. These "time series" were simulated for the pre-project condition and the following with-project conditions:

(1) Grey Mountain minimum and maximum bounding conditions and

(2) Poudre minimum and maximum bounding conditions.

With-project simulations were provided for stations CLP-2, CLP-3a, and CLP-3b.

Once the pre- and with-project hydrologic time series were established, habitat analyses were conducted for all life stages of rainbow and brown trout. In each analysis, monthly flow values were converted to corresponding WUA values from flow versus WUA curves for each species and life stage. This resulted in a monthly habitat time series consisting of 30 monthly habitat values representing habitat conditions under the simulated range of flows.

The final monthly value for either flow or habitat was calculated by averaging all flows (or habitat values) which fell between the 50th and 90th percentiles of occurrence. This calculation resulted in an index value that approximately equalled the flow (or habitat) exceeded about 63 percent of the time, or a value in the lower range of either flow or habitat. Use of this average "50th to 90th percentile exceedance value" was specifically recommended by CDOW during consultation and was the basis for all flow and habitat analyses described in this report.

Habitat time series analyses performed for each life stage considered the periodicity of each species. Since adult and juvenile life stages occurred throughout the year, habitat values for all months were determined. For fry, habitat values were determined for those months when emergence could first occur through the end of the summer, at which time they were considered to be juveniles. This period extended from March to September for brown trout and from April through September for rainbow trout. For the spawning life stage, habitat values were determined for those months when spawning could potentially occur. This period extended from September through November for brown trout and from February through April for rainbow trout.

The effects of the project were determined by generating pre-project summary tables of the available habitat for each river segment. Available habitat was determined by multiplying the segment length expressed in 1,000- foot increments by the monthly 50 to 90 percent WUA value for each species and life stage. With-project summary tables were generated for those river segments where flow modifications were expected or where partial inundation occurred. The effects of flow modifications were determined by using with-project habitat exceedance values and segment lengths to determine available habitat. In partially inundated segments, available habitat was determined using a segment length that had been reduced by subtracting the number of 1000-foot increments inundated from the original length. In segments that were completely inundated, pre-project available habitat values were used to show the habitat losses for that segment.

Overall project effects were evaluated by comparing the total amount of habitat available under pre- and with-project conditions. Total habitat values were determined by summing the available habitat by month from each segment by species and life stage in the affected portions of the study area. Because no flow modifications or inundation has been proposed in the reaches upstream from an elevation of 5680 feet, and because these areas were studied primarily to address potential beneficial flow modifications in the future, they were not used in calculating total habitat values. The quantification of overall project effects was expressed as the percent change in total available habitat by month for each species and life stage.

2.3.4.2 Habitat Quality Index

The Habitat Quality Index (HQI) model developed by Binns (1982) was used to characterize stream trout habitat within proposed reservoir inundation areas. The HQI was developed using data from Wyoming trout streams as a predictive tool to accomplish the following:

(1) characterize the existing habitat conditions and features;
(2) identify any habitat deficiencies;
(3) provide a baseline against which future habitat alterations could be judged;
(4) assess the ability of a stream to support trout.

The model assumes that the ability of a stream to support trout is a function of the quantity and quality of stream habitat present, that the best habitat for trout will be associated with a high population level (standing crop) of trout, and that standing crop is a consistent index of existing habitat quality (Binns and Eiserman, 1979).

The HQI was developed over a period of time by selecting 12 variable attributes and establishing criteria by which they were measured. Attributes were measured in 44 Wyoming trout streams where trout standing crop estimates were available, and the relationships between habitat attributes and trout standing crop were explored with multiple regression analysis. Based on this analysis, the following 10 attributes were selected for inclusion in the model:

(1) late summer streamflow;
(2) annual streamflow variation;
(3) maximum water temperature;
(4) nitrogen (as nitrate) concentration;
(5) average water velocity;
(6) macroinvertebrate abundance and diversity;
(7) substrate;
(8) trout cover (in stream);
(9) eroding stream banks;
(10) stream width.

Model building trials using attributes with significant correlation coefficients has led to the development of two HQI models to date. The most recent version (model II) was used to calculate the HQI score, which was expressed mathematically as:

$$\log_{10}(Y + 1) = [(-0.903) + (0.807)\log_{10}(X_1 + 1) + (0.877)\log_{10}(X_2 + 1) + (1.233)\log_{10}(X_3 + 1) + (0.631)\log_{10}(F+1) + (0.182)\log_{10}(S+1)]$$

where,

Y = Predicted trout standing crop (pounds per acre);

X_1 = Late summer streamflow (cfs);

X_2 = Annual streamflow variation (cfs);

X_3 = Maximum summer stream temperature (°C);

F = Food index = $X_3*X_4*X_9*X_{10}$ (dimensionless);

S = Shelter index = $X_7*X_8*X_{11}$ (dimensionless);

X_4 = Nitrogen (as nitrate) concentration (mg/l);

X_7 = Trout cover (dimensionless);

X_8 = Eroding streambanks (dimensionless);

X_9 = Substrate (dimensionless);

X_{10} = Average water velocity (feet/second);

X_{11} = Stream width (feet).

The model was tested using HQI scores and standing crop estimates from 44 Wyoming trout streams and found to have a high degree of precision. The relationship between HQI scores and trout standing crop was defined by the equation of the regression analysis as follows (Binns, 1985):

Trout standing crop (lbs/acre)= 5.686 + 0.9557*(HQI score)

Study Site Selection

Within the study area, two HQI study sites were selected in the proposed inundation area in order to quantify stream habitat that would be lost as a result of the project. Both study sites were located to correspond with IFIM study sites. One site was located on the Poudre River at station CLP-2 and the second site was located on the North Fork at station NFCLP-1 (Figure 2.5).

Field Data Collection

Field data were collected at both study sites during September 1987. Data on all habitat attributes were collected with the exception of stream flow, temperature, and nitrogen concentration, which were determined from historic records (USGS, various years; NCWCD, 1987a,b).

Model Calculations

Following data compilation, habitat attribute scores were determined and model calculations were performed. The resultant HQI scores were used to estimate trout standing crop at each station. The calculated standing crop estimates were compared with actual standing crop measurements from study sections in order to verify the accuracy of the model.

The HQI analysis was used to establish a baseline from which strategies for mitigation of stream inundation losses could be compared. This comparison was based on the concept that a standard measurement of habitat quantity and quality, or Habitat Unit (HU), could be defined as the habitat required to perpetuate one pound of trout standing crop per surface acre. Since HQI defines habitat in terms of standing crop, it can be used to estimate HU (Conder and Binns, 1986). The calculated standing crop estimates were expressed as HU/mile and were multiplied by the number of miles potentially inundated by the project to determine HU losses. Results of this analysis were used to evaluate potential replacement habitat or habitat improvement strategies which could be considered for mitigation.

2.3.4.3 Stream Temperature Study

A stream temperature study was performed to determine the temporal and spatial water temperature relationships in the Poudre River from the proposed Grey Mountain Damsite downstream to Taft Hill Road under pre- and with-project conditions. This segment of river included the outlet of the Charles Hansen Supply Canal from Horsetooth Reservoir, the Larimer County Canal diversion, the Jackson Ditch, and ended at the Larimer-Weld diversion. These features as well as the upstream discharge were the major features that determined the hydrology in the study area. The study had two major components:

(1) monitoring of existing stream temperatures;
(2) model simulation of pre- and with-project stream temperatures.

Monitoring of existing stream temperatures was performed for a one-year period (March 1987 through February 1988) by placing continuous recording thermographs at key locations downstream from the proposed mainstem reservoir, at the mouth of the canyon at river mile 54.7, in the Horsetooth Reservoir outfall (prior to entering the river) at river mile 53.8, and upstream from the Larimer-Weld diversion at river mile 45.9 (Figure 2.5). Thermographs were checked twice monthly to change recording tapes and calibrate the instruments. Once retrieved, bi-hourly data were transcribed to data summary forms and daily average, maximum, and minimum temperatures were determined. Monthly means from the daily data for average, maximum, and minimum temperatures were then calculated for use in model calibration.

Model simulation of pre- and with-project stream temperatures required data on historic temperatures, hydrology, meteorology, and information regarding various channel parameters (such as shade, width, slope, etc.). Historical temperature data for the Poudre River in the study area were limited to once monthly grab samples taken at USGS water quality stations at the mouth of the canyon (USGS Station 6-7520) and at Shields Street (USGS Station 06752258). These data were not sufficient for model calibration since the grab sample temperatures were not obtained so that actual monthly mean temperatures could be calculated. The existing data were summarized, however, into means for the period of record and used as input temperatures since they were the best data available. The temperature monitoring described in the previous paragraph was conducted to provide data for model calibration since it was more precise than the historical data.

Historic river flow data were obtained for the USGS gage at the canyon mouth. These data were used to classify historic conditions as wet, dry, or normal. Historic meteorology data were obtained for Fort Collins, Colorado, from Mountain States Weather Service (1987). These two databases were used as the historic data input to the water temperature model. The period of record for hydrology calculations was 1954 through 1983, and the period of record for meteorology calculations was 1978 through 1987. Specific hydrologic and meteorologic variables utilized were as follows:

(1) mean monthly river flow;
(2) mean monthly water temperature;
(3) mean monthly air temperature;
(4) mean monthly wind speed;
(5) mean monthly relative humidity;
(6) mean monthly percent possible sunshine.

An exceedance analysis was performed on each data set to determine the extreme conditions for both air temperature and river flow. For historic meteorology and hydrology, the average annual values were sorted into ascending order and exceedance calculated by:

$$P = 100 - [(m/n + 1) * 100]$$

where,

P = Exceedance probability;
m = Rank value for variable;
n = Total number of rank.

Hot and wet years were determined based on the 20+ percent exceedance level, and cold and dry years were determined based on the 80+ percent exceedance level. Normal years for both hydrology and meteorology were based on means for the entire period of record.

Additional data on topography, channel geometry, and shading were compiled and used to complete the model input files. Gradients, reach lengths, and topographic shading were measured directly from USGS 7.5-minute quadrangle maps. Channel geometry data (stream width and roughness coefficients) were obtained from the IFIM studies. Field measurements of riparian vegetation were made to determine shading parameters such as vegetation height, offset, and density.

The predictive model used was the Instream Water Temperature Model (Theurer et al., 1984). This model is a dynamic temperature steady flow model that incorporates both heat flux and heat transport principles to predict thermal changes under a variety of environmental and geographic conditions. Water temperatures were simulated for the year types listed in the analysis matrix (Table 2.2) and output was summarized for selected output points and time periods.

The predictive modeling for this study included a full range of meteorologic and hydrologic conditions (i.e., hot/dry conditions to cold/wet conditions). A comparison was then made of pre- and with-project conditions to determine the effects of the project on stream temperatures and resident trout populations.

TABLE 2.2

Analysis Matrix for Water Temperature Model

Hydrology	Meteorology		
	Normal	Hot (1981)	Cold (1982)
Normal	X	X	X
Wet (1961)	X	X	X
Dry (1981)	X	X	X

2.3.4.4 Reservoir Quality Index

The Reservoir Quality Index (RQI) developed by Whitworth (1985) was used to estimate the habitat potential of the proposed mainstem reservoir. Reservoir habitat units (RHU) calculated in the model were based on the following parameters: maximum reservoir depth at the normal maximum pool, estimated total dissolved solids (TDS) concentration, and the average weight of trout in Colorado reservoirs. One RHU is defined as a measure of the reservoir habitat quantity and quality needed to support one pound of trout standing crop per acre (Conder and Binns, 1986).

Reservoir depth was obtained from data provided by NCWCD. The present TDS concentration was estimated using historic water quality and stream flow data from USGS gaging stations for the Poudre River at the mouth of the canyon and for the North Fork near Red Feather Lakes Road. Reservoir TDS concentration was calculated as a weighted percent based on reservoir inflows from the Poudre River and the North

Fork (with 83.5 percent of the inflow assumed from the Poudre River and 16.5 percent assumed from the North Fork). The average weight of trout in Colorado reservoirs was obtained from R. Pistono (1987).

Model output was used to provide an estimate of potential reservoir trout standing crop and to assist in developing a preliminary reservoir stocking program as part of the preliminary mitigation evaluation.

2.4 RESULTS AND DISCUSSION

2.4.1 Description of Existing Environment

2.4.1.1 Fish Populations

A total of 11 species of fish have been reported in the aquatic resources study area (Table 2.3). Fish populations in the Poudre River were typical of Colorado mountain streams where brown trout (Salmo trutta) and rainbow trout (Salmo gairdneri) are the dominant species. Fish populations found in the North Fork were typical of transitional streams where both cold and warm water species are found (Aquatic Management Associates, 1986a).

Cache la Poudre River

Species and Relative Abundance

In the Poudre River, rainbow trout and brown trout were the principal fish species found. Brook trout (Salvelinus fontinalis), cutthroat trout (Salmo clarki), mountain whitefish (Prosopium williamsoni), white suckers (Catastomus commersoni), longnose dace (Rhinichthys cataractae), and fathead minnows (Pimephales promelas) were also reported (Klein, 1974; Aquatic Management Associates, 1987b).

Fish populations in the upper portion of the study area have been studied since at least 1962. A primary purpose of studies conducted since that time was to evaluate the effects of special regulations, which were implemented in 1963 by CDOW in an effort to provide better fishing, in terms of larger and more abundant fish, and to emphasize the sporting aspect of trout fishing (Klein, 1974). The special regulations most recently enforced in the three "wild trout water" areas included tackle restrictions (flies and lures only), minimum size limits of 41 cm (16 inches), and bag limits of two fish per day (CDOW, 1988).

TABLE 2.3

Percent Composition of Fish Species Collected at Study Locations in the Mainstem and North Fork of the Cache la Poudre River during 1986 and 1987[1]

Species	Poudre River at the Anderson Ranch	North Fork Upstream from Seaman Reservoir	North Fork Downstream from Seaman Reservoir
Brown trout	46.3 - 57.2	4.6 - 14.6	2.8 - 6.5
Rainbow trout	13.7 - 20.2	2.0 - 8.6	0.4 - 1.5
Mountain whitefish	0.0 - 1.2	--	--
White sucker	0.0 - 1.9	7.5 - 13.1	3.4 - 15.5
Longnose sucker	1.2 - 5.3	0.1 - 0.9	2.3 - 6.2
Longnose dace	19.8 - 34.2	52.5 - 66.1	2.7 - 69.4
Fathead minnow	0.0 - 0.4	0.0 - 7.5	--
Johnny darter	--	0.3 - 24.7	--
Yellow perch	--	0.0 - 1.1	21.7 - 74.3
Creek chub	--	0.0 - 1.1	--
Sunfish	--	0.0 - 0.3	0.0 - 0.6

(1) Data sources: Aquatic Management Associates (1986b, 1987b); Aquatics Associates (1987).

At nearly all sampling locations in the upper Poudre River (Upper Wild Trout Water, Lower Control, Middle Wild Trout Water, and Kelly Flats Campground), the most common fish species was rainbow trout, accounting for 53 to 62 percent of the salmonids collected. In the downstream portions of the study area at stations near the Munroe Diversion and at the Anderson Ranch, brown trout accounted for 78 to 93 percent of the salmonids collected (Table 2.4).

Density and Biomass

Average density and biomass were estimated at all sampling stations for brown and rainbow trout collected from 1980 to 1987 (Table 2.4). Average density ranged from 415 to 937 trout per hectare (ha). Mean total trout biomass ranged from 37.5 to 118.7 kg/ha. The highest average biomass estimates were generally found in areas managed with special regulations, while lowest standing crop estimates were reported at locations where standard regulations applied. The lowest average biomass estimate was reported at the Anderson Ranch, downstream from the outlet of the Charles Hansen Supply Canal from Horsetooth Reservoir, where stream channelization, low flows (less than 2 cfs), and extreme fluctuations in stream flow typically occur. Trout biomass estimates at the two sites within or downstream of the proposed mainstem reservoir (Lower Wild Trout Water [LWTW] and Anderson Ranch) averaged 63.6 kg/ha. The average biomass for the six upstream sites was 91.1 kg/ha. Although the average downstream biomass is lower than the upstream average, the estimate of 89.7 at the LWTW site downstream of the Munroe Diversion is quite close to the 91.1 kg/ha average for the upstream sites. Therefore, differences between estimates above or below the proposed mainstem reservoir are primarily due to the low biomass at Anderson Ranch. Biomass values for the entire study area were similar to those found in 1983 and 1984 by Nehring and Anderson (1984) in certain "quality" Colorado trout streams (Arkansas River, 84-127 kg/ha; Blue River, 27-152 kg/ha; Colorado River, 62-124 kg/ha; Eagle River, 38-97 kg/ha; South Fork of the Rio Grande River, 85-184 kg/ha; and the St. Vrain, 19-159 kg/ha).

Population Variation Factors

Natural variations in yearly population statistics documented by past studies of Poudre River trout populations have been attributed to several factors including angler harvest, fishing regulations, and overwinter mortality. Comparison of density and creel census data indicated a relationship between standing crop in the fall and mortality of trout due to angler harvest throughout the year (Nehring and Anderson, 1981). In 1963, a dramatic increase in trout density was found at the UWTW station after special regulations were implemented. An 80 percent decrease in harvest was also reported (Klein, 1974). The effect of harvest on populations was also apparent at Indian Meadows and the UWTW in 1983 and 1984 following a reduction in bag limits from eight to two fish per day. Nehring and Anderson (1985) reported a 33 percent increase in biomass as a result of reduced bag limits and harvest.

Variations in population statistics also demonstrated the vulnerability of trout populations to overwinter mortality. Following a mild winter and subsequent low runoff in 1981, a significant increase in biomass and density occurred as a result of increased survival of fish through the winter and production added during the summer (Nehring and Anderson, 1982). Increased recruitment of brown trout to the population was noted in 1983 when a strong 1981 year class was found to be the primary cause for the increase in density (Nehring and Anderson, 1984). Comparison of biomass estimates for brown trout less than 15 cm in length at the Anderson Ranch station also indicated increased recruitment from spring and fall in 1987 when biomass increased from 3.3 to 35.7 kg/ha (Aquatic Management Associates, 1987b; Aquatics Associates, 1987).

TABLE 2.4

Average Trout Population Statistics in the Mainstem and North Fork of the Cache la Poudre Rivers in the Study Area, 1980 to 1987 (Range in Parenthesis)

Study Site Location	N[1]	Number of Fish/ha			Percent Composition		Biomass (kg/ha)		
		Brown	Rainbow	Total	Brown	Rainbow	Brown	Rainbow	Total
CACHE LA POUDRE RIVER									
Big Bend Campground	5	353 (227-451)	119 (74-202)	474 (299-643)	75 (69-81)	25 (19-31)	52.2 (41.3-60.2)	14.8 (10.2-22.6)	67.0 (51.5-80.8)
UWTW (5.0 mi. upstream from Rustic)	7	385 (133-481)	426 (248-665)	809 (381-1108)	47 (35-65)	53 (35-65)	57.8 (18.4-76.8)	60.9 (30.4-94.3)	118.7 (48.8-160.6)
Lower Control (2.0 mi. upstream from Rustic)	7	279 (202-353)	427 (175-568)	700 (377-870)	41 (32-54)	59 (46-68)	39.6 (29.6-56.2)	52.3 (26.4-68.6)	91.9 (56.0-124.8)
Indian Meadows (MWTW; 1.0 mi. downstream from Rustic)	7	274 (160-412)	452 (339-650)	730 (641-930)	38 (24-55)	62 (45-76)	41.6 (23.4-61.5)	60.9 (50.2-92.6)	102.1 (72.2-144.7)
Kelly Flats Campground	8	360 (265-605)	429 (242-618)	784 (507-1005)	46 (37-63)	54 (37-63)	45.0 (31.0-66.4)	44.1 (24.3-72.3)	89.0 (60.9-138.7)
Upstream from Munroe Diversion	5	752 (547-989)	86 (54-114)	840 (621-1079)	89 (84-95)	11 (5-16)	67.2 (56.2-77.6)	10.7 (4.4-17.8)	77.9 (68.0-85.4)
Downstream from Munroe Diversion (LWTW)	7	856 (580-1299)	67 (29-106)	937 (627-1361)	93 (91-100)	7 (0-12)	82.7 (62.0-103.0)	6.9 (1.6-10.4)	89.7 (66.5-105.5)
Anderson Ranch (0.9 mi. downstream from the Horsetooth Reservoir outfall)[2]	3	322 (109-546)	89 (44-178)	415 (152-740)	78 (71-87)	22 (13-29)	29.4 (22.5-34.4)	8.1 (5.5-10.3)	37.5 (30.9-46.0)
NORTH FORK OF THE CACHE LA POUDRE RIVER									
Upstream from Seaman Reservoir[2]	3	129 (40-213)	65 (0-123)	191 (40-279)	76 (52-100)	24 (0-48)	38.8 (16.1-55.4)	18.0 (0.0-29.2)	56.8 (16.1-80.1)
Downstream from Seaman Reservoir[2]	3	261 (148-361)	53 (0-94)	311 (148-424)	86 (74-100)	14 (0-26)	113.5 (74.1-152.6)	16.2 (0.0-28.2)	129.7 (74.1-173.0)

(1) Number of sampling events (generally once per year).

(2) Data sources: Aquatic Management Associates (1986b, 1987b), Aquatics Associates (1987). All other data were collected by CDOW (Nehring and Anderson, 1981, 1982, 1983, 1984, 1985, 1986; CDOW, 1987a).

Length-frequency data presented by Nehring and Anderson (1981, 1982, 1983, 1984, 1985) and Aquatic Management Associates (1986b, 1987b) indicated that Poudre River trout populations were comprised of a small number of fish greater than 30 cm (12 inches) in length. A measure of size structure that relates to the quality of the fishery is the number of fish per unit area greater than a designated "quality size". In most Colorado streams, 35 cm (14 inches) is considered a quality size. However, in the Cache la Poudre River, few fish of this size are found because of slower growth rates due to colder water temperatures and increased fisherman harvest. As a result, 30 cm (12 inches) is considered a quality size for the Poudre River (Nehring and Anderson, 1985).

Growth rates in the upper Poudre River have been documented to be slow (Klein, 1974). Nehring and Anderson consistently found low growth rates attributable to the short growing season. Mean lengths of young-of-the-year (YOY) trout were generally less in the upper Poudre River than for other Front Range streams (Nehring and Anderson, 1982).

Except in wild trout waters, the Poudre River receives extensive stocking of catchable size (greater than 15 cm) rainbow trout from the confluence of Joe Wright Creek to the Munroe Diversion. Stocking rates ranged from 77 to 365 kg per kilometer (km) from 1979 to 1987. Stocked fish had little impact on population estimates, as hatchery reared trout are more vulnerable to angling pressure (Nehring and Anderson, 1983). Essentially all trout stocked in the upper Poudre River were rapidly creeled by mid-September (Marshall, 1973). Fisherman use in the upper portion of the study area was classified as moderate to extremely high (Marshall, 1973). Nehring and Anderson (1981, 1982) repeatedly found that trout populations in the lower Poudre River upstream and downstream from the Munroe Diversion were depressed due to extremely high fishing pressure. In areas of extreme fishing pressure, bag limits of two trout per day in the UWTW were not effective in reducing total angling mortality (Nehring and Anderson, 1982).

<u>North Fork of the Cache la Poudre River</u>

<u>Species and Relative Abundance</u>

North Fork fish species collected during 1986 and 1987 included brown trout, rainbow trout, white sucker, longnose sucker, longnose dace, fathead minnow, johnny darter, yellow perch (<u>Perca flavescens</u>), creek chubs (<u>Semotilus atromaculatus</u>), and hybrid sunfish (<u>Lepomis</u> sp.) (Table 2.3).

Density and Biomass at Upstream Stations

Dominant fish species captured upstream from Seaman Reservoir included white sucker, longnose dace, johnny darter, and brown trout. White suckers were collected on all sampling occasions. Density estimates ranged from 251 to 386 fish/ha. Although sucker density was less than for salmonids, white suckers consistently represented the greatest biomass at 107.3 to 150.8 kg/ha. Greater biomass estimates were due to the fact that the average weights of white suckers collected ranged from 282.8 to 593.6 g, and nearly all fish were greater than 20 cm in length. Longnose dace were quite numerous but represented a lower biomass due to their small size.

Brown trout were the dominant salmonid species, representing 52 to 100 percent of the salmonids collected (Table 2.4). Upstream from Seaman Reservoir, total trout density estimates were 255, 279, and 40 fish/ha, respectively, for samples from the fall of 1986 and spring and fall of 1987. Similar trends were reported for total trout biomass with estimates of 74.1, 80.1, and 16.1 kg/ha, respectively. The biomass estimate of 16.1 kg/ha calculated for the fall of 1987 was substantially less than estimates reported on other sampling occasions. The flow of 1.8 cfs measured at that time represented a significant reduction from the flows of 12.6 and 11.6 cfs measured during the fall of 1986 and spring of 1987 sampling periods. The detrimental effects of low flow conditions and subsequent warm water temperatures were reported as the likely cause for the reductions in trout densities and biomass (Aquatics Associates, 1987). A strong YOY age class was consistently reported for brown and rainbow trout, indicating natural reproduction was occurring in this section of the North Fork.

Density and Biomass at Downstream Stations

Downstream from Seaman Reservoir, brown and rainbow trout were collected. However, fish species composition was dominated by yellow perch, white suckers, and longnose dace (Table 2.3). Yellow perch, and white and longnose suckers made up the greatest portion of the biomass.

During the fall of 1986 and spring of 1987, the greatest density and biomass estimates were calculated for yellow perch. Reported densities were 3651 and 5758 fish/ha with biomass estimates of 213.5 and 323.2 kg/ha. Only YOY yellow perch were collected in October of 1987, and while earlier samplings indicated populations ranged from 15 to 18 cm in length, individuals collected in the fall of 1987 ranged from 4 to 8 cm in length. It was suspected that yellow perch were discharged into the study reach from Seaman Reservoir.

Numerous white and longnose suckers were collected during all sampling efforts. Reported densities ranged from 760 to 1344 fish/ha, while biomass estimates ranged from 76.7 to 91.6 kg/ha. Highest concentrations were found in the fall of 1987 when sucker biomass exceeded values calculated for trout and yellow perch.

Brown trout were the most common salmonid, accounting for 74 to 100 percent of the salmonids captured. Density estimates for trout ranged from 148 to 424 fish/ha (Table 2.4). Total trout biomass estimates were 142.1, 173.0, and 74.1 kg/ha, respectively, during the fall of 1986 and spring and fall of 1987. The size ranges for brown and rainbow trout were distributed towards the larger length intervals. Individuals collected were age 1+ or greater, and the YOY age class was absent. As a result of reservoir releases from Seaman Reservoir, extreme streamflow fluctuations occurred in the study reach. Reported flows varied from less than 1 cfs to over 350 cfs within a 24-hour period (Gustafson, 1986). The flow regime was reported to be one of the more important factors affecting fish population characteristics downstream from Seaman Reservoir on the North Fork.

Tributary Streams

Boyd Gulch, Watha Gulch, Falls Gulch, Hewlett Gulch, and 11 unnamed tributaries have their confluence with the Poudre River in the proposed project inundation area. Tributaries to the North Fork within the study area include Obenchain Draw, Long Draw, and 12 unnamed tributaries. Except for Hewlett Gulch, all tributaries are shown as intermittent streams on 7.5-minute USGS topographic maps.

A field reconnaissance survey was conducted by Aquatic Management Associates (1987c) to determine the importance of tributary streams to resident fish populations in the study area. The reconnaissance revealed that all tributaries were dry when observed during low-flow conditions during August and September of 1986. No previous reports of fish resources in these tributaries were identified. Therefore, it was concluded that tributary streams to the Poudre River and the North Fork do not support fish populations or provide suitable fisheries habitat.

Reservoirs

Seaman Reservoir is located in the project area on the North Fork, approximately 1.3 miles upstream from the confluence with the Poudre River (Figure 2.2). This reservoir is owned and operated by the City of Greeley as part of their water supply system. The reservoir is approximately 1320 acres in size with a maximum depth of 72 feet. However, reservoir levels are reduced significantly during August and September (Gustafson, 1986).

Following the construction of Seaman Reservoir in 1947, the Colorado Department of Game, Fish, and Parks managed Seaman Reservoir as a "put and take" trout lake until 1965 when the lake was closed to public fishing. Fish population investigations between 1948 and 1965 indicated the following fish species: rainbow trout, lake trout (Salvelinus namaycush), white suckers, longnose suckers, walleye (Stizostedion vitreum), yellow perch, bluegill, creek chubs, and golden shiners (Notemigonus crysoleucas). However, fish populations were lost in October of 1965 and again in September of 1976 when the City of Greeley drained the reservoir for repair and maintenance work. Hanzon and Matter (1976) reported that reservoir waters contained large quantities of silt from July floods, which resulted in a major fish kill. Although recent fish population surveys have not been performed in Seaman Reservoir, high densities and biomass were consistently reported for yellow perch at the fish sampling site downstream from the reservoir (Aquatic Management Associates, 1986b, 1987b). It was suspected that yellow perch were discharged from Seaman Reservoir.

2.4.1.2 Species of Special Concern

The presence of johnny darter populations in the study area was first documented by Aquatic Management Associates (1986b). Two fish were captured at a sampling station on the North Fork upstream from Seaman Reservoir on October 3, 1986. Following documentation of johnny darter presence, a review of the existing literature on johnny darters (Aquatic Management Associates, 1987a) indicated that populations were historically widespread in the Platte River Basin in Colorado. However, their range and abundance have been reduced in the last 90 years. A recent study by Propst (1982b) indicated the distribution of johnny darter populations is generally limited to stream segments in the transition zone between foothills and plains stream types along the east slope. Individuals are usually found in streams 15 to 45 cm deep, in slow to moderate velocities (0 to 50 cm/sec), and over a substrate of sand and rubble. They are often found near aquatic plants. Johnny darters are also found in small ponds and lakes that have a sand and rubble bottom (Propst, 1982b). These fish tend to avoid excessively turbid and silty areas (Kuehne and Barbour, 1983) and are usually absent in areas where sand and sediment have filled the interstitial spaces.

In east slope streams, johnny darter populations are unevenly distributed and absent from many sites (Aquatic Management Associates, 1987a; Propst, 1982b). The number of johnny darters collected in samples taken prior to the current study never exceeded 59 specimens at any given sampling location. Generally, the number of johnny darters found was less than 20 fish (Aquatic Management Associates, 1987a).

During sampling surveys of the North Fork upstream from Seaman Reservoir in 1987, 47 johnny darters were captured on April 9, 1987, which comprised 8.6 percent of the total fish captured (Aquatic Management Associates, 1987b). On October 6, 1987, 181 johnny darters were captured, which accounted for 24.7 percent of the fish captured (Aquatics Associates, 1987). In both sampling efforts, a variety of size classes (35-60 mm) were found, indicating that natural reproduction was taking place. Recently, johnny darters have also been noted upstream from Halligan Reservoir, above the study region (Kehneier, 1987) during trout surveys conducted by CDOW.

During the current survey within the study area, no johnny darters were found in the sampling areas on the mainstem of the Poudre River (Table 2.5). Brown and rainbow trout were found at all four mainstem sites and longnose dace were caught at JD-3 and JD-4. A total of 29 johnny darters were intercepted at JD-6, on the North Fork of the Poudre River, approximately 1.3 miles south of the Seaman Reservoir. There, they represented 10.9 percent of the total catch, which was dominated by longnose dace and small longnose suckers and included no trout (Table 2.5). As was found in previous surveys, the catch included a variety of lengths (Figure 2.8), suggesting natural reproduction was occurring. Their mean length was 57.38 mm ($\pm$9.48 mm; p=0.05) and ranged from 45 to 63 mm (Figure 2.8). Weight at length was variable, and no significant length-weight relationships were found. The average weight of the fish in the sample was 1.45 g ($\pm$0.92 g, p=0.05).

The catch patterns of johnny darter in the study area reflect the distribution of suitable johnny darter habitat within the study region. Low velocity waters over sandy substrates, which are typical of the habitat in which johnny darters are normally found, are much more common on the North Fork than in the mainstem. The mainstem environment within the study area contains few sand and rubble substrate areas and typically has water velocities in excess of that preferred by johnny darters (Table 2.5; Section 2.4.2.4).

2.4.1.3 Macroinvertebrate Populations

A total of 47 taxa of macroinvertebrates were collected (Table 2.6) at six sampling stations located on the Poudre River and North Fork (Figure 2.4). Except for a species of flatworm (Dugesia) and snail (Lymnaea), all organisms collected were insects with aquatic life stages. In general, macroinvertebrate densities were greater and the number of taxa and species diversity were lower in the North Fork than in the Poudre River (Table 2.7). Species composition differed significantly as rheophilic organisms were dominant at Poudre River sites and species associated with pond-like environments were common in the North Fork. Analysis of macroinvertebrate population characteristics was based on data collected on three occasions by Aquatic Management Associates (1986b, 1987b) and Aquatics Associates (1987).

<u>Poudre River</u>

Benthic macroinvertebrate communities in the Poudre River were composed of 38 taxa (Table 2.6) of aquatic macroinvertebrates commonly encountered in similar streams located in the central Rocky Mountains (Ward, et al., 1986). Lotic or riverine species of Plecoptera (stoneflies), Ephemeroptera (mayflies), Trichoptera (caddisflies), and Diptera (midges and flies) comprised the predominant groups found. Differences in taxonomic composition between Poudre River sample sites were attributed to altitudinal distribution patterns of the species collected.

Total density of benthic organisms ranged between 240 and 1120 per square meter at the four Poudre River sample sites (Table 2.7). Although densities were frequently higher at downstream sites, consistent trends in density were not observed. Similarly, there were no consistent trends between the time of the year and macroinvertebrate density. The seasonally highest densities varied with the site and year. Total number of taxa collected per site ranged from 13 to 20, and species diversity values ranged between 2.24 and 3.22 (Table 2.7). Diversity values were within the range expected for similar unpolluted streams (Zimmermann and Ward, 1984).

TABLE 2.5

Total Catch, Catch per Hour Electroshocking (CPUE), and Percent Composition by Species Collected at Poudre River Survey Sites During the Johnny Darter Surveys in 1987 and 1988

Sampling Site	Date	Substrate	Area Sampled (m^3)	Species	Catch	CPUE	Percent Composition
Mainstem							
JD-1	29 Mar 1988	Lg. Cobble/ Boulders	1642	Rainbow Trout	5	4.0	16.13
				Brown Trout	26	20.8	83.80
JD-2	29 Mar 1988	Sm. Cobble/ Boulders	600	Rainbow Trout	1	0.8	5.26
				Brown Trout	18	14.4	94.74
JD-3	29 Mar 1988	Cobble/ Boulders	603	Rainbow Trout	1	0.8	3.57
				Brown Trout	26	20.8	92.86
				Longnose Dace	1	0.8	3.57
JD-4	18 Nov 1987	---------	1495	Rainbow Trout	8	6.0	19.05
				Brown Trout	21	15.8	50.00
				Longnose Dace	13	9.8	23.33
North Fork							
JD-6	7 Apr 1988	Cobble/ Sand	995	Johnny Darter	29	23.2	10.90
				Yellow Perch	14	11.2	5.26
				White Suckers	7	5.6	2.63
				Longnose Dace/Sm. Longnose Suckers	216	172.8	81.20

TABLE 2.6

List of Macroinvertebrate Taxa Collected at Sampling Sites in the Mainstem and North Fork of the Cache la Poudre Rivers during 1986 and 1987[1]

	Poudre River Sites				North Fork Sites	
Taxon	CLP-4	CLP-1	CLP-2	CLP-3	NFCLP-1	NFCLP-2
Ephemeroptera						
Baetis sp.	X	X	X	X	X	X
Paraleptophlebia heteronea	X	X	X	X	X	
Rhithrogena sp.	X	X	X	X		X
Ephemerella infrequens/inermis	X		X	X	X	X
Drunella doddsi	X	X	X	X		
Drunella grandis	X	X	X	X		
Tricorythodes minutus			X		X	X
Heptagenia sp.					X	
Plecoptera						
Prostoia sp.	X	X	X	X	X	
Claasenia sabulosa	X	X	X	X		
Pteronarcella badia	X	X	X	X		
Skwala parellela	X	X	X	X		
Pteronarcys californica	X	X				
Chloroperlidae			X	X		
Odonata						
Argia sp.					X	X
Enallagma sp.					X	X
Ophiogomphus sp.					X	X
Lepidoptera						
Petrophila sp. (Paragyractis sp.)					X	X
Trichoptera						
Hydropsyche sp.	X	X	X	X	X	X
Arctopsyche grandis	X	X	X	X		
Cheumatopsyche sp.			X	X	X	X
Brachycentrus americanus	X	X				X
Brachycentrus occidentalis			X	X		X
Dolophilodes sp.		X	X		X	
Helicopsyche borealis					X	X
Neothremma sp.					X	X
Glossosoma sp.			X	X		
Micrasema sp.	X			X		
Rhyacophila sp.	X	X				
Lepidostoma sp.		X		X		
Homophylax sp.		X				
Apatanta sp.			X			
Hesperophylax sp.				X		
Coleoptera						
Heterlimnius corpulentus	X	X	X	X	X	X
Optioservus sp.		X	X	X	X	X

TABLE 2.6 (Continued)

Taxon	Poudre River Sites				North Fork Sites	
	CLP-4	CLP-1	CLP-2	CLP-3	NFCLP-1	NFCLP-2
Diptera						
Atherix pachypus	x	x	x	x	x	
Hexatoma sp.	x	x	x	x	x	
Simulium sp.	x	x	x	x	x	
Eukiefferiella sp.	x		x	x		x
Orthocladius sp.	x	x		x		
Chironomidae indet				x	x	x
Antocha sp.	x			x		
Tipula sp.		x		x		
Bibiocephala sp.			x			
Chironomus sp.						x
Turbellaria						
Dugesia sp.			x		x	x
Gastropoda						
Lymnaea sp.						x

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(1) Data sources: Aquatic Management Associates (1986b, 1987b); Aquatics Associates (1987). Samples were collected during the fall of 1986, and the spring and fall of 1987.

<u>North Fork</u>

Benthic macroinvertebrate communities in the North Fork were composed of 28 taxa of aquatic macroinvertebrates. Taxa characteristic of lotic environments, including stoneflies, the mayflies <u>Drunella</u> sp. and <u>Rithrogena</u> sp., and the caddisflies <u>Rhyacophila</u> sp. and <u>Arctopsyche</u> grandis, were usually absent from North Fork samples. However, species of <u>Odonata</u> (dragonfly larvae), <u>Lepidoptera</u> (moth larvae), <u>Turbellaria</u> (flatworms), and <u>Gastropoda</u> (snails), which favor lentic or slow-moving pond-like environments, were collected. Other species that were restricted to North Fork samples included the caddisflies <u>Helicopsyche</u> <u>borealis</u> and <u>Neothremma</u> sp., and the mayfly <u>Hepatagenia</u> sp. (Table 2.6).

Total densities of benthic organisms ranged from 916.7 to 6426.7 per square meter at the two North Fork sampling sites. Density estimates were consistently higher downstream from Seaman Reservoir than upstream from the reservoir. Total number of taxa collected per site ranged from 11 to 17 with slightly greater numbers collected downstream from Seaman Reservoir. Species diversity values ranged from 1.77 to 3.09 (Table 2.7). Macroinvertebrate population characteristics found in the North Fork were similar to those found in other Colorado streams where low flow conditions are common (Zimmermann, 1988).

TABLE 2.7

Total Density, Number of Taxa, and Shannon Diversity for Macroinvertebrate Communities in the Mainstem and North Fork of the Cache la Poudre Rivers[1]

	Poudre River Sites				North Fork Sites	
	CLP-4	CLP-1	CLP-2	CLP-3	NFCLP-1	NFCLP-2
Total Density[2]						
Fall 1986	730.0	240.0	1006.7	1120.0	2450.0	1313.3
Spring 1987	980.0	686.7	470.0	746.7	6426.7	3766.7
Fall 1987	376.7	433.3	770.0	793.3	1676.7	916.7
Number of Taxa						
Fall 1986	15	14	16	19	17	11
Spring 1987	19	18	13	20	14	13
Fall 1987	13	17	20	19	14	14
Shannon Diversity						
Fall 1986	2.90	2.99	2.77	2.24	2.52	2.09
Spring 1987	3.16	2.54	2.87	3.22	2.36	1.77
Fall 1987	2.88	2.53	3.00	3.07	1.98	3.09

[1] Data sources: Aquatic Management Associates (1986b, 1987b); Aquatics Associates (1987).

[2] Total density reported as numbers per square meter.

The data indicated that several factors influenced the characteristics of the macroinvertebrate communities in the North Fork. The occurrence of high densities was attributed to the effects of Halligan and Seaman Reservoir releases on the downstream benthic community, as altered environments below reservoirs often enhance benthic productivity (Zimmermann and Ward, 1984). Significant reductions in stream flow were documented upstream from Seaman Reservoir during sampling efforts in the fall of 1987 when a discharge of 1.8 cfs was measured. Flows of 11.6 and 12.6 cfs were reported during previous sampling efforts.

In addition to the influences of Halligan and Seaman Reservoirs, which alter flow and thermal regimes, marked differences between the North Fork and Poudre River watersheds were reported to have effects on macroinvertebrate populations. The North

Fork has a lower gradient and flows through a wider valley, much of which is heavily grazed by livestock. In contrast, the Poudre River flows through a narrow, often shaded canyon. These factors have interacted to create distinctly different aquatic environments. Review of the data suggested that while a normal lotic benthic community was found in the Poudre River, the altered environment of the North Fork precluded the establishment of populations of many rheophilic species.

2.4.1.4 Fisheries Habitat

Within the aquatic resources study area, a wide range in the quantity and quality of fish habitat occurs. In the canyon section of the Poudre River, habitat is typical of that found in mountainous areas of the Colorado Front Range. Stream substrate is dominated by cobbles, with some boulders. Small areas of gravel deposits occur behind large boulders and along stream banks where water velocity is reduced. In upstream meadow areas where gradients are low, gravel deposits are more common. Boulders are more common in steep canyon areas where gradients are high. Pools, runs, and riffles include the general types of stream habitat present. Throughout much of the canyon, long runs and riffle areas are most common, with occasional pools found downstream from riffles and large boulders or by large rock outcrops along the streambanks. Adult trout cover exists primarily behind boulders, in pool areas, and along stream margins where overhanging vegetation or fallen trees occur. Although some livestock grazing occurs in upstream portions of the canyon, streambanks are generally stable. In areas where State Highway 14 is immediately adjacent to the stream, streambanks are comprised of angular boulders used to prevent undercutting of the highway. In downstream portions of the canyon, some streambank erosion occurs due to livestock grazing and human activities. Water quality in the canyon section is good, and stream temperatures are similar to those found in other Colorado mountain streams.

In the downstream portion of the Poudre River, habitat is typical of that found in other transitional streams. Substrate in the upper portions of this segment is predominantly cobble. Some gravel deposits occur, but are limited by high peak flows. Increases in gravel deposits occur in the downstream portions of the section as flows are reduced by irrigation diversions. Long run and riffle areas are the most common habitat types found. Some pools exist by bridge abutments and around diversion structures. Areas providing adult trout cover are limited to pools and stream margins where overhanging vegetation and fallen trees occur. Streambank erosion is occurring throughout the section in portions where livestock are grazed and in urbanized areas. Approximately 2.2 miles of river near the downstream end of the study area were channelized following the 1983 high water year. Water quality remains good in this section (Mars, 1978). Summer water temperatures in the downstream portion are generally cold due to releases from the bottom of Horsetooth Reservoir. However, water temperatures increase in a downstream direction as water is diverted to irrigation ditches. This warming trend occurs because the lower instream flows are subject to greater heat exchange with the air and because increased solar radiation from the more open canopy adds additional heat.

In the North Fork, substrate varies throughout, with cobble and occasional boulders dominant in areas where water velocities are highest. Silt and sand are deposited in areas of reduced water velocity, and bedrock is periodically dominant as the river flows through constricted canyon sections. Pool, run, and riffle habitat types occur throughout. Pools occur where steep canyon walls or large rock outcrops are found along the stream margins. Adult trout cover is provided in pools and behind boulders. Streambank erosion caused by livestock grazing is prevalent throughout the North Fork and probably contributes to lowered water quality. A water quality gaging station was established on the North Fork in November 1986, but comprehensive historical data on water quality were not available. Reduced river flows and increased water temperatures contribute to the growth of algae mats and aquatic macrophytes that cover the substrate in numerous areas throughout the North Fork. Summertime stream temperatures may be limiting trout populations in some years.

2.4.2 Effects Assessment

2.4.2.1 Fish Populations

Approximately 7.5 miles of existing stream habitat on the Poudre River and 7.5 miles on the North Fork would be inundated by the proposed mainstem reservoir (Grey Mountain Alternative). Fish populations would be affected in those areas where stream habitat is converted to reservoir habitat. Project effects would also include the loss of 1.6 miles of stream on the Poudre River that is managed as wild trout water by CDOW.

Brown trout and rainbow trout are the principal game fish found in affected stream areas on the Poudre River. Fish populations occurring in affected areas on the North Fork also include brown and rainbow trout. However, white suckers, longnose suckers, and yellow perch are the dominant species in the North Fork.

Project construction would also result in the flooding of Seaman Reservoir. Fisheries inventories were not performed in Seaman Reservoir to identify populations that could be affected by the project.

2.4.2.2 Species of Special Concern

Within the study area, there appears to be little or no use of the mainstem of the Poudre River by johnny darters. The results of the various surveys conducted since October 1987 indicate that the species is, however, widely distributed throughout the North Fork. Their distribution apparently extends upstream of Halligan Reservoir. The proposed mainstem reservoir would inundate approximately 7.5 miles of that habitat. Some populations may, however, become established around the edges of the proposed reservoir where shallow, sandy areas develop and are expected to persist in North Fork reaches above the project inundation zone.

2.4.2.3 Macroinvertebrate Populations

Changes in the macroinvertebrate community are expected with construction of the proposed reservoir. Although the present levels of understanding preclude specific predictions regarding species interaction and quantitative effects, general predictions can be made based on recent data (Aquatic Management Associates, 1986b, 1987b; Aquatics Associates, 1987), studies of other regulated streams in Colorado (Ward, 1976a; Zimmermann and Ward, 1984), and other literature concerning the ecology of regulated streams (Ward, 1974, 1975, 1976b,c, 1984a,b; Ward and Short, 1978; Ward et al., 1986; Ward and Stanford, 1979a,b; Stanford and Ward, 1979; Short and Ward, 1980; Gray and Ward, 1982).

Changes in benthic fauna are expected downstream from the proposed reservoir primarily as a result of altered thermal and flow regimes. Diel and seasonal stream temperature fluctuations and maximum temperatures will be reduced, and seasonal minimum temperatures will be above freezing. The stream reach will be ice free in winter months for some distance below the proposed reservoir, eliminating ice scouring of the streambed.

Changes in taxonomic composition can be expected. Certain groups, primarily Plecoptera, which require water temperatures of 0°C to complete their life cycle, may be greatly reduced or eliminated. Densities of other species of Ephemeroptera and Diptera may increase greatly. Non-insect groups may become more prevalent. Large populations of amphipods frequently develop in algae mats and submerged macrophytes below reservoirs. Macroinvertebrate density and biomass may increase, while species diversity may decrease. Changes in life history timing may also occur with delayed or hastened emergent periods. In terms of food chain effects, reservoir operation in front range Colorado streams has often resulted in increased trout food production and a more stable, though less diverse, invertebrate community.

2.4.2.4 Fish Habitat

Instream Flow Incremental Methodology

The project effects on the Cache La Poudre mainstem include loss of riverine habitat due to inundation and modification of habitat due to flow changes downstream of the proposed mainstem reservoir. An assessment of the extent of these effects on existing habitat conditions follows.

The pre-project monthly time series results for both brown and rainbow trout showed that when compared to other life stages, very little spawning habitat was available over the 30-year period of flow analysis. This lack of spawning habitat occurred in every river segment modeled. However, sufficient numbers of YOY and juvenile fish were collected during fish sampling efforts to indicate that a significant amount of spawning does occur.

The lack of predicted spawning habitat was the result of the spawning substrate curves (Figures 2.6 and 2.7) and actual occurrence patterns of preferred spawning substrate in the stream. The spawning curves excluded large particle sizes (such as cobble) as suitable spawning material. In the majority of the study area, substrate was predominately cobble or a mixture of cobble and gravel, with gravel occurring in small patches behind boulders. In such situations, the actual preferred gravel extent was probably under-represented due to the IFIM measurement resolution.

Although the WUA output indicated that the spawning life stage was habitat limited for brown and rainbow trout, this result was probably not representative due to use of the gravels in small or isolated pockets. Studies conducted on other Colorado rivers have shown that even a low amount of spawning habitat does not effectively limit the population (Bovee, 1988).

Segment CLP-1

Adult and juvenile brown trout WUA peaked at approximately 100 to 150 cfs and decreased with increased flow (Figure 2.9). Brown trout fry habitat peaked at approximately 50 to 100 cfs and slowly decreased as flow increased. Brown trout spawning habitat peaked at 150 cfs, decreased from 150 to 200 cfs, and increased slightly as flow increased. The WUA-discharge relationship in this study was similar to that shown by Nehring and Anderson (1984) using a three-flow IFG4 data set simulation.

Rainbow trout adult habitat peaked at 150 to 200 cfs and sharply decreased with increased flow (Figure 2.10). Rainbow trout juvenile habitat peaked at 50 cfs, decreased quickly as flows approached 200 cfs, and then slightly decreased with increased flow. Rainbow trout fry habitat peaked near 25 cfs and like juvenile habitat, quickly decreased up to 200 cfs and then gradually decreased with increased flow. Peak rainbow spawning habitat occurred from 150 to 300 cfs, decreased from 300 to 400 cfs, and then slightly increased with increased flow. This slight increase with high flows was probably due to favorable spawning habitat becoming available at the edge of the river as flow increased. The WUA versus discharge relationships for all life stages (Figure 2.10) showed peaks in habitat for discharges from approximately 50 to 150 cfs.

The average 50 to 90 percent exceedance values for pre-project flows showed peak flows occurred during the May and June runoff period and were lowest during the winter months (Figure 2.11). Flows in the optimum range for brown and rainbow trout (Figures 2.9 and 2.10) occurred during April, September, and October.

Results of the habitat time series analysis showed the lowest predicted pre-project habitat for brown trout fry occurred during the May through July runoff period (Figure 2.12, and Table 2.8). This is also the same time of year that the lowest juvenile rainbow trout habitat was predicted (Figure 2.13 and Table 2.8). These low habitat values during the midwinter period are probably due to low flows during these months. Zero rainbow trout spawning habitat was predicted because the flows greater than 100 cfs (Figure 2.13) were not available during the February-April period when spawning occurred (Figure 2.11).

TABLE 2.8

Pre-Project 50 to 90 Percent Exceedance Values for Brown and Rainbow Trout WUA in Segment CLP-1

Brown Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
6.3	Oct.	18,621	21,804		891
	Nov.	15,830	17,752		358
	Dec.	10,680	11,904		
	Jan.	8,573	9,556		
	Feb.	8,082	9,008		
	Mar.	11,571	12,898	5,346	
	Apr.	17,945	20,688	8,357	
	May	9,124	10,409	3,802	
	Jun.	7,332	7,824	3,018	
	Jul.	8,627	9,618	3,575	
	Aug.	15,143	17,481	5,842	
	Sep.	19,926	24,148	9,064	1,712

Rainbow Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
6.3	Oct.	32,971	14,725		
	Nov.	26,175	13,278		
	Dec.	17,494	9,047		
	Jan.	14,043	7,262		
	Feb.	13,238	6,846		0
	Mar.	18,954	9,802		0
	Apr.	31,248	13,945	17,155	0
	May	16,256	4,199	3,840	
	Jun.	13,558	3,228	2,915	
	Jul.	15,498	3,906	3,531	
	Aug.	33,961	6,999	6,677	
	Sep.	40,372	13,525	13,568	

The life stages that were probably habitat limited were fry for brown trout and fry and juvenile for rainbow trout. Habitat predictions for these life stages were less than 50 percent of the succeeding life stage for over six months of the year.

The proposed reservoir formed by constructing a dam at either the Grey Mountain or Poudre sites would totally inundate this segment. No riverine habitat would be available under with-project conditions.

Segment CLP-2

Brown trout adult and juvenile habitat peaked at approximately 75 to 200 cfs, then decreased with increased flow (Figure 2.14). Brown trout fry habitat peaked at 200 cfs and slowly decreased as flow increased. Brown trout spawning habitat did not appear until approximately 350 cfs and increased slightly as flow increased.

Rainbow trout adult habitat peaked at 200 cfs and sharply decreased with increased flow (Figure 2.15). Rainbow trout juvenile habitat peaked at 50 to 100 cfs, decreased rapidly as flows approached 200 cfs, and then slightly decreased with increased flow. Rainbow trout fry habitat peaked at near 25 cfs and, like juvenile habitat, quickly decreased up to 200 cfs and then gradually decreased with increased flow. There was no spawning habitat predicted at any flow. This was probably due to the limited amount of gravel substrate within the study site, since gravel only appeared in very small pockets behind boulders.

Minimum bounding flows for segment CLP-2 showed the same general pattern for both the Grey Mountain and Poudre alternatives (Figures 2.16 and 2.17). Generally, under the minimum bounding releases, flows were identical to pre-project conditions except during May and June when flow was reduced by approximately 200 cfs (during June) due to reservoir storage. Low winter flows of about 25 cfs occurred from November through March under both pre-project and minimum bounding releases.

These changes were greater under the Grey Mountain alternative but the maximum difference between alternatives, seen in June, was still a very small percentage of total flow.

Flows for the maximum bounding condition showed two significant differences from pre-project conditions: (1) a decrease in peak summer flow, not as substantial as that seen under the minimum bounding condition; and (2) an increase in fall and winter flows resulting from releases to the river. As with the minimum bounding condition, these changes were greater under the Grey Mountain alternative (Figure 2.16) than under the Poudre Alternative (Figure 2.17).

Results of habitat time series for pre-project conditions showed habitat peaked during March and April (Table 2.9) and again during September and October for both species, indicating that flows during these times were in the optimum habitat range. The smallest amount of habitat was available during early summer runoff. Predicted Rainbow trout habitat was approximately twice that predicted for brown trout. This trend was evident in all river segments and was probably due to the broader preference curves for rainbow trout. Brown trout fry and rainbow trout juveniles were probably habitat limited. As in segment CLP-1, there were several months when habitat values predicted for these life stages were less than 50 percent of the succeeding life stage. There was no change in potentially limiting habitat under with-project conditions.

Analysis of minimum bounding releases for the Grey Mountain alternative showed that habitat for both brown and rainbow trout increased during the with-project summer high flow period (Table 2.10). Increases that ranged from 10 to 17 percent during May and June were predicted (Table 2.11). Increased values during April and July and decreased values during October were also predicted, but were less than 10 percent.

Maximum bounding releases for the Grey Mountain alternative provided significantly higher habitat for brown (Figure 2.18) and rainbow trout (Figure 2.21) adults than provided under minimum bounding releases. These habitat gains (greater than 40 percent during winter months) occurred in all months except May, June, and July, and were particularly great during December, January, and February (Table 2.11). Small habitat losses, as with the minimum bounding releases occurred during the summer months due to high flow conditions.

TABLE 2.9

Pre-Project WUA Values for
Brown and Rainbow Trout in Segment CLP-2

Brown Trout WUA (sq ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	13,048.16	14,789.92	4,255.16
Nov.	11,329.12	12,839.25	3,180.57
Dec.	9,927.94	11,351.45	2,613.02
Jan.	8,999.09	10,355.02	2,302.71
Feb.	8,899.55	10,226.51	2,290.01
Mar.	10,385.20	11,869.05	2,733.14
Apr.	12,421.04	14,074.12	3,969.83
May	5,868.60	7,260.62	2,730.78
Jun.	4,941.74	6,193.06	2,289.64
Jul.	6,424.27	7,881.34	2,979.76
Aug.	11,208.60	13,573.06	4,630.23
Sep.	13,368.57	15,592.76	4,715.00

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	37,898.24	24,473.51	22,956.77
Nov.	31,798.54	23,426.77	24,690.31
Dec.	27,938.17	21,319.66	24,260.54
Jan.	25,443.20	19,649.91	22,886.03
Feb.	25,134.72	19,368.54	22,035.94
Mar.	29,207.38	22,252.69	24,428.41
Apr.	35,948.51	22,249.95	18,604.95
May	21,211.28	7,310.32	3,373.83
Jun.	17,578.68	6,159.56	2,775.09
Jul.	23,706.95	8,041.18	3,816.42
Aug.	41,760.48	15,315.10	8,828.28
Sep.	42,612.49	23,400.92	19,952.46

Table 2.10

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-2
Grey Mountain Alternative
Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	13,154.72	13,523.67	14,856.24	15,882.19	4,241.66	4,800.67
Nov.	11,329.12	13,607.20	12,839.25	15,456.24	3,180.57	4,591.37
Dec.	9,927.94	13,393.68	11,351.45	15,098.90	2,613.02	4,375.64
Jan.	8,999.09	13,295.18	10,355.02	14,956.41	2,302.71	4,290.82
Feb.	8,899.55	13,085.19	10,226.51	14,707.37	2,290.01	4,153.62
Mar.	10,392.05	13,189.02	11,876.34	14,823.29	2,736.93	4,215.29
Apr.	12,438.49	13,273.74	14,096.83	15,752.80	3,940.59	4,768.15
May	6,732.52	6,483.44	8,271.92	7,963.83	3,078.81	2,995.31
June	5,191.37	5,127.18	6,505.76	6,425.41	2,405.10	2,375.46
July	6,574.59	6,080.08	8,046.49	7,478.68	3,052.66	2,837.34
Aug.	11,207.02	9,740.77	13,571.04	11,967.67	4,632.39	4,163.57
Sep.	13,369.80	13,037.02	15,595.79	15,669.85	4,713.77	4,836.70

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	37,788.07	44,441.24	24,500.02	23,578.59	23,086.69	20,242.93
Nov.	31,798.54	40,422.88	23,426.77	25,086.00	25,101.52	23,083.18
Dec.	27,938.17	38,662.46	21,319.66	25,182.84	24,369.98	23,843.16
Jan.	25,443.20	37,993.14	19,649.91	25,177.99	23,012.17	24,169.25
Feb.	25,134.72	37,105.08	19,368.54	24,922.00	22,364.95	24,314.24
Mar.	29,227.79	37,463.09	22,304.03	24,995.26	24,712.10	24,136.91
Apr.	35,724.75	43,293.15	23,464.71	22,143.70	20,974.44	17,940.52
May	25,017.90	23,974.39	8,487.87	8,134.21	4,112.33	3,877.65
June	18,465.99	18,238.55	6,470.51	6,390.81	2,915.09	2,879.13
July	24,422.01	22,119.39	8,235.18	7,567.68	3,925.84	3,523.42
Aug.	41,770.54	37,290.75	15,311.97	12,882.25	8,825.53	6,985.18
Sep.	42,632.32	46,933.83	23,401.94	19,510.39	19,954.27	13,275.60

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TABLE 2.11

Percent Change Due to Flow Modifications for Brown and Rainbow Trout WUA in Segment CLP-2 (2.9 River Miles) Grey Mountain Alternative

Brown Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	0.82	3.64	0.45	7.39		
Nov.	0.00	20.11	0.00	20.38		
Dec.	0.00	34.91	0.00	33.01		
Jan.	0.00	47.74	0.00	44.44		
Feb.	0.00	47.03	0.00	43.82		
Mar.	0.07	27.00	0.06	24.89	0.14	54.23
Apr.	0.14	6.86	0.16	11.93	-0.74	20.11
May	14.72	10.48	13.93	9.69	12.74	9.69
Jun.	5.05	3.75	5.05	3.75	5.04	3.75
Jul.	2.34	-5.36	2.10	-5.11	2.45	-4.78
Aug.	-0.01	-13.10	-0.01	-11.83	0.05	-10.08
Sep.	0.01	-2.48	0.02	0.49	-0.03	2.58

Rainbow Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.29	17.28	0.11	-3.66		
Nov.	0.00	27.12	0.00	7.08		
Dec.	0.00	38.39	0.00	18.12		
Jan.	0.00	49.33	0.00	28.13		
Feb.	0.00	47.62	0.00	28.67		
Mar.	0.07	28.27	0.23	12.32		
Apr.	-0.62	20.43	5.46	-0.48	12.74	-3.57
May	17.95	13.03	16.11	11.27	21.89	14.93
Jun.	5.05	3.75	5.05	3.75	5.04	3.75
Jul.	3.02	-6.70	2.41	-5.89	2.87	-7.68
Aug.	0.02	-10.70	-0.02	-15.89	-0.03	-20.88
Sep.	0.05	10.14	0.00	-16.63	0.01	-33.46

Juvenile brown and rainbow trout habitat was also considerably enhanced under the maximum bounding condition (Figures 2.19 and 2.22; Table 2.10). Fry for rainbow trout showed little change under either minimum or maximum bounding releases (Figure 2.23). Brown trout fry, however, obtained significantly increased habitat under maximum bounding releases, probably because of their greater velocity tolerance (Figure 2.20; Table 2.11).

With-project habitat for the Poudre alternative (Table 2.12) showed the same patterns for both species and all life stages as for the Grey Mountain alternative (Table 2.10). That is, for adult and juveniles of both species, fall and winter (September through April) habitat was increased with maximum bounding releases while habitat with minimum bounding releases was again insignificantly different from pre-project habitat (Figures 2.24, 2.25, 2.27, 2.28). Similarly, rainbow fry habitat remained essentially unchanged under either minimum or maximum bounding releases (Figure 2.29), while brown trout fry showed increased habitat in April and May under maximum releases (Figure 2.26).

The major difference between the Grey Mountain and Poudre alternatives (Tables 2.11 and 2.13) was the increased rainbow and brown adult and juvenile habitat for the maximum bounding releases were consistently greater for the Grey Mountain alternative because of the greater fall and winter releases afforded by the increased yield from the larger reservoir storage capacity.

Segment CLP-3

Brown trout adult, juvenile, and fry habitat peaked at approximately 100 to 400 cfs and decreased with increased flow (Figure 2.30). Rainbow trout adult, juvenile, and fry habitat also peaked at 100 to 400 cfs and decreased with increased flow (Figure 2.31). Rainbow adult habitat showed the greatest decrease with increased flow of all the life stages.

Table 2.12

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-2
Poudre Alternative

Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	13,154.72	13,548.62	14,856.24	15,697.09	4,241.66	4,717.35
Nov.	11,329.12	12,998.90	12,839.25	14,610.25	3,180.57	4,101.50
Dec.	9,927.94	12,159.87	11,351.45	13,715.68	2,613.02	3,634.83
Jan.	8,999.09	11,832.31	10,355.02	13,369.29	2,302.71	3,454.54
Feb.	8,899.55	11,649.35	10,226.51	13,175.79	2,290.01	3,353.87
Mar.	10,392.05	11,971.93	11,876.34	13,516.97	2,736.93	3,531.46
Apr.	12,417.99	13,308.26	14,058.25	15,312.87	3,935.09	4,545.78
May	6,251.54	6,161.38	7,702.49	7,593.52	2,891.43	2,856.81
June	5,059.95	5,028.24	6,341.32	6,301.45	2,344.27	2,329.70
July	6,539.57	6,285.15	8,008.72	7,710.44	3,035.56	2,931.22
Aug.	11,207.02	10,416.53	13,571.04	12,690.22	4,632.39	4,445.44
Sep.	13,369.80	13,270.52	15,595.79	15,837.18	4,713.77	4,766.60

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	37,788.07	41,769.38	24,500.02	24,415.86	23,086.69	21,638.12
Nov.	31,798.54	36,792.37	23,426.77	24,870.01	25,106.52	24,273.25
Dec.	27,938.17	34,244.27	21,319.66	24,204.76	24,369.98	25,045.55
Jan.	25,443.20	33,275.49	19,649.91	23,896.11	22,934.43	25,329.87
Feb.	25,134.72	32,734.34	19,368.54	23,731.75	22,109.53	25,237.36
Mar.	29,227.79	33,688.51	22,290.86	23,954.52	24,555.41	24,860.58
Apr.	35,680.09	40,175.40	23,236.51	22,881.96	20,580.46	19,083.09
May	22,911.74	22,510.40	7,827.23	7,701.45	3,694.41	3,615.42
June	17,998.81	17,886.26	6,306.68	6,267.29	2,841.34	2,823.60
July	24,273.67	23,113.06	8,191.80	7,842.03	3,901.33	3,684.16
Aug.	41,770.54	40,087.66	15,311.97	13,971.56	8,825.53	7,765.49
Sep.	42,632.32	45,612.62	23,401.94	21,673.07	19,954.27	17,023.09

TABLE 2.13

Percent Change Due to Flow Modifications for
Brown and Rainbow Trout WUA in Segment CLP-2 (2.9 River Miles)
Poudre Alternative

Brown Trout WUA (sq ft/1000 ft)

Month	Adult		Juvenile		Fry	
	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	0.82	3.84	0.45	6.13		
Nov.	0.00	14.74	0.00	13.79		
Dec.	0.00	22.48	0.00	20.83		
Jan.	0.00	31.48	0.00	29.11		
Feb.	0.00	30.90	0.00	28.84		
Mar.	0.07	15.28	0.06	13.88	0.14	29.21
Apr.	-0.02	7.14	-0.11	8.80	-0.88	14.51
May	6.53	4.99	6.09	4.58	5.88	4.62
Jun.	2.39	1.75	2.39	1.75	2.39	1.75
Jul.	1.79	-2.17	1.62	-2.17	1.87	-1.63
Aug.	-0.01	-7.07	-0.01	-6.50	0.05	-3.99
Sep.	0.01	-0.73	0.02	1.57	-0.03	1.09

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult		Juvenile		Fry	
	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.29	10.21	0.11	-0.24		
Nov.	0.00	15.70	0.00	6.16		
Dec.	0.00	22.57	0.00	13.53		
Jan.	0.00	30.78	0.00	21.61		
Feb.	0.00	30.24	0.00	22.53		
Mar.	0.07	15.34	0.17	7.65		
Apr.	-0.75	11.76	4.43	2.84	10.62	2.57
May	8.02	6.12	7.07	5.35	9.50	7.16
Jun.	2.39	1.75	2.39	1.75	2.39	1.75
Jul.	2.39	-2.51	1.87	-2.48	2.23	-3.47
Aug.	0.02	-4.01	-0.02	-8.77	-0.03	-12.04
Sep.	0.05	7.04	0.00	-7.38	0.01	-14.68

Channel morphology throughout segment CLP-3 was homogenous, but the flow regime differed significantly above and below the Larimer County Canal during the irrigation season. Due to this change in flow, the segment was divided into two segments at the Larimer County Canal. Comparisons of monthly exceedance plots for pre-project flows upstream (segment CLP-3a) and downstream (segment CLP-3b) from the Larimer County Canal showed over 10 percent of the average flow was diverted into the canal from April through October (Figures 2.32 and 2.34). Peak flows of approximately 1250 cfs were predicted for segment CLP-3a compared to 950 cfs for segment CLP-3b.

With-project exceedance plots of flow showed flows during summer months were decreased in both segments CLP-3a and CLP-3b (Figures 2.32 - 2.35). The largest reductions occurred in May and June.

Segment CLP-3a had both summer and winter periods of low available habitat for the pre-project condition (Table 2.14). These were due to low winter flows and elevated summer flows. Habitat values increased in spring and fall when the flows were in the optimum range. In segment CLP-3b, pre-project habitat for brown and rainbow trout was equal to or slightly less than that predicted for segment CLP-3a from October through April (Table 2.15). Due to a reduction in flows downstream from the Larimer County Canal during the irrigation season, habitat availability for both brown and rainbow trout was greater in segment CLP-3b from May through September (Table 2.15). As in segment CLP-2, no spawning habitat was predicted for brown and rainbow trout throughout segment CLP-3.

Differences in flows in segment CLP-3 between the Grey Mountain and Poudre alternatives were due primarily to the greater storage capacity and correspondingly greater yield of the Grey Mountain Reservoir. The smaller storage capacity of Poudre Reservoir resulted in slightly lower with-project maximum bounding flows from July-April when the releases were completely controlled, and higher with-project maximum bounding flows in May and June during the spring runoff. With-project minimum bounding flows were also higher than for the Grey Mountain Alternative in May and June due to the reduced capacity to store spring runoff (Figures 2.32 - 2.35).

TABLE 2.14

Pre-Project WUA Values for Brown and Rainbow Trout in Segment CLP-3A

Brown Trout WUA (sq ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	21,084.12	8,576.68	24,848.06
Nov.	9,501.73	3,818.52	10,659.97
Dec.	6,393.16	2,569.23	7,172.37
Jan.	4,667.31	1,875.56	5,235.96
Feb.	5,092.13	2,046.41	5,712.90
Mar.	6,739.25	2,708.40	7,560.68
Apr.	16,986.36	6,574.29	19,553.01
May	9,810.36	2,713.84	11,087.16
Jun.	6,585.74	2,181.49	5,978.31
Jul.	8,675.00	2,415.69	9,331.25
Aug.	11,898.53	3,314.50	14,244.59
Sep.	26,037.65	9,068.49	30,812.66

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	39,756.84	15,468.21	20,765.78
Nov.	15,966.10	7,651.55	13,842.99
Dec.	10,742.51	5,148.09	9,314.15
Jan.	7,842.40	3,758.22	6,799.73
Feb.	8,556.42	4,100.52	7,418.75
Mar.	11,324.12	5,426.87	9,818.36
Apr.	30,242.59	12,398.79	18,423.73
May	15,369.93	3,640.78	3,672.15
Jun.	9,034.35	2,343.79	2,197.79
Jul.	12,292.67	3,173.89	3,136.08
Aug.	21,615.38	4,510.07	4,589.97
Sep.	53,367.17	15,098.53	17,040.89

TABLE 2.15

Pre-Project WUA Values for
Brown and Rainbow Trout in Segment CLP-3B

Brown Trout WUA (sq. ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	20,292.29	23,684.74	8,309.79
Nov.	10,282.41	11,535.97	4,132.26
Dec.	7,356.95	8,253.68	2,956.66
Jan.	5,566.83	6,245.34	2,237.20
Feb.	6,052.26	6,790.17	2,432.36
Mar.	7,333.17	8,227.24	2,947.04
Apr.	15,390.84	17,650.70	5,908.75
May	11,828.93	14,089.37	3,325.39
Jun.	7,363.35	7,113.77	2,262.77
Jul.	11,427.93	13,575.34	3,182.35
Aug.	17,982.01	22,163.47	5,309.05
Sep.	24,869.51	29,757.48	9,375.88

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult	Juvenile	Fry
Oct.	37,359.94	15,212.75	21,086.74
Nov.	17,278.09	8,280.22	14,969.93
Dec.	12,361.98	5,924.36	10,718.38
Jan.	9,353.97	4,482.76	8,110.19
Feb.	10,169.93	4,873.83	8,817.67
Mar.	12,322.37	5,905.41	10,683.98
Apr.	27,120.85	11,321.82	17,832.34
May	21,106.76	4,433.40	4,404.07
Jun.	10,265.94	2,653.68	2,503.35
Jul.	19,914.48	4,294.65	4,323.20
Aug.	37,776.72	6,704.51	6,133.22
Sep.	51,536.86	16,107.97	19,859.63

Grey Mountain minimum release schedule habitat exceedance plots for segments CLP-3a and CLP-3b showed values for both brown and rainbow trout increased above pre-project levels during May-July due to reduced flows during that period (Tables 2.16 and 2.17, Figures 2.36-2.41 and 2.48-2.53). During this time, increases for brown and rainbow trout in segment CLP-3a ranged from approximately 0 to 25 percent (Table 2.18). In segment CLP-3b, the effects of May and June flow reductions were more significant. During this time, habitat increases for brown and rainbow trout adults and juveniles ranged from about 25 percent (Table 2.18).

Grey Mountain maximum bounding releases for segments CLP-3a and CLP-3b showed significant increases in habitat above pre-project levels for both trout species due to higher fall and winter flows (Tables 2.16 and 2.17). Increases from October-April ranged from 4 to 339 percent (Tables 2.18 and 2.19) Decreases in habitat from 3 to 27 percent were observed from July-September due to higher releases during the irrigation season.

The Poudre alternative with minimum bounding releases exhibited the same summer and winter periods of low habitat availability observed for the Grey Mountain alternative, and varied only slightly from pre-project conditions (Figures 2.42-2.47, 2.54-2.59, Tables 2.20 and 2.21). With-project maximum habitat areas were still much greater than pre-project values during the fall and winter, but were lower than with-project maximum habitat areas for the Grey Mountain alternative due to decreased capacity to provide higher winter flows. Percentage changes due to flow modifications for the Poudre alternative (Tables 2.22 and 2.23) were generally smaller than for the Grey Mountain alternative (Tables 2.18 and 2.19). Maximum increases were about 175 percent for the Poudre alternative, compared to as much as 340 percent for the Grey Mountain alternative.

<u>Segment CLP-4</u>

Habitat for both adult and juvenile brown and rainbow trout peaked at approximately 100 cfs and gradually decreased with increasing flows (Figures 2.60 and 2.61). Brown trout fry habitat peaked at approximately 50 cfs, while rainbow fry habitat peaked at approximately 10 cfs. This difference in fry habitat was probably due to differences in the velocity preference of each species. Brown trout fry habitat showed a decrease after the peak at 50 cfs and then peaked again at approximately 1300 cfs. The second peak was probably from the inundation of cobble bars at the higher flows.

Table 2.16

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-3A
Grey Mountain Alternative

Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	20,889.42	24,128.77	24,561.21	29,030.88	8,534.63	9,348.00
Nov.	9,501.73	20,590.19	10,659.97	24,098.58	3,818.52	8,508.83
Dec.	6,393.16	19,701.28	7,172.37	22,817.88	2,569.23	8,085.39
Jan.	4,667.31	19,285.36	5,235.96	22,218.39	1,875.56	7,886.96
Feb.	5,092.13	18,826.66	5,712.90	21,557.75	2,046.41	7,668.33
Mar.	6,739.25	18,802.73	7,560.68	21,523.18	2,708.40	7,656.98
Apr.	17,076.97	22,576.16	19,653.45	27,035.94	6,591.48	9,116.33
May	11,130.90	10,548.01	13,112.18	12,242.58	3,088.15	2,910.03
June	7,561.72	7,246.08	7,413.21	6,904.43	2,287.48	2,260.85
July	8,843.82	8,231.17	9,632.95	8,560.20	2,432.45	2,333.46
Aug.	11,898.53	10,784.46	14,244.59	12,621.20	3,314.50	2,966.66
Sep.	26,037.65	22,884.36	30,812.66	27,389.62	9,068.49	7,559.89

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	39,127.64	49,465.81	15,423.62	16,117.15	20,902.50	20,308.65
Nov.	15,966.10	38,107.44	7,651.55	15,370.76	13,842.99	22,509.29
Dec.	10,742.51	35,617.58	5,148.09	14,998.48	9,314.15	22,859.57
Jan.	7,842.40	34,452.31	3,758.22	14,824.43	6,799.73	23,176.97
Feb.	8,556.42	33,167.34	4,100.52	14,632.17	7,418.75	23,263.53
Mar.	11,324.12	33,100.66	5,426.87	14,622.16	9,818.36	23,216.73
Apr.	30,247.62	44,201.38	12,395.89	15,959.12	18,930.24	20,858.51
May	19,154.37	17,337.94	4,181.66	3,942.07	4,223.75	4,004.45
June	10,563.81	10,092.78	2,730.94	2,604.35	2,581.67	2,441.92
July	12,553.63	11,553.38	3,242.02	3,001.41	3,225.46	2,907.83
Aug.	21,615.38	17,804.11	4,510.07	4,033.90	4,589.97	4,143.15
Sep.	53,367.17	47,226.56	15,098.53	11,646.54	17,040.89	12,427.23

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Table 2.17

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-3B
Grey Mountain Alternative

Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	20,186.96	23,829.35	23,524.31	28,707.63	8,291.99	9,316.72
Nov.	10,282.41	20,777.59	11535.97	24,368.39	4,132.26	8,597.67
Dec.	7,356.95	19,933.82	8,253.68	23,152.54	2,956.66	8,196.01
Jan.	5,566.83	19,502.36	6,245.34	22,530.73	2,237.20	7,990.25
Feb.	6,052.26	19,058.17	6,790.17	21,891.16	2,432.36	7,778.75
Mar.	7,333.17	18,945.98	8,227.24	21,729.59	2,947.04	7,725.34
Apr.	15,541.33	22,304.50	17,820.47	26,630.77	5,955.03	9,090.11
May	14,231.01	13,159.77	17,370.29	15,959.71	4,076.35	3,732.21
June	9,139.32	8,559.75	10,093.16	9,134.38	2,514.85	2,396.76
July	11,753.92	10,356.40	14,054.26	11,998.21	3,279.28	2,839.89
Aug.	17,982.01	15,263.63	22,163.47	18,810.41	5,309.05	4,410.57
Sep.	24,869.51	26,555.62	29,757.48	31,449.42	9,375.88	9,429.35

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	37,015.29	48,481.31	15,187.85	16,126.00	21,230.54	20,692.32
Nov.	17,278.09	38,632.46	8,280.22	15,449.10	14,979.00	22,455.79
Dec.	12,361.98	36,268.01	5,924.36	15,095.95	10,718.38	22,765.50
Jan.	9,353.97	35,059.53	4,482.76	14,915.18	8,110.19	23,050.46
Feb.	10,169.93	33,815.84	4,873.83	14,729.07	8,817.67	23,124.61
Mar.	12,322.37	33,501.89	5,905.41	14,682.16	10,683.98	23,163.76
Apr.	27,234.75	43,270.20	11,344.11	15,938.55	18,247.76	21,017.97
May	27,894.86	24,931.18	5,311.32	4,937.17	5,095.94	4,834.85
June	13,320.28	12,080.66	3,361.08	3,127.83	3,365.95	3,077.52
July	20,931.35	16,444.97	4,431.18	3,853.58	4,471.55	3,946.60
Aug.	37,776.72	30,913.52	6,704.51	5,693.57	6,133.22	5,373.89
Sep.	51,536.86	54,817.09	16,107.97	15,969.71	19,859.63	18,788.50

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TABLE 2.18

Percent Change Due to Flow Modifications for
Brown and Rainbow Trout WUA in Segment CLP-3A
(1.5 River Miles)
Grey Mountain Alternative

Brown Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.92	14.44	0.00	16.83		
Nov.	0.00	116.70	0.00	126.07		
Dec.	0.00	208.16	0.00	218.14		
Jan.	0.00	313.20	0.00	324.34		
Feb.	0.00	269.72	0.00	277.35		
Mar.	0.00	179.00	0.00	184.67	0.00	182.71
Apr.	0.53	32.91	0.00	38.27	0.00	38.67
May	13.46	7.52	0.00	10.42	0.00	7.23
Jun.	14.82	10.03	0.00	15.49	0.00	3.64
Jul.	1.95	-5.12	0.00	-8.26	0.00	-3.40
Aug.	0.00	-9.36	0.00	-11.40	0.00	-10.49
Sep.	0.00	-12.11	0.00	-11.11	0.00	-16.64

Rainbow Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-1.58	24.42	-0.29	4.20		
Nov.	0.00	138.68	0.00	100.88		
Dec.	0.00	231.56	0.00	191.34		
Jan.	0.00	339.31	0.00	294.45		
Feb.	0.00	287.63	0.00	256.84		
Mar.	0.00	192.30	0.00	169.44		
Apr.	0.02	46.16	-0.02	28.72	2.75	13.22
May	24.62	12.80	14.86	8.28	15.02	9.05
Jun.	16.93	11.72	16.52	11.12	17.47	11.11
Jul.	2.12	-6.01	2.15	-5.43	2.85	-7.28
Aug.	0.00	-17.63	0.00	-10.56	0.00	-9.73
Sep.	0.00	-11.51	0.00	-22.86	0.00	-27.07

TABLE 2.19

Percent Change Due to Flow Modifications for
Brown and Rainbow Trout WUA in Segment CLP-3B
(3.6 River Miles)
Grey Mountain Alternative

Brown Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.78	10.84	-0.80	11.95		
Nov.	-2.67	50.56	-3.24	57.02		
Dec.	-1.07	81.43	-1.23	89.02		
Jan.	-1.77	113.04	-1.82	121.65		
Feb.	-1.89	89.35	-2.30	95.37		
Mar.	-0.74	71.83	-0.98	76.07	-0.43	74.85
Apr.	-1.96	22.52	-2.00	25.02	-0.92	24.23
May	16.94	8.66	17.26	9.07	22.02	10.37
Jun.	25.04	13.47	35.75	20.06	21.05	9.63
Jul.	2.21	-14.26	2.43	-15.28	2.49	-16.86
Aug.	0.00	-18.37	0.00	-17.43	0.00	-23.19
Sep.	0.00	3.87	0.00	3.26	0.00	0.32

Rainbow Trout WUA (sq ft/1000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.92	29.77	-0.16	6.00		
Nov.	0.00	123.59	0.00	86.58		
Dec.	0.00	193.38	0.00	154.81		
Jan.	0.00	274.81	0.00	232.72		
Feb.	0.00	232.51	0.00	202.21		
Mar.	0.00	171.88	0.00	148.62		
Apr.	0.42	59.55	0.20	40.78	2.33	17.86
May	32.16	18.12	19.80	11.36	15.71	9.78
Jun.	29.75	17.68	26.66	17.87	34.46	22.94
Jul.	5.11	-17.42	3.18	-10.27	3.43	-8.71
Aug.	0.00	-18.17	0.00	-15.08	0.00	-12.38
Sep.	0.00	6.36	0.00	-0.86	0.00	-5.39

Table 2.20

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-3A
Poudre Alternative

Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	20,889.42	22,352.17	24,561.21	27,381.74	8,534.63	9,138.41
Nov.	9,501.12	18,034.22	10,659.29	20,429.17	3,818.27	7,293.71
Dec.	6,393.16	15,897.16	7,172.37	17,874.48	2,569.23	6,397.93
Jan.	4,667.31	14,553.97	5,235.96	16,328.97	1,875.56	5,849.12
Feb.	5,092.13	13,806.37	5,712.90	15,490.86	2,046.41	5,548.75
Mar.	6,739.25	14,684.17	7,560.68	16,494.60	2,708.40	5,906.16
Apr.	17,000.39	20,304.03	19,558.03	23,787.42	6,566.92	8,362.99
May	10,210.74	9,983.65	11,729.20	11,383.20	2,807.03	2,743.20
June	6,998.80	6,874.84	6,516.30	6,343.64	2,242.39	2,226.03
July	8,743.01	8,445.78	9,455.89	8,936.15	2,415.86	2,371.74
Aug.	11,898.53	11,298.27	14,244.59	13,340.51	3,314.50	3,121.58
Sep.	26,037.65	24,834.46	30,812.66	29,480.67	9,068.49	8,470.87

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	39,127.64	45,207.72	15,423.62	15,980.73	20,902.50	20,636.27
Nov.	15,965.08	30,994.62	7,651.06	14,284.06	13,842.10	23,201.07
Dec.	10,742.51	26,850.94	5,148.09	12,753.87	9,314.15	22,037.41
Jan.	7,842.40	24,457.86	3,758.22	11,719.07	6,799.73	20,955.33
Feb.	8,556.42	23,204.80	4,100.52	11,116.24	7,418.75	19,558.36
Mar.	11,324.12	24,746.46	5,426.87	11,800.13	9,818.36	20,056.27
Apr.	30,151.79	37,808.76	12,383.37	15,237.42	18,804.41	21,282.54
May	16,361.62	15,680.29	3,804.27	3,709.43	3,860.71	3,762.85
June	9,713.16	9,514.13	2,504.70	2,455.83	2,334.84	2,290.29
July	12,393.72	11,895.64	3,202.72	3,084.45	3,173.14	3,018.84
Aug.	21,615.38	19,619.30	4,510.07	4,256.40	4,589.97	4,371.30
Sep.	53,367.17	50,996.49	15,098.53	13,693.54	17,040.89	15,085.95

2321K

Table 2.21

With-Project Minimum and Maximum Bounding WUA Values
for Brown and Rainbow Trout in Segment CLP-3B
Poudre Alternative
Brown Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	20,186.96	22,410.78	23,524.31	26,783.65	8,291.99	9,067.47
Nov.	10,281.19	18,250.45	11,534.60	20,728.94	4,131.77	7,394.05
Dec.	7,356.95	16,516.86	8,253.68	18,604.42	2,956.66	6,655.30
Jan.	5,566.83	15,415.96	6,245.34	17,299.57	2,237.20	6,196.52
Feb.	6,052.26	14,677.61	6,790.17	16,477.00	2,432.36	5,900.97
Mar.	7,333.17	15,170.37	8,227.24	17,050.83	2,947.04	6,104.02
Apr.	15,464.75	19,779.31	17,740.86	22,998.24	5,930.53	8,120.15
May	12,560.29	12,129.06	15,112.25	14,539.64	3,540.61	3,404.55
June	8,159.98	7,943.44	8,453.58	8,086.70	2,344.25	2,307.73
July	11,569.93	10,837.65	13,789.84	12,712.23	3,224.10	2,991.69
Aug.	17,982.01	16,580.12	22,163.47	20,451.66	5,309.05	4,832.32
Sep.	24,869.51	25,949.69	29,757.48	30,883.53	9,375.88	9,428.64

Rainbow Trout WUA (sq ft/1,000 ft)

	Adult		Juvenile		Fry	
Month	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	37,015.29	43,698.13	15,187.85	15,921.95	21,230.54	21,141.45
Nov.	17,276.06	31,558.97	8,279.24	14,388.87	14,978.81	23,292.65
Dec.	12,361.98	28,014.92	5,924.36	13,210.69	10,718.38	22,539.07
Jan.	9,353.97	25,919.68	4,482.76	12,408.68	8,110.19	22,006.11
Feb.	10,169.93	24,700.00	4,873.83	11,806.56	8,817.67	20,543.96
Mar.	12,322.37	25,601.37	5,905.41	12,177.97	10,683.98	20,615.56
Apr.	27,138.92	36,242.48	11,331.53	15,023.05	18,132.86	21,463.36
May	23,143.65	21,886.42	4,708.33	4,551.15	4,654.45	4,532.06
June	11,475.89	11,135.64	2,970.96	2,886.96	2,883.88	2,778.25
July	20,318.97	18,053.42	4,352.81	4,057.96	4,389.36	4,132.78
Aug.	37,776.72	34,299.52	6,704.51	6,116.66	6,133.22	5,636.89
Sep.	51,536.86	53,894.49	16,107.97	16,078.79	19,859.63	19,381.59

2321K

TABLE 2.22

Percent Change Due to Flow Modifications for
Brown and Rainbow Trout WUA in Segment CLP-3A (1.5 River Miles)
Poudre Alternative

Brown Trout WUA (sq ft/1000 ft)

Month	Adult		Juvenile		Fry	
	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-0.92	8.39	-1.15	10.20		
Nov.	-0.01	89.80	-0.01	91.64		
Dec.	0.00	148.66	0.00	149.21		
Jan.	0.00	211.83	0.00	211.86		
Feb.	0.00	171.13	0.00	171.16		
Mar.	0.00	117.89	0.00	118.16	0.00	118.07
Apr.	0.08	19.53	0.03	21.66	-0.11	27.21
May	4.08	1.77	5.79	2.67	3.43	1.08
Jun.	6.27	4.39	9.00	6.11	2.79	2.04
Jul.	0.78	-2.64	1.34	-4.23	0.01	-1.82
Aug.	0.00	-5.04	0.00	-6.35	0.00	-5.82
Sep.	0.00	-4.62	0.00	-4.32	0.00	-6.59

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult		Juvenile		Fry	
	Min.	Max.	Min.	Max.	Min.	Max.
Oct.	-1.58	13.71	-0.29	3.31		
Nov.	-0.01	94.13	-0.01	86.68		
Dec.	0.00	149.95	0.00	147.74		
Jan.	0.00	211.87	0.00	211.83		
Feb.	0.00	171.20	0.00	171.09		
Mar.	0.00	118.53	0.00	117.44		
Apr.	0.30	25.02	-0.12	22.89	2.07	15.52
May	6.45	2.02	4.49	1.89	5.13	2.47
Jun.	7.51	5.31	6.87	4.78	6.24	4.21
Jul.	0.82	-3.23	0.91	-2.82	1.18	-3.74
Aug.	0.00	-9.23	0.00	-5.62	0.00	-4.76
Sep.	0.00	-4.44	0.00	-9.31	0.00	-11.47

2275K

TABLE 2.23

Percent Change Due to Flow Modifications for Brown and Rainbow Trout WUA in Segment CLP-3B (3.6 River Miles) Poudre Alternative

Brown Trout WUA (sq ft/1000 ft)

Month	Adult Min.	Adult Max.	Juvenile Min.	Juvenile Max.	Fry Min.	Fry Max.
Oct.	-0.52	10.44	-0.68	13.08		
Nov.	-0.01	77.49	-0.01	79.69		
Dec.	0.00	124.51	0.00	125.41		
Jan.	0.00	176.93	0.00	177.00		
Feb.	0.00	142.51	0.00	142.66		
Mar.	0.00	106.87	0.00	107.25	0.00	107.12
Apr.	0.48	28.51	0.51	30.30	0.37	37.43
May	6.18	2.54	7.26	3.20	6.47	2.38
Jun.	10.82	7.88	18.83	13.68	3.60	1.99
Jul.	1.24	-5.17	1.58	-6.36	1.31	-5.99
Aug.	0.00	-7.80	0.00	-7.72	0.00	-8.98
Sep.	0.00	4.34	0.00	3.78	0.00	0.56

Rainbow Trout WUA (sq ft/1000 ft)

Month	Adult Min.	Adult Max.	Juvenile Min.	Juvenile Max.	Fry Min.	Fry Max.
Oct.	-0.92	16.97	-0.16	4.66		
Nov.	-0.01	82.65	-0.01	73.77		
Dec.	0.00	126.62	0.00	122.99		
Jan.	0.00	177.10	0.00	176.81		
Feb.	0.00	142.87	0.00	142.24		
Mar.	0.00	107.76	0.00	106.22		
Apr.	0.07	33.63	0.09	32.69	1.69	20.36
May	9.65	3.69	6.20	2.66	5.69	2.91
Jun.	11.79	8.47	11.96	8.79	15.20	10.98
Jul.	2.03	-9.35	1.35	-5.51	1.53	-4.40
Aug.	0.00	-9.20	0.00	-8.77	0.00	-8.09
Sep.	0.00	4.57	0.00	-0.18	0.00	-2.41

The 50 to 90 percent exceedance plots of flows in the Poudre River near Rustic are applicable to both segment CLP-4 and segment CLP-5 (Figure 2.62). Flows were low during the winter months and peaked during the spring runoff period.

Habitat exceedance plots showed that the winter period had the highest predicted habitat values for this segment for both brown and rainbow trout (Figures 2.63 and 2.64, and Table 2.24). Lowest predicted habitat values were found during the April and October low-flow periods. Peak flows in spring and summer reduced the habitat somewhat from the winter high habitat for adult and juvenile brown trout. Available habitat for adult, juvenile, and fry rainbow trout was also reduced during the high-flow period. However, these reductions were generally not as great as those during the low-flow period. No spawning habitat was predicted for either species.

The life stages that were probably habitat limited were fry for brown trout and juveniles for rainbow trout due to reduced habitat during the high-flow months. Rainbow juveniles and brown trout fry had approximately 60 percent less habitat area than the next succeeding life stage during this time. Rainbow fry habitat was approximately equal to rainbow juvenile habitat.

There were no predicted changes in habitat in this segment since there are presently no predicted changes in flow regime.

Segment CLP-5

WUA-flow relationships showed brown trout habitat for adult, juvenile, and fry life stages peaked at approximately 100 to 150 cfs (Figure 2.65). Rainbow trout habitat peaked at approximately 150 cfs for adults and at less than 50 cfs for fry and juveniles (Figure 2.66). Spawning habitat for both species was not available until flows were relatively high.

Pre-project flows determined for the Poudre River at Rustic were applied in this segment (Figure 2.62).

TABLE 2.24

Pre-Project 50 to 90 Percent Exceedance Values for
Brown and Rainbow Trout WUA in Segment CLP-4

Brown Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
38.0	Oct.	2,256	2,638		0
	Nov.	9,104	10,600		0
	Dec.	9,989	11,584		
	Jan.	10,638	12,353		
	Feb.	10,138	11,786		
	Mar.	10,325	11,991	3,478	
	Apr.	1,661	1,944	422	
	May	8,330	9,548	3,078	
	Jun.	5,724	7,066	3,064	
	Jul.	7,561	8,772	3,047	
	Aug.	8,325	9,512	2,965	
	Sep.	8,462	9,711	2,984	0

Rainbow Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
38.0	Oct.	6,197	4,948		
	Nov.	25,162	17,913		
	Dec.	28,441	18,532		
	Jan.	29,879	19,994		
	Feb.	28,261	19,496		0
	Mar.	29,010	19,456		0
	Apr.	4,565	3,644	5,398	0
	May	26,172	8,807	8,045	
	Jun.	15,756	4,638	2,894	
	Jul.	22,050	7,284	6,641	
	Aug.	26,279	8,774	8,205	
	Sep.	26,055	9,449	8,419	

Habitat time series results for brown trout showed the highest amount of habitat during the winter when flows were in the optimum range (Figure 2.67 and Table 2.25). The lowest flows resulted in the lowest habitat available. The summer peak flows also caused a sharp decline in available habitat. Habitat time series results for rainbow trout also showed the highest amount of habitat available during the winter months (Figure 2.68). This was again due to winter flows being closer to the optimum range than were flows at other times of the year. Rainbow trout adult habitat sharply declined during the April low flow and summer peak flow periods.

The life stages that were probably habitat limited for rainbow trout were due to large reductions in habitat during summer peak flows. Habitat values for rainbow juveniles that were less than 50 percent of the adult habitat were also found during most of the year.

As with the previous segment, there were no predicted changes in habitat due to the proposed project.

<u>Segment NFCLP-1</u>

WUA-flow relationships showed brown trout adult, juvenile, and fry habitat peaked at approximately 25 cfs, decreased from 25 to 30 cfs, and then increased with flow (Figure 2.69). The decrease and following increase in WUA was probably due to the channel configuration in this segment. There were large gravel-cobble bars within this segment around which the channel meandered at low flows. The lower peak in WUA reflected conditions in the low flow channel, and the WUA increases at higher flows reflected inundation of lateral gravel bars, greatly expanding the wetted and habitat areas of the channel. No spawning habitat was predicted for brown trout in this segment.

Rainbow trout WUA also exhibited two peaks, the first at approximately 25 cfs, followed by a decrease and then an increase with increased flows (Figure 2.70). Again, this is probably due to the channel configuration and high flow inundation of lateral cobble bars. Spawning habitat also reflected this phenomenon. Spawning habitat was unavailable until a flow of 125 cfs and then slightly increased with flow. Existence of some rainbow trout spawning habitat in the absence of brown trout spawning habitat was probably due to the difference between the spawning preference curves for the two species.

TABLE 2.25

Pre-Project 50 to 90 Percent Exceedance Values for
Brown and Rainbow Trout WUA in Segment CLP-5

Brown Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
8.0	Oct.	2,708	3,062		0
	Nov.	11,744	13,948		0
	Dec.	13,349	16,627		
	Jan.	14,153	17,344		
	Feb.	13,267	16,024		
	Mar.	13,661	16,715	8,341	
	Apr.	1,995	2,255	860	
	May	7,693	10,207	4,454	
	Jun.	3,086	3,040	1,965	
	Jul.	5,724	6,925	3,235	
	Aug.	7,592	10,086	4,441	
	Sep.	8,489	11,203	4,807	0

Rainbow Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
8.0	Oct.	4,613	2,440		
	Nov.	20,265	9,399		
	Dec.	23,588	10,041		
	Jan.	24,784	10,801		
	Feb.	23,072	10,376		0
	Mar.	23,905	10,469		0
	Apr.	3,398	1,797	3,229	0
	May	15,206	2,187	1,721	
	Jun.	5,528	492	447	
	Jul.	10,117	1,381	1,099	
	Aug.	14,847	2,114	1,669	
	Sep.	16,657	2,613	2,054	

In the pre-project condition, peak flows occurred during the spring runoff period (Figure 2.71). Low flows occurred from July through September, which were in part influenced by upstream diversions.

Pre-project habitat time series plots for both species indicated that available habitat peaked during the runoff period (Figures 2.72 and 2.73, and Table 2.26). This was the time of the year when flows were in the optimum habitat range.

Brown trout fry habitat appeared to be limiting in this segment. Fry habitat was approximately 45 to 50 percent that of the juvenile habitat. Brown trout adult habitat was less than or approximately equal to juvenile habitat. Rainbow trout juvenile habitat appeared to be limiting as there was approximately 20 to 50 percent as much juvenile habitat as adult habitat. More rainbow fry habitat than juvenile habitat was available during all months.

Segment NFCLP-1 would be totally inundated by the proposed project. As a result, a total loss of riverine habitat would occur.

<u>Segment NFCLP-2</u>

The WUA versus flow relationships showed brown trout adult, juvenile, and fry habitat peaked at approximately 50 to 100 cfs and decreased with increased flow (Figure 2.74). Limited amounts of brown trout spawning habitat appeared at flows over 300 cfs. This was likely due to the distribution of the substrate within this segment, which was predominantly cobble with limited gravel at the channel margins. Occasional high discharges from Seaman Reservoir prevented the accumulation of gravel in the channel.

The WUA versus flow relationships for rainbow trout showed adult habitat peaked at 50 to 100 cfs and sharply decreased with increased flow (Figure 2.75). Juvenile habitat peaked at approximately 40 cfs and then decreased slightly with increased flow. Rainbow trout fry habitat peaked near 25 cfs and, like juvenile habitat, gradually decreased with increased flow. Rainbow spawning habitat was similar to that for brown trout, with none available below approximately 300 cfs. This slight increase in habitat values probably resulted from favorable spawning habitat appearing at the edge of the river as flows increased.

TABLE 2.26

Pre-Project 50 to 90 Percent Exceedance Values for Brown and Rainbow Trout WUA in Segment NFCLP-1

Brown Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
6.3	Oct.	4,485	5,860		0
	Nov.	2,690	2,908		0
	Dec.	2,753	2,923		
	Jan.	2,560	2,720		
	Feb.	2,853	3,050		
	Mar.	3,072	3,348	1,660	
	Apr.	4,357	5,588	3,020	
	May	7,436	10,467	5,811	
	Jun.	8,439	12,009	6,761	
	Jul.	3,429	4,336	2,345	
	Aug.	2,984	3,244	1,602	
	Sep.	3,216	3,530	1,772	0

Rainbow Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
6.3	Oct.	9,326	2,769		
	Nov.	5,082	1,967		
	Dec.	5,148	2,074		
	Jan.	4,789	1,927		
	Feb.	5,357	2,127		0
	Mar.	5,832	2,216		0
	Apr.	9,292	2,583	4,016	0
	May	17,511	3,625	4,344	
	Jun.	20,101	3,761	4,672	
	Jul.	7,047	2,177	3,249	
	Aug.	5,657	2,161	3,991	
	Sep.	6,130	2,290	4,008	

Flows in segment NFCLP-2 (Figure 2.76) were similar to those for segment NFCLP-1 (Figure 2.71). However, monthly values were slightly lower throughout the year (Table 2.27). The flow in this segment was reduced during the late summer as in the upstream segment.

Habitat time series results showed brown trout habitat peaked during the summer period when flows were elevated (Figure 2.77 and Table 2.25). The lowest habitat occurred during the winter low-flow periods. Rainbow trout habitat also peaked during the summer and late summer periods (Figure 2.78).

Brown trout fry habitat appeared to be limiting in this segment. Fry habitat was approximately 20 percent as available as juvenile habitat for all months. Again, brown adult habitat was less available than juvenile habitat. Rainbow trout juvenile habitat also appeared to be limiting in this segment. There was from 30 to 75 percent as much juvenile as adult habitat. Rainbow fry habitat was more available than juvenile habitat in the late summer and early fall.

Segment NFCLP-2 would be totally inundated by the proposed project. As a result, a total loss of riverine habitat would occur.

Habitat Quality Index

Standing crop estimates were calculated for Poudre River and North Fork study sites based on field measurements and HQI model simulations. A standing crop estimate of 41.4 kg/ha (36.9 lbs/acre) was calculated for the Poudre River study site (CLP-2). This standing crop estimate was comparable to total trout biomass of 46.0 and 41.7 kg/ha reported in the Poudre River at the Anderson Ranch during the fall of 1986 and the spring of 1987 (Aquatic Management Associates, 1986b, 1987b). This value was also similar to some estimates reported by Nehring and Anderson (1981) at Big Bend Campground (51.5 kg/ha) and the UWTW stations (48.8 kg/ha). Based on the area sampled, calculations indicated 41.0 Habitat Units per acre (HU/acre) or a total of 315.7 HU/mile on the Poudre River.

A standing crop estimate of 18.0 kg/ha (16.1 lbs/acre) was calculated for the North Fork study site (NFCLP-1). Although the calculated standing crop estimate was lower than total trout biomass reported by Aquatic Management Associates (1986b, 1987b) during the fall of 1986 (74.1 kg/ha) and spring of 1987 (80.1 kg/ha), this value was similar to the 16.1 kg/ha reported upstream from Seaman Reservoir in the fall of 1987 (Aquatics Associates, 1987). Calculations indicate 21.1 HU/acre or 90.7 HU/mile in the North Fork project area.

TABLE 2.27

Pre-Project 50 to 90 Percent Exceedance Values for Brown and Rainbow Trout WUA in Segment NFCLP-2

Brown Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
1.2	Oct.	6,950	7,801		0
	Nov.	3,439	4,015		0
	Dec.	5,347	6,295		
	Jan.	4,529	5,325		
	Feb.	4,339	5,205		
	Mar.	3,851	4,505	929	
	Apr.	7,068	8,159	1,989	
	May	6,712	8,246	2,661	
	Jun.	6,974	8,552	2,696	
	Jul.	7,508	8,662	2,254	
	Aug.	8,122	9,354	2,330	
	Sep.	7,863	8,884	2,103	0

Rainbow Trout WUA (sq ft/1000 ft)

River Miles	Month	Adult	Juvenile	Fry	Spawning
1.2	Oct.	13,518	8,206		
	Nov.	7,139	5,000		
	Dec.	11,226	7,931		
	Jan.	9,491	6,695		
	Feb.	9,299	6,603		0
	Mar.	8,017	5,476		0
	Apr.	14,246	7,843	7,933	0
	May	13,936	5,066	3,946	
	Jun.	14,629	5,300	4,303	
	Jul.	14,986	8,414	8,672	
	Aug.	16,257	9,855	12,224	
	Sep.	15,574	10,409	14,184	

Construction of the mainstem reservoir would result in the inundation of about 15 miles of stream, including 7.5 miles of the Poudre River and 7.5 miles of the North Fork. Predicted habitat values were 315.7 HU/mile and 90.7 HU/mile, respectively, for the Poudre River and the North Fork. With project construction, 2683.5 HU would be lost on the mainstem and 707.5 HU would be lost on the North Fork, or a total loss of 3391.0 HU.

TABLE 2.28

Temperature (°C) Requirements for Rainbow[1] and Brown[2] Trout

Species	Life Stage	Optimal	Tolerance	Lethal
Brown	Adult	12-19	0-27	27.2
	Juvenile	7-19	0-27	29
	Fry	7-12	5-25.5	25.5
	Spawning	7-9		
Rainbow	Adult	12-18	0-25	25
	Juvenile	15-20		
	Fry	13-19		

[1]Raleigh et al. (1984b)
[2]Raleigh et al. (1984a)

Stream Temperature

The monitoring results and model output were interpreted with respect to the available literature on water temperature preference for rainbow trout and brown trout. Table 2.28 summarizes temperature criteria for both species. Recommended temperatures for optimal adult growth for both species range from 12 to 19°C (Raleigh et al., 1984a,b). Lethal temperatures for rainbows are reported at 25°C and just over 27°C for brown trout. The upper lethal limits depend on acclimatization time as well as temperature. Temperature criteria for juvenile and fry rainbow and spawning for rainbow or brown trout were not available from the Raleigh publications.

Monitoring Results

Mean monthly water temperatures downstream of the proposed damsites ranged from near 0°C to near 18°C from March 1987 through December 1987 (Table 2.29). The highest temperatures occurred during July and August. Summer monthly temperatures were lower at Taft Hill Road than at the canyon mouth due to the colder water entering the river from the Hansen Canal. Winter temperatures at both the canyon mouth and at Taft Hill Road were less than 2.0°C (Table 2.29 and Figure 2.79).

River flows during this same time period were typical of most snowmelt rivers with low winter flows (less than 30 cfs) and peak summer flows in June. The flows at all monitoring locations were less than 100 cfs for seven months of the year (Figure 2.80).

Monthly stream temperatures were within the tolerance limits for both rainbow and brown trout for the entire monitoring period at both the canyon mouth and at Taft Hill Road. Summer mean monthly temperatures were in the optimum range for both species (Table 2.29). Daily maximum temperatures, however, exceeded the optimum or tolerable ranges of rainbow trout, when cooler water from Hansen Canal was not available, as documented by Bartholow (1988), during certain summer periods.

Downstream water temperatures can be a result of either air temperature, discharge, or a combination of both factors. At the canyon mouth the water temperatures appeared more correlated with air temperature than discharge. As air temperatures increased, water temperatures also increased (Figure 2.81). Water temperatures did not seem to increase or decrease as a function of flow (Figure 2.82).

Water temperatures at Taft Hill Road seemed to have a linear relationship with air temperature and a nonlinear relationship with flow (Figures 2.83 and 2.84). The water temperatures were not as closely related to air temperature at Taft Hill Road as at the canyon mouth. This was probably due to the influence of the Hansen Canal inflow during the summer months.

Model Results

The final calibrated model predicted mean monthly water temperatures at the Taft Hill Road site that were generally within 2°C of observed temperatures (Table 2.30, Figure 2.85). November had the highest error, but attempts at further calibration did not significantly improve the overall model results.

TABLE 2.29

Monitored Mean Monthly Water Temperatures (°C) during 1987

Month	Canyon Mouth	Hansen Canal	Taft Hill Rd.
March	4.0	7.4	3.8
April	10.0	7.4	11.8
May 9.5	9.0	11.0	
June 13.7	13.8	15.1	
July 17.6	8.9	15.2	
August	17.0	10.8	15.9
September	13.1	13.5	15.4
October	8.5	10.7	11.5
November	3.5	-	6.5
December	0.9	-	1.9

Historic temperatures were modeled using historic hydrology and meteorology as described earlier. None of the mean monthly historic water temperature data was in the range that would be lethal, and in most cases it was in the optimum range. Therefore, only normal and hot/dry conditions were selected as the years summarized in this section. These years provided information about the average conditions in the study area as well as possible upper lethal conditions. Both longitudinal and point location output from the model were evaluated.

Starting temperatures in the canyon for the existing condition (pre-project) were calculated from historic records. The data for normal conditions were determined from the monthly temperature readings for the period of record. While these were once per month samples, the averaged values approximated monthly temperatures. The temperatures increased and decreased with monthly air temperature, and there were no abrupt temperature changes during the year. The hot/dry conditions (1981) had only one value per month, but since both meteorologic and hydrologic extremes occurred in the same year, the data approximated those conditions.

TABLE 2.30

Predicted Versus Observed Temperatures for 1987 Data at Taft Hill Road

Month	Predicted	Observed	Error
January	0.0	-	-
February	2.5	-	-
March	4.9	3.8	1.1
April	11.9	11.8	0.1
May	11.0	11.0	0.0
June	15.6	15.1	0.5
July	15.5	15.2	0.3
August	17.4	15.9	1.5
September	16.8	15.4	1.4
October	10.8	11.5	-0.7
November	3.4	6.5	-3.1
December	0.0	1.9	-1.9

With-project release temperatures were synthesized from Horsetooth Reservoir water temperature profiles. Reservoir profiles were available for the ice free months (April-October). These data were summarized, and average temperatures as a function of depth were provided by the Northern Colorado Water Conservancy District. A synthetic mainstem reservoir release temperature for both normal and hot conditions was constructed from these data (Figure 2.86). The release temperatures ranged from 4°C to near 14°C in hot years. The hot year data were one standard deviation above the average value. Since no data were available for winter months, a 4°C (bottom release) was assumed attainable.

There were two major differences in the pre- and with-project temperatures at the canyon mouth. The winter with-project temperatures were higher than existing temperatures and summer with-project release temperatures were lower than existing canyon temperatures (Figures 2.87 and 2.88). The flows at the canyon mouth and at Taft Hill Road were similar during most months for both pre- and with-project conditions. The main difference occurred during summer months when with-project flows were lower than existing flows. This condition existed during both normal and hot/dry years (Figures 2.89 - 2.92).

Longitudinal Profiles

Mean monthly water temperatures were highest during the July-September period in both normal and hot/dry years. Normal July temperatures were near 18°C from the mouth of the canyon (RM 54.7), downstream to just above the Hansen Canal inflow (RM 53.8) (Figure 2.93). The colder canal inflow caused a sharp decrease in water temperature, which gradually increased to near 14°C at Taft Hill Road. This same trend occurred under with-project conditions, but temperatures at Taft Hill Road were near 10°C due to the lower release temperature. Maximum monthly temperatures at the mouth of the canyon were 1-2°C higher than the mean monthly temperatures. At Taft Hill Road, maximum monthly temperatures were 2-3°C higher than the means. Normal August temperatures had the same pattern as normal July temperatures, but temperatures upstream of the Hansen Canal were slightly higher than normal July temperatures (Figure 2.94). The temperature regime downstream of the Hansen Canal was similar for existing and with-project conditions. There was little difference between existing and with-project temperatures under normal September conditions, and maximum monthly temperatures during this month were near mean values (Figure 2.95). This was probably due to the lower air temperatures in September.

Hot/dry conditions produced the highest instream water temperatures, as expected. Existing mean monthly water temperatures during July were near 22°C upstream of the Hansen Canal and monthly maximums were above 23°C. For with-project conditions, the mean temperatures for the same time period were under 12°C for the same segment of river, and maximums were below 16°C (Figure 2.96). August temperatures in hot/dry years approached 22°C in the canyon mouth under existing conditions and approached 13°C for the same section under with-project conditions (Figure 2.97). Maximum August temperatures were near 24°C under existing conditions and near 17° with the project. As with normal conditions, September mean and maximum temperatures were similar for both existing and with-project conditions (Figure 2.98).

Mean monthly water temperatures in the Poudre River study area under existing conditions were not detrimental to trout survival under most hydrologic and meteorologic conditions. The summer mean temperatures were within published optimum ranges for the entire study area. Hot/dry years produced the highest water temperatures, as expected, but these temperatures were still several degrees under the lethal limits for both brown and rainbow trout. The elevated temperatures under these conditions probably caused some stress for the trout in the affected section of the river. These high temperatures were not normally evident downstream of the Hansen Canal inflow, but were encountered when canal inflow was temporarily suspended. Pre-project temperature conditions are generally characterized as suitable or optimal with occasional daily periods of stressful conditions.

With-project summer water temperatures were lower than existing conditions, mainly due to the potential for lower reservoir release temperatures. With-project winter temperatures were slightly higher than pre-project temperatures because of the heat retention of the large volume of reservoir water.

The existing temperature regime would support trout populations in all segments analyzed, although temperatures appear to be suboptimal during July and August in hot/dry years and possibly in winter months of all years when temperatures were near 0°C. During summer periods when releases from Horsetooth Reservoir were temporarily curtailed, temperatures could rise above optimal or possibly lethal limits for rainbow trout as documented by Bartholow (1988). With-project conditions during July and August of hot/dry years and in the winter were better than existing conditions. With-project spring temperatures were cooler than optimal for rainbow trout, but were within a suitable range. Any negative trout growth effects of cool spring temperatures would be minimal and more than balanced by the improved with-project temperatures in late summer.

To assess effects of different with-project flow regimes, additional analyses were conducted for hot years by simulating stream temperatures for minimum (dry year) and maximum (wet year) hydrologic conditions. These analyses quantified the expected changes in downstream temperatures with differing releases from the proposed reservoir. Figures 2.99 through 2.101 present longitudinal mean and maximum temperature profiles under minimum and maximum bounding flow regimes. Temperatures during hot/wet years began 2-5°C lower than hot/dry years near river mile 57 due to discharges increasing by 181, 105, and 99 cfs in July, August, and September, respectively. These temperature declines were due to changes in release temperatures from the proposed mainstem reservoir caused by lower inflow temperatures. Inflow temperatures during dry years were one standard deviation higher than wet year temperatures, and the inflow temperature differences are carried through to generate higher starting reservoir release temperatures. Downstream of the proposed reservoir, the temperature differences were maintained until colder water from the Hansen Canal entered the system. Below Hansen Canal, inflow water temperatures increased at nearly the same rate regardless of flow.

Since air temperature and release temperature were the driving variables (rather than flow) for water temperature in the with-project condition, varying flows below the proposed dam would have little effect on downstream temperatures. Any improvements in the thermal regime due to project operation would therefore need to be focused on altering release temperatures rather than flows. Increasing winter temperatures and decreasing peak temperatures in July and August would be the most beneficial for trout populations.

Reservoir Quality Index

Assuming that the proposed reservoir would have a maximum depth of 390 feet and an estimated TDS concentration of 88 mg/l, RQI model calculations predict the reservoir would support 1.8 trout/acre (4.4 trout/ha). At an average fish weight of 0.75 pounds and 1.8 trout/acre, an estimated potential standing crop of 1.3 lbs/acre (1.5 kg/ha), or 1.3 Reservoir Habitat Units per acre is estimated.

2.4.3 Mitigation

This section addresses potential mitigation measures for trout and species of special concern in the Cache la Poudre river segments within the study area that would be potentially affected by the proposed mainstem reservoir. The section is intended to identify various potential mitigation measures relative to specific effects and to discuss them in terms of their implementation considering resource agency responsibilities and perspec-
tives. Where appropriate, estimated mitigation costs are presented.

Mitigation measures for trout species are presented in three categories: (1) in-kind mitigation, related to project-related habitat impacts; (2) land or access acquisition to bring into public use presently inaccessible stream sections to mitigate for potentially inundated sections; and (3) biomass or standing crop replacement to balance the estimated difference between predicted reservoir biomass and the biomass of the stream segments that would be inundated. Comparisons between the Poudre and Grey Mountain reservoir alternatives are also provided. Based on this comparison, a summary and recommendation section is provided. The mitigation discussion concludes with the identification of potential mitigation for species of special concern.

2.4.3.1 Trout

In-Kind Mitigation

Historically, resource agencies, particularly CDOW and USFWS, have requested replacement of inundated trout stream reaches with equal stream habitat units, primarily through flow- or channel-related instream habitat improvement in the same or a neighboring stream. For trout stream reaches potentially affected by streamflow changes, in-kind mitigation has also been the preferred measure. This suggests streamflow-related mitigation either in the affected reach or in a similar reach where there is a potential for flow control.

In-kind mitigation would be based on the assumption that mitigation would be accomplished through replacement of stream habitat units for rainbow and/or brown trout (the selected target species), either in terms of WUA and stream miles or, in the case of temperature, in terms of maintaining or bringing reaches into an acceptable temperature range.

In-kind mitigation alternatives in the following section are related to three categories of project effects:

(1) flow-related effects downstream from either the Poudre or Grey Mountain Damsites ("downstream" effects);

(2) effects related to loss of Poudre and North Fork stream habitats to inundation ("inundation" effects); and

(3) effects related to changes in temperature downstream from either Poudre or Grey Mountain damsite ("temperature" effects).

Downstream Mitigation Alternatives

The downstream changes in WUA at stations CLP-2, CLP-3a, and CLP-3b showed significant habitat increases under maximum bounding releases. These increases would represent an overall positive effect within the study area which could serve to reduce the mitigation requirement for inundation impacts. If the minimum bounding releases were adopted, the overall downstream effect would be essentially neutral (or slightly positive) and little inundation mitigation through enhanced WVA would be possible from managed reservoir releases.

Inundation Mitigation Alternatives

Inundation of both the Poudre and North Fork reaches would constitute the primary project effect on aquatic resources. A maximum of 15.0 miles would be transformed from stream habitat to reservoir habitat. Any trout fishery developed in the reservoir would probably not offer aquatic resources mitigation potential because of the in-kind (stream habitat) replacement restriction, although it could, depending on developed facilities and access, be considered as a form of recreation mitigation.

Because of the significant habitat increases under maximum bounding releases, it is possible that mitigation requirements for inundation effects would be reduced proportional to the total amount (in terms of a stream miles-by-habitat increase factor) of increased habitat. If the habitat in the seven miles below the Grey Mountain Damsite were doubled, then it is conceivable that the inundation effects would be reduced by as much as seven miles leaving 8.0 miles of inundation effect to be mitigated in-kind.

The short length of the study area downstream from either proposed damsite limits the extent to which in-kind mitigation solely within the study area could compensate for inundation impacts. In-kind mitigation for inundated area, however, could be provided upstream of the current study area through flow control through reduced summer flows and increased winter flows. Similarly, maximum bounding releases could provide significant habitat increases downstream from the lower study area boundary. The length of these upstream and downstream reaches is sufficient, given significant habitat increases, to fully mitigate for inundation impacts, provided flows could be managed satisfactorily.

Mitigation measures involve purchasing land or access and bringing currently private or inaccessible stream reaches into the public domain for sport fishing would depend on the quality of the stream reaches acquired or accessed. It is assumed that upper Poudre River private land would be acquired on an equal basis, that is, one mile of acquired land or access would mitigate for one mile of inundated stream. Costs of acquiring land were estimated based on current real estate values obtained from various realty agents in the Ft. Collins area. Minimum land values in Poudre Canyon were about $750 per acre for steep lots with limited or interrupted river frontage. Flatter lots with river frontage were valued at approximately $2000 per acre, with those particularly suitable for residences as much as $3000 per acre. Mitigation costs were calculated for the $750 and $3000 per acre costs to cover the range of potential costs.

Estimated costs were based on an assumed requirement for 15.0 miles or 13.0 miles (Grey Mountain and Poudre alternatives, respectively) with assumed widths of either 50 or 100 feet to provide for parking access and management. Estimated costs of acquisition are presented in Table 2-31. The figures represent a range of mitigation costs under the one-for-one mitigation policy. A two-for-one policy would obviously double the cost. It is likely that the instream habitat increases from releases approaching the maximum bounding releases could reduce the inundation impact by as much as seven miles, again reducing land acquisition mitigation cost by roughly half. The costs range considerably, but the high range costs are considered more appropriate for use in a planning level study.

Biomass or Standing Crop Replacement

If the calculated biomass differential were to be the basis for a mitigation requirement, it would be necessary to stock 1,000 or 1,300 pounds (for Poudre or Grey Mountain Reservoirs, respectively) of trout in the reservoir. Using the Grey Mountain estimate and assuming an adult weight of 0.4 pound, 3,250 adult rainbow would be required. At $0.45 per fish (A. Weiland, CDOW Hatcheries Department, personal communication, 1988), the cost would be $1,470 per year.

However, it is generally CDOW policy to stock fingerling, rather than catchable size, rainbow trout in reservoirs. Assuming a 75 percent fingerling-to-adult mortality rate, 13,000 fingerlings would be required instead of the 3,250 adult fish. At $0.08 per fingerling (A. Weiland, CDOW Hatcheries Department, personal communication, 1988), the cost of replacement mitigation would be $1,040 per year.

If the reservoir was stocked to its full carrying capacity (about 2,000 pounds), the cost would be $1,600.00 per year.

TABLE 2.31

Cost of Mitigation Land Acquisition
for Grey Mountain and Poudre Alternatives
(Low Cost = $750.00/Acre, High Cost = $3000/Acre)

Alternative	Stream Miles Inundated	Acres		Cost $ (Low)		Cost $ (High)	
		50 ft width	100 ft width	50 ft width	100 ft width	50 ft width	100 ft width
Grey Mountain	15.0	99	198	74,250	148,500	297,000	594,000
Poudre	13.0	87	173	65,000	130,000	259,500	519,000

Temperature Mitigation Alternatives

Water temperature effects downstream from either the Poudre or Grey Mountain Damsites would relate primarily to a release structure design capable of withdrawing water in the 15-17°C range during July and August. Such release temperatures would substantially improve upon pre-project temperature conditions below both proposed damsites. These benefits would be added to those already expected from an overall increase downstream in winter temperatures. Such releases would most likely have to be drawn from the top 5-10 feet of the reservoir based on expected reservoir temperature profiles. The release structure would have to be designed to maintain releases from near the reservoir surface. The costs of such a structure would be a primary consideration in determining the feasibility of temperature mitigation.

As with flow mitigation, the project could potentially provide more downstream mitigation benefit below Taft Hill Road than within the boundaries of the area considered in this study. It was determined that cool water (between 5 and 10°C) releases from the mainstem reservoir could provide substantial relief from lethal (for rainbow trout) temperatures below the Larimer County Canal Diversion. Such cold releases would suppress trout growth rates between either damsite and the Larimer County Canal diversion, but would potentially bring more river miles into production than would be affected by cold temperatures.

Poudre vs. Grey Mountain Mitigation Considerations

Based primarily on instream habitat and temperature considerations for assumed in-kind mitigation, the Grey Mountain Reservoir alternative would be preferred primarily because of its substantially greater enhancement of downstream WUA under the maximum bounding releases schedule. This would be conditioned, however, by the inundation of 2 more stream miles. If mitigation were considered only within the current study area, selection between Poudre and Grey Mountain alternatives would be difficult because of the balancing between increased WUA (with Grey Mountain) and less inundation and more stream habitat improvement (with Poudre).

In the context of applying mitigation outside of the current study area, the Grey Mountain alternative would be favored because:

(1) Its greater storage capacity would provide increased flexibility in storing flows and in providing reregulation of flows downstream;

(2) Any additional inundation (over the Poudre alternative) would be more than balanced by habitat improvements through significantly more river miles; and

(3) The greater volume and further downstream dam location would provide a better source of cooler water, nearer to the downstream reaches where cooling is most desired.

In terms of land acquisition or access mitigation, the Poudre alternative would be slightly preferred because of the lower number of miles inundated. In terms of biomass replacement mitigation, the Poudre alternative would again be favored because of the smaller stream/reservoir biomass differential, but relative costs of this mitigation are so minimal that it is not a basis for choice.

Mitigation Summary and Recommendation

The preceding mitigation discussion leads to the following conclusions and recommendations:

- For in-kind mitigation of stream trout resources, both the Poudre or Grey Mountain project alternatives would be difficult to mitigate if mitigation was restricted solely to the area between Taft Hill Road and the upper reservoir limit. Even with the benefits of reservoir releases approaching maximum bounding releases, the number of stream miles inundated outweigh the potentials for habitat improvement in the short reaches between either dam and the lower study boundary. Considering mitigation potential only within the present study area, the Poudre and Grey Mountain alternatives are considered equal because of the balance between Grey Mountain habitat increased and lower Poudre inundation length.

- Potential in-kind mitigation opportunities appear to be good both above and below the proposed mainstem reservoir. There is considerable local and CDOW interest in improving the fishery habitat conditions in the currently degraded reaches below Taft Hill Road. Studies have been completed which show the potential for reservoir-related temperature contributions to improved downstream habitat (Bartholow, 1988).

- More detailed mitigation and feasibility evaluations for the Poudre Project can be provided following further study of downstream (below Taft Hill Road) flow and temperature requirements and the capability of the mainstem reservoir to meet them.

2.4.3.2 Species of Special Concern

Inundation of North Fork reaches inhabited by johnny darters may pose difficult mitigation. Because johnny darters do not appear to inhabit the Poudre River, in-kind mitigation downstream of the project would not be possible through flow or temperature improvements. The only area available for in-kind mitigation is upstream of the proposed reservoir. Here, mitigation might be provided by flow control in the North Fork between the proposed mainstem reservoir and Halligan Reservoir. If Halligan Reservoir were enlarged, controlled releases (in concert with storage in a mainstem reservoir) might reduce the frequent flooding and siltation now seen in reaches between Seaman and Halligan Reservoirs. Flood reductions and elevated base flows could substantially increase johnny darter habitat in upstream North Fork reaches which darters currently inhabit.

2.5 SUMMARY

2.5.1 Fish Populations

Fish populations are expected to shift within the inundation zone of the proposed project. Due to the loss of riverine habitat, the species composition will probably shift from a dominance of trout species to a more even composition of species which favor a reservoir environment. Brown trout and rainbow trout will still be present in the reservoir, but their density will be lower unless density is enhanced through reservoir stocking. Johnny darter populations in the North Fork will be substantially impacted by inundation, but will probably continue to occupy their existing range outside of the inundation zone.

2.5.2 Macroinvertebrates

Macroinvertebrate population numbers downstream of the project are expected to increase with the project, while species diversity is expected to decrease. These effects are due to changes in substrate composition, temperature and flow regimes, and algal and macrophyte growth. The effect that these changes may have on fish populations is not quantifiable at this time. However, increases in macroinvertebrate biomass generally result in higher trout production below reservoirs along the Colorado front range.

2.5.3 Habitat and Temperature

Effects of the proposed mainstem reservoir on habitat are due to either inundation or flow modification. Since the proposed reservoir would inundate about 13.0 or 15.0 miles (Poudre or Grey Mountain alternative, respectively) of approximately 24 miles (or 66 percent) of riverine habitat in the study area, the primary habitat effects are due to inundation. These changes are for the inundation zone and downstream areas only, since upstream sites are not directly affected by the project. The net result of the project is approximately a 60 percent loss of overall stream habitat in the study area. Since downstream flow-related effects are primarily neutral to positive (depending on reservoir releases), the overall loss is primarily due to the area inundated by the reservoir.

This loss is substantially offset under maximum bounding reservoir releases. Due to the relatively short length of the downstream reach, however, it is unlikely that habitat area lost to inundation can be completely recovered by flow modifications within that reach. Habitat enhancement of downstream areas (below Taft Hill Road) should be considered to fully mitigate for project effects on fisheries habitat.

Stream temperatures will be improved by project operation due to cooling of the highest summer temperatures and warming of the near freezing winter temperatures. Additional improvements can be gained with control of reservoir release temperatures in order to allow for maximum fish growth in the summer and minimal losses in the winter. Any project-related changes in stream temperature within the study area will be most significant above the Hansen Canal outfall. Below the outfall down to Taft Hill Road, temperatures are reduced substantially and the influence of the proposed project is minimized. Again, consideration of temperature effects downstream of Taft Hill Road offers a more positive overall mitigation potential than the limited reach above the Hansen Canal.

Differences between the Poudre and Grey Mountain alternatives relate primarily to inundation of trout habitat and instream flow effects; temperature effects between the two damsites were not significant. Inundation effects favored the Poudre alternative, while instream flow effects favored the Grey Mountain alternative. Selection of one alternative based on applying potential mitigation measures strictly within an area including the impoundment zone and downstream reaches to Taft Hill Road is not realistic. Final damsite selection should consider mitigation measures which extend downstream (through the City of Ft. Collins).

2.6 REFERENCES

Aquatic Management Associates. 1986a. Review of Literature on Aquatic Resources in the Cache la Poudre River in Colorado, August 1986. Report to the Northern Colorado Water Conservancy District and Resource Management Services, Inc. Fort Collins, Colorado.

Aquatic Management Associates. 1986b. Interim Report of Fish and Macroinvertebrate Populations for the Cache la Poudre Water and Power Project, Fall 1986. Report to the Northern Colorado Water Conservancy District and Resource Management Services, Inc. Fort Collins, Colorado.

Aquatic Management Associates. 1987a. Review of Literature on Johnny Darters in Colorado for the Cache la Poudre Water and Power Project, February 1987. Report to the Northern Colorado Water Conservancy District and Resource Management Services, Inc. Fort Collins, Colorado.

Aquatic Management Associates. 1987b. Interim Report of Fish and Macroinvertebrate Populations for the Cache la Poudre Water and Power Project, Spring 1987. Report to the Northern Colorado Water Conservancy District and Envirosphere Company. Fort Collins, Colorado.

Aquatic Management Associates. 1987c. Tributary Characterization for the Cache la Poudre Water and Power Project, January 1987. Report to the Northern Colorado Water Conservancy District and Resource Management Services, Inc. Fort Collins, Colorado.

Aquatics Associates. 1987. Interim Report of Fish and Macroinvertebrate Populations for the Cache la Poudre Water and Power Project, Fall 1987. Report to the Northern Colorado Water Conservancy District and Envirosphere Company. Fort Collins, Colorado.

Bartholow, J. 1988. Preliminary Analysis of Water Temperature Data for the Poudre River Corridor Fishery Plan. U.S. Fish and Wildlife Service Aquatic Systems Branch. Fort Collins, Colorado. 12 pp.

Binns, N.A. 1982. Habitat Quality Index Procedures Manual. Wyoming Game and Fish Department. Cheyenne, Wyoming.

Binns, N.A. 1985. Calculation of Habitat Units. Interdepartmental Communications, Wyoming Game and Fish Department. Cheyenne, Wyoming.

Binns, N.A., and F.M. Eiserman. 1979. Quantification of Fluvial Trout Habitat in Wyoming. Trans. Amer. Fish. Soc. 108: 215-228.

Bovee, K.D. 1982. A Guide to Stream Habitat Analysis Using the Instream Flow Incremental Methodology. Instream Flow Information Paper 12. U.S.D.I. Fish and Wildlife Service, Office of Biological Services. FWS/OBS-82/26. 248 pp.

Bovee, K.D. 1988. Personal Communication. Fort Collins, Colorado.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology, Vol. 1. Iowa State University Press. Ames, Iowa.

Conder, A.L., and N.A. Binns. 1986. Reservoir Impact Analysis Using Habitat Units for Trout Streams. Proceedings of the 21st Annual Meeting, Colo-Wyo Chapter of the American Fisheries Society. Fort Collins, Colorado.

CDOW (Colorado Division of Wildlife). 1985. Wildlife Commission Minutes, February 1985. Colorado Division of Wildlife. Denver, Colorado. p. 11643.

CDOW (Colorado Division of Wildlife). 1987a. Fish Population Sampling Summaries for 1986 and 1987. Unpublished Data. Department of Natural Resources, Colorado Division of Wildlife. Denver, Colorado.

CDOW (Colorado Division of Wildlife). 1988. Colorado Fishing Season Information. Department of Natural Resources, Colorado Division of Wildlife. Denver, Colorado.

Everhart, W.H., A.W. Eipper, and W.D. Youngs. 1975. Principles of Fishery Science. Cornell University Press. Ithaca, New York.

Gray, L.J., and J.V. Ward. 1982. Effect of Sediment Release from a Reservoir on Stream Macroinvertebrates. Hydrobiol. 96: 177-184.

Gustafson, R. 1986. Personal Communication. Fort Collins, Colorado.

Hanzon, B.D., and F.W. Matter. 1976. Report of Discharge from Seaman Reservoir. Unpublished Information. Colorado Department of Health, Water Quality Control Division. Denver, Colorado.

Hydro-Triad, Ltd. 1988. Hydrologic Network Modeling Cache la Poudre Project, January 1988. Final Report. Report to the Northern Colorado Water Conservancy District. Lakewood, Colorado.

Kehneier, K. 1987. Colorado Division of Wildlife, Fort Collins, Colorado, Personal Communication.

Klein, W.D. 1974. Special Regulations and Elimination of Stocking: Influence on Fishermen and the Trout Population at the Cache la Poudre River, Colorado. Technical Publication No. 30. Department of Natural Resources, Colorado Division of Wildlife. Denver, Colorado.

Kuehne, R.A., and R.W. Barbour. 1983. The American Darters. The Univ. Press of Kentucky, Lexington, Kentucky.

Labadie, J.W. 1987. River Basin Network Flow Model; Program MODSIM. Draft, April 1987. Department of Civil Engineering, Colorado State University. Fort Collins, Colorado.

Larimer-Weld Council of Governments. 1985. Areawide Water Quality Management Plan Update. Larimer-Weld Council of Governments. Loveland, Colorado.

Lloyd, M., J.H. Zar, and J.K. Karr. 1968. Calculations of Information--Theroetical Increases of Diversity. Am. Mid. Nat. 79(2): 257-272.

Mars, J.P. 1978. Water Quality Investigations of the Cache la Poudre River, May-July 1977. Colorado Department of Health, Water Quality Control Division. Denver, Colorado.

Marshall, T.L. 1973. Trout Populations, Angler Harvest and Value of Stocked and Unstocked Fisheries of the Cache la Poudre River, Colorado. Ph.D. Dissertation, Colorado State University. Fort Collins, Colorado.

Milhous, R.T. 1984. The Use of One Velocity Calibration Data Set with IFG4. PHABSIM Technical Note No. 4. 6 p.

Milhous, R.T., D.L. Wenger, and T. Waddle. 1984. User's Guide to the Physical Habitat Simulation System. Instream Flow Information Paper 11. U.S. Fish Wildl. Serv. FWS/OBS-81/43 Revised. 475 pp.

Mountain States Weather Service. 1987. Local Climatological Data, Annual 1987. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1981. Stream Fisheries Investigations. Job Progress Report, Federal Aid Project F-51-R-6. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1982. Stream Fisheries Investigations. Job Progress Report, Federal Aid Project F-51-R-7. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1983. Stream Fisheries Investigations. Job Progress Report, Federal Aid Project F-51-R. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1984. Stream Fisheries Investigations. Job Progress Report, Federal Aid Project F-51. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1985. Stream Fisheries Investigations. Job Progress Report, Federal Aid Project F-51. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

Nehring, R.B., and R.M. Anderson. 1986. Stream Fisheries Investigations. Unpublished Data. Department of Natural Resources, Colorado Division of Wildlife. Fort Collins, Colorado.

NCWCD (Northern Colorado Water Conservancy District). 1987a. Project Flow Data, Cache la Poudre Water and Power Project. Unpublished Data. November 1987. Loveland, Colorado.

NCWCD (Northern Colorado Water Conservancy District), 1987b. Project Flow Data, Cache la Poudre Water and Power Project. Unpublished Data. December 1987. Loveland, Colorado.

Odum, E.P. 1979. Fundamentals of Ecology, Third Edition. W.B. Saunders Company. Philadelphia, Pennsylvania. Pp. 148-154.

Pistono, R.P. 1987. Personal Communication. Lander, Wyoming.

Propst, D.L. 1982a. The Warmwater Fishes of the Platte River System, Colorado, 1978-1980. Colorado Division of Wildlife. Fort Collins, Colorado. 161 pp.

Propst, D.L. 1982b. The Warmwater Fishes of the Platte River Basin, Colorado: Distribution, Ecology, and Community Dynamics. Ph.D. Dissertation, Colorado State University. Fort Collins, Colorado. 283 pp.

Raleigh, R.F., O.D. Zuckerman, and P.C. Nelson. 1984a. Habitat Suitability Index Models and Instream Flow Suitability Curves: Brown Trout. U.S. Fish and Wildlife Service. FWS/OBS-82/10.71.

Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984b. Habitat Suitability Information: Rainbow Trout. U.S. Fish and Wildlife Service. FWS/OBS-82/10.60. 64 p.

Short, R.A., and J.V. Ward. 1980. Leaf Litter Processing in a Regulated Rocky Mountain Stream. Can. J. Fish. Aquat. Sci. 37: 123-127.

Stanford, J.A., and J.V. Ward. 1979. Stream Regulation in North America. In: J.V. Ward and J.A. Stanford (eds.). The Ecology of Regulated Streams. Plenum Press, New York. Pp. 213-236.

Texas Water Development Board. 1972. Economic Optimization and Simulation Techniques for Management of Regional Water Resource Systems; River Basin Simulation Model SIMYLD-II; Program Description. Texas Water Development Board. Austin, Texas.

Theurer, F.D., K.A. Voos, and W.J. Miller. 1984. Instream Water Temperature Model. Instream Flow Information Paper No. 16. U.S. Fish and Wildlife Service. FWS/OBS-84/15.

USGS (U.S. Geological Survey). Various Years. Water Resources Data for Colorado. 1971 through 1982, and 1987.

Ward, J.V. 1974. A Temperature-Stressed Stream Ecosystem Below a Hypolimnial Release Mountain Reservoir. Arch. Hydrobiol. 74: 247-275.

Ward, J.V. 1975. Downstream Fate of Zooplankton from a Hypolimnial Release Mountain Reservoir. Verh. Internat. Vereein. Theor. Angew. Limnol. 19: 1798-1804.

Ward, J.V. 1976a. Comparative Limnology of Differentially Regulated Sections of a Colorado Mountain River. Arch. Hydrobiol. 78(3): 319-342.

Ward, J.V. 1976b. Effects of Thermal Constancy and Seasonal Temperature Displacement on Community Structure of Stream Macroinvertebrates. In: G.W. Esch and R.W. McFarlane (eds.), Thermal Ecology II, ERDA Symposium Series (Conf.750425). Pp. 302-307.

Ward, J.V. 1976c. Effects of Flow Patterns Below Large Dams on Stream Benthos: A Review. In: J.F. Orsborn and C.H. Allman (eds.). Instream Flow Needs Symposium, Vol. II, Amer. Fish. Soc. Pp. 235-253.

Ward, J.V. 1984a. Ecological Perspectives in the Management of Aquatic Insect Habitat. In: V.H. Resh and D.M. Rosenberg (eds.), The Ecology of Aquatic Insects. Praeger, New York. Pp. 558-577.

Ward, J.V. 1984b. Stream Regulation of the Upper Colorado River: Channel Configuration and Thermal Heterogeneity. Verh. Internat. Vereein. Limnol. 22: 1862-1866.

Ward, J.V., and R.A. Short. 1978. Macroinvertebrate Community Structure of Four Special Lotic Habitats in Colorado, U.S.A. Verh. Internat. Vereein. Limnol. 20: 1382-1387.

Ward, J.V., and J.A. Stanford. 1979a. The Ecology of Regulated Streams. Proceedings of the First International Symposium on Regulated Streams. Erie, Pennsylvania. April 18-20, 1979. Plenum Press, New York. 398 p.

Ward, J.V., and J.A. Stanford. 1979b. Ecological Factors Controlling Stream Zoobenthos with Emphasis on Thermal Modification of Regulated Streams. In: J.V. Ward and J.A. Stanford (eds.). The Ecology of Regulated Streams. Plenum Press, New York. Pp. 35-56.

Ward, J.V., and J.A. Stanford. 1979c. Limnological Considerations in Reservoir Operation: Optimization Strategies for Protection of Aquatic Biota in the Receiving Stream. Proceedings of the Mitigation Symposium, U.S. Dept. Agric. Fort Collins, Colorado. Pp. 496-501.

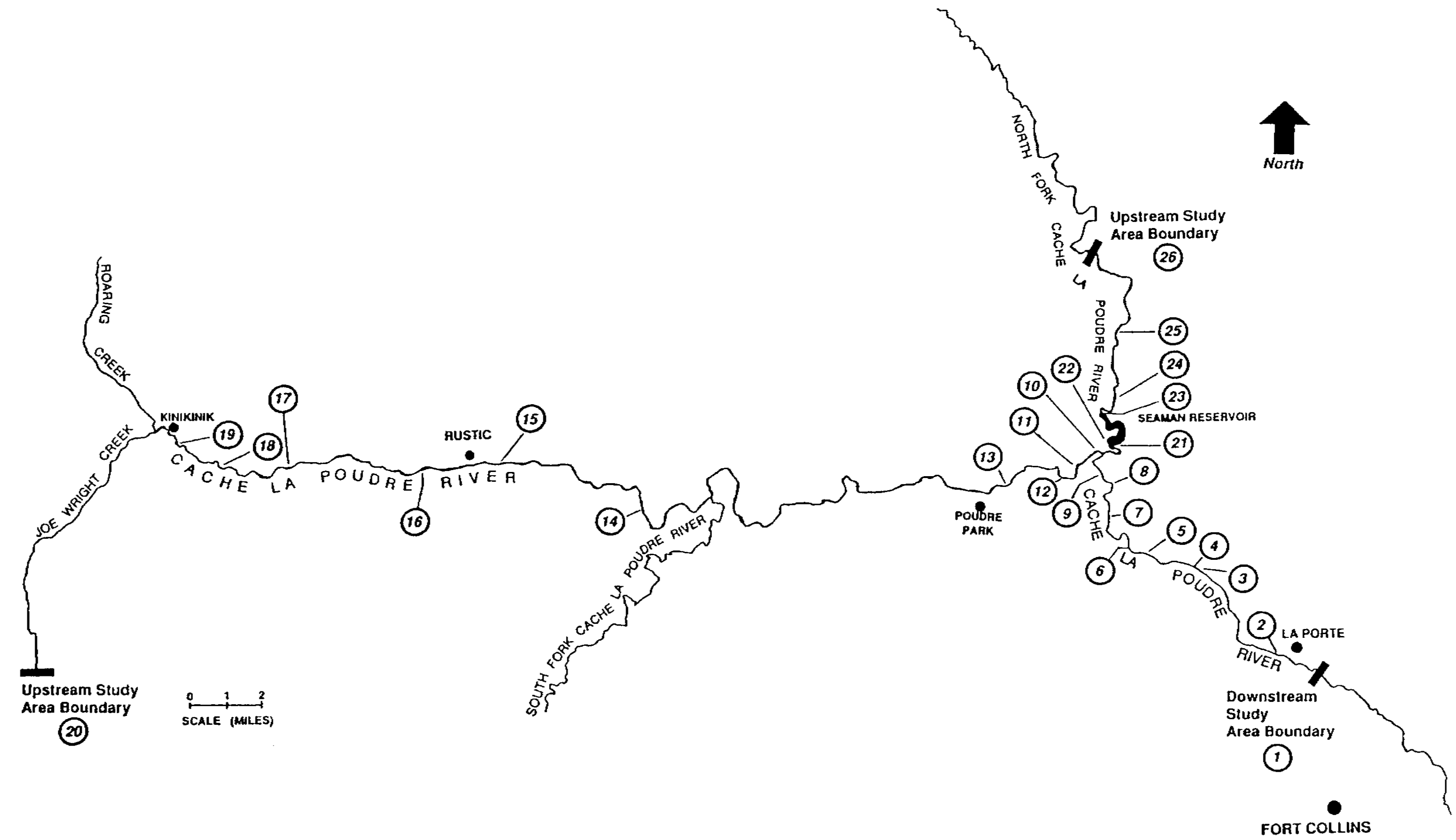
Ward, J.V., and J.A. Stanford. 1983. The Serial Discontinuity Concept of Lotic Ecosystems. In: T.D. Fontaine and S.M. Bartell (eds.), Dynamics of Lotic Ecosystems, Ann Arbor Science Publishers. Ann Arbor, Michigan. Pp. 29-42.

Ward, J.V., H.J. Zimmermann, and L.D. Cline. 1986. Lotic Zoobenthos of the Colorado River System. In: B.R. Davies and K.F. Walker (eds.), The Ecology of River Systems, Dr. W. Junk Publishers. The Netherlands. Pp. 403-424.

Whitworth, W.E. 1985. Reservoir Quality Index Models: Regression Models of Trout Productivity for Small Reservoirs in Wyoming. Completion Report. University of Wyoming. Lander, Wyoming.

Zimmermann, H.J. 1988. Personal Communication. Fort Collins, Colorado.

Zimmermann, H.J., and J.V. Ward. 1984. A Survey of Regulated Streams in the Rocky Mountains of Colorado, U.S.A. In: A. Lillehammer and S.J. Saltvert (eds.). Regulated Rivers. Oslo University Press. Oslo, Norway. Pp. 251-262.



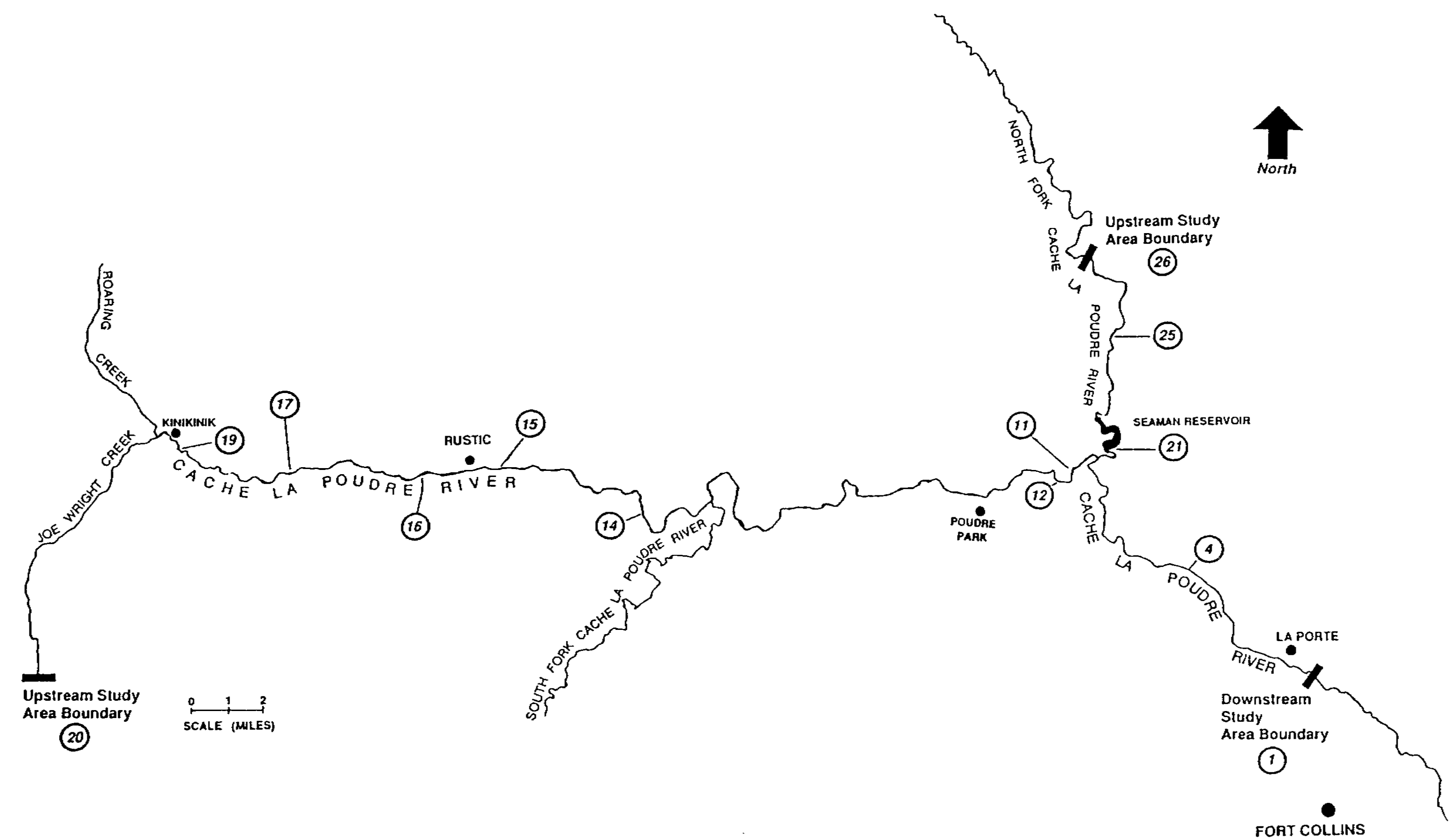
NOTE: Refer to Table 2.1 for location descriptions.

COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

Aquatic Resources Study Area

DATE 11/28/88 Figure 2.1



NOTE: Refer to Table 2.1 for location descriptions.

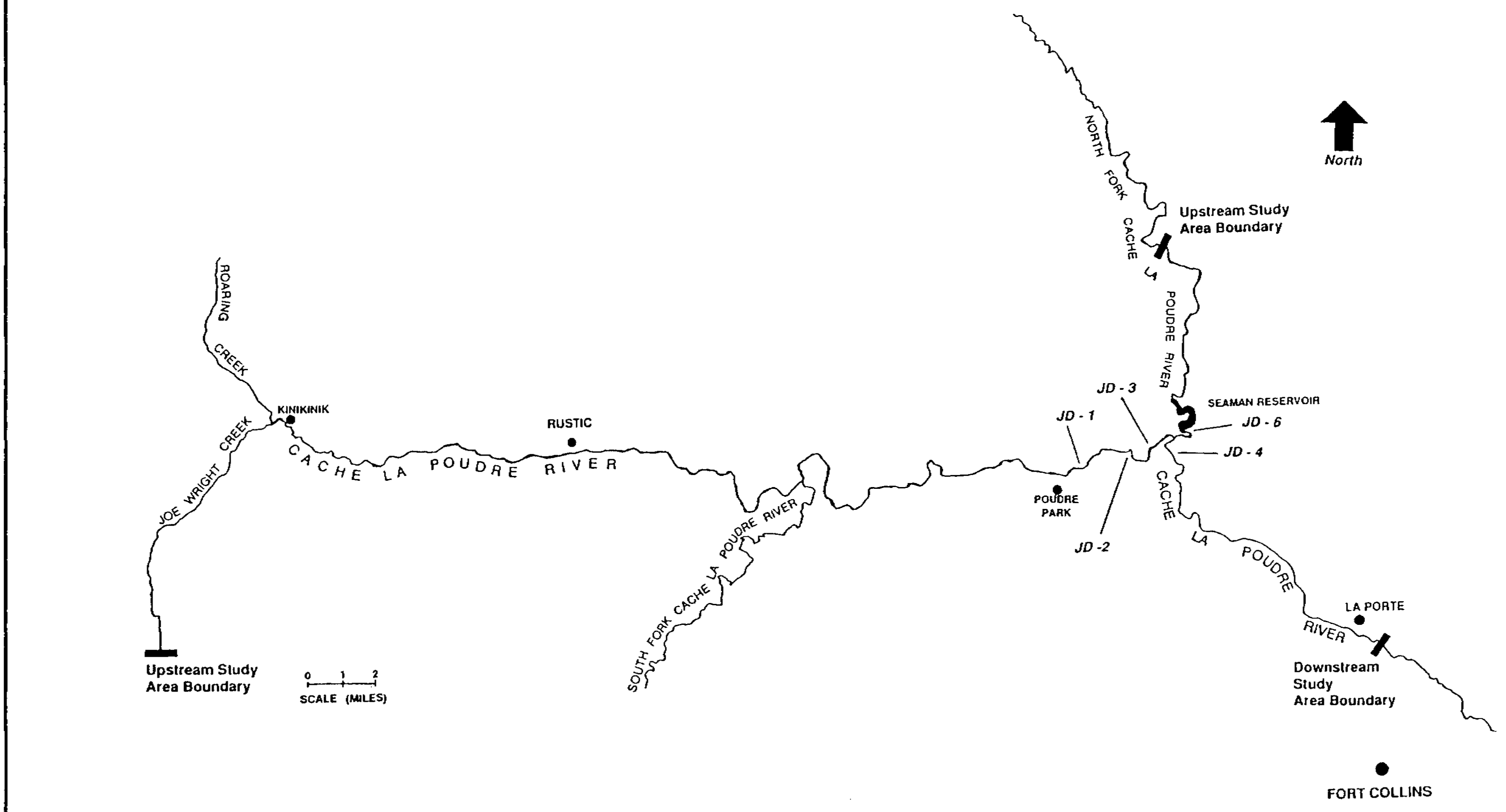
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

FISH SAMPLING STATIONS

DATE 11/28/88

FIGURE 2.2



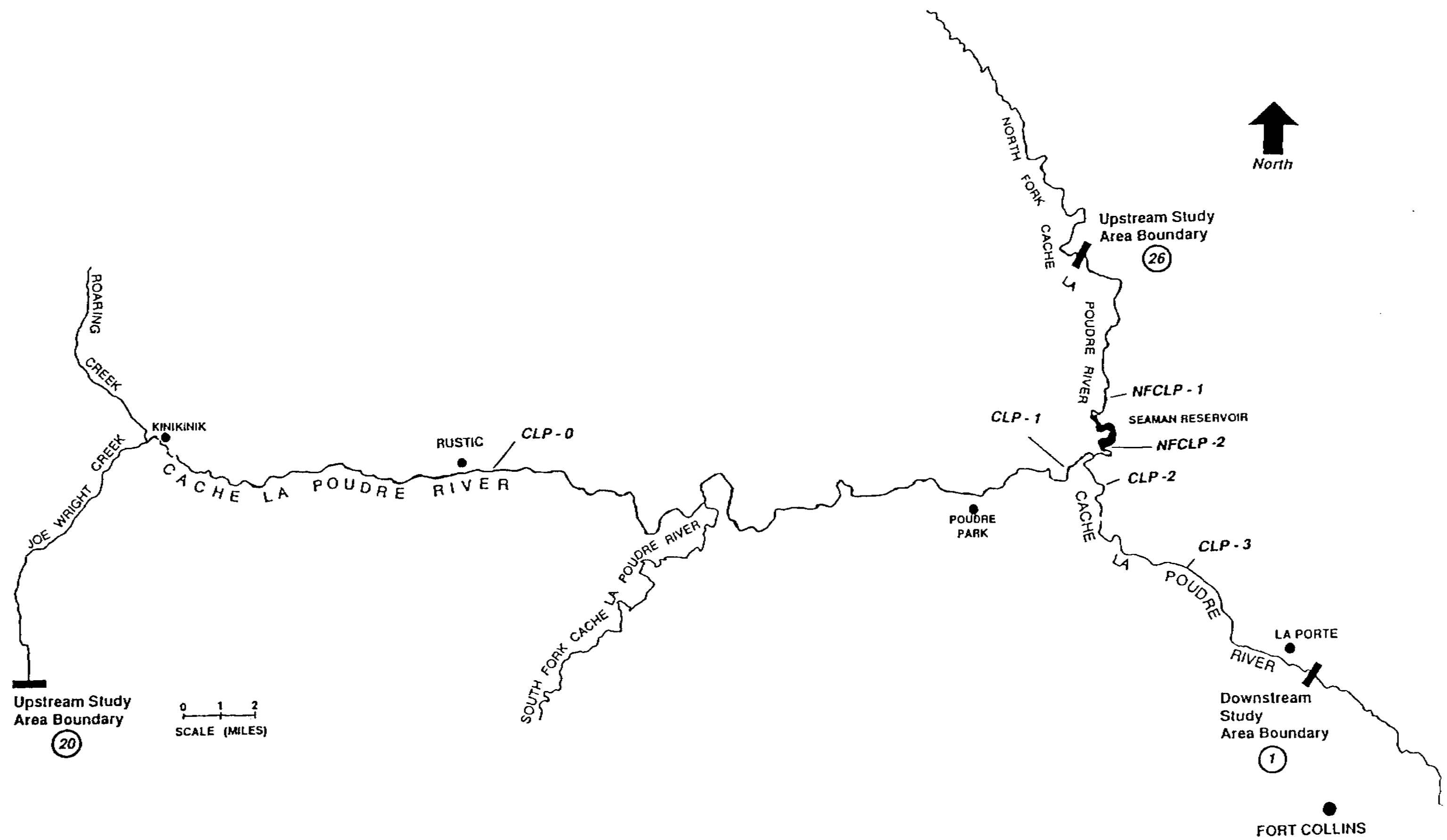
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

JOHNNY DARTER SURVEY SAMPLING STATIONS

DATE 11/28/88

FIGURE 2.3

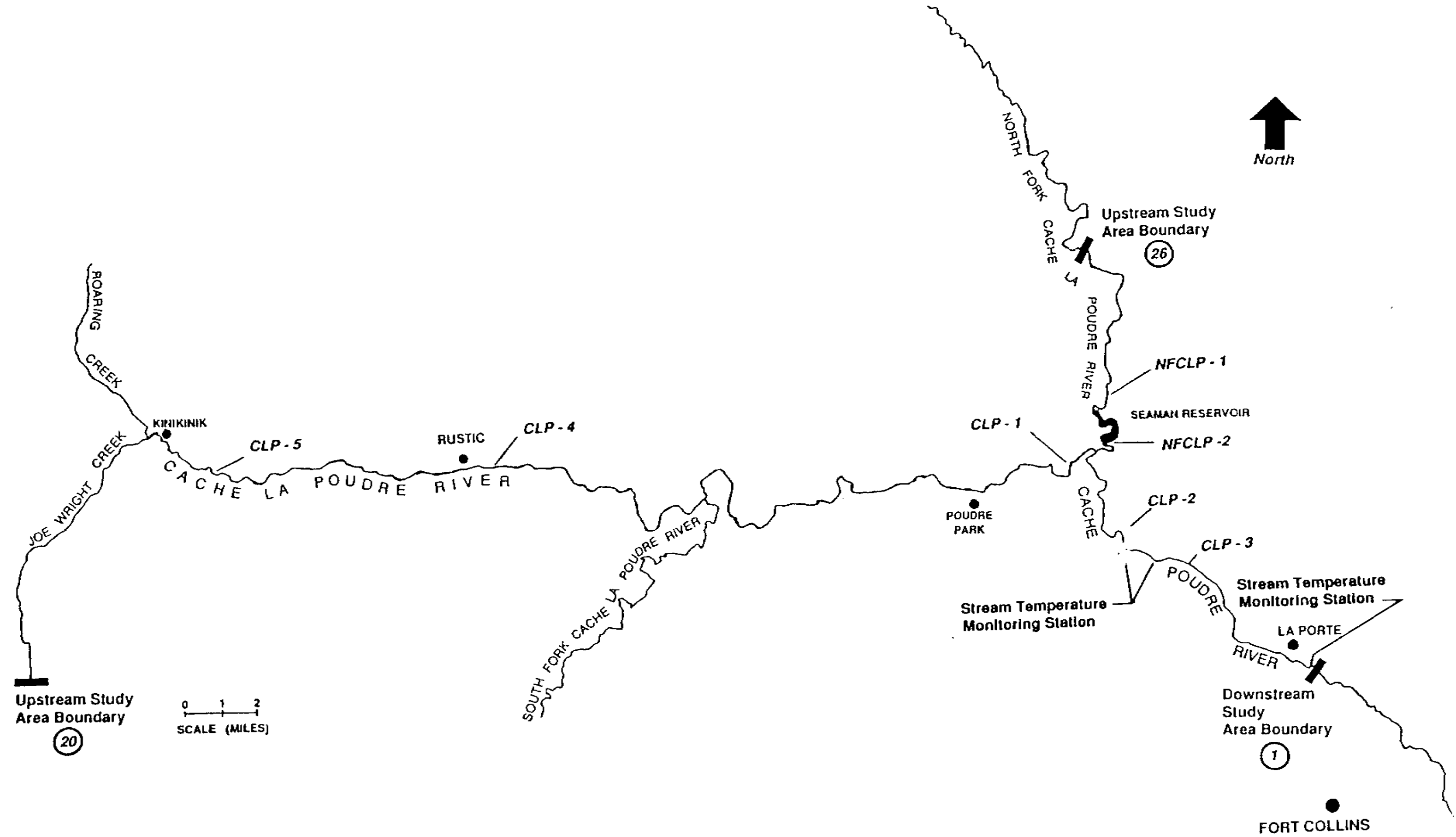


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MACROINVERTEBRATE SAMPLING STATIONS

DATE 11/28/88	FIGURE 2.4



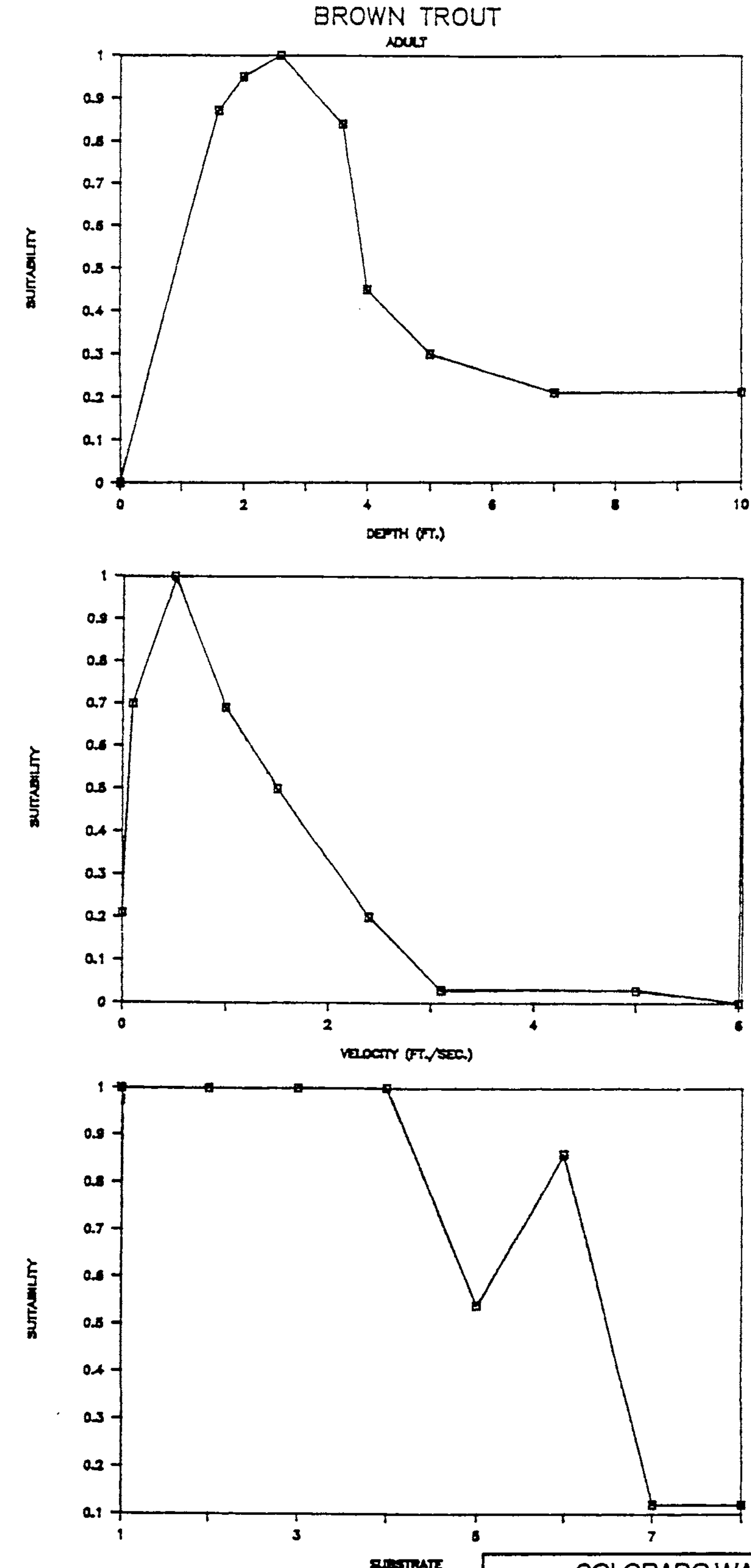
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT SAMPLING SITES

DATE 11/28/88

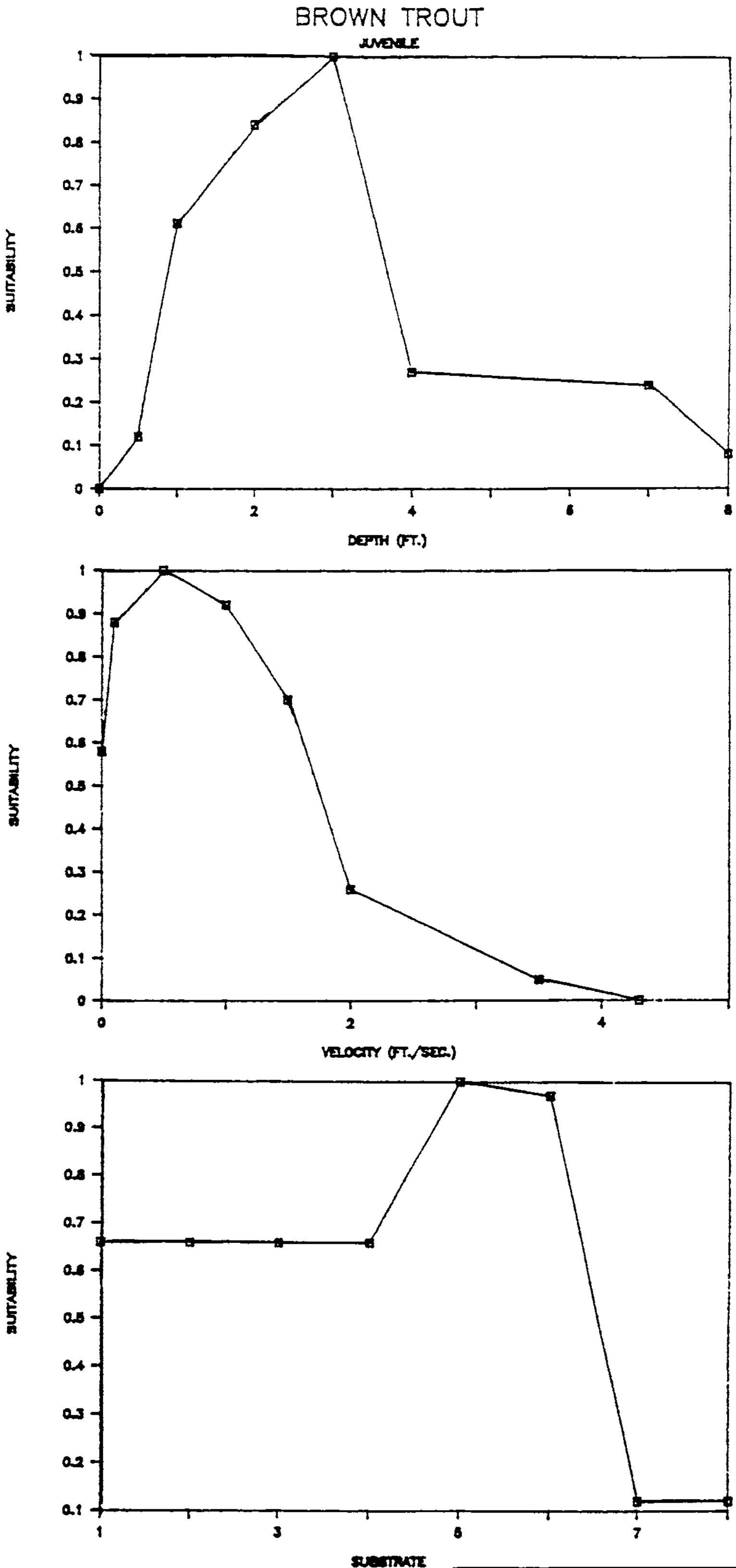
FIGURE 2.5



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR BROWN TROUT

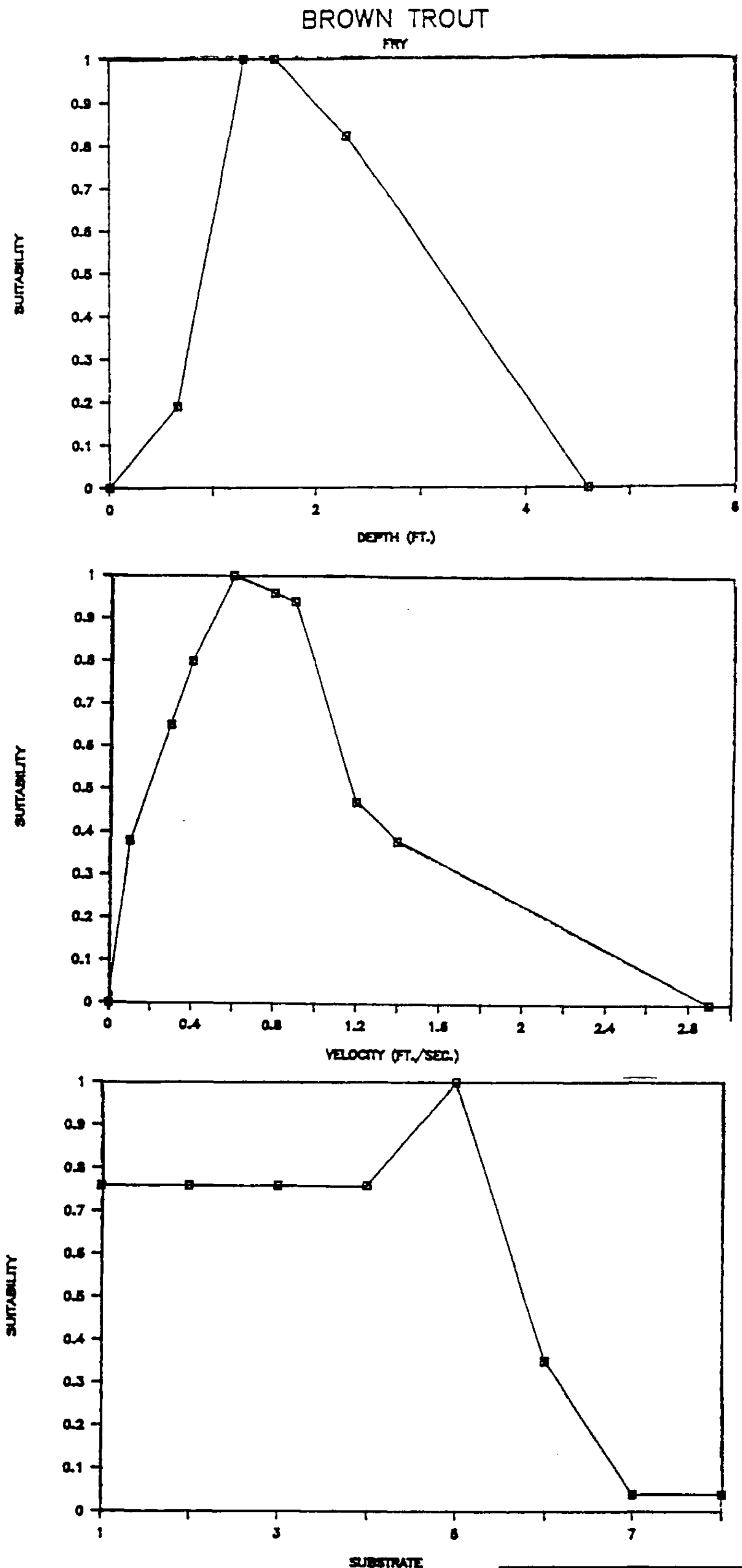
DATE 11/28/88 FIGURE 2.6



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR BROWN TROUT

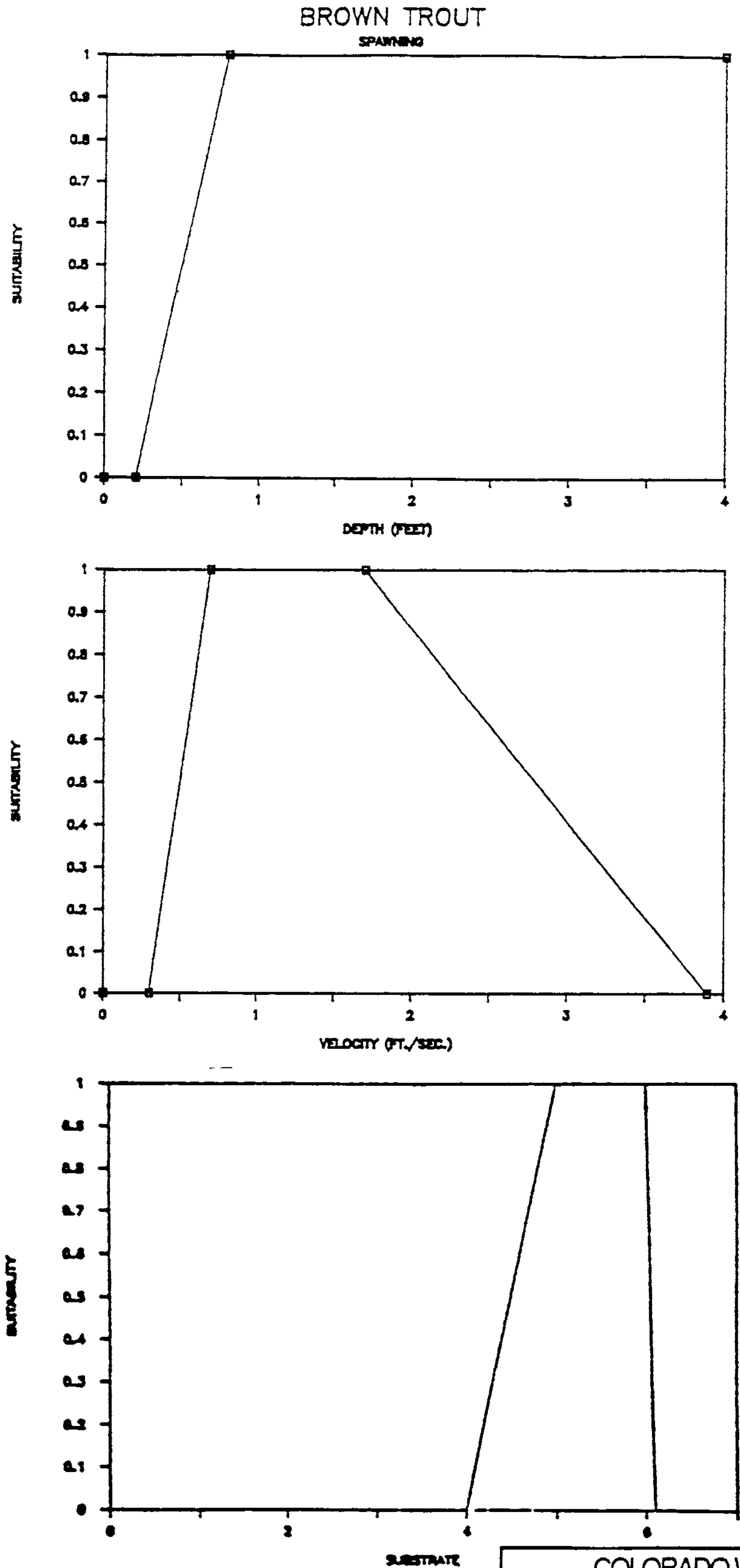
DATE 11/28/88	FIGURE 2.6 (Cont'd)



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR BROWN TROUT

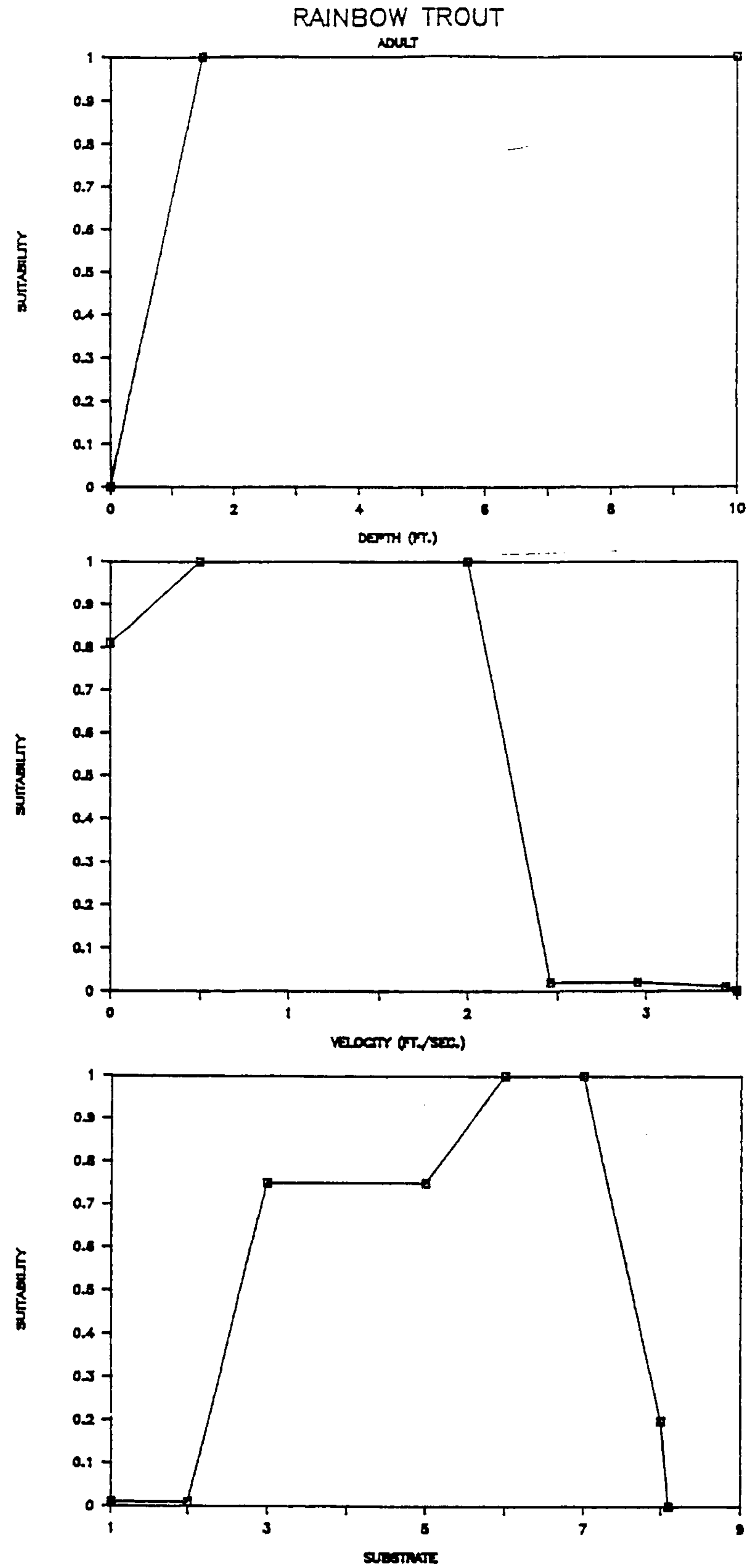
DATE 11/28/88 FIGURE 2.6 (Cont'd)



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR BROWN TROUT

DATE 11/28/88 FIGURE 2.6 (Cont'd)

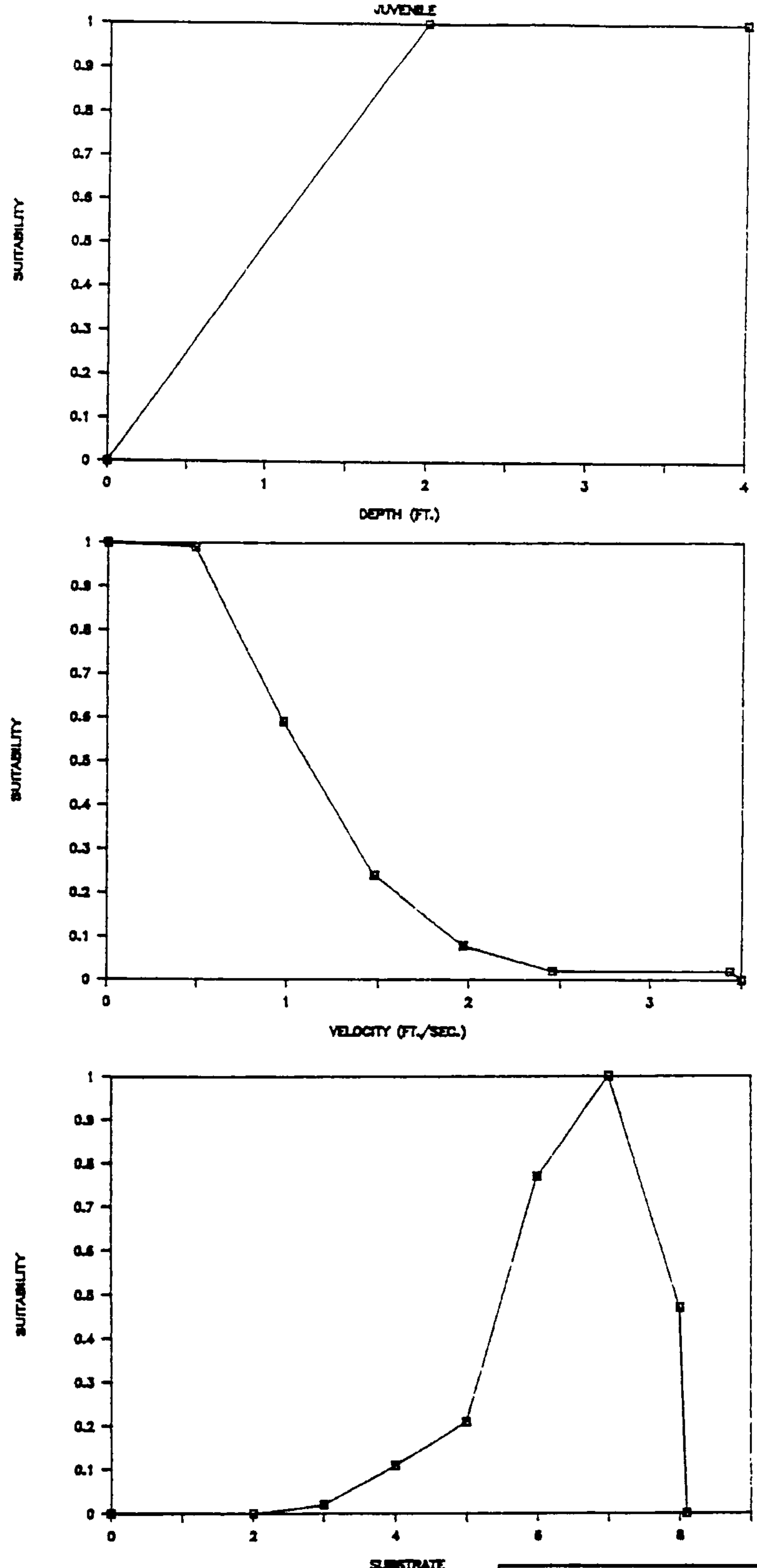


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR RAINBOW TROUT

DATE 11/28/88 FIGURE 2.7

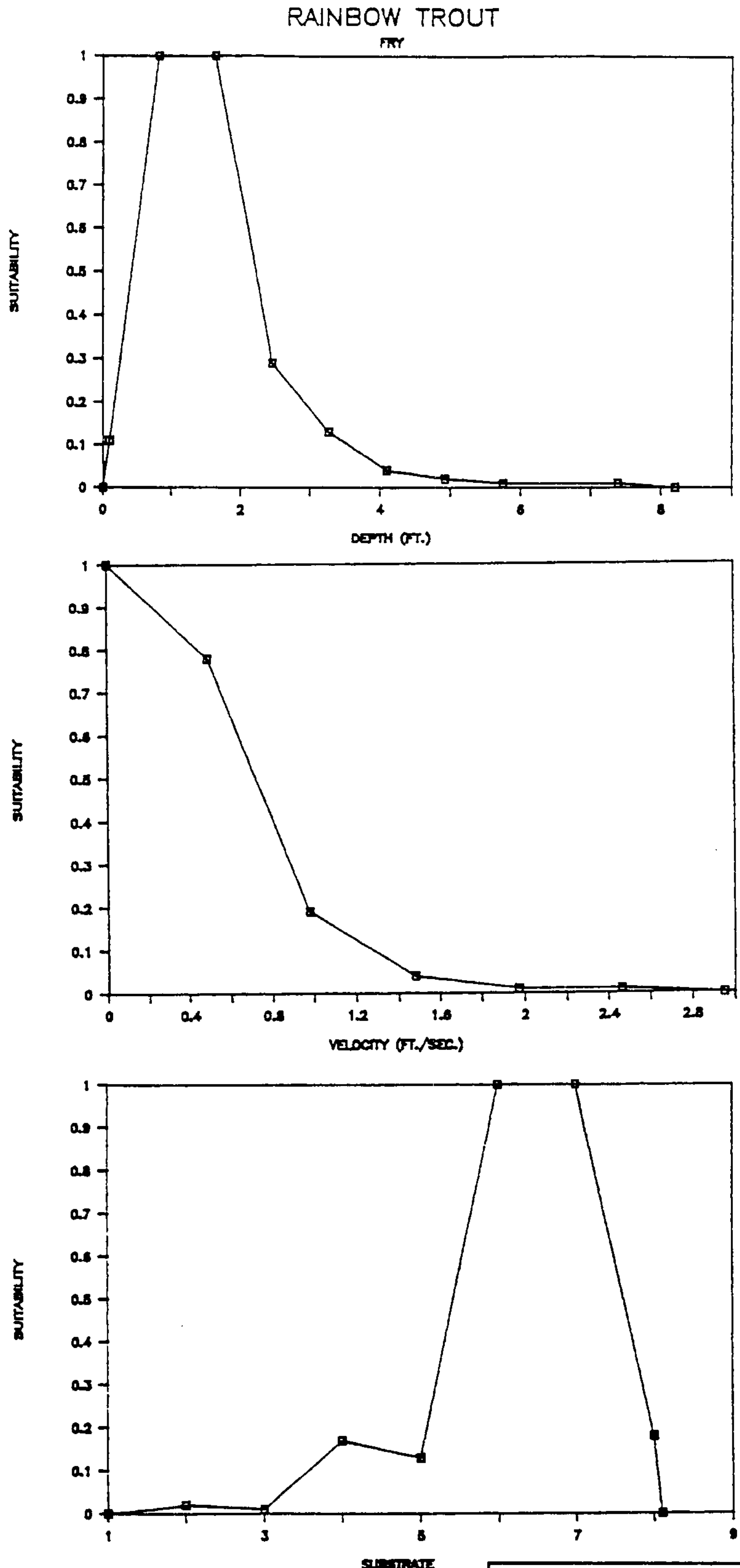
RAINBOW TROUT



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR RAINBOW TROUT

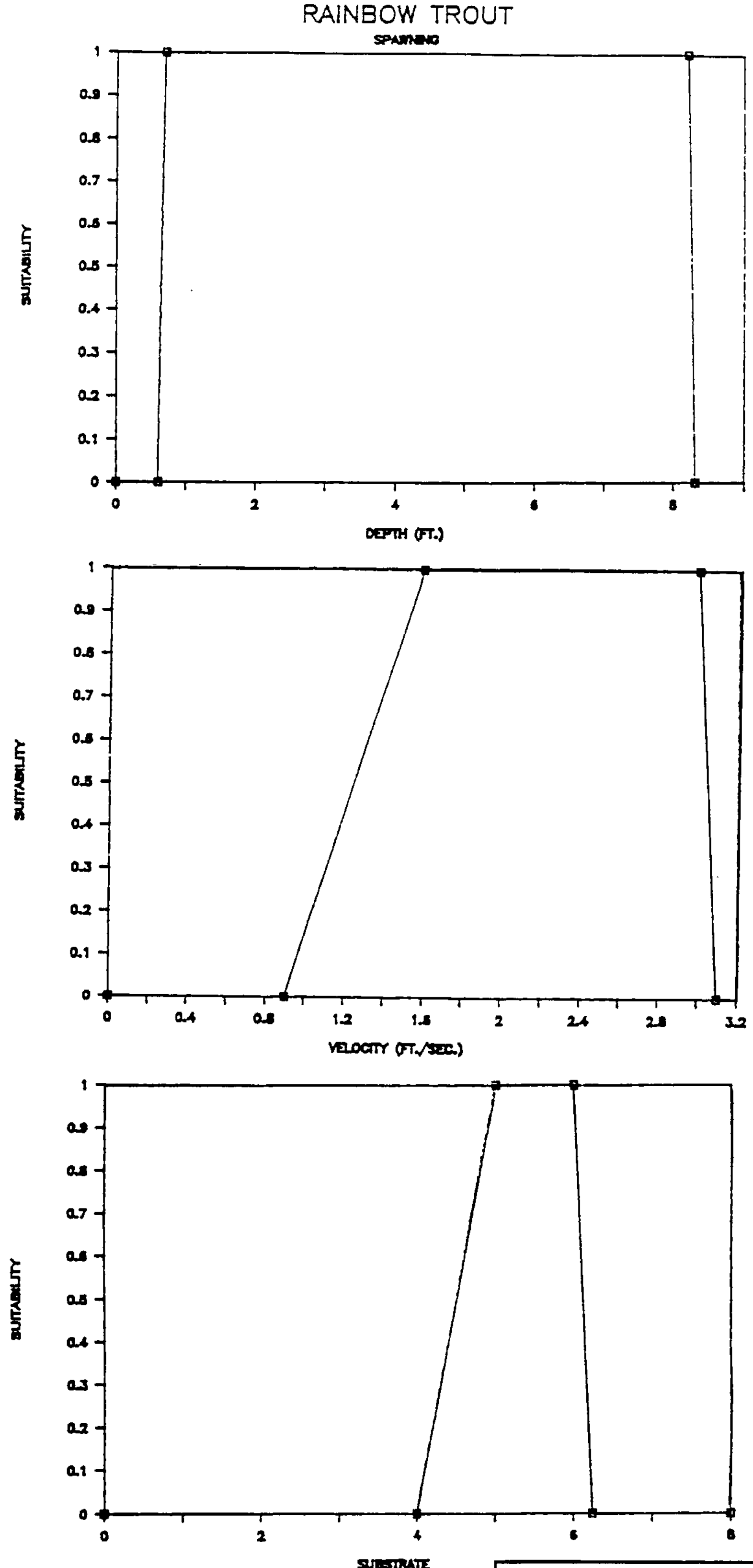
DATE 11/28/88 FIGURE 2.7 (Cont'd)



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR RAINBOW TROUT

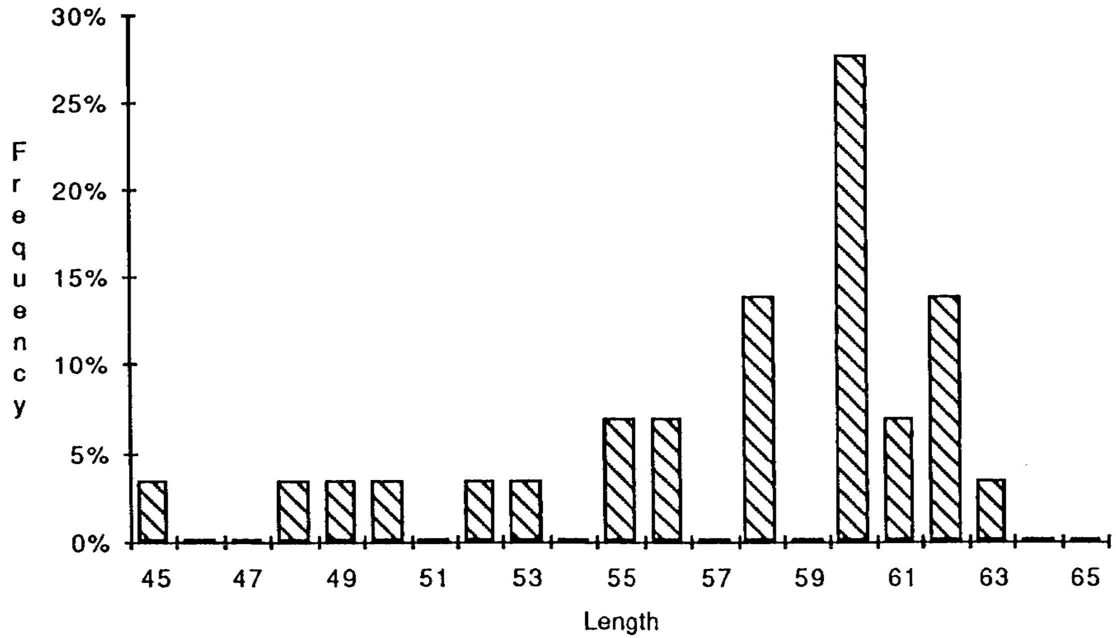
DATE 11/28/88 FIGURE 2.7 (Cont'd)



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

HABITAT PREFERENCE CURVES FOR RAINBOW TROUT

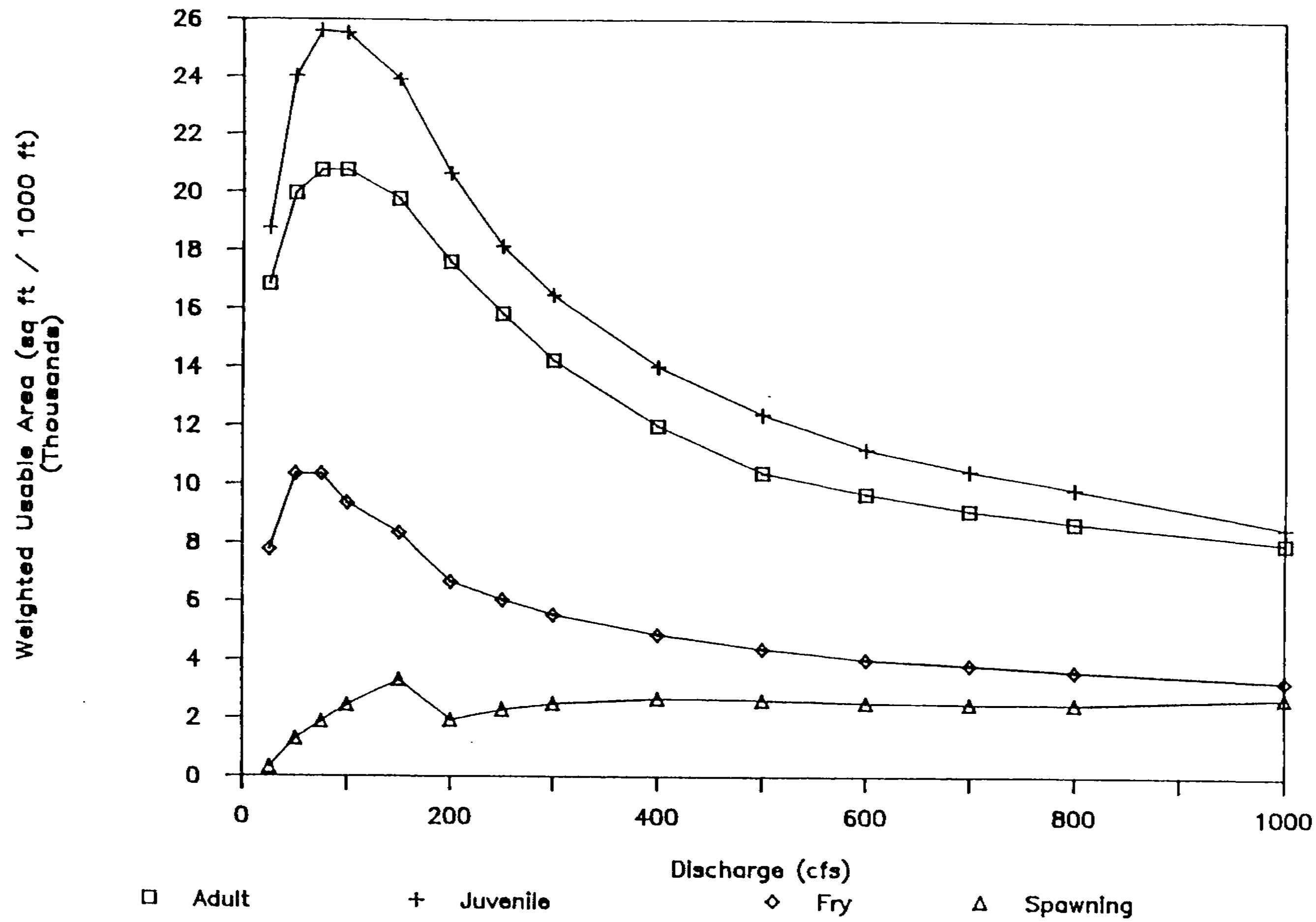
DATE 11/28/88 FIGURE 2.7 (Cont'd)



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

LENGTH-FREQUENCY OF JOHNNY DARTER CATCH AT JD-6, APRIL 4, 1988

DATE 11/28/88 FIGURE 2.8

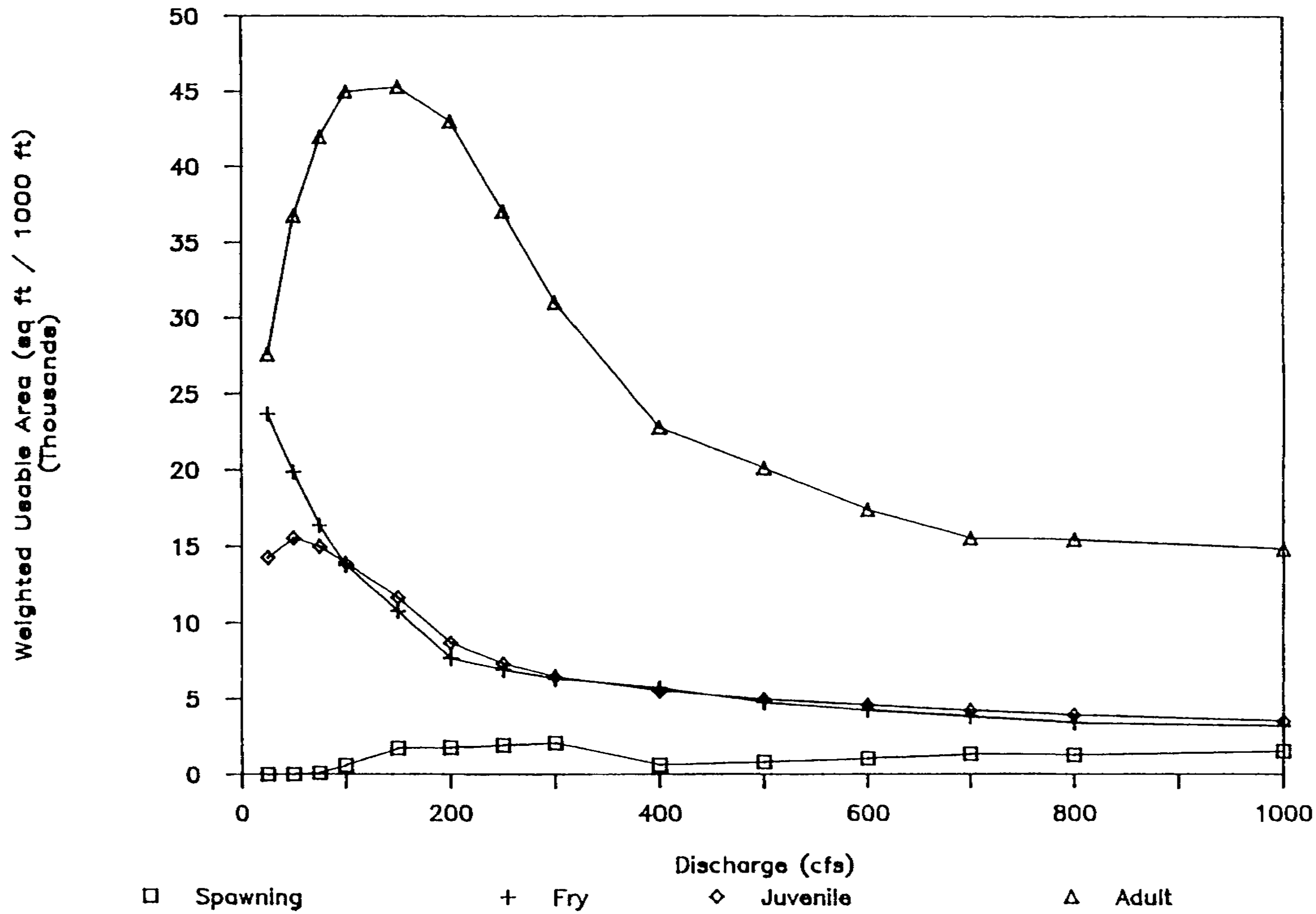


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT CLP-1

DATE 11/28/88 FIGURE 2.9

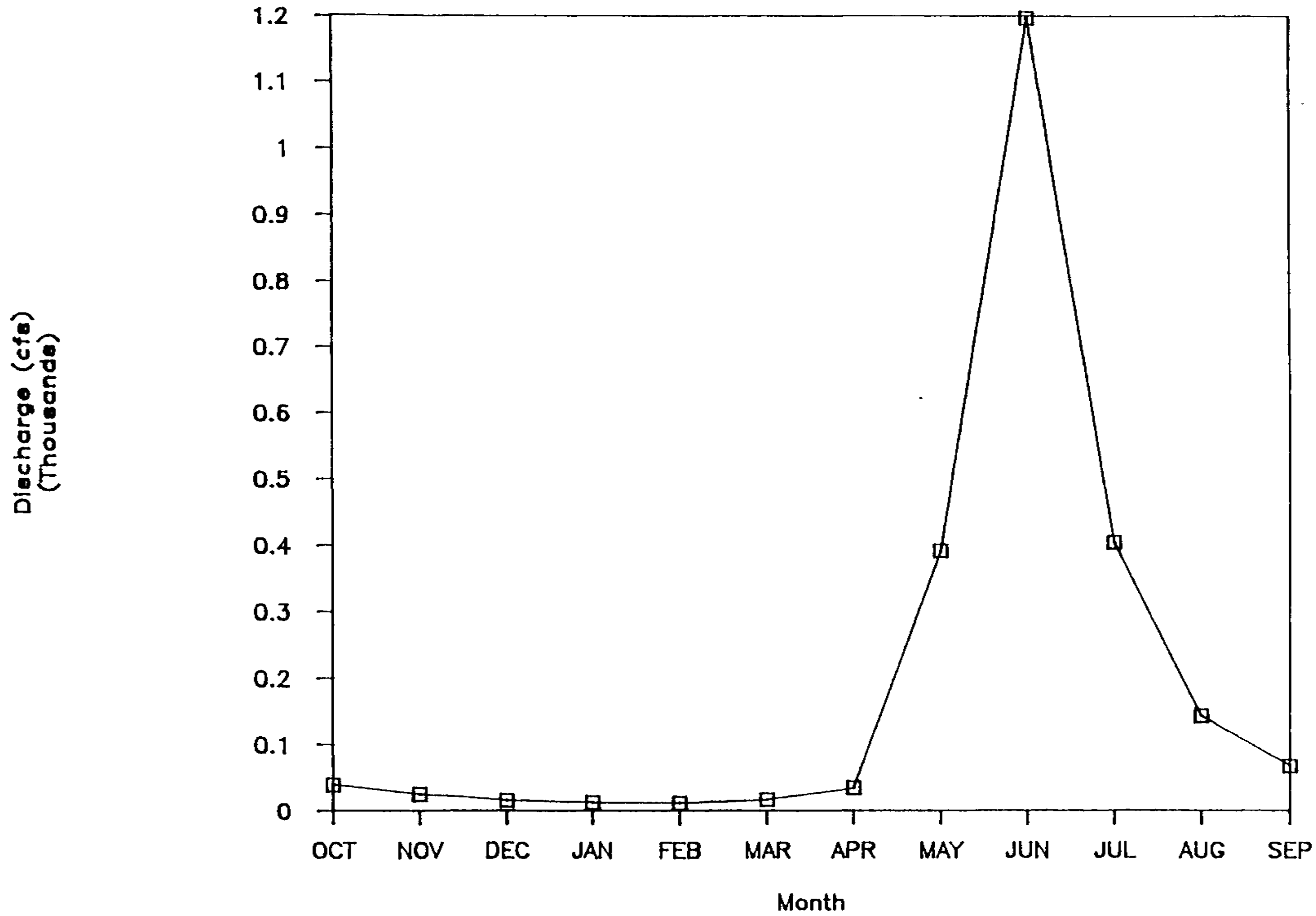


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT CLP-1

DATE 11/28/88

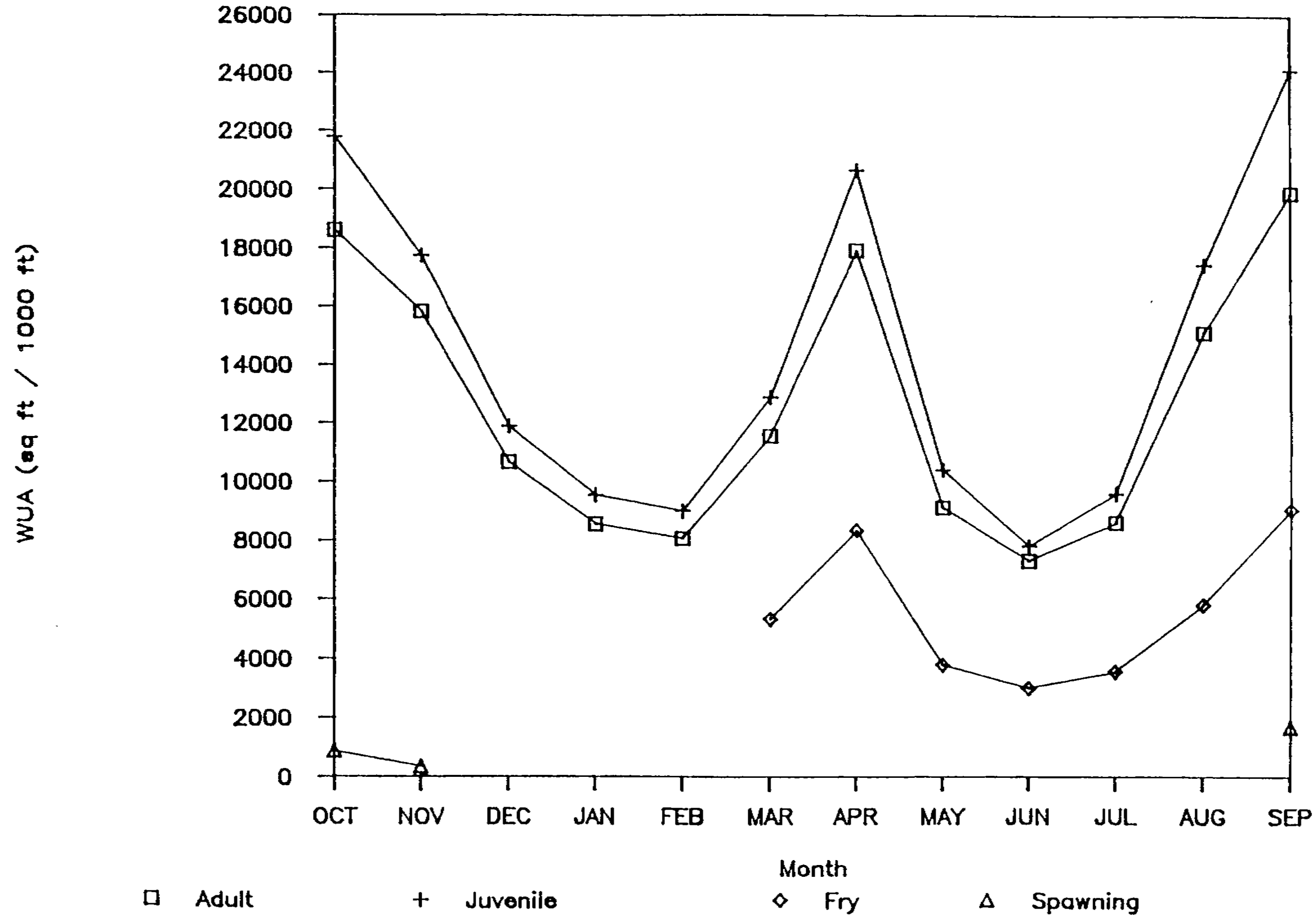
FIGURE 2.10



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT DISCHARGE IN SEGMENT CLP-1

DATE 11/28/88 FIGURE 2.11



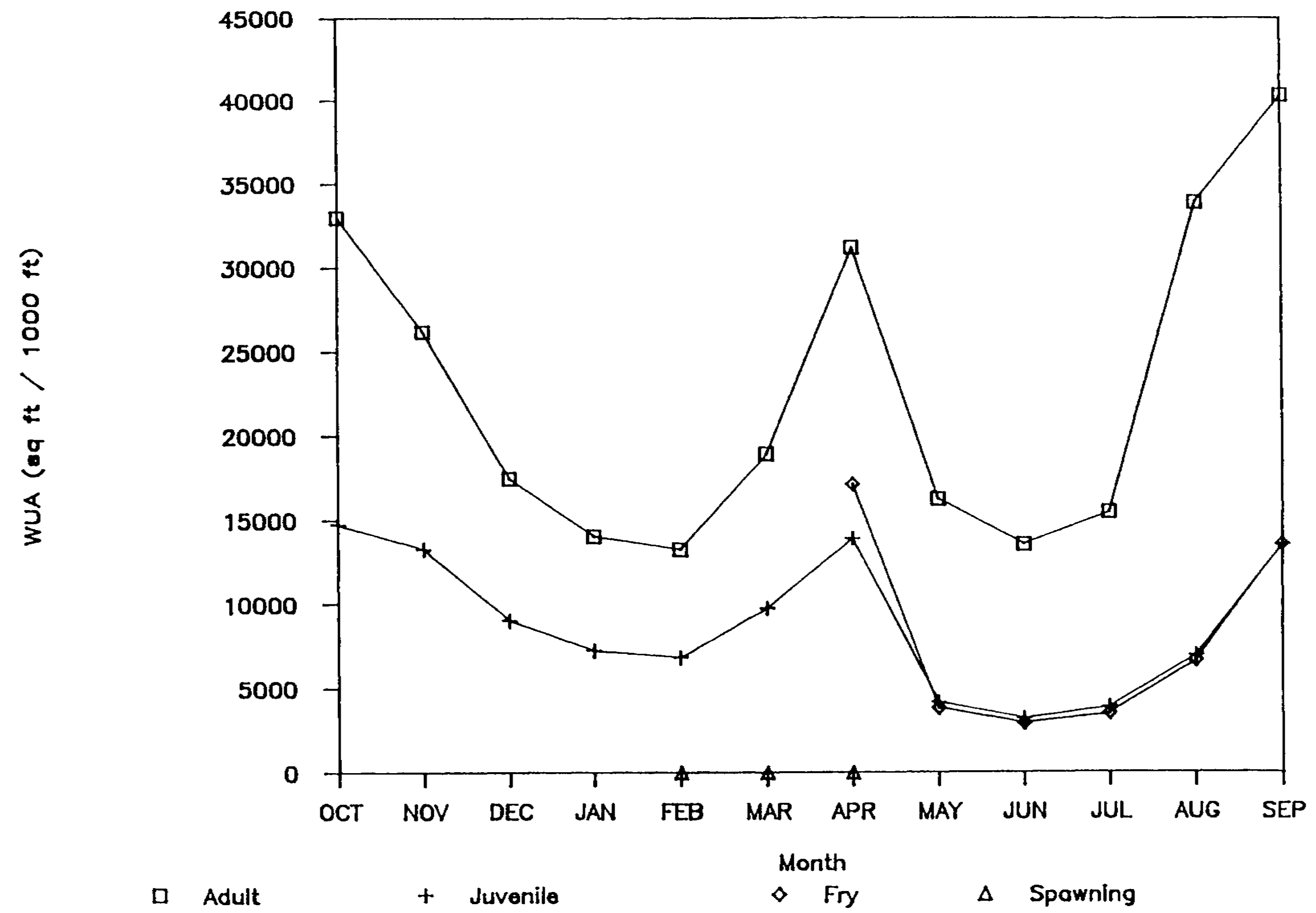
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT HISTORIC BROWN TROUT WUA IN SEGMENT CLP-1

DATE 11/28/88

FIGURE 2.12



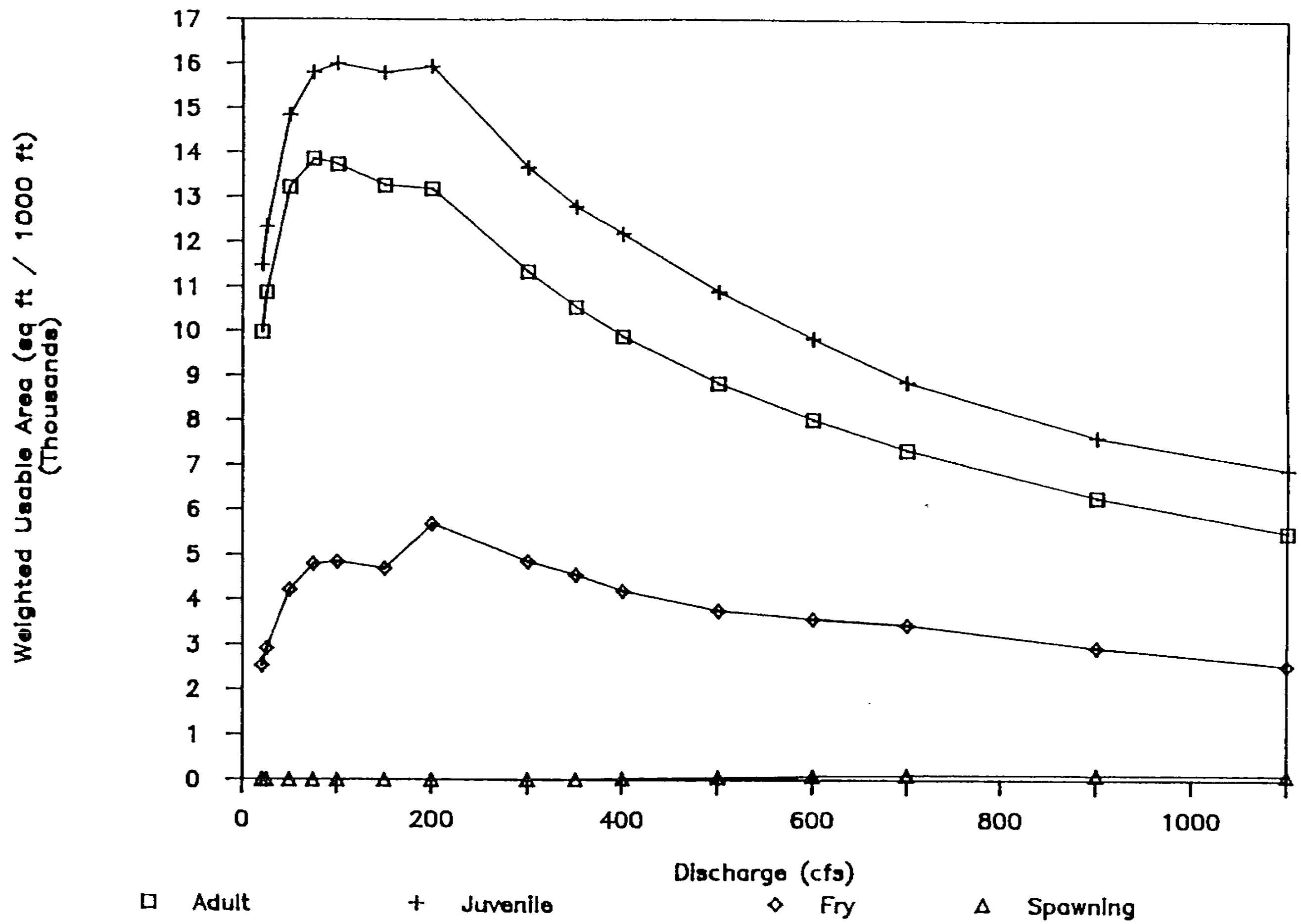
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT HISTORIC RAINBOW TROUT WUA IN SEGMENT CLP-1

DATE 11/28/88

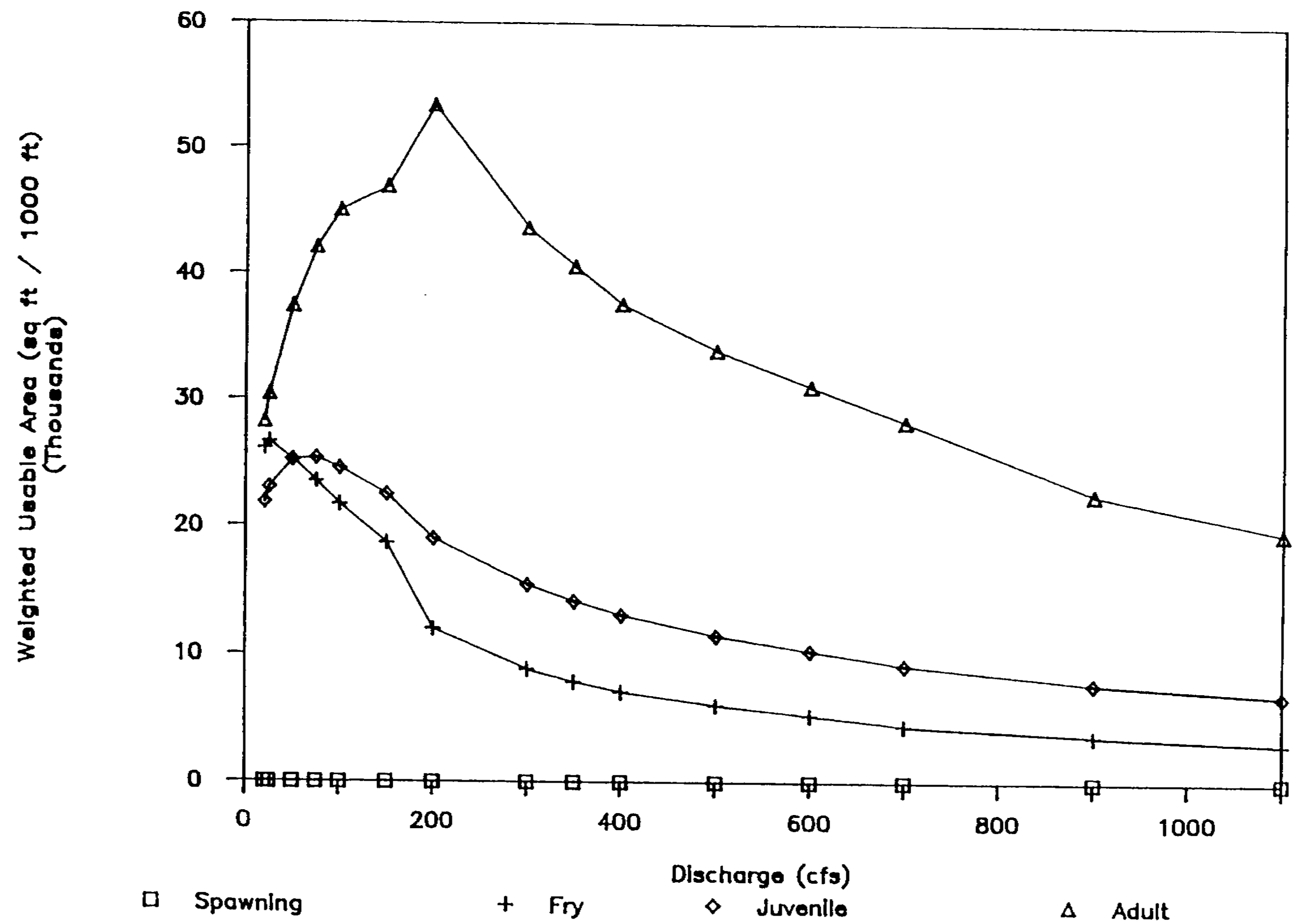
FIGURE 2.13



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-2

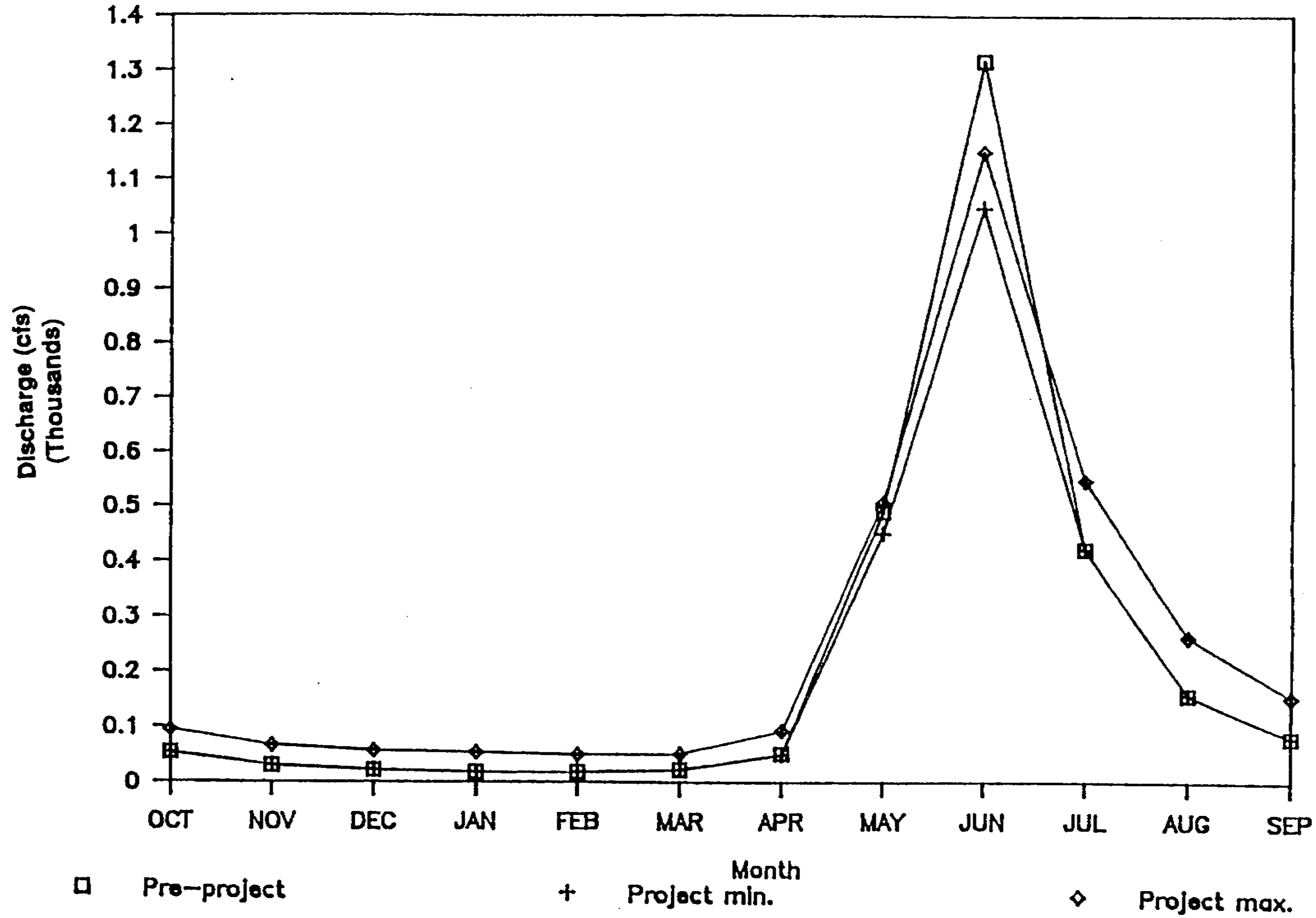
DATE 11/28/88 FIGURE 2.14



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-2

DATE 11/28/88 FIGURE 2.15

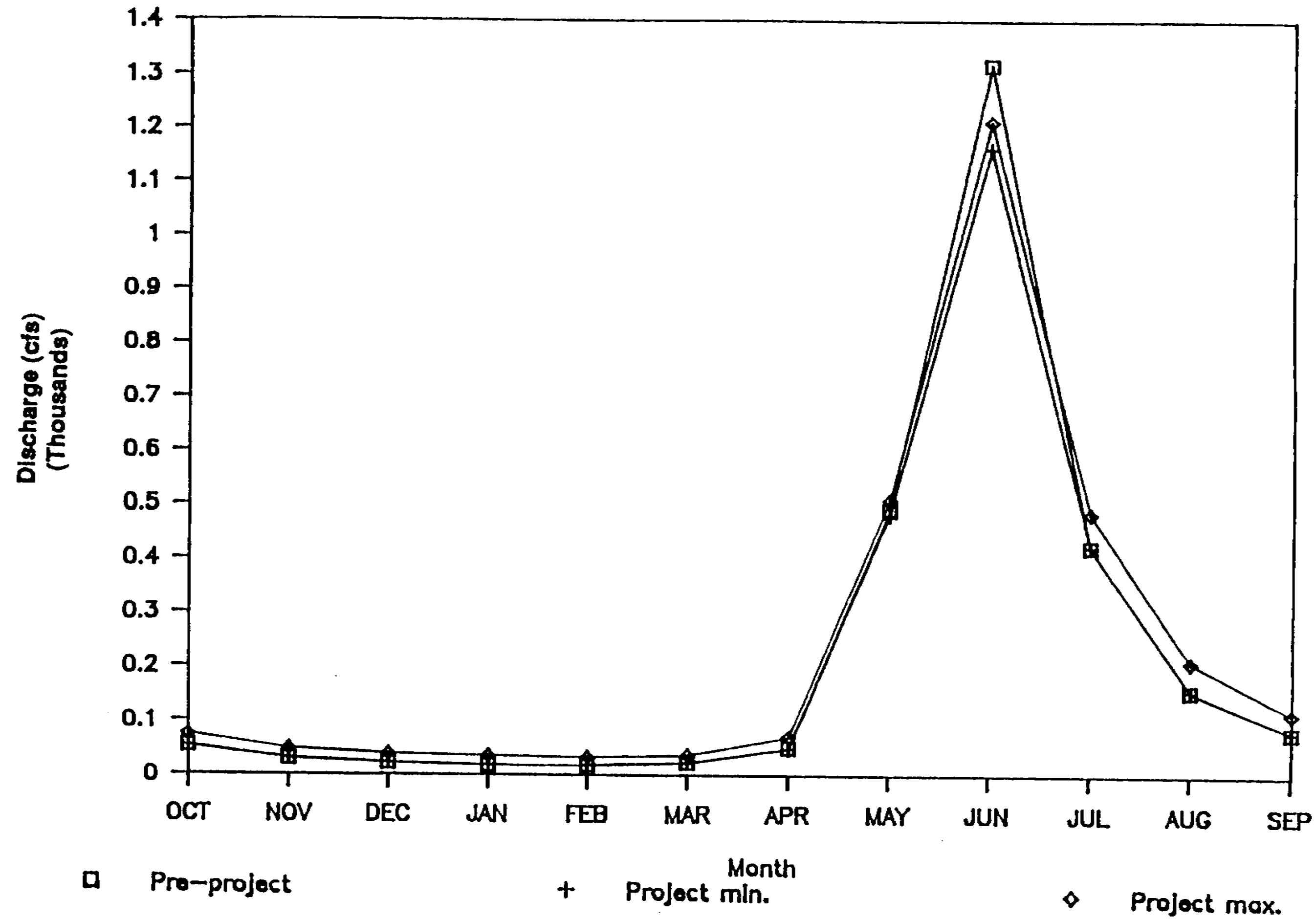


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-2 GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.16

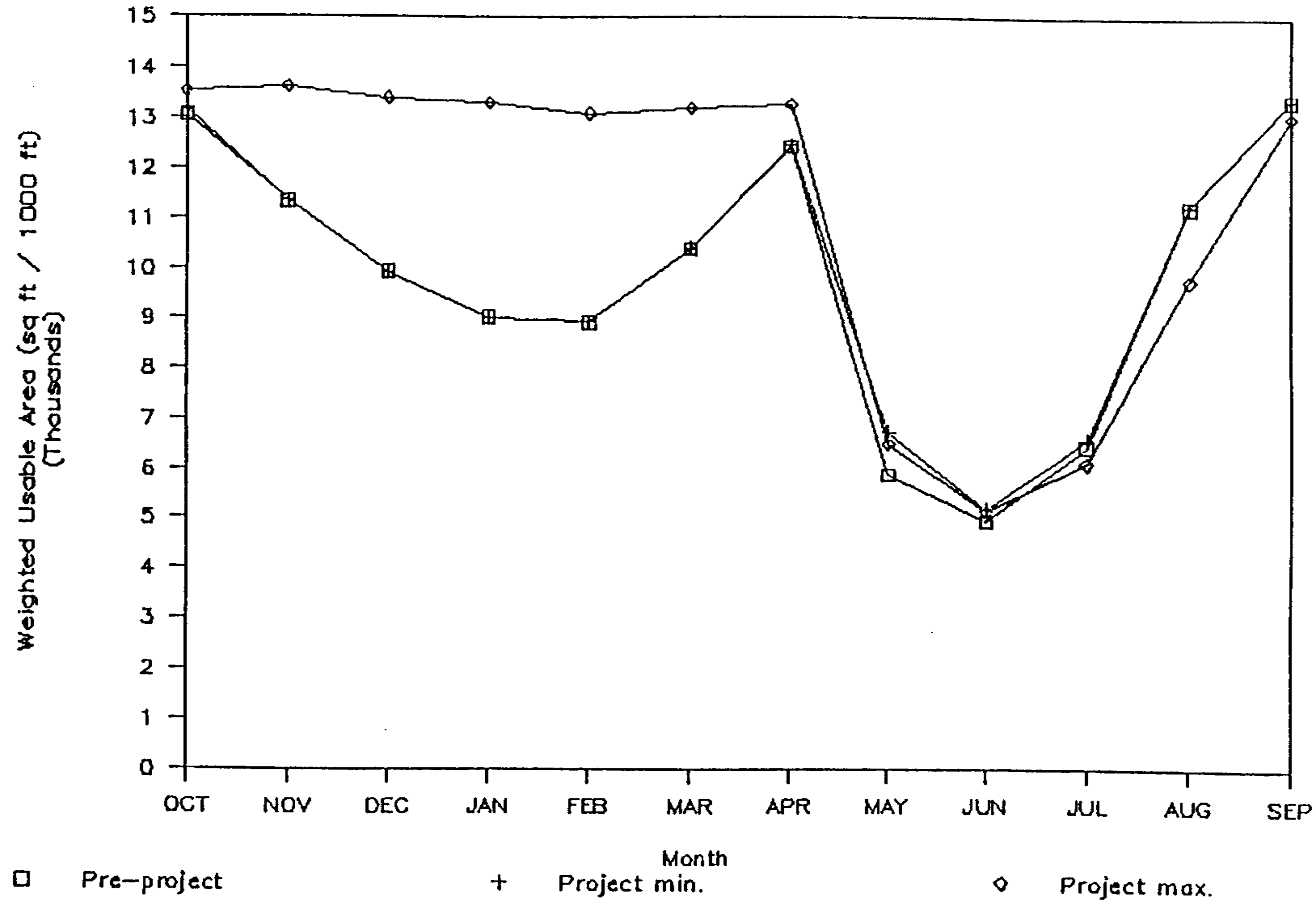


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.17

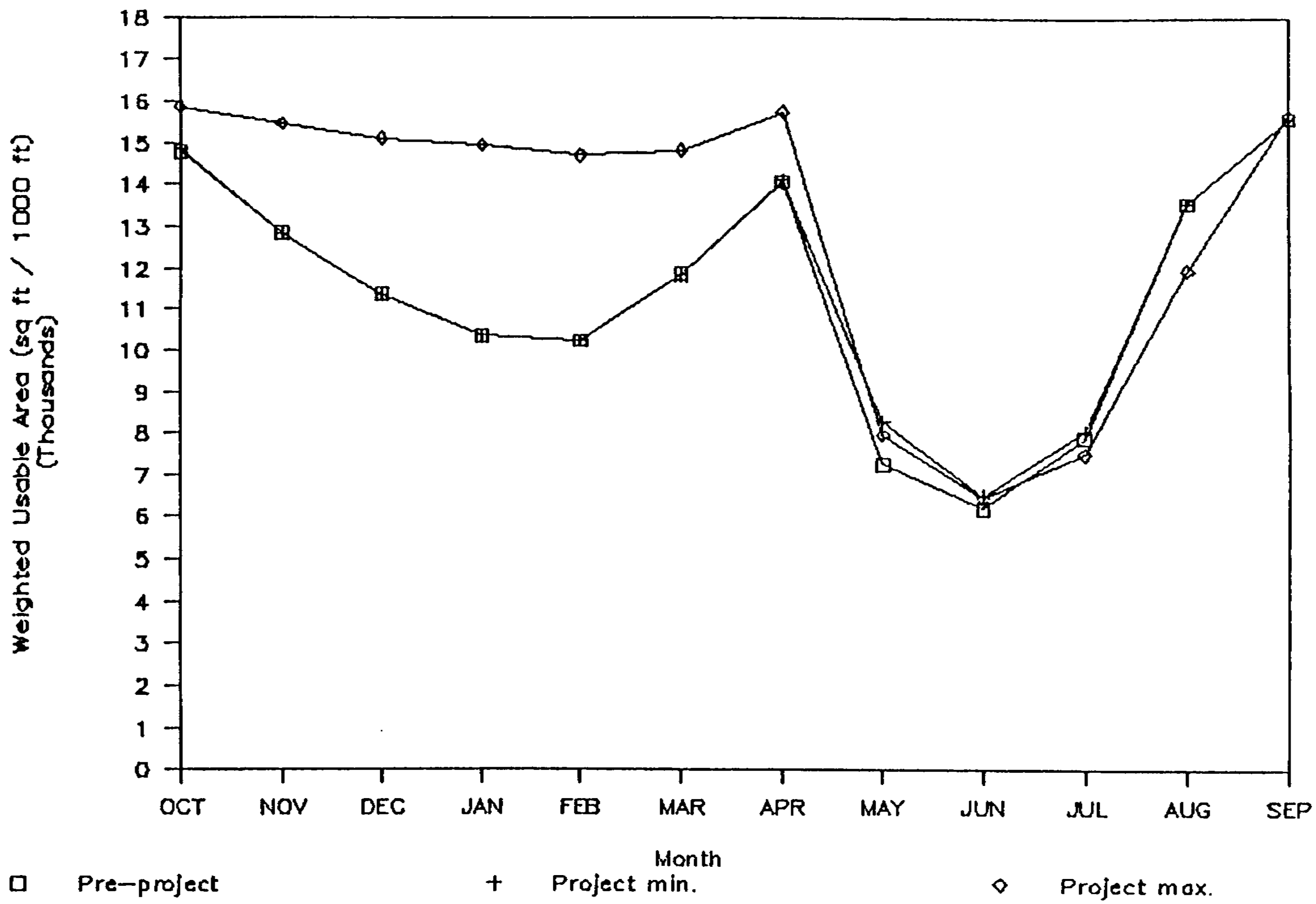


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY BROWN TROUT ADULT
HABITAT SEGMENT CLP-2
GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.18



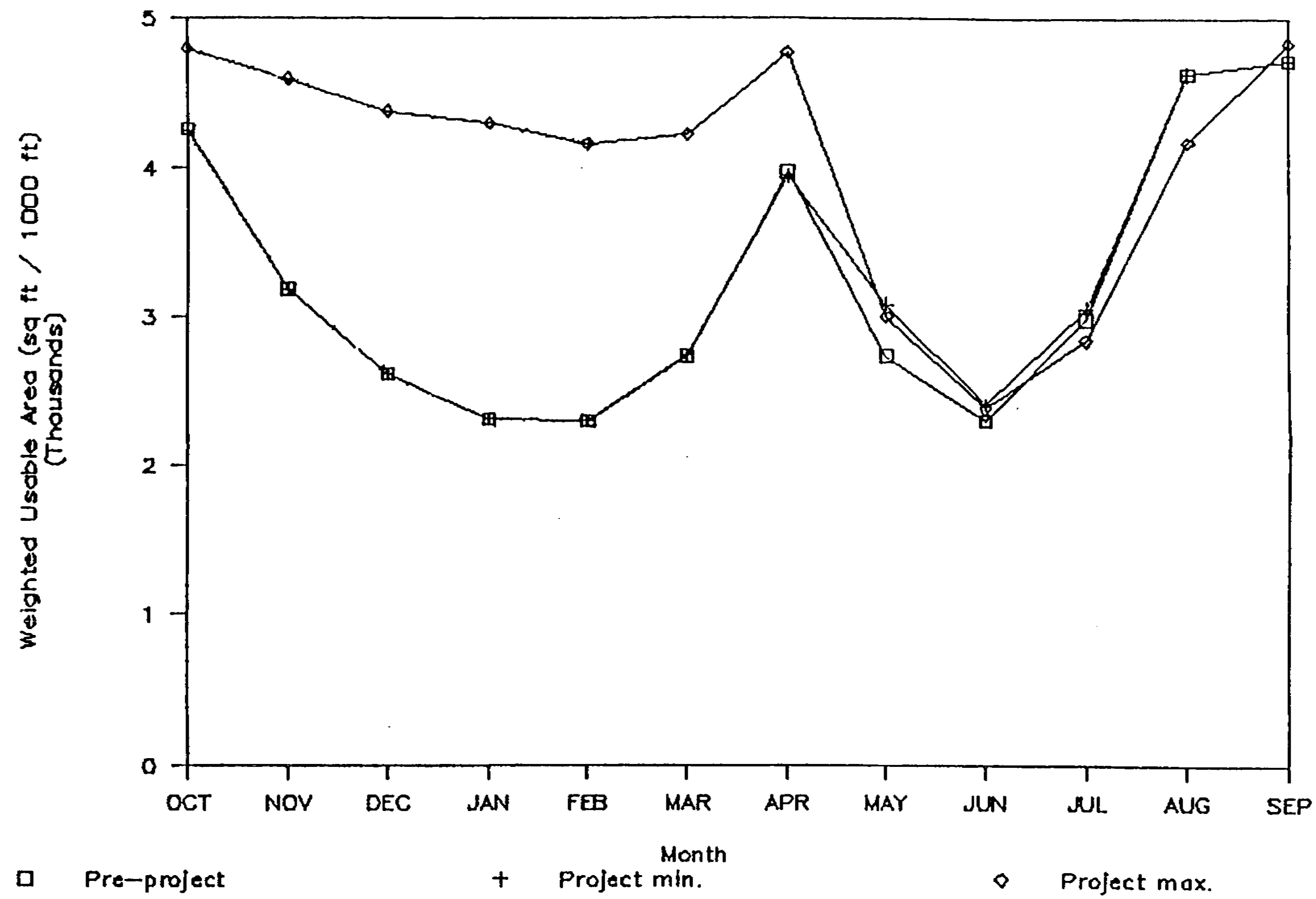
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT JUVENILE HABITAT SEGMENT CLP-2 GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.19

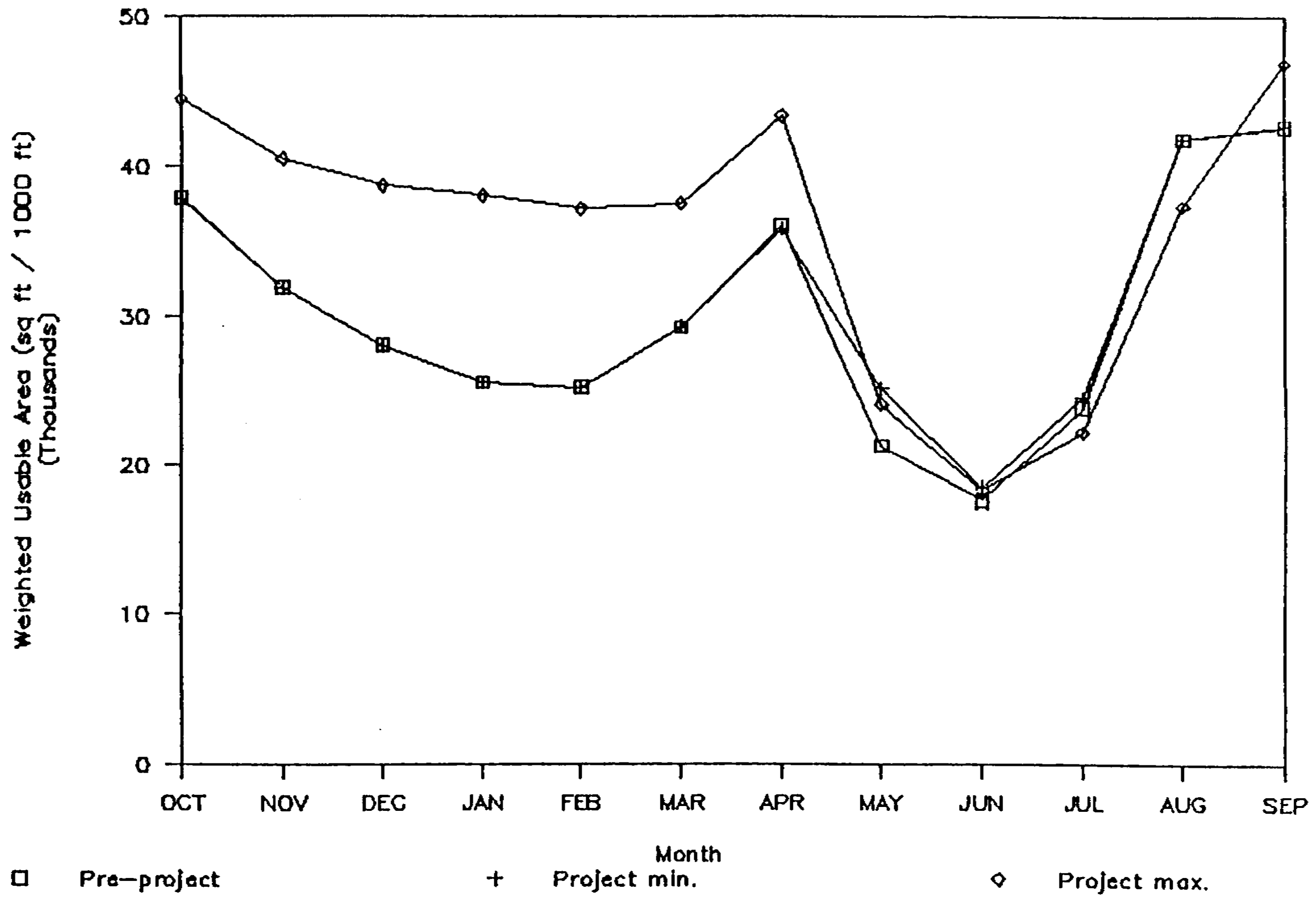


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT FRY HABITAT SEGMENT CLP-2 GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.20

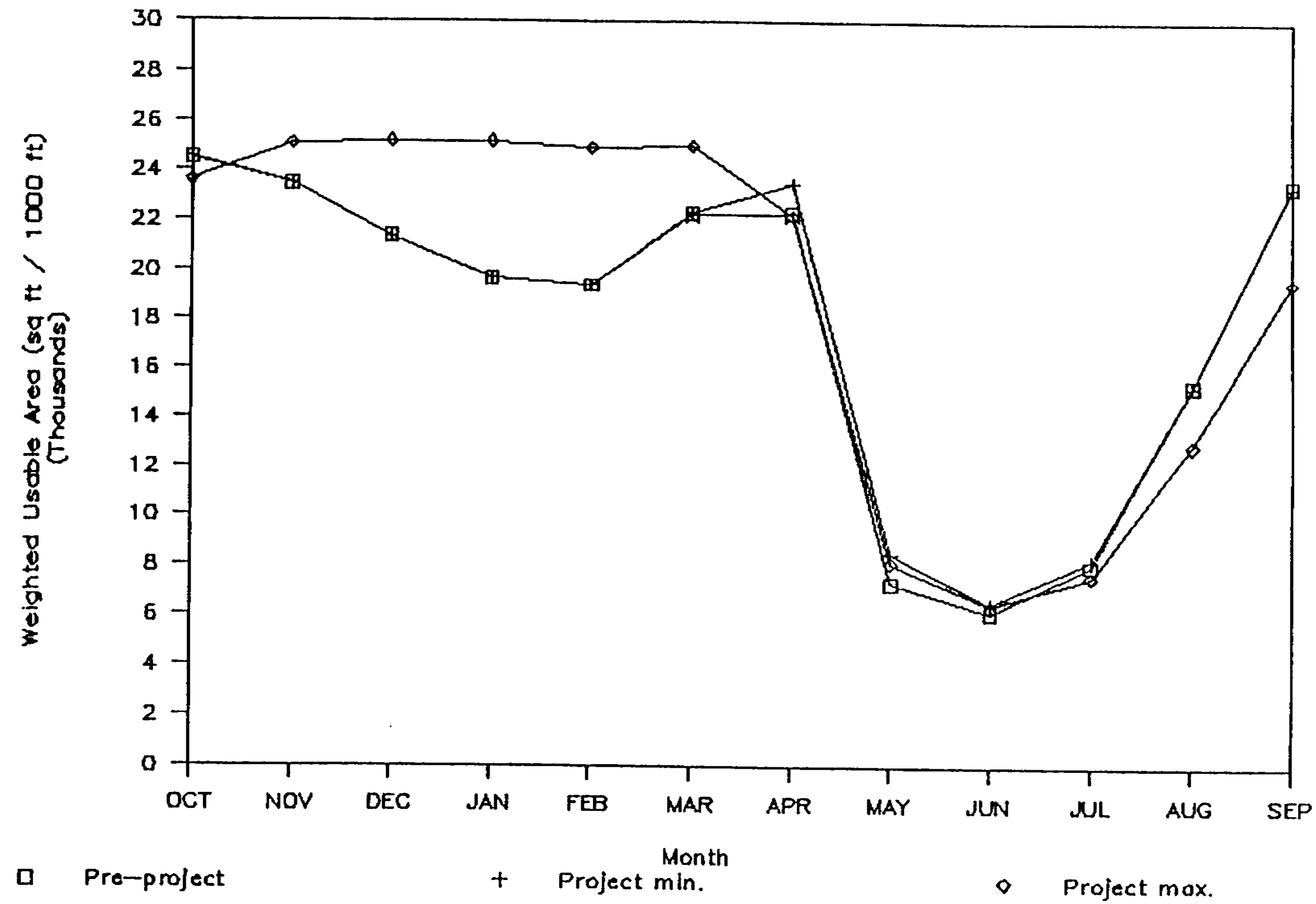


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT ADULT HABITAT SEGMENT CLP-2 GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.21

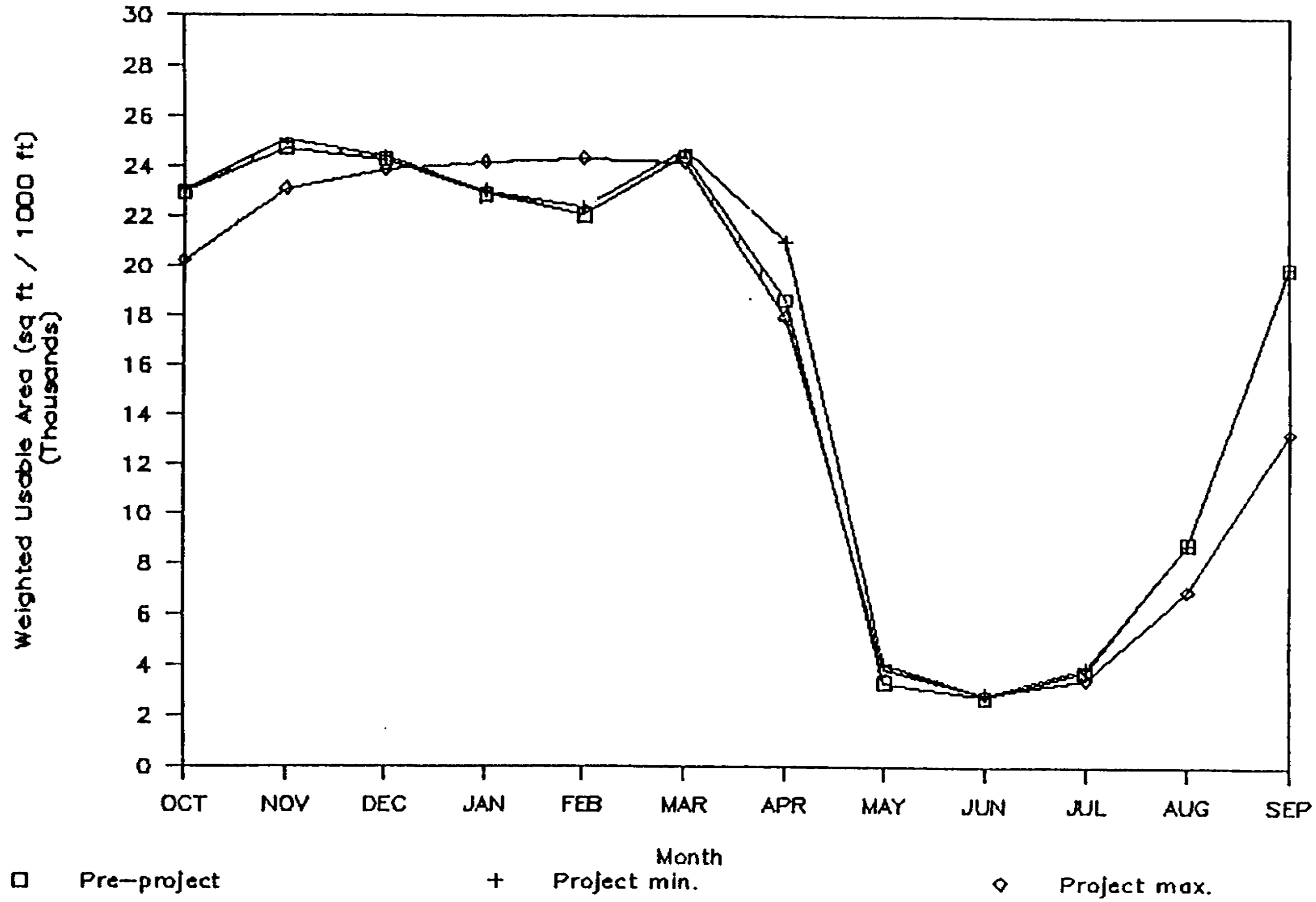


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE
HABITAT SEGMENT CLP-2
GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

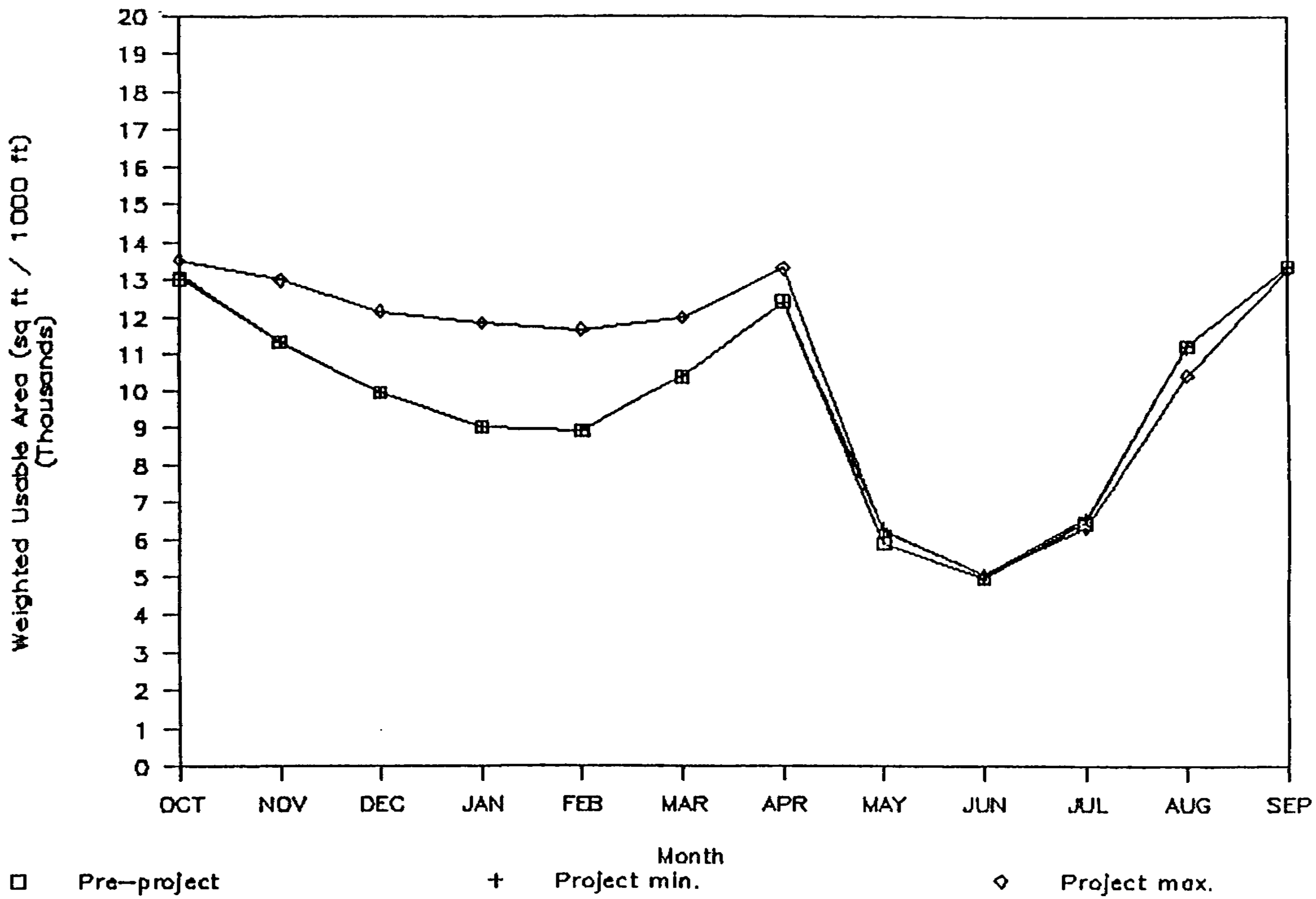
FIGURE 2.22



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT FRY HABITAT SEGMENT CLP-2 GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88 FIGURE 2.23

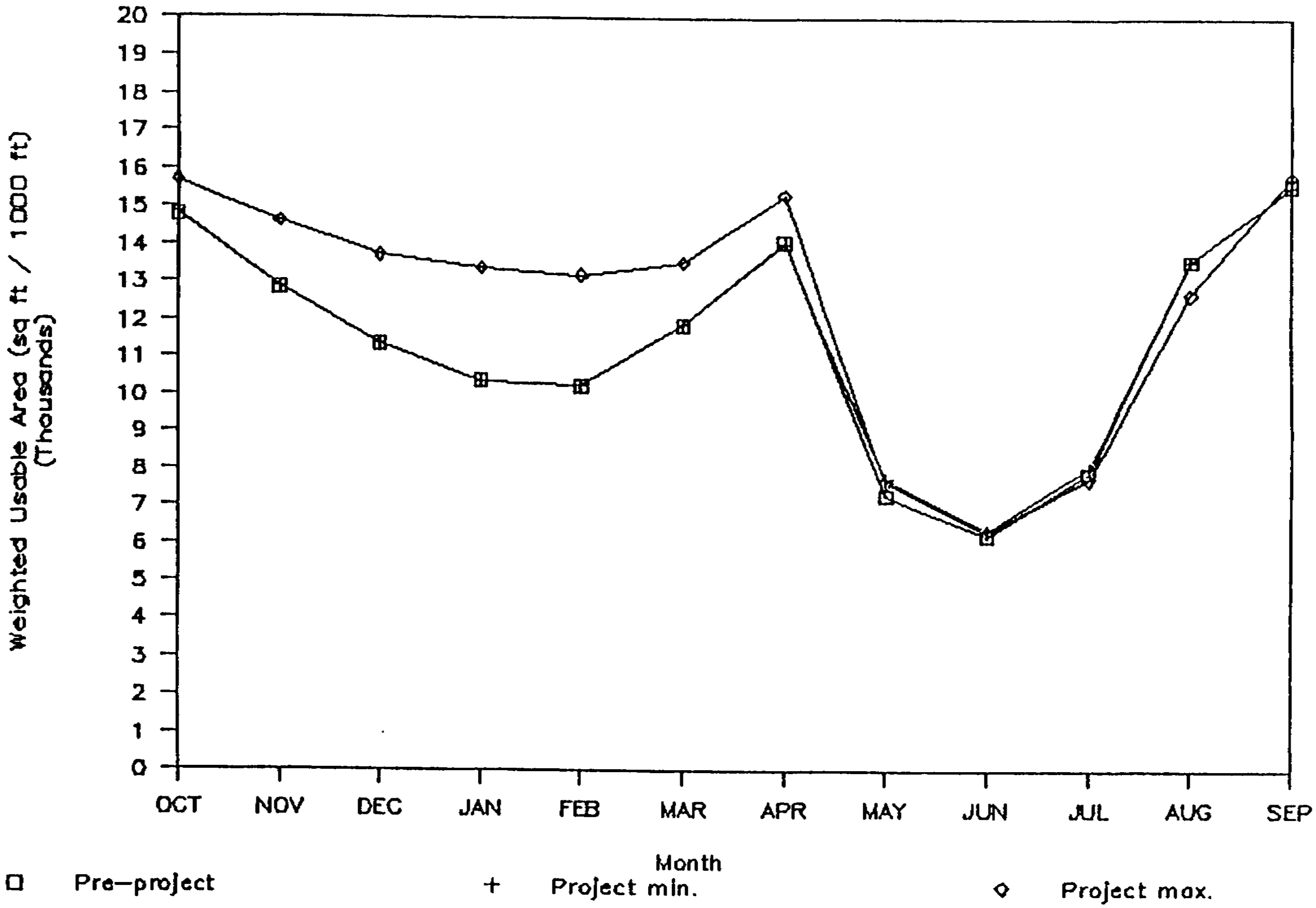


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT ADULT HABITAT SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.24

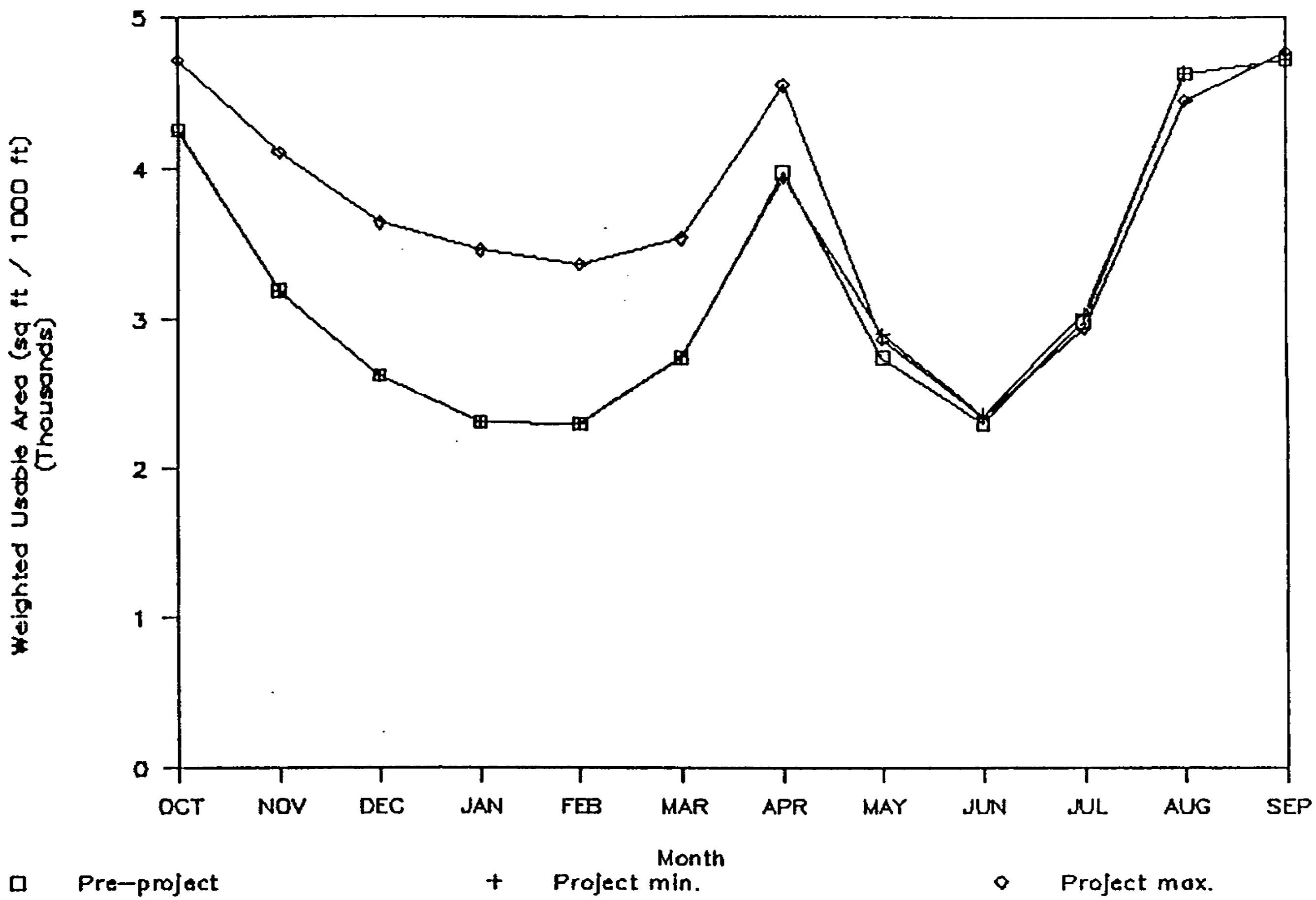


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT JUVENILE HABITAT SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88

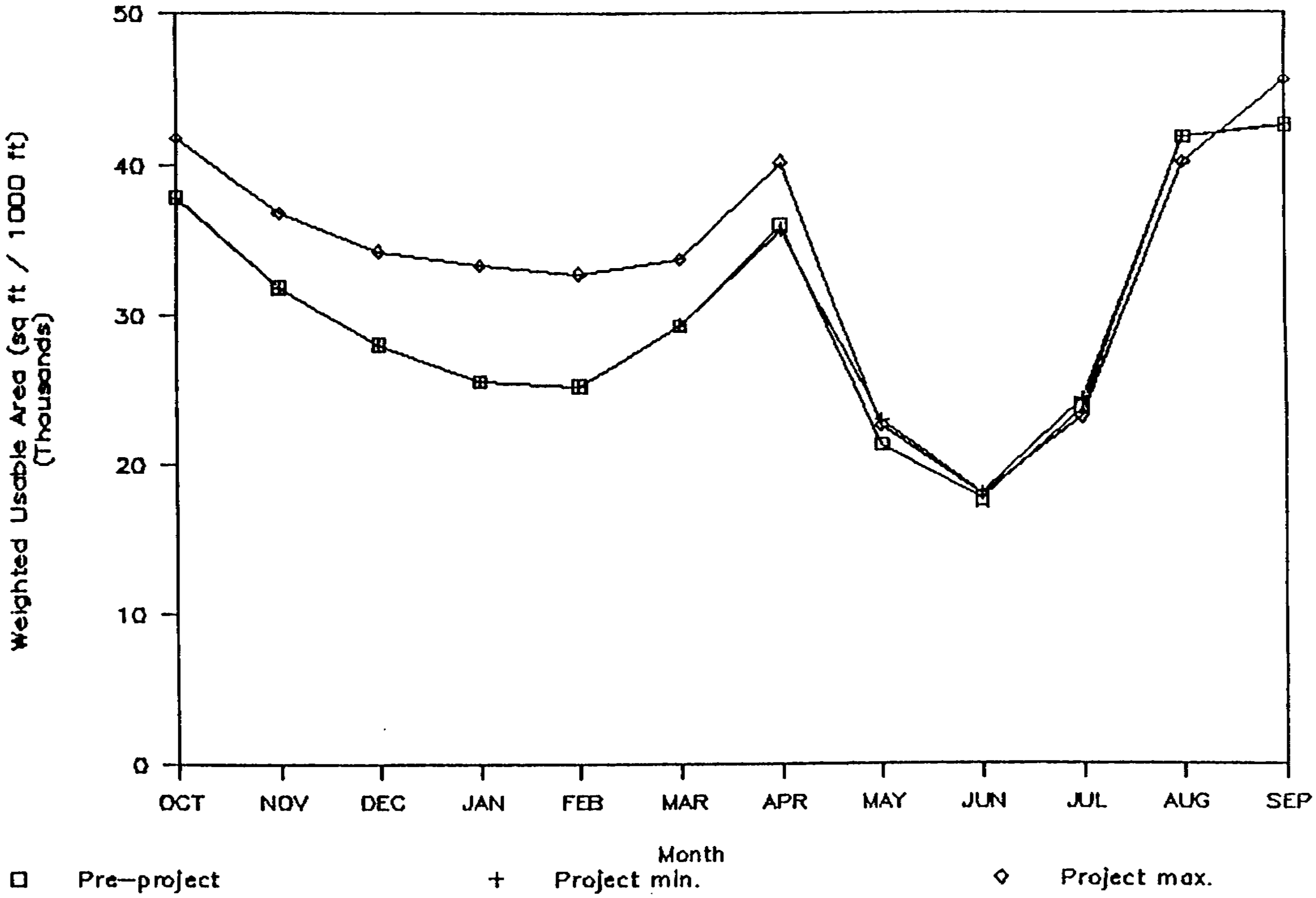
FIGURE 2.25



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT FRY HABITAT SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88 FIGURE 2.26

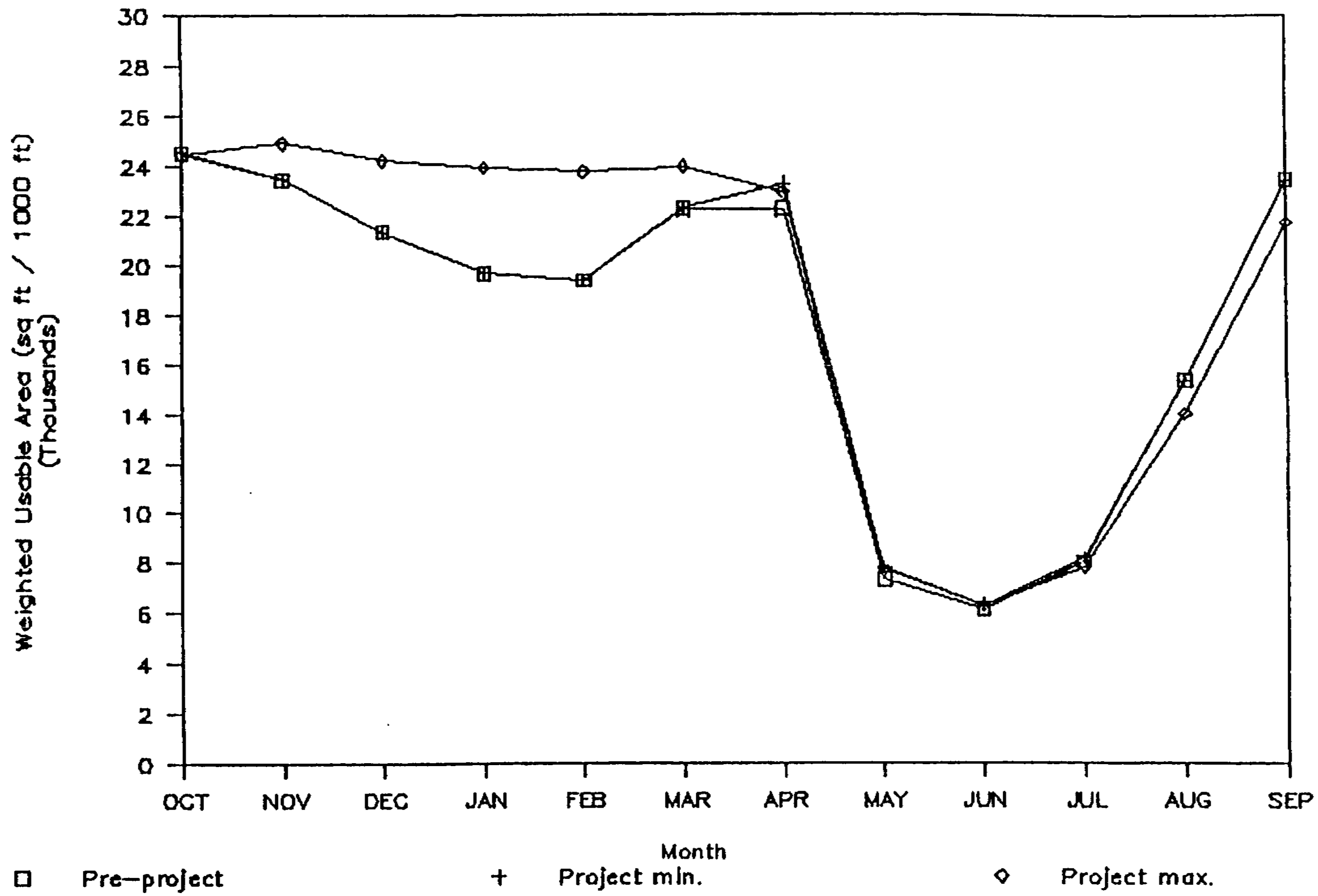


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT ADULT HABITAT SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.27

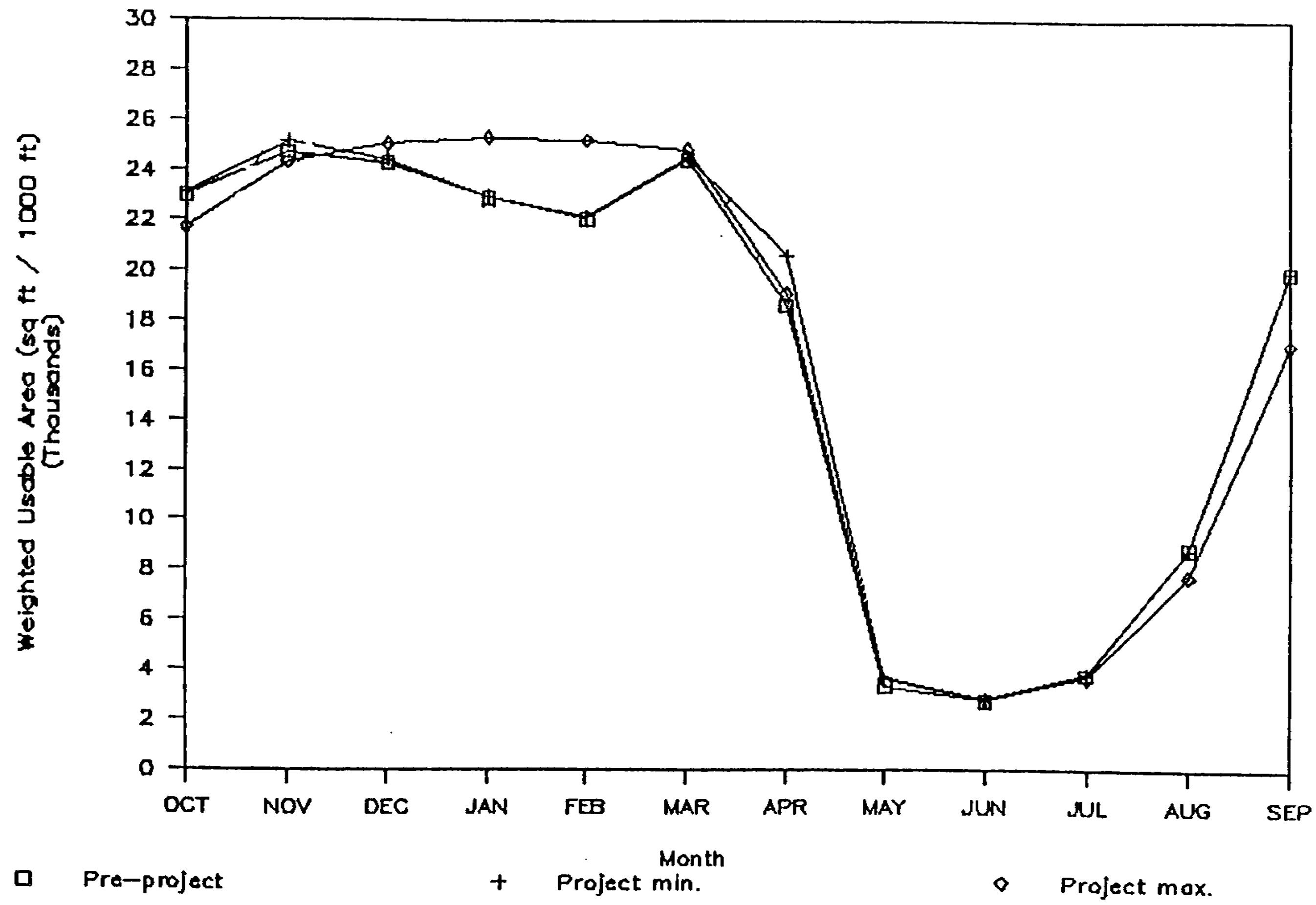


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE HABITAT SEGMENT CLP-2 POUDRE ALTERNATIVE

DATE 11/28/88

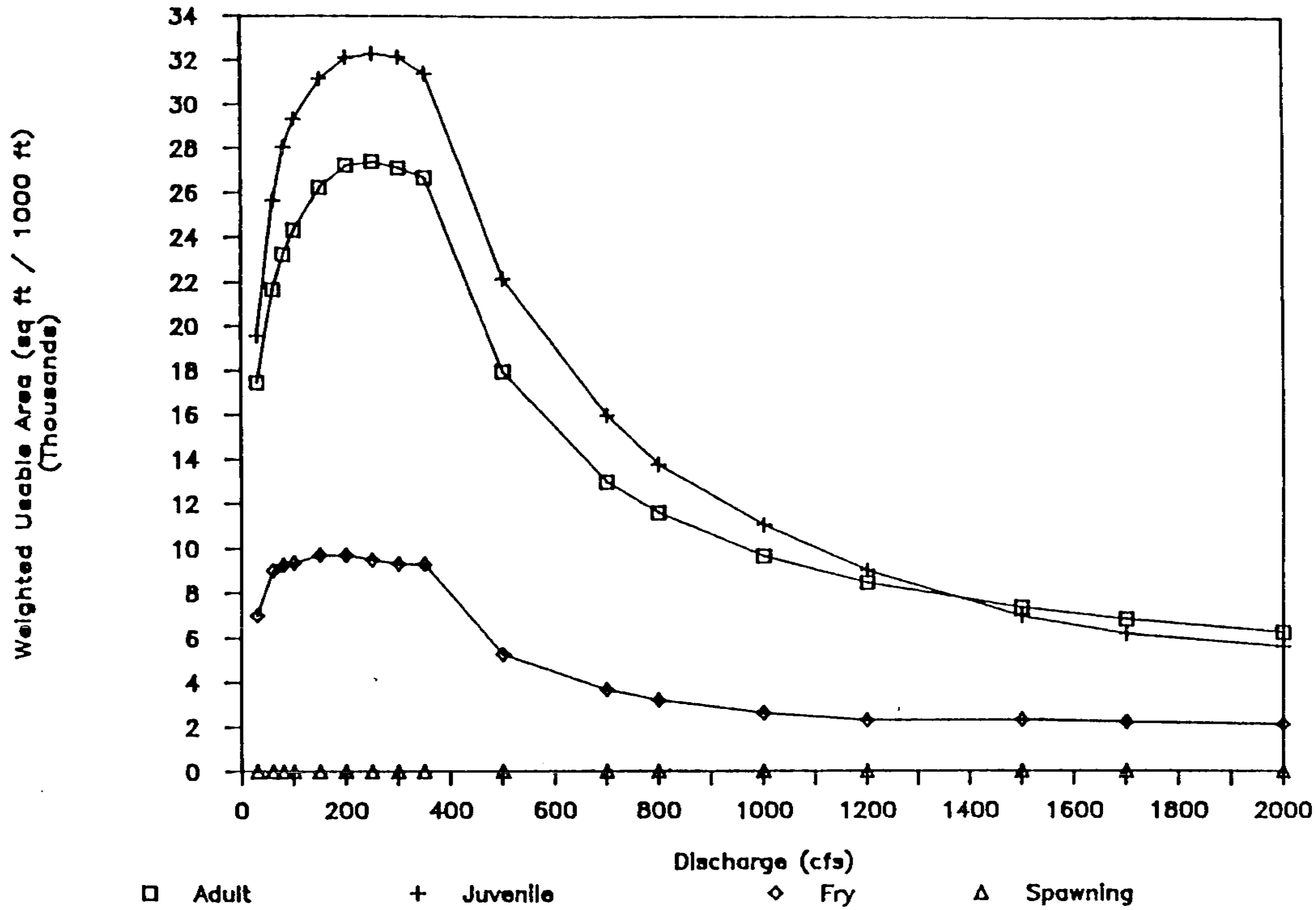
FIGURE 2.28



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY RAINBOW TROUT FRY
HABITAT SEGMENT CLP-2
POUDRE ALTERNATIVE

DATE 11/28/88 FIGURE 2.29

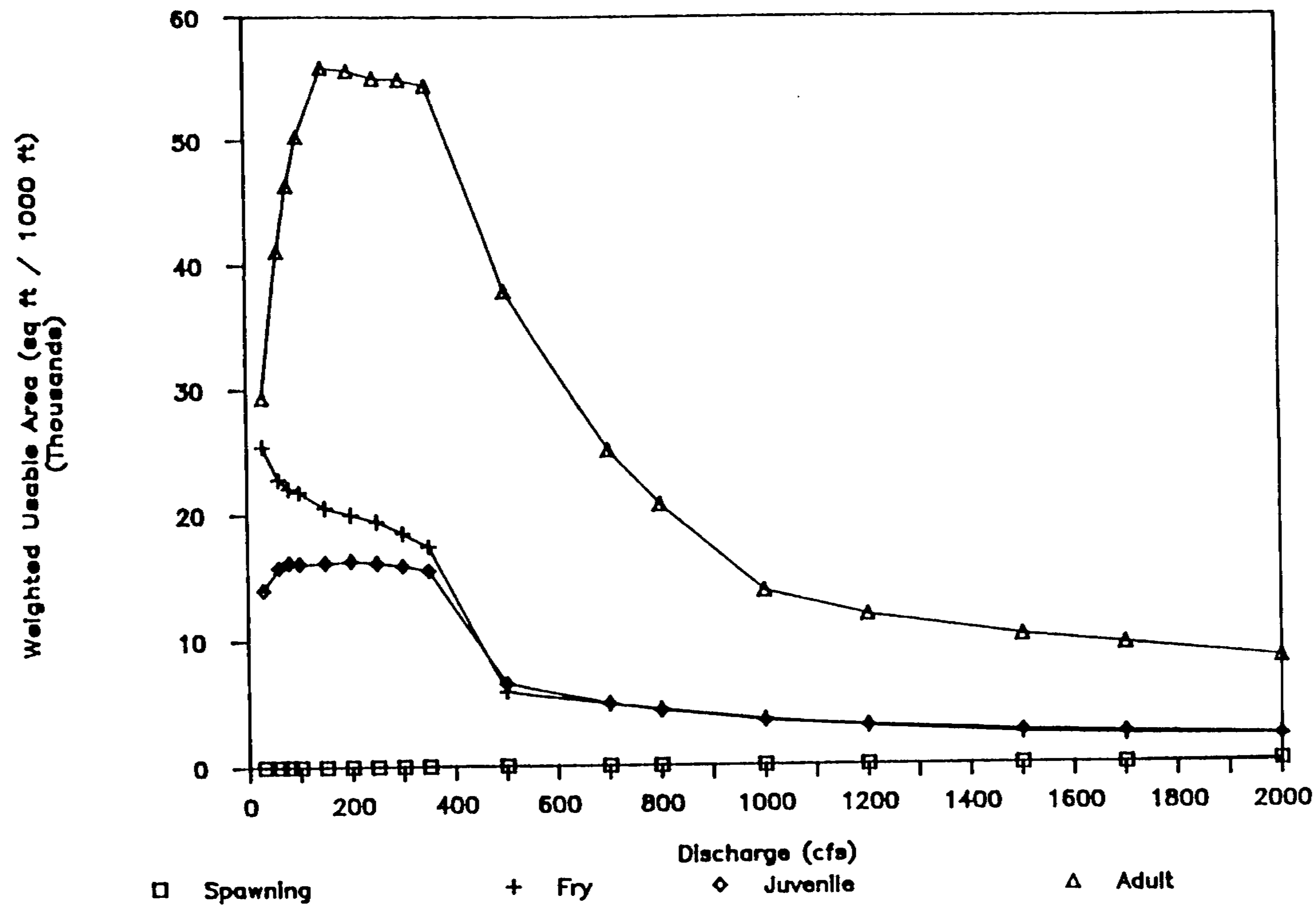


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT CLP-3

DATE 10/26/88

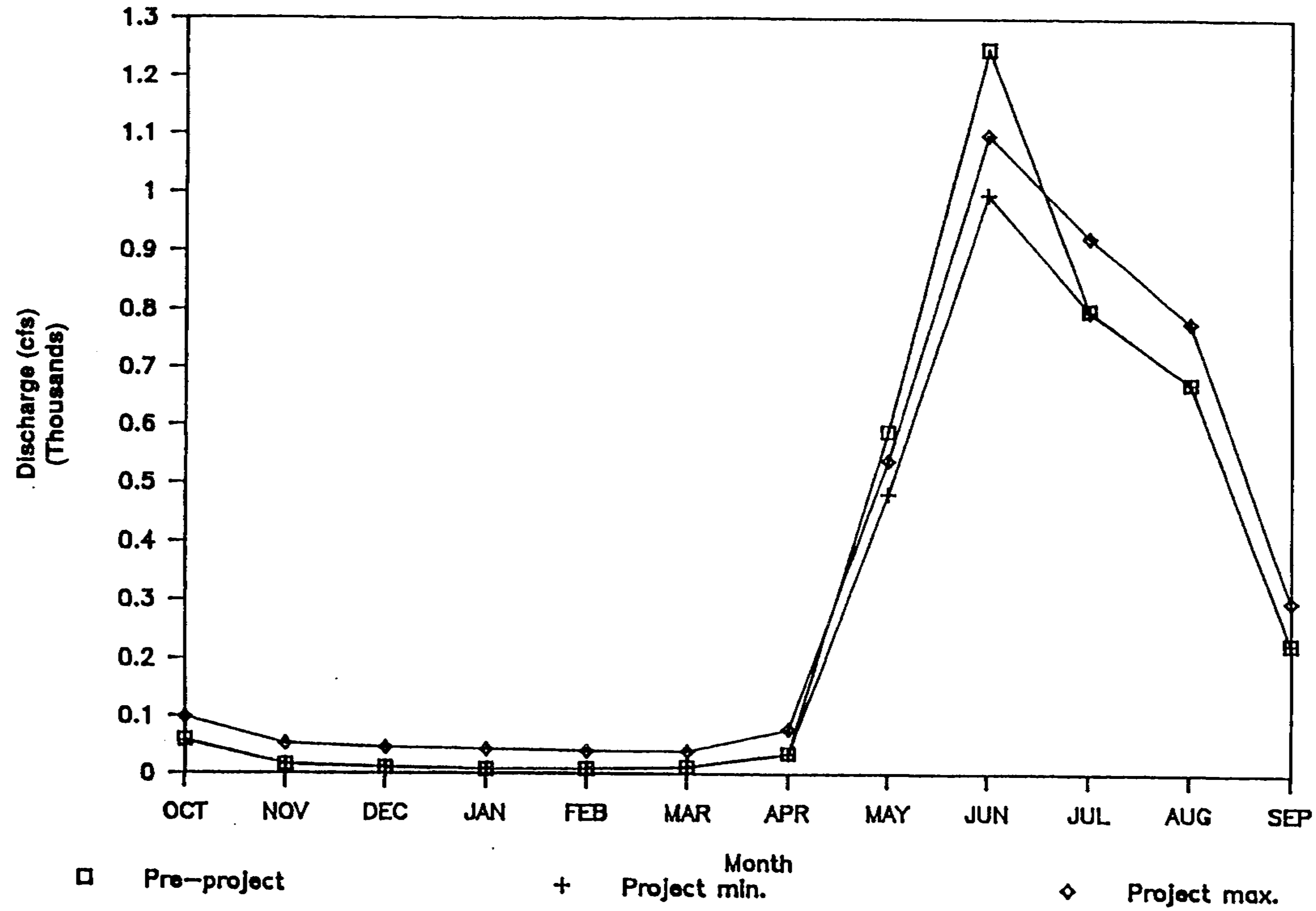
FIGURE 2.30



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-3

DATE 10/26/88 FIGURE 2.31

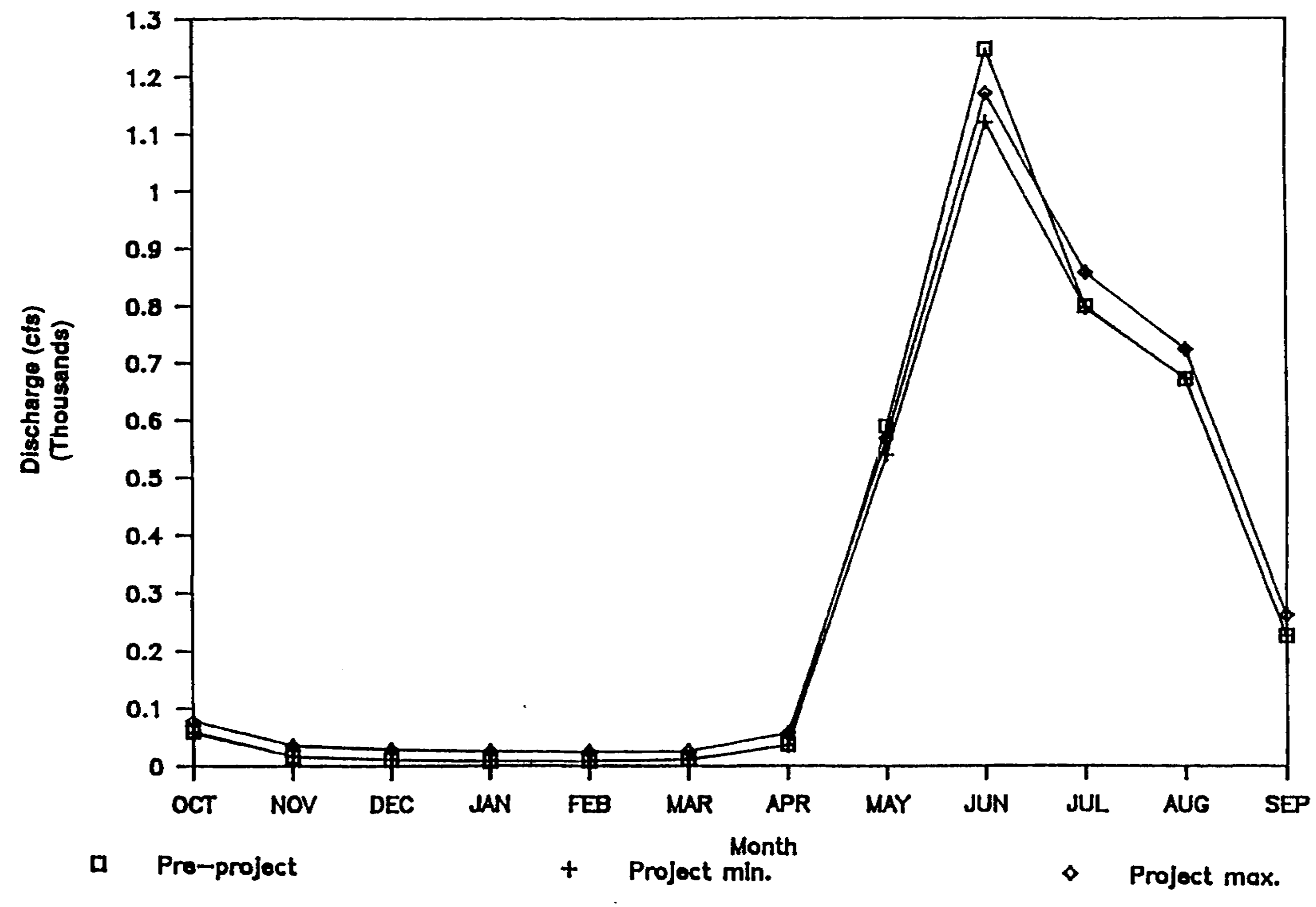


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-3A GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.32

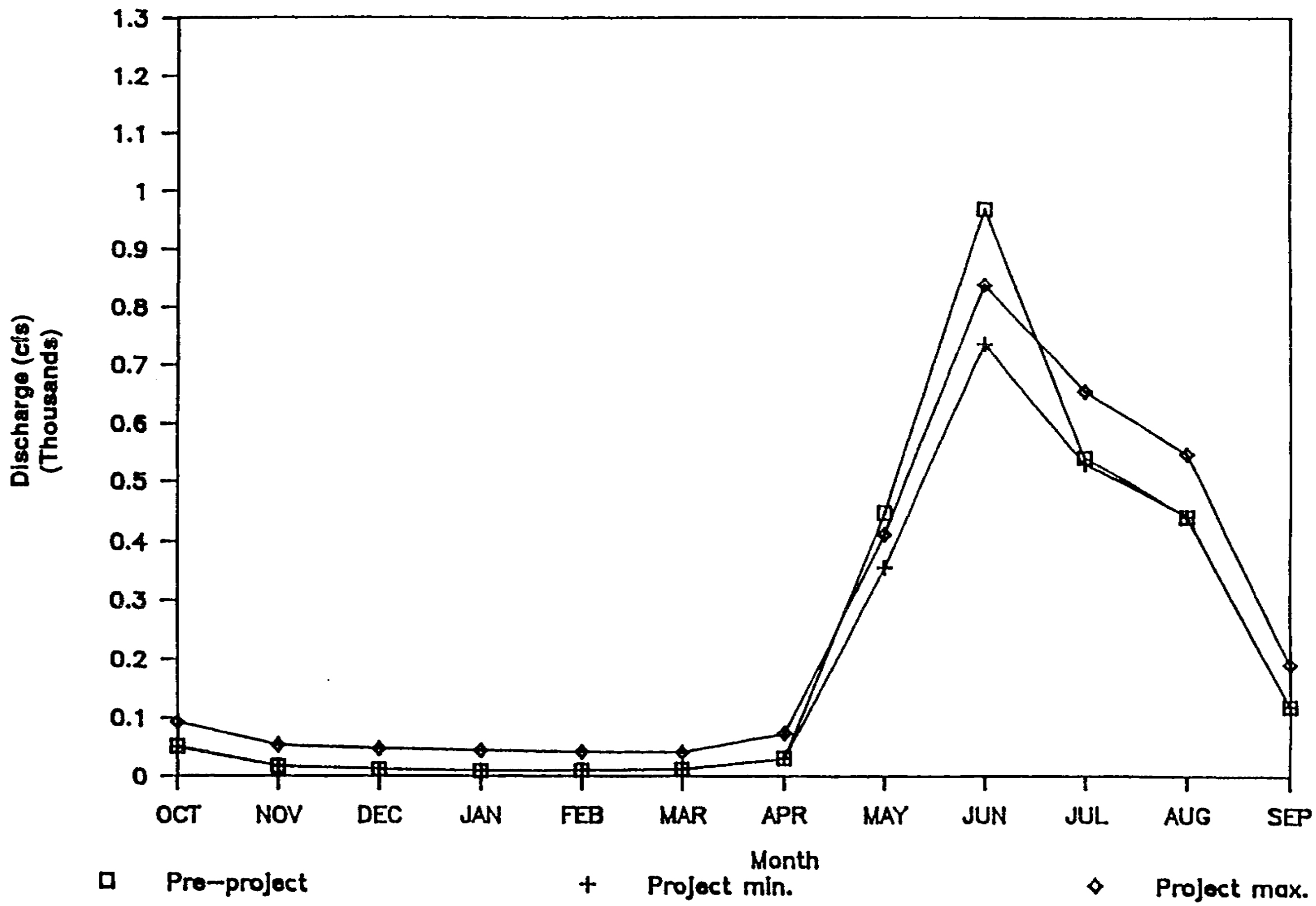


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-3A POUDRE ALTERNATIVE

DATE 11/28/88

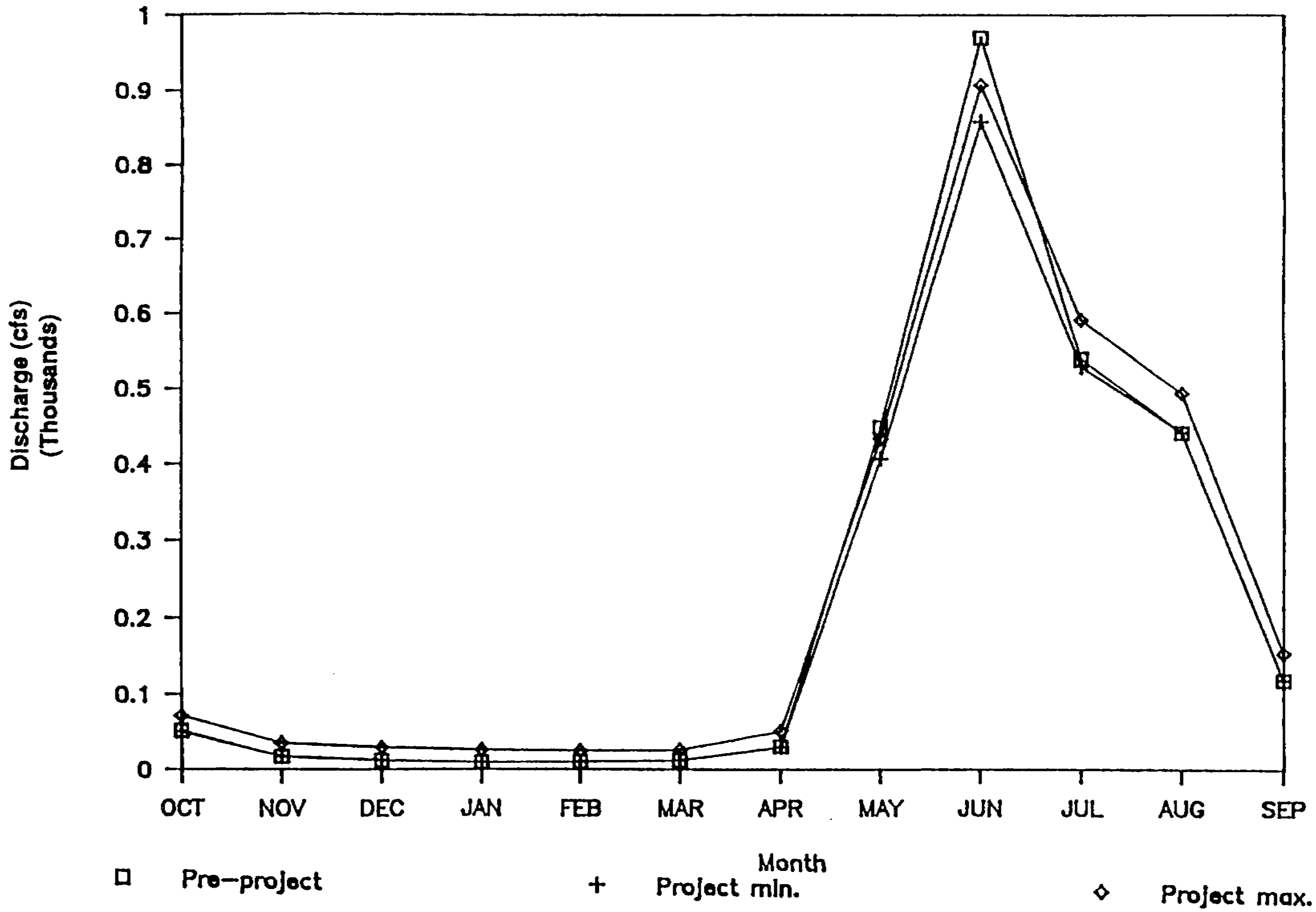
FIGURE 2.33



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88 FIGURE 2.34

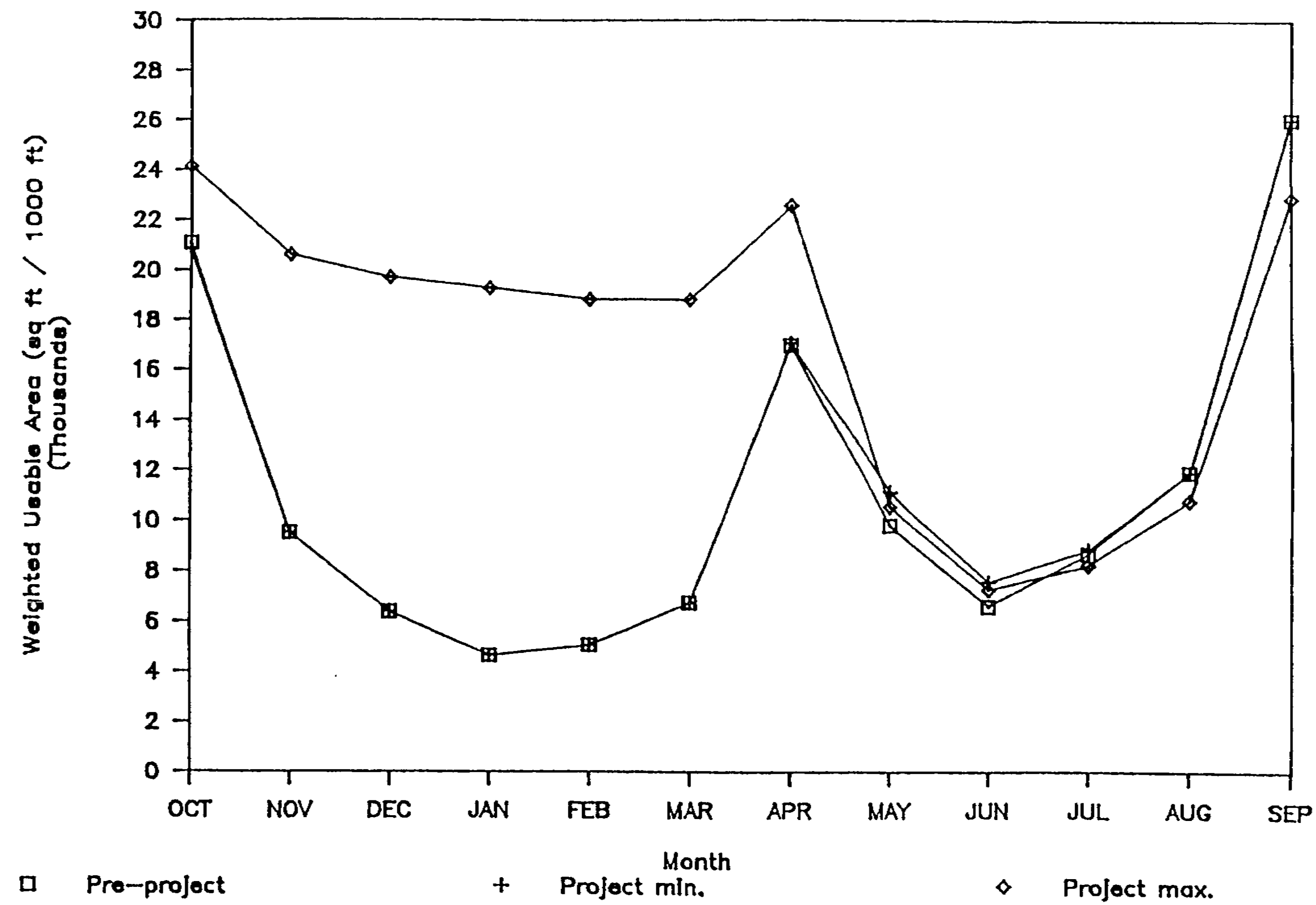


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOTS OF DISCHARGE IN SEGMENT CLP-3B POUDRE ALTERNATIVE

DATE 11/28/88

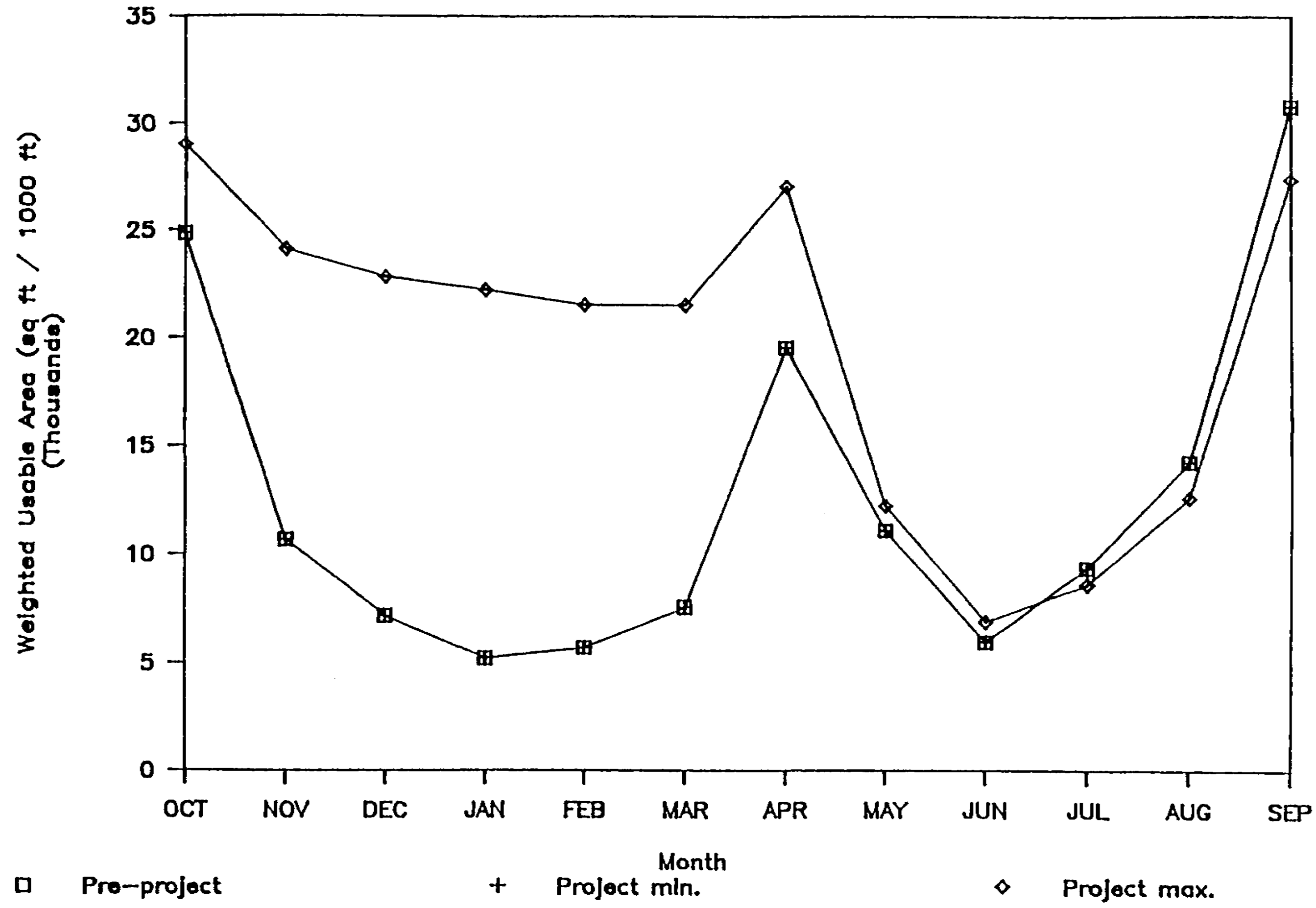
FIGURE 2.35



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT ADULT HABITAT SEGMENT CLP-3A GREY MOUNTAIN ALTERNATIVE

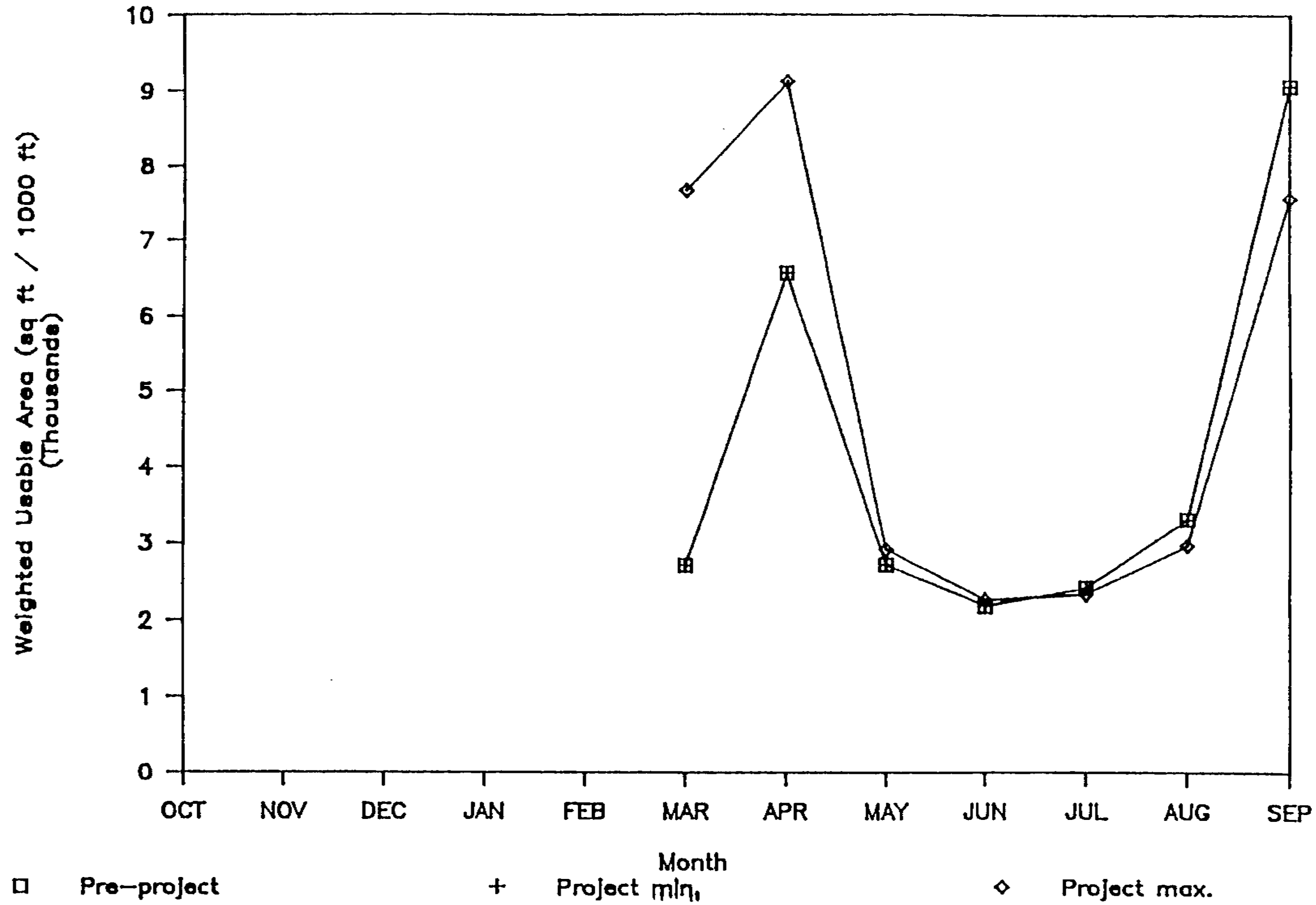
DATE 11/28/88 FIGURE 2.36



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY BROWN TROUT JUVENILE
HABITAT SEGMENT CLP-3A
GREY MOUNTAIN ALTERNATIVE

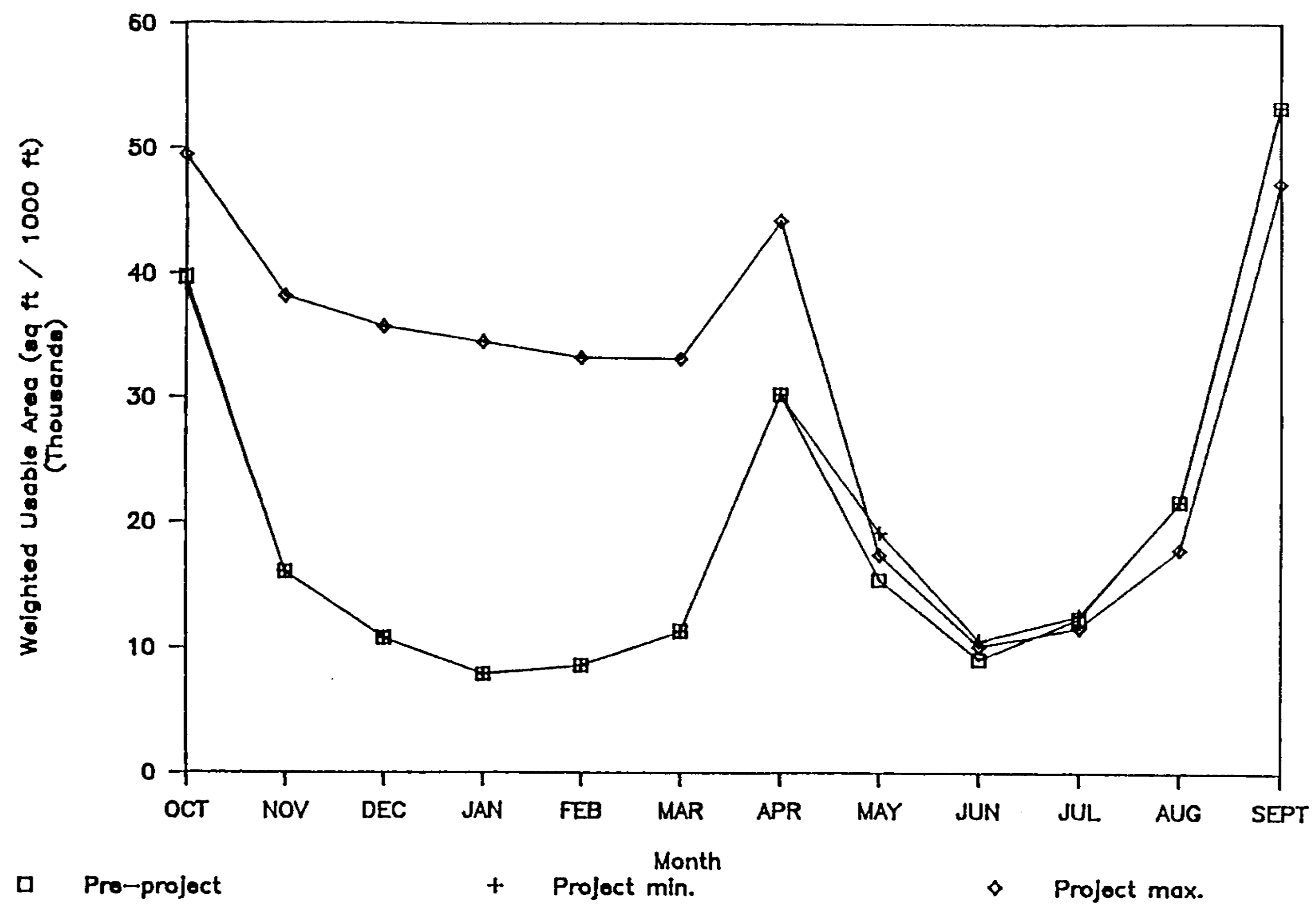
DATE 11/28/88 FIGURE 2.37



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT FRY HABITAT SEGMENT CLP-3A GREY MOUNTAIN ALTERNATIVE

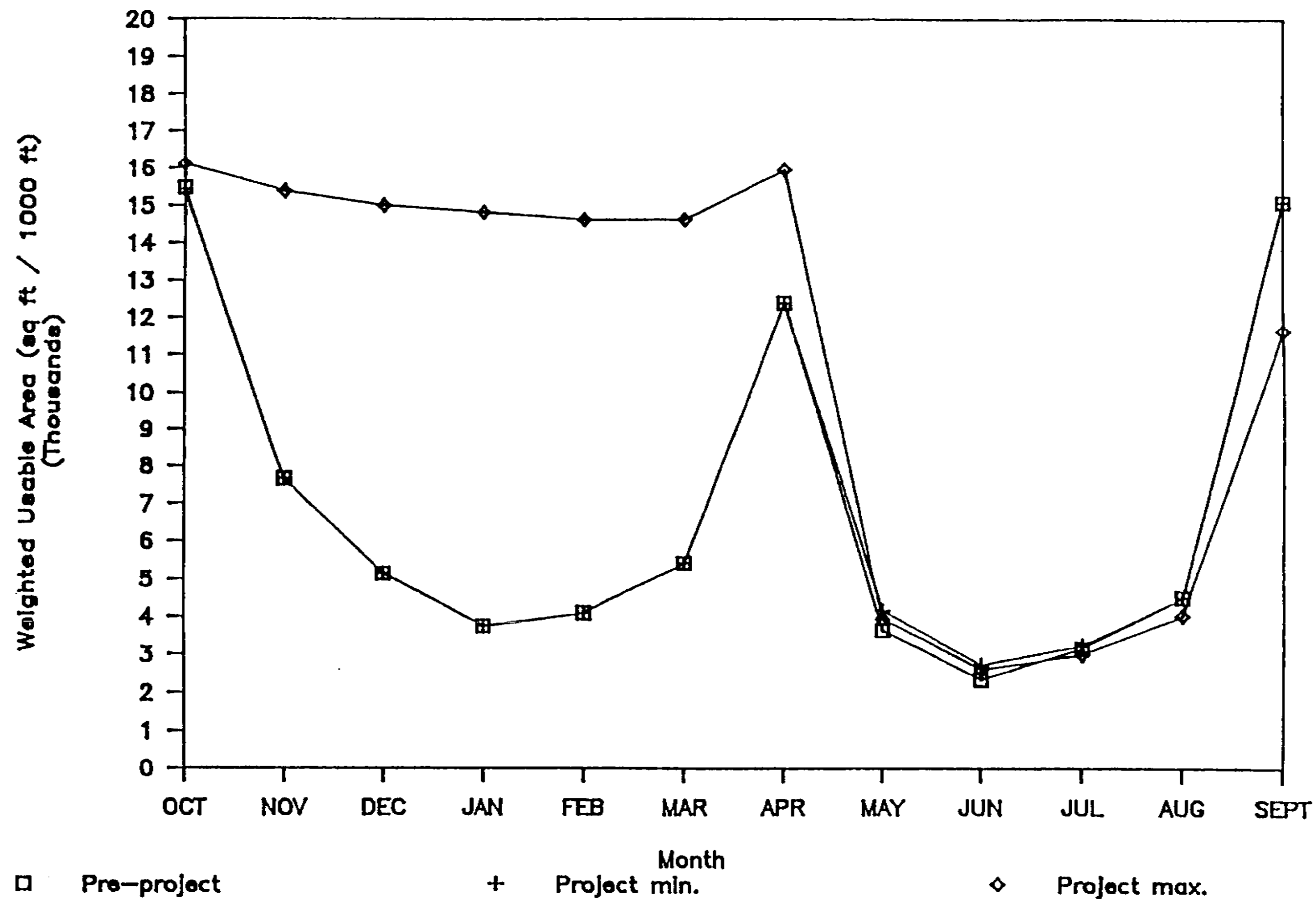
DATE 11/28/88 FIGURE 2.38



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT ADULT HABITAT SEGMENT CLP-3A GREY MOUNTAIN ALTERNATIVE

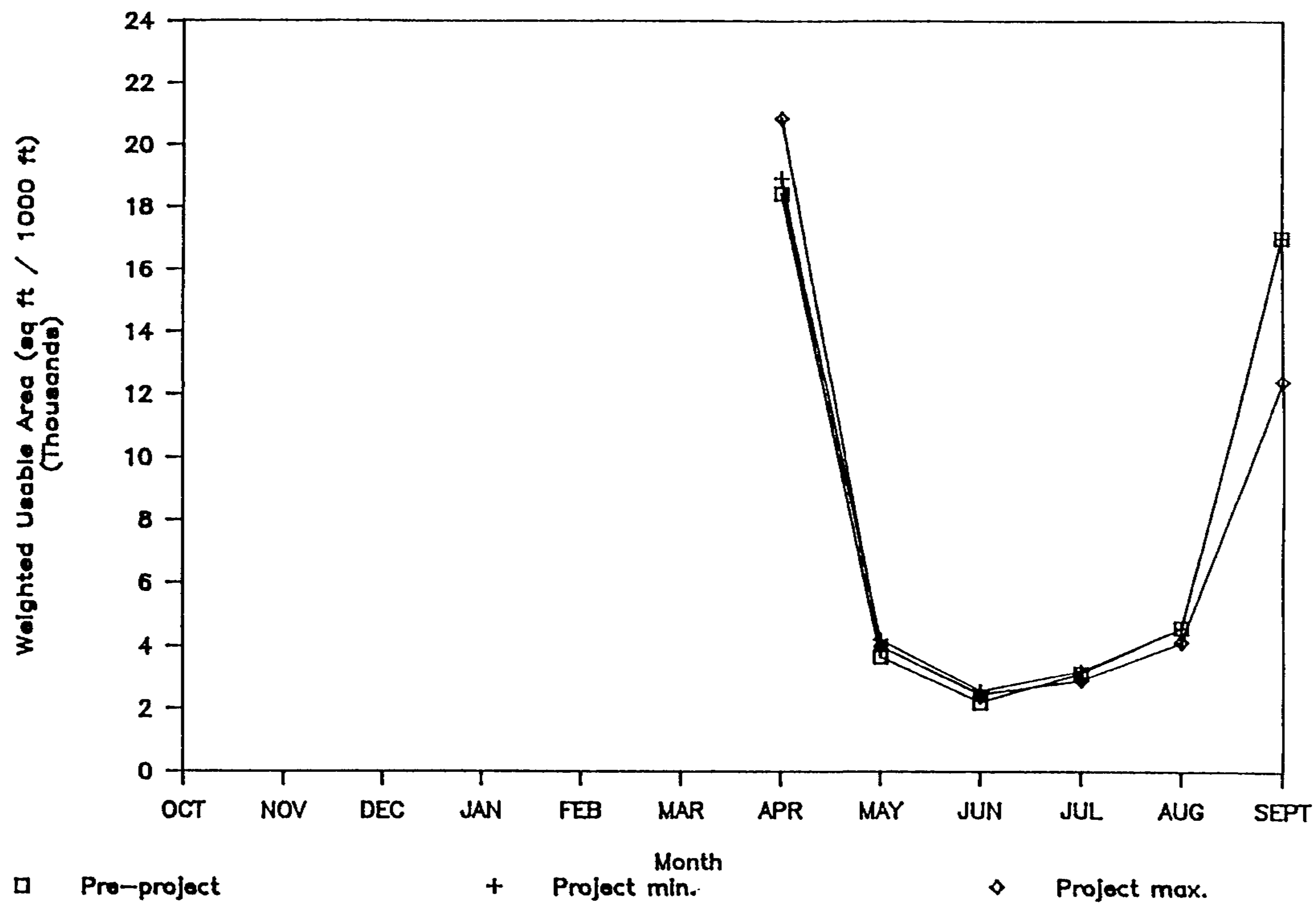
DATE 11/28/88 FIGURE 2.39



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE HABITAT SEGMENT CLP-3A GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88 FIGURE 2.40

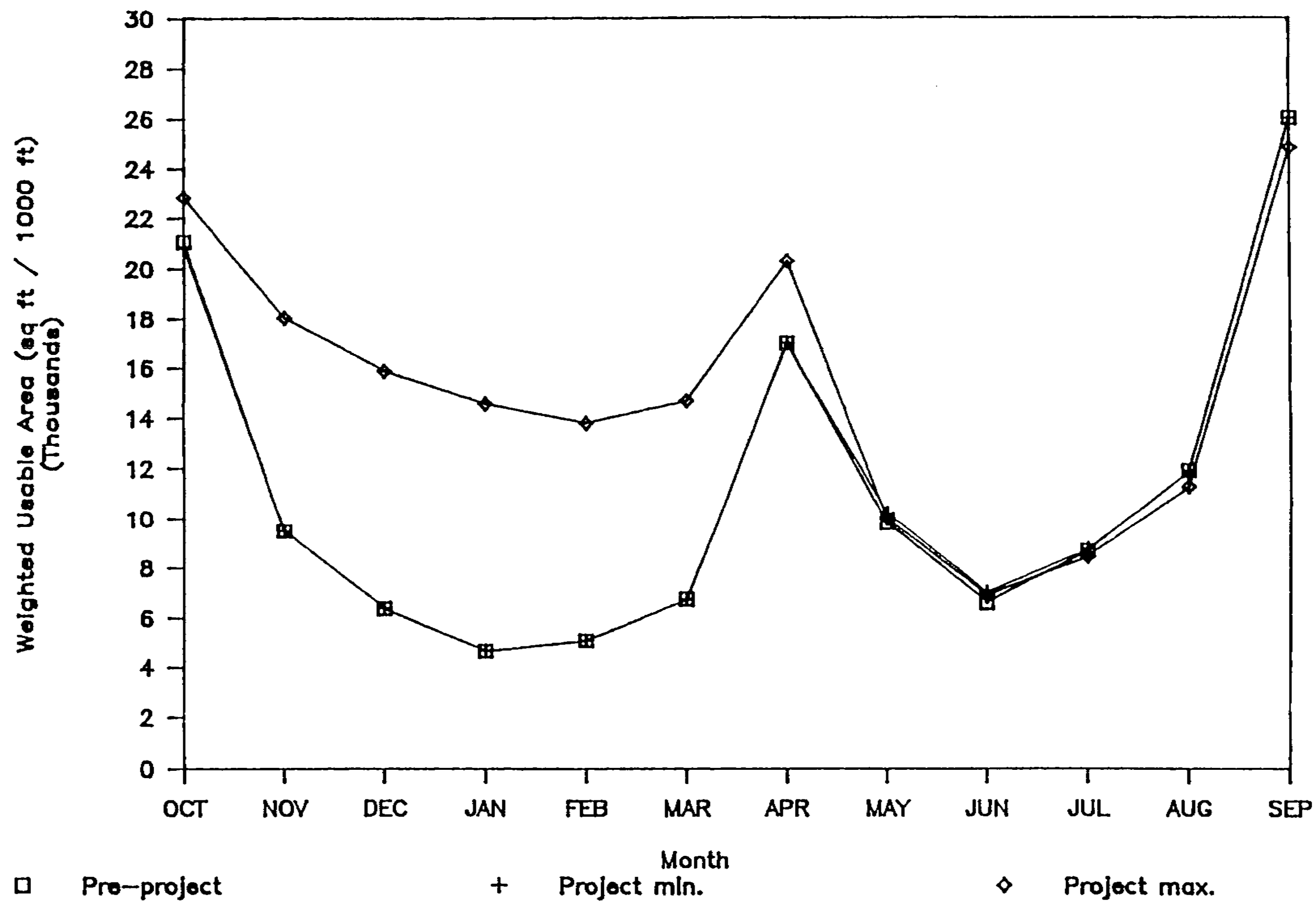


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY RAINBOW TROUT FRY
HABITAT SEGMENT CLP-3A
GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.41

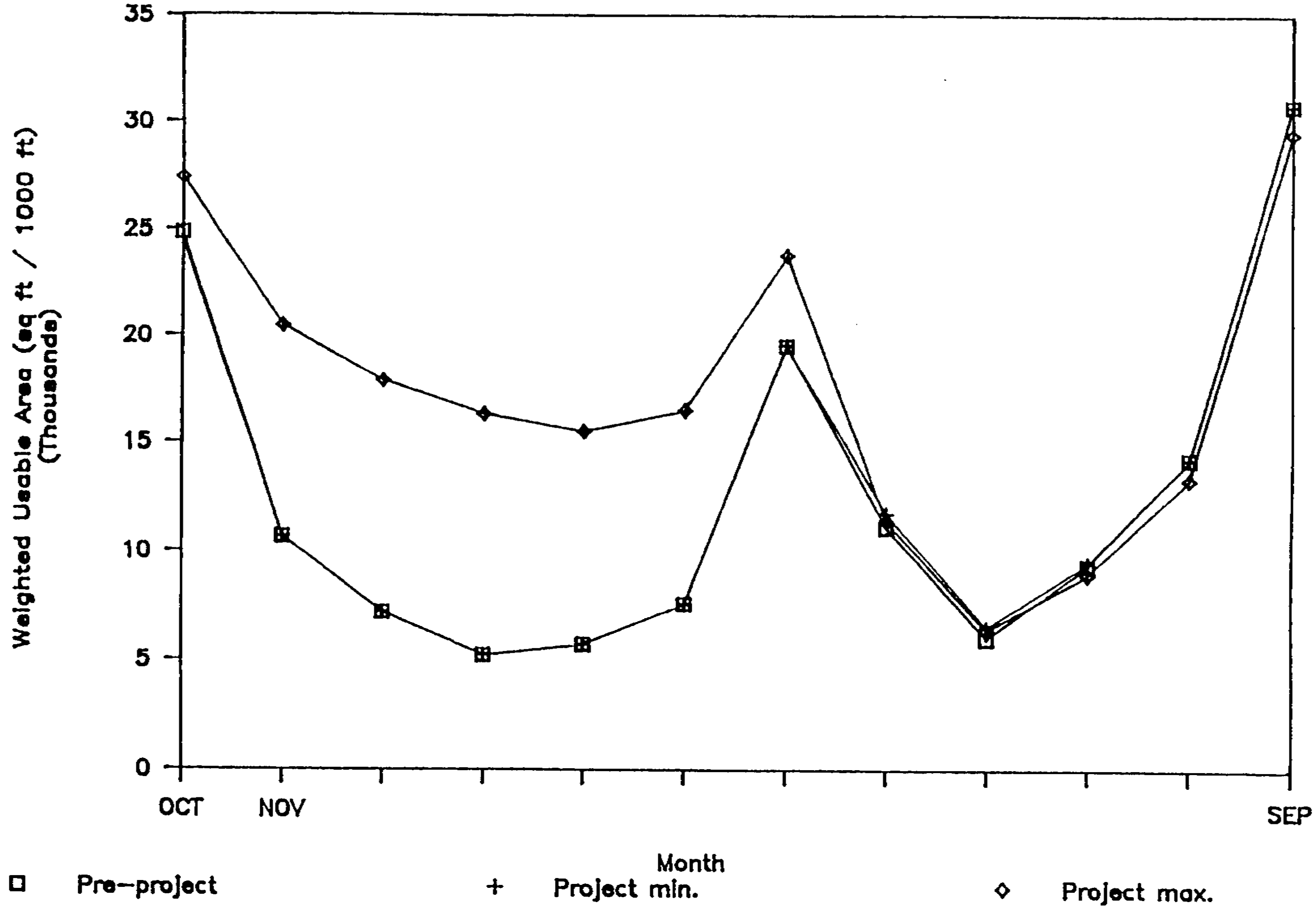


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY BROWN TROUT ADULT
HABITAT SEGMENT CLP-3A
POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.42

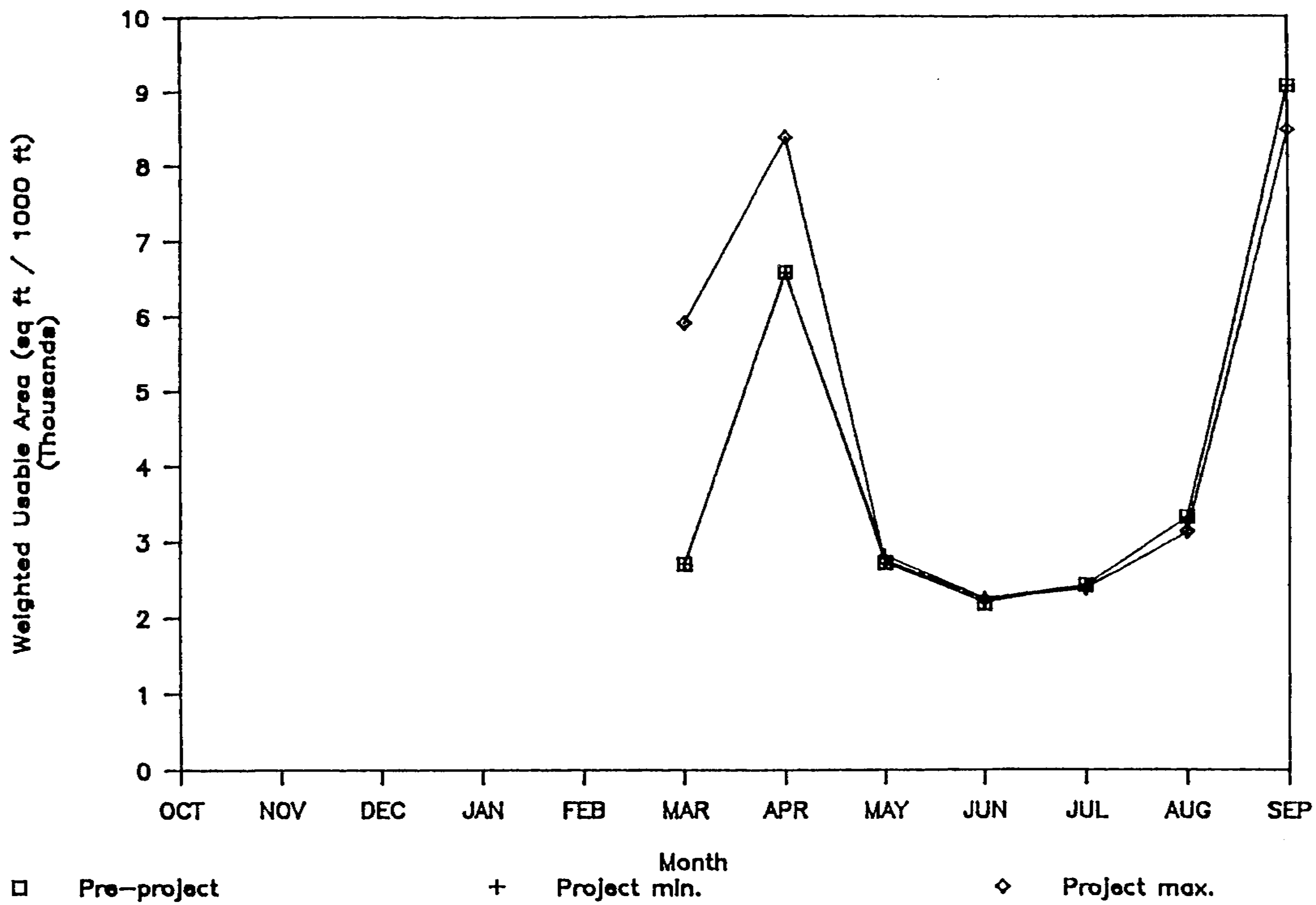


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

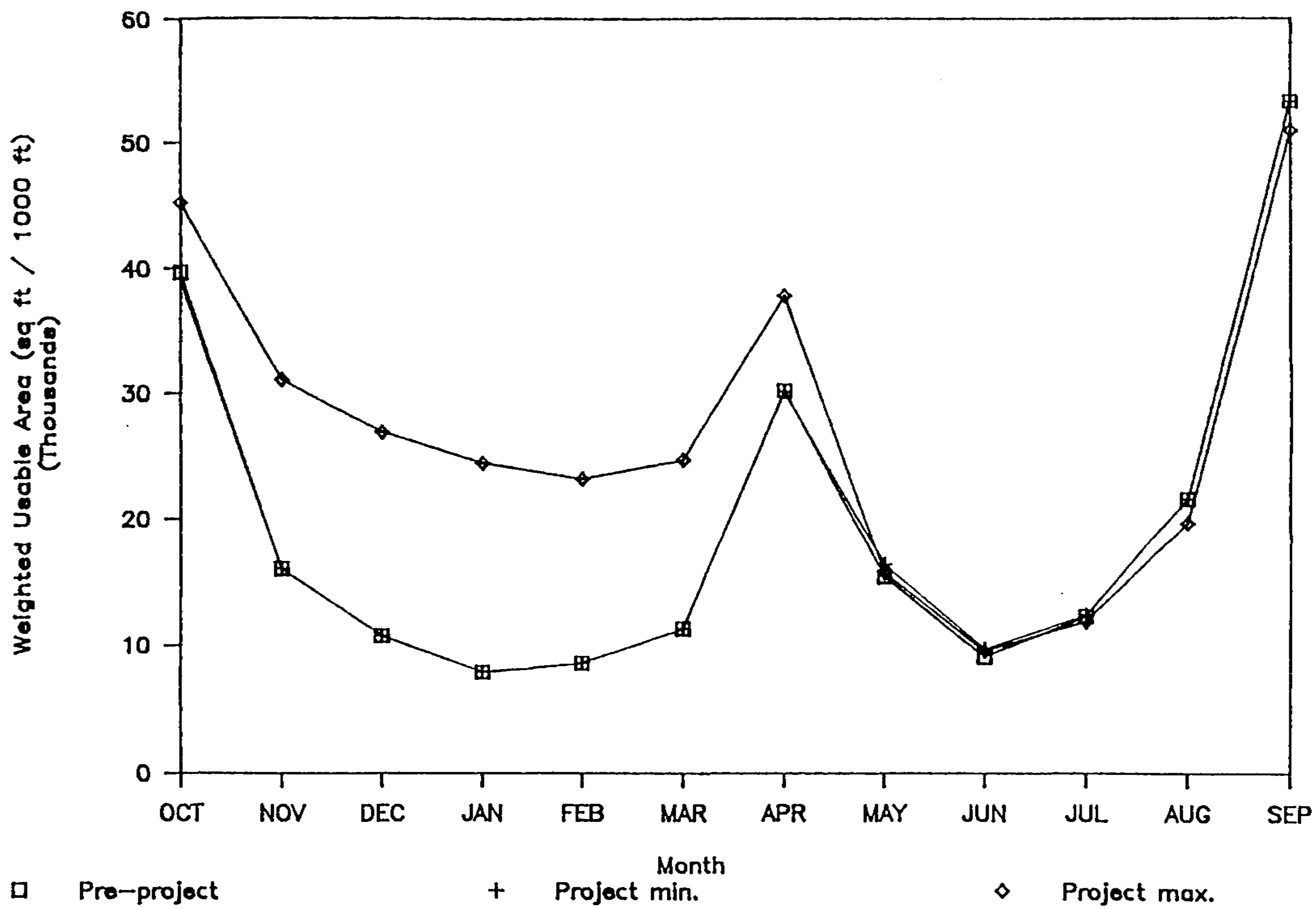
MONTHLY BROWN TROUT JUVENILE HABITAT SEGMENT CLP-3A POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.43



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY CACHE LA POUDRE WATER AND POWER PROJECT	
MONTHLY BROWN TROUT FRY HABITAT SEGMENT CLP-3A POUDRE ALTERNATIVE	
DATE 11/28/88	FIGURE 2.44

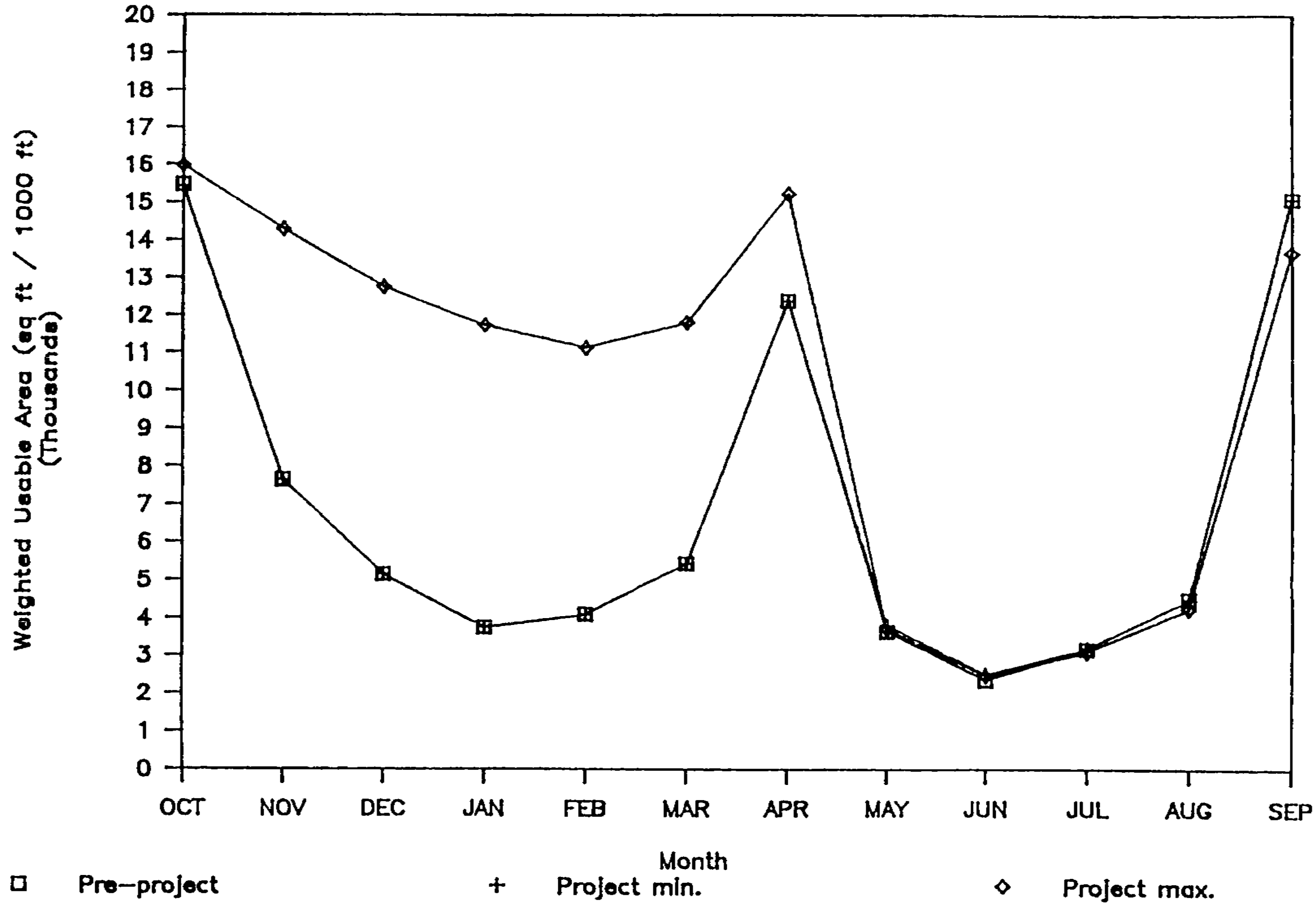


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT ADULT HABITAT SEGMENT CLP-3A POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.45

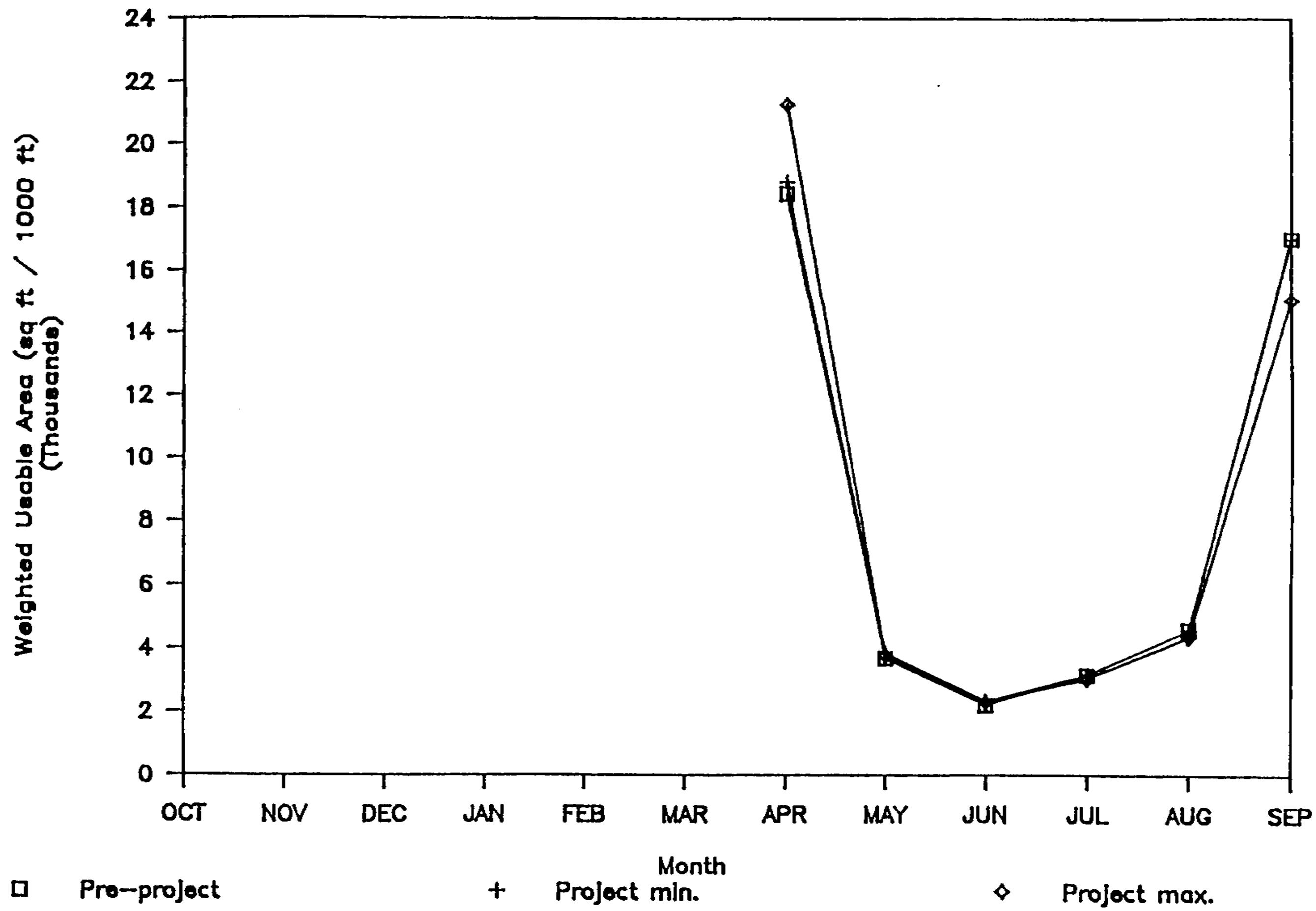


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE HABITAT SEGMENT CLP-3A POUDRE ALTERNATIVE

DATE 11/28/88

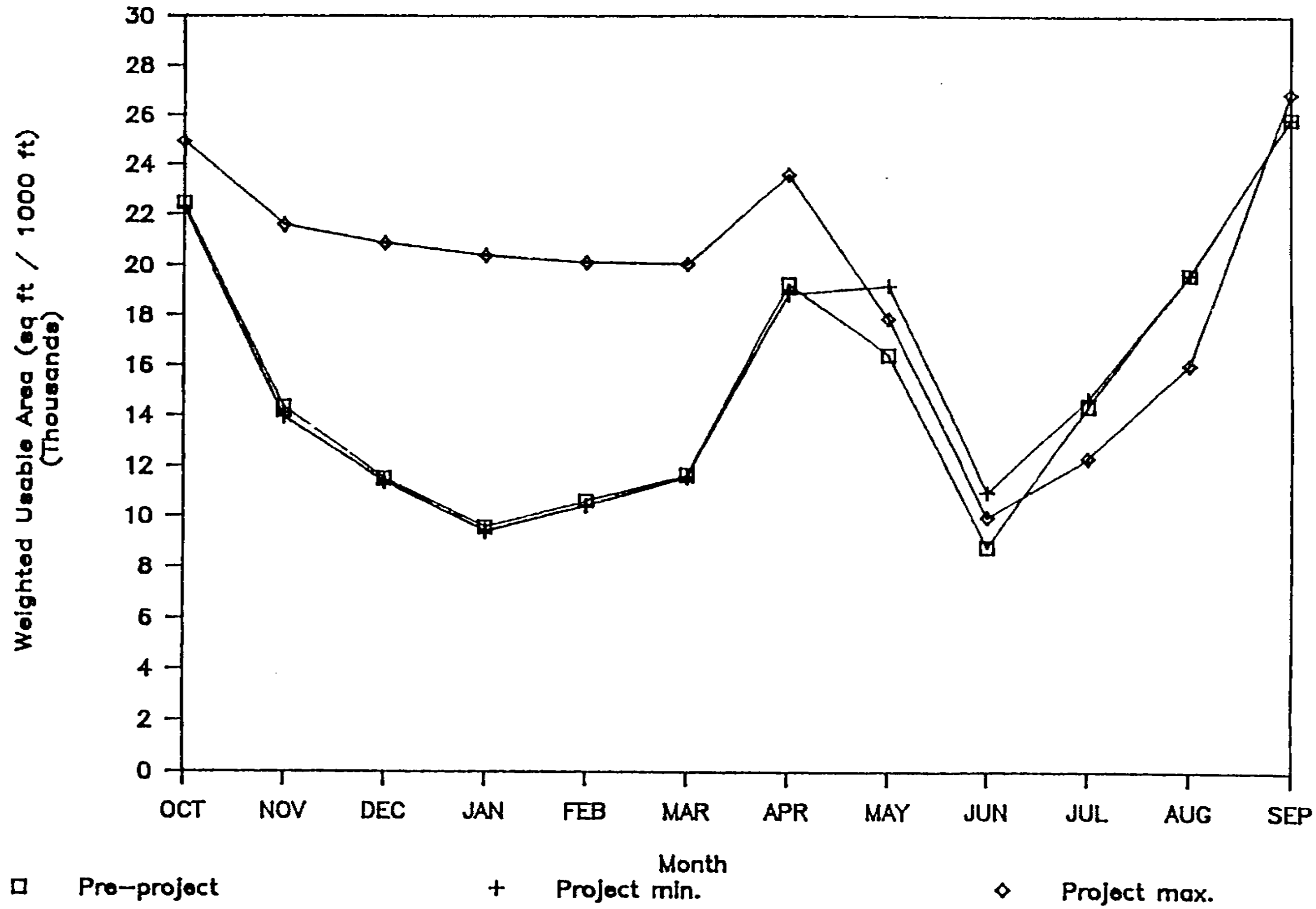
FIGURE 2.46



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT FRY HABITAT SEGMENT CLP-3A POUDRE ALTERNATIVE

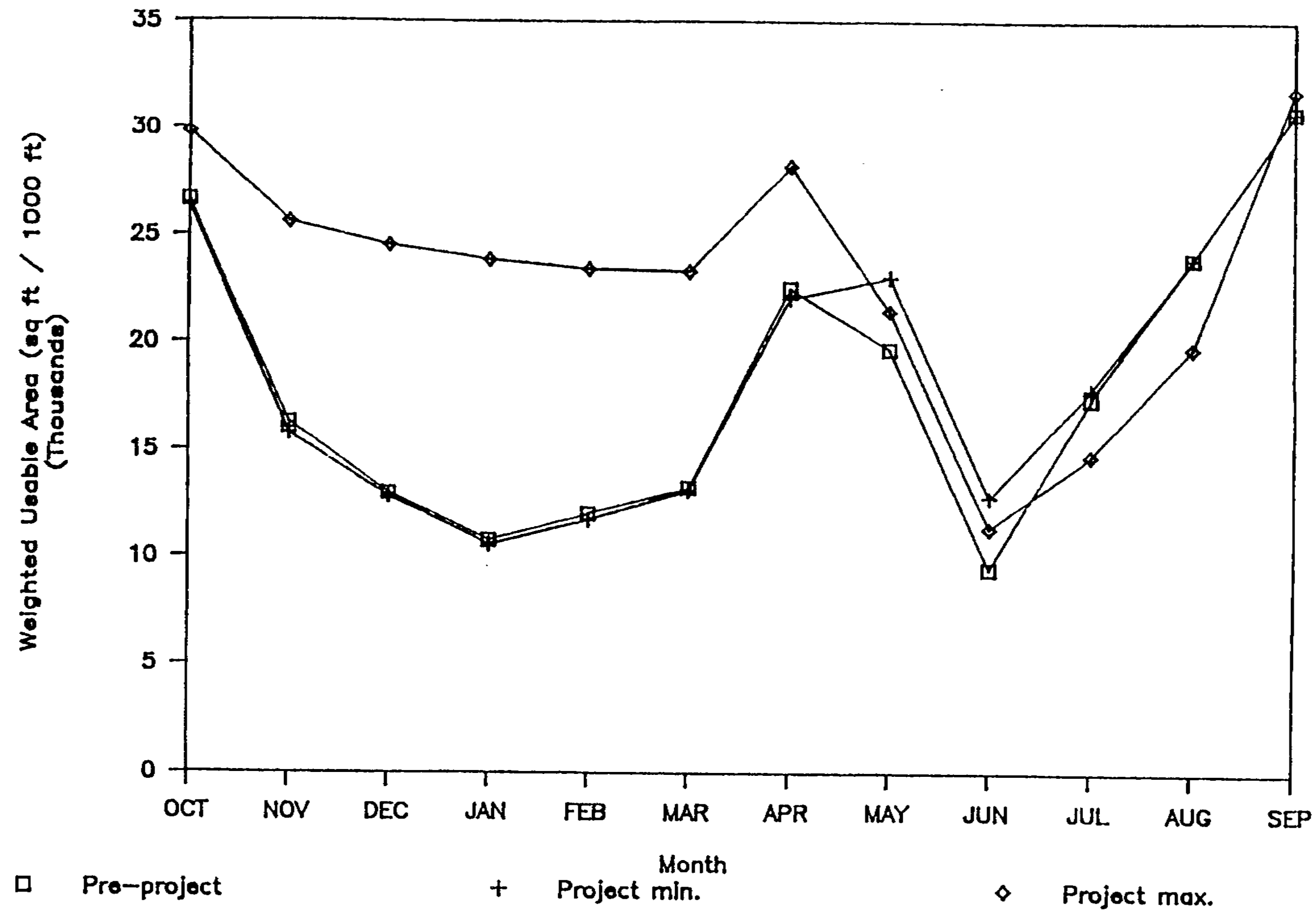
DATE 11/28/88 FIGURE 2.47



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT ADULT HABITAT SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

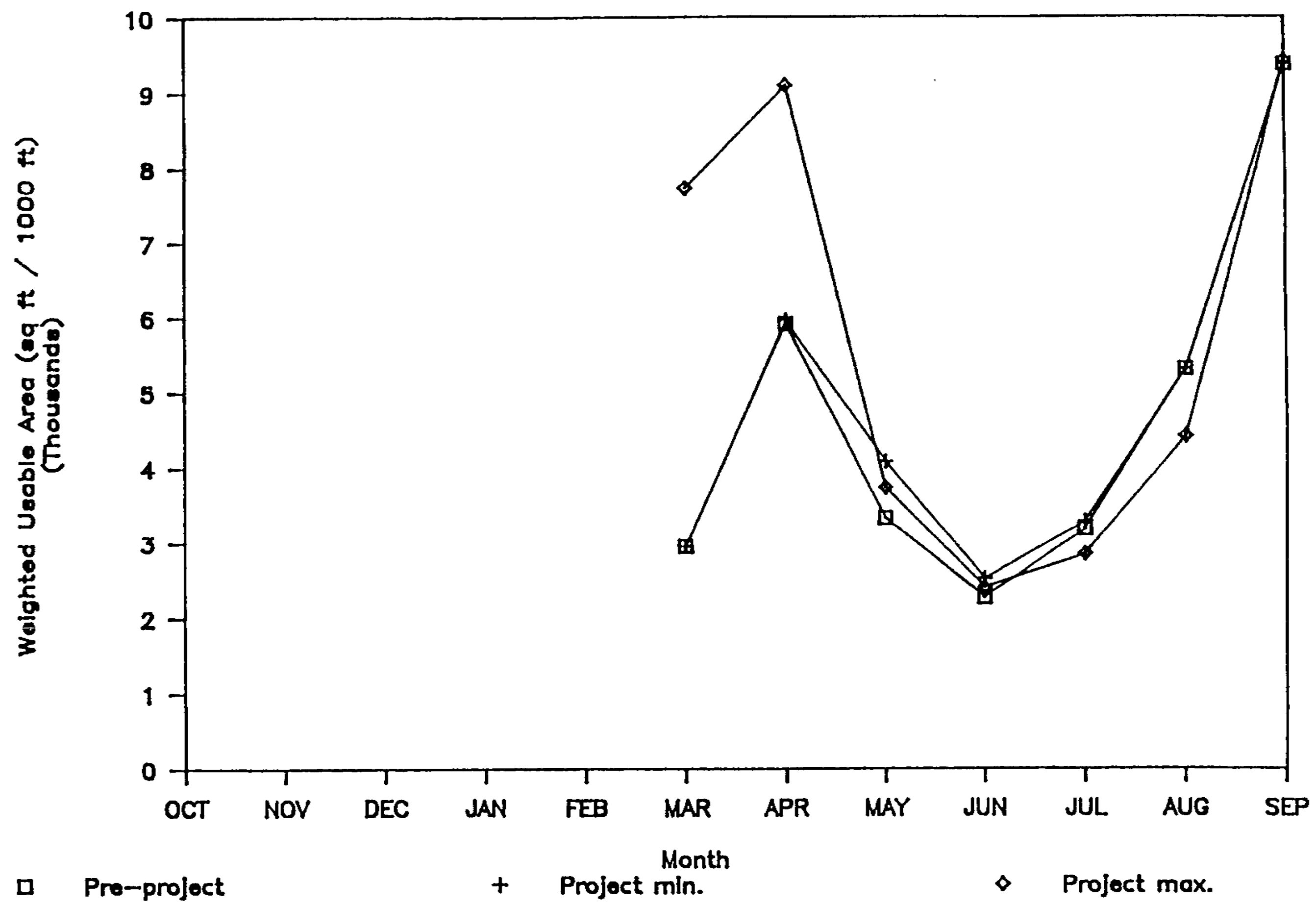
DATE 11/28/88 FIGURE 2.48



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT JUVENILE HABITAT SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

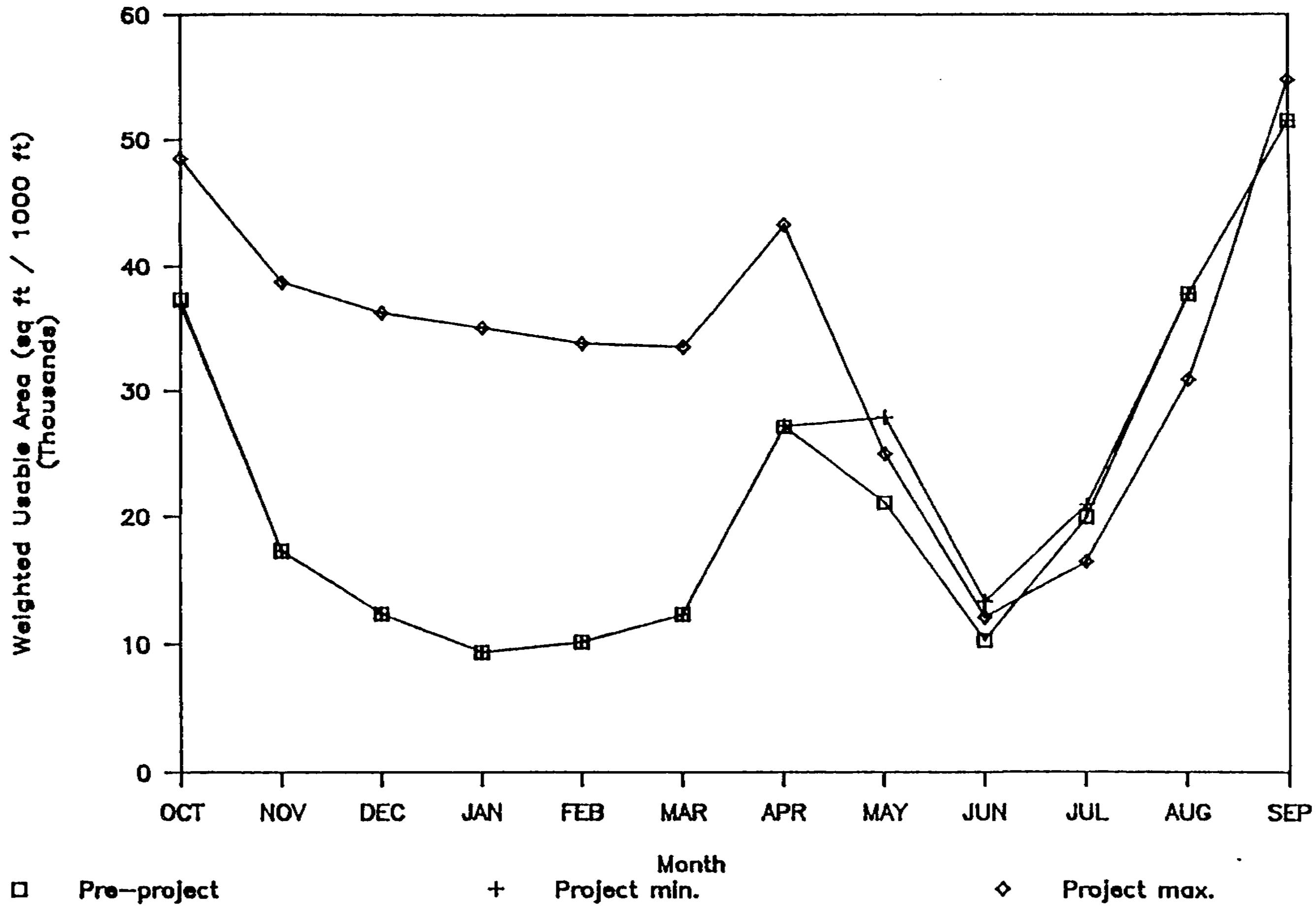
DATE 11/28/88 FIGURE 2.49



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT FRY HABITAT SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

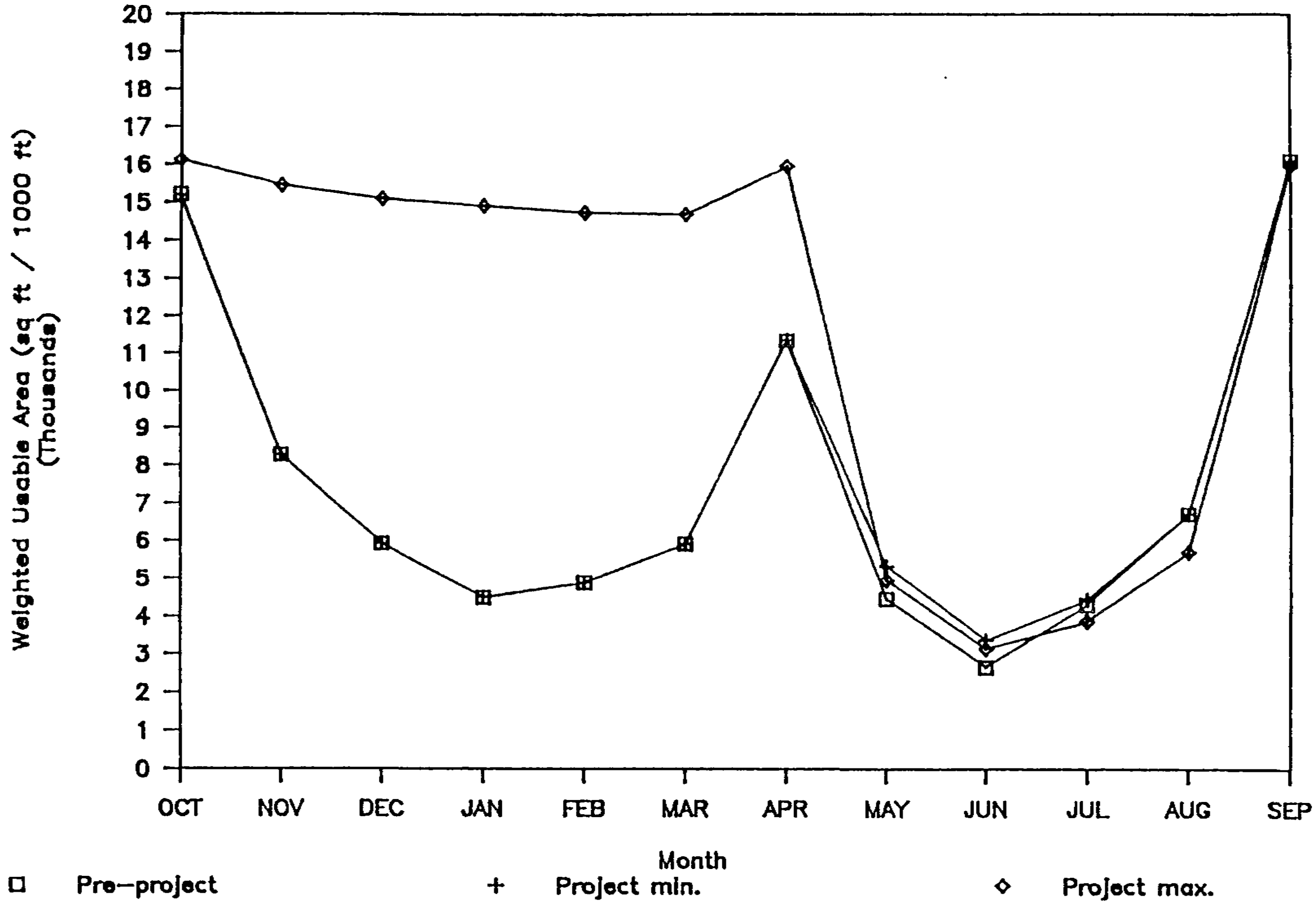
DATE 11/28/88 FIGURE 2.50



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY RAINBOW TROUT ADULT
HABITAT SEGMENT CLP-3B
GREY MOUNTAIN ALTERNATIVE

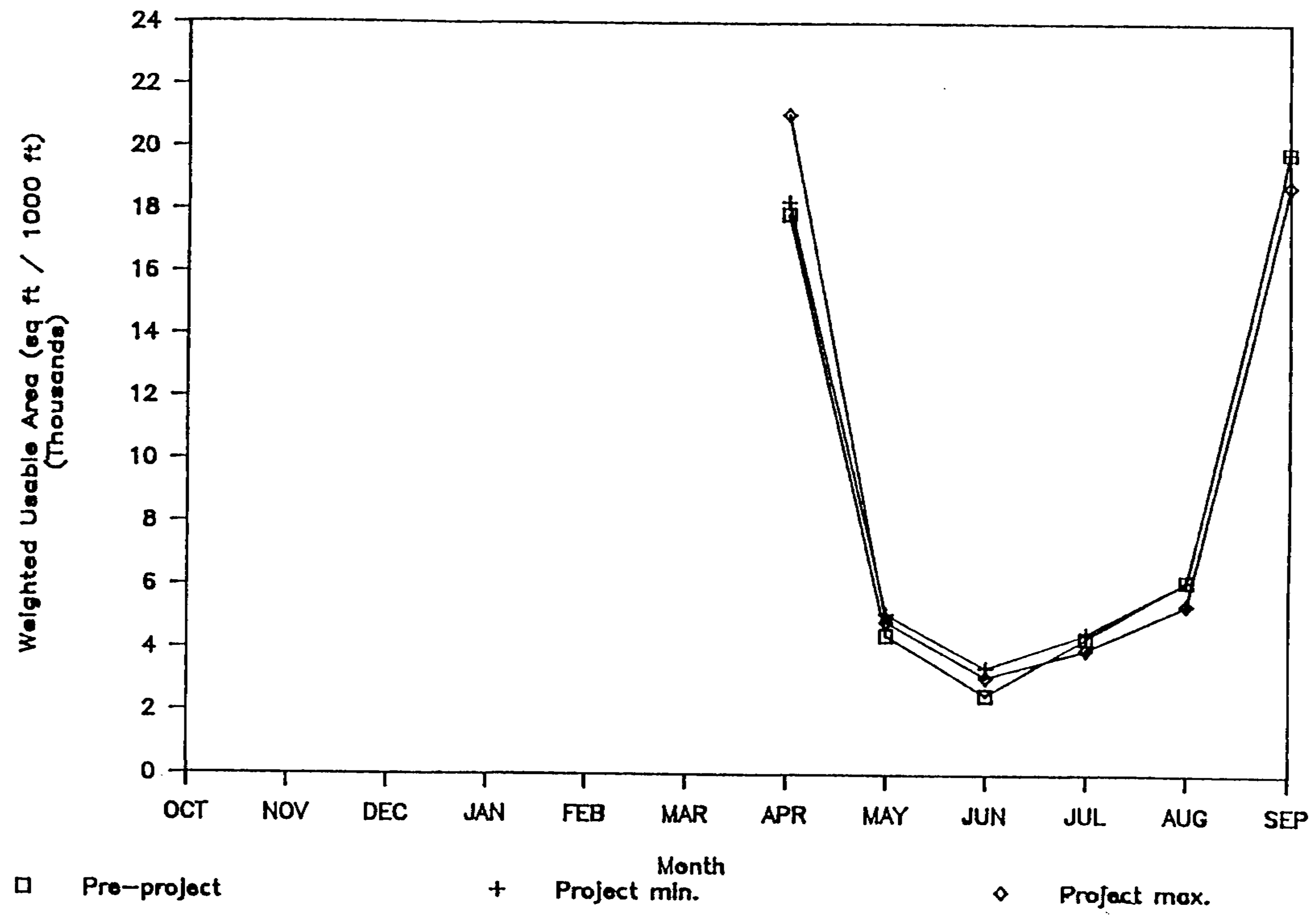
DATE 11/28/88 FIGURE 2.51



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE HABITAT SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88 FIGURE 2.52

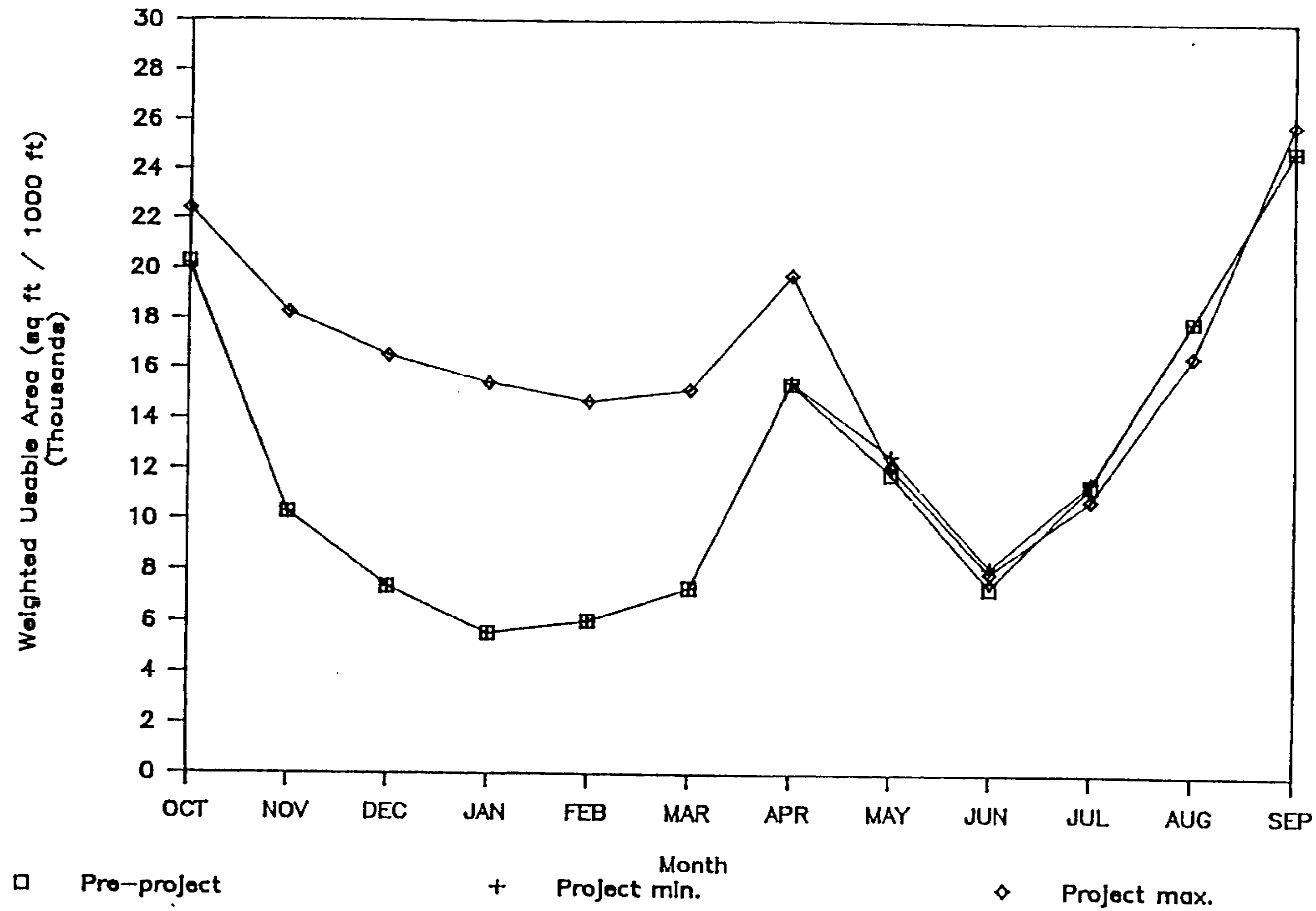


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT FRY HABITAT SEGMENT CLP-3B GREY MOUNTAIN ALTERNATIVE

DATE 11/28/88

FIGURE 2.53



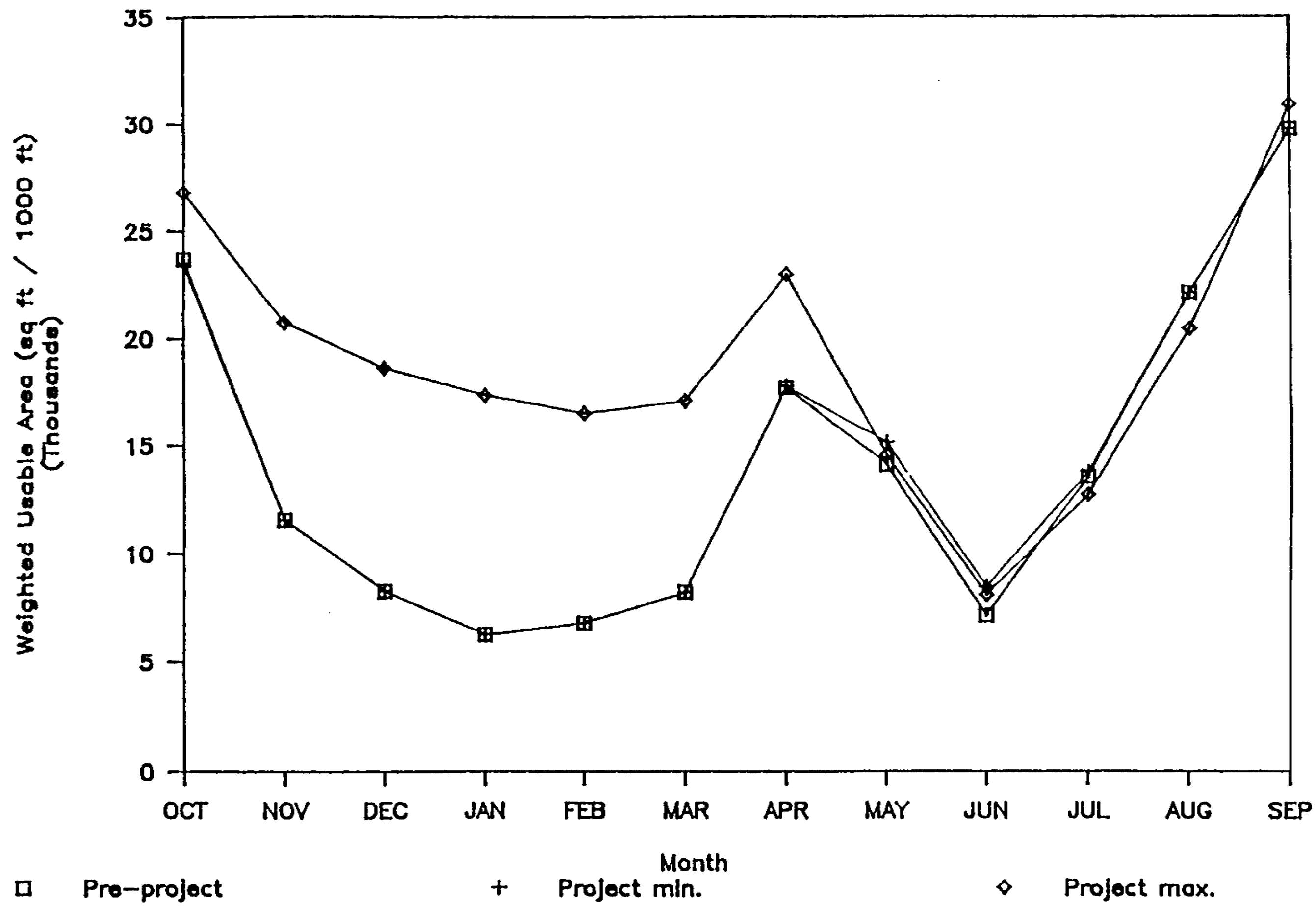
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT ADULT HABITAT SEGMENT CLP-3B POUDRE ALTERNATIVE

DATE 11/28/88

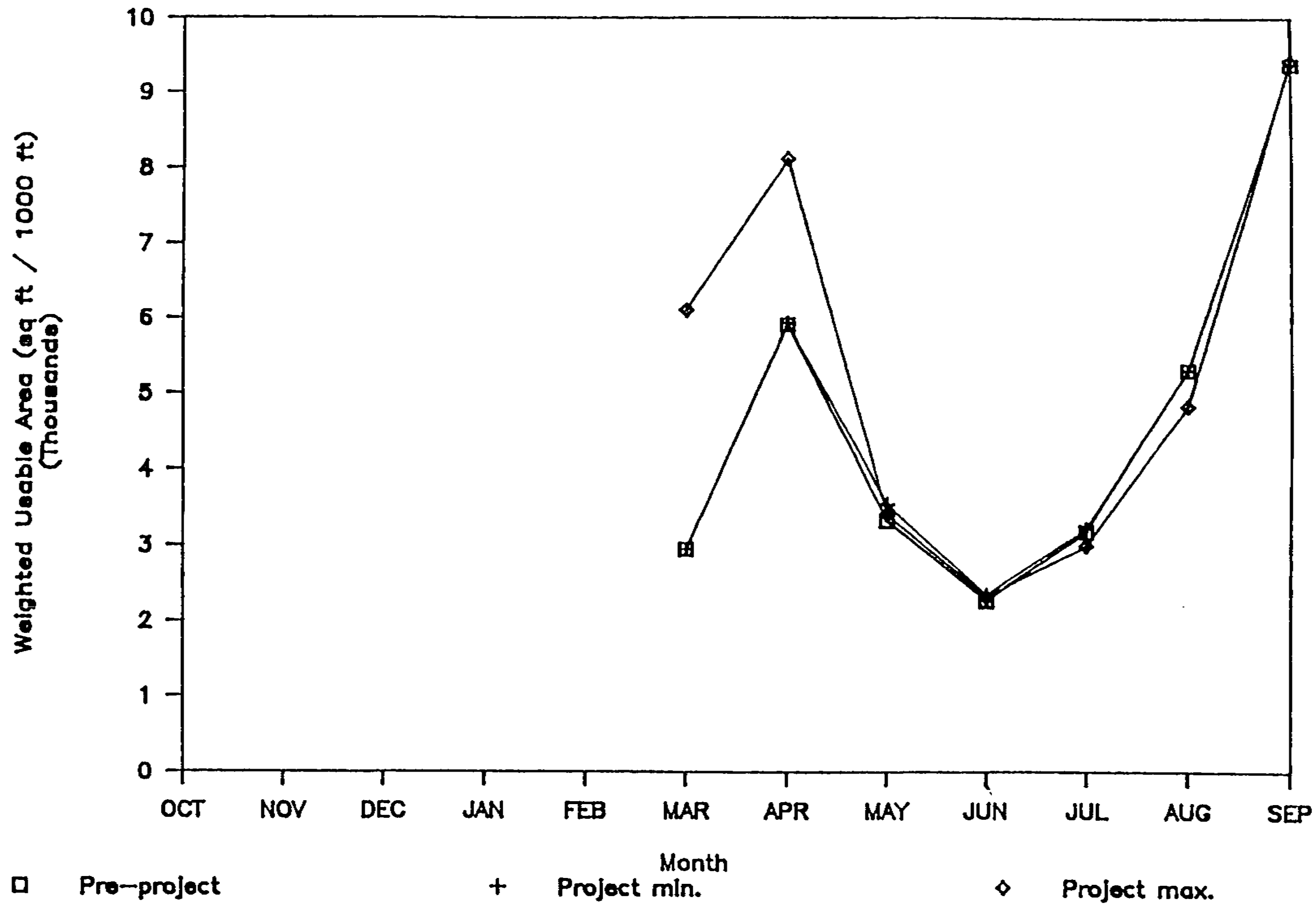
FIGURE 2.54



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY BROWN TROUT JUVENILE HABITAT SEGMENT CLP-3B POUDRE ALTERNATIVE

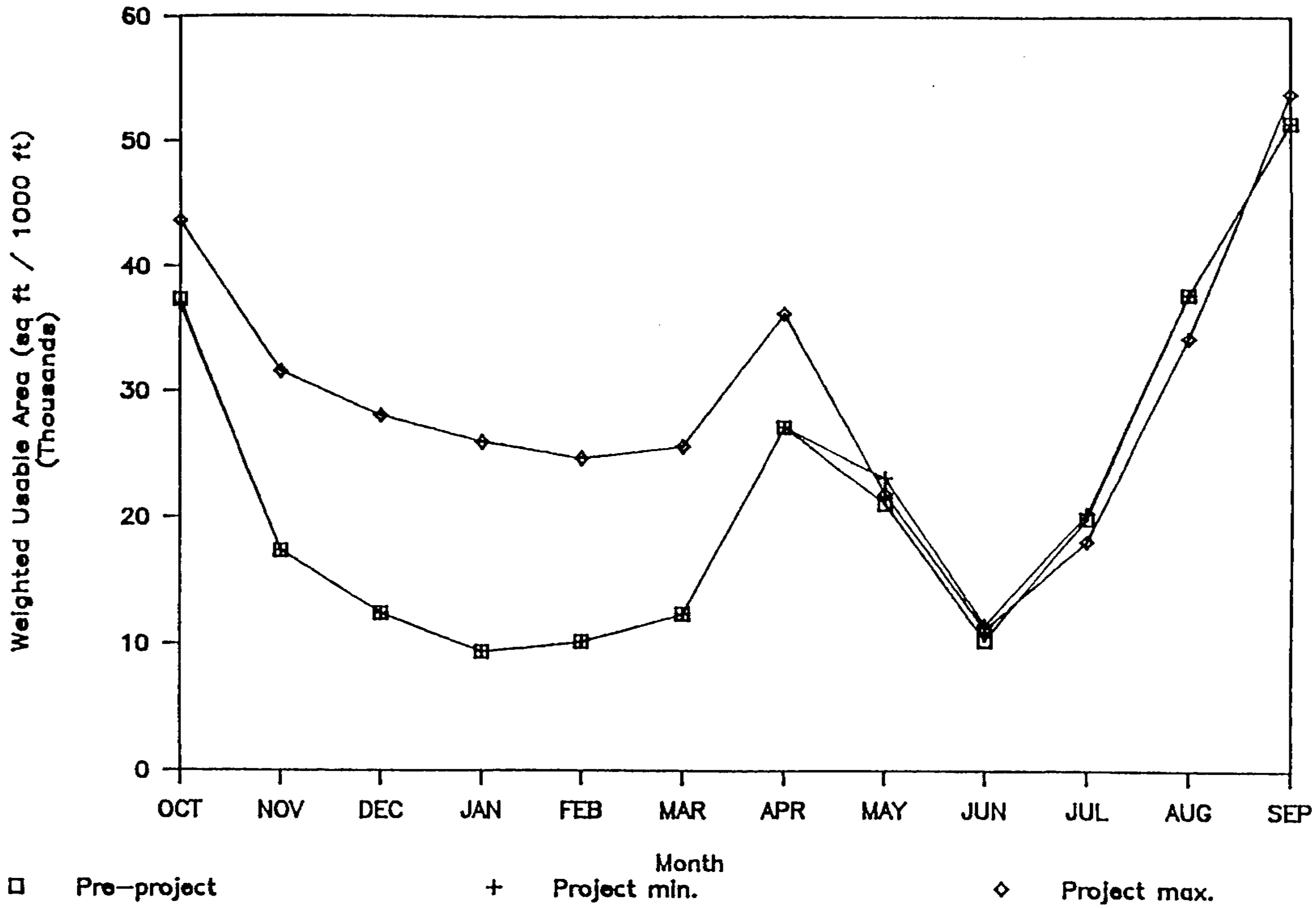
DATE 11/28/88 FIGURE 2.55



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY BROWN TROUT FRY
HABITAT SEGMENT CLP-3B
POUDRE ALTERNATIVE

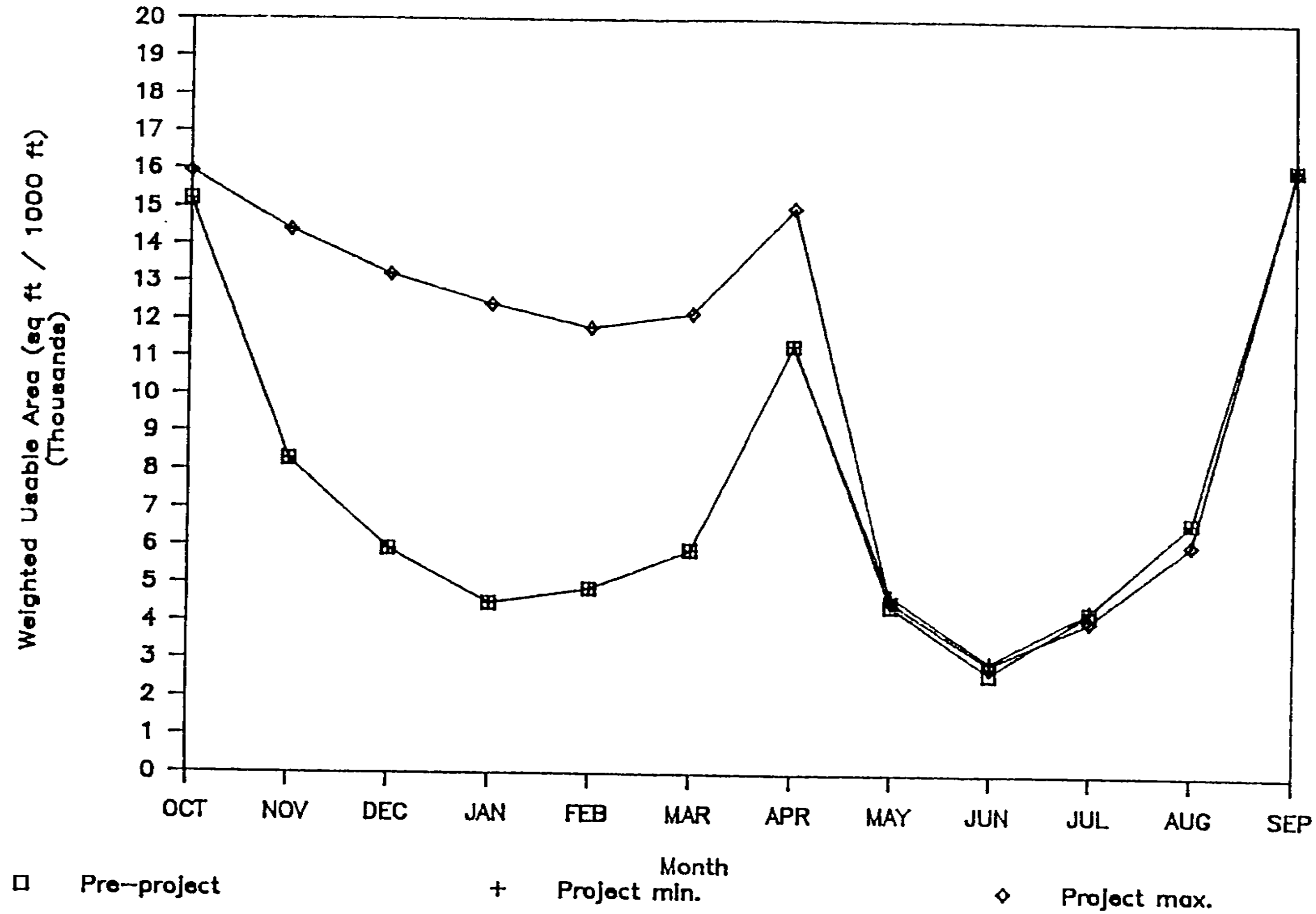
DATE 11/28/88 FIGURE 2.56



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT ADULT HABITAT SEGMENT CLP-3B POUDRE ALTERNATIVE

DATE 11/28/88 FIGURE 2.57

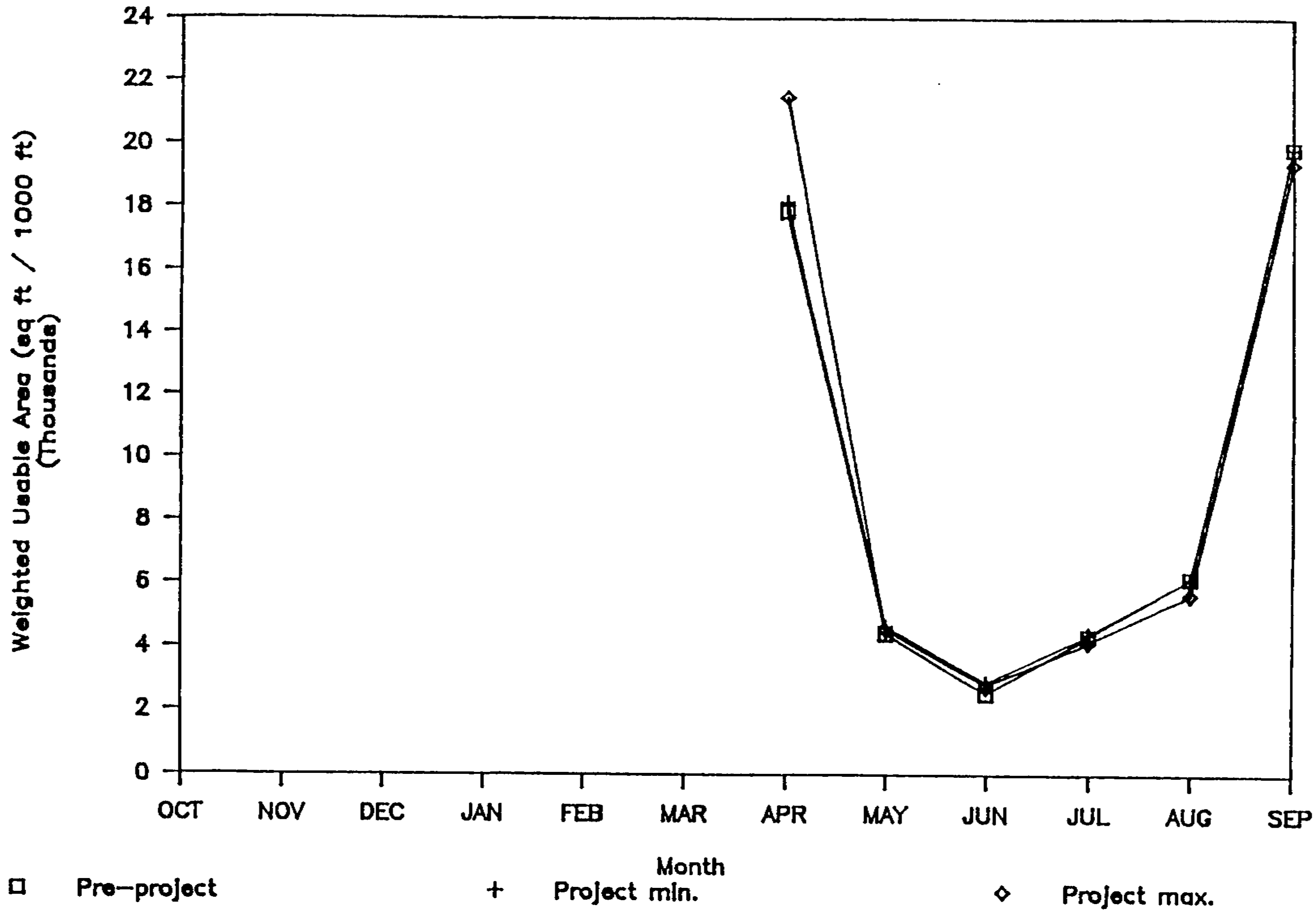


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT JUVENILE HABITAT SEGMENT CLP-3B POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.58

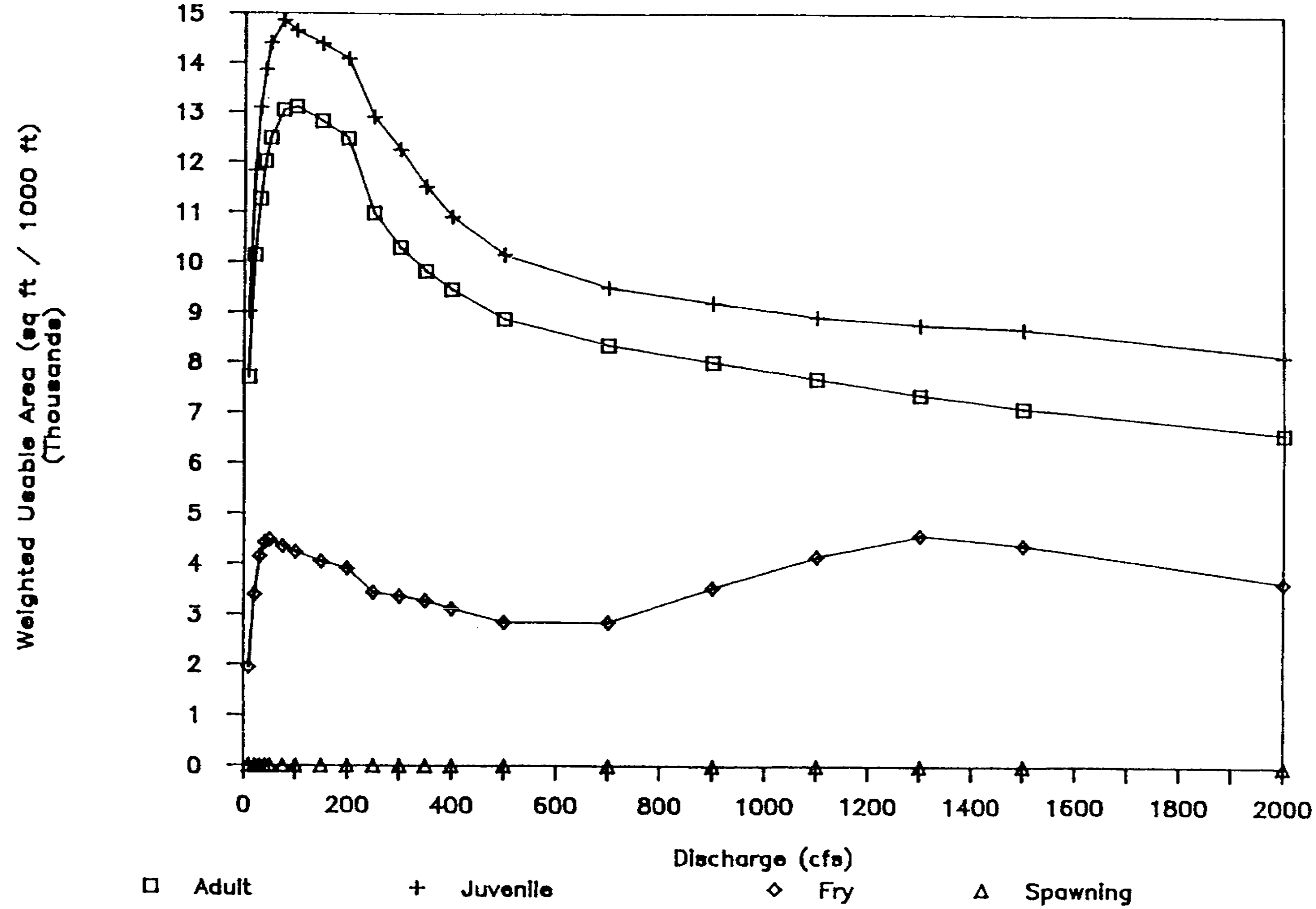


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY RAINBOW TROUT FRY HABITAT SEGMENT CLP-3B POUDRE ALTERNATIVE

DATE 11/28/88

FIGURE 2.59

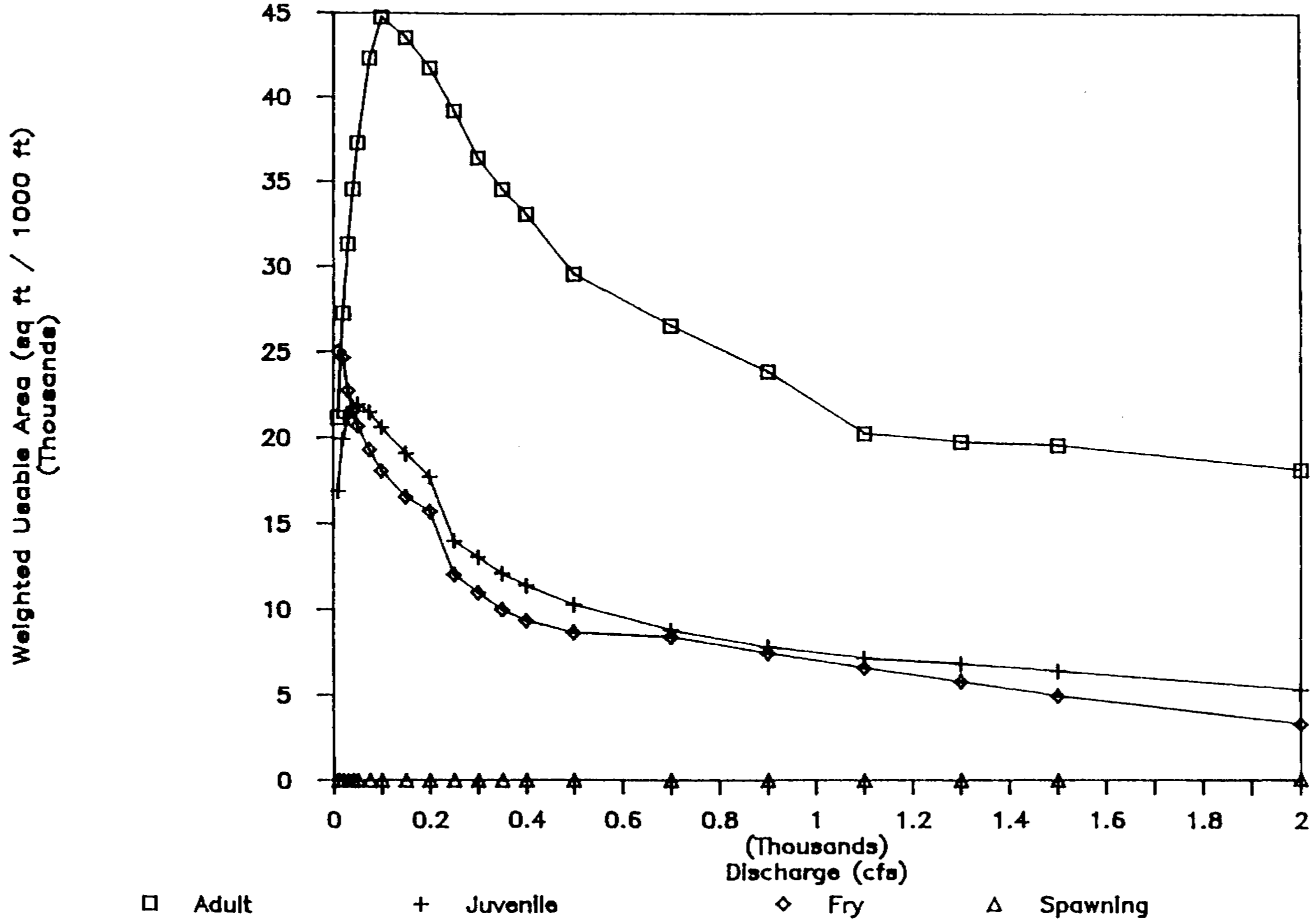


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-4

DATE 11/28/88

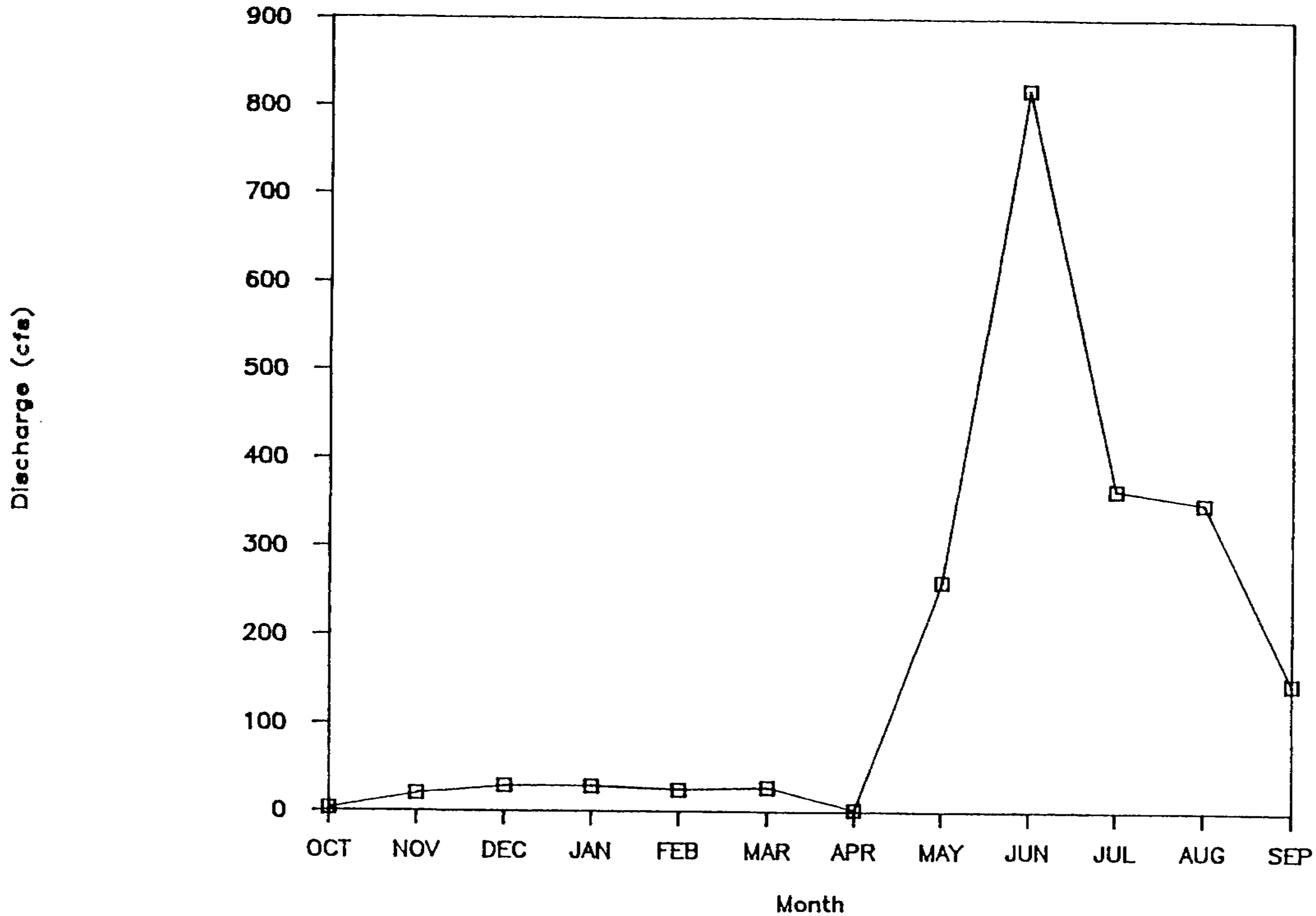
FIGURE 2.60



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT CLP-4

DATE 11/28/88 FIGURE 2.61

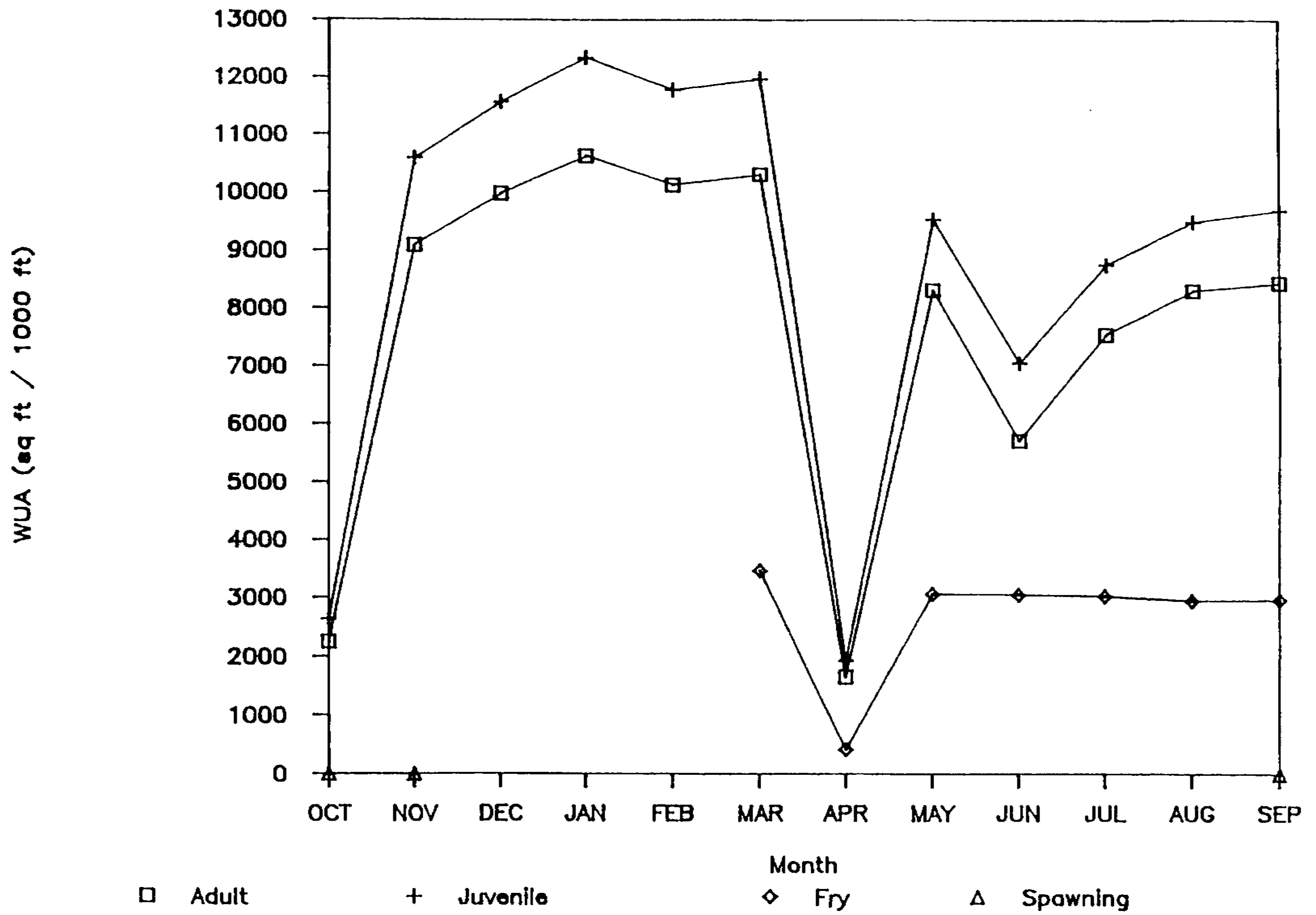


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT DISCHARGE IN THE CACHE LA POUDRE RIVER AT RUSTIC, CO

DATE 11/28/88

FIGURE 2.62



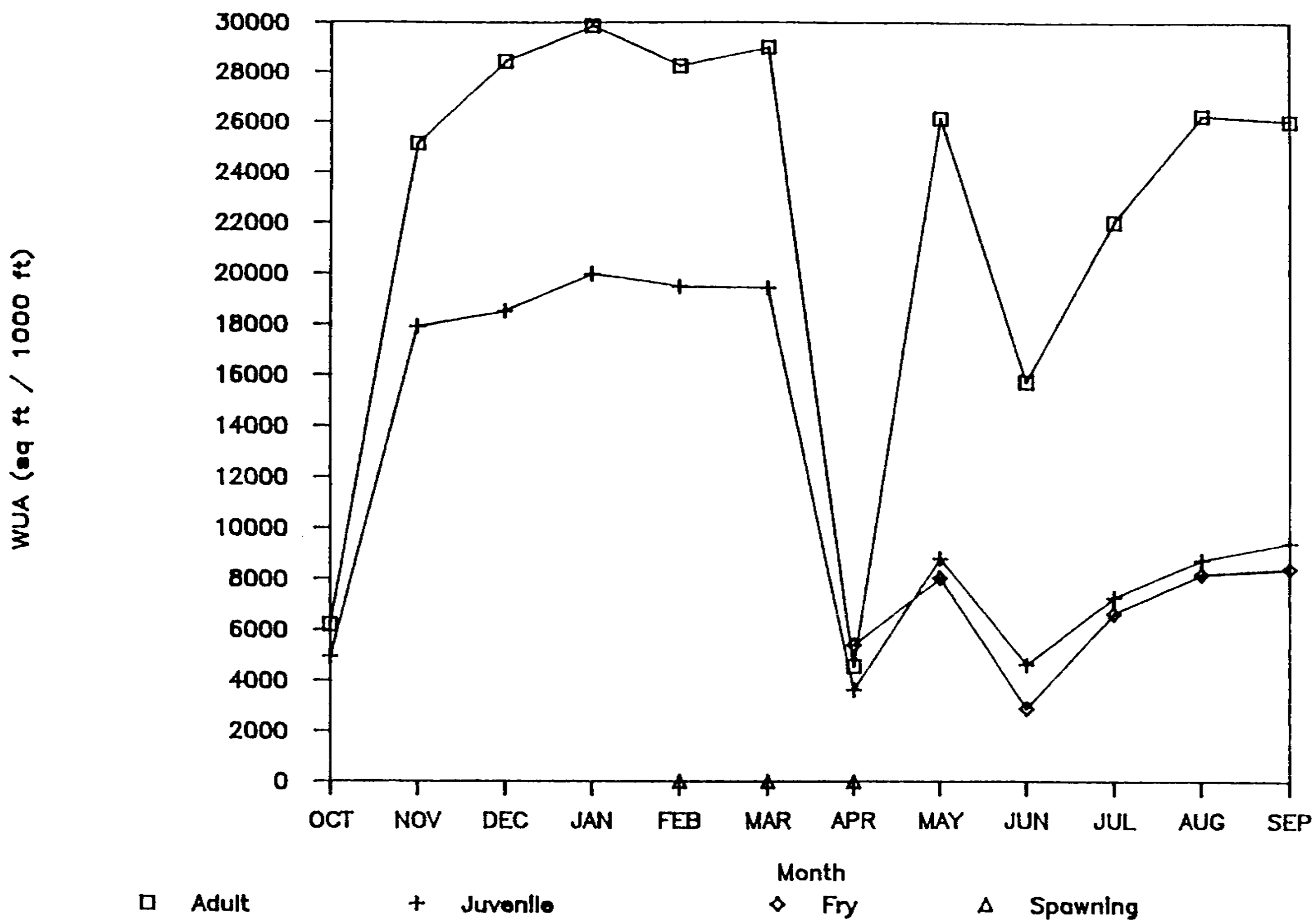
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT BROWN TROUT WUA IN SEGMENT CLP-4

DATE 11/28/88

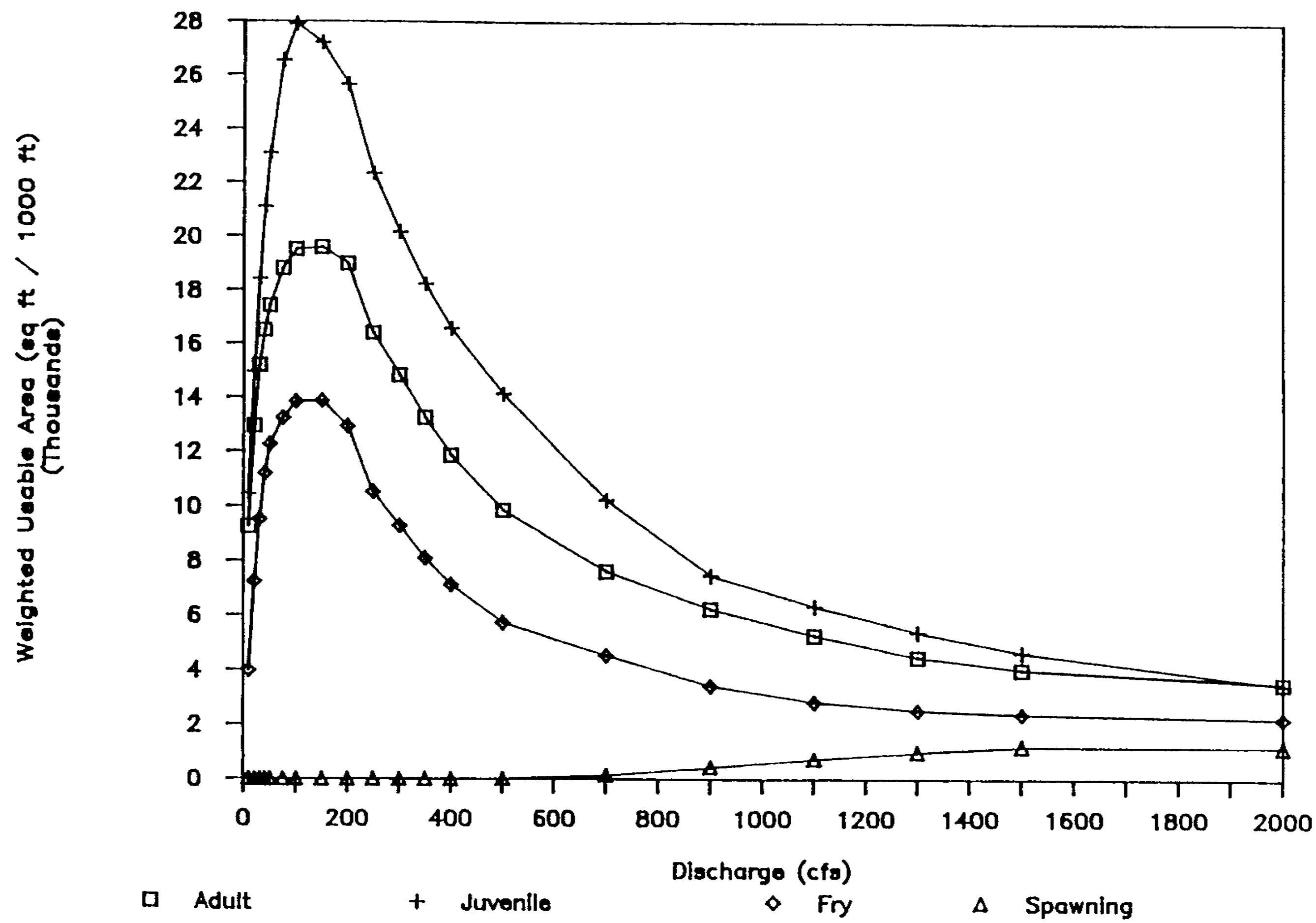
FIGURE 2.63



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT RAINBOW TROUT WUA IN SEGMENT CLP-4

DATE 11/28/88 FIGURE 2.64

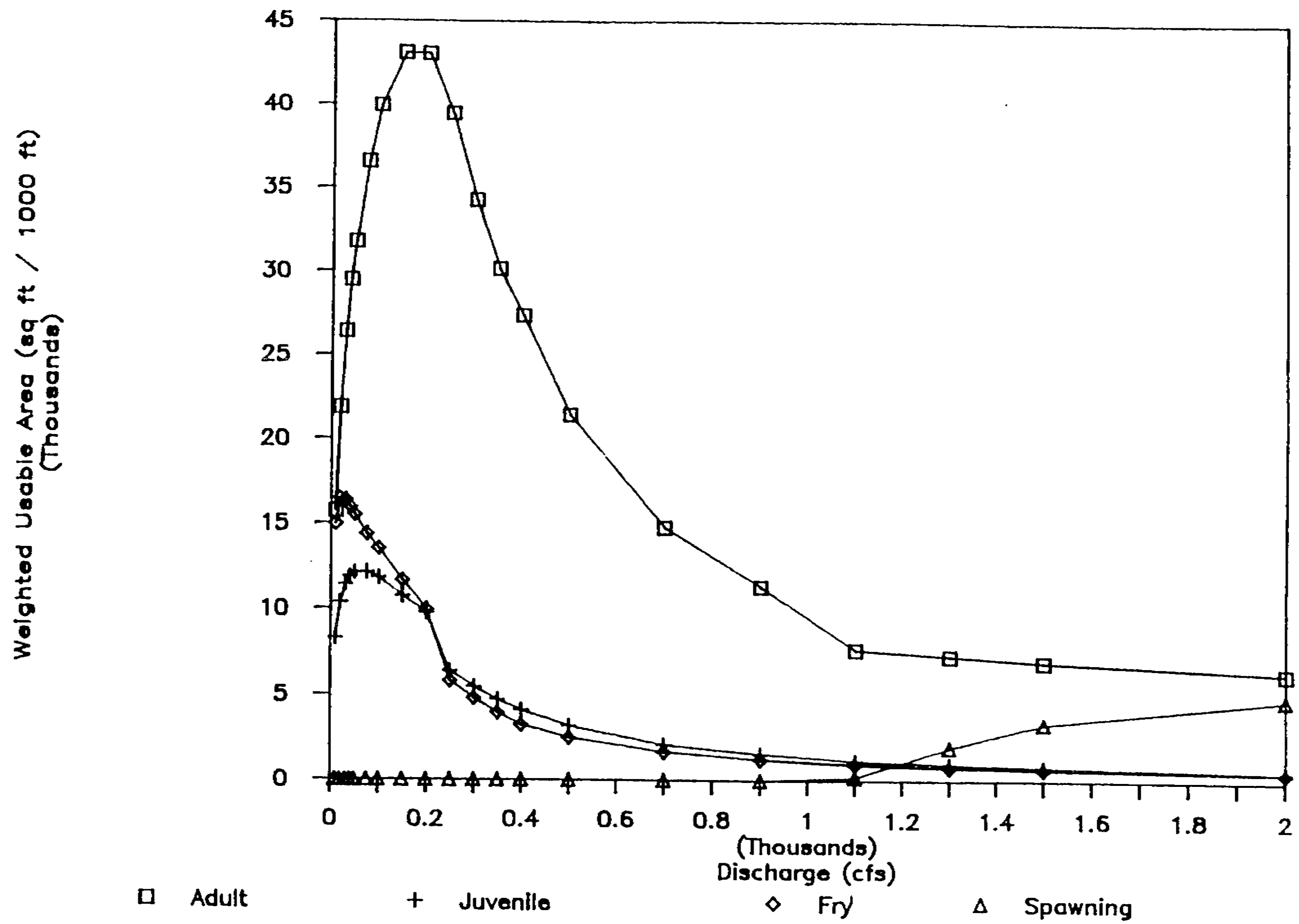


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-5

DATE 11/28/88

FIGURE 2.65

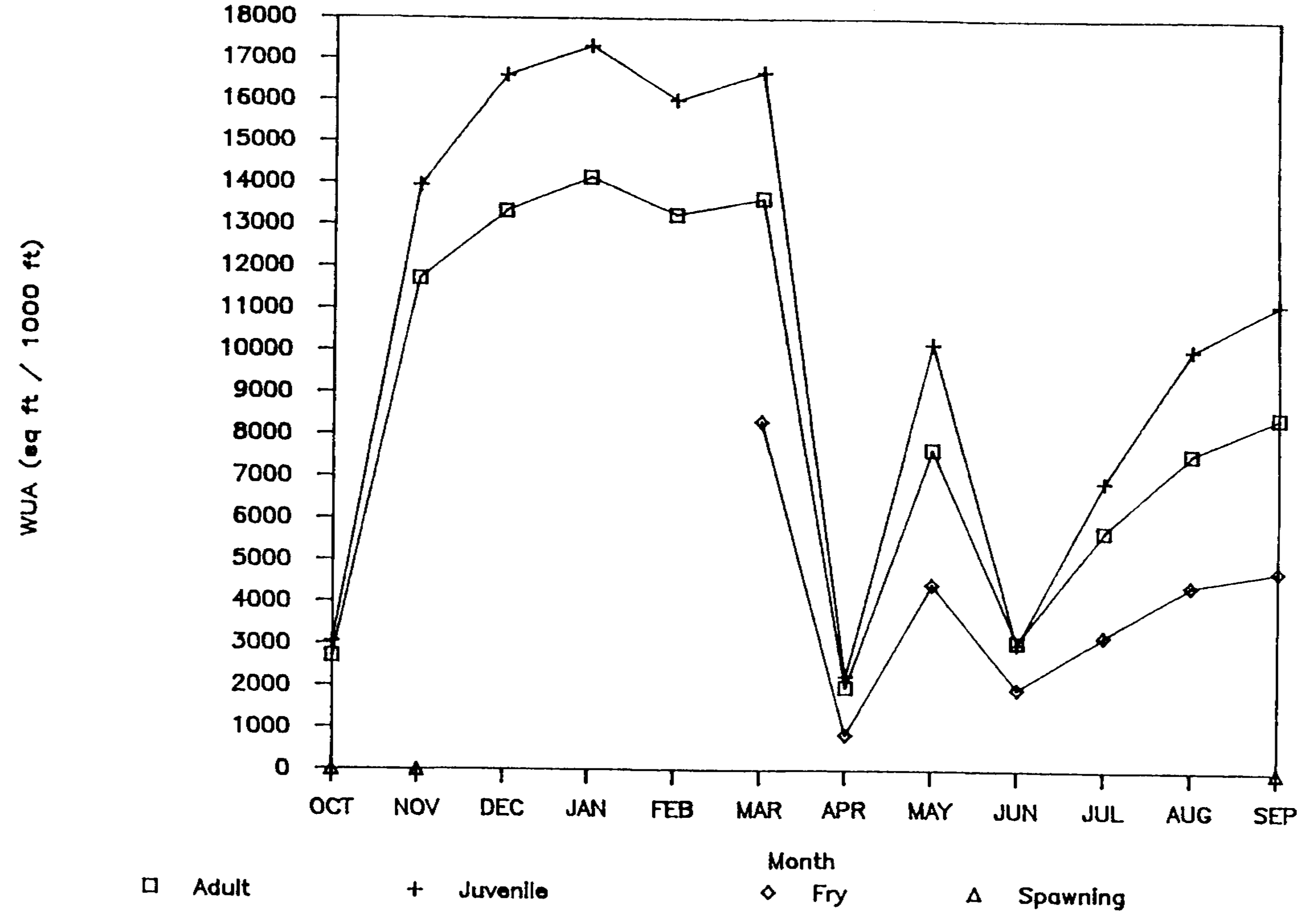


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT CLP-5

DATE 11/28/88

FIGURE 2.66

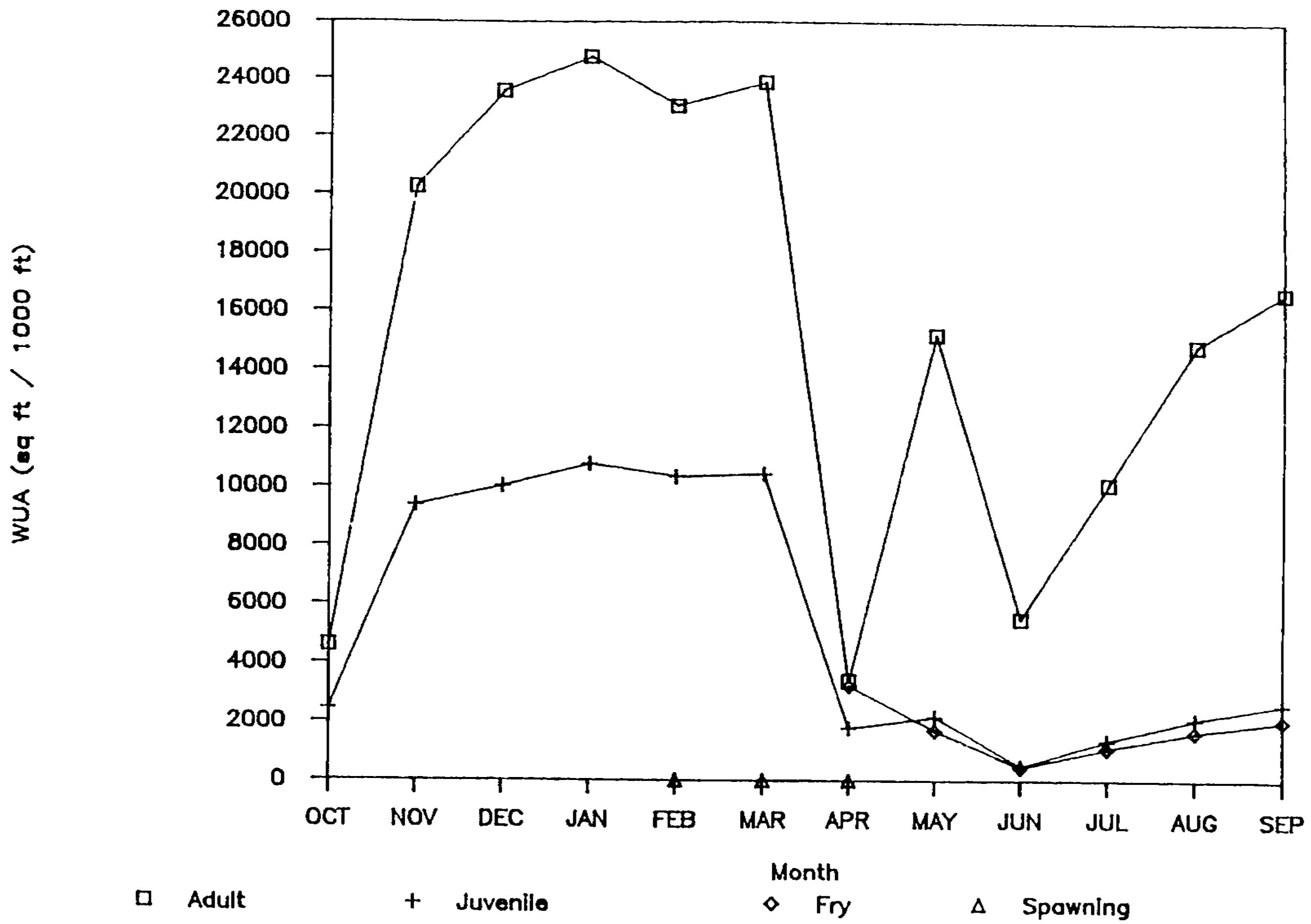


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT BROWN TROUT WUA IN SEGMENT CLP-5

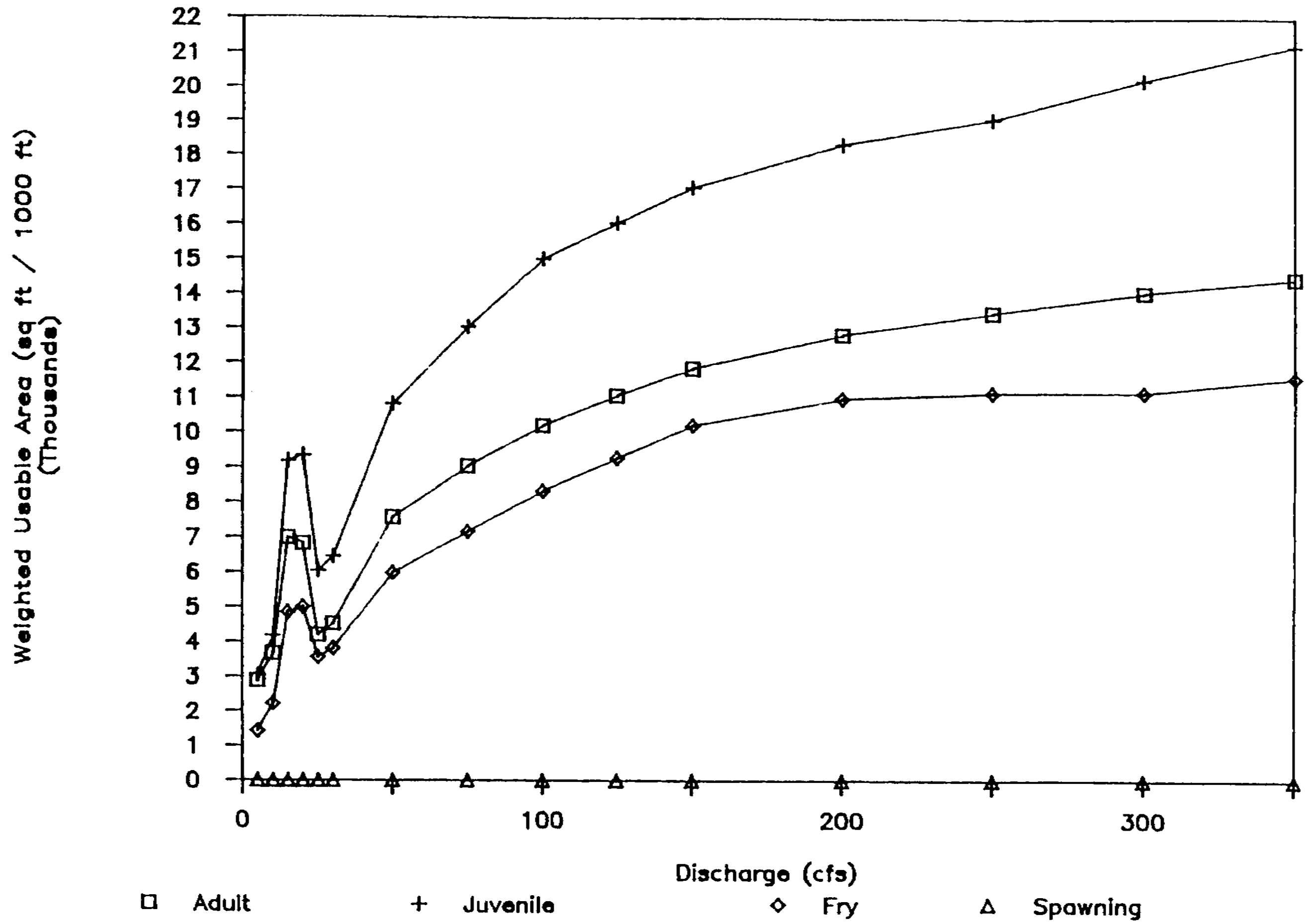
DATE 11/28/88 FIGURE 2.67



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT RAINBOW TROUT WUA IN SEGMENT CLP-5

DATE 11/28/88 FIGURE 2.68

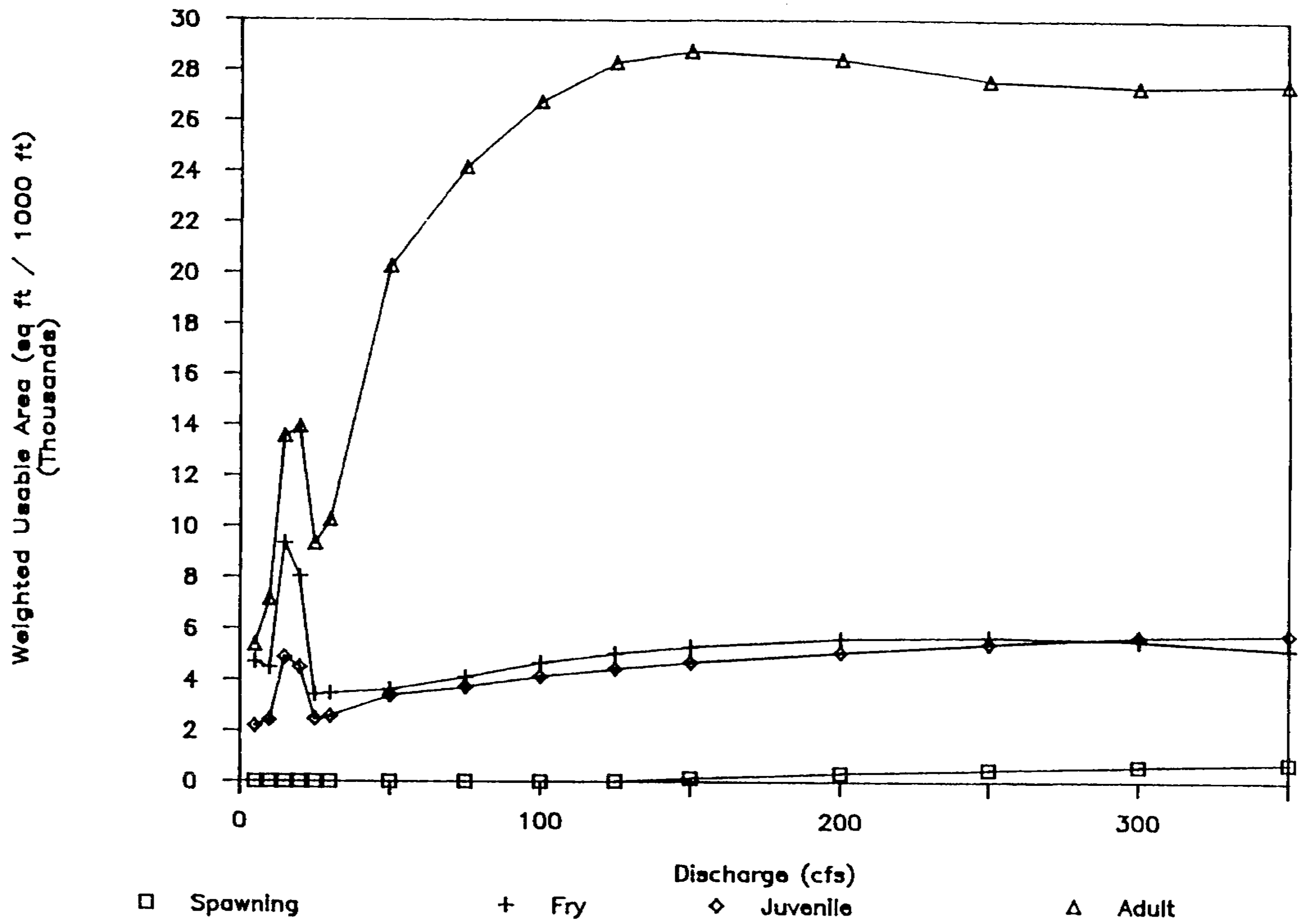


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT NFCLP-1

DATE 11/28/88 FIGURE 2.69



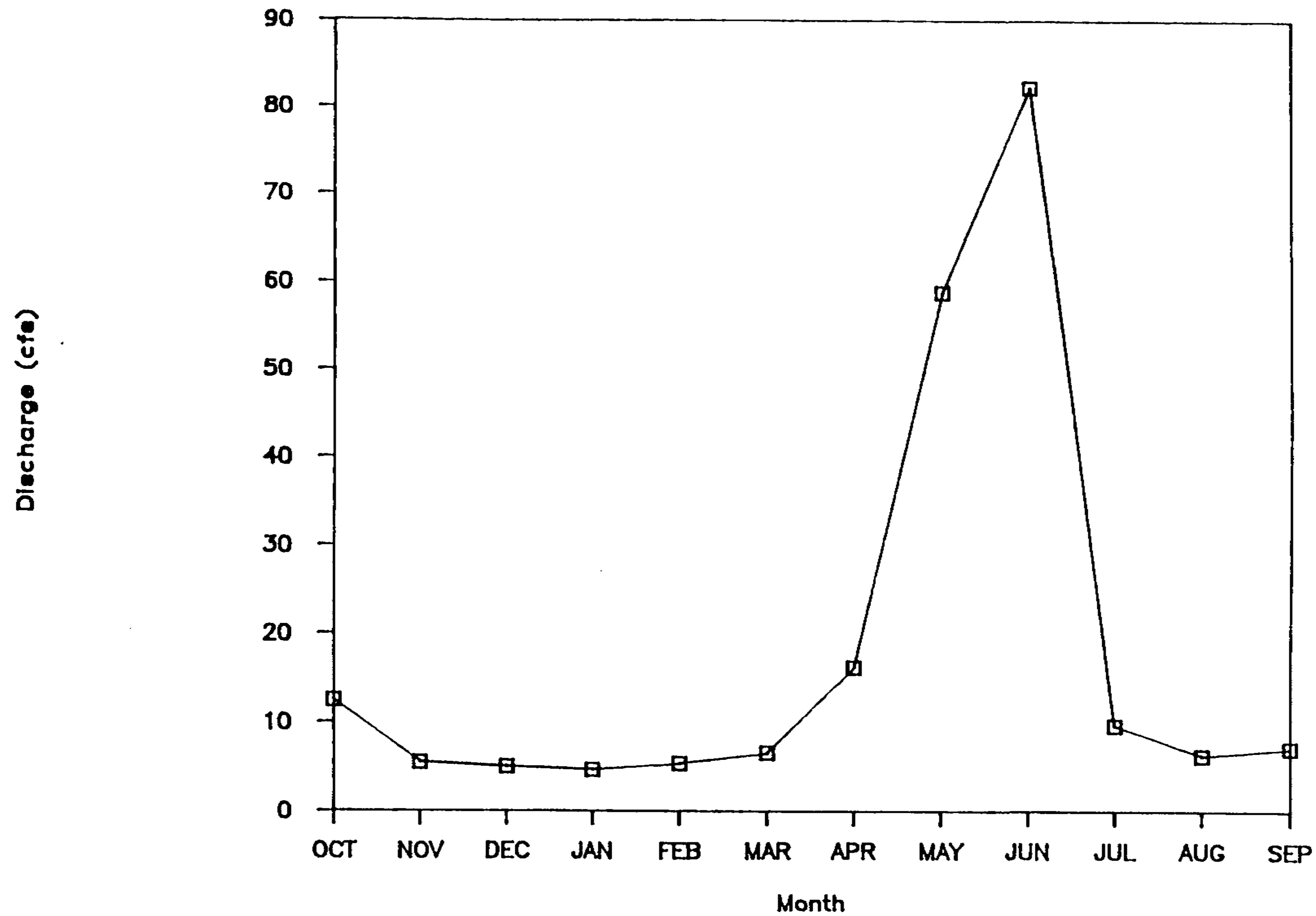
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT NFCLP-1

DATE 11/28/88

FIGURE 2.70

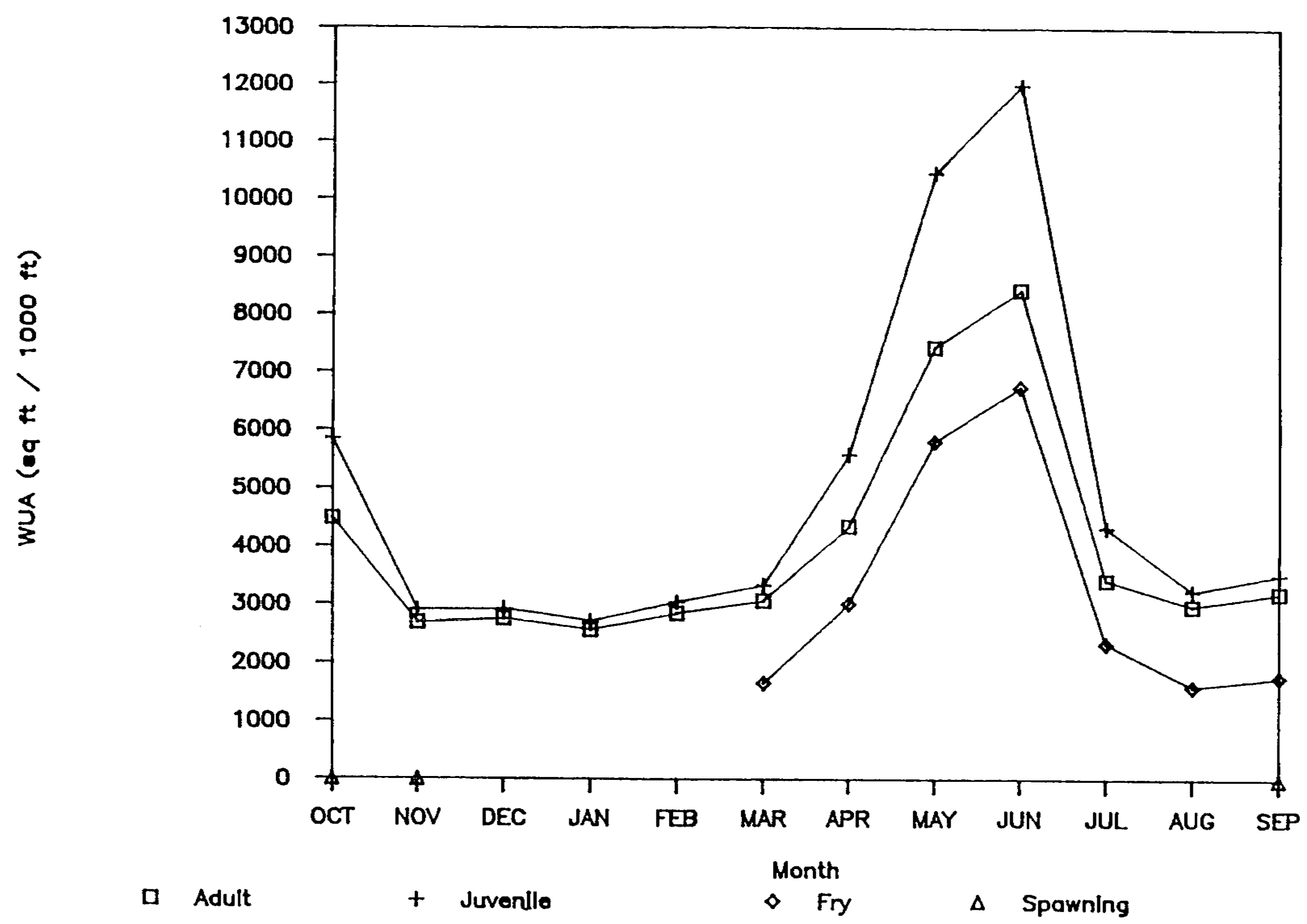


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT DISCHARGE IN SEGMENT NFCLP-1

DATE 11/28/88

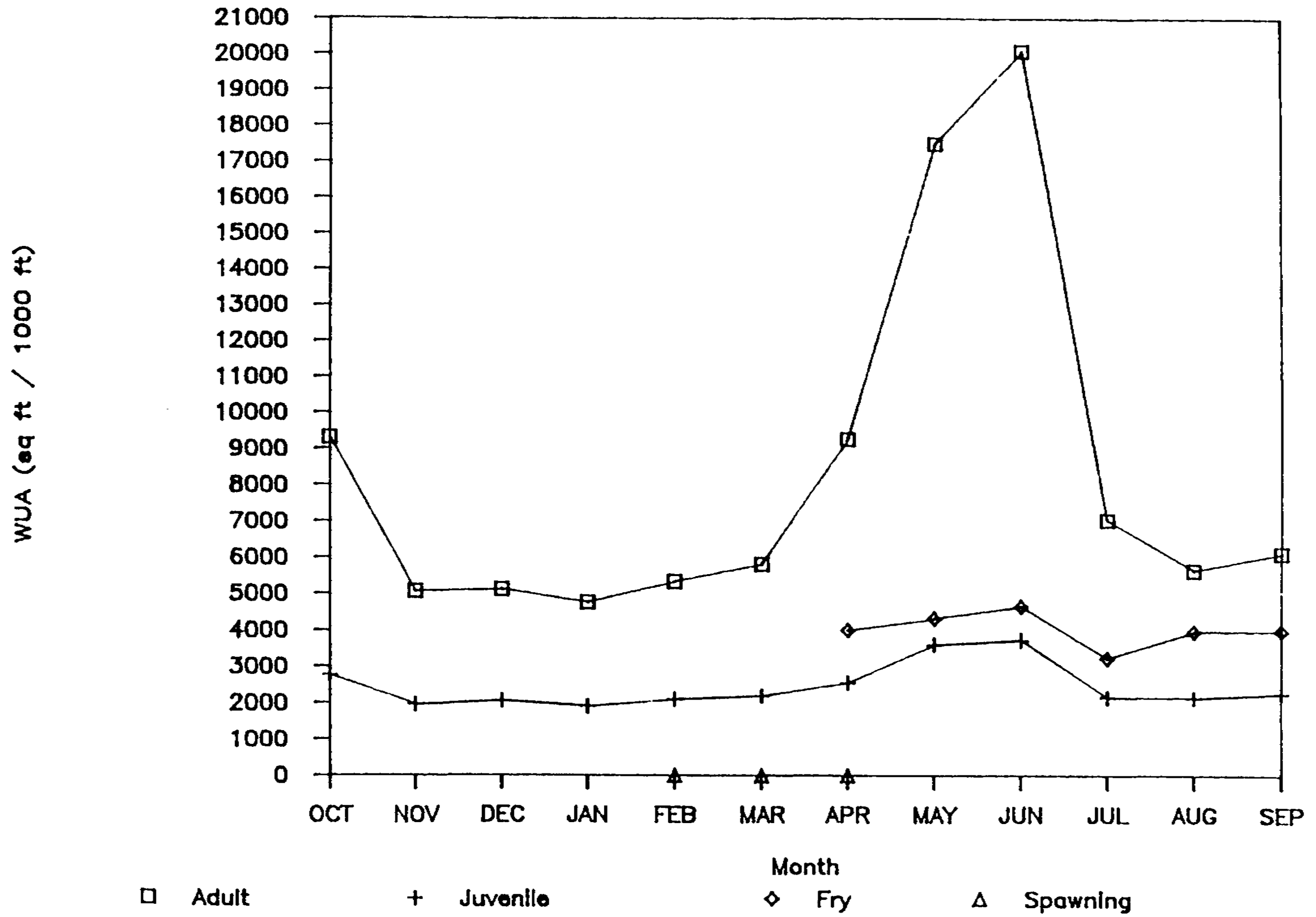
FIGURE 2.71



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT BROWN TROUT WUA IN SEGMENT NFCLP-1

DATE 11/28/88 FIGURE 2.72

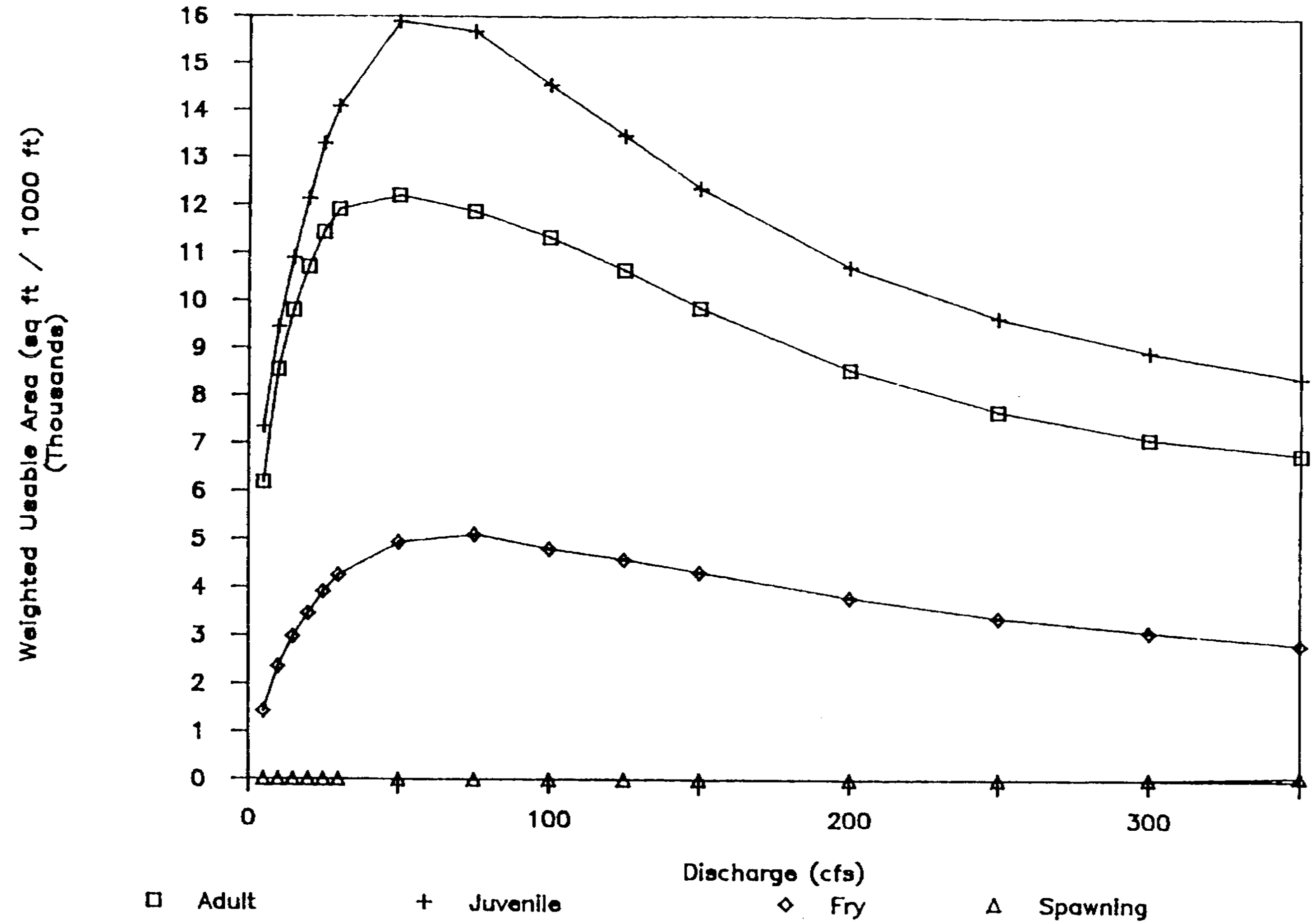


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT RAINBOW TROUT WUA IN SEGMENT NFCLP-1

DATE 11/28/88

FIGURE 2.73



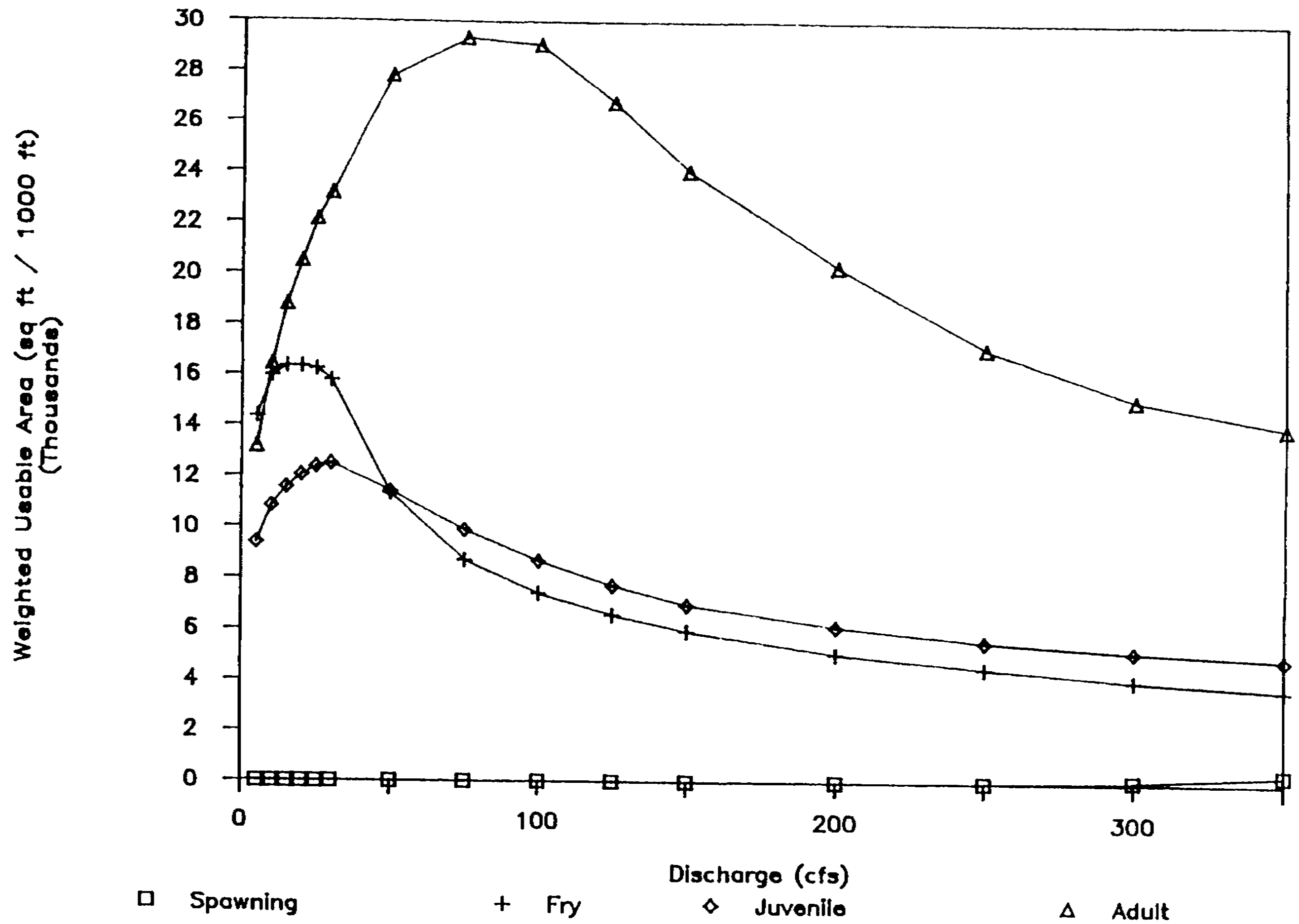
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

BROWN TROUT WUA VS. DISCHARGE RELATIONSHIP IN SEGMENT NFCLP-2

DATE 11/28/88

FIGURE 2.74

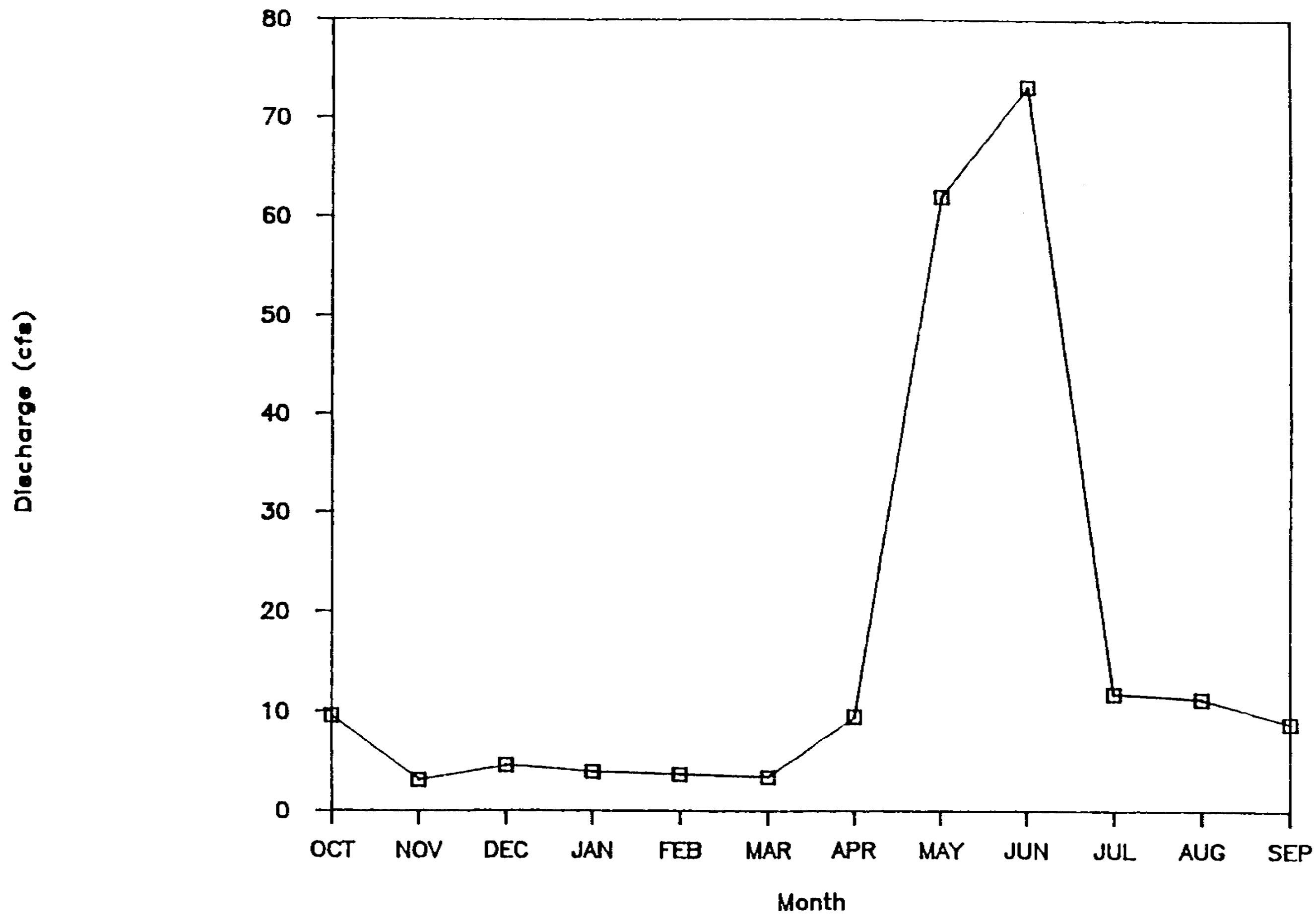


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

RAINBOW TROUT WUA VS. DISCHARGE
RELATIONSHIP IN SEGMENT NFCLP-2

DATE 11/28/88

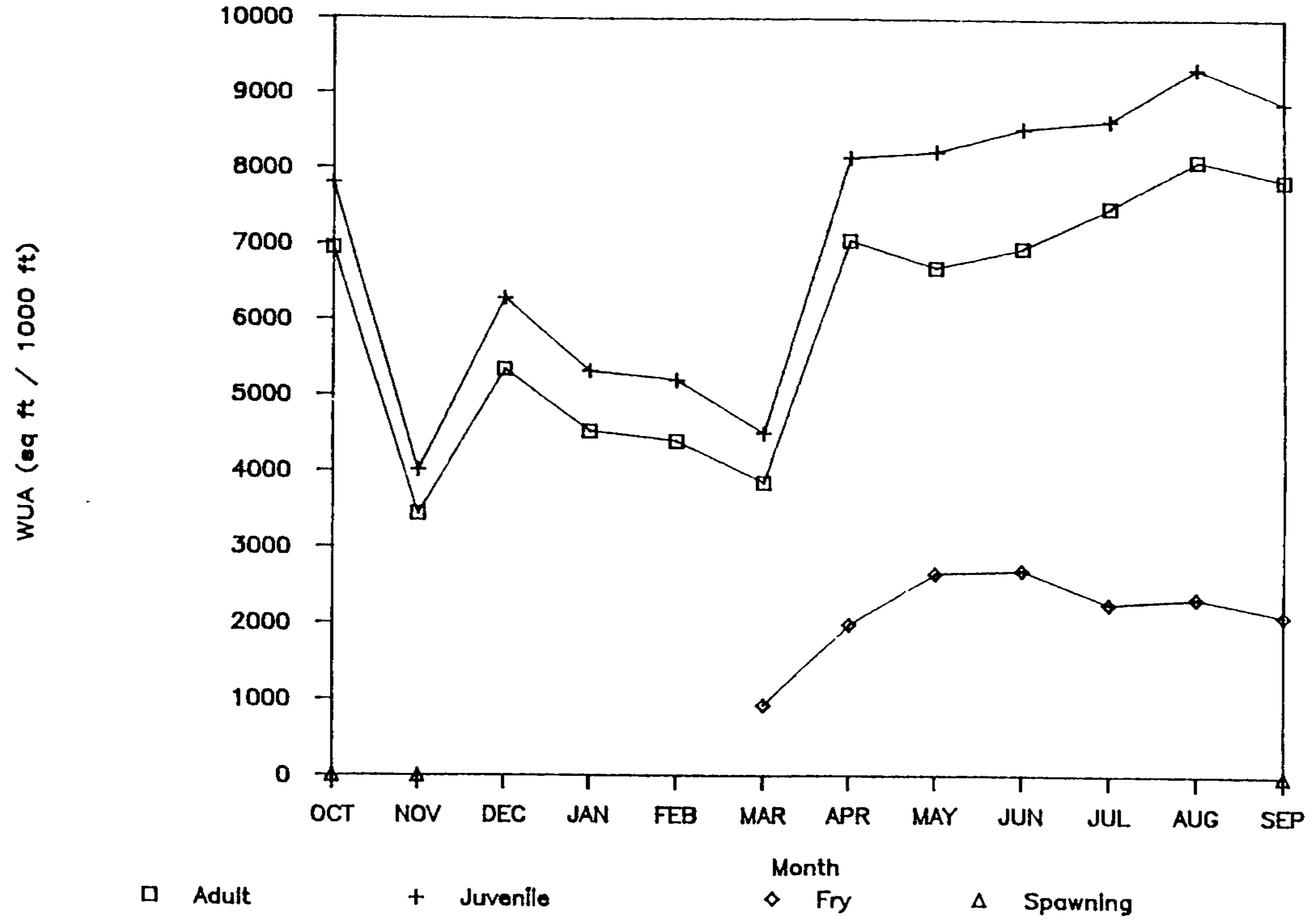
FIGURE 2.75



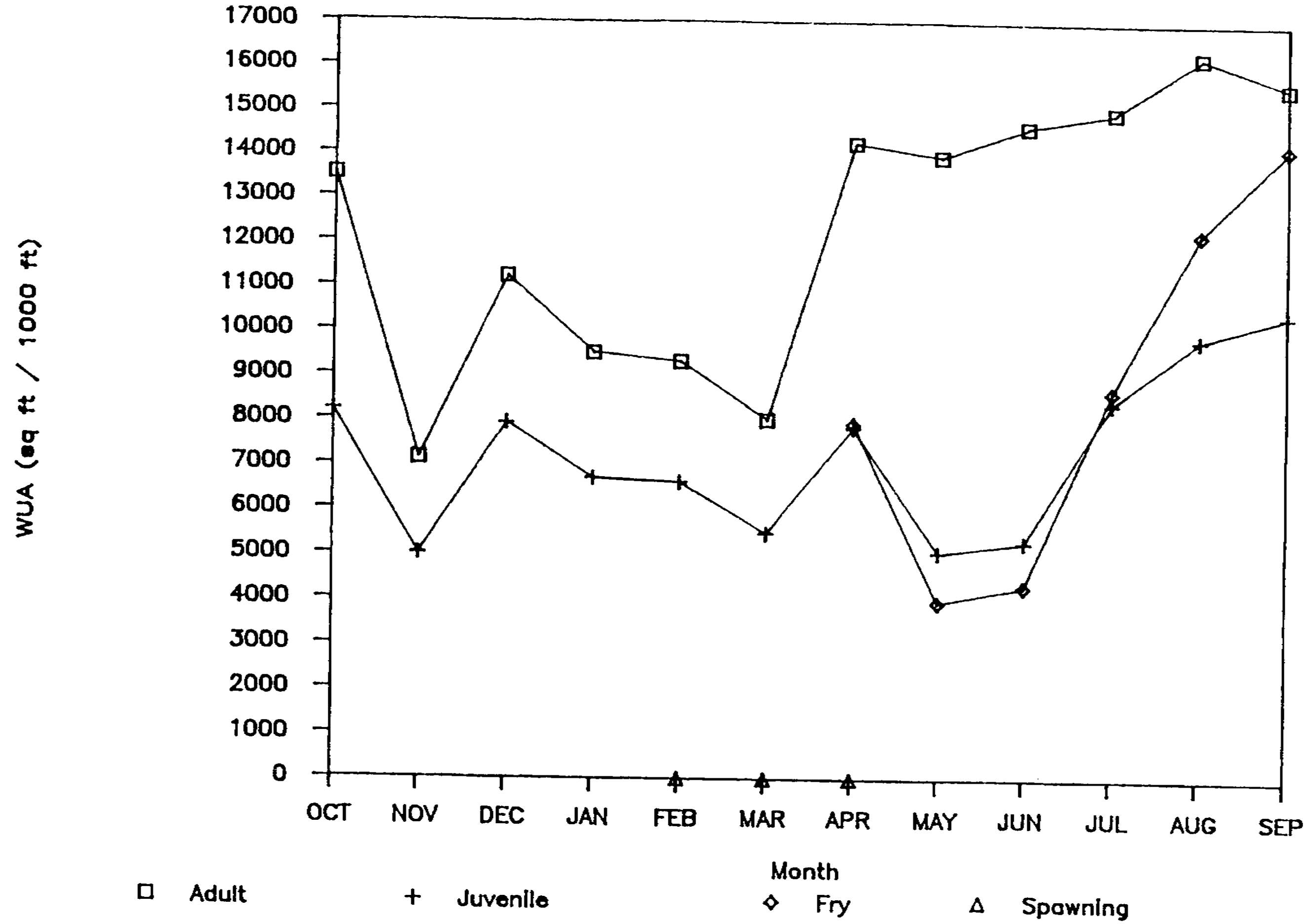
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT DISCHARGE IN SEGMENT NFCLP-2

DATE 11/28/88 FIGURE 2.76



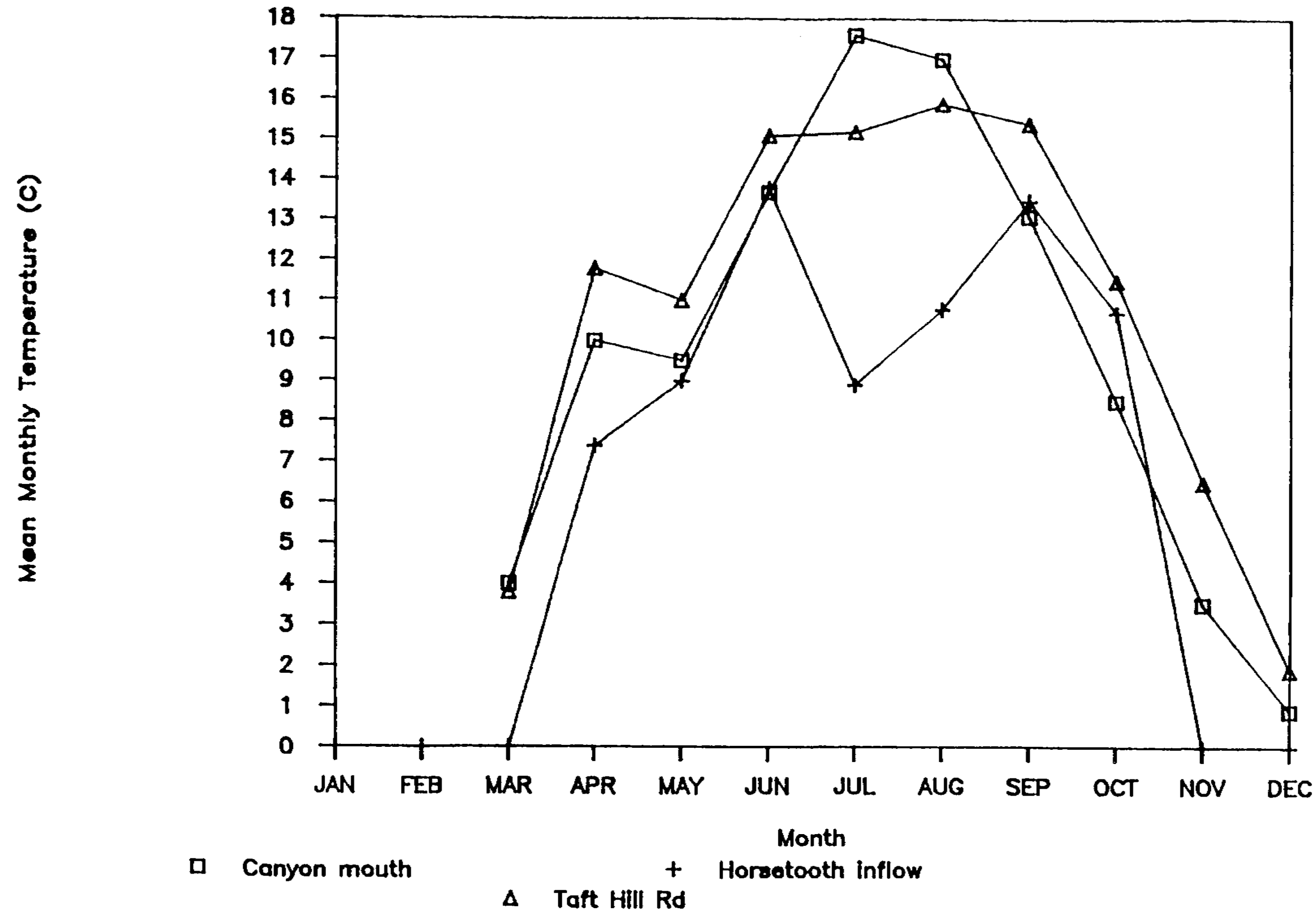
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY CACHE LA POUDRE WATER AND POWER PROJECT
MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT BROWN TROUT WUA IN SEGMENT NFCLP-2
DATE 11/28/88 FIGURE 2.77



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

MONTHLY 50 TO 90 PERCENT EXCEEDANCE PLOT OF PREPROJECT RAINBOW TROUT WUA IN SEGMENT NFCLP-2

DATE 11/28/88 FIGURE 2.78

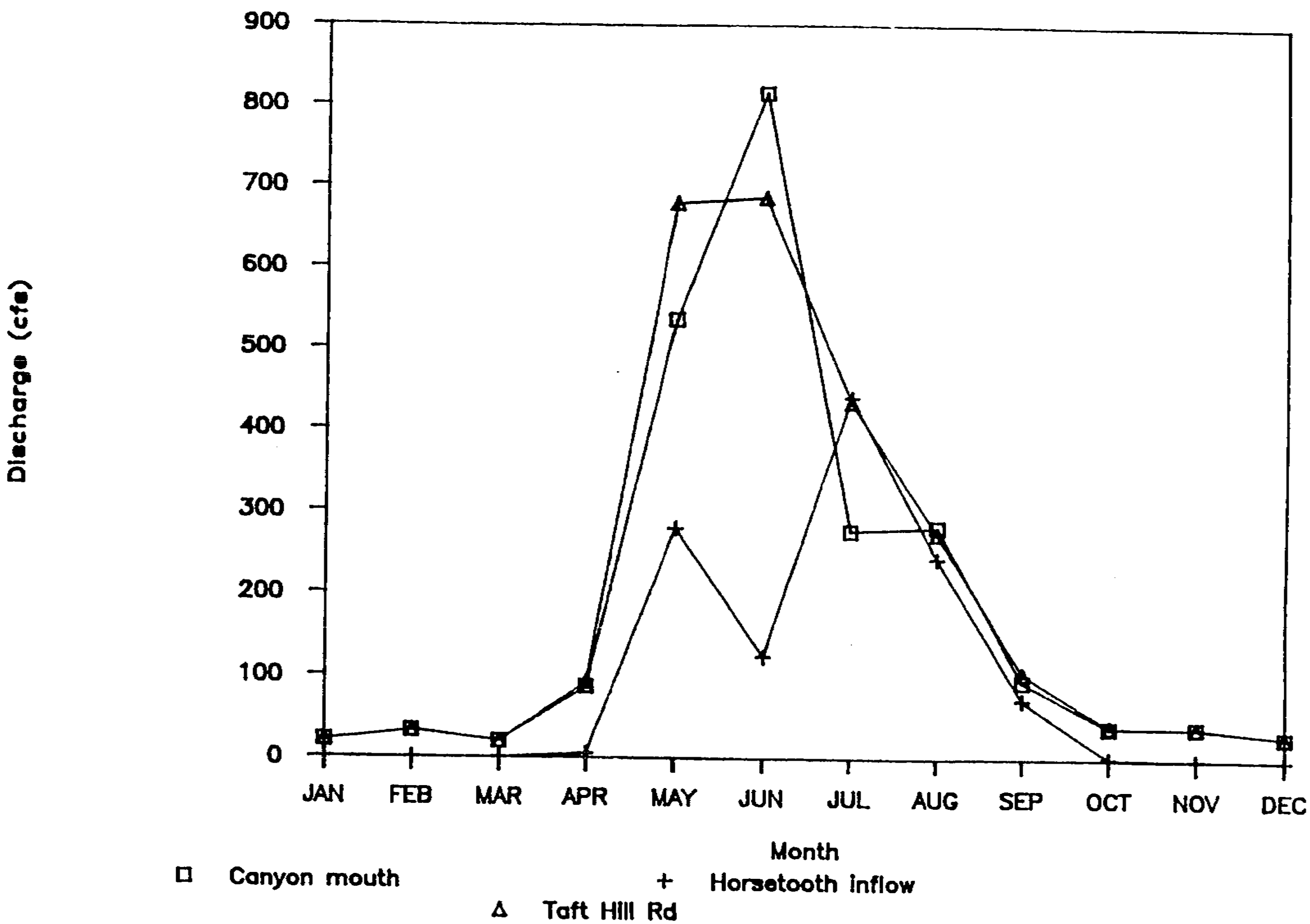


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

1987 MONITORED WATER
TEMPERATURES

DATE 11/28/88

FIGURE 2.79



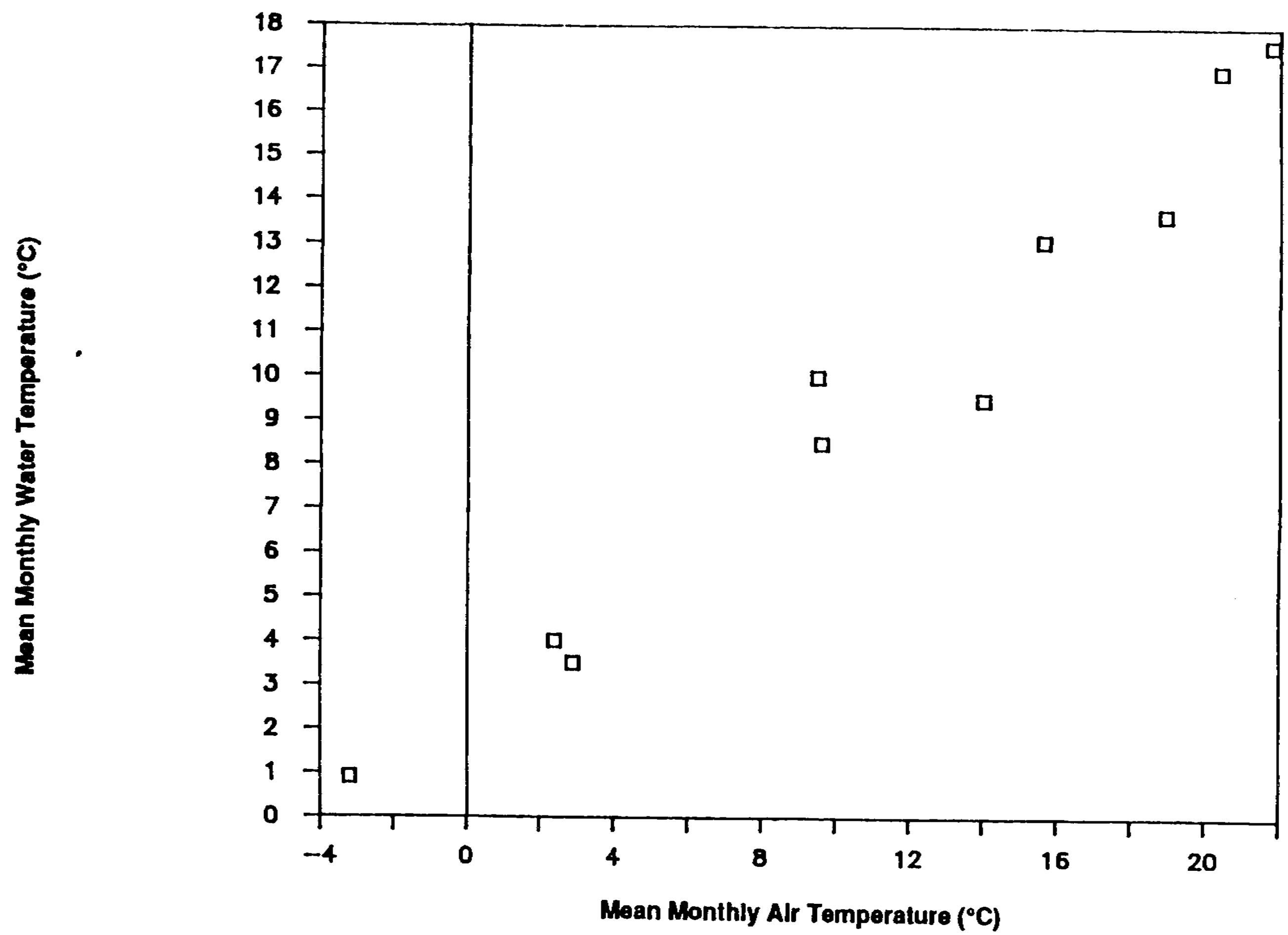
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

1987 POUDRE RIVER DISCHARGE AT MONITORING STATIONS

DATE 11/28/88

FIGURE 2.80

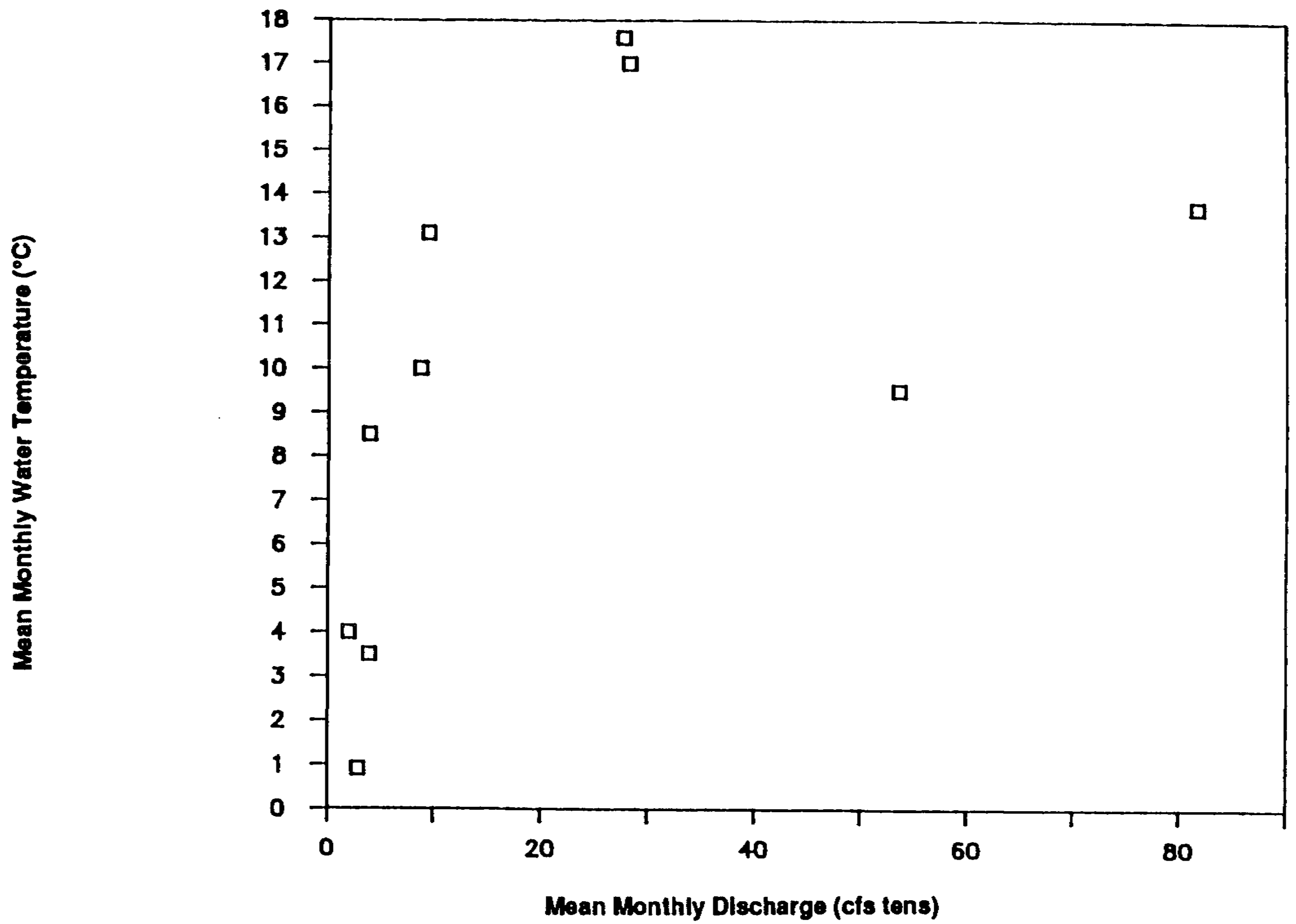


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

1987 WATER VS. AIR TEMPERATURE
AT CANYON MOUTH

DATE 11/28/88

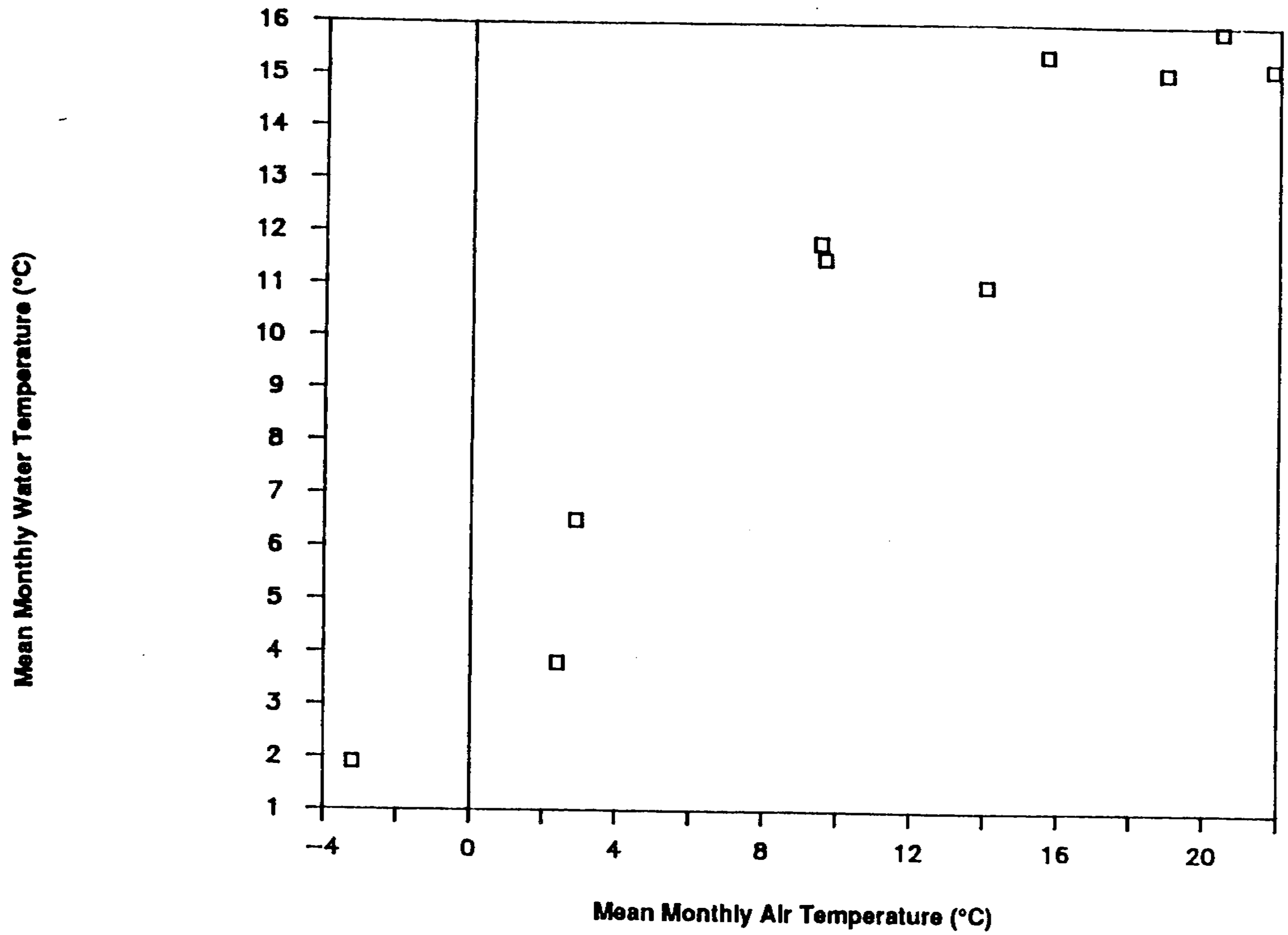
FIGURE 2.81



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

1987 WATER TEMPERATURE VS.
DISCHARGE AT CANYON MOUTH

DATE 11/28/88 FIGURE 2.82

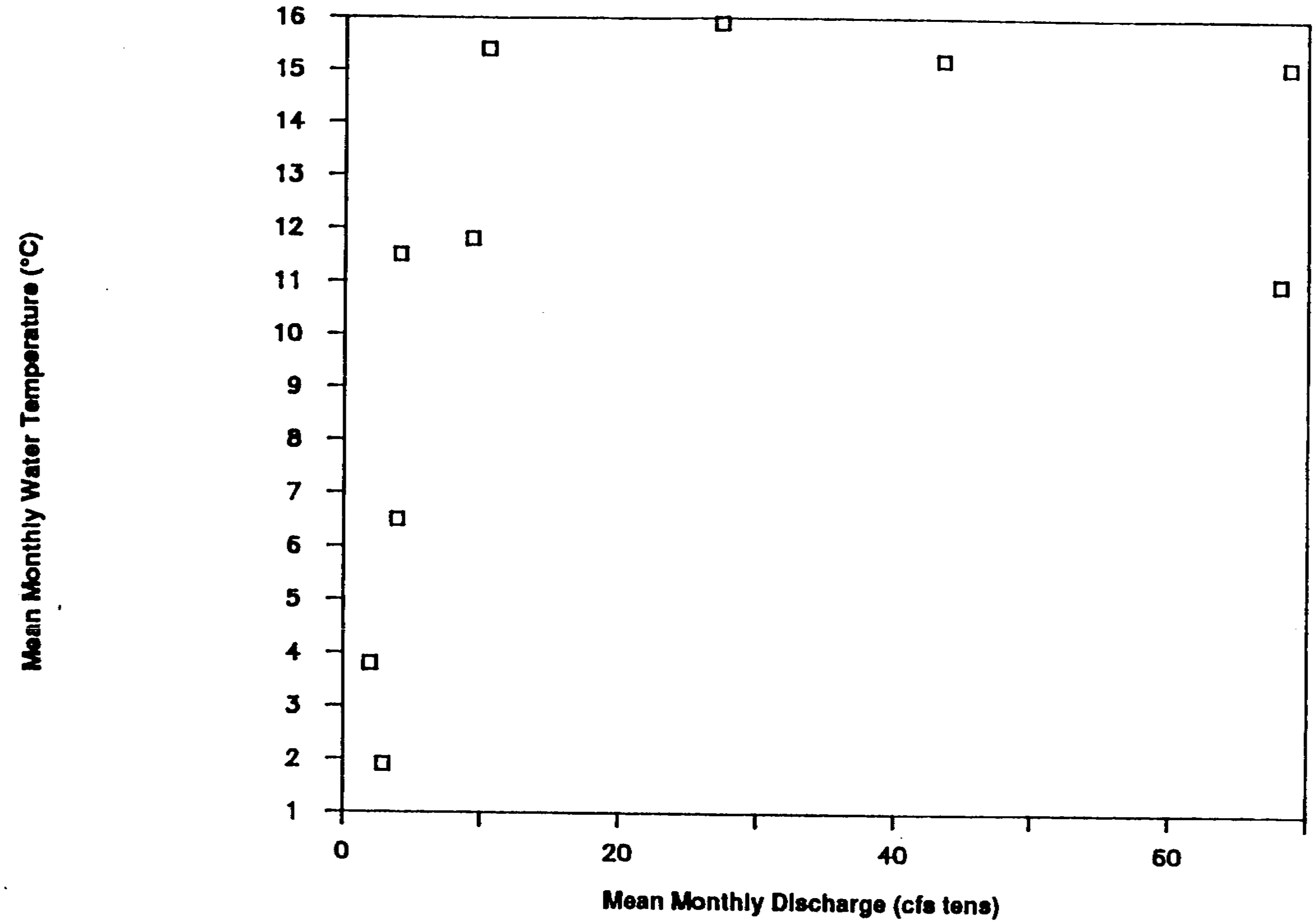


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

1987 WATER VS. AIR TEMPERATURE
AT TAFT HILL ROAD

DATE 11/28/88

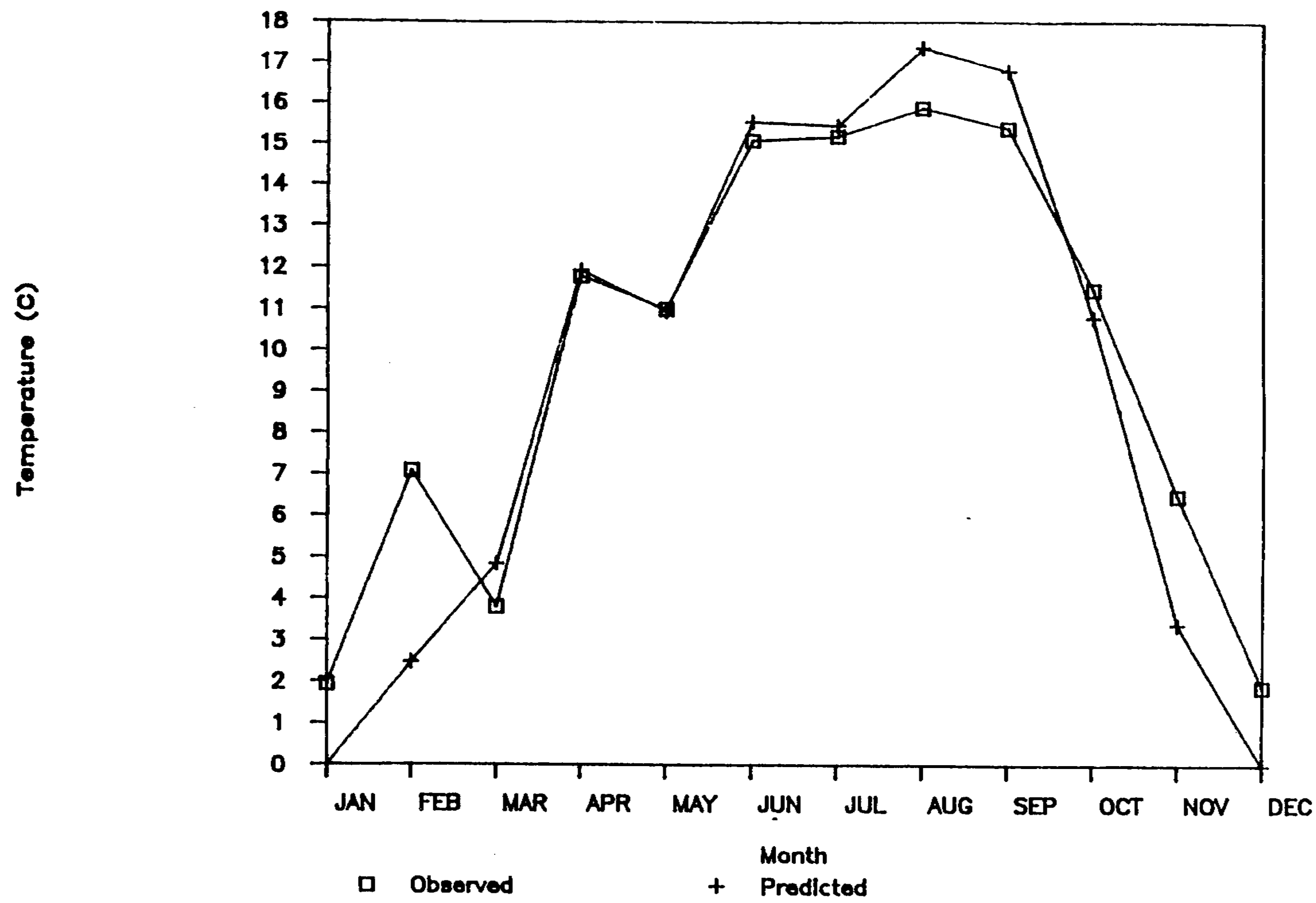
FIGURE 2.83



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

1987 WATER TEMPERATURE VS.
DISCHARGE AT TAFT HILL ROAD

DATE 11/28/88 FIGURE 2.84

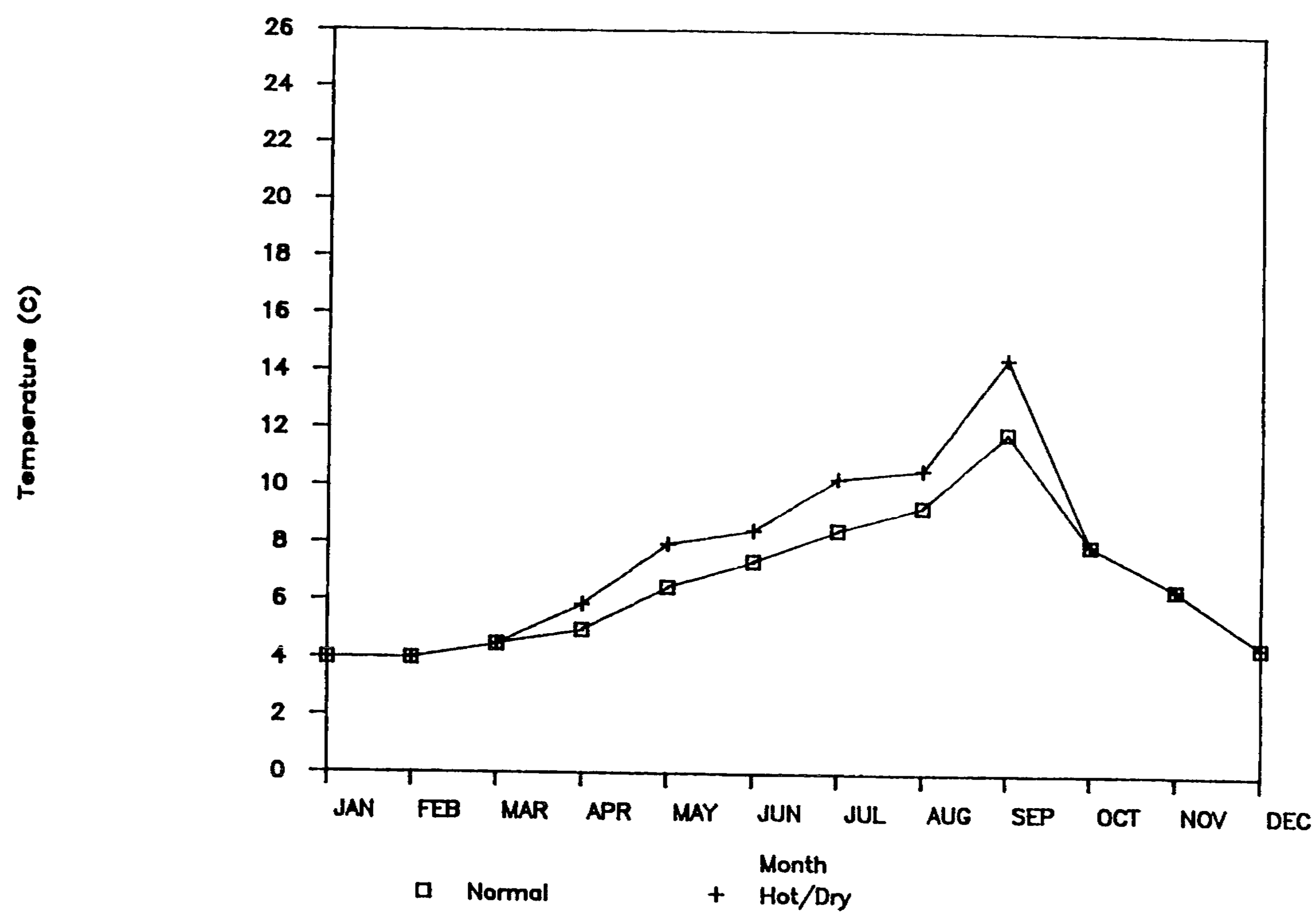


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

1987 PREDICTED VS. OBSERVED TEMPERATURE AT TAFT HILL ROAD

DATE 11/28/88

FIGURE 2.85



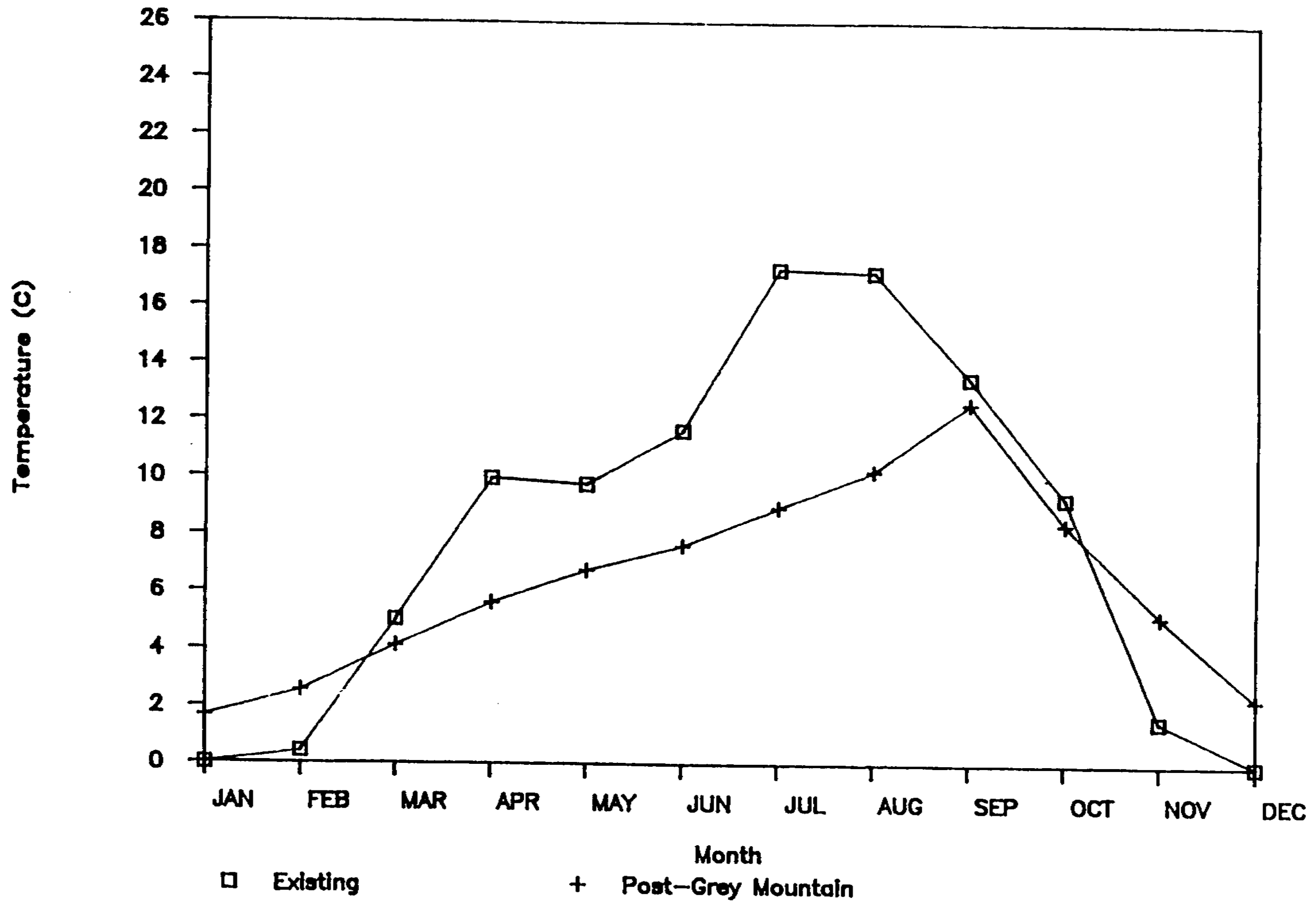
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER MODELED RELEASE TEMPERATURES

DATE 11/28/88

FIGURE 2.86



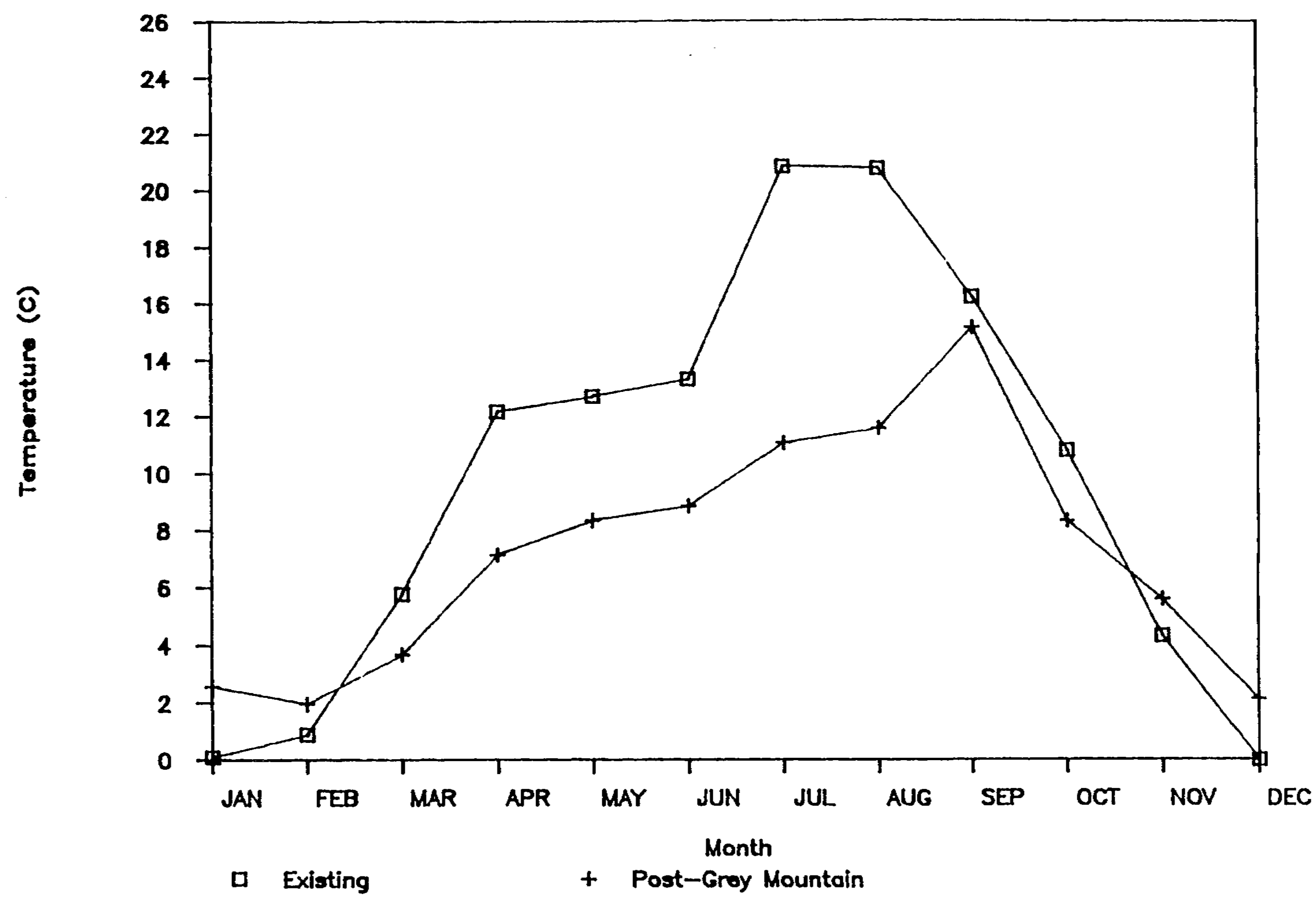
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER NORMAL YEAR TEMPERATURES AT CANYON MOUTH

DATE 11/28/88

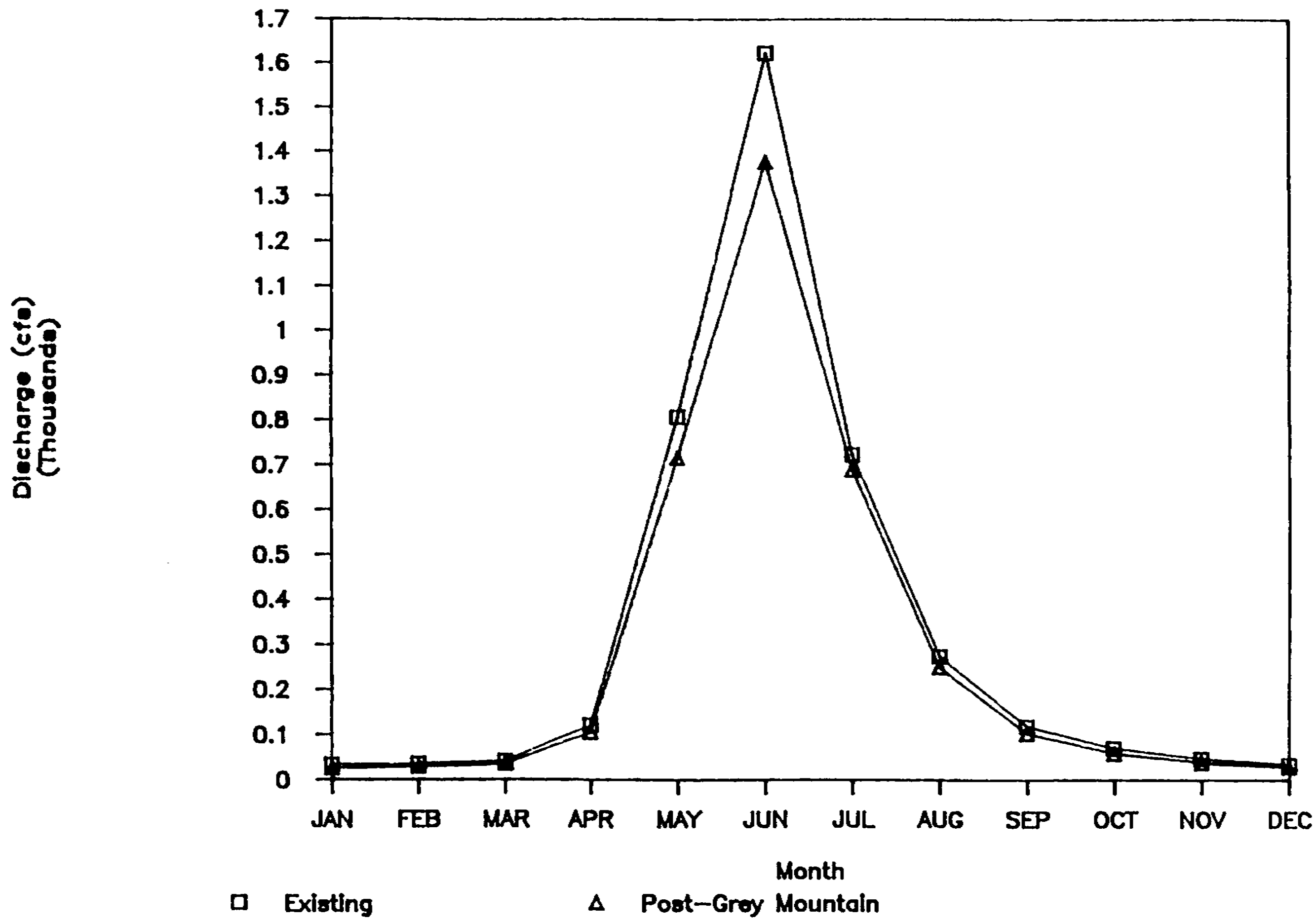
FIGURE 2.87



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER HOT/DRY YEAR TEMPERATURES AT CANYON MOUTH

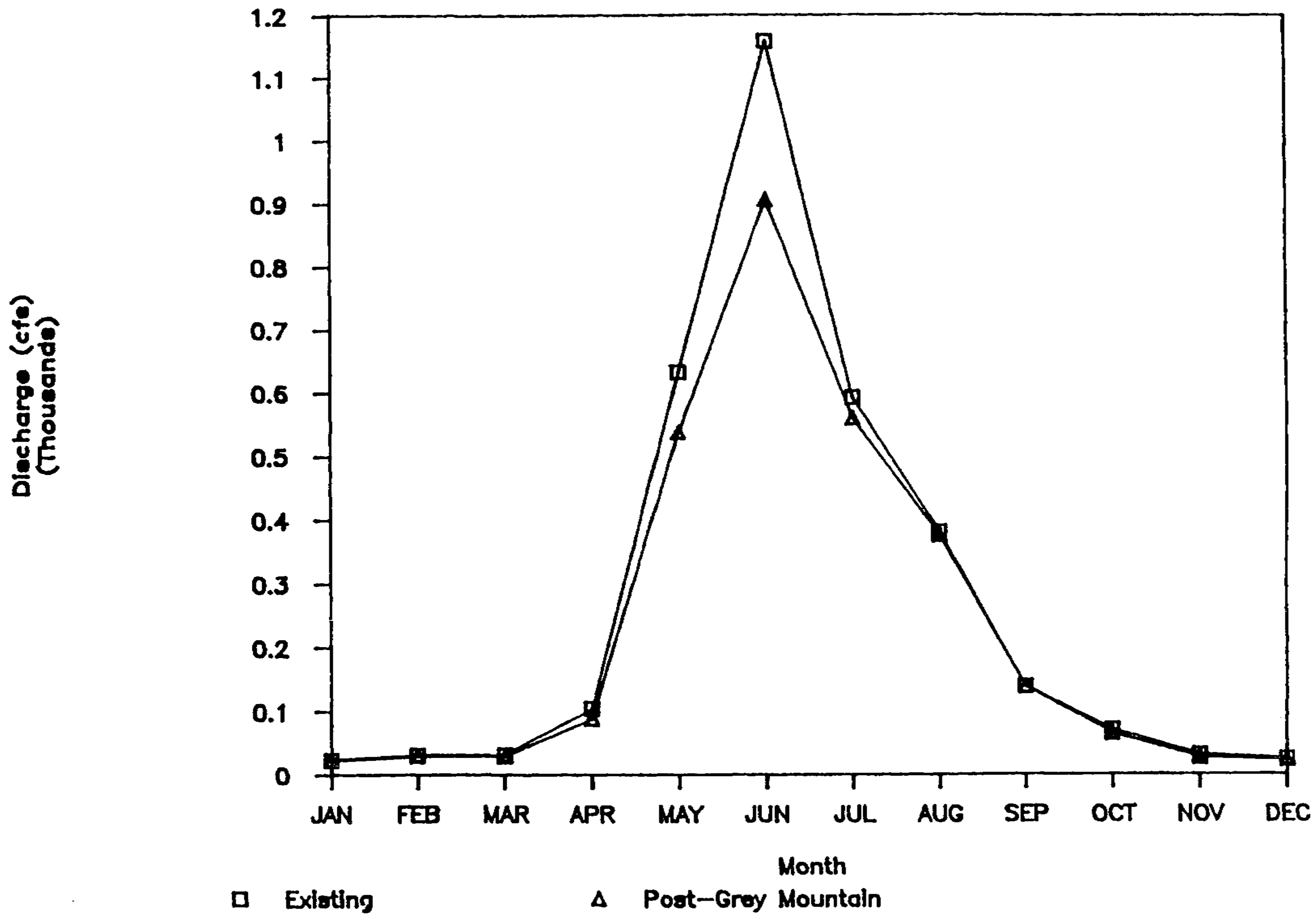
DATE 11/28/88 FIGURE 2.88



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER NORMAL DISCHARGE
AT CANYON MOUTH

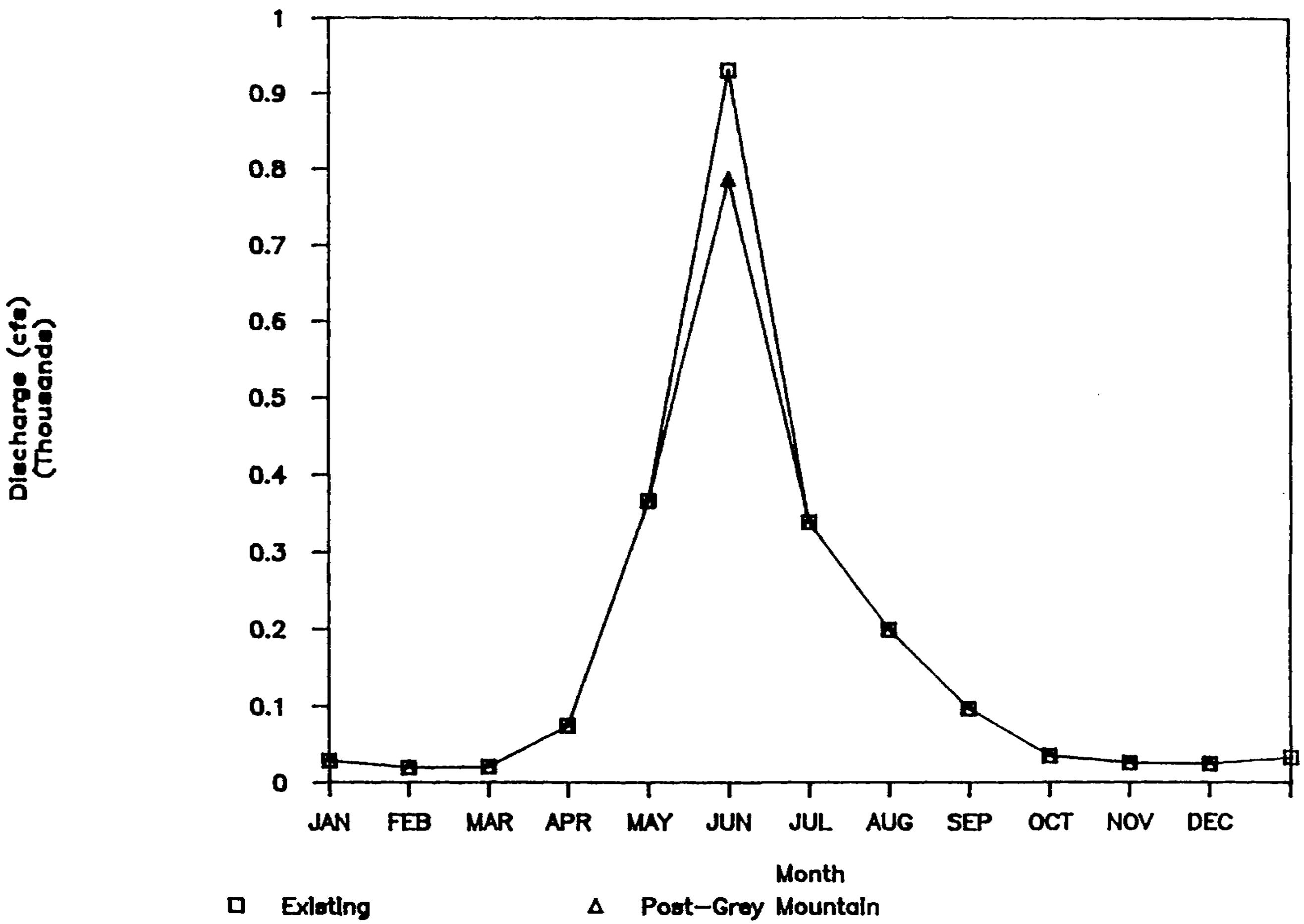
DATE 11/28/88 FIGURE 2.89



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER NORMAL DISCHARGE
YEAR AT TAFT HILL ROAD

DATE 11/28/88 FIGURE 2.90

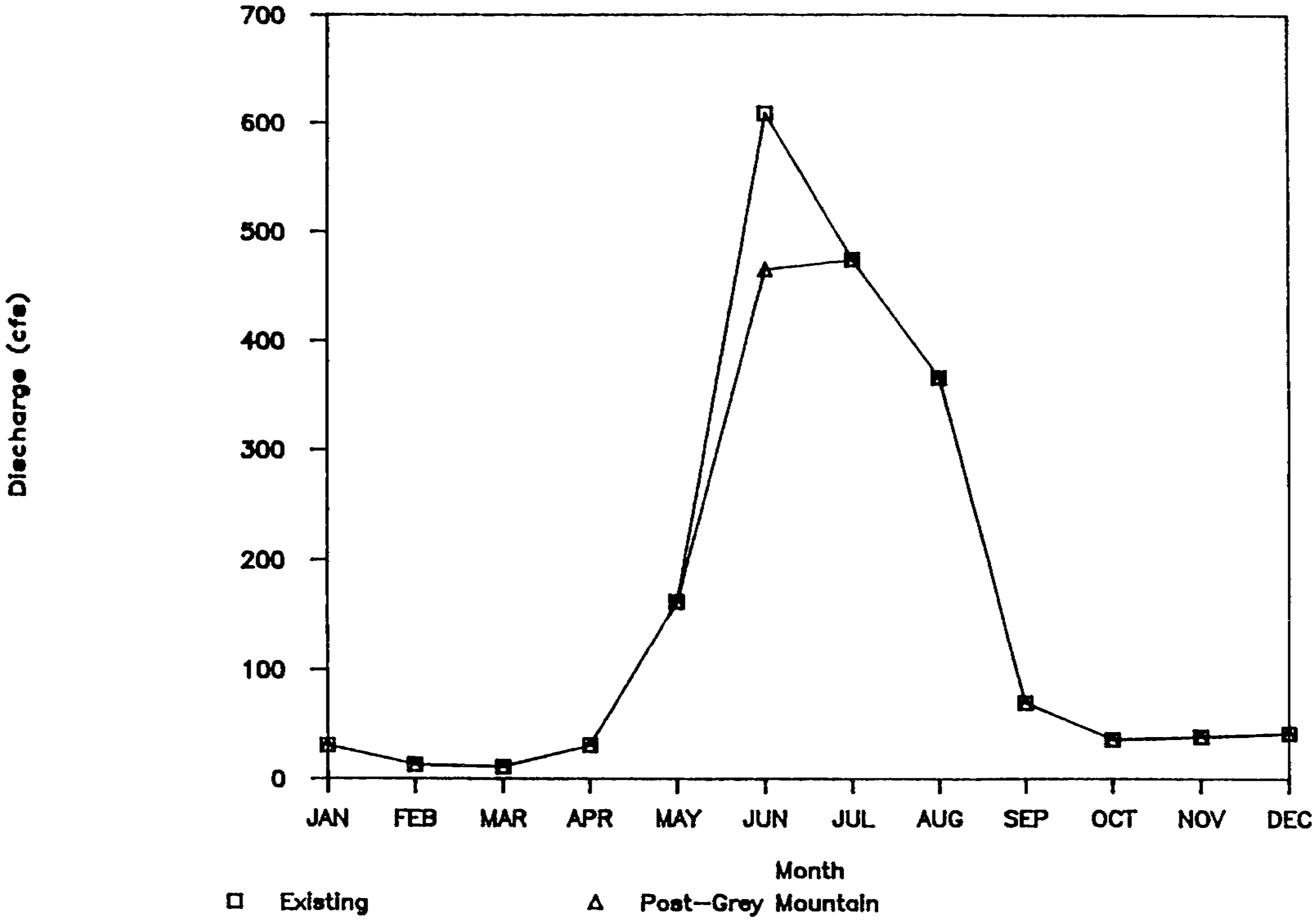


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER HOT/DRY YEAR
DISCHARGE AT CANYON MOUTH

DATE 11/28/88

FIGURE 2.91

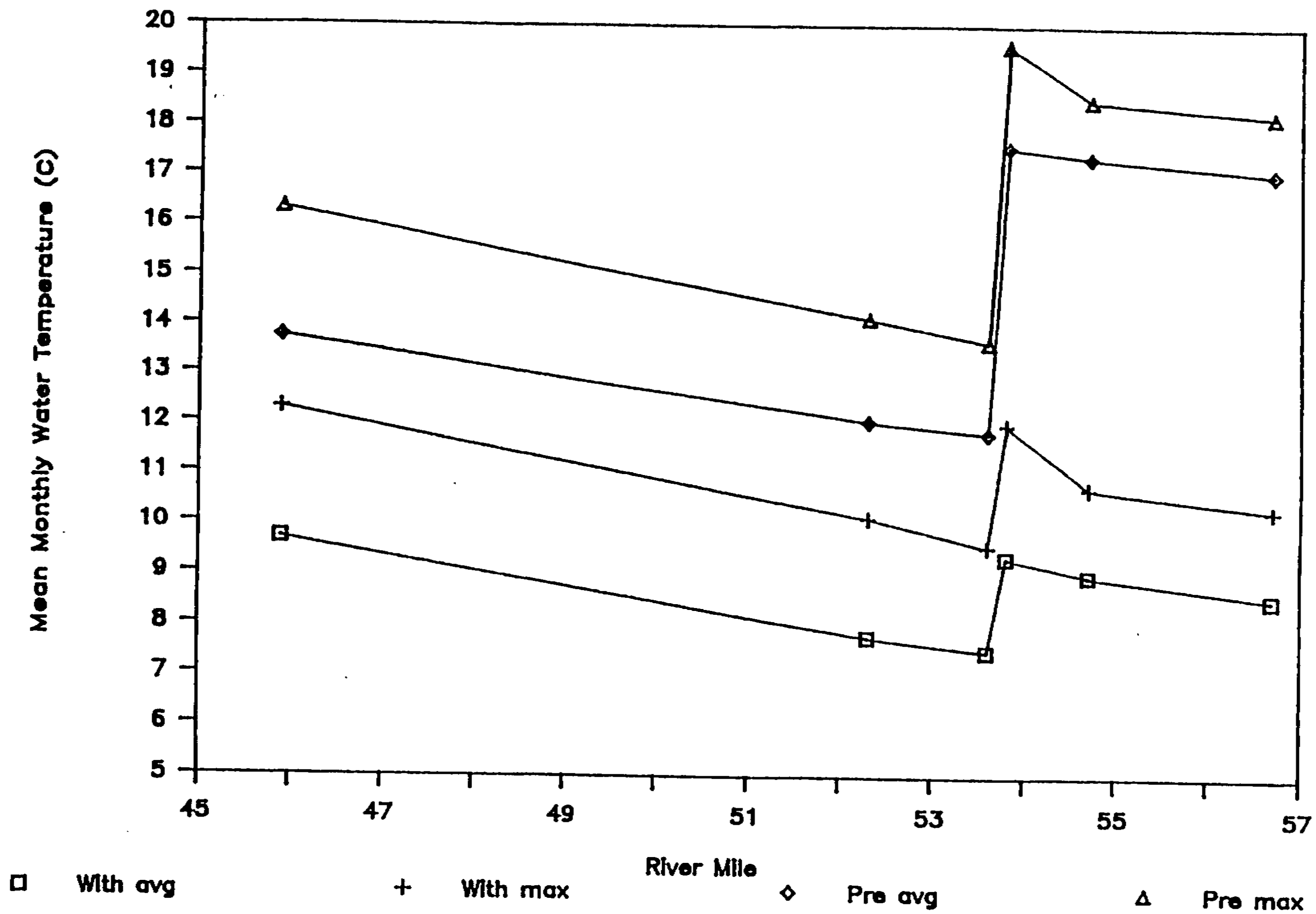


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER HOT/DRY YEAR
DISCHARGE AT TAFT HILL ROAD

DATE 11/28/88

FIGURE 2.92

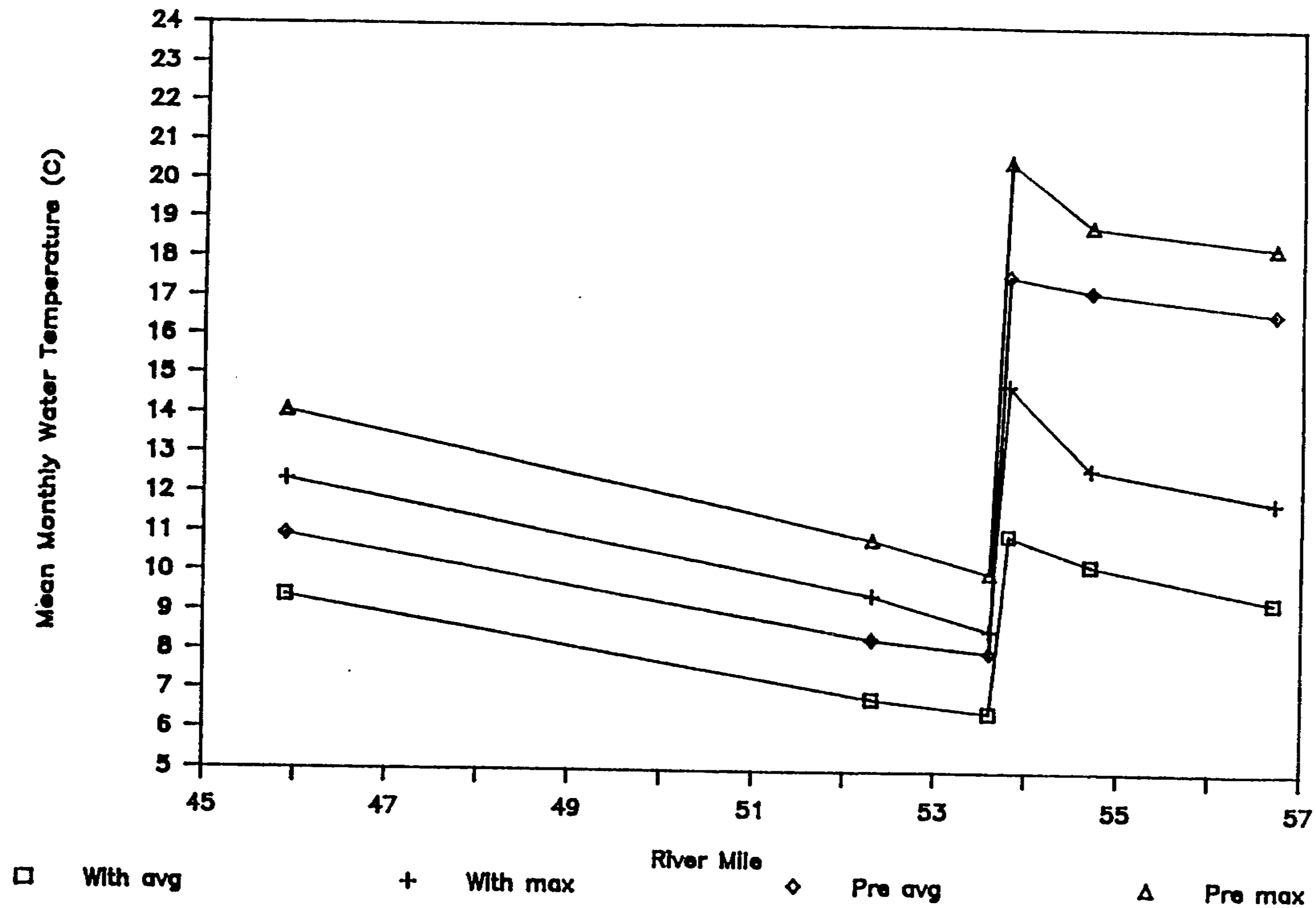


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER
NORMAL JULY TEMPERATURES
(AVERAGE AND MAXIMUM)

DATE 11/28/88

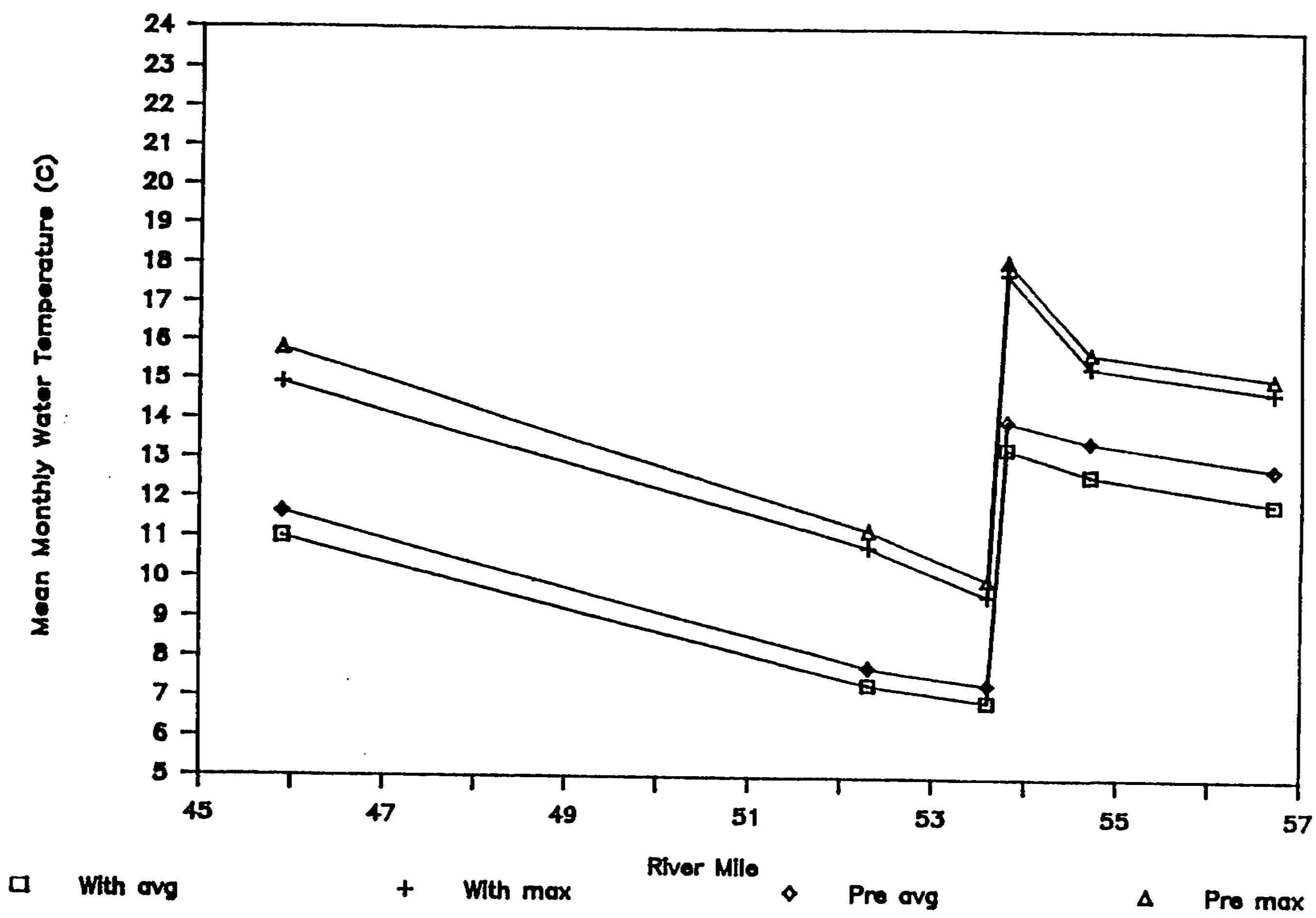
FIGURE 2.93



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER
NORMAL AUGUST TEMPERATURES
(AVERAGE AND MAXIMUM)

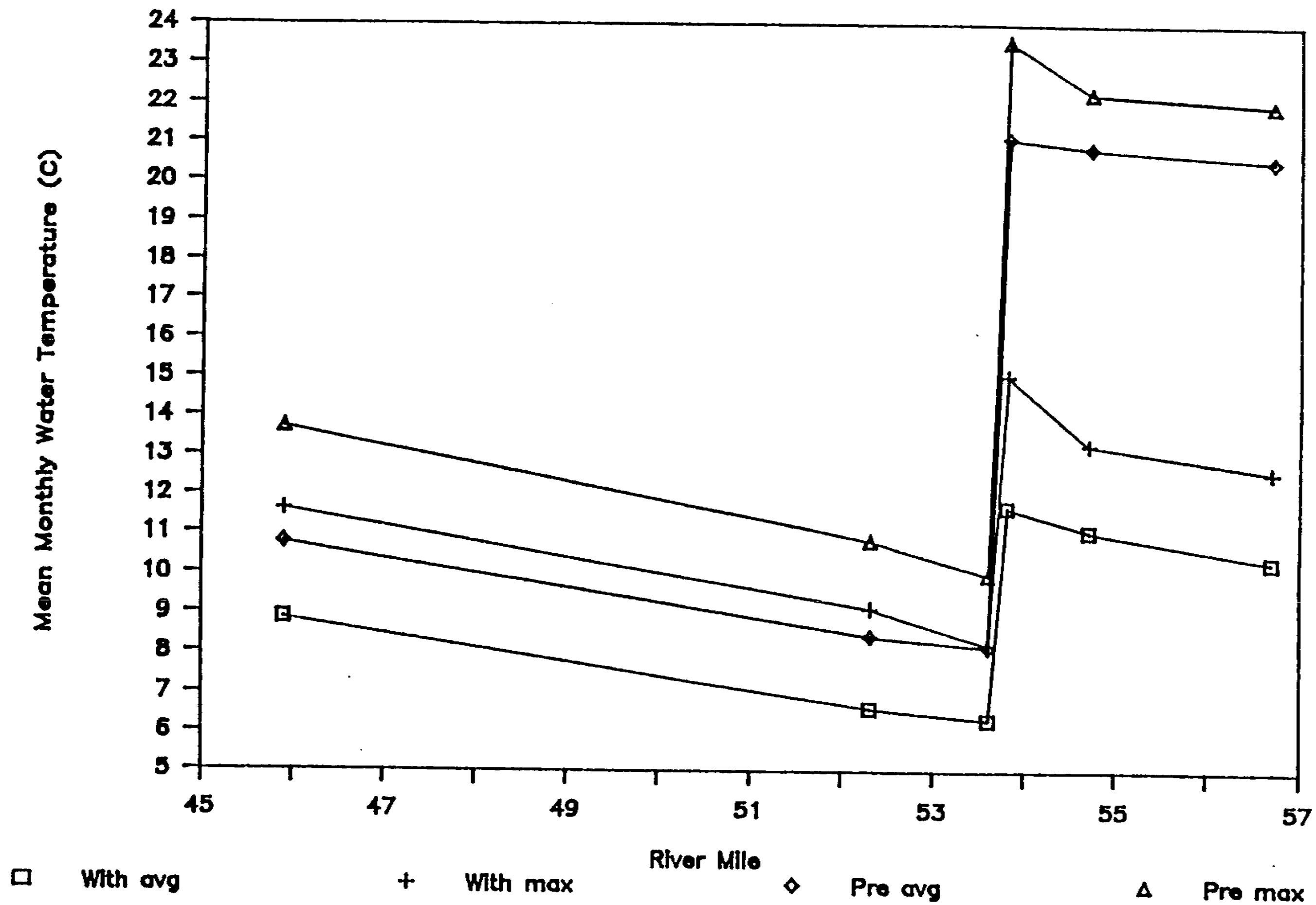
DATE 11/28/88 FIGURE 2.94



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER
NORMAL SEPTEMBER TEMPERATURES
(AVERAGE AND MAXIMUM)

DATE 11/28/88 FIGURE 2.95

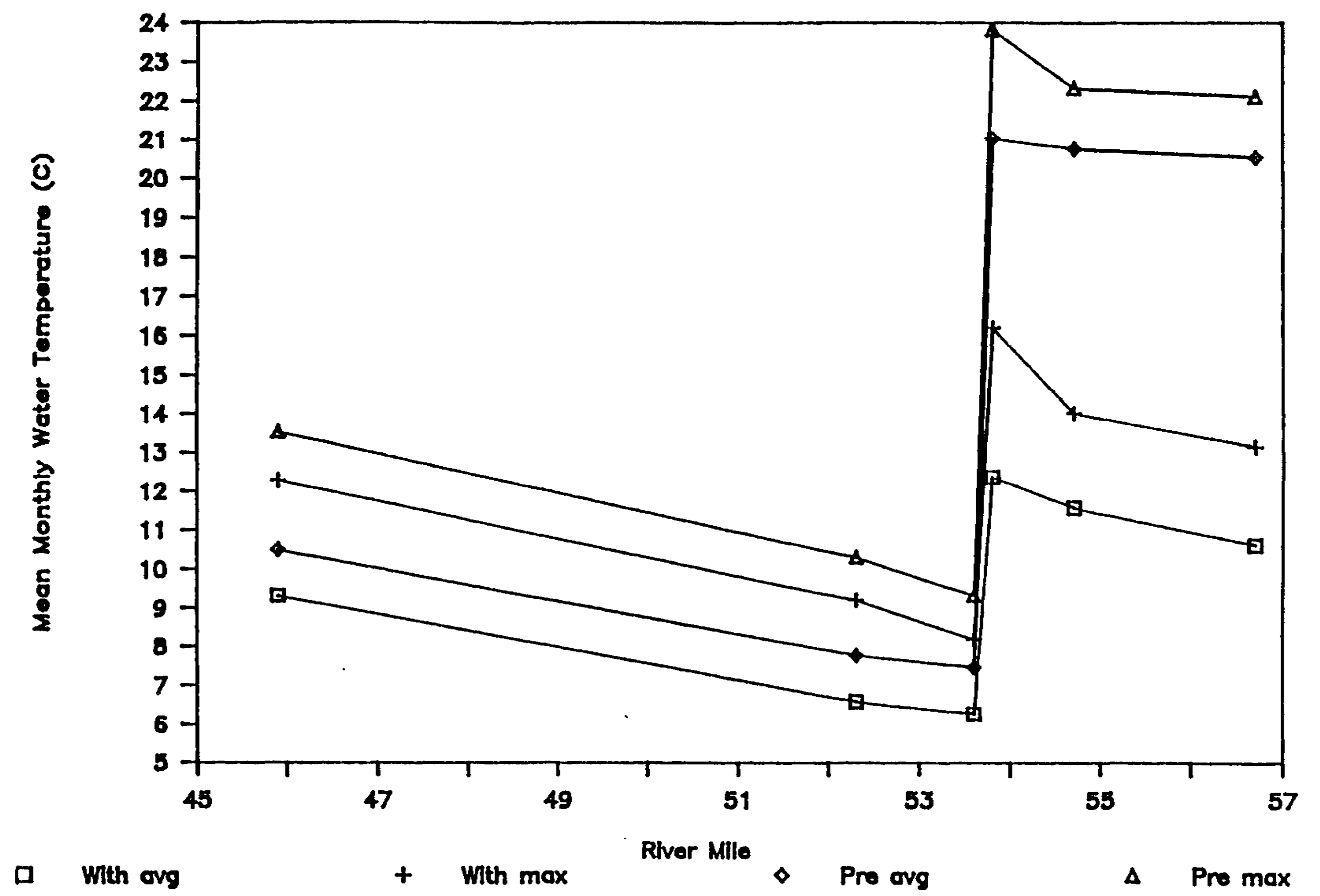


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER
HOT/DRY JULY TEMPERATURES
(AVERAGE AND MAXIMUM)

DATE 11/28/88

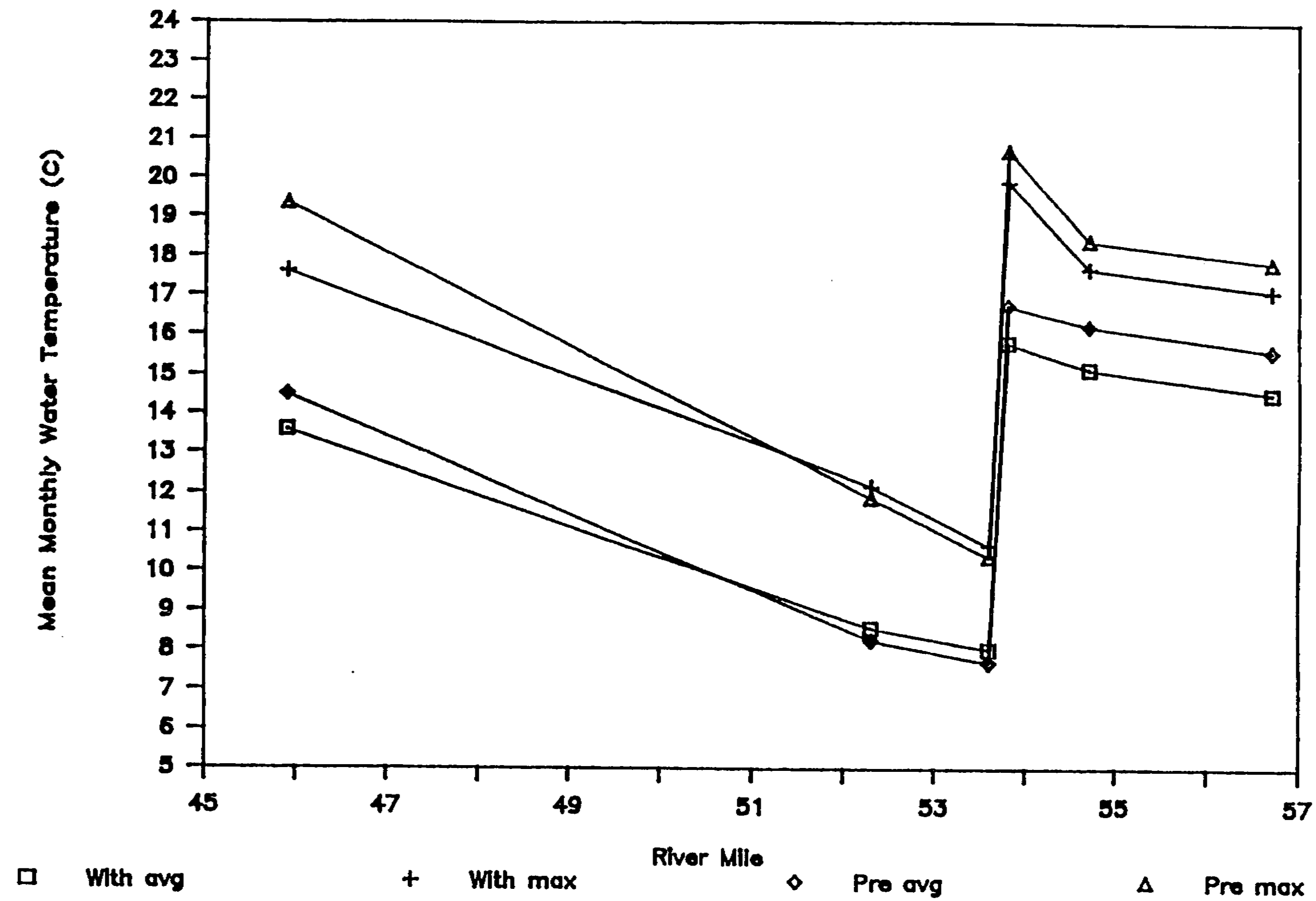
FIGURE 2.96



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND
POWER PROJECT

POUDRE RIVER
HOT/DRY AUGUST TEMPERATURES
(AVERAGE AND MAXIMUM)

DATE 11/28/88 FIGURE 2.97

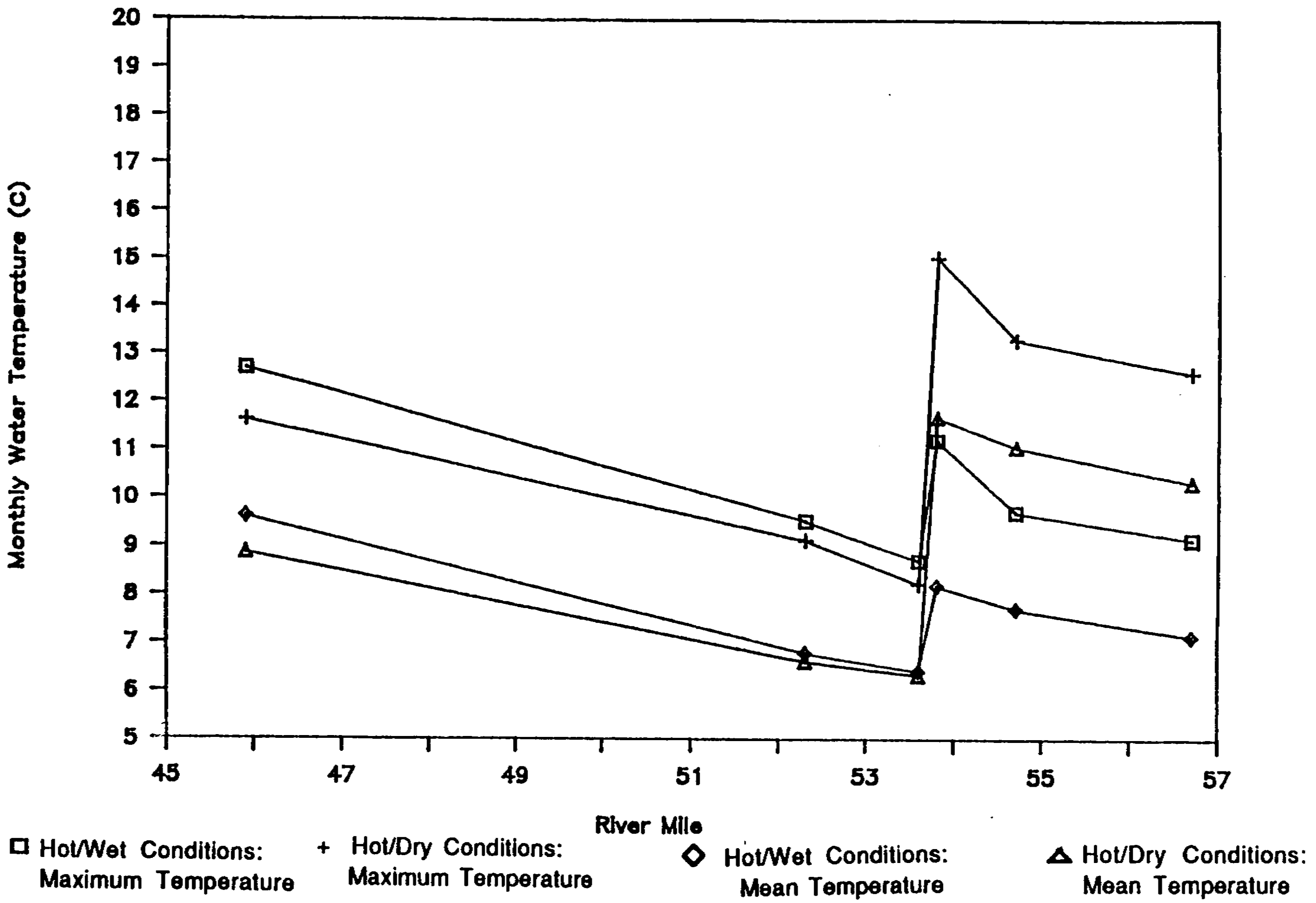


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER
HOT/DRY SEPTEMBER TEMPERATURES
(AVERAGE AND MAXIMUM)

DATE 11/28/88

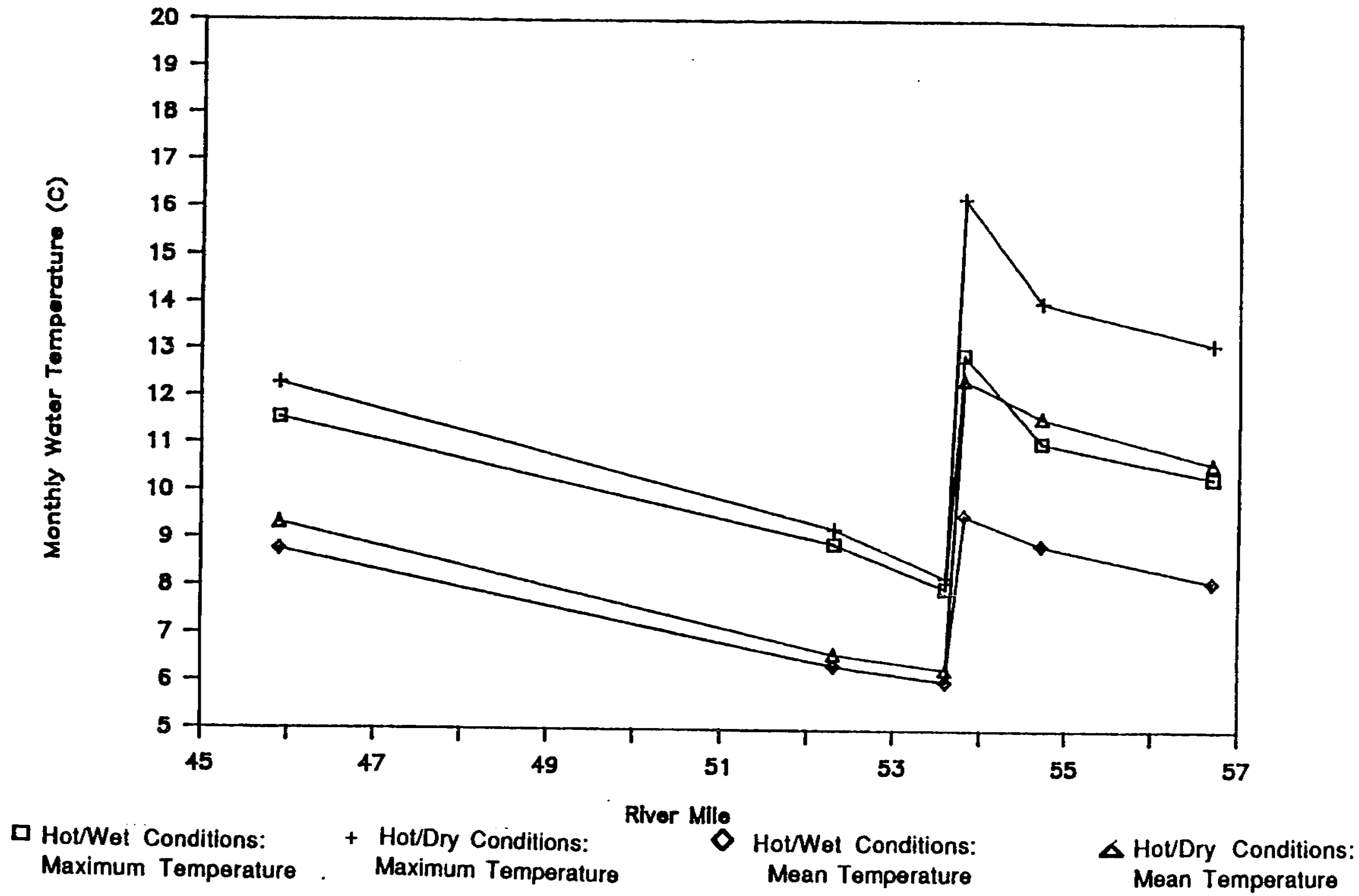
FIGURE 2.98



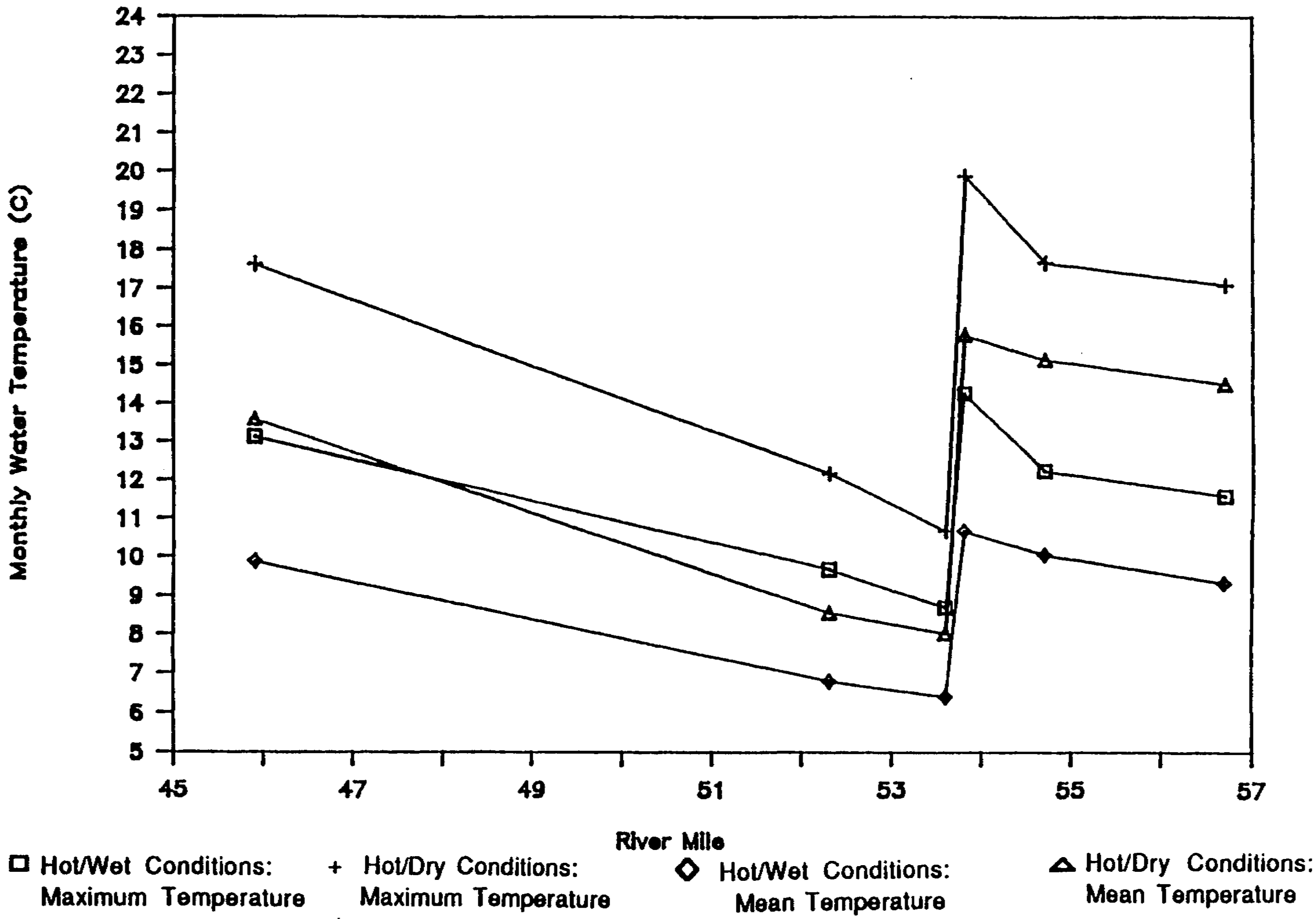
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER WITH-PROJECT JULY TEMPERATURE PROFILES (AVERAGE AND MAXIMUM)

DATE 11/28/88 FIGURE 2.99



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY CACHE LA POUDRE WATER AND POWER PROJECT	
POUDRE RIVER WITH-PROJECT AUGUST TEMPERATURE PROFILES (AVERAGE AND MAXIMUM)	
DATE 11/28/88	FIGURE 2.100



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE WATER AND POWER PROJECT

POUDRE RIVER WITH-PROJECT SEPTEMBER TEMPERATURE PROFILES (AVERAGE AND MAXIMUM)

DATE 11/28/88

FIGURE 2.101

CHAPTER 3.0

BOTANICAL RESOURCES STUDIES

3.0 BOTANICAL RESOURCE STUDIES

3.1 INTRODUCTION

The botanical resource studies addressed potential effects of the proposed project on vegetation including plant species and associations of special concern. The studies were designed to meet the requirements of the Endangered Species Act, Executive Order 11990 (Protection of Wetlands), and state regulations concerning the identification and protection of species of concern and natural areas in Colorado. The objectives of the botanical resource studies were to: (1) characterize the plant communities comprising the existing environment; (2) document the presence or absence of plant species or associations of special concern, including state or federal threatened or endangered species; (3) evaluate the potential effects of the proposed project alternatives on botanical resources; and (4) recommend possible mitigation measures for further consideration. In addition to these objectives, the botanical resource studies were designed to support the wildlife resource studies (Task 15 of the Basin Study Extension). Field data for the two studies were collected simultaneously at the sample sites.

The botanical resource studies comprised Task 12 of the 1987-1988 Cache la Poudre Basin Study Extension. Task 12 activities were organized into the following subtasks:

Subtask No.	Description
12a	Botanical Characterization
12b	Species of Special Concern Documentation
12c	Effects Assessment
12d	Mitigation Proposals
12e	Task Report

The botanical resource studies were managed by Dr. David Every of Envirosphere Company, Bellevue, Washington with assistance from Colleen McShane, Jay Brueggeman, Greg Green, and Ron Tressler also of Envirosphere. Eric Berg of Wildlife Management Consultants of Fort Collins, Colorado, assisted with aerial photo interpretation, field work, and logistics. Additional field assistance was provided by the Colorado Division of Wildlife (CDOW), U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (FS), Northern Colorado Water Conservancy District (the District), and Colorado Water and

Power Development Authority (the Authority). Northwest Cartography, Inc., a subsidiary of Roy F. Weston, Inc., Seattle, Washington, produced the vegetation cover type map and developed the area summaries.

3.2 STUDY AREA

The District is considering several potential damsites along the mainstem of the Cache la Poudre River. Based on preliminary engineering studies, the preferred damsites for providing a mainstem reservoir are the Grey Mountain 1, Grey Mountain 2, and Poudre sites (Figure 3.1). The Grey Mountain 1 site is located approximately 2.5 miles downstream from the confluence of the mainstem and the North Fork of the Cache la Poudre River. The resulting reservoir would extend approximately 7.5 miles up the mainstem to the town of Poudre Park and approximately 7.5 miles up the North Fork, including the area currently inundated by Seaman Reservoir. The normal maximum reservoir water surface elevation would be 5,630 ft above mean sea level (MSL) and the elevation at flood level would be 5,640 ft MSL. The reservoir formed by dam construction at the Grey Mountain 1 site would inundate about 1,600 acres at normal maximum pool. The Grey Mountain 1 site is the mainstem dam site identified in the FERC preliminary permit granted to the District in September, 1985 (FERC Project No. 9290).

The Grey Mountain 2 damsite is located approximately one-half mile upstream from the Grey Mountain 1 site. This site is identified in the Cache la Poudre Basin Study (Harza, 1987). Both the normal maximum reservoir water surface elevation and the water surface elevation at flood stage would be the same for a reservoir formed by a dam at the Grey Mountain 2 site as for a reservoir formed by constructing a dam at the Grey Mountain 1 site. In other words, the inundation area resulting from construction of a dam at the Grey Mountain 2 site would be entirely contained within the inundation area resulting from a dam at the Grey Mountain 1 site. Therefore, project effects on botanical resources for Grey Mountain 1 would be larger than for Grey Mountain 2, representing an upper bound for the Grey Mountain alternatives. Consequently, botanical studies were conducted for the Grey Mountain 1 alternative only, and all references to "Grey Mountain" in the documentation for botanical resources studies refer to the Grey Mountain 1 project configuration.

The Poudre damsite alternative is located less than one-half mile downstream from the confluence of the mainstem and the North Fork near the junction of State Highway 14 and the road to Seaman Reservoir. The Poudre Reservoir would extend approximately 5.5

miles up the mainstem and 7.5 miles up the North Fork. The water surface elevations of the Poudre Reservoir at normal maximum and flood level would be the same as for the Grey Mountain alternatives. The Poudre Reservoir would inundate 1,350 acres at normal maximum pool which is 250 acres less than the Grey Mountain Reservoir 1 at normal maximum pool.

The boundary of the study area for the Grey Mountain and Poudre alternatives was defined in consultation with the FWS, FS, and CDOW personnel. The study area included the land potentially impacted by the mainstem Cache la Poudre reservoir, land that could be impacted by projects under future consideration (Glade Reservoir and Poudre Forebay), and a border area for potential mitigation (Figure 6.1). The project areas for the Grey Mountain and Poudre alternatives included the lands that would be inundated by the proposed reservoirs as well as a buffer zone that extends 40 ft in elevation above the maximum reservoir water surface elevation at flood stage (5,640 ft). The buffer zone was established to account for impacts resulting from construction activities such as clearing land, temporary buildings, construction, roads, etc.

The Grey Mountain project area covered approximately 2,400 acres of land between elevation 5,250 ft and elevation 5,680 ft along the mainstem and North Fork of the Cache la Poudre River. The Poudre project area covered approximately 2,000 acres of land between elevation 5,340 ft and elevation 5,680 ft along the mainstem and North Fork.

The study area outside the two project areas included over 37,000 acres. It ranged from an elevation of about 5,200 ft at Hook and Moore Glade to an elevation of approximately 7,500 ft at Grey Rock Mountain. The entire study area was in Larimer County, Colorado, and covered 39,489 acres. Approximately one-half of the area was within the Arapaho and Roosevelt National Forests.

3.3 METHODS

3.3.1 Botanical Characterization

The purpose of the botanical characterization was to classify, quantify, describe, and map the vegetation in the study area in order to evaluate the effects of the proposed project on vegetation, wildlife, and land use practices. Consequently, the botanical characterization required the following steps: (1) selecting a vegetation cover type classification system; (2) mapping of cover types; (3) calculating cover type areas and producing a cover map; and (4) conducting field surveys to describe the structure and composition of each cover type. A detailed description of each step is described below.

3.3.1.1 Cover Type Classification System Selection

The vegetation cover type classification system selected for the Cache la Poudre study was patterned after the classification of vegetation series used by the Roosevelt National Forest (FS, 1984). A comparison between the classification system used in this study and the system used by the FS is provided in Table 3.1. Sixteen cover types were identified in the study area.

3.3.1.2 Cover Type Mapping

Cover types were classified and delineated on aerial photographs of the study area. The steps followed in this process were: (1) aerial photograph selection; (2) photo interpretation; (3) verification of cover types; (4) data transfer to orthophotographs maps.

Aerial Photograph Selection

The most recent aerial photographs of the study area were taken on October 4, 1986 by the District. These photographs were black and white stereo pairs scaled at 1:12,000. All cover typing was done on mylar overlays using the 1986 aerial photographs. Supplemental information was provided by color infrared aerial photographs from the FS. These photographs were taken in September 1984 at 1:24,000 scale and were used primarily to identify riparian and wetland cover types.

TABLE 3.1
Vegetation Classification

U.S. Forest Service Vegetation Series (1) (Roosevelt National Forest)	Cover Type Used in This Study
Ponderosa pine/Douglas-fir	Closed Canopy Conifer Forest(2) Open Canopy Conifer Forest(2) Pinyon Pine Forest(3)
Mountain Shrub	Mountain Shrub
Mountain Grassland	Grassland Palustrine Marsh/Meadow(2)
Rock	Rock and Talus
	Agriculture(3) Developed(3) Disturbed(3)
Riparian	Riparian Forest(2) Riparian Shrub(2) Riparian Grassland(2)
Water	Palustrine Pond(2) Lacustrine(2) Riverine(2)

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(1) FS, 1984, page II-10

(2) These types were subdivided to provide more detail for impact assessment and for the wildlife habitat studies.

(3) These types were not recognized on the Roosevelt National Forest.

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Other sets of aerial photographs available from state and federal agencies were reviewed but were not suitable for cover typing due to the age, scale, or quality of the photography.

Photo Interpretation

Aerial photographs were acquired in stereo pairs so that a three dimensional view obtained with a mirror stereoscope could be used for more accurate interpretation. One set of aerial photographs covering the study area was overlaid with mylar overlays. The study area boundaries, as determined by the HEP team, were marked on the mylar overlays, and the outline of each cover patch or polygon was delineated. A symbol, specific to each cover type, was marked on the mylar within each polygon. The minimum mapping unit was one acre for riparian and wetland types and five acres for upland types.

Two photo interpretation aids were developed to enhance the accuracy and consistency of the results. The primary aid was a systematic key that defined the photo characteristic of each cover type (Table 3.2). The key was developed by using the aerial photos to define the range of photo characteristics of a particular cover type. The quantitative definitions (i.e., percent tree cover, percent shrub cover) of each cover type in the key were developed from the literature. During development of the key, ground verification was conducted to confirm the quantitative definition and specific photo characteristics associated with each cover type. As an additional aid, grid patterns (transparencies with rectangular grids of varying density) were used to estimate the proportion of tree or shrub cover as defined in the photo interpretation key. The key and grid facilitated the ability of the photo interpreter to consistently identify each cover type patch or polygon and delineate its boundaries. For purposes of this report, a cover type patch is defined as a polygon.

Verification of Cover Typing

The initial photo interpretation of cover types was done by one photo interpreter and then checked by a second photo interpreter.

TABLE 3.2

Key to the Cover Types of the Cache La Poudre Project

Step		Proceed to Step:	Cover Type
1.a.	Land	2	
1.b.	Permanent water	13	
2.a.	Lands where man's disturbance dominates	3	
2.b.	Lands where "natural character" prevails	5	
3.a.	Lands where vegetative cover is essentially removed or activity essentially precludes wildlife use (mines, quarries, dams, highways) . . .		Disturbed
3.b.	Developed areas with enough vegetative cover to provide habitat value (greater than 20 percent) .	4	
4.a.	Residential/commercial areas		Developed
4.b.	Cropland or improved pasture		Agriculture
5.a.	Non-vegetated areas (cover less than 10 percent trees, less than 20 percent shrubs, less than 30 percent herbs)		Rock/Talus
5.b.	Vegetated areas	6	
6.a.	Uplands (not including wetlands or riparian areas)	7	
6.b.	Lands along streams or with saturated soils at least part of the year and with vegetation clearly responding to higher water availability (i.e., wetlands and riparian areas)	10	
7.a.	Forested areas (greater than or equal to 10 percent tree cover)	8	
7.b.	Non-forested areas (less than 10 percent tree cover)	9	
8.a.	Open forest on low foothills where pinyon pines dominate		Pinyon Pine Forest
8.b.	Open canopy forest usually dominated by ponderosa pine (10 to 60 percent tree cover) usually with shrub understory		Open Conifer Forest

1361K

TABLE 3.2 (Continued)

Key to the Cover Types of the Cache La Poudre Project

Step	to Step:	Proceed Type	Cover
8.c.	Closed canopy conifer forest, dominated by ponderosa pine or Douglas-Fir (greater than 60 percent canopy closure)		Closed Canopy Conifer Forest
9.a.	Shrub cover greater than or equal to 20 percent . . .		Mountain Shrub
9.b.	Grass dominated (less than 20 percent shrubs)		Grassland
10.a.	Lands supporting hydrophytic vegetation, with saturated soils a majority of the growing season (wetlands - Palustrine)	11	
10.b	Lands along water courses, usually within the floodplain, with vegetation responding to higher water availability at least part of the year (Riprian)	12	
11.a	Wetlands with greater than 50 percent shallow open water at least part of the growing season (often impounded)		Palustrine Ponds
11.b	Wetlands dominated by persistent emergent vegetation, with less than 50 percent open water		Palustrine Marsh/Meadow
12.a.	Greater than 10 percent tree cover (either deciduous or conifer)		Riparian Forest
12.b.	Without trees, dominated by shrubs (greater than 20 percent shrub cover)		Riparian Shrubland
12.c.	Without trees and with less than 20 percent shrub cover		Riparian Grassland

TABLE 3.2 (Continued)

Key to the Cover Types of the Cache La Poudre Project

Step		Proceed to Step:	Cover Type
13.a.	Streams (including gravel bars and flood scour zones)		Riverine
13.b.	Lakes or reservoirs		Lacustrine
13.c.	Ponds (less than 20 acres and less than 6.5 ft (2 m) deep)	See 11a	

Mapping for the entire study area was verified by a combination of low altitude overflights and on-the-ground checking during the 1987 spring and summer field sampling.

Data Transfer to Orthophoto Maps

Complete orthophoto coverage (1:24,000 scale) of the study area was obtained from the U.S. Geological Survey. The information mapped on aerial photos was transferred to overlays on the orthophotos to correct for angular distortion inherent in aerial photos. This procedure provided an accurate data base for determining the area of each cover type and producing a map.

3.3.1.3 Map Production and Acreage Calculation

A Geographic Information System (GIS) was used to map and calculate the area of each cover type. A GIS is a computer database management system with the capabilities of resource mapping, accounting, and analysis. The following four steps were required: (1) digitizing; (2) map registration and checking; (3) area calculations; and (4) map production.

Digitizing

The GIS used for this project was an arc-based topological system that stored line data as a series of arcs (line segments). Entering data from a map into the GIS requires digitizing, a mechanical process that involves tracing a line with a computer "mouse." The line is broken into a series of segments or arcs that are then stored in the GIS. The polygon boundaries were digitized using the mylar overlays from the orthophoto quadrangle maps. Each polygon in the study area was assigned a unique identifying number that associated it with a specific quadrangle map. The symbol identifying the cover type of each polygon was plotted by the GIS on a map and associated with the polygon number in the digital database. The digital database provided a complete record of the area and cover type of each polygon.

Map Registration and Checking

The data from separately digitized mylars were linked by the GIS into a single project-wide data set that could be presented at a variety of map scales. This was accomplished by digitizing a master control grid from the USGS 1:24,000 quadrangle orthographic maps. The control grid consisted of section corners and other identifiable land features. A set of working maps or edit plots (line maps with symbols) at 1:24,000 scale was produced for both pre-impoundment and the projected post-impoundment conditions showing the habitat symbol associated with each polygon. The maps were then checked against the original photo-interpreted data to confirm that each polygon had the proper cover type.

Area Calculations

A computer software program was run with the GIS to calculate the area of each polygon and produce summary statistics for pre-impoundment and post-impoundment periods. The data were reported by cover type.

Map Production

The final habitat map was photographically produced using the USGS 1:24,000 quadrangle maps as the base map. Edit plots, registered to the quadrangle maps, were produced by the GIS at 1:25,000 scale for the final map. This scale was chosen so that the final map would be a manageable size. The computerized data were then used to generate the color separation negatives needed to produce a color map.

3.3.1.4 Field Studies

The objective of the field studies was to collect the data necessary to describe the structure and composition of each cover type. The field data collection program was designed in conjunction with the field studies for wildlife habitat evaluation. Field data were collected during August 10-14, August 17-21, and September 15 - 16, 1987. This time period allowed measurement of peak vegetative growth.

Sampling Design

The nearly 40,000 acres in the study area were divided into four zones to account for variation in habitat characteristics due to elevation: (1) elevation 5,180 to 5,680 ft; (2) elevation 5,680 to 6,280 ft; (3) elevation 6,280 to 6,880 ft; and (4) elevation 6,880 to 7,420 ft. The area potentially impacted by the Grey Mountain and Poudre alternatives was in Zone 1. Zone 1 was further divided into three aspect categories (north, southeast, west). Zones 2, 3, and 4 were not divided into aspect because of the large area, highly varied topography, and the uncertainty of their availability for mitigation. Because Zone 1 would be directly affected by the proposed project, it was narrowly defined to more accurately characterize the botanical resources and to reduce the influence of environmental variability on the botanical resource measurements. The other three zones were sampled in order to comprehensively characterize botanical resources in the entire study area.

A total of 184 sampling sites were randomly distributed in 122 polygons across the four elevational zones in the study area (Table 3.3 and Figure 3.2). Within the combined Grey Mountain and Poudre project areas, 82 sites were randomly distributed in 56 polygons as follows: 25 sites in 17 polygons on south slopes; 28 sites in 19 polygons on north and west slopes; and 29 sites in 20 polygons on east slopes. The other 66 polygons were located outside the project areas: 36 sites in 22 polygons in Zone 1; 26 sites in 18 polygons in Zone 2; 18 sites in 12 polygons in Zone 3; and 22 sites in 14 polygons in Zone 4. Nearly half of the polygons sampled were allocated to the project areas because of the importance of characterizing the botanical resources to be affected by either proposed project alternative. The number of polygons allocated to each elevation zone outside the project areas was based on the size of the area in each zone and the complexity of cover types or plant association. Zone 1 outside the project areas had the largest acreage and most diverse cover types. Consequently, it was allocated the highest number of polygons. The other three zones had much smaller areas and fewer cover types.

TABLE 3.3

Number and Distribution of Sites Sampled in Polygons for Each Cover-Type in the Cache la Poudre Project Study Area (1)

Sampling Locations	Closed Canopy Conifer Forest	Open Canopy Conifer Forest	Mountain Shrub	Grassland	Agriculture	Riparian Forest	Riparian Shrubland	Riparian Grassland	Palustrine Marsh/Meadow	Total
PROJECT AREAS										
Mainstem South										
Polygons	3	3	3	3	--(2)	5	--	--	--	17
Sites	5	5	5	5	--	5	--	--	--	25
Mainstem North/West										
Polygons	1	3	3	3	--	5	3	1	--	19
Sites	3	5	5	5	--	5	3	2	--	28
Mainstem East										
Polygons	3	3	3	3	--	3	3	2	--	20
Sites	5	5	5	5	--	3	3	3	--	29
Subtotal										
Polygons	7	9	9	9	--	13	6	3	--	56
Sites	13	15	15	15	--	13	6	5	--	82
OUTSIDE PROJECT AREAS										
Zone 1										
Polygons	--	3	3	3	3	5	3	--	2	22
Sites	--	5	5	5	7	5	5	--	4	36
Zone 2										
Polygons	3	3	3	3	--	3	3	--	--	18
Sites	5	5	5	5	--	3	3	--	--	26
Zone 3										
Polygons	3	3	3	3	--	--	--	--	--	12
Sites	5	5	5	3	--	--	--	--	--	18
Zone 4										
Polygons	6	6	1	1	--	--	--	--	--	14
Sites	8	8	3	3	--	--	--	--	--	22
Subtotal										
Polygons	12	15	10	10	3	8	6	--	2	66
Sites	18	23	18	16	7	8	8	--	4	102
TOTAL STUDY AREA										
Polygons	19	24	19	19	3	21	12	3	2	122
Sites	31	38	33	31	7	21	14	5	4	184

(1) Pinyon Pine and Palustrine Pond types were not sampled because they were present only outside the project areas and would not be affected by either project alternative. Riverine and lacustrine cover types were not sampled because the measurements required could be obtained from maps, aerial photographs or the literature.

(2) Dashes signify that the cover type was not sampled because it was either absent or present in very small amounts.

Five sites were sampled in three polygons for each cover type in the project areas and each elevation zone outside the project areas. One polygon contained three sites, and two polygons contained single sites. The measurements in the polygon with three sites provided information on the local variability of the structural characteristics in a given cover type. The measurements among the three polygons provided information on the spatial variability within the cover type for the project areas and each zone. Sampling intensity was adjusted downward for poorly represented cover types and upward for abundant cover types such as shrublands and upland forests. The small amount of area in poorly represented cover types (riparian and palustrine types) generally limited sampling to a single site in each polygon. Consequently, the sampling program was designed to characterize the botanical features of cover types in the project areas and the study area and to estimate the variability of those features.

An 82 ft x 82 ft (25 m x 25 m) quadrant was established at each sampling site in a given polygon for measuring the cover type characteristics. The site was located by randomly selecting one quarter of a polygon marked on an aerial photograph, pacing 180 ft (55 m) in a direction perpendicular to the point of entry, and then 33 ft (10 m) in a randomly chosen direction. The end point represented the first corner of the quadrat. The quadrat was oriented by randomly selecting the first side of the quadrat and flipping a coin to determine the location of the adjacent side. Additional quadrats, required in polygons with multiple sampling sites, were established by pacing 164 ft (50 m) in a random direction from a randomly chosen corner of the previous quadrat. Quadrats were replaced by a 164 ft (50 m) transect line in herbaceous and shrubland cover types because these types did not contain trees. A 50 m transect line was also used in riparian forest types because the areas were frequently too narrow to randomly place a quadrat or were small enough to sample the entire polygon.

These procedures were adjusted for small polygons. Small polygons were entered from the most accessible point and the 55 m distance to the sampling site was reduced to 30 m to accommodate the quadrat. The distance between multiple quadrats was also reduced in small polygons. Sampling sites were rejected if they were less than 20 m from the edge of the polygon, in a disturbed area, or in a non-representative cover type inclusion.

Field Sampling

Data collected for the botanical studies included tree, shrub, and herbaceous canopy cover, tree density, diameter at breast height (dbh), basal area, and shrub height. Three basic sampling procedures were used to measure these parameters within each sampled polygon: (1) quadrat, (2) line intercept, and (3) plot frame. A 0.15 ac (0.0625 ha) quadrat was used for tree density measurements. The line intercept procedure was used for measurements of tree and shrub canopy cover (Canfield, 1941). Measurements were made along a tape on two adjacent, randomly selected sides of the quadrat. Percent cover was estimated by measuring the distance between the outer boundaries of tree and shrub canopies along the tape and calculating the proportion of the total length of tape represented by each parameter. A 0.9 ft^2 (0.1 m^2) plot frame was used for herbaceous cover measurements (Daubenmire, 1959). The frame was placed every 16 ft (5 m) along the two sides of the quadrat used to measure tree and shrub cover. In addition, species composition and relative abundance were estimated.

3.3.2 Documentation of Plant Species and Associations of Special Concern

The objective of this task was to determine the presence and location in the study area of any plants or associations of special concern, including species classified by the state or FWS as threatened or endangered. This process involved six steps: (1) examination of historical records to identify the special species or associations expected to occur in the study area; (2) determination of the habitat requirements of each species or plant association of special concern; (3) location of these habitats in the study area; (4) search of each of these locations systematically; (5) general searches throughout the study area for species of special concern in unexpected locations; and (6) documentation of the procedures and the results. Each of these steps is explained below.

3.3.2.1 Identification of Potential Species or Associations of Concern in the Study Area

The Colorado Natural Areas Program (CNAP) maintains an up-to-date database including locations, literature, and population status of plants and associations of concern at both the state and federal levels. A report was requested from the CNAP on the occurrence of plant species or associations of concern in the study area. Five plant species and no associations were identified in this report as potentially occurring in the study area. The February 1987 list of "Plant Species of Special

Concern" (CNAP, 1987) was used as the basis for all plant searches. The guide for plant associations was "Plant Associations of Special Concern in Colorado" (CNAP, 1986a). Wetlands were considered to have special significance even though no types in the study area were listed as plant associations of special concern.

3.3.2.2 Determination of Habitat Requirements

Plant habitat requirements include substrate, soil moisture, slope, aspect, elevational range, associated species, and sometimes microsite factors such as shade requirements. The habitat requirements for the plants of special concern reported to occur in the study area were determined from four sources: (1) the literature, including field manuals and floras (e.g., Harrington, 1954; Weber, 1976), monographs, and rare plant status reports; (2) label data from plant specimens at the University of Colorado herbarium; (3) descriptions by botanists who have seen the species in natural habitats, including Dieter Wilkin at Colorado State University, William Weber at the University of Colorado, and the CNAP staff; and (4) site visits to known locations of the species to observe habitat conditions. Known populations of two of the five potential species that occur in or near the study area were visited. A reported location of a third species was searched without success. No specific historical locations of the other two species have been reported for the region.

3.3.2.3 Identification of Potential Habitats in the Study Area

After the habitat requirements for species of special concern were defined, all locations in the study area with similar habitat parameters were identified. Specific historical locations within the study area for two species were obtained from the CNAP. Other potential locations in the study area were identified using the information on cover types, elevation, slope, aspect, and location from topographic maps and aerial photos. Potential locations for several species were refined further by looking for key combinations of habitat parameters during an aerial overflight of the study area or by using binoculars or a spotting scope. The process resulted in searching a number of specific locations in the study area for each species.

3.3.2.4 Searches of Specific Locations

All locations with a reasonable likelihood of containing any of the species of special concern were searched. These included historical locations, locations that appeared to meet all the habitat requirements, as well as other locations with similar habitat features. The searches were conducted when the target species were in flower or fruit to optimize the ability to locate and identify the plants.

The search of each location was designed to maximize the probability of locating the species. Therefore, the search pattern was adapted for each location depending on size, visibility, and expected distribution of the plant within the location. For a species with narrow habitat requirements, such as rock crevices, only the microsites that met the requirements were searched. For species with broad habitat requirements, a search was conducted along a series of parallel lines. The number of lines and the distance between lines were determined by the size of the search area, the size and visibility of the target plant, and any obstructions to visibility in the area.

3.3.2.5 General Searches

The field program for the botanical characterization involved sampling 184 sites in 122 polygons distributed throughout the study area (Figure 3.2). At each of these sites, searches were designed to locate species of special concern that might occur in unexpected areas.

3.3.2.6 Documentation

Plant species of special concern were documented in field notebooks and field trip reports. Locations were mapped and voucher specimens collected and catalogued. Search locations, level of effort, and results were recorded in field notebooks. At the end of each field trip, the field notes were summarized into a trip report. Location information was marked on USGS 7.5-minute topographic maps or draft cover maps. When a species of concern was found, a small voucher specimen was collected if the population was large enough. These specimens were prepared for archiving at the University of Colorado Herbarium for independent verification of the identification.

3.4 RESULTS

3.4.1 Description of Existing Environment

3.4.1.1 Botanical Characterization

Sixteen cover types were identified in the 39,489-acre study area (Table 3.4). The distribution of these types was influenced by a west to east moisture gradient. The dryer eastern portion of the study area was dominated by grasslands. The western portion was at higher elevation, had more topographic relief, and was dominated by conifer forests. The transitional central portion of the study area was dominated by shrublands. The cover types and their distribution in the study area are illustrated in Exhibit I (found in the map pocket on the back cover of this report). The characteristics of each cover type in the study area are described below.

The description of each cover type includes the comparable plant associations as defined by the FS for the Arapaho and Roosevelt National Forests, which contain most of the land in the study area. Plant associations are defined by a combination of tree and understory species, soil, and topography. The FS uses plant associations as a method of classifying lands based on potential or climax vegetation (Hess and Alexander, 1986; Johnston, 1987). Climax vegetation is defined as that which has reached a steady state with its environment (Daubenmire, 1968).

Upland Forested Cover Types

Three upland forested cover types were identified in the study area: Closed Canopy Conifer; Open Canopy Conifer; and Pinyon Pine. These types represented over 31 percent of the study area. Open and Closed Canopy Forests represented 28 and 26 percent of the Grey Mountain and Poudre project areas, respectively. There was no Pinyon Pine Forest in either of the project areas.

Closed Canopy Conifer Forest

The Closed Canopy Conifer type was defined as forest dominated by ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) with more than 60 percent tree canopy cover based on aerial photograph interpretation. It occupied about 5,527 acres or about 14 percent of the study area, all in the western half. It occurred primarily on north aspects and occasionally on east and west aspects at elevations ranging from about 5,300 to 7,600 feet. Stands dominated by Douglas-fir were associated with more moist microclimates and occurred almost exclusively on steep north-facing slopes. Ponderosa pine and Rocky Mountain juniper (*Juniperus scopulorum*) were often intermixed with Douglas fir in these areas, particularly in younger stands (Hess and Alexander, 1986). Ponderosa pine was the climax tree species on drier sites. Understory shrub cover in Closed Canopy Forest was generally low. Common shrubs were ninebark (*Physocarpus monogynus*), cliffbush (*Jamesia americana*), snowberry (*Symphoricarpos sp*.), currants (*Ribes sp*.), and skunkbrush (*Rhus trilobata*).

TABLE 3.4

Area of Cover Types Within and Outside the Grey Mountain and Poudre Project Areas

Cover Type	Study Area		Grey Mountain Project Area		Outside Grey Mountain Project Area	Poudre Project Area		Outside Poudre Project Area
	Area (ac)	Relative Percent	Area (ac)	Relative Percent	Area (ac)	Area (ac)	Relative Percent	Area (ac)
Closed Canopy Conifer	5,527	14.0	234	9.8	5,293	218	11.5	5,309
Open Canopy Conifer	6,790	17.2	396	16.5	6,394	321	16.9	6,469
Pinyon Pine Forest	178	0.5	0	0.0	178	0	0.0	178
Mountain Shrub	13,469	34.1	972	40.6	12,497	698	36.9	12,771
Grassland	10,276	26.0	334	13.9	9,942	269	14.2	10,007
Rock and Talus	264	0.7	22	0.9	242	14	0.7	250
Agriculture	968	2.5	0	0.0	968	0	0.0	968
Developed	158	0.4	9	0.4	149	8	0.4	150
Disturbed	974	2.5	125	5.2	849	108	5.7	866
Riparian Forest	388	1.0	75	3.1	313	62	3.3	326
Riparian Shrub	121	0.3	17	0.7	104	13	0.7	108
Riparian Grassland	16	0.04	9	0.4	7	8	0.4	8
Palustrine Marsh/Meadow	53	0.1	0	0.0	53	0	0.0	53
Palustrine Pond	53	0.1	0	0.0	53	0	0.0	53
Riverine	178	0.4	127	5.3	51	99	5.2	79
Lacustrine (existing)	77	0.2	77	3.2	0	77	4.0	0
TOTALS	39,489		2,397		37,092	1,895		37,594

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Herbaceous canopy cover was usually sparse. Important graminoides were spike fescue (Hesperochloa kingii), needlegrasses (Stipa sp.), wheatgrasses (Agropyron sp.), and mountain muhly (Muhlenbergia montana), and Ross' sedge (Carex rossii). Common forbs were yarrow (Achillea millefolium), harebell (Campanula rotundifolia), windflower (Anemone multifida), brittle bladder-fern (Cystopteris fragilis), geranium (Geranium sp.), and wild onion (Allium sp.).

The Closed Canopy Conifer Forest cover type in the study area included five of the forest associations defined for the Arapaho and Roosevelt National Forests (Hess and Alexander, 1986):

- Douglas-fir/Ross' sedge (Pseudotsuga menziesii/Carex rossii)
- Douglas-fir/mountain ninebark (Pseudotsuga menziesii/ Physocarpus monogynus)
- Douglas-fir/cliffbush (Pseudotsuga menziesii/Jamesia americana)
- Ponderosa pine/Ross' sedge (Pinus ponderosa/Carex rossii)
- Ponderosa pine/spike fescue (Pinus ponderosa/Hesperochloa kingii).

The Douglas-fir/mountain ninebark type was the most widespread forest association in the Grey Mountain and Poudre project areas and in the study area. The other four associations were more localized. For example, the Douglas-fir/cliffbush association was found only on very steep north to northwest-facing slopes that were dominated by huge boulders. The ponderosa pine/spike fescue association was localized at the toe of east-facing slopes where the soil was moderately deep.

The Closed Canopy Forest represented about 218 and 234 acres (10 percent) of the Poudre and Grey Mountain project areas, respectively. A total of 98 percent of this type was south of the mainstem or east of the North Fork of the Cache la Poudre River on north and west-facing slopes. Trees were relatively small, averaging below commercial timber size. Tree size ranged from seedlings to 7.8 inches (19.9 cm) dbh and averaged 4.9 inches (12.5 cm) dbh. Basal area varied from 268 to 953 ft^2 per acre (10.1 to 35.9 m^2 per ha) (Table 3.5). Tree density ranged from 236 to 1,069 trees per acre (576 to 2,640 per ha) and tree canopy cover averaged about 63 percent. Ponderosa pine was dominant over Douglas-fir in about 60 percent and codominant in another 30 percent of the sites sampled in the project areas. Rocky Mountain juniper was present in 60 percent of the sample sites and provided at least 5 percent of the tree canopy cover in about 30 percent of the sites. Shrub cover averaged 14 percent and included 18 species of shrubs. Currants (mostly wax currant) and mountain mahogany (Cercocarpus montanus) were each present in more than 75 percent of the sites. Currants provided greater than 5 percent cover in half the sites sampled. Other prominent shrubs were fringed sage (Artemesia frigida), chokecherry (Prunus virginiana), and snowberry. Forb and grass cover averaged less than 2 percent. Forb diversity was high although no one species provided more than 5 percent cover in any of the sites sampled. The most prominent graminoides were Ross' sedge, cheatgrass (Bromus tectorum), Griffith's wheatgrass (Agropyron griffithsii), and needlegrass. Ross' sedge provided greater than 5 percent cover in 31 percent of the sites sampled in the project areas. Cheatgrass occurred in about 40 percent of the sample sites and was a dominant understory species on two sites. The structure, composition, cover, and diversity of the Closed Canopy Conifer represented in the project areas were typical of other lower elevation forests in the Arapaho and Roosevelt National Forests (Hess and Alexander, 1986) (Table 3.5).

Closed Canopy Conifer represented about 14 percent of the land outside the project areas. Average tree, shrub, and herbaceous canopy cover was similar to that measured in the project area (Table 3.5). However, tree density was lower and tree size was higher outside the project areas. Douglas-fir was dominant over ponderosa pine in about 50 percent of the sites sampled outside the project areas. The project areas were at the lowest elevational range of these species and the moist sites favoring Douglas-fir were more common at the higher elevations outside the project areas. Two shrub species, common juniper (Juniperus communis) and bitterbrush (Purshia tridentata), were much more prominent outside the project areas. Each occurred in about half the sites sampled. The dominance of Douglas-fir, the larger tree size, and the greater diversity of understory species probably reflects the greater elevational range and more varied topography outside the project areas. Cheatgrass occurred in only about 10 percent of the sites sampled outside the project areas and there was less evidence of the effects of cattle grazing.

Open Canopy Conifer Forest

The Open Canopy Conifer Forest type was defined as forests dominated by conifers other than pinyon pine (Pinus edulis) with 10 to 60 percent tree canopy cover based on aerial photo interpretation.

TABLE 3.5

Characteristics of the Closed Canopy Conifer Forests.

		Project Areas	Outside the Project Areas	Study Area	Arapaho/ Roosevelt National Forest (1)
Number of Sites Sampled		11	16	27	21
Trees Density (#/ha)	Mean	1,453	1,158	1,278	-- (2)
	Range	576-2,640	352-1,872	352-2,640	1,173-2,373
Basal Area (m^2/ha)	Mean	22.1	23.6	23.0	
	Range	10.1-35.9	14.2-36.6	10.1-36.6	28.3-40.2
Dbh (cm)	Mean	12.5	14.9	13.9	--
	Range	8.3-19.9	10.4-24.1	8.3-24.1	10.0-60.0
Tree Canopy Cover (percent)	Mean	62.7	53.6	57.3	--
	Range	44.0-96.2	38.9-93.4	38.9-96.2	--
Shrub Canopy Cover (percent)	Mean	14.2	12.2	13.0	--
	Range	2.2-37.7	0.0-26.4	0.0-37.7	2-38
Herbaceous Canopy Cover (percent)	Mean	1.2	2.4	1.9	--
	Range	0.4-2.5	0.3-6.6	0.3-6.6	2-12

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(1) Data recombined from Tables A-1, A-3, and A-4 of Hess and Alexander, 1986.

(2) Dashes indicate that data were not available.

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This type occupied 6,790 acres or 17 percent of the study area. Ponderosa pine was the dominant tree species. Rocky Mountain juniper, Douglas-fir, and occasionally pinyon pine were associated species. Open Canopy Conifer Forests were primarily on south, east, or west facing slopes where the sites were drier than those occupied by Closed Canopy Conifer Forests. The open canopy of this cover type promoted a relatively high understory cover of shrubs (about 20 percent cover), usually dominated by mountain mahogany. Other common shrubs were bitterbrush, chokecherry, wild plum (Prunus americana), skunkbrush, currants, snowberry, rabbitbrush (Chyrsothamnus nauseosus), and ninebark. Grasses were also a significant component of the understory, and three to nine species were identified in each stand sampled. Forb cover was generally sparse, but diverse.

The Open Canopy Conifer Forest cover type in the study area was primarily represented by the ponderosa pine/mountain mahogany (Pinus ponderosa/Cercocarpus montanus) association defined for Arapaho and Roosevelt National Forests (Hess and Alexander 1986). There were also patches of the ponderosa pine/bitterbrush (Pinus ponderosa/Purshia tridentata) association.

Open Canopy Conifer Forest represented 320 and 396 acres (about 16 percent) of the Poudre and Grey Mountain project areas, respectively. A total of 56 percent of this cover type in the project areas was east of the North Fork and 27 percent was south of the mainstem. Average tree canopy cover was 18 percent, and ponderosa pine was the dominant tree. Average herbaceous canopy cover was 7 percent, and shrub canopy cover was 20 percent. Mountain mahogany represented over 5 percent cover in all sites and over 25 percent cover in almost half the sites. The structure, composition, cover, and diversity of the open canopy conifer represented in the project areas were typical of other open forests in the Arapaho and Roosevelt National Forests (Hess and Alexander, 1986) (Table 3.6).

Open Canopy Conifer Forest occupied about 17 percent of the land outside the project areas, primarily in the northwestern portion of the study area. Average tree, shrub, and herbaceous canopy cover outside the project areas were similar to that measured within the project areas (Table 3.6). At higher elevations, bitterbrush was one of the prominent shrubs, replacing mountain mahogany in some sites.

TABLE 3.6

Characteristics of the Open Canopy Conifer Forests

		Project Areas	Outside the Project Areas	Study Area	Arapaho/Roosevelt National Forest (1)
Number of Sites Sampled		15	23	38	8
Tree Density (#/ha)	Mean	263.4	223.3	239.2	-- (2)
	Range	80-512	48-464	48-512	426.7-640.0
Basal Area (m^2/ha)	Mean	9.7	10.0	9.9	--
	Range	3.7-20.6	0.2-26.1	0.2-26.1	20.2-26.9
Dbh (cm)	Mean	20.8	19.9	20.3	--
	Range	12.1-34.9	6.2-44.4	6.2-44.4	10.0-50.0
Tree Canopy Cover (percent)	Mean	17.9	20.6	19.5	--
	Range	0.0-37.6	0.0-53.0	0.0-53.0	--
Shrub Canopy Cover (percent)	Mean	20.1	19.5	19.7	--
	Range	8.3-43.1	2.2-40.6	2.2-43.1	16-27
Herbaceous Canopy Cover (percent)	Mean	7.1	5.1	5.9	--
	Range	0.8-17.7	1.5-13.1	0.8-17.7	5-10

(1) Data recombined from Tables A-1 and A-3 of Hess and Alexander, 1986.

(2) Dashes indicate that data were not available.

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Pinyon Pine Forest

There were 178 acres of Pinyon Pine Forest cover type associated with a limestone formation in the northeastern quarter of the study area. This is the northern-most pinyon pine forest in Colorado (Weber 1976). Pinyon pine was the dominant species but the stands usually included a few ponderosa pine and Rocky Mountain juniper. Mountain mahogany was the dominant understory shrub, and the herbaceous cover was sparse. There was no Pinyon Pine Forest cover type in either of the project areas, and no similar forest habitat type was defined on the Arapaho and Roosevelt National Forests (Hess and Alexander, 1986).

Non-Forested Upland Habitats

Three upland, non-forested cover types were identified in the study area: Mountain Shrub, Grassland, and Rock/Talus. These types represented over 60 percent of the study area and 52 to 55 percent of the Poudre and Grey Mountain project areas, respectively.

Mountain Shrub

The Mountain Shrub cover type was defined as areas with more than 20 percent shrub cover and less than 10 percent tree cover. It represented 13,469 acres or 34 percent of the study area and was the most abundant cover type. This cover type occupied almost every aspect or slope. Larger shrubs and higher canopy cover were characteristic of mesic sites, generally found on north-facing slopes. Drier sites or ones with poor soil structure had sparser cover and smaller shrubs. The dominant species was mountain mahogany, but in swales and along draws skunkbrush and wild plum sometimes formed dense thickets. Other shrub species were wax currant (Ribes cereum), chokecherry, ninebark, snowberry, rabbitbrush, and boulderberry (Rubus deliciosus). A wide variety of grass and forb species were also found in this cover type. Cheatgrass dominated the understory, comprising at least 25 percent canopy cover in more than 75 percent of the sample sites. Sunflower (Helianthus pumilus) was common in sites where the shrub canopy cover was sparse. Cactus (Opuntia sp. or Pediocactus simpsonii) and several plants with woody bases such as wild buckwheat (Eriogonum sp.), snakeweed (Gutierrezia sarothrae), and fringed sage were also frequent components of the Mountain Shrub cover type.

The Mountain Shrub cover type in the study area included at least three of the shrubland associations defined by the FS for Arapaho and Roosevelt National Forests

(Johnston, 1987). Mountain Shrub sites in the eastern part of the study area on gradual slopes were similar to the mountain mahogany-skunkbrush/big bluestem (Cercocarpus montanus - Rhus aromatica sp. trilobata/Andropogon gerardii) association. Some shrub stands on north-facing slopes had characteristics of the mountain mahogany/thickspike wheatgrass (Cercocarpus montanus/Agropyron dasystachya) association. Shrub stands on south-facing slopes often had a composition similar to that of the mountain mahogany/
needle-and-thread grass (Cercocarpus montanus/Stipa comata) association.

The Mountain Shrub cover type represented about 698 and 972 acres (about 40 percent) of the Poudre and Grey Mountain project areas, respectively. A total of 80 percent of the Mountain Shrub was north of the mainstem and along both sides of the North Fork. Shrub canopy cover averaged 35 percent, and herbaceous canopy cover averaged 34 percent. In all the sites sampled, mountain mahogany made up at least 25 percent canopy cover. These values show that the vegetation in this type was relatively open.

Mountain Shrub occupied about 34 percent of the land outside the project areas. Average shrub and herbaceous canopy cover and composition were similar to that within the project areas.

Grassland

The Grassland cover type was defined as upland areas with more than 30 percent herbaceous cover, less than 20 percent shrub cover, and less than 10 percent tree cover. It excluded cultivated, disturbed, or developed areas. This type occupied 10,276 acres or 26 percent of the study area. The Grassland type included a wide variety of grass and forb species. Dominant grasses were blue grama (Bouteloua gracilis), needle grasses, wheatgrasses, bluegrass (Poa sp.), bluestem (Andropogon sp.), and brome (Bromus sp.).

The Grassland cover type in the study area included at least three associations defined by the FS for Arapaho and Roosevelt National Forests and north central Colorado (Johnston, 1987). Most Grasslands in the study area were representative of the needle-and-thread/blue gramma (Stipa comata/Bouteloua gracilis) association, although the blue grama/western wheatgrass (Bouteloua gracilis/Agropyron smithii) and blue gramma/needlegrass (Bouteloua gracilis/Stipa sp.) associations were also observed.

Grasslands were prevalent at elevations below 5,700 ft and were represented in smaller patches up to about 6,800 ft. Most of the grasslands were on gentle slopes with relatively fertile soil, but patches existed on steeper slopes. Some of these patches may have been the result of fires (Biastock, 1988).

Grasslands represented 269 and 334 acres (14 percent) of the Poudre and Grey Mountain project areas, respectively. A total of 86 percent of this type was north of the mainstem and along both sides of the North Fork. Herbaceous cover averaged about 50 percent, and the composition was about 80 percent grass and 20 percent forb. Much of the Grassland identified along the mainstem of the river was on disturbed areas along Highway 14 that were revegetated with weedy species.

Grasslands represented about 25 percent of the land outside the project areas, primarily in the eastern one-third of the study area below 5,700 ft elevation. Average herbaceous canopy cover and grass/forb composition was similar inside and outside the project areas.

Rock and Talus.

The Rock and Talus cover type was defined as rock outcrops with less than 10 percent tree cover, less than 20 percent shrub cover, and less than 30 percent herbaceous cover. This cover type represented 263 acres or about 0.6 percent of the study area and usually occurred on cliffs and steep slopes. Prominent rock types in the study area included granite at Grey Rock, limestone near Hook and Moore Glade, and metamorphic and igneous rocks of Precambrian age along the river canyon. Vegetative cover was sparse but included trees, shrubs, grasses, and forbs in crevices of the rock. Cliffbush was one of the most prominent shrubs and alumroot (Heuchera bracteata) was a prominent herbaceous species. This cover type corresponded most closely to the Rocky Slopes, Screes, and Cliffs association defined for the Arapaho and Roosevelt National Forests (Johnston, 1987).

Rock and Talus represented about 14 and 23 acres (1 percent) of the Poudre and Grey Mountain project areas. It was primarily distributed along the bases of cliffs near the river. Rock and Talus occupied less than one percent of the land outside the project areas. The majority of this cover type outside the project areas was represented by high cliffs and the peak of Grey Rock Mountain.

Riparian Cover Types

Riparian cover types were distinguished from upland types by their close association with streams and rivers. Riparian habitats in this study were defined as cover types adjacent to water courses where seasonally wet soils influenced plant productivity and composition (Roberts, 1983). Riparian vegetation was found along permanent and ephemeral streams, including springs and washes. Three types of riparian habitat were identified in the study area: forest, shrub, and grass. Riparian cover types occupied about 1.3 percent of the study area and 4 percent of the Grey Mountain and Poudre project areas.

Riparian Forest

The Riparian Forest cover type was defined as streamside vegetation with more than 10 percent tree canopy cover. This type represented 383 acres or about about 1 percent of the study area. Individual patches of Riparian Forest were usually small, averaging about 1.7 acres. The most prominent tree species in Riparian Forest areas was either plains or narrowleaf cottonwood (Populus sargentii and P. angustifolia), but peach-leaved willow (Salix amygdaloides), box elder (Acer negundo), ponderosa pine, Douglas-fir, Rocky Mountain juniper, hackberry (Celtis occidentalis), alder (Alnus tenuifolia), and river birch (Betula fontinalis) were also found. Shrubs were diverse in the understory and included chokecherry, wild plum, snowberry, skunkbrush, willow (Salix sp.), golden currant (Ribes aureum), wild rose (Rosa sp.), and poison ivy (Toxicodendron rydbergii). Vines, including western virgin's bower (Clematis ligusticifolia) and wild grape (Vitis vulpina) were common. The herbaceous understory included a wide variety of grasses and forbs such as bluegrass, reed-canary grass (Phalaris arundinacea), redtop Agrostis gigantea), sedges (Carex sp.), rushes (Juncus sp.), goldenrod (Solidago sp.), stinging nettle (Urtica dioica), hounds tongue (Cynoglossum officinale), milkweed (Asclepias arenaria), ragweed (Ambrosia psilostachya), thistle (Cirsium sp.), and mint (Mentha sp.). The density and cover of the herbaceous understory were directly related to the availability of moisture or the permanence of the stream and the amount of grazing.

The Riparian Forest cover types included two forest associations defined for the Arapaho and Roosevelt National Forests. The narrowleaf cottonwood/coyote willow (Populus angustifolia/Salix exigus) association corresponded to some of the Riparian Forest type in the study area above 6,500 ft. Lower elevation Riparian Forests in the study area represented the plains cottonwood/willow (Populus sargentii/Salix sp.) association (Johnston, 1987).

The Riparian Forest cover type occupied about 62 and 75 acres (3 percent) of the Poudre and Grey Mountain project areas, respectively. The Riparian Forest was adjacent to the river, the most important permanent water source in the study area. Tree canopy cover averaged 47 percent and shrub cover averaged 23 percent. Shrub height averaged 7.5 ft (2.3 m), almost 3 ft (0.9 m) taller than shrubs in upland cover types. Riparian Forest areas were often severely grazed by cattle, because of their proximity to water, high herbaceous cover, and structural diversity.

The Riparian Forest type occupied 1 percent of the land outside the project areas. Tree canopy cover averaged 70 percent and shrub cover averaged about 7 percent. Shrub cover was lower than in the project areas probably because most of the streams outside the project areas were ephemeral. The higher tree canopy cover in Riparian Forests outside the project areas may have been an artifact of the difficulty of defining the boundaries of riparian areas adjacent to ephemeral streams.

Riparian Shrub

The Riparian Shrub cover type was defined as streamside vegetation with less than 10 percent tree cover and more than 20 percent shrub cover. This type represented 121 acres or about 0.3 percent of the study area. Common shrubs were hawthorn (Crataegus succulenta), wild plum, chokecherry, coyote willow (Salix exigus), snowberry, and skunkbrush. Many of the vines, forbs, and grasses common in Riparian Forest were also found in the Riparian Shrub cover type. In the woody draws of low elevation ephemeral streams this type included the chokecherry-snowberry/western wheatgrass (Prunus virginiana - Symphoricarpos occidentalis/Agropyron smithii) association identified by the FS for Arapaho and Roosevelt National Forest (Johnston, 1987). The Riparian Shrub adjacent to the permanent streams in the study area corresponded to the willow/bluegrass (Salix exigus - Salix sp./Poa sp.) association (Johnston, 1987).

Riparian Shrub represented 13 to 17 acres (0.7 percent) of the Poudre and Grey Mountain project areas, respectively. Shrub canopy cover averaged 69 percent and herbaceous cover averaged 64 percent, nearly twice as high as the Mountain Shrub type. Like the Riparian Forest, this habitat type showed signs of heavy grazing.

The Riparian Shrub type occupied only 0.3 percent of the land outside the project areas. Shrub canopy cover outside the project areas averaged 60 percent and herbaceous canopy cover averaged 34 percent. These values are lower than in the project areas, probably because most of the streams outside the project areas were only seasonally wet.

Riparian Grassland

The Riparian Grassland type was defined as streamside vegetation with more than 30 percent herbaceous cover, less than 20 percent shrub, and less than 10 percent tree cover. This type was found in only a few locations which represented about 16 acres in the study area. These patches were generally on flat areas next to river bends where silt had been deposited. These sites were dominated by herbaceous plants. Dominant grasses were Kentucky bluegrass (Poa pratensis), smooth brome (Bromus inermis), red top, and timothy (Phleum pratense). Other grasses, sedges, and rushes were common, as were forbs such as thistle, sweet clover (Melilotus sp.), mullein (Verbascum thapsus), stinging nettle, clover (Trifolium sp.), goldenrod, scouring rush (Equisetum sp.), and ragweed. The height, density, and diversity of herbaceous cover related directly to the amount of grazing the site had undergone. Shrub cover was low, and it consisted primarily of coyote willow, snowberry, and wild rose.

About half the Riparian Grassland in the study area (8 to 9 acres) was in the project areas. Herbaceous cover averaged 64 percent, and 79 percent of the herbaceous cover was grass. Tree and shrub cover was less than one percent. Because of its proximity to water and high palatability of herbaceous cover, this cover type was heavily grazed by cattle throughout the study area.

Palustrine or Wetland Cover Types

Wetlands were areas dominated by plants adapted to growing on seasonally saturated soils (Cowardin et al., 1979).

Two wetland types were identified in the study area: Palustrine Marsh/Meadow and Palustrine Pond. Together, they represented about 106 acres or 0.3 percent of the study area. There were no wetlands in either the Grey Mountain or Poudre project areas.

Palustrine Marsh/Meadow

The Palustrine Marsh/Meadow cover type was defined as herbaceous vegetation restricted to perennially wet sites associated with low or flat areas adjacent to springs or seeps. There were about 53 acres of this type in the study area. The largest patch of Palustrine Marsh/Meadow was in Grey Rock Meadow. Smaller patches were found on the eastern portion of the study area. This type was dominated by sedges, red top grass, mannagrass (Glyceria sp.), foxtail barley (Hordeum sp.), timothy, bluegrass, rushes, cattails (Typha latifolia), and bulrushes (Scirpus sp.). Common forbs were smartweed (Polygonum sp.), watercress (Rorippa nasturtium-aquaticum), sticktights (Bidens sp.), water parsley (Denanthe samentose), and willow herb (Epilobium sp.). The herbaceous cover was generally high because water was plentiful during the growing season. Included in this type were some of the associations in the Mountain Riparian Grassland and Fresh-Water Riparian Grassland communities identified by the FS for the Arapaho and Roosevelt National Forests (Johnston, 1987).

Palustrine Pond

The Palustrine Pond cover type consisted of shallow ponds with little emergent vegetation. There were 13 ponds in the study area, representing about 53 acres (0.1 percent). Most of the ponds were man-made impoundments that served as water sources for cattle. The largest one was a settling pond for a cement operation. Several of these ponds were perennially wet and others were dry by the end of summer.

Riverine

The Riverine cover type included the mainstem and the North Fork of the Cache la Poudre River. It included the river, pools, riffles, cliff bases, boulders, and sand bars within the normal high water mark. There were about 178 acres (0.5 percent) of the Riverine cover type in the study area. The Riverine cover type represented 99 and 127 acres (5 percent) of the Poudre and Grey Mountain project areas, respectively.

Lacustrine

The only Lacustrine (lake) cover type in the study area and the project areas was Seaman Reservoir. Seaman Reservoir occupies about 150 acres at full pool and half that at normal maximum drawdown (77 acres). The reservoir has little rooted or emergent vegetation because of fluctuations in water level.

Developed Types

Developed cover types were defined as areas where man's activities dominated the landscape. These represented about 2,100 acres (5 percent) in the study area and 115 and 134 acres (6 percent) in the Poudre and Grey Mountain project areas, respectively. Three developed types were identified in the study area.

Agriculture

Agriculture occupied 968 acres or about 2.5 percent of the study area. None of this cover type was identified in the Grey Mountain or Poudre project areas. Agricultural areas were at low elevations (below 5,400 ft) in the southern part of the study area. The predominant crops were alfalfa and pasture grasses. All other crops combined occupied only less than 10 acres. All areas with signs of active cultivation were labeled as Agriculture, even though some were not intensively cultivated at the time of this study.

Developed

Developed land was defined as areas other than agriculture with human use as a dominant factor, but with some vegetative cover. Developed areas included residences with yards and outbuildings. This type occupied about 158 acres in the study area and 8 to 9 acres in the Poudre and Grey Mountain project areas, respectively.

Disturbed

Disturbed land was defined as areas with little or no vegetation because of intensive human activity. Disturbed areas included roads, canals, mines, industrial sites, and the drawdown zone of Seaman Reservoir. When Seaman Reservoir was at normal maximum drawdown, this type represented 974 acres or about 2.5 percent of the study area and 108 and 125 acres (5 percent) of the Poudre and Grey Mountain project areas, respectively. About 60 percent of this type in the Grey Mountain project area was the drawdown zone of Seaman Reservoir. For the Poudre project area, about 71 percent of the disturbed land was in this drawdown zone. The remaining disturbed areas were mostly along the mainstem.

Disturbance and Ecological Succession

The major sources of disturbance to plant associations in the study area included fire, logging, grazing, and development. Succession is the natural process of change in the plant communities that follows a disturbance event.

Fires have occurred every year in the study area. Lightning fires have probably been more frequent than man-caused fires (Biastock, 1988). The fires, though fairly frequent, have been relatively small because there is a fire suppression policy for the National Forest, private, and State lands. On the 2.3-million-acre Arapaho and Roosevelt National Forests, about 65 fires per year burn a total of 1,064 acres (FS, 1984). The fires have commonly occurred in open areas and along ridge tops where they have been low in intensity. These surface fires have removed the understory but seldom killed forest stands. They remove or thin the above-ground parts of grasses, forbs, shrubs, and young ponderosa pines. The vegetation that grows after such a fire has been composed mainly of annual grasses and forbs whose seeds survive in the soil, perennials that sprout from underground parts, and the plants that survive the fire. Fires are generally not sufficiently intense to kill the larger ponderosa pine trees. Fire-adapted shrubs such as mountain mahogany resprout from underground parts. Vegetation will usually reestablish quickly as the same types that burned.

Timber harvesting has not been of major importance in the study area since before the turn of the century. There have been no timber sales on National Forest land in the study area (Winkler, 1988). A small number of trees have been harvested on private land, some of which were probably removed because of a mountain pine beetle outbreak south of the Cache la Poudre River (Winkler, 1988). Timber harvesting, therefore, has had only a minor effect on plant associations in the study area, and the harvest rate is not expected to change in the foreseeable future.

Cattle grazing has historically been extensive in the study area. After the FS reduced grazing allotments and tightened control of the length of the grazing period in the early 1960s, overgrazing on federal lands was controlled.

Little information exists concerning development trends in the study area. However, much of the study area is in the National Forest or includes lands owned by the State of Colorado. It is also unlikely that privately owned land will be developed in parcels less than 35 acres because of present state laws. Therefore, the rate of industrial, residential, and recreational development over the next 50 years is expected to be low.

The rate of plant succession in the study area is very slow because of the arid climate. Changes in successional stages from grassland to shrubland or shrubland to forest require long periods of time. Moreover, factors responsible for reversing succession (i.e., logging, fire, grazing) do not apply to the study area except for development, which is expected to be low.

3.4.1.2 Plant Species or Associations of Special Concern

The five plant species of special concern identified by CNAP (1986b) as occurring in or near the study area (CNAP, 1986b) are described below.

Gaura neomexicana Wooton sp. coloradensis (Rydb.) Raven & Gregory

Description

This species, also known as the Colorado butterfly weed, is in the evening primrose family (Onagraceae). It is listed by the FWS (1985) as a Candidate, Category 1 species. This classification means that the plant has not been formally listed as threatened or endangered at this time, but enough information exists to do so. CNAP classifies this species as rare (20 or fewer populations) in Colorado and elsewhere. There is one verifiable population in Colorado and a few in Wyoming and Nebraska. The historical populations near the study area have not been confirmed since 1944.

The Colorado butterfly weed is described as a biennial or perennial herbaceous plant up to 4 ft (120 cm) tall with a branched flowering stem and lance-shaped leaf blades 1-6 inches (2-15 cm) long with entire margins or very small teeth. The flowers have petals 0.2-0.5 inches (5-14 mm) long that are white or pink, turning pinkish or reddish in age. It blooms in July and August.

Habitat Requirements

The Colorado butterfly weed was reported to grow in "humic soil in wet areas and bottoms of drainages; 5000-6000 feet" (Ellis and Fay, 1978). The known habitat is reported to be "mountain meadows, transition zones between wet stream bottoms and dry uplands; 4000-6500 feet" (Laird, 1982) No further information was found on herbarium specimens or from other botanists and no nearby verified populations were available to visit.

Locations Searched in the Study Area

No historical locations were identified for this species in the study area. All wetland and riparian areas were searched (Figure 3.2).

Populations Identified in the Study Area

No populations of this species were identified in the study area.

Physaria bellii Mulligan

Description

This species, known as Bell's twinpod, is in the mustard family (Brassicaceae or Cruciferae). It is listed by the FWS (1985) as a Candidate, Category 2 species. This classification means that the species has not been formally designated as threatened or endangered, but current information suggests that listing may be appropriate. Additional information and surveys are required before the listing process could begin. CNAP classifies this species as rare (20 or fewer populations) in Colorado and elsewhere. It is endemic to Colorado (not found elsewhere) and only a few populations north of Boulder and north of Fort Collins have been located.

Bell's twinpod is a perennial with a basal rosette of grey-green leaves up to 3 inches (7.6 cm) long. The flowering stems are 2-5 inches (2-12.7 cm) tall. The flowers are not distinctive, and the species is distinguished from other closely related species on the basis of the characteristics of its fruits. The fruits are made up of 2 somewhat inflated pods, 0.15-1.5 inches (4-6 mm) long with 2 seeds in each, that are shed from the plant. The plants flower in May and produce fruits by June.

Habitat Requirements

Bell's twinpod is reported to be "restricted to shales" (Weber, 1976), and the known habitat is "loose, grey shale washes on east-facing slopes of hogbacks" (Peterson, 1982). A very light grey colored substratum is particularly important for its establishment and growth (Weber, 1987). The elevation of the populations near Boulder is about 5700 ft, and the populations near Fort Collins are at about 5400 ft.

Two populations of Bell's twinpod near Fort Collins were visited to determine specific habitat requirements. In the SW quarter of Section 16, Township 9 North, Range 69 West, a substantial population of several thousand plants was found on a low hogback ridge with light grey soils of a shaley texture. The shale appeared to form a surface mulch that kept the soil from drying out. The species was common on all aspects. The associated shrubs included mountain mahogany and skunkbrush and the herbaceous understory was sparse with very little grass. The most common associated species included bladder-pod (Lesquerella sp.), evening star (Mentzelia sp.), and milkvetch (Astragalus sp.).

Locations Searched in the Study Area

No historical locations for this species were identified in the study area. All light grey soil outcrops in the study area were searched (Figure 3.2). Only a few such outcrops were identified, all in the easternmost third of the study area.

Populations Identified in the Study Area

No populations of this species were identified in the study area.

Aletes humilis Coulter & Rose

Description

This species, known as Larimer aletes, is in the carrot family (Apiaceae or Umbelliferae). It is listed by the FWS (1985) as a Candidate, Category 2 species. CNAP classified this species as rare (20 or fewer populations) in Colorado and elsewhere. It has been identified in only six locations, all on granite cliffs and summits, in Larimer County, Colorado.

Larimer aletes forms compact mats up to about 10 inches (25.4 cm) in diameter and 6 inches (15.2 cm) tall that grow in the crevices of cliffs or summits of granite or at cliff bases. The leaves are shiny green, hairless, pinnate, with 5 to 7 deeply toothed or lobed leaflets. The yellow flowers and the fruits are born on short stems, hidden among the leaves. The plants have a short blooming period in about mid-May and produce fruits by early June.

Habitat Requirements

Larimer aletes has been reported as "forming mats on vertical granite cliffs and in cracks and crevices on summits of rocky granite tors; it has also been found in cracks of granite rock under forest trees at bases of granite cliffs, 6900-7800 ft." (FS, undated). Discussion with CNAP staff (Macey, 1987) indicated that the elevation range may extend as low as 6600 ft in Phantom Canyon.

A known population of Larimer aletes at Grey Rock within the study area was visited to determine specific habitat requirements. The species was found at the summit of the Grey Rock Mountain where the the trail levels off. It was common in crevices of granite at the north end of the summit. The massive granite had occasional cracks and crevices, but was not highly fractured. The crevices containing the Larimer aletes were large enough to have collected soil, appeared rather moist, and often had a northern exposure.

Locations Searched in the Study Area

All cliffs approaching an elevation of 6600 ft within or adjacent to the project areas were scanned with binoculars or a spotting scope to determine the occurrence of Larimer aletes. In addition, all cliffs adjacent to Grey Rock Meadow in the study area were surveyed (Figure 3.2).

Populations Identified in the Study Area

In addition to the known population at the summit of Grey Rock Mountain, Larimer aletes was also found at the base of some massive granite boulders on Grey Rock Mountain, in a soil consisting of a fine gravel of decomposed granite.

Pellaea atropurpurea (L.) Link

Description

This species, known as the purple-stem cliffbrake, is in the fern family (Polypodiaceae). It is relatively common in the midwest and eastern U.S., and therefore, is not classified by FWS as threatened or endangered. However, it is rare in Colorado, and has been identified in only five recorded locations. CNAP classifies it as a species requiring more information prior to status determination.

The purple-stem cliffbrake has evergreen fronds from 4 inches (10 cm) to over a foot (30.5 cm) tall, crowded on short rhizomes. The fronds are from 1 to 3 times pinnate, and the ultimate segments are blue-green, oblong, and sessile. Spores are born along the rolled-under margin of the segments.

Habitat Requirements

The purple-stem cliffbrake was reported as "epipetric in crevices in calcareous cliffs and rock ledges, on limestone walls, in limey mortar on walls, or rarely terrestrial." (Lellinger, 1985). It has been reported in Owl Canyon in the study area " . . . in limestone ledges along sides of fairly deep arroyo in Pinus edulis woodland, northeast exposure . . . ca. 6000 ft alt." (Weber, 1955). Owl Canyon was visited to determine the specific habitat requirements of this species. The area was searched carefully, but no representatives of this species were found. The only northeast-facing cliffs in the area were nonvegetated road cuts.

Locations Searched in the Study Area

The limestone cliffs at Owl Canyon (a historical location for the species) occurred at a break in the north-south trending limestone formation. Owl Canyon and all the similar breaks in this limestone formation were searched (Figure 3.2).

Populations Identified in the Study Area

No populations of this species were identified in the study area.

Solidago ptarmicoides (Nees.) T. & G.

Description

This species, known as prairie goldenrod, is in the sunflower family (Asteraceae or Compositae). Its range includes Colorado and extends north to Saskatchewan and east to New England. It is not classified by FWS as threatened or endangered. However, it is rare in Colorado and has been identified from only seven historical locations in the northcentral and central portions of the state. CNAP classifies it as a species requiring more information prior to status determination.

The prairie goldenrod is perennial, 6-20 inches (15.2-50.8 cm) tall with narrow leaves 2-6 inches (5-15 cm) long. It has few to several heads with white ray flowers (unusual for a goldenrod). Blooming starts in July.

Habitat Requirements

The habitat of the prairie goldenrod has been described as "banks and bluffs, often on rocky ground . . . 6000-7500 ft" (Harrington, 1954). An herbarium label identified its habitat as ponderosa pine savannah. No locations were known near the study area, and no site visit could be made to determine specific habitat requirements.

Locations Searched in the Study Area

Since the single historical location for this species in the area was listed only as "Owl Canyon," the locations in that vicinity that could be described as "banks or bluffs with rocky soil" were searched. However, this habitat description was not specific enough to designate other search areas. All the plants with a growth habit and description similar to Solidago ptarmicoides that were encountered during the field sampling and in searches for other species were examined.

Populations Identified in the Study Area

No populations of this species were identified in the study area.

3.4.2 Effects Assessment

3.4.2.1 Effects on Plant Communities

The primary effect of the proposed project on plant communities would be inundation by the reservoir. Other direct effects would include the occupation of land by the dam, powerhouse, transmission lines, maintenance areas, access roads, recreational facilities, and relocated Highway 14.

The land mapped and evaluated as the Grey Mountain and Poudre project areas (Figure 3.1) was designed to account for most of the affects of the proposed project. The project areas included the land upstream from each alternative damsite to an elevation of 5,680 ft. The normal maximum reservoir surface elevation would be 5,630 ft at full pool. A temporary flood could raise the pool level to 5,640 ft. The area between 5,640 ft and 5,680 ft elevation should account for most of the area that will be affected by the dam, powerhouse, associated facilities, roads, recreational development, and other disturbances.

Grey Mountain Reservoir would affect 2,397 acres and the Poudre Reservoir would affect about 1,895 acres (Table 3.7). A total of 12 out of the 16 cover types in the study area would be affected by the project (Figure 3.3). The four most abundant cover types in the study area are Mountain Shrub, Grassland, Open Canopy Conifer Forest, and Closed Canopy Conifer Forest. These cover types represent about 81 percent of the area affected by either project alternative. The acreage lost by these types represents only about 5 percent of their current total in the study area (Table 3.7). The most notable losses would be the Riverine and associated Riparian cover types. Construction of either project alternative would eliminate about 20 percent of the Riparian cover types in the study area. The Grey Mountain and Poudre alternatives would eliminate 71 and 56 percent, respectively of the river in the study area. Regionally, rivers and Riparian cover types comprise a small amount of area and are relatively scarce. Due to their proximity to water, Riparian cover types are valuable to wildlife, and have a high productivity and species diversity. However, the value of the Riparian vegetation in the project areas has been reduced due to heavy grazing, development, recreational activities, and the close proximity of Highway 14.

Indirect effects of the proposed project are expected to be small compared to the direct effects. For example, the additional use of irrigation water from the project may cause wetland habitats to be created in places where none exist. In addition, the reservoir may affect vegetation as a result of: (1) increased erosion associated with construction; (2) microclimatic changes due to the presence of the reservoir; (3) more forest fires due to increased recreation use in the area; and (4) landslides or slumping due to wave action along steep areas of the reservoir shoreline (Taber, 1973; Alaska Power Authority, 1985). There is no evidence to determine if these indirect effects would occur for the Cache la Poudre Project. However, the effects of erosion can be minimized if standard construction practices are followed. In addition, because the substrate along much of the mainstem and North Fork consists of cliffs and rocks, significant slumping due to wave action is unlikely.

3.4.2.2 Effects on Plant Species or Associations of Special Concern

No species of special concern were found in the project areas of either the Grey Mountain or Poudre alternatives. Therefore, the likelihood that a species of special concern would be affected by the project is negligible. No plant associations of special concern or natural wetlands were identified in the project areas or the study area. Therefore, no effects on plant associations of special concern are expected.

TABLE 3.7

Area of Cover Types in the Cache la Poudre Study Area and Project Areas for Grey Mountain and Poudre Alternatives

Cover Type	Study Area		Grey Mountain Alternative		Poudre Alternative	
	Area (ac)	Percent	Project[1] Area (ac)	Percent Loss	Project[1] Area (ac)	Percent Loss
Closed Canopy Conifer	5,527	14.0	234	-4.2	218	-3.9
Open Canopy Conifer	6,790	17.2	396	-5.8	321	-4.7
Pinyon Pine Forest	178	0.5		0.0	0	0.0
Mountain Shrub	13,469	34.1	972	-7.2	698	-5.2
Grassland	10,276	26.0	334	-3.3	269	-2.6
Rock and Talus	264	0.7	22	-8.3	14	-5.3
Agriculture	968	2.5	0	0.0	0	0.0
Developed	158	0.4	9	-5.7	8	-5.1
Disturbed	974	2.5	125	-12.8	108	-11.1
Riparian Forest	388	1.0	75	-19.3	62	-16.0
Riparian Shrub	121	0.3	17	-14.1	13	-10.7
Riparian Grassland	16	0.04	9	-56.3	8	-50.0
Palustrine Marsh	53	0.1	0	0.0	0	0.0
Palustrine Pond	53	0.1	0	0.0	0	0.0
Riverine	178	0.4	127	-71.4	99	-55.6
Lacustrine (existing)	77	0.2	77	-100.0	77	-100.0
Totals	39,489		2,397		1,895	

(1) Project areas include the land to be inundated by the reservoir with a maximum flood pool level of 5,640 feet and the surrounding area to elevation 5,680 ft.

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3.5 DISCUSSION

3.5.1 Comparison of Alternatives

The main difference between the Grey Mountain and Poudre alternatives is the size of the affected area. The Grey Mountain alternative will affect about 500 acres more than the Poudre alternative. The proportions of the various cover types affected by the two alternatives would be similar (Figure 3.3). Therefore, no difference other than size was evident.

3.5.2 Regional Importance of Effects

The importance of the terrestrial cover types in the project areas was directly related to their abundance or scarcity in the region. The Mountain Shrub, Open Canopy Conifer Forest, Grassland, Rock/Talus, and Closed Canopy Forest are widespread along the north Front Range of the Colorado Rocky Mountains. Conversely, the Riparian cover types comprise a very small amount of acreage in this area but are valuable to wildlife, have a high species diversity, and are highly productive. Consequently, loss of the Riparian acreage associated with either alternative would be much more significant than the loss of upland cover types. The quality of Riparian types in the project areas has been reduced because of heavy grazing. However, the potential for recovery from disturbance by these Riparian cover types is higher than for other cover types because of the close proximity of water.

3.6 MITIGATION

The most important effect on botanical resources from the proposed project would be loss of Riparian cover types adjacent to the mainstem and North Fork of the Cache la Poudre River. Mitigation for these losses could include creation of wetland areas with seepage or spill water from irrigation. Mitigation for losses of upland cover types could also be accomplished through some form of reclamation. However, mitigation for effects from the proposed project on botanical resources can be largely accomplished by mitigation for wildlife resources since wildlife mitigation provides for replacing lost habitat or cover types. Therefore, the preliminary cost estimates for the wildlife mitigation plan should be sufficient to cover mitigation for effects on botanical resources as well.

3.7 REFERENCES

Alaska Power Authority. 1985. Susitna Hydroelectric Project. Draft Exhibit E. Chapter 3. Fish, Wildlife, and Botanical Resources. Section 3.

Biastock, Bill. 1988. Personal communication. U.S. Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Telephone conversation with A.D. Every (Envirosphere Co.), January 29, 1988.

Colorado Natural Areas Program (CNAP). 1986a. Plant associations of special concern in Colorado. Colorado Natural Areas Program, February, 1986.

Colorado Natural Areas Program (CNAP). 1986b. Letter to Eric Berg reporting the results of searching the CNAP data base for occurrences of rare, threatened or exemplary plants, animals, and plant associations in the Study Area. July 28, 1986.

Colorado Natural Areas Program (CNAP). 1987. Plant species of special concern. Colorado Natural Areas Program, February, 1987.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. La Roe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Biological Services Program, FWS/OBS-79/31.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33:43-46.

Ellis, S. and P. Fay. 1978. An illustrated guide to the proposed threatened and endangered plant species in Colorado. Contract report to the U.S. Fish and Wildlife Service, Denver, Colorado. April 1978.

Forest Service. 1984. The Arapaho and Roosevelt National Forests land and resource management plan. Rocky Mountain Region, USDA Forest Service.

Forest Service. undated. Status report for Aletes humilis. Part of a Roosevelt National Forest report.

Harrington, H.D. 1954. Manual of the plants of Colorado. Sage Books, Denver.

Harza. 1987. Cach la Poudre Basin study and hydropower resources report. Prepared for the Colorado Water Resources and Power Development Authority. Denver, Colorado.

Hess, Karl, and Robert R. Alexander. 1986. Forest vegetation of the Arapaho and Roosevelt National Forests in central Colorado: a habitat type classification. USDA Forest Service Research Paper RM-266, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Johnston, Barry, C. 1987. Plant associations of Region Two, Edition 4, USDA Forest Service, Rocky Mountain Region, R2-ECOL-87-2, Lakewood, Colorado.

Laird, D. (compiler). 1982. Status report for Gaura neomexicana sp. coloradensis. Colorado Natural Heritage Inventory. 20 Aug. 1982.

Lellinger, D.B. 1985. A field manual of the ferns and fern-allies of the United States and Canada. Smithsonian Institution Press, Wash. D.C.

Macey, S. 1987. Personal communication with David Every, Envirosphere Company, June 29, 1987. Colorado Natural Areas Program.

Marr, John W. 1961. Ecosystems of the east slope of the Front Range in Colorado. University of Colorado Studies, Series in Biology, No. 8. 134 pp. University of Colorado Press. Boulder, Colorado.

Peterson, J.S. (compiler). 1982. Status report for Physaria bellii. Colorado Natural Heritage Inventory, 13 Jul 1982.

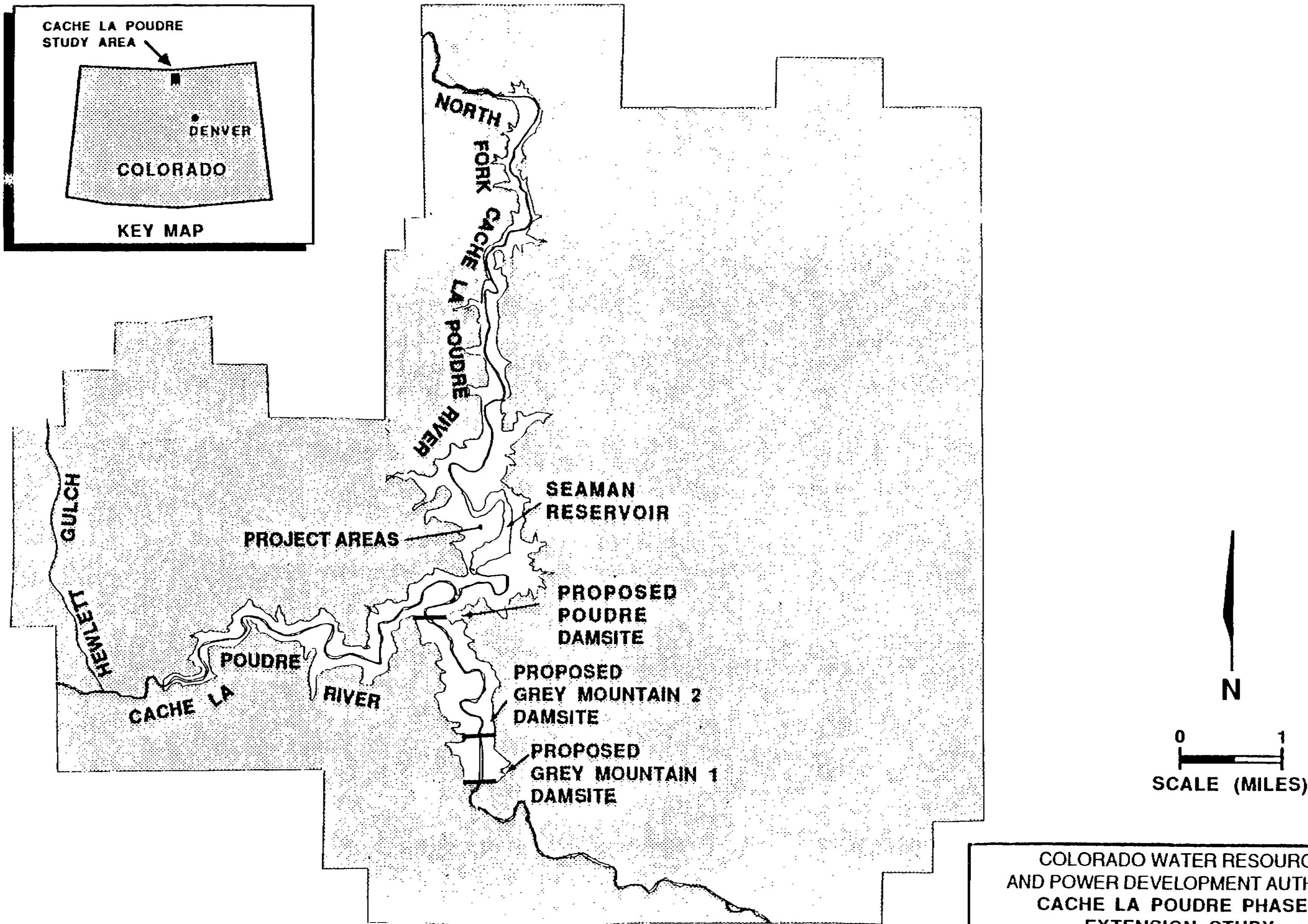
Roberts, L.D. 1983. Riparian habitat in the proposed Grey Rocks reservoir. M.S. Thesis. Colo. St. Univ., Ft. Collins. 135 pp.

Taber, R.D. 1973. Biotic surveys for Ross Lake Basin. Report for January - December. 1972. University of Washington.

Weber, W.A. 1976. Rocky Mountain flora. Colorado Associated University Press. Boulder, Colorado.

Weber, W.A. 1955. Additions to the flora of Colorado. University of Colorado Studies 3:67.

Winkler, F. 1988. Personal communication. U.S. Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Telephone conversation with A.D. Every (Envirosphere Co.), February 4, 1988.



GREY MOUNTAIN 1 DAMSITE
IS DEFINED IN PRELIMINARY PERMIT

GREY MOUNTAIN 2 DAMSITE IS DEFINED
IN CWRPDA BASIN STUDY (Harza, 1987)

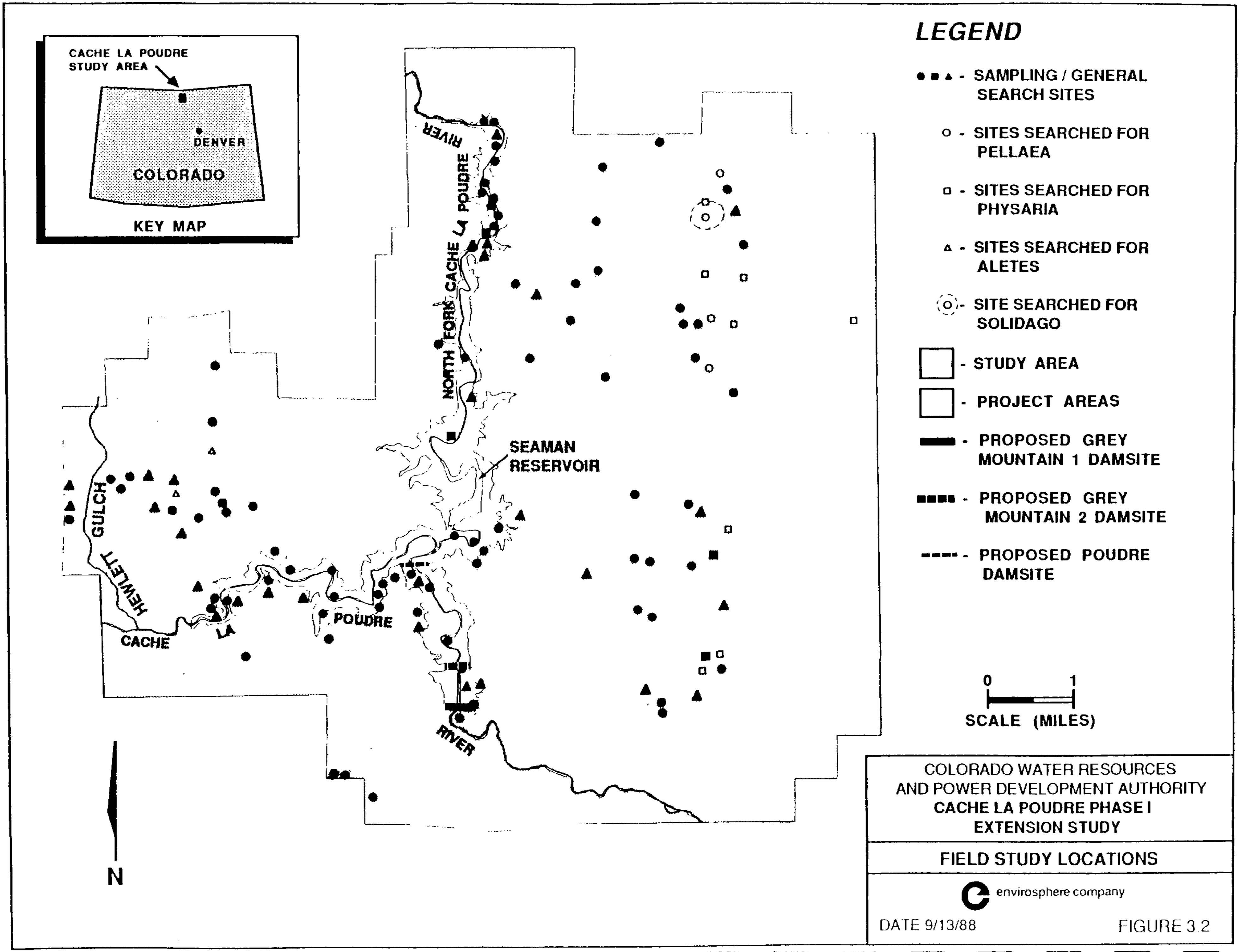
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE PHASE I
EXTENSION STUDY

STUDY AREA

envirosphere company

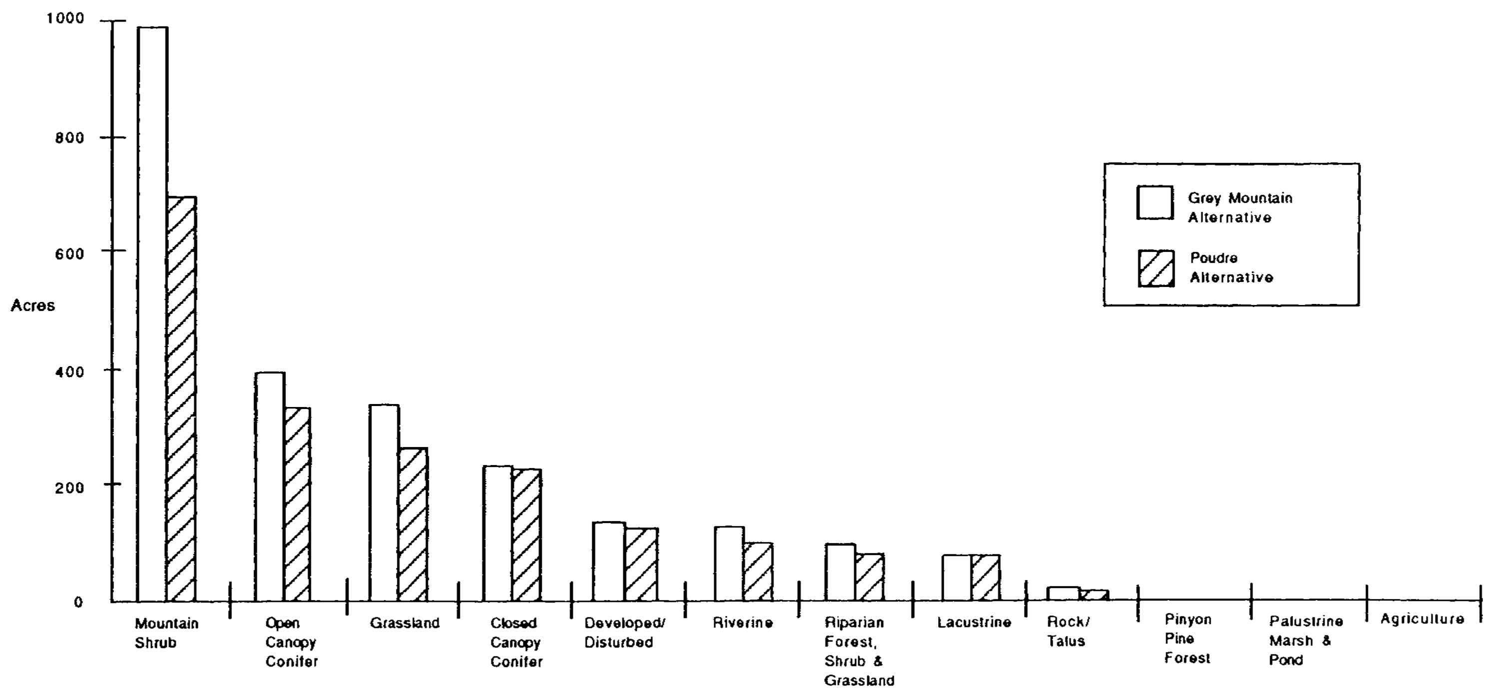
DATE 10/24/88

FIGURE 3.1



FIELD STUDY LOCATIONS

FIGURE 3.2



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE PHASE I EXTENSION STUDY

AREA OF EACH COVER TYPE AFFECTED BY THE PROPOSED PROJECT ALTERNATIVES

envirosphere company

DATE 9/15/88

FIGURE 3.3

CHAPTER 4.0

CULTURAL RESOURCES STUDIES

4.0 CULTURAL RESOURCES

4.1 INTRODUCTION

The cultural resource investigations comprised Task 13 of the 1987-1988 Cache la Poudre Basin Study Extension funded by the Colorado Water Resources and Power Development Authority. These investigations were designed to support effects assessments and identify potential mitigation measures as part of a preliminary environmental feasibility assessment.

4.1.1 Study Objectives and Cultural Resources Scope of Work

The objectives of the cultural resource investigations were as follows:

(1) Conduct background research for the purpose of identifying known archaeological sites in the project vicinity, areas that have been previously inventoried, and critical cultural resource issues that may adversely affect project plans;

(2) Conduct intensive inventory of areas to be directly affected by the project, and identify and record cultural resources in those areas;

(3) Evaluate identified cultural resources per significance criteria of the National Register of Historic Places (36 CFR 60);

(4) Assess the nature and degree of project effects on significant archaeological sites;

(5) Propose mitigative strategies for affected significant archaeological sites;

(6) Assess the feasibility of the project in terms of cultural resource concerns; and

(7) Prepare a final report on the cultural resource investigations.

The cultural resources scope of work or study plan was comprised of the following eight subtasks:

Subtask	Description
13a	Agency Consultation
13b	Project Area Background Research
13c	Field Investigations
13d	Data Processing and Analysis
13e	Significance Evaluation and Effects Assessment
13f	Mitigative Measures
13g	Preliminary Feasibility Assessment
13h	Task Report

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Agency consultation (Subtask 13a), which entailed solicitation of Forest Service and State of Colorado/Office of Archaeology and Historic Preservation (OAHP) comment on the initial study plan, was undertaken in advance of the other subtasks. The results of all work conducted under Subtasks 13b through 13g are presented in this task report. A supplemental report has also been prepared in accordance with the requirements of the Forest Service and Colorado OAHP (Grant et al., 1988).

4.1.2 Task Organization

Cultural resource investigations were conducted by Centennial Archaeology, Inc. (CAI) under subcontract to Envirosphere Company. All studies were undertaken by CAI personnel except the historical overview and evaluation studies, which were performed by Robert G. Rosenberg under a consulting agreement with CAI. Christian J. Zier served as Principal Investigator and Marcus P. Grant as Field Supervisor. Daniel A. Jepson acted as Crew Chief, and Robert G. Rosenberg as Project Historian. Full-time field crew members were William N. Fallon and Ann P. Harrison. Short-term crew members were Andrea M. Barnes and Elaine Olson. C. Mike Prewitt, Environmental Studies Manager, administered cultural resource and other environmental studies for Envirosphere Company. Overall project management was provided by Blaine N. Dwyer, Colorado Water Resources and Power Development Authority, and Karl J. Dreher, Northern Colorado Water Conservancy District.

Background research was conducted between June 7 and August 14, 1987. Field investigations were initiated on August 18 and concluded October 6, 1987. The remaining subtasks were completed between early October of 1987 and late April of 1988.

All field investigations were conducted under the terms of a Cultural Resource Special Use Permit issued to CAI by the Forest Service (Arapaho, Roosevelt, and Routt National Forests; expiration date - April 1989) and Archaeological Permit No. 87-7 issued by the State of Colorado (Colorado Historical Society; expiration date - December 31, 1987).

4.1.3 Legal Basis of the Study

Cultural resource investigations on federally owned and managed lands, and those potentially affected by activities requiring federal licensing, are supported by a battery of statutes which seek to preserve and protect properties of archaeological and historical significance. Principal among them are the Act for the Preservation of American Antiquities (1906), the Reservoir Salvage Act (1960), the National Historic Preservation Act of 1966 (as amended), the National Environmental Policy Act of 1969, Executive Order 11593 of 1971, the Archeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, and the Archeological Resources Protection Act of 1979. Cultural resources on State of Colorado lands are protected under Colorado Revised Statute 24-80-401 through 409 (1973).

4.2 STUDY AREA

Two basic types of cultural resource study were undertaken. The Class I investigation consisted of research of existing records to ascertain if portions of the current project area have been inventoried previously. The Class I investigation also included determining the location, nature, and significance qualities of known cultural resources. The Class III investigation consisted of intensive pedestrian inventory conducted for the purpose of discovering, recording, and evaluating sites within a defined impact area. The process of evaluating site significance included limited test excavation.

4.2.1 Class I Study Area

The geographical scope of the study differed between Subtask 13b (project area background research) and Subtask 13c (field investigations). Because of data availability and the relative ease with which they could be collected, the Class I investigation was conducted for a contiguous block of 82 square miles (52,480 acres) encompassing all facilities associated with the proposed three project stages: mainstem or alternative reservoir, Glade Reservoir, and forebay reservoir. The Class III investigation was conducted only within the inundation area proposed for the mainstem reservoir and an associated, narrow, buffer zone identified specifically for the cultural resource study.

The area targeted for Class I background research was irregularly shaped (Figure 4.1). The eastern boundary was approximately 3 miles to the east of U.S.

Highway 287 where that route traverses the Hook and Moore Glade. The northern boundary, which is stepped, extended from North Poudre Reservoir No. 15 westward across Highway 287 just north of Owl Canyon, and then southwestward to a point in Hewlitt Gulch 3.5 miles north of the Poudre Canyon. The western boundary paralleled the west side of Hewlitt Gulch. The southern boundary trended easterly and southeasterly from lower Hewlitt Gulch to the north end of Horsetooth Reservoir, through the community of Bellvue, and then northeasterly to a point just east of Curtis Lake. Legal descriptions of lands included in this phase of the study were as follows:

T7N, R69W: Section 6
T7N, R70W: Section 1
T8N, R69W: Sections 4-9, 16-18
T8N, R70W: Sections 1-6, 8-16, 23-26, 36
T8N, R71W: Sections 1, 12
T9N, R69W: Sections 4-9, 16-21, 28-33
T9N, R70W: Sections 1, 9-16, 21-36
T9N, R71W: Sections 23-26, 35-36

Map coverage of these areas was provided by the Buckeye, Horsetooth Reservoir, Laporte, Livermore, Poudre Park, and Wellington, Colorado USGS 7.5' quadrangles.

4.2.2 Class III Study Area

The intensively surveyed area associated with the mainstem reservoir consisted of the inundation area created from the farthest downstream alternative damsite presently being considered (Grey Mountain) plus a 0.5-kilometer-wide buffer zone on all sides. The survey area began approximately 2 miles upstream from the mouth of Poudre Canyon and extended upstream to the north and west along the mainstem of the Cache la Poudre River some 7 miles to the community of Poudre Park (Figure 4.2). The survey area also included the lower 7.5 miles of the North Fork of the Cache la Poudre River, which extends northward from its point of confluence with the mainstem in Poudre Canyon. The intensively surveyed area, including the aforementioned buffer zone, varied in width from less than 0.25 mile to nearly 2 miles. All or portions of the following sections were included in the Class III study:

T8N, R70W: Sections 3-10, 16
T8N, R71W: Section 1
T9N, R70W: Section 9, 10, 15, 16, 21, 22, 27-29, 31-34
T9N, R71W: Section 36

Map coverage of the survey area was provided by the Laporte, Livermore, and Poudre Park USGS 7.5' quadrangles.

4.3 METHODS

4.3.1 Significance Criteria

The National Register of Historic Places (NRHP) was established in its modern form by the National Historic Preservation Act of 1966 (see Subsection 4.1.3). Cultural resources are deemed significant if they possess attributes which qualify a given site for inclusion in the NRHP. Protection or other mitigative action is legally afforded only those properties which qualify for NRHP inclusion. A site need not be enrolled in the NRHP to merit such consideration, but must be determined eligible for inclusion.

Eligibility criteria for the NRHP are presented in implementing federal regulations 36 CFR 60. These regulations require that a site, district, building, or object possess integrity of location, design, setting, materials, workmanship, feeling, and association. In addition, these regulations require one or more qualities relating to association with important historical events or persons; embodiment of distinctive architectural, structural, or artistic values; or likelihood to yield prehistoric or historic data of national, regional, or local importance.

General NRHP eligibility guidelines are set as a means of overcoming the inherent ambiguity of the 36 CFR 60 criteria (Grant et al., 1988). Prehistoric cultural resources that are generally eligible for NRHP nomination include intact pre-Paleo-Indian, Paleo-Indian, and Early Archaic sites; sites that are deeply stratified (have superimposed levels representing multiple occupations); sites of a single time period which exhibit substantial intact buried deposits; intact rock art sites (petroglyphs, pictographs); communal kill sites (e.g., buffalo jumps); complex lithic material quarries; and unique sites. Prehistoric cultural resources that are generally ineligible include surface lithic scatters, isolated artifacts or features, and sites of any type which exhibit poor physical integrity. Historic cultural resources that are generally eligible for the NRHP include sites representative of the fur trade, early exploration, and pre-1880 military themes; physically intact homesteads; well-preserved and representative examples of any theme pertinent to the history of the region; sites which contain unique or outstanding examples of architectural styles, periods, construction techniques, materials, or craftsmanship; sites which exhibit historically important engineering features or industrial processes; and unique historic sites. Generally ineligible historic resources include sites less than 40 years old, isolated artifacts or features (e.g., prospect pits), and sites lacking physical integrity.

4.3.2 Approach to Class I Study

4.3.2.1 Prehistoric Resources Background Research

Class I prehistoric data were gathered from a number of institutions and individuals. The primary information source for known cultural resources within the study area was the comprehensive site file system of the Office of Archaeology and Historic Preservation (OAHP), Colorado Historical Society, Denver. A computerized search of OAHP site records was requested on June 17, 1987, and a manual search of OAHP files was conducted on July 9, 1987. Site forms for all cultural resource locations indicated on the computerized printout were reviewed, pertinent reports on file with OAHP were examined, and site locations plotted on OAHP file maps were transferred to USGS 7.5' quadrangles for project use.

A number of institutions and individuals in Larimer County having relevant information and/or materials were contacted and interviewed. Material comprising the Roy Coffin collection, curated at the Fort Collins Pioneer Museum, was examined and Coffin's notes were reviewed with the assistance of Karen Eberhart, Curator of Collections, on July 24, 1987. Forest Service archaeologist John Slay was interviewed on June 26, 1987. Mr. Slay provided copies of Forest Service reports on small projects within the study area. Dr. Elizabeth A. Morris, Department of Anthropology, Colorado State University (CSU), was interviewed on July 10, 1987. At that time, data in the CSU archaeological site records were compared with the OAHP computer printout to ensure that all known site locations within the study area had been identified. Robert J. Burgess, a professional archaeologist who had conducted extensive fieldwork along the northern perimeter of the Class I study area during the 1970s, was interviewed on June 20, 1987. Mr. Burgess provided maps showing locations of 16 prehistoric sites within the study area which had not yet been included in OAHP site files.

In addition to the activities described above, published and unpublished reports and masters theses relevant to the study area were reviewed. Principal among these sources were unpublished theses in anthropology by Burgess (1981), Kainer (1976), and Thompson (1986), available from the CSU Morgan Library, along with published and unpublished reports from small projects within and near the study area by Anderson (1966), Morris and Marcotte (1976), and Grant (1978).

4.3.2.2 Historic Resources Background Research

Colorado OAHP site records also served as a basic information source for historical data in the project area. Other Colorado repositories also contained collections relevant to the study area. They included the CSU Morgan Library, Fort Collins; the Norlin Library, Western History Division, University of Colorado, Boulder; the Denver Public Library, Denver; the Colorado State Historical Society Library, Denver; and the files of the Supervisor's Office, Arapaho-Roosevelt National Forest, Fort Collins, and associated Ranger District offices. Published and unpublished literature sources relevant to local and regional history included Eberhart (1974), Gleyre and Alleger (1936), Hall (1889-1895), Henderson (1926), Krakel (1954), Mehls (1984), Ormes (1975), Roberts (1938), and Watrous (1911). In addition to the various sources noted above, information was obtained in the course of two interviews. Mr. Benjamin Alexander and Ms. Molly Nortier, both of Administration and Conservation, Fort Collins Water Utilities, were contacted on December 7, 1987.

4.3.3 Approach to Class III Study

4.3.3.1 Site and Isolated Find Definitions

Prehistoric archaeological sites are defined minimally as occurrences of three or more items of lithic debitage (by-products of chipped stone tool manufacture), two or more tools (artifacts modified intentionally prior to use, or as a result of use), one tool plus one item of debitage, or any feature (hearth, stone circles, etc.) whether associated with artifacts or not. To be considered part of a single site, an artifact must be separated from the next nearest artifact by no more than 50 meters. Prehistoric isolated finds (IFs) are defined as occurrences of fewer than three pieces of debitage, or isolated tools or tool fragments, occurring more than 50 meters from other prehistoric materials.

Historic sites are defined as occurrences of any historic structure or feature other than isolated cairns, small retaining walls, or prospect pits. Historic IFs are defined as any occurrences of artifacts such as bottle fragments, horseshoes, or tin cans, situated at least 50 meters from other historic materials, or occurrences of small retaining walls, prospect pits, or cairns with no associated artifacts. To merit recording as a site or IF, an occurrence of historic materials had to be at least 40 years old.

4.3.3.2 Survey and Recording Methods

The project area was subjected to a pedestrian survey of variable intensity. A total of 100 percent surface coverage was given all areas exhibiting slopes of 10 degrees (18 percent grade) or less, as well as ridge crests, hanging terraces, and canyon rims, regardless of slope. Areas characterized by slopes greater than 10 degrees (with exceptions as noted above) were subjected to reconnaissance examination of at least 10 percent of the land surface.

When employing intensive survey techniques (i.e., in areas of 10-degree slopes or less), spacing between surveyors did not exceed 25 meters. When examining steeper slopes, spacing between surveyors was dictated to a large extent by terrain. Surveyors attempted to follow any small terrace systems, grade changes, and vegetation zone boundaries that occurred on the canyon side slopes. All vertical rock faces and potential rock shelter locations were examined.

When archaeological materials were located, all visible artifacts and features were marked with pin flags, and the general area was examined systematically to accurately define site boundaries. A site datum was established and marked with a short segment of PVC pipe. Each site was assigned a unique field number with a "CA" prefix (denoting a Centennial Archaeology, Inc. site), and this number was marked on the datum stake in permanent ink. A site sketch map was then drawn using a Brunton pocket transit with distances determined by pacing. The map illustrated site datum and boundaries, formal artifacts and features, concentrations of debitage, and natural and man-made features of the immediate site area (drainages, roads, rock outcrops, etc.). Two sites were mapped in greater detail owing to topographic and cultural complexities.

At least one black-and-white overview photograph was taken of each recorded site, and features were photographed individually. All facades of intact structures were photographed.

Each site location was plotted on the appropriate USGS 7.5' quadrangle. Colorado OAHP Archaeological Component Forms and Inventory Records were completed for each site, and Historic/Architectural Component Forms were completed for each historic structure. Colorado OAHP Isolated Find Records were completed for each IF locality. Isolated Finds were assigned temporary field numbers prefixed by IF and beginning with IF-1. Surface collection was limited to temporally diagnostic artifacts such as projectile points with intact haft elements (basal portions of stone artifacts that were affixed to wooden arrow foreshafts, bone handles, etc.).

Shovel probing was conducted on several sites as a facet of the recording process. On sites for which a valid determination of significance could not be made on the basis of surface evidence alone, shovel probing was used to determine whether a potential for buried deposits existed, and therefore if formal evaluative test excavations were necessary. Shovel probing was also conducted within five rock shelters having no visible evidence of occupation. Two of these shelters were found to contain buried archaeological materials.

Shovel probes were placed at intervals ranging from 1 meter to 20 meters depending on the areal extent of a given site. All shovel probe locations were plotted on site maps. The probes were generally 30 cm in diameter and were excavated to a maximum depth of 75 cm. All loose fill was passed through 0.25-inch hardware mesh; artifacts were collected and bagged separately by shovel probe unit. Shovel probe placement was subjective, with locations chosen to maximize data recovery while minimizing time expenditures. All excavations were backfilled.

4.3.3.3 Test Excavation Methods

Formal subsurface test excavations were conducted on five sites in order to formulate valid determinations of significance. Subsurface testing was also conducted at two nonsite locations. One of these localities was a rock shelter high on a canyon slope in dense timber; the other was a charcoal concentration exposed in a cut bank at an undeveloped campground.

Most excavation units varied in size from 1 meter on a side to 2 meters on a side, and included a variety of rectangular configurations. Test excavations of stone circles utilized two 50-cm by 3-meter trenches oriented at right angles to one another. Excavation proceeded in arbitrary 10-cm levels. All loose fill was passed through 0.25-inch hardware mesh. Debitage and nondiagnostic bone fragments were bagged by level; diagnostic items were bagged and field-catalogued separately. An excavation level record form was completed for each arbitrary level.

One-half of any basin-shaped feature (e.g., a shallow fire hearth) or cobble concentration encountered during testing was excavated by arbitrary 10-cm levels and the remaining half was left intact. Fill from features was water-screened through 1/32-inch mesh, and recovered material was bagged and catalogued separately from general level artifacts. If sufficient amounts of charcoal were present, samples were recovered for radiocarbon dating.

Stratigraphic profiles were drawn of at least one wall of each completed excavation unit. Walls were also photographed if stratigraphy was sufficiently defined. All excavation units were backfilled following excavation.

4.3.4 Approach to Laboratory Analysis

At the conclusion of fieldwork, permanent site numbers were assigned by the Colorado OAHP. The OAHP numbers followed the Smithsonian tripartite system in which the initial digit (5) represents Colorado, the succeeding two upper case letters represent a county (in this case, LR for Larimer County), and the final number represents the sequential placement of a particular site among all sites recorded within a county. As an example, 5LR1098 is the 1098th site to have been recorded in Larimer County, Colorado.

All recovered artifacts were cleaned in warm water and subsequently labeled by site number and artifact number. Artifact numbers run sequentially from 1 through n for each site and were appended to the site number (such as 5LR1098.1 for the first artifact, 5LR1098.2 for the second, etc.). Lithic debitage and nondiagnostic faunal materials (nonhuman bone) from general excavation levels were catalogued by level; all other items were catalogued individually.

Labeled artifacts were bagged for curation with an identification card enclosed. A University of Colorado Museum-Cultural Resource Data File Card was completed for each site from which materials were collected.

Lithic materials were examined for general manufacturing and use attributes. Specimen dimensions, general morphology, and any use-wear patterns were noted.

Faunal materials were examined for species identification and for evidence of cultural alteration, such as incisions, spiral fractures, and carbonization. A comparative collection was used to identify the species of faunal remains.

A sample of soil from within each excavated feature was recovered for flotation analysis. The sample was separated after flotation into light fraction and heavy fraction groups, which were examined microscopically for floral and other organic materials. Identification of seeds and seed fragments was made with the aid of a comparative collection.

4.4 RESULTS

4.4.1 Existing Environment

4.4.1.1 Synopsis: Prehistoric Chronology of the Region

Chronological outlines for northeastern Colorado have been prepared recently by Morris (1982) and Eighmy (1984). Morris divides the regional cultural history into nine periods while Eighmy recognizes eight periods. The chronological scheme presented below draws from both Morris and Eighmy but is organized in three major stages (Paleo-Indian, Archaic, and Late Prehistoric) with periods as internal subdivisions. Certain bracketing dates have also been revised slightly to reflect recent data.

Paleo-Indian Stage

The earliest firmly established and dated human occupation of the Central Plains and southern Rocky Mountains region was represented by the Paleo-Indian stage. This stage spanned approximately the last 5,000 years of the Pleistocene epoch and is divided generally into three periods. The earliest period, known as Clovis, extended from approximately 12,000 years before present (B.P.) to 10,500 years B.P. This was followed by the Folsom period, which was in evidence until approximately 9,000 years B.P. Following Folsom was the more broadly defined Plano period, represented archaeologically by a variety of projectile point types common to the Plains region. The Plano period terminated at approximately 7,000 years B.P.

Distinctive projectile point styles are affiliated with each period, as are unique and apparently specialized subsistence practices. Clovis period sites are commonly associated with remains of mammoth (Mammuthus sp.) while Folsom is associated with now-extinct bison (e.g., Bison antiquus). Plano period sites exhibit essentially modern varieties of fauna but are suggestive of a continuation of the big game hunting tradition.

Archaic Stage

Early Archaic Period

By approximately 7,000 years B.P., late Paleo-Indian stage projectile points were replaced by large side-notched points indicating the onset of the Early Archaic period of the Archaic stage. This period coincides with the Altithermal climatic episode. During this time, portions of North America were affected by an accelerated continental warming trend which resulted in major ecological changes (Antevs, 1948 and 1955). The lifeway which developed in response to these conditions was characterized by increased dependence on small mammal and wild plant resources, apparently intensified occupation of foothill and montane localities, and possibly decreased exploitation of the Plains regions east of the Rocky Mountains (Kehoe, 1981; Benedict and Olson, 1978; Frison, 1978). Early Archaic sites were characterized as representing a broad spectrum hunting and gathering economy practiced by a relatively diffuse population. Ground stone artifacts, used for the processing of vegetal foods, first appeared in significant quantities on Early Archaic sites.

Middle Archaic Period

By approximately 4,500 years B.P., the large side-notched projectile points of the Early Archaic period were replaced by lanceolate and shouldered forms, usually exhibiting bifurcated bases. These projectile points, representing the McKean Technocomplex, indicated the onset of the Middle Archaic period.

During this time the harsh conditions of the Altithermal episode gave way to a cooler and more variable climate. Several minor glacial advances may have occurred along the Colorado Front Range during this period (Benedict, 1979). The basic hunting and gathering lifeway of the Early Archaic period may have continued throughout the Middle Archaic period, possibly with increased exploitation of plains regions.

Late Archaic Period

Approximately 3,000 years B.P., Middle Archaic-type points were replaced by large and variable corner-notched forms indicative of the Late Archaic period. Projectile points of this type were often considered to be representative of the Apex Complex on the Colorado Front Range (Irwin-Williams and Irwin, 1966). Morphologically similar specimens on the Northwestern Plains were regarded as part of the Pelican Lake Complex (Frison, 1978).

Climatic conditions remained favorable throughout the Late Archaic period. Sites attributable to the period exhibited an increase in frequency over earlier sites. Whether this apparent increase in site frequency represented an expanding population as Fredlund (1979) and others have suggested, or was simply a result of better preservation and higher visibility because of more recent age, is uncertain. The basic hunting and gathering economy evident for earlier Archaic manifestations continued throughout the Late Archaic period.

Late Prehistoric Stage

Early Ceramic Period

By approximately 2,000 years B.P., or slightly later, large corner-notched projectile points were replaced by morphologically similar but significantly smaller specimens. The diminution of projectile point size indicated a shift from the use of the spear thrower or atlatl to the bow and arrow. This event was approximately contemporaneous with the introduction of ceramic technology to eastern Colorado, an innovation that may have been imported from horticultural areas to the east and north of the Colorado plains (Cassells, 1983).

Earliest ceramic occupation in Colorado in the foothills and plains is often referred to as Plains Woodland. This period is thought to represent an extremely attenuated plains-oriented manifestation of Eastern Woodland cultures, or at least a diffusion of traits from that region. Along the Colorado Front Range within the South Platte River Basin, the Plains Woodland occupation is represented archaeologically by small corner-notched, serrated projectile points and cord-impressed ceramic vessels with conical bases (Nelson, 1971). These materials tend to occur most frequently in open campsites, but are often associated with stone enclosures (Anderson, 1976). Sites of this period are also found in association with high-altitude game drive systems (Benedict, 1975).

Middle and Late Ceramic Periods

By approximately 1,000 years B.P., cord-marked ceramics and corner-notched projectile points were replaced by ceramics with a variety of surface treatments as well as smooth-surfaced vessels and small, laterally-notched (side-notched) projectile points. Some researchers feel that these materials represented a later influx of groups and/or technological innovations from the Eastern Woodlands, first defined in Nebraska as the Upper Republican phase (Cassells, 1983). Although Upper Republican sites in other areas were associated with maize horticulture, no conclusive evidence of horticulture at Upper Republican sites in eastern Colorado has been found.

By approximately 300-500 years B.P., small tri-notched projectile points and smooth-surfaced ceramic vessels were dominant in the plains region. These materials may have been of Shoshonean origin (Frison, 1978). In certain contexts within eastern Colorado, similar types of artifacts were assigned to the Dismal River Aspect of the Plains Apache (Gunnerson, 1960).

Tri-notched projectile points recovered from the upper levels of the Glenrock site in eastern Wyoming were believed to postdate 230 years B.P. (Frison, 1970), indicating that the tri-notched projectile point tradition persisted into Protohistoric times.

4.4.1.2 Synopsis: Historic Chronology of the Region

Multiple historic themes are relevant to the project area. The following narrative treats each theme as a separate topic, and events are described chronologically.

The Rocky Mountain Fur Trade

The study area was first exploited by Euro-Americans when fur trappers and traders came to the region in the early nineteenth century. Although the Cache la Poudre country was far from the main western fur-trading centers, it was utilized and influenced by the Taos trade to the south and the Missouri River trade to the north. Taos acted as a natural base of operations for trappers in the central and southern Rockies, especially after Mexican independence in 1821.

Perhaps because it was on the fringes of both the Missouri River and Taos trade areas, the Cache la Poudre country was not well known to more than a handful of men. As late as 1843, John C. Fremont had difficulty obtaining a knowledgeable guide to lead him westward into the mountains via the Cache la Poudre River. As early as 1807 or 1808, a small trapping party led by Ezekiel Williams was driven south from the headwaters of the Yellowstone by the Blackfeet. A few survivors entered northern Colorado by way of the Snowy Range or by following the North Platte River into North Park. Many notable mountain men, such as Kit Carson, trapped the waters of the Laramie River and some undoubtedly followed it into the high country and crossed over to the Cache la Poudre. Indeed, legend claims that the Cache la Poudre River was named by a party of trappers bound for an 1836 rendezvous on the Green River.

The fur trade, based on the demand for beaver pelts, reached its peak from 1820 to 1840. When the eastern and European fashion industry no longer clamored for beaver skins, the fur trade shifted to procuring buffalo hides. Fixed fur posts such as Fort Vasquez, Fort Lupton, and Fort Jackson sprang up in the South

Platte Valley (in present-day Weld County, Colorado) to serve the new trade. Most were abandoned or served as stage stations by the 1860s (Ubbelohde et al., 1972; Krakel, 1954; Hafen, 1928).

Government Exploration

Prior to the building of an extensive system of forts, roads, and telegraph lines, the U.S. Army realized the need to reconnoiter the vast unknown regions of the West. The Corps of Topographical Engineers under Col. J.J. Abert sent numerous expeditions west in the 1840s and 1850s to gather both military and scientific information. Perhaps the best known explorer of this era was John C. Fremont, "The Pathfinder." In 1842, Fremont proceeded up the South Platte River to Fort St. Vrain, then traveled north to Fort Laramie along the eastern base of the Front Range and the Laramie Mountains. He continued westward on the new Oregon Trail, carefully mapping it to South Pass for emigrant parties (Fremont, 1845; Goetzmann, 1959). In 1843, Fremont followed Ashley's general route through the study area, attempting to penetrate the Front Range and find a suitable passage westward for emigrant travel. Fremont used the services of Alexis Godoy, although he had two famous mountain men, Kit Carson and Tom Fitzpatrick, in his party. They attempted to follow the Cache la Poudre River upstream, but perhaps realizing that the course was unsuitable for emigrant wagons, eventually headed northward through mountains and foothills to the Laramie Plains and beyond (Fremont, 1845).

In 1850, Howard Stansbury traveled portions of what would become the Overland Trail, a southern alternative of the Oregon Trail (see description below). Numerous other government expeditions explored the regions to the north that would become Wyoming Territory but did not have any direct influence upon the study area. With the coming of the Civil War, government attention was necessarily diverted eastward. However, much of the information gathered during this time period was used by the military during the Plains Indian Wars that began at the close of the Civil War.

The Transportation Frontier

The value of the Overland Trail as an emigrant route was first officially recognized in 1850 by Captain Stansbury of the Corps of Topographical Engineers. Returning from a survey of the Salt Lake Valley, he was guided along the route east of Fort Bridger by Jim Bridger. Used in conjunction with the Lodgepole Trail across extreme western Wyoming Territory and the Nebraska Panhandle, it offered a route about 60 miles shorter than the Oregon Trail. Variations of this route were used by Cherokee Indian parties bound for California, as well as by the military who gradually improved portions of the route (the Bryan Expedition of 1856 and the Barleson Expedition of 1857). Ben Holladay used the route starting in 1862 for his Overland stage and mail line. This route diverged from the Oregon Trail near present-day North Platte, Nebraska, and followed the South Platte River to Julesburg, Colorado (Stansbury, 1853).

The South Platte portion of the route was heavily used by gold seekers during the 1859 Pikes Peak gold rush. The route continued along the river to Latham (near Greeley), where it turned northwest and followed the Cache la Poudre River to La Porte (north of Fort Collins). From La Porte, it generally followed modern U.S. Route 287, and passed through the Class I study area, crossing the Laramie Range to the Laramie Plains. It skirted the Medicine Bow Range to the north around Elk Mountain, then headed west across southern Wyoming to join the Oregon Trail near present-day Granger, Wyoming.

In addition to the Overland Trail, a toll road was constructed up the Poudre River and over Cameron Pass into North Park by Samuel B. Stewart in 1879-1880. Short-lived gold and silver booms at Teller City and Lulu City provided the impetus for the road building. A stage line was established from Fort Collins to Teller City along this route. Any remnants of this route have probably been destroyed by modern State Highway 14 (Leyendecker, 1980).

The study area was indirectly affected by the construction of the first transcontinental railroad to the north in 1867-1868. As the Union Pacific Railroad built through and created the towns of Cheyenne and Laramie, the Cache la Poudre region became the scene of extensive tie cutting operations, as described below. The only railroad line to enter the Class I study area was the Ingleside Branch of the Colorado & Southern, built in 1906. From Bellvue Junction, it extended 9.9 miles to the Ingleside Quarry. This line was extended northward from Ingleside to Rex in 1929 (Wilkins, 1974). It has only recently been abandoned.

The Railroad Tie and Lumber Industry

As early as March and April 1867, hundreds of men were engaged in cutting railroad ties in the Laramie Mountains for the Union Pacific Railroad. The pioneer companies were Gilman and Carter (later Coe & Carter); Paxton and Turner; and Sprague, Davis and Company. Most of the tie operations were conducted within a short distance of the projected line. However, Robert Chambers encouraged tie contractors to cut in the large stands of lodgepole pine timber near Chambers Lake. In the spring of 1868, the ties were floated down the Laramie River in what was probably the first tie drive in the Rocky Mountain West (Watrous, 1911). In 1869-1870, when the Denver Pacific Railroad was built to connect Denver with the transcontinental railroad at Cheyenne, tie cutting camps were established on Pennock, Fish, and Beaver Creeks, and on the forks of the Cache la Poudre River. Thousands of ties were then floated down the Cache la Poudre to Greeley. Ties continued to be floated down the river until 1882 (Leyendecker, 1980).

Mining

Mining never became a significant industry in the Cache la Poudre region. During the initial prospecting phase, hopeful miners scoured the foothills and mountains of western Larimer County. There was a short-lived flurry of activity at Lulu City (1879-1884) near the crest of the Continental Divide between Milner and Cameron Passes in the present Rocky Mountain National Park. In 1877, a silver rush to North Park on the west side of the Divide led to the establishment of Teller City, which reached a peak population of 1200. The silver deposits quickly played out, and inadequate transportation to distant markets turned Teller City into a ghost town nearly overnight (Eberhart, 1974). The mining camp of Manhattan was located in 1886 about 4 miles northwest of present-day Rustic in Poudre Canyon. Gold was discovered there during a systematic search organized by Fort Collins businessmen. The inevitable rush ensued, and a concentrating works was built to treat the ore in 1888. However, the deposits did not justify the effort, and the camp was finally abandoned.

Settlement of the Project Area

Cattle ranching emerged with the construction of the transcontinental railroad. Texas cattle were driven north and fattened on the rich prairie grasses in northeastern Colorado and southeastern Wyoming Territories adjacent to the railroad. The railroad in turn shipped the cattle to eastern markets.

Cattlemen generally preceded the sheep ranchers by about 10 years, thus usurping the better lands. In Colorado Territory, sheep were introduced in 1869, and the sheep industry generally benefited from the Blizzard of 1886-87, which devastated cattle herds.

The small homesteader followed the cattleman and sheepman onto the open western ranges. Land records for the study area show that most of the land was taken up in small parcels (160 acres or less), starting in the early 1880s. Settlers used the conventional Homestead Act of 1862 or purchased their land outright with cash entry patents. Homestead activity continued at a steady pace through the dry land farming era and into the early 1920s, when most of the available land had been taken up or had become part of the National Forest system. Many homestead parcels failed and were canceled or relinquished, to be ultimately patented by later settlers (Bureau of Land Management, no date).

As the fertile valleys of the study area became more settled, several water projects were started in the high country to the west. In 1886, a dam was constructed at Chambers Lake. This dam had to be rebuilt several times due to flooding before a concrete dam was constructed in 1910 and improved in 1925. The Laramie-Poudre Tunnel was begun in 1904 and completed in 1915. This tunnel diverted waters from the Laramie River into the Cache la Poudre River for use by farmers on the prairie (Leyendecker, 1980). Several ditches and canals are shown on historic maps near or within the study area, including the Poudre Valley Canal, the North Poudre Supply Canal, and associated tunnels and other unnamed ditches.

Tourism

Tourism began to have an impact on the Poudre Canyon area as early as the 1860s. Although the chief resort settlements within the Poudre Canyon were located west of the study area, various cabin foundations, stone chimneys, and building depressions remain from the early days of tourism.

The National Forest

Portions of today's Roosevelt National Forest were set aside as part of the Medicine Bow Forest Reserve in 1897. In 1902, President Theodore Roosevelt withdrew thousands of acres in this region from settlement. This parcel was added to the Medicine Bow National Forest of Wyoming in 1905, and was managed by a supervisor in Saratoga, Wyoming, and a ranger based in Walden, Colorado. Portions of Grand, Boulder, and Larimer Counties were designated the Colorado National Forest in 1910. However, a large portion of the newly created forest was removed in 1915 to form Rocky Mountain National Park. Additional acreage comprising much of today's Estes-Poudre District was added in 1916-1917. This included a significant portion of the study area (Leyendecker, 1980).

4.4.1.3 Cultural Resources in the Class I Study Area

Over 1100 archaeological and historical sites have been recorded within Larimer County. Known sites within the study area which are currently listed in the Colorado OAHP site files comprise fewer than 4 percent of this sample. Over 25 percent of known sites within the study area were recorded during a Class II (sampling) survey conducted within lower Poudre Canyon in 1978 (Grant, 1978). Consequently, the distribution of known sites, as well as their overall frequency, reflects the uneven and generally limited amount of survey coverage that has occurred within the study area. The absence of known archaeological sites within large portions of the study area therefore should not be interpreted as necessarily indicating a true dearth of sites.

A total of 39 previously recorded sites are on record within the Class I study area. Of this number, 25 are prehistoric and 14 are historic. No sites in the Class I study area are presently enrolled in the National Register of Historic Places, and most have not been evaluated per NRHP criteria. Descriptive and management data about these sites are given in text tables and appendices in a supplemental report (Grant, et al., 1988).

A number of as-yet-unrecorded sites are also known to exist in the Class I study area (Grant et al., 1988). These include 16 prehistoric sites in the Owl Canyon Pinon Grove in the northern portion of the area.

4.4.1.4 Cultural Resources in the Class III Study Area

A total of 20 historic sites and 9 prehistoric archaeological sites were recorded during the intensive survey of the proposed mainstem reservoir inundation and buffer area. One previously recorded archaeological site (5LR548) was located within the survey area and another (5LR512) was located immediately west of the survey area. Also recorded were 10 historic isolated finds and 8 prehistoric isolated finds.

Nonhabitation historic sites included remnants of bridges, road grades, canals, and mines. Historic habitation sites included dugouts, cellar holes, masonry foundations, and standing structures. These sites were associated with a variety of themes including homesteading, ranching and farming, and early tourism.

Four of the prehistoric sites, including 5LR548, were open camps consisting of hearth areas or fire pits and associated artifact scatters located in open terrain. One prehistoric open camp also contained stone circles. Three of the prehistoric sites were open lithic scatters with one associated stone circle, and two were sheltered camps located within small rock shelters. Both sheltered camps consisted solely of buried archaeological components. One site consisted entirely of lithic debitage and ground stone fragments located in open terrain.

Most historic isolated finds were small prospect pits lacking associated artifacts. Also recorded as historic isolated finds were small field stone retaining walls not associated with artifacts or other features, an isolated cairn, and a horseshoe. Three of the prehistoric isolated finds were fragments of bifaces (lithic tools intentionally modified on both surfaces) and two were single pieces of lithic debitage. One utilized flake, one ground stone fragment, and one projectile point were also recorded as prehistoric isolated finds.

Descriptive data about the 29 sites and 18 isolated finds in the Class III study area are given in Table 4.1. Another site is known to exist in the area, but because access was not allowed to the site by the landowner, it is not listed in Table 4.1.

4.4.1.5 Results of Test Excavations

Site 5LR1098

Five excavation units, ranging in size from 0.75 meters by 1.50 meters to 2.0 meters by 2.0 meters, were excavated into cobble concentrations (Features 12, 15, 91, 92, and 93) and surrounding areas. These features were chosen as the best examples of the various feature types that occur on the site. Two

0.50-meter by 3.0-meter trenches adjoining one another at right angles were excavated through Feature 26, a stone circle.

Diagnostic artifacts collected from the site by a nonarchaeologist, in combination with testing data, suggested that occupation of the site spanned the Paleo-Indian through Late Prehistoric stages. However, archaeological debris from multiple habitations was manifested as a single occupational plane.

Stratigraphic and archaeological evidence suggested that site 5LR1098 represented numerous activity loci which accumulated through time within the site area. The site appeared to have been subjected to at least one extensive but low-energy erosional event. This resulted in the settlement of artifactual materials comprising the various loci on a common erosional surface. Some of the site's components may have been deposited after the erosional event; this appeared to be true of a tested stone circle.

TABLE 4.1

Cultural Resource Descriptive Data

Permanent No.	Temporary (Field) No.	Description	Age
5LR1095	CA-48	Poudre Valley Canal: earthen dry-laid masonry canal	AD 1880s
5LR1096	CA-49	Earthen ditch	Unknown historic
5LR1097	CA-50	Explosives storage cellar	AD 1912-1920
5LR1098	CA-51	Open camp/stone circle	Middle Paleo-Indian through Late Prehistoric
5LR1099	CA-52	Prehistoric/historic campsite	Unknown prehistoric/ probable pre-1890 historic
5LR1100	CA-53	Open camp with ground stone	Unknown prehistoric
5LR1101	CA-54	Log cabin and 3-bay garage	AD 1890-1920
5LR1102	CA-55	Yauger Homestead: rock shelter with prehistoric deposits	AD 1912-1930; Late Prehistoric
5LR1103	CA-56	Bridge pylons of local stone and concrete	AD 1935-1936
5LR1104	CA-57	Cribbed log bridge remnants	Unknown historic
5LR1105	CA-58	Dry-laid retaining walls, BBQ pits, check dam, well, cistern	AD 1935/1936-1960s

TABLE 4.1 (Continued)

Cultural Resource Descriptive Data

Permanent No.	Temporary (Field) No.	Description	Age
5LR1106	CA-59	Rock bed shored by timber and dry-laid masonry	AD 1890-1920?
5LR1107	CA-60	Greyrock Lodge: historic habitation, 5 structures	AD 1923-1931
5LR1108	CA-61	Open lithic scatter/ chipped and ground stone	Unknown prehistoric
5LR1109	CA-62	Open lithic scatter and stone circle	Unknown prehistoric
5LR1110	CA-63	Open lithic scatter with stone circle/ possible hearth	Unknown prehistoric
5LR1111	CA-64	Stone foundation dugout, associated features	AD 1891-1940s
5LR1112	CA-65	Rock shelter with lithic debitage and faunal remains	Late Prehistoric
5LR1113	CA-66	William Poland Homestead: 10 historic structures	AD 1889-1915
5LR1114	CA-67	Stone foundation and chimney, retaining walls, dump, and road bed	AD 1915-?
5LR1115	CA-68	George Wollner Homestead: dugout	AD 1919
5LR1116	CA-69	Small open pit mine	Unknown historic

TABLE 4.1 (Continued)

Cultural Resource Descriptive Data

Permanent No.	Temporary (Field) No.	Description	Age
5LR1117	CA-70	Two cisterns/troughs, a sluice, milled lumber	Unknown historic
5LR1118	CA-71	Sheet metal shack and 2 auto engine blocks	Unknown historic
5LR1119	CA-72	Stone and timber fence	Pre-1900
5LR1120	CA-74	Log cabin and outhouse	Early twentieth century
5LR1121	CA-75	Open pit mine and tailings	Unknown historic
5LR1122	CA-73	Stone circle and open lithic scatter	Late Prehistoric
5LR1123	CA-76	Fort Collins Water Filtration Facility: 3 historic buildings and masonry canal	AD 1918-1987
5LR1124	IF-1	White chert biface tip	Unknown prehistoric
5LR1125	IF-2	Prospect pit	Unknown historic
5LR1126	IF-3	Prospect pit	Unknown historic
5LR1127	IF-4	Cast iron horseshoe	Unknown historic
5LR1128	IF-5	Prospect pit	Unknown historic
5LR1129	IF-6	Side-notched quartz projectile point	Early Archaic

TABLE 4.1 (Continued)

Cultural Resource Descriptive Data

Permanent No.	Temporary (Field) No.	Description	Age
5LR1130	IF-7	Chalcedony biface tip	Unknown prehistoric
5LR1131	IF-8	Prospect pit	Unknown historic
5LR1132	IF-9	Dry-laid field stone wall	Unknown historic
5LR1133	IF-10	Prospect pit	Unknown historic
5LR1134	IF-11	Cairn	Unknown historic
5LR1135	IF-12	Utilized quartzite flake	Unknown prehistoric
5LR1136	IF-13	Chert biface tip	Unknown prehistoric
5LR1137	IF-14	Collapsed foot bridge	Unknown historic
5LR1138	IF-15	Dry-laid field stone wall	Unknown historic
5LR1139	IF-16	Bifacially ground sandstone slab (incomplete)	Unknown prehistoric
5LR1140	IF-17	Red chert tertiary flake	Unknown prehistoric
5LR1141	IF-18	Lavender chert tertiary flake fragment	Unknown prehistoric

Despite the lack of stratigraphic integrity, the site exhibited various activity loci which appeared spatially intact. The compression of various components onto a common level, through low-energy erosion, resulted in lateral separation rather than vertical stratification of disparate components.

An undetermined number of hearth-type features at the site contained shallowly buried intact basins with organic fill. Two such features yielded charcoal and organic material suitable for radiocarbon age estimates (ages of 1080 ± 80 and 570 ± 60 B.P.; Late Prehistoric stage) and investigation of subsistence patterns. Further, at least one stone circle appeared to contain an intact occupational level.

Site 5LR1099

One 3-meter by 50-cm excavation or test unit (TU 1) was excavated within Feature 2, a stone enclosure. This unit, oriented north-south, nearly bisected the enclosure. Approximately 50 cm on the extreme northern and southern ends of the test unit were located outside the stone enclosure; the remainder of the unit was within the feature.

Testing indicated that Feature 2 is a remnant of a crude historic structure of pre-1890 age. A scatter of wood-burning stove parts and a shovel blade noted on the surface adjacent to the feature may be directly associated with the stone enclosure. The exact function of the enclosure is unknown, but it seems likely that it is a remnant of a temporary shelter used during open range ranching activities.

Site 5LR1102

Three 1-meter by 1-meter test units were excavated. TU 1 was located directly below the dripline near the center of the rock shelter. TU 2 was located 6 meters west of TU 1. This unit was excavated to determine whether cultural deposits extended a significant distance beyond the rock shelter dripline. TU 3 was placed near the southern end of the shelter. This unit was excavated to assess the potential areal extent of cultural deposits within the shelter and to determine whether geologic strata within the rock shelter were consistent throughout the site area.

Two distinct cultural components were identified. The lower component, which occurred at depths of 1.1-1.7 meters, was the more clearly defined stratigraphically. It yielded lithics, possible ground stone, and traces of charcoal, but could not be dated. The upper cultural component, 10-50 cm below the surface, may represent two or more occupations. It yielded lithics (including a projectile point), ground stone, and bone, and a radiocarbon date of 1650 ± 50 B.P. (Late Prehistoric stage).

5LR1110

One 1-meter by 1-meter unit (TU) was excavated in a nonarchitectural area a few meters northwest of datum. Two 50-cm by 3-meter trenches, TU 2a and TU 2b, were excavated along the south and west edges, respectively, of Feature 1, a stone circle.

Testing indicates that at least one shallowly buried cultural component is present on site. Given the limited amount of excavation conducted and the nature and depth of site sediments, additional archaeological components may be present. The fact that TU 1 is located well away from any surface artifacts suggests that material is widely distributed throughout the site and that surface artifact distributions may not reflect the nature or density of subsurface materials.

5LR1112

One 1-meter by 2-meter excavation unit (TU 1) was placed immediately south of the north-south centerline of the rock shelter, with the southeast corner located directly below the dripline. The unit extended westward 2 meters into the rock shelter. One 1-meter by 1-meter excavation unit (TU 2) was placed 10 meters east of the rock shelter dripline. Since topographic mapping revealed the presence of an abandoned river channel approximately 15 meters east of the dripline, TU 2 was placed on what was believed to be the western flood terrace of this abandoned channel.

A total of 11 geologic strata, some containing cultural materials, were identified within TU 1; no cultural evidence was found in TU 2. At least two stratigraphically distinct occupational horizons were evident in TU 1. The deeper component, which is undated, occurs at 1.4-1.5 meters below surface and yielded lithic artifacts and remains of a pit-type feature. The upper component, 40-60 cm deep, produced lithic and ground stone artifacts, faunal remains, a hearth, and a possible wood-and-stone structural remnant. It yielded a radiocarbon date of 1200 ± 50 B.P. (Late Prehistoric stage).

Sedimentological data indicated that alternating periods of predominately alluvial and predominately aeolian (wind-borne) deposition occurred throughout the shelter's history and that prehistoric utilization of the shelter was keyed to these depositional patterns. Alluvial deposits consisted of progressively finer sediments approaching the surface, and hence the river channel appeared to have meandered continually away from the rock shelter. The river may have occupied a visible channel scar east of the shelter during deposition of certain strata, visible in the shelter, and its present channel farther east during deposition of others.

Because of the erosional potential of alluvial action within the rock shelter, it is possible that complete stratigraphic (and cultural) records have accumulated, then been destroyed. If this is true, the present stratigraphic and cultural record may represent only relatively recent (i.e., very late Holocene) events.

4.4.2 Effects Assessment

4.4.2.1 Project Effects on Significant Cultural Resources Assuming Grey Mountain Damsite is Selected

A total of 22 cultural resources lie within the inundation area of the reservoir that would be created by constructing a dam at the Grey Mountain site. Of these, 6 (5LR1098, 5LR1102, 5LR1110, 5LR1112, 5LR1113, and 5LR1123) were evaluated as significant per NRHP eligibility criteria. Inundation would cause disturbance and damage at all 6 sites and would restrict access to the sites. Inundation could also result in deposition of sediment at the site localities, although the rate and degree of sedimentation may vary greatly from one site to the next.

4.4.2.2 Project Effects on Significant Cultural Resources Assuming Poudre Damsite is Selected

A total of 17 cultural resources lie within the inundation area of the reservoir that would be created by constructing a dam at the Poudre site. The same 6 significant sites that would be affected by constructing a dam at the downstream damsite (Grey Mountain alternative) would be disturbed and damaged if the Poudre damsite were selected. No significant sites are located between the two alternative damsites. Effects to these 6 sites would the same as those described above in Subsection 4.4.2.1.

4.5 DISCUSSION

4.5.1 Comparison of Effects: Grey Mountain and Poudre Alternatives

The potentially adverse effects to significant cultural resources are identical for the two mainstem reservoir alternatives. In either case, six significant sites (four prehistoric and two historic) would be inundated. Thus, there is no preferred alternative in terms of effects on NRHP-eligible properties.

4.5.2 Summary of Project Effects on Cultural Resources

Construction at either of the presently proposed damsites would result in disturbance and damage to six significant cultural properties through inundation. Two sites (5LR1102, 5LR1113) situated at or just below the proposed normal reservoir water surface elevation (elevation 5630 feet) would be subject to attrition of physical integrity through wave action upon cultural deposits and structural remnants. In addition, 5LR1102 could be contaminated through downward percolation of any water-carried petroleum-based residues (if power boats were operated on the reservoir). Sites 5LR1098, 5LR1110, and 5LR1112 would suffer loss of integrity through erosion, contamination, and if reservoir drawdown were sufficient, wave action. In addition, data loss at 5LR1098 would occur through flotation of macrofloral materials and/or charcoal from exposed hearths. Site 5LR1123 would experience progressive structural decay, possibly accompanied by undermining of foundations, and would be inaccessible at nearly all times because of its location in very deep water.

4.6 MITIGATION

4.6.1 Alternatives for Effect Mitigation

The term "mitigation" refers to actions that reduce or compensate for the adverse effects to a significant historical or archaeological property that result from an undertaking (Advisory Council on Historic Preservation, 1986). Mitigative measures may include the following:

(1) Limiting the magnitude of the undertaking;

(2) Modifying the undertaking through redesign or reorientation of construction on the project;

(3) Repair, rehabilitation, or restoration of an affected historic property;

(4) Preservation and maintenance of affected historic and archaeological properties;

(5) Documentation (drawings, photographs, histories) of buildings or structures that might be lost or substantially altered;

(6) Relocation of historic properties; and

(7) Salvage of archaeological or architectural information and materials (data retrieval).

Avoidance of effects to significant cultural resources is always the preferred mitigative recommendation, since it ensures their continued existence. Avoidance is often not feasible, however, and in such cases, mitigation will usually consist of some form of data retrieval prior to impact. For prehistoric sites, this may include partial or complete excavation, intensive instrument mapping, controlled surface collection, or some combination thereof (e.g., mapping in conjunction with surface collection). On historic sites, this may include architectural or engineering drawings, intensive photo documentation of structures, archival research, and occasionally, partial or complete excavation of site elements. Analysis and reporting of data are integral parts of all forms of mitigation.

4.6.2 Recommended Mitigative Measures for Significant Cultural Resources

4.6.2.1 Site 5LR1098

Mitigation at this prehistoric open camp should emphasize excavation of intact features. Approximately 10 of the more than 90 features visible on the surface, representing all of the identifiable activity areas/feature concentrations, should be fully excavated. Feature 26, a stone circle with an apparently intact occupational surface that was test excavated in 1987, should be included in the sample. Hearth excavation units in three areas of the site (east side, central area, west side) should be extended vertically until the ancient Pleistocene river channel fill deposits, consisting of stream-rounded cobbles and boulders underlying the fine-grained terrace mantle, are encountered. Hearth and stone circle excavation should include bulk soil retrieval for both flotation of macrofloral remains and extraction of small artifacts (e.g., through fine water screening). Archaeological excavation of the site should be supplemented by additional geomorphological investigation, both in the site area proper and along the lower reaches of the North Fork of the Cache la Poudre River. This study would serve to refine the present interpretation of the development of the terrace upon which the site is situated (McFaul et al., 1988) and would facilitate comparison with general stream terrace development processes of the region. Mitigative excavation at 5LR1098 must be undertaken when existing reservoir waters are low enough to expose the site surface and to allow deep probes into the ancient stream channel (± 2 meters) without flooding the pits.

Total estimated cost of mitigation, including analyses and reporting: $10,000.

4.6.2.2 Site 5LR1102

Test excavations demonstrated the existence of at least two stratigraphically distinct prehistoric components, the lower component deeply buried at 1.1 to 1.7 meters below the surface. The central rock shelter area (vicinity of TU 1) has been shown to be disturbed within 20 cm of the surface and exhibits abundant historic refuse. Lateral areas, to the north and south, display greater integrity.

Mitigation at this rock shelter should consist of excavation focusing on lateral areas within the shelter. Two small excavation blocks, each consisting of two contiguous units, should be placed in each area. Because of the considerable depth of cultural deposits and attendant problems working in confined space, individual units should measure minimally 1.5 meters by 1.5 meters. Thus, each block would have overall horizontal dimensions of at least 1.5 meters by 3.0 meters. In addition, a 1.0-meter by 1.0-meter test unit should be placed in a small, shallow rock shelter immediately upslope and east of the main shelter, to ascertain the presence of buried cultural deposits at that location and the relationship between any such materials and those in the principal excavation area. All units should be excavated until sterile soil is reached.

Excavation should incorporate total bulk soil retrieval from one 1.5-meter by 1.5-meter unit for purposes of flotation and fine water screening. This would allow comprehensive retrieval of macro-floral remains, small artifacts (e.g., microliths), gastropods, and if needed, charcoal for radiocarbon analysis. Excavation should also include geomorphological analysis of site deposits and general site setting.

Total estimated cost of mitigation: $40,000.

4.6.2.3 Site 5LR1110

Mitigation at this prehistoric lithic scatter/stone circle site should focus on a stone circle situated near the southern edge of the site (Feature 1) and an area of probable intact subsurface deposition in the central portion of the site. Up to one-half of the interior of Feature 1, plus contiguous exterior areas, totaling 8 square meters, should be excavated to sterile soil. A contiguous block of 4 to 6 square meters should be excavated in the central site area, with final block size determined by the nature and volume of cultural materials encountered. Excavation should include selective bulk soil retrieval within the stone circle and in any subsurface features such as hearths.

Total estimated cost of mitigation: $8,000.

4.6.2.4 Site 5LR1112

Mitigation at this prehistoric site should be concentrated entirely within the shelter. A single contiguous block should be excavated adjacent to and north of TU 1 to maximize the possibility of exposing additional portions of Features 1 and 3, the hearth and possible structure, originally encountered during testing. A block 4 square meters in surface area should be excavated. If buried feature position so dictates, this block may be placed such that it "wraps around" the north and west sides of TU 1, thus presenting an "L" configuration. The block should be excavated vertically until sterile alluvium is reached. It may be necessary to partially or completely shovel out the fill in TU 1 (which was backfilled following testing) because the soft, unconsolidated sands may tend to slump when reexposed.

Excavation should include total bulk soil retrieval from one 1-meter by 1-meter unit within the block for flotation and fine water screening. Geomorphological analysis of the site and surroundings should also be conducted in an effort to place the site in a proper context relative to stream terrace development and channel changes.

Total estimated cost of mitigation: $28,000.

4.6.2.5 Site 5LR1113

Recommended mitigative measures at this historic homestead include excavation of a single 1-meter by 2-meter unit into cultural fill within Feature 3, a large structural foundation, accompanied by detailed transit site mapping; 4-inch by 5-inch large-format photography of prominent features, inscriptions, and drawings; and additional historical records research including investigation of complete homestead records available in the National Archives, Washington, D.C.

Total estimated cost of mitigation: $5,000.

4.6.2.6 Site 5LR1123

This site, a recently abandoned water filtration plant with related improvements, dates back to 1918. Mitigation should consist of full recording to Historic American Engineering Record (HAER) standards, including 4-inch by 5-inch large-format photography of all features (including interiors and equipment) and development of a complete historic narrative. Because of the extensive modifications to the plant since its inception, original building plans and records should be consulted to verify dates of construction of the various components.

Total estimated cost of mitigation: $3,500.

4.7 SUMMARY

4.7.1 Existing Environment

Class I background research indicates that 39 previously recorded prehistoric and historic archaeological sites exist in the general project vicinity. This and other information suggests that the region has been occupied at least intermittently for the past 10,000 to 12,000 years. Historic occupation and use of the project area over the past two centuries or more can be documented archivally, although actual physical evidence of historic activities does not predate the 1880s.

Class III inventory of 6390 acres within the proposed mainstem reservoir and associated buffer zone led to the discovery of 29 sites. Another site is known to exist within the survey area. However, the landowner at the site would not allow access. Of the 30 sites total, 10 are prehistoric and 20 are historic. Prehistoric sites include open lithic scatters and camps with lithic and ground stone artifacts, hearths, and stone circles, and rock shelters containing deeply stratified deposits. Occupational evidence at prehistoric sites spans the past 10,000 to 11,000 years, although most datable components are of the Late Prehistoric stage. Historic sites consist of homesteads, miscellaneous structural remnants, mines, canals, and a water filtration plant. Various historic themes are represented including settlement, mining, tourism/recreation, and transportation. All recorded historic sites postdate 1880.

In addition to sites, 18 isolated finds were recorded of which 8 are prehistoric and 10 are historic.

4.7.2 Effects Assessment

Of 29 newly recorded sites, 6 are assessed as eligible for inclusion in the National Register of Historic Places. A site known to exist in the Class III area could not be reevaluated per NRHP eligibility criteria due to denial of access by a private landowner, and eligibility status is unknown. All 18 isolated finds are assessed as ineligible for the NRHP.

All six significant sites would be partially or wholly inundated by reservoir waters (at normal reservoir water surface elevation of 5630 feet) regardless of the mainstem damsite option that is chosen. In all cases, inundation would eventually cause destruction. Specific effects as a consequence of inundation could include attrition from wave action, contamination by petroleum-based substances, flotation of cultural materials, and siltation. In addition, access to some sites may be permanently restricted. Finally, sites at or near the reservoir high water line may be subjected to vandalism due to increased public access.

4.7.3 Mitigation

Mitigation in the form of data retrieval is recommended at all six significant sites. For the four prehistoric sites (5LR1098, 5LR1102, 5LR1110, and 5LR1112), recommended mitigative measures consist of partial excavation, with efforts concentrated in prehistoric activity areas (e.g., features), or in the case of rock shelters, in undisturbed areas where stratified deposits are known to occur. Mitigation at one historic site, a homestead (5LR1113), should consist of small-scale excavation in combination with mapping, photodocumentation, and additional archival research. At the remaining historic site, a water filtration facility (5LR1123), mitigation should consist of full recording to Historic American Engineering Record (HAER) standards accompanied by photodocumentation and production of a complete narrative.

Estimated mitigation costs at individual sites range from $3,500 to $40,000. The total estimated cost of mitigation is $94,500.

4.8 REFERENCES

Advisory Council on Historic Preservation. 1986. Section 106, Step by Step. Washington, D.C.

Anderson, D.C. 1966. The Gordon Creek Burial. Southwestern Lore 32:1-6.

Anderson, J.L. 1976. A Techno-Functional Analysis of the Flaked Lithic Materials from Three Woodland Period Sites on the High Plains, Southwestern Colorado. Ms. on file, Colorado Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver, Colorado.

Antevs, E. 1948. Climatic Change and the Pre-White Man. University of Utah Bulletin 38(2):167-191.

Antevs, E. 1955. Geologic-Climatic Dating in the West. American Antiquity 20:317-335.

Benedict, J.B. 1975. The Murray Site: A Late Prehistoric Game Drive in the Colorado Rocky Mountains. Plains Anthropologist 20(70):161-174.

Benedict, J.B. 1979. Getting Away from It All: A Study of Man, Mountains, and the Two-Drought Altithermal. Southwestern Lore 45(3):1-12.

Benedict, J.B., and B.L. Olson. 1978. The Mount Albion Complex: A Study of Prehistoric Man and the Altithermal. Center for Mountain Archeology Research Report, No. 1. Ward, Colorado.

Bureau of Land Management. No date. Master Title Plats, Historical Indices, Tract Books and General Land Office Plats. Public Land Office, Bureau of Land Management, Denver, Colorado.

Burgess, R.J. 1981. Cultural Ecological Investigations in the Owl Canyon Rockshelter (5LR104). Masters thesis, Department of Anthropology, Colorado State University, Fort Collins, Colorado.

Cassells, E.S. 1983. The Archaeology of Colorado. Johnson Books, Boulder, Colorado.

Eberhart, P. 1974. Guide to the Colorado Ghost Towns and Mining Camps. Sage Books, Chicago, Illinois.

Eighmy, J.L. 1984. Colorado Plains Prehistoric Context. Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver, Colorado.

Fredlund, L.B. 1979. Benson's Butte, 2BH1726. Cultural Resource Division Report of Investigations, No. 8. Montana Tech Alumni Foundation, Mineral Research Center, Butte, Montana.

Fremont, J.C. 1845. Report of the Exploring Expeditions to the Rocky Mountains in the Year 1842, and to Oregon and Northern California in the Years 1843-44. Gales and Seaton Printers, Washington, D.C.

Frison, G.C. 1970. The Glenrock Buffalo Jump, 48CO304: Late Prehistoric Period Buffalo Procurement and Butchering. Plains Anthropologist Memoir, No. 7.

Frison, G.C. 1978. Prehistoric Hunters of the High Plains. Academic Press, New York, New York.

Gleyre, L.A., and C.N. Alleger. 1936. History of the Civilian Conservation Corps in Colorado. Press of the Western Newspaper Union, Denver, Colorado.

Goetzmann, W.H. 1959. Army Exploration in the American West, 1803-1863. Yale University Press, New Haven, Connecticut.

Grant, M.P. 1978. Preliminary Reconnaissance of Threatened Archaeological Resources in the Lower Poudre Canyon, Larimer County, Colorado. Prepared for Arapaho-Roosevelt National Forest Land Use Planning Office. Ms. on file, Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver, Colorado.

Grant, M.P., C.J. Zier, and R.G. Rosenberg. 1988. Cultural Resource Investigations in Stage One Areas of the Basin Study Extension, Cache la Poudre Water and Power Project, Larimer County, Colorado. Centennial Archaeology, Inc., Fort Collins, Colorado.

Gunnerson, J.H. 1960. An Introduction to Plains Apache Archeology: The Dismal River Aspect. Bureau of American Ethnology Bulletin, No. 173. Washington, D.C.

Hafen, L.R. 1928. Fort Jackson and the Early Fur Trade on the South Platte. Colorado Magazine 5:9-17.

Hall, F. 1889-1895. A History of the State of Colorado. Blakely Printing Company, Chicago, Illinois.

Henderson, C.W. 1926. Mining in Colorado: A History of Discovery, Development and Production. U.S. Geological Survey Professional Paper, No. 138. Washington, D.C.

Irwin-Williams, C., and H.J. Irwin. 1966. Excavations at Magic Mountain: A Diachronic Study of Plains-Southwest Relations. Denver Museum of Natural History Proceedings, No. 12. Denver, Colorado.

Kainer, R.E. 1976. Archaeological Investigations of the Spring Gulch Site (5LR252). Masters thesis, Department of Anthropology, Colorado State University, Fort Collins, Colorado.

Kehoe, A.B. 1981. North American Indians, A Comprehensive Account. Prentice-Hall, Englewood Cliffs, New Jersey.

Krakel, D.F. 1954. South Platte Country: A History of Old Weld County, Colorado, 1739-1900. Powder River Publishers, Laramie, Wyoming.

Leyendecker, L.E. 1980. Level I Historic Cultural Resource Survey of the Arapaho and Roosevelt National Forests and the Pawnee National Grassland. Report on file, U.S. Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado.

McFaul, M., C.J. Zier, and E. Anderson. 1988. The Seaman Reservoir Mammoth Locality (5LR1098), North Fork Cache la Poudre River, Colorado. LaRamie Soils Service, Laramie, Wyoming, and Centennial Archaeology, Inc., Fort Collins, Colorado.

Mehls, S.F. 1984. Colorado Plains Historic Context. Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver, Colorado.

Morris, E.A. 1982. Archaeological Research Strategy in the South Platte River Valley of Northeastern Colorado. In: P.D. Francis and E.C. Poplin (eds.). Directions in Archaeology: A Question of Goals. Proceedings of the Fourteenth Annual Conference of the Archaeological Association of the University of Calgary, Calgary, Alberta.

Morris, E.A., and J. Marcotte. 1976. Archaeological Investigations on the Joe Wright Reservoir Project. Laboratory of Public Archaeology, Cultural Resources Management Report, No. 7. Colorado State University, Fort Collins, Colorado.

Nelson, C.E. 1971. The George W. Lindsay Ranch Site, 5JF11. Southwestern Lore 37(1):1-14.

Ormes, R. 1975. Tracking Ghost Railroads in Colorado. Century One Press, Colorado Springs, Colorado.

Roberts, R.W. 1938. Farm Family Living in the Northern Colorado Irrigated District. Master's Thesis, Colorado State College of Agriculture and Mechanics, Fort Collins, Colorado.

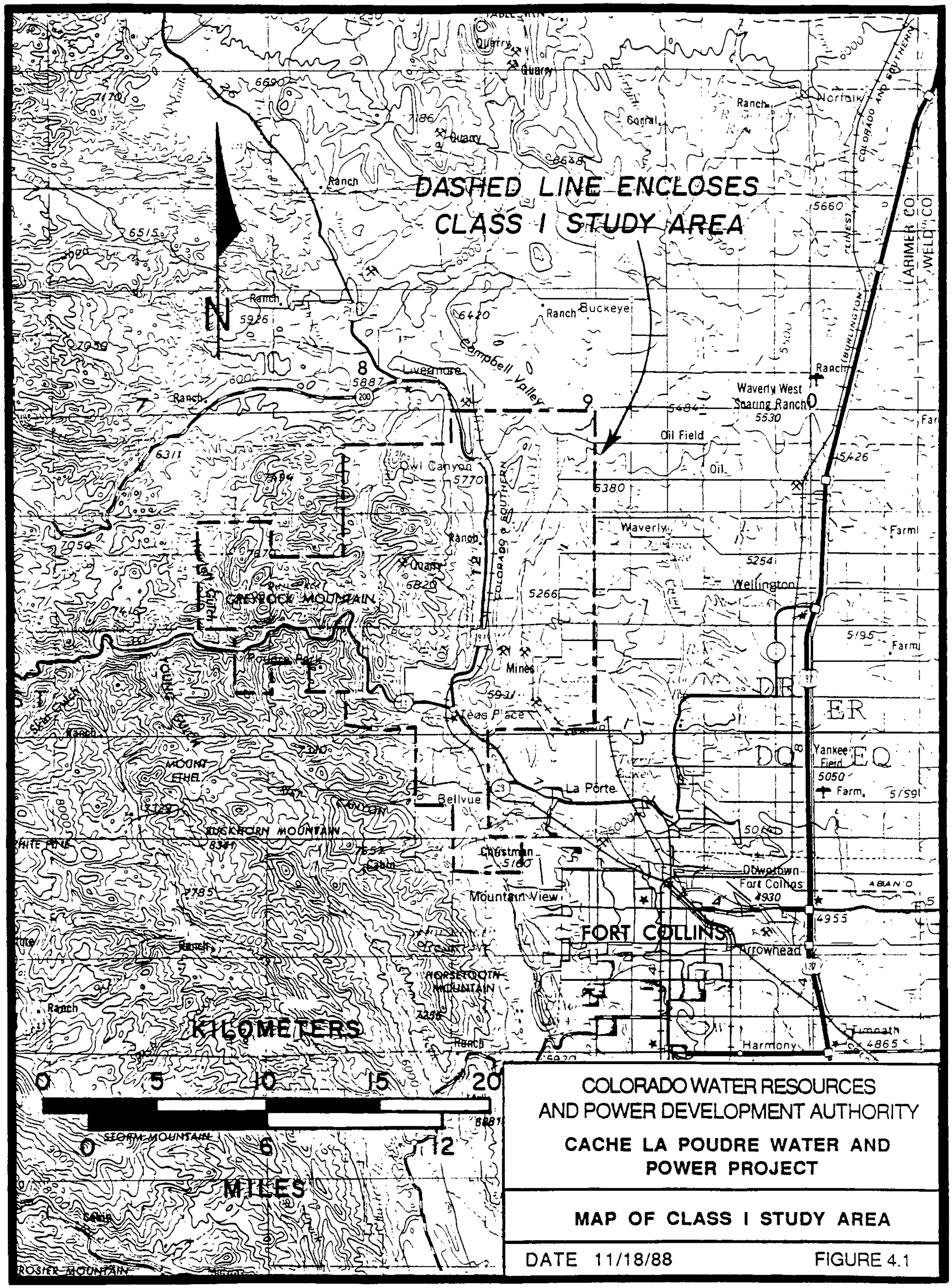
Stansbury, H. 1853. Exploration and Survey of the Valley of the Great Salt Lake of Utah. U.S. Engineer Department (Published by Order of the House of Representatives), Robert Armstrong Printers, Washington, D.C.

Thompson, K.W. 1986. Phoebe Rockshelter: A Multi-Component Site in Northcentral Colorado. Masters thesis, Department of Anthropology, Colorado State University, Fort Collins, Colorado.

Ubbelohde, C., M. Benson, and D. Smith. 1972. A Colorado History. Pruett Publishing Company, Boulder, Colorado.

Watrous, A. 1911. History of Larimer County, Colorado. Courier Printing and Publishing Co., Fort Collins, Colorado.

Wilkins, T.E. 1974. Colorado Railroads: Chronological Development. Pruett Publishing Company, Boulder, Colorado.

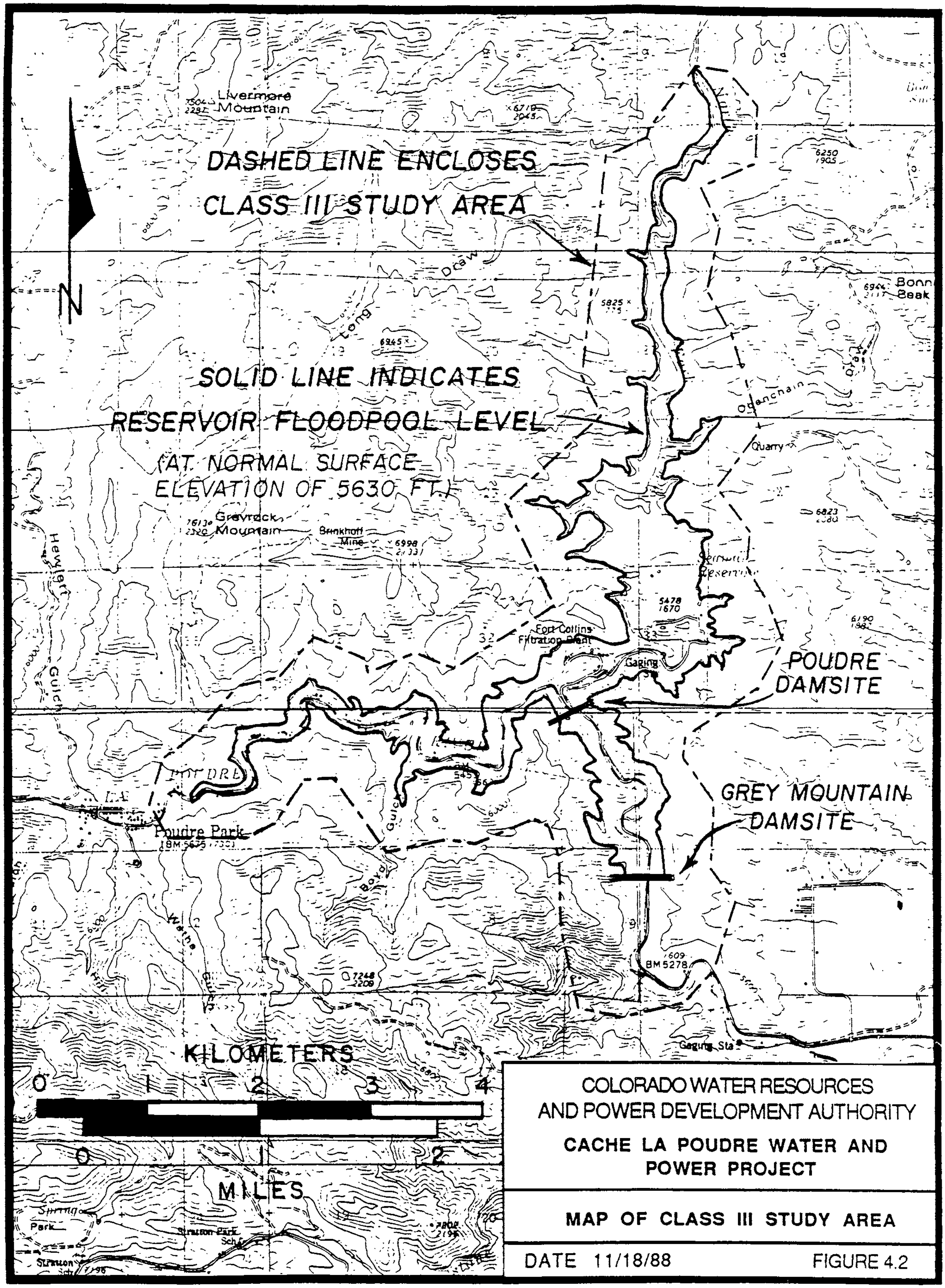


COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MAP OF CLASS I STUDY AREA

DATE 11/18/88 FIGURE 4.1



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE WATER AND POWER PROJECT

MAP OF CLASS III STUDY AREA

DATE 11/18/88 FIGURE 4.2

CHAPTER 5.0

RECREATION, AESTHETICS, AND LAND USE STUDIES

5.0 RECREATION, AESTHETICS, AND LAND USE STUDIES

5.1 INTRODUCTION

This report documents recreation, aesthetics, and land use studies for the proposed Cache la Poudre Water and Power Project conducted during late 1987 and 1988. The recreation, aesthetics, and land use scope of work was identified as Task No. 14 of the Cache la Poudre Basin Study Extension undertaken by the Colorado Water Resources and Power Development Authority (Authority) and the Northern Colorado Water Conservancy District (District). The 1987-88 studies update and expand upon the results of the previous Cache la Poudre Basin Study, which was completed in 1987.

5.1.1 Project Description

The preferred configuration for Stage 1 of the proposed project consists of a water storage reservoir and conventional hydroelectric generation plant that would be located on the mainstem of the Cache la Poudre River, approximately 10 miles northwest of the City of Fort Collins (see Figure 5.1). The water storage component of the project would be used to supply water to customers served by the District. A hydroelectric plant with a capacity of about 20 MW would be located at the dam, and revenue from power sales would be used to reduce the cost of providing the water supply.

Two alternative dam locations for impounding the mainstem reservoir were considered during the Basin Study Extension. The Grey Mountain Damsite alternative is located approximately 2 miles downstream of the confluence of the mainstem and the North Fork of the Poudre River, near the northern edge of Section 9, T. 8 N., R. 70 W. At a normal maximum water surface elevation of 5630 ft, the reservoir created by this dam would have a surface area of approximately 1600 acres. The reservoir would extend up the mainstem to just below the community of Poudre Park and approximately 6.5 miles up the North Fork. This alternative would have an active water storage capacity of approximately 190,000 af.

The second alternative under consideration is the Poudre Damsite located just downstream of the confluence of the mainstem and North Fork, near the southwest corner of Section 33, T. 9 N., R. 70 W. This dam would impound water to the same normal maximum water surface elevation, creating a reservoir with a surface area of approximately 1350 acres. The upstream extent of the Poudre Reservoir would be the same as the Grey Mountain Reservoir. Poudre Reservoir would have an active storage capacity of approximately 130,000 af.

Development of either site would require several ancillary facilities in addition to the dam, reservoir, and powerhouse. Current plans include a switchyard and transmission line, access spur roads, borrow pits, and construction staging areas. Locations for the switchyard and transmission line have not yet been proposed. Borrow material would be obtained from the reservoir area, just upstream from the dam. Consequently, borrow pits would be inundated by the reservoir. Construction staging areas would probably be situated just upstream and downstream from the dam so as to minimize overall project disturbances.

Construction of Stage 1 of the Cache la Poudre Project would also require the relocation of Colorado Highway 14. The highway currently parallels the river along the floor of the canyon and would be inundated by the proposed reservoir. The recreation, aesthetics, and land use studies described herein considered one alternative for relocating Highway 14. This alternative consists of a new route generally parallel to the southern shore of the mainstem reservoir. The relocated highway section would be approximately 6 to 7 miles long.

The proposed project is at the preliminary feasibility evaluation level. The prior Basin Study identified two preferred alternatives for the mainstem reservoir that were potentially feasible and worthy of further evaluation. The Basin Study Extension has concentrated on key environmental studies for these two alternatives. Engineering plans were still at a conceptual level at the time the studies described in this report were performed. More detailed engineering studies and further environmental evaluations will be conducted as project plans advance through full feasibility and licensing levels of study.

5.1.2 Study Objectives

The overall objective of the Basin Study Extension was to evaluate expected project effects and potential mitigation measures in sufficient detail to conduct a preliminary environmental feasibility assessment. The Task 14 studies of recreation, aesthetics, and land use were also performed to address this overall objective. To accomplish this objective, the Task 14 studies were intended to provide a more complete baseline characterization of existing recreation, aesthetic, and land use resources in the affected area compared to information previously available.

Beyond this general objective, the Task 14 studies were organized to meet the following seven specific requirements of the scope of work:

1. Consult with appropriate agencies concerning the scope and methods of study;
2. Conduct an inventory of existing conditions, based primarily on literature review and existing agency file data;
3. Survey whitewater guides currently operating on the Cache la Poudre River to determine use patterns and water flow requirements;
4. Survey recreationists along the Cache la Poudre River during the 1988 spring-summer recreation season to supplement existing baseline data and provide input to the assessment of project effects;
5. Identify direct and indirect effects of the project on existing recreation, aesthetic, and land use resources;
6. Conduct a preliminary assessment of project feasibility based on project effects and potential measures for mitigation; and
7. Prepare a final task report documenting the results of these studies.

As described above, the current studies are an extension of earlier work that identified project alternatives for further evaluation. The Basin Study Extension represents an intermediate level of study that will be followed by more detailed studies as necessary. The Task 14 studies provide key information on project feasibility from the perspective of recreation, aesthetics, and land use. Future studies will refine the conclusions of the current studies, based on more detailed engineering information, and support the development of detailed plans for mitigation. Future studies will also contribute to a license application for the proposed project, at such time as a decision is made to apply for an FERC license or other permits needed for construction.

5.1.3 Study Area

Task 14 studies were conducted within a study area comprised of the immediate area encompassing the proposed project facilities, termed the primary study area, and a larger surrounding area, termed the secondary study area. The primary study area encompassing approximately 34,000 acres in the immediate vicinity of the proposed project facilities was evaluated for all three Task 14 disciplines. The larger secondary study area, consisting essentially of Larimer County, was used to provide a regional perspective for the recreation studies. Recreation resources beyond the boundaries of the secondary study area were also considered where necessary for proper context in evaluation. The division of the study area into a primary and secondary area is not meant to convey that more of the effort to characterize resources and effects was concentrated in the primary study area. Rather, the division is utilized because certain resources would be affected by the proposed project only locally (primary study area) while others would be affected regionally (secondary study area). Maps and additional discussion of study area definition are provided in Sections 5.2, 5.3, and 5.4 for recreation, aesthetics, and land use, respectively.

5.1.4 General Methods

The Task 14 studies involved three related but distinct disciplines, required a variety of techniques for discrete minor components of the studies, and relied largely upon information obtained from previous studies rather than on data obtained from new investigations. Consequently, nouniform methodology can be adequately and succinctly described for all aspects of Task 14. The Task 14 study methods are, therefore, described very generally in this section. Additional methodological details are included where appropriate along with the technical material for each discipline.

All three Task 14 disciplines employed various methods for the inventory of existing conditions and identification of project effects. In all cases the inventory approach included review of applicable literature and maps, along with contacting appropriate agencies to obtain file data on existing conditions. Visual inspection of the project area also provided confirmation or modification of data obtained from previous studies, as well as direct input to the characterization of existing visual resources.

In general, project effects were identified through simple comparison of existing resources with the locations of project facilities. This comparison provides meaningful information because the effects mechanisms are typically displacement of existing uses or the visibility of project landscape changes. Therefore, the effects assessments required determination of displaced recreation activity levels, the number of viewers affected by proposed landscape changes, and land uses that would be inundated by the proposed reservoir. However, in several cases additional analyses were required, such as modeling changes in the recreational capacity of project area lands or changes in stream recreation due to altered river flows.

The recreation studies also included two survey efforts. One of these consisted of a series of interviews, using a formal questionnaire, with the small group of whitewater guides currently operating on the Cache la Poudre River. A second and more extensive survey was conducted in the field along the river from April through September of 1988, and produced responses to formalized questions from more than 500 recreationists.

The Task 14 studies were managed by Envirosphere Company of Bellevue, Washington, under contract to the Authority. Envirosphere personnel conducted the aesthetics and land use studies and led the agency consultation effort for all Task 14 studies. Recreation studies were performed primarily by Outdoor Recreation Resources Associates (ORRA) of Fort Collins, Colorado under the direction of Dr. Patrick Reed. The District contributed staff time to the recreation field survey conducted during 1988. Baseline data and input for scoping and analysis were received from the Forest Service (FS), the Colorado Division of Parks and Outdoor Recreation (CDPOR), the Colorado Division of Wildlife (CDOW), and the Larimer County Parks and Planning Departments.

5.1.5 Chapter Organization

The remainder of this chapter comprises the substantive documentation of the Task 14 studies. Sections 5.2 through 5.4 address recreation, aesthetics, and land use, respectively. Each of these sections is organized in the same manner. The five major subheadings in each section provide an overview for each discipline, descriptions of existing conditions, identification of project effects, discussions of potential mitigation measures, and a summary of recommended future studies. Subheadings within the project effects sections distinguish between direct and indirect effects where appropriate. For clarity and convenience, discussions of the Grey Mountain and Poudre damsite alternatives are also separated.

A summary evaluation for all three disciplines is provided in Section 5.5. This section reviews the key results for each discipline and addresses the overall conclusions with respect to the preliminary feasibility evaluation. References for all three disciplines are included in Section 5.6, and all figures are presented at the end of the Task 14 report. Supporting technical documentation for the recreation studies is provided in Appendix B.

5.2 RECREATION

5.2.1 Overview

Recreation studies comprised the most extensive and detailed component of the Task 14 effort. This was due to the variety and significance of recreational resources in the general area, and the complexity of recreational issues associated with the proposed Cache la Poudre Project. This overview describes the specific objectives for the recreation studies, their geographic scope, and general methods used for data collection. The remainder of Section 5.2 describes existing conditions, expected project effects, potential mitigation measures, and recommended future studies.

5.2.1.1 Study Objectives

Principal concerns surrounding the development of a water storage project often include displacement of existing recreation opportunities and the effect of the project on downstream recreation activities. These concerns also apply to development of a reservoir on the mainstem of the Poudre.

Key recreation issues associated with the proposed project are summarized in Table 5.1. The Task 14 recreation studies were designed to address the various aspects of these general issues, to a level commensurate with the current level of project planning and respective schedules for various acations. For example, planning studies related to management of the upstream wild and scenic river corridor and the potential downstream national recreation area are not complete and could not adequately be addressed in the Task 14 studies. As described in Section 5.1.2, the Basin Study Extension will be followed by additional studies and project licensing work, if the proposed project is pursued. Assuming the project is pursued, the Task 14 recreation studies must specifically be followed by the development of a recreation plan for the project. This plan would evaluate the resource constraints and opportunities associated with the project, and provide a detailed master plan of specific actions proposed to develop these opportunities. Due to the ensuing planning effort, the emphasis of the Task 14 recreation studies was on establishing an improved project baseline for existing conditions and on addressing the key issues related to project effects. Because most of the recreational activity in the area that would be immediately affected is dispersed use, relatively little data on this use existed at the time of the study. Much of the study effort for recreation was, therefore, allocated to inventory activity, including structured interviews with commercial outfitters operating on the river and a 1988 spring-summer field survey of recreationists at selected locations along the Poudre River.

TABLE 5.1

Simulated Reservoir Surface Levels
Issue Category/Issue

A. General

- o Displacement of public recreational opportunities in project area
- o Reduced quality of remaining opportunities

B. Land Oriented

- o Loss of existing and proposed developed facilities (e.g., camping, picnicking)
- o Loss of hunting area and access
- o Loss of ORV opportunities

C. Water Oriented

- o Loss of whitewater boating mileage and access sites
- o Loss of angling opportunities and access

D. Upstream From Proposed Project

- o Effect on Wild and Scenic River oppportunities
- o Affect on reservoirs or other up-valley resources

E. Downstream From Proposed Project

- o Change in flows used from boating, fishing
- o Effect on proposed fishery through Fort Collins
- o Relationship to proposed National Recreation Area and associated studies

Analysis of project effects was conducted in recognition of concerns identified by the agencies with administrative responsibility for recreation within the study area, as represented through consultation meetings and correspondence. The FS administrator of the Arapaho and Roosevelt National Forests expressed interest in the effects of the proposed water storage project on the recreation supply and demand within the Forest. In particular, the FS concerns include how the proposed project might affect the agency's ability to meet Forest plan objectives for developed and dispersed recreation. The agency also indicated concern about the possible displacement of river users from the study area to wild and scenic portions of the river above Poudre Park or to a proposed national recreation area along the Poudre River in the Fort Collins area. Whitewater boating represents a significant part of this concern, as the FS issues permits to commercial rafters on the Poudre.

The CDPOR is responsible for regulating the commercial river running activities on Colorado rivers, including the Poudre. CDPOR leases and operates two developed river access sites near the mouth of the canyon, which could be affected by the operation of a water storage project. CDPOR has also expressed interest in developing new sites, including a possible state river park, a river access site at the Fort Collins water filtration plant, and an environmental education center. These development opportunities could conceivably be precluded by one or both of the project alternatives, or could be displaced later if CDPOR development preceded the project.

Whitewater boating use, involving the CDPOR access sites and other segments of the river, is a key issue. Currently, six commercial river runners have permits with the FS that allow them to provide guided river trips on the Poudre, and many private rafters and kayakers also use the river. Development and operation of the project could adversely affect two floatable reaches of the Poudre, the 2.3 mile "Bridges" (or "Pineview") section below Poudre Park and the 2.8 mile "Filter Plant" section below the Fort Collins water filtration plant.

The CDOW manages the fish and wildlife resources of the state, including the fishing and hunting opportunities in the lower Poudre Canyon. CDOW would also manage any angling in the new reservoir that would be created by the project. A section of the lower Poudre above the mouth of the canyon has been designated as wild trout water, and angling in this section could be displaced, diminished, or enhanced by the project. CDOW also owns land near the mouth of the canyon to which other displaced recreationists might be attracted, thereby reducing its wildlife-related value.

The City of Fort Collins has identified issues related to potential effects on several local recreational programs, including the proposed national recreation area and an urban fishery. Current low summer and fall river flows may not be sufficient to justify such programs, and the suficiency of reservoir releases for these purposes was identified as a concern. Fort Collins also has expressed concerns relating to the recreation plan, specifically that water quality and treatment processes could be adversely affected by recreational use of an upstream reservoir.

In response to these issues, and the overall Task 14 study objectives identified in Section 5.1.2, the following specific objectives were developed for the recreation study:

1. Compile baseline information on recreation opportunities by georaphic location for the primary and secondary study areas;

2. Identify the type and amount of existing developed recreation facilities and dispersed recreation opportunities, subdivided where possible by land class within the recreation opportunity specturm (ROS);

3. Develop information on existing developed and dispersed recreational use, by facility type, activity type, and ROS class where available;

4. Determine the effects of the proposed project on recreational resources and activities, using established criteria and standard assessment techniques;

5. Identify potential measures to replace, maintain, or enhance recreational opportunities related to or affected by the proposed project, taking into account the ability of existing supply to meet current and future use; and

6. Identify needs for future studies to address key informational gaps that limit the analysis of project effects or development of mitigative and enhancement measures.

5.2.1.2 Study Area

The study area was comprised of a primary area surrounded by a secondary area to reflect differing needs for data for the various recreational activities (see Figure 5.2).

The larger secondary study area encompassed nearly all of Larimer County, or the western half of State Planning Region Number 2. This area was identified as the region of interest for most of the inventory component of the recreation studies. The secondary study area was generally large enough to provide sufficient context for the recreational resources and activities potentially affected by the proposed project. Existing recreation facilities, opportunities, and uses within this area were inventoried and summarized to provide a description of typical conditions for the northern Front Range. Tabulation of recreation resources within this broader area also allowed judgments as to the uniqueness of the recreation resources in the primary study area. In addition, it was assumed that the secondary study area would provide the main geographic context of analysis in the subsequent development of a project recreation plan.

The smaller primary study area was delineated so as to include all recreation activities or opportunities that would be displaced by the project. The primary study area, indicated in more detail in Figure 5.3, included the area of direct effects on recreational activities that would be displaced through inundation or the construction of project features. Most of the indirect effects resulting from changes in acreage of recreation experience settings or altered river flow immediately downstream of the project would also occur within this area. The primary study area included all of the area that would be visible from the proposed reservoir and all significant publicly-owned lands in the vicinity of the project. The eastern boundary of the primary study area was near US Highway 287, and the western boundary extended past Poudre Park. The northern boundary extended as far as Eagles Nest, about 2 miles beyond the end of the proposed project reservoir, while the southern boundary extended up to 2 miles south of the river.

In some cases, inventory and analysis activities extended beyond the boundaries of the formally defined study area. Particularly where the recreation opportunities in either the primary or secondary area are few, or of relatively unique character or quality, the entire state of Colorado was reviewed to determine which other opportunities represented comparable or substitute sites for users. This broader focus primarily applied to coldwater stream angling and whitewater boating resources.

5.2.1.3 Methods

A variety of data collection and analysis methods were used in conducting the Task 14 recreation studies. Separate analyses were prepared for the primary and secondary study areas, using the same methods. The methods employed are summarized below for both the baseline data and effects assessment components of the studies. Additional detail on specific sources or derivation of data are provided in the remainder of the text. Certain key assumptions and data limitations are also acknowledged in the following discussion.

<u>Baseline Data</u>

The goal of the Task 14 recreation study with respect to baseline data was to collect sufficient data to describe the type and amount of recreational resources that could be affected by the project. The recreation study was primarily a reconnaissance assessment relying upon existing information. Existing information was generally obtained through review of public agency management plans and supporting documents, review of applicable literature, and contacts with public and private recreation specialists. These secondary data were supplemented by surveys of river users and commercial whitewater boating operators to provide a more complete characterization of baseline conditions.

Public agencies responsible for managing recreation opportunities within the study area represented the most important source of secondary data for the recreation studies. These agencies primarily included the FS, CDPOR, CDOW, the National Park Service, and the Larimer County Parks Department. Agency materials used in the inventory process included official management plans adopted by the respective agencies, maps and brochures published to serve as public recreation guides, special studies undertaken by the agencies, and a variety of file data on existing recreational facilities and use.

Because the FS is the largest manager of lands and recreation opportunities within the study area, it was the primary source of inventory data. The management plan for the Arapaho-Roosevelt National Forest (FS, 1984) and its supporting information provided a basic framework concerning management direction and quantitative recreation measures. The forest map (FS, 1985) provided a tabulation of developed recreation facilities maintained by the Forest Service.

Agency files were also reviewed for visitation data from the recreation information management (RIM) system, acreage data for lands within the various recreation opportunity spectrum (ROS) classifications, and agency records of whitewater boating by commercial outfitter permittees.

The CDPOR is also a significant source of comprehensive recreation data. CDPOR periodically develops a statewide comprehensive outdoor recreation plan (SCORP) that provides statewide policy and planning guidance concerning recreation developments and activities. In addition to the SCORP, CDPOR publications provide inventory data on facilities managed by the agency within the study area. Data on use of these facilities, including two facilities within the primary study area, are contained in CDPOR files.

The other major agencies managing recreation within the study area have not adopted management plans specific to the study area. However, data on facilities and use within the study area were obtained from the CDOW, the National Park Service, the U.S. Bureau of Reclamation, and the Larimer County Parks Department.

Appropriate recreation literature was reviewed for both generic and site-specific information. For example, published literature addressed such subjects as national and regional trends for participation in various activities, and the values that users place on their recreation experiences. Other literature sources included materials on local and regional opportunities for water-based recreation, and use patterns for whitewater boating or other specific activities. Much of the relevant literature was from studies conducted by Colorado State University. These studies included some particularly relevant work involving the optimal allocation of water for recreational uses and the economic value of water-based recreation, most of it based on field studies in the northern front range area of Colorado.

Interviews and discussions with agency recreation specialists were valuable in understanding current recreational use within the study area, as well as agency concerns. One or more interviews with staff members from the above agencies were conducted during the consultation, inventory, and analysis processes. Numerous contacts were made with FS and CDPOR staff, because these agencies have very active roles in recreation management and maintain the most extensive recreation data. Several experienced and active members of recreational user groups were also contacted to discuss their knowledge of river use and preferences.

The secondary data and personal contacts were supplemented through two primary data collection activities. These included structured interviews with representatives of commercial whitewater outfitters and a larger field survey of users at several sites along the river.

In late 1987 and early 1988, representatives of the six commercial whitewater outfitters using the lower Poudre Canyon were interviewed. These interviews were conducted in a structured format using a detailed, uniform questionnaire. The purpose of this effort was to determine opinions regarding desirable river characteristics, including the utility of different river flow levels. The commercial operators also expressed their preferences for different physical, managerial, and social settings for whitewater boating opportunities.

A recreation survey was also conducted in the lower Poudre Canyon in cooperation with the CDPOR during the spring, summer, and fall of 1988. A main focus of the survey was to determine why different types of users chose certain sections of the river, including the sections that would be immediately affected by the proposed project. Other key questions addressed use frequency patterns and how the flow level of the river that particular day affected the quality of the recreation experience. The survey also inquired about background factors such as user origin (by zip code), travel distance, frequency of use, and experience level. A copy of the survey form is included in Appendix B.

River users were contacted every other day from April 20 through September 29, 1988. A total of 538 users were surveyed during this period. Most respondents were contacted by CDPOR seasonal rangers at the agency's Lower and Upper Picnic Rock river access sites in the lower canyon. Users were also contacted at Greyrock Trailhead near Poudre Park and along the river between Greyrock Trailhead and Diamond Rock Picnicground. The latter area was covered on 15 randomly chosen days during the same period. On spring and fall days, when use was relatively low, the survey personnel were able to contact all users encountered. This level of sampling was not possible during busier summer periods, when representative users were systematically selected. Some users who indicated that they had not used the river at the time of the interview were asked to take a survey and return it at the end of the day. All types of users were interviewed without preference for activity, origin, experience, sex or age (as long as the person was 16 years old or over).

Effects Assessment

The approach used in assessing the expected effects of the project was generally to identify the magnitudes of change or effect and compare these to the corresponding supply of regional opportunities. The primary measures of project effects on recreation are changes in capacity of dispersed and developed opportunities, existing and potential visitor use, and the economic value associated with recreational use. Effects were assessed on the basis of direction and magnitude of change in these measures without attempting to define the significance fo these changes.

For developed recreation, effects were measured in terms of total sites, number of individual units, persons-at-one-time capacity, and annual economic values. Losses or changes in recreation sites, acreage, capacity, or days were assumed to have a direct influence on existing or potential recreational use. Total use changes were measured in two ways, due to differing agency preferences for units of measurement. First, use was measured by the number of people throughout the year that use a given resource, which provided estimates of total visits or use occasions. Second, measures of recreation visitor days (RVDs) were examined to determine changes in the total time (days or hours) spent recreating by visitors.

Anticipated project effects were also differentiated between direct and indirect effects. Direct effects were considered to be those resulting immediately from the displacement of existing facilities and activities, and would occur within the primary study area. Indirect effects would result from diminished utility of activities downstream or in adjacent areas due to enviornmental changes created by the project and would occur within both the primary and secondary study areas. Despite this distinction, the same methods were applied to both study areas and both types of effects.

For dispersed recreation, the direct and indirect effects on recreation were measured in terms of expected net acreage changes among four different types of experience settings and two capability (or capacity) classes. Resulting changes in expected persons-at-one-time capacities were also determined, using capacity coefficients reported in the 1984 forest plan (FS, 1984). Setting definitions and characterizations were as generally described in the Guide to Colorado Natural Resource Recreation (Colorado Tourism Board, 1988). This publication used terminology that was slightly different from the ROS developed by FS researchers. However, the classification concepts were essentially the same, and the new system was agreed to by all agencies with jurisdiction in the study area. Included in the calculations were direct effect conversion of land-based setting acres to water-based setting acres and indirect effect shifts in land-based experience settings. Also used were total miles of linear corridors affected, including miles of the river inundated or subject to altered flow ranges, miles of hiking trails inundated, miles of state highway to be relocated, and new miles of shoreline that would be created by project reservoirs. Whitewater boating opportunities were measured in a combination of river miles and average annual days within defined flow ranges.

Recreational use and/or for dispersed areas were modeled with relevant historical factors, use assumptions, and management schemes to attempt to replicate observed or reported use figures and patterns. This was used to simulate current use without the project. To describe the realistic as-is potential of these opportunities, the models were then adjusted to predict what the maximum use could be, given existing site limitations, particularly parking requirements. Similarly, the realistic potential of the new conditions with the proposed reservoirs was also calculated, including changes in acreage.

Assumptions used in the models were reviewed with agency recreation specialists, and the significant coefficients were selected jointly. Key coefficients in the models included persons-at-one-time capacities per acre or mile, season lengths, time spent at the site, and users per vehicle or boat.

Figures were derived from either the forest plan, literature reviews of comparable situations, or the professional judgement of agency staff.

Finally, unit recreation use values were developed through literature review for application in estimating the total annual value for each setting or activity. Basic unit values for recreation activities occurring in the study area were taken from the compendium of unit values provided in Walsh et al. (1988). This publication is a comprehensive review of prior empirical studies of recreation unit values. The prior studies addressed a wide variety of recreational activities and geographic settings. Unit values used in the Task 14 analysis were selected on the basis of the closest activity and geographic match among all studies reviewed by Walsh et al. Additional information on the specific sources of these unit values is provided in Appendix B. All values were adjusted from the study base year to 1987 dollars using the GNP implicit price deflator, following the approach of Sorg and Loomis (1984) and Walsh et al. (1988).

Assumptions and Limitations

The assessment of the expected effects of the proposed project on the recreation resources of the lower Poudre Canyon is necessarily limited by uncertainties about future conditions. Consequently, the following basic assumptions have been made in this assessment:

1. Current patterns of recreational use in the primary and secondary portions of the study area will continue generally unchanged throughout the assessment time period. This assumption is consistent with the typical approach of anticipating future events based on relatively recent historic patterns. It also recognizes the uncertainties associated with technological change, societal tastes, and the status of the national, regional, and local economies. The uncertainties in these variables effectively prevent making predictions about the introduction of new uses or the drastic decline in popularity of existing uses.

2. No additional recreational opportunities outside of the lower Poudre Canyon which could affect existing use in the primary and secondary

study area will be developed. This assumption is based on current public agency development plans for providing developed and dispersed recreation opportunities within the assessment time period.

3. The streamflow data used for the streamflow-related analyses represent typical flow conditions over time and provide an adequate historical sample.

4. Flow data from one point on the Poudre River can be acceptably used to estimate river recreation capacity in other nearby river segments by adjusting stream velocity as a linear function of the average gradient in a stream reach. Stream velocity data is measured against volume at only one point, the USGS gage near the canyon mouth. To analyze upstream reaches, the same velocity/volume relationship is applied.

Aside from these necessary assumptions, the ability to precisely determine all project effects was limited by data availability and adequacy. In some cases the data desired for a specific purpose were available but not in sufficient detail, while in other cases data were simply not available without extensive studies to generate primary data. These study limitations are summarized below.

1. Most of the literature review material applicable for estimating the effects of the Stage 1 Poudre Project was developed specifically for other sites and years and not for the Cache la Poudre River during the late 1980s. It was considered appropriate to judiciously utilize such information to characterize current users of the lower Poudre Canyon, although the precision of such extrapolation was unknown.

2. The data on simulated project flow releases that were used in the analysis of streamflow effects did not have the desired level of detail. The only data on expected project releases that were available for this analysis were mean monthly values. These mean values could have masked whatever variation might occur in hourly, daily, or weekly flows within a given month. Consequently, it was assumed that daily variations in

with-project releases would follow the pattern of the without-project historic flows.

3. Determination of the direct and indirect effects on recreational activities has been based on estimates of existing use levels, rather than projections of future, without-project use. Development of future use projections was an original objective of these studies. However, this was judged by the consultants to be inappropriate at the present time upon further review of baseline data and future use determinants. The two recreational activities most likely to be significantly affected by Stage 1 of the proposed project were determined to be angling and whitewater boating, as demonstrated in Section 5.2.3. Reliable future use projections for either of these activities could not be developed at this time, as described below. In the case of angling, the limitations involve baseline data and annual variations that make trends difficult to identify. The only specifically applicable angling data obtained during the present recreation inventory are the 1984 creel census results for the lower Poudre wild trout waters.[1] The existence of only one year of baseline data does not allow analysis of apparent use trends. Further, angling activity levels on a given stream are particularly susceptible to change with year-to-year variations in streamflow and weather conditions that directly affect fishing success. Consequently, it is also inappropriate to apply a specified or assumed annual growth rate to existing use estimates based on the creel census because 1984 may not have been a representative base year. Future whitewater boating levels will be heavily influenced by planning actions currently in progress. The FS is presently maintaining the current level of permitted commercial whitewater use on the Poudre River until the Wild and Scenic River management plan is completed. The draft plan is scheduled to be completed in late summer of 1989, indicating that allowable use levels may not be adopted for 1 to 2 years. Because commercial use accounts for an estimated 90 percent of all whitewater use in the primary study area, as reported in Section 5.2.2, it is inappropriate to speculate on future use levels until the FS has adopted a management plan. While demand for this activity may grow in the near

term, actual use will apparently be constrained to existing levels through management action.

4. Certain limitations on use of the data from the 1988 field survey must be acknowledged. The primary purpose of the field survey was to elicit user preferences, across all key user groups, for ranges of river flow relative to their chosen recreational activity. To this end, users were surveyed on over 50 percent of all days during a 5-month period of the year. Users were contacted at numerous key recreation sites along the including the Upper and Lower Picnic Rock river access sites, the Greyrock Mountain Trailhead, Diamond Rock Picnic ground, and at informal recreation sites along the river between Diamond Rock and Lower Picnic Rock. As with any sampling program, this survey design cannot guarantee perfect representation of all recreational users and activities, and the results could be marginally affected by annual variations in seasonal and climatic factors. While it is believed that the survey results are appropriately representative, limitations based on sample coverage are carefully noted in the report.

5.2.2 Existing Conditions

The inventory of existing conditions are presented below. The material contains descriptions of existing land and water resources, recreation opportunities, developed recreational facilities, developed and dispersedrecreational use patterns, and key trends relevant to the effects assessment. The discussion of existing conditions proceeds from the surrounding region to the secondary study area, to the specific conditions for the primary study area.

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(1) Some information on the level of angling use was derived from the 1988 field survey, but this information was largely qualitative in nature. The survey was designed primarily with the intent to identify user flow preferences, rather than to provide statistically valid estimates of total use, so the Poudre River, angler responses for the survey cannot be expanded to estimate annual visits.

5.2.2.1 General Setting

The Cache la Poudre River is situated within the northern front range region of Colorado. To varying degrees, the many public land recreational opportunities of this area have local, regional, and even national significance. The importance of these opportunities is due to their wide variety, high quality, and accessibility.

Recreational resources within this region that are of particular significance, as indicated by special Federal land-use deisgnations, include Rocky Mountain National Park, several wilderness areas, and the Cache la Poudre River itself. To the south of the Poudre Canyon, Rocky Mountain National Park annually attracts more than 2.3 million visitors, a visitation level comparable to Yellowstone National Park (National Park Service, 1985). Surrounding the Poudre Canyon is the Roosevelt National Forest. Together the combined Arapaho-Roosevelt National Forests record more than 10 million recreation visitor days annually, ranking fifth among all national forests in the U.S. (FS, 1984).

Highway 14 provides access to several wilderness areas located on national forest lands, including the Cache la Poudre, Comanche Peak, Neota, Never Summer, and Rawah Wilderness Areas. The Poudre Canyon also provides an alternate access to the Arapaho National Recreation Area located west of Rocky Mountain National Park.

In 1986, 75 miles of the Cache la Poudre River were designated as Colorado's first national wild and scenic river (100 Stat. 3330). Forty-four miles of the mainstem above the community of Poudre Park were classified as "recreational", meaning that they are easily accessible and may already have some developments along the shoreline. The same act also authorized a comprehensive evaluation of 18.5 miles of the river from northwest of Fort Collins to the Larimer-Weld county line, to determine the river's suitability for designation as a national recreation area (100 Stat. 3331).

The major recreational resources identified above receive use from both national and regional markets. The northern Front Range provides other recreation opportunities that are primarily regional or local in use. The CDPOR accommodates 1.5 million visits annually among its northern region parks (CDPOR, 1988a). Along with the Bureau of Reclamation and Larimer County, CDPOR administers recreation use at several large reservoirs including Boyd and Carter Lakes near Loveland. A third reservoir, Horsetooth, is located just outside the mouth of the Poudre canyon. The three reservoirs collectively attract nearly 750,000 visitors a year (Bureau of Reclamation, 1988).

The greatest use pressure on the Poudre Canyon and other northern Front Range recreation attractions comes primarily from the regional population. The recreation opportunities of the Poudre Canyon are reasonably close to nearly two-thirds of the state's 3.2 million residents (CDPOR, 1986). The mouth of the canyon is only a 20 minute drive from Fort Collins and less than 2 hours from the Denver metropolitan area. Because the river is easily accessed by Highway 14 for more than 40 miles of its length, the regional population has an excellent opportunity to engage in river related recreation.

5.2.2.2 Secondary Study Area

The secondary study area defined for the recreation inventory is essentially coterminous with Larimer County, Colorado. The following material generally describes existing recreational opportunities and activity levels within this secondary area, with two exceptions. In the case of specialized angling and whitewater boating opportunities, some addtional information on a statewide basis is included in order to provide appropriate regional perspective. Recreational land classes are discussed first, followed by descriptions of developed and dispersed recreational opportunities and activities.

Public lands in the northern Front Range and adjoining foothills, primarily lands within the Arapaho-Roosevelt National Forest, offer extensive opportunities for dispersed recreation. Information on the experience setting composition of national forest lands in the Poudre Canyon and the Arapaho-Roosevelt National Forest is presented in Table 5.2. About 45 percent of the Arapaho-Roosevelt National Forest is classified in the semi-primitive nonmotorized (or walk-in) experience category, and another 30 percent is roaded natural (or roaded open country).(1) Because Highway 14 transects the Poudre Canyon, the majority of the canyon area offers a roaded natural (roaded open country) or rural (highway rural) experience. Outside of the highway corridor there are few roads and steep slopes, and most of the land offers a semi-primitive nonmotorized (walk-in) recreation experience. The Poudre Canyon figures in Table 5.2 apply only to FS lands in a relatively narrow corridor along the river; experience setting distribution beyond this corridor would be similar to the rest of the Forest.

Developed Recreation

Developed recreation facilities in the region include campgrounds, picnic areas, boat launches, fishing access sites, and trailhead sites. A summary of major public facilities within the secondary study area and their use levels is provided below, organized by administering agency. The primary agencies are the FS, National Park Service, CDPOR, and Larimer County.

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(1) The initial recreation experience classification terms used here are from the Recreation Opportunity Spectrum (ROS) system, which has been used for almost 10 years by the Forest Service and Bureau of Land Management. For a detailed description of the ROS system refer to the ROS Users Guide and The Recreation Opportunity Spectrum: A Framework for Planning, Management, and Research, both published by the Forest Service. The terms in parentheses are corresponding classifications from the Colorado Natural Resource Recreation settings system. See the map publication entitled Guide to Colorado Natural Resource Recreation, jointly prepared by the Colorado Tourism Board (1988) and several federal and state recreation agencies. The recreation experience taxonomies used in this publication are modeled after the ROS system.

TABLE 5.2

National Forest Dispersed Recreation Settings

ROS Setting(1)	Urban	Rural	Roaded Natural	Semi-primitive Motorized	Semi-primitive Nonmotor-ized	Primi-tive	Total
Poudre Canyon (USFS Lands)							
Acres	0	10,659	12,250	142	12,929	0	35,980
Pct Total	0	30	34	0	36	0	100
Arapaho-Roosevelt NF							
Acres	0	85,637	385,106	136,138	573,722	82,774	1,263,377
Pct Total	0	7	30	11	45	7	100

(1) Colorado Natural Resource Recreation Setting equivalents are respectively "Developed-Urban," "Highway-Rural," "Roaded Open Country," "Four Wheel," "Walk-in," and "Back Country."

Source: FS, 1982.

The FS is a major provider of developed recreation within the region. The agency operates a total of 21 campgrounds, 9 picnicgrounds, 19 trailheads, 1 rest area, and 3 fisherman parking sites within the secondary study area (FS, 1985). These facilities provide a total of over 400 individual campsites and nearly 80 picnic sites. More than half of the campgrounds and picnic grounds are located in the Poudre Canyon providing a total of about 130 camsites and 35 picnic sites. From 1982 through 1986, the Poudre Canyon facilities annually accounted for more than half of the total camping and picnicking use in the Estes-Poudre Ranger District and about 20 percent of the total for the Arapaho-Roosevelt National Forest (FS, 1982-1986).

Use at the 13 FS campgrounds in the canyon was reported at an average annual total of nearly 40,000 recreation visitor days (RVDs) between 1982 and 1986. (See Appendix Table B.137.) FS RIM data suggested that annual visitation of these campgrounds has decreased since 1982, unless revised agency estimating procedures were responsible for the apparent downward trend. A number of smaller, less cost-effective sites have been or are scheduled to be closed over the next several years. Nevertheless, use at several of the developed sites in the canyon is currently at or above capacity on weekends and holidays (Alden, 1989). The 4 picnicgrounds in the area accommodated an average annual total of just less than 3400 RVDs during the period of 1982 to 1986.

Information being prepared for use in the FS Wild and Scenic River management plan indicates that developed camping use along the Poudre River is expected to increase. Overall use for a subset of 6 campgrounds along the river is projected to grow by over 13 percent from 1988 to 1995, and by 9 percent from 1995 to 2000 (Alden, 1989).

The National Park Service operates a number of large developed facilities in Rocky Mountain National Park. Approximately half of the park is in Larimer County, and this portion contains most of the developed areas in the park. This area includes five major campgrounds, which accommodated nearly 160,000 overnight stays in 1985 (National Park Service, 1985).

State-operated recreational facilities include two state parks located near the urban areas of Larimer county. Lory State Park, managed by CDPOR, is a large area of about 2400 acres located just west of Horsetooth Reservoir and 5 miles from Fort Collins (CDPOR, no date). While it is a state park, Lory only has backcountry campsites and minimal developed facilities. The park is generally used for hiking and riding activities.

Boyd Lake State Park is located just northeast of Loveland. Boyd Lake has about 10 miles of shoreline and 1750 surface acres. The state park is rather intensively developed, with nearly 250 day use and overnight camping spaces, 9 boat launch lanes, a swimming beach and bath house, and food concessions (Maurier, 1988). Boyd Lake receives an average of more than 450,000 visitors annually. Actual use during the 1987-88 fiscal year was reported at over 463,000 visitors (CDPOR, 1988b). Popular activities in the park include camping, picnicking, angling for cold and warm water species, swimming, power boating, sailing, and windsurfing.

Two other large reservoirs have recreational facilities operated by the Larimer County Parks Department. Both reservoirs are within easy travel distance of Fort Collins and other northern Front Range cities. The 1900-acre Horsetooth Reservoir has about 25 miles of shoreline and accommodates nearly 90,000 users each year (U.S. Bureau of Reclamation, 1988). It offers a wide range of activities including angling for several species, power boating, waterskiing, swimming, picnicking, hiking, and horseback riding. Developed facilities include about 130 campsites with over 200 vehicle spaces, and 4 boat ramps with 10 launch lanes (McFarlane, 1988). Carter Lake, located about 6 miles southwest of Loveland, is used more heavily and receives 130,000 visits annually (U.S. Bureau of Reclamation, 1988). The 1100-acre lake has 8 miles of shoreline. Larimer County provides about 180 campsites, 220 vehicle spaces, and 3 boat ramps with 8 launch lanes at the lake (McFarlane, 1988). Carter Lake provides the same general types of recreation opportunities as Horsetooth.

Park managers for Boyd, Carter, and Horsetooth report the reservoirs are often used to capacity during the summer season and actually exceed capacity on summer holiday weekends (Maurier, 1988; McFarlane, 1988).

Dispersed Recreation

The most popular forms of dispersed recreation (activity that does not occur at specific developed facilities) in the secondary study area include hiking, sightseeing, hunting or other wildlife use, angling, and whitewater boating. Hiking opportunities in the area are well documented in a number of hiking guides to Colorado (Ferguson, 1988; Hagen, 1987; Boddie and Boddie, 1984; Lowe and Lowe, 1973). There are more than 60 identifiable hiking trails within the secondary study area, as indicated on Figure 5.4. These trails are concentrated near the Poudre and its tributaries and in or near Rocky Mountain National Park. All of these trails are within 50 miles of the proposed project and provide more than 300 miles of hiking opportunity. A list naming all of these trails is included as Appendix B, Table B.138. The most popular trails in the canyon include the 3.5 mile Greyrock National Recreational Trail and the Mount McConnel, Hewlett Gulch, and Roaring Creek trails. These trails together accommodate nearly 9000 recreation visitor days annually (FS, 1982, 1986). According to Kelly (1987) and Hartman et al. (1988), the long-term national trend is for increased participation in hiking. However, hiking use in the canyon appears to have been stable in the last few years, based on FS recreational use data evaluated in this study.

State Highway 14 parallels and is in view of the Poudre River almost the entire length of the canyon. Consequently, in addition to providing important river access, vehicle touring or sightseeing along the highway is an end in itself for many visitors. The level of use and scenic quality of the highway have prompted the FS to consider nominating it as a national scenic byway within the national forest system (FS,1984). Walsh and Gilliam (1982) estimated that sightseeing was the primary purpose for about 40 percent of the outings along Colorado mountain highways, and the secondary purpose of another 25 percent. U.S. Highways 34 and 36 and Colorado Highway 7 also offer significant opportunities for vehicle touring within the secondary study area.

Big game hunting is a major fall recreational activity in the region. Deer and elk hunting occurs in and around the Poudre Canyon. CDOW big game management units 19 and 191, covering nearly 700 square miles from Cherokee Park to near Loveland, were used by nearly 5000 deer hunters and 2300 elk hunters in 1987 (CDOW, 1988a). More than 30,000 total recreation days of hunting were spent in the two units. The FS (1982-1986) estimates that about 3400 recreation visitor days of big game hunting occurred in the Estes-Poudre Ranger District (south of the river) in 1986, and another 13,100 days in the neighboring Red Feather Ranger District north of the river. Popular nonconsumptive forms of wildlife recreation in the region, such as birdwatching, were difficult to estimate.

More than 13 miles of the Cache la Poudre River in three different sections are designated wild trout water by the Division of Wildlife (see Figure 5.4). Wild trout waters are managed to produce self-sustaining wild trout populations, and are not stocked with hatchery fish. A creel census conducted by CDOW in 1984 estimates that there were at least 29,000 visitor hours of trout fishing on the Poudre (CDOW, 1985). At a typical visit duration of 4 hours, this equates to 7250 visits and over 2400 RVDs of use.

The Poudre is the only river in the secondary study area with designated wild trout water. Statewide, there are more than 20 other rivers with over 110 miles of designated wild trout water. There are also about 150 miles of designated gold medal trout water, which represents the highest quality trout habitat and angling opportunity, distributed among 13 streams in Colorado. Although the Poudre River has no designated gold metal trout water, and there are other differences in quality of opportunity between the Poudre and the other rivers with wild trout waters, these rivers are nominally comparable to the Poudre angling resource. Pertinent data on stream sections and distances from the proposed project are summarized in Table 5.3. As can be seen from the table, most of the rivers with designated wild trout waters are more than 100 miles from the lower Poudre. However, many of these high-quality trout streams are as close or closer to the Denver and Boulder urban areas than is the Poudre. Key attributes for all of the trout streams shown on the map are included in Appendix B, Table B.139.

TABLE 5.3

Designated Wild Trout and Gold Medal River Mileage in Colorado (Excluding Poudre River)

Approximate Distance in Miles to Project	Wild Trout Streams		Gold Medal Streams	
	Number of Sections	Total Miles	Number of Sections	Total Miles
0-10	0	0	0	0
11-25	0	0	0	0
26-50	2	11	0	0
51-100	3	24	4	68
100+	15	77	9	81
	20	112	13	149

Sources: CDOW, 1988b
CDOW, 1987

Whitewater boating opportunities along the Poudre are also within a set of relatively limited statewide resources. The whitewater boating opportunity offered by the Poudre River earns it a listing in the Federal Interagency

Whitewater Committee's (1985) River Information Digest for frequently used western whitewater rivers managed by Federal agencies. Popular boating guides and publications describe the river as "one of the most popular boating rivers in the West--certainly the most popular river in the Colorado Front Range" (Anderson and Hopkinson, 1987); "northern Colorado's finest whitewater boating stream" (Stohlquist, 1982);, and "one of Colorado's premier kayaking rivers" (Wheat, 1983). However, one estimate suggests that in the past, the Poudre accounted for only about 1 percent of the total commercial boating expenditures in the state (Tierney, 1980). The same source estimated that overall boating use of the Poudre increased by only about 1 percent per year from 1976 to 1980, which is one of the lowest growth rates in the state.

The length of the Poudre River that is runnable depends upon water flow and the skill of the whitewater boater. Nearly all boaters use the river on a daily trip basis. Generally, the lower Poudre Canyon is most suitable for boaters of novice and intermediate skill level because it has a gentle gradient and is easily accessible by highway. Upper sections of the river have steeper gradients, numerous obstacles, colder water, and demand more skills of the boaters. This is especially true at higher water flows. Boating below Picnic Rock (near the mouth of the canyon) is not recommended because of numerous low head dams and water diversions, bridges, fences, and lower water flows.

Use of the river above Picnic Rock for whitewater boating is acknowledged by state and Federal river managers to be increasing, although exact records are generally not available except for permitted commercial use. Probably the largest single factor limiting the growth of commercial boating on the Poudre is the relatively short season that the river is runnable. Typically, most commercial operations begin in mid-May and cease by mid-July.

A map of floatable whitewater rivers in Colorado is presented as Figure 5.6. As with trout waters, most of these streams are more than 100 miles from the lower Poudre but many are closer to most of the major Front Range cities than is the Poudre. As indicated in Table 5.4, there are no other rivers suitable for novices within 100 miles. More detailed information on the characteristics of these rivers is presented in Appendix B, Table B.140.

Trends in Water-Based Recreation

At the national level, the demand for water-based recreation in general appears to be growing steadily. This increase has been noted by private researchers (Kelly, 1987; Brown, 1985; Fletcher, 1984; and Tierney, 1980) as well as Federal and state planners (FS, 1988a; Hartman et al. 1988; and Field and Martinson, 1986). The draft 1989 Resource Planning Act (RPA) assessment by the FS indicates that national demand for kayaking will increase by up to 13 percent by the year 2000, and demand for motor boating by 6 percent (FS, 1988a).

TABLE 5.4

Other Floatable Whitewater Rivers in Colorado (Excluding Poudre River)

Approximate Distance in Miles to Project	Novice Skill Level		Intermediate Skill Level		Expert Skill Level	
	Number of Sections	Total Miles	Number of Sections	Total Miles	Number of Sections	Total Miles
0-10	0	0	0	0	0	0
11-25	0	0	0	0	0	0
26-50	0	0	0	0	2	18
51-100	0	0	6	114	4	21
100+	14	426	15	400	14	166
	14	146	21	514	20	205

Sources: Interagency Whitewater Committee, 1985
Wheat, 1983

The President's Commission on Americans Outdoors (1986) reported that water recreation on flatwater lakes has been and will continue to be important to Americans. Power boating demand will increase and opportunities should be expanded to meet it. However, the report further states that recreation use of rivers and steams is increasing rapidly as well, and that such opportunities now must be protected where they exist.

The CDPOR has also recognized the issue of rising demand coupled with scarce water recreation opportunities at the state level. According to the 1986 SCORP, boat registration has increased by over 120 percent since 1970 (CDPOR, 1986). This is one indicator of increasing demand for boating in general, without distinction between power and nonpower boating or river and flatwater boating. With respect to river recreation, the SCORP describes two issues of statewide importance: how to best provide for the rapid growth of river recreation in the state, and the impact of water development projects on river recreation opportunities, an important component of the state's tourist industry. The SCORP notes that increased competition will result among those users who are not displaced to alternative sites.

Other general recreational trends are worth noting when discussing future recreational use of the Poudre River. Leisure time has been declining over the past decade and people are now taking more, but shorter vacation trips. One result of this pattern is that people are more interested in reducing travel distances and are therefore using recreation attractions closer to home (Kelly, 1987; Hartman et al., 1988). Combined with the growing popularity of water-based recreation in general, both whitewater and flatwater opportunities in the northern Front Range will be subject to future demand increases that are likely to be above the level created by population growth and changes in population age structure.

This is supported by the results of the 1988 recreation field survey. According to this survey, about 80 percent of the respondents live within a 2-hour travel radius of the lower Poudre Canyon. The survey also suggests that "convenience and accessibility" are the most important reasons for choosing the Poudre among hikers, picnickers, and anglers.

Definitive trends for local reservoir recreation use are difficult to document due to imprecise record keeping, although Federal and state recreation managers readily acknowledge that use is increasing. The survey population did not include flatwater recreationists, but it can reasonably be assumed that a 2-hour travel time is also an applicable limit for most reservoir users.

5.2.2.3 Primary Study Area

Visitors to the lower Poudre Canyon find a variety of forested and rocky landforms, vegetation, wildlife, and scenery. The canyon provides a diversity of recreation activities and experience settings. Using characterizations which have been jointly developed by Federal and state agencies, Poudre Canyon recreation experience settings range from "roaded open country" settings (or areas having substantially modified natural landscapes with considerable evidence of other people) to "walk-in" settings (or areas having mostly natural landscapes with little evidence of other people). Complete definitions for these experience settings are provided in Appendix B, Table B.135. Due to the presence of the highway, several small communities and clusters of private homes, and water diversion and treatment structures, the lower Poudre Canyon is a substantially modified natural landscape with evidence of other people. The experience settings prevalent in the canyon are defined as areas where recreation management controls may be easily seen and visitors encounter a minimum of risk while encountering a considerable number of other recreational users. The principal recreation activities available in the lower Poudre Canyon include vehicle touring and sightseeing, fishing, hunting, camping, picnicking, hiking, and several forms of whitewater boating.

As described in more detail in Section 5.4.2.1, the Federal government is a principal landowner in the lower Poudre Canyon. The FS currently manages lands within the river corridor that are available and suitable for dispersed recreation activities. Recreation opportunities are also available on publicly-owned lands administered by other agencies, although these agencies do not have formal management plans for lands in the canyon.

The recreational opportunities within the primary study area are principally undeveloped and river-oriented in nature. Public access to the river for picnicking, angling, and whitewater use probably occurs as much at undesignated pull-outs along the highway as in developed state and Federal facilities. Information on existing resources and use patterns is provided in the following paragraphs for developed and dispersed recreation. Because dispersed recreation is dominant in the study area, and is particularly difficult to monitor, many of the figures presented in this section may not necessarily represent the full extent of recreational use.

Developed Recreation

Developed recreation facilities within the primary study area are managed by the FS and the CDPOR. FS facilities presently include the Ansel Watrous Campground, Poudre Park Picnicground and Diamond Rock Picnicground west of the community of Poudre Park, plus five private recreation cabins.[1] CDPOR operates the Upper and Lower Picnic Rock river access sites, located near the mouth of the canyon. Data on estimated 1987 use, measured in RVDs and visits, are presented in Table 5.5. Actual use reports for FS facilities during 1987 were not available. Consequently, 1987 use in these cases was estimated to be 5 percent above the 1986 level.

The Lower Picnic Rock river access site (RAS) is open to the public year around, although fees are only collected between May 15 and September 15. About 16,000 people are estimated to have used the area during the 1987 fee period and an additional 13,000 are estimated to have used the area during the non-fee period (Maurier, 1987a). The 30,800 total visitors account for an estimated 6400 RVDs of use. Lower Picnic Rock provides about 45 vehicle spaces, staging for whitewater boating, several picnic tables and fire grills, and a block vault toilet (but no water). No overnight camping is permitted, and the standard $3 daily use fee is charged during the fee period.

During peak river flow periods, Lower Picnic Rock is the primary staging area and take-out point for commercial rafting operations in the lower Poudre Canyon. Between April and September, commercial rafters are estimated to account for about 40 percent of the use, with kayakers representing another 10 percent (Maurier, 1987a). Angling and picnic use at the site increase as the peak river flows subside.

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(1) These facilities are owned by private residents but are located on land leased from the FS under special use permit. These cabins are not open to the public for recreational use, but private use of the cabins is commonly reported by the FS in its recreation statistics.

TABLE 5.5

Estimated 1987 Developed Recreation Use,
Primary Study Area

	RVDs		Visits	
	Annual Use	Percent of Total Use	Annual Use	Percent of Total Use
Lower Picnic Rock RAS	6,400	33	30,800	53
Upper Picnic Rock RAS	4,500	23	21,500	37
Greyrock Trailhead	---[1]	---	---	---
Private Recreation[2] [3] Cabins (5)	2,700	14	1,400	2
Ansel Watrous[3] Campground	4,700	24	400	1
Diamond Rock[3] Picnicground	600	3	2,400	4
Poudre Park[3] Picnicground	300	2	1,200	2
	19,200	100	57,700	100

1/ Use included in Table 5.6 on dispersed recreation.

2/ Privately owned facilities operated under special use permit, not available for public use.

3/ 1987 use assumed to be 5 percent higher than reported 1986 use.

Sources: Maurier, 1987a
FS, 1982-86

Annual use at Upper Picnic Rock is estimated to be about 70 percent of the use at Lower Picnic Rock, or slightly more than 20,000 visits and 4500 RVDs. No fee is presently charged at Upper Picnic Rock, but a fee structure will be instituted in the future (Maurier, 1988). Upper Picnic Rock is comparable to Lower Picnic Rock in terms of management and facilities provided, except that it has fewer vehicle spaces (about 30). Use trends for the Upper and Lower Picnic Rock sites could not be determined because records have been kept for only 2 years.

The three FS sites that are open to the public account for about 30 percent of the total use in the primary study area, as measured in RVDs. Ansel Watrous Campground is the first public campground west of the mouth of the canyon. It has 19 campsites, a water supply, and a parking area for fishermen. Overnight users are charged $6 per night. RIM reports indicate that this campground is open year round. Ansel Watrous received 5700 RVDs of use on average during the period of 1982 to 1986, but only 4700 RVDs have been estimated for 1987. Due to the long visit duration associated with camping, this use corresponds to only 400 annual visits.

The Diamond Rock Picnicground has seven spaces and a block vault toilet. No fees are charged to use the area. Use of Diamond Rock averaged a little more than 600 RVDs annually between 1982 and 1986, which is also the estimated level for 1987. Based on an assumed typical visit duration of 3 hours, this equates to 2400 annual visits. The small Poudre Park Picnicground is located just downstream from Diamond Rock. It has two picnic units and a toilet. Use for 1987 was estimated at 300 RVDs and 1200 visits.

Five private recreation cabins are located on National Forest land in the primary study area, two east of the Greyrock Trailhead bridge and three west of the bridge. Currently on year-to-year lease to private individuals, these homes may not serve as primary residences although they are open year around. Annual use for the five cabins was estimated at 2700 RVDs or 1400 visits for 1987.

The trailhead for the Greyrock Mountain National Recreation Trail is also located in the primary study area. While the trailhead itself is a developed facility, very little actual use occurs at the trailhead. Greyrock Trail use is therefore included under dispersed recreation.

Several new recreation facilities are proposed for development within the primary study area. Beginning in the summer of 1989, CDPOR plans to begin leasing a part of the City of Fort Collins filtration plant property, which is no longer being used for water treatment, to provide public access to the river (Maurier, 1988). Early phases of development will include a parking lot, toilet, and three boat launching spaces. Later phases may include conversion of settling ponds to fishing ponds for children and handicapped anglers, and construction of an environmental interpretation facility.

Proposals for a visitor information station have been discussed jointly by the FS, CDPOR, and CDOW (Maurier, 1988). This facility would be located across from the Upper Picnic Rock river access site. It would provide canyon visitors with information on recreational opportunities, facilities, and management in the canyon.

Dispersed Recreation

The primary study area offers a variety of dispersed activities. The primary activities include hiking, sightseeing, hunting, angling, and whitewater boating. Existing resources, opportunities, and use patterns for these activities are described in the following paragraphs.

The Greyrock Trail below the community of Poudre Park is designated as a national recreational trail by the FS. This trail is the only maintained trail in the primary study area, and represents virtually the entire hiking resource.[1] A moderately steep 7-mile round-trip hike, the trail loop is located in a walk-in experience setting for most of its length. At the top of Greyrock Mountain hikers are treated to spectacular views of the Rocky Mountains to the west and the Great Plains to the east. In addition to the vista from the top, the trail is very popular with local residents because it is close to Fort Collins, has a paved trailhead parking lot, and is generally open year round. The trail generates about 6500 RVDs of use annually or 19,500 visits, as indicated in Table 5.6.

Highway 14 parallels and is in view of the Poudre River almost the entire length of the canyon through the primary study area. Division of Highway (1982-1987) traffic counts show that the average annual daily traffic (AADT) through the primary study area was about 1700 vehicles in 1987. Traffic volume has fluctuated within a range of about 300 AADT, from 1400 to 1700 AADT, over the past 5 years. It is assumed that 80 percent of the traffic occurs in daylight hours, and passenger cars account for 70 percent of all traffic. Using Walsh and Gilliam's (1982) estimate of the recreational traffic component of total passenger traffic, an annual average of more than 300 cars per day use the highway for sightseeing. FS recreation data indicate that this corresponds to about 207,000 annual sightseeing visits.

Big game hunting for deer, elk, and antelope occurs near the North Fork of the Poudre. Accurate figures on use specific to this area are unavailable. However, based on the areal proportion of accessible land in the primary study area compared to the area within big game units 19 and 101, as reported previously, use in 1987 is estimated at 100 RVDs. Small game and upland bird hunting undoubtedly also occurs in the area, although in small numbers. Nonconsumptive forms of wildlife appreciation also occur in the canyon, but estimates of use are not reported by the managing agencies.

Other forms of dispersed recreation are water-based and depend very much on the flow level in the Poudre, particularly angling and whitewater boating. Table 5.7 describes the mean annual number of days per month that the river is within given flow ranges, as measured at the USGS gaging station at the mouth of the canyon from 1962 to 1986. This 25-year period of record includes several relatively high-flow years in the mid-1980s, and was the most up-to-date flow data available at the time interview and survey results were analyzed.

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(1) The "Winterseen Trail" is shown on various maps as extending east from the Greyrock Trail. Forest Service personnel indicate this is an old trail that has not been maintained for some time (Rankin, 1988). While officially closed, it probably receives some unreported use.

TABLE 5.6

Estimated 1987 Dispersed Recreation Use,
Primary Study Area

	RVDs		User Visits	
	Annual Use	Pct Total Use	Annual Use	Pct Total Use
Angling	1,600	3	4,700	2
Hiking	6,500	14	19,500	8
Hunting	100	0	100	0
Picnicking	100	0	400	0
Sightseeing	37,400	80	207,000	87
Whitewater Boating	1,000	2	6,000	3
	46,700	100	237,700	100

Sources: CDOW, 1988a
CDOW, 1985
CDPOR, 1987
FS, 1982-1986

TABLE 5.7

Poudre River Flows
Mean Days Per Year in Specified Range(1)
(Measured at Canyon Mouth Gauge)
1962 through 1986

Flow Range	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
0 - 250 cfs	30.8	28.1	30.7	27.1	6.7	0.4	4.4	15.8	28.1	30.1	29.7	30.8	262.7
251 - 500 cfs	.2	.2	.2	1.3	7.1	1.3	6.9	10.1	1.8	0.8	0.3	0.2	30.4
501 - 750 cfs	.0	.0	.1	.5	4.6	2.2	6.0	3.9	.2	.1	.0	.0	17.6
751 - 1000 cfs	.0	.0	.0	.4	3.0	2.8	5.1	1.0	.0	.0	.0	.0	12.3
1001 - 1250 cfs	.0	.0	.0	.1	2.5	4.1	3.2	.0	.0	.0	.0	.0	9.9
1251 - 1500 cfs	.0	.0	.0	.2	2.4	4.0	2.0	.1	.0	.0	.0	.0	8.7
1501 - 1750 cfs	.0	.0	.0	.4	1.0	3.2	1.4	.0	.0	.0	.0	.0	6.0
1751 - 2000 cfs	.0	.0	.0	.0	.8	3.5	.7	.0	.0	.0	.0	.0	5.0
2001 - 2250 cfs	.0	.0	.0	.0	.9	2.6	.6	.0	.0	.0	.0	.0	4.1
2251 - 2500 cfs	.0	.0	.0	.0	.8	1.3	.2	.0	.0	.0	.0	.0	2.3
2501 - 2750 cfs	.0	.0	.0	.0	.3	1.2	.1	.0	.0	.0	.0	.0	1.6
2751 - 3000 cfs	.0	.0	.0	.0	.2	1.3	.0	.0	.0	.0	.0	.0	1.5
3000+ cfs	.0	.0	.0	.0	.6	2.2	.4	.0	.0	.0	.0	.0	3.2

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(1) Bold type signifies approximate extent of flow sufficiency for whitewater rafting.

Source: USGS, 1987

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Flows at this gaging location have been reduced by water taken out of the river at three diversions within approximately 5 miles upstream of the gaging station. Consequently, these flow data were measurably below flows in the upstream sections of the river.

Angling is very popular along the river through the primary study area. About 4.3 miles of the river from the Monroe Diversion (about 3.5 miles downstream of Poudre Park) to the Poudre Valley Canal headgate (near Lower Picnic Rock) have been designated as wild trout water, and can be fished with artificial lures and flies only. A creel census by the Division of Wildlife estimated that about 5800 hours (480 RVDs) of fishing occurred on this stretch in 1984 (CDOW, 1985). Of the five sections included in the creel census, angling use of this stretch was exceeded only by the use on the river segment between Mountain Park Campground and the Pingree Park Road. However, the total catch for the lower section of the canyon was the smallest of the five sections of the river studied. Brown and Frey (1988) reported that more and larger rainbow trout are caught in this section compared to other upstream sections, but fewer and smaller brown trout. Angling on the North Fork of the Poure in the primary study area presently is not allowed.

Assuming an average visit duration of 4 hours, the CDOW creel census data indicate 1450 visits during 1984 on the lower wild trout section of the Poudre. Fishing activity can vary significantly with streamflow conditions and other factors from year to year. Consequently, it is not known whether 1984 represents a typical year. To account for such variations and possible growth in use since 1984, 2000 visits is assumed to be the typical annual level for the 4.3 miles of wild trout water from the Monroe Diversion to the Poudre Valley Canal. Due to lack of developed access, essentially no angling use is assumed to occur downstream of the Poudre Valley Canal or on the North Fork. For purposes of this analysis, per-mile use of the remainder of the river from the western study area boundary to the Monroe Division is assumed to be at 75 percent of the wild trout use level. Consequently, typical annual angling use is estimated at about 1300 visits on the 3.7 miles of river from Poudre Park to the Monroe Diversion, and 1400 visits on the 4 miles of river above Poudre Park. This results in a total of 4700 annual visits or 1600 RVDs in the entire primary study area, of which 3300 visits or 1100 RVDs occur between Poudre Park and the Poudre Valley Canal.

The recreation field survey indicated that the most important reason that the anglers surveyed chose this section of the river was convenience and accessibility (61 percent), followed by satisfaction with the level of river flow (14 percent). Anglers using the Poudre River below the Fort Collins water filtration plant who were contacted during the 1988 season preferred flows in the vicinity of 485 cfs.[(1)] This is very comparable to results of a prior study for the river which found that the optimum willingness-to-pay of anglers occurred at 500 cfs (Daubert and Young, 1982). Historically, the river flow has been between 250 and 750 cfs for about 45 days per year. This generally occurred from mid-July to mid-May.

Based on FS records, about 900 RVDs of whitewater boating occurred on the lower Poudre in 1987 (FS, 1988b). About 5,000 to 6,000 service days (visits) of commercial river running use are recorded annually by permitted outfitters on the lower Poudre (see Table 5.8). There are presently six commercial whitewater outfitters offering both half and full day rafting trips. Estimates are that between 70 and 80 percent of the commercial use occurs on the 2.8 mile "Filter Plant" run below the inactive Fort Collins water treatment plant, with the remainder estimated to be relatively evenly divided between the 2.3 mile "Bridges" (or "Pineview") run below Poudre Park and the 4.0 mile "Lower Mishawaka" run starting at Mishawaka. Very little commercial use (about 25 days) occurs above the Lower Mishawaka run. Noncommercial use of these river sections by private rafts and kayaks is estimated to be about 5 to 10 percent of the total boating use. About 60 percent of the total commercial rafting use and 90 percent of the noncommercial use occurs on weekends. Peak hours on the river are between 10 a.m. and 2 p.m.

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(1) Based on regression analysis of survey responses with $r^2 = .337$, $p < 0$.

Commercial river outfitters and guides were also interviewed as part of these studies separate from the field survey. They reported that the level of water in the river and the timing of river flows were the first and second most important considerations in offering their services. River flows affect the level of risk and challenge by changing the frequency and difficulty of rapids, and also affect the amount of time required to float a given section. Table 5.9 indicates the difficulty classes for three key

TABLE 5.8

Commercial Whitewater Boating Use in Lower Poudre Canyon, 1985-1987

	Service Days					
	1985		1986		1987	
Outfitter	Lower Section (1)	Upper Section (2)	Lower Section (1)	Upper Section (2)	Lower Section (1)	Upper Section (2)
Adrift Adventures	200	200	1003	405	714	1455
Adventure Quest	283	717	788	788	190	299
Boulder Outdoor Center	19	19	0	89	0	150
Estes Park Adventures	2500	6	1928	200	1582	0
Wanderlust Adventures	150	15	579	7	290	12
Wildwater (Discovery)	100	138	479	451	83	862
	3252	1095	4777	1940	2859	2778

(1) Lower section corresponds to Filter Plant run.

(2) Upper section includes Upper and Lower Mishawaka and Bridges runs, plus short sections in Narrows area.

Source: FS, 1988b

TABLE 5.9

Classes of Most Difficult Rapids(1) in Primary Study Area by Flow Range

Flow Range	River Sections, Rapids Class: Filter Plant	Bridges	Lower Mishawaka
0 - 250 cfs	II	II	II
251 - 500 cfs	II	II	III
501 - 750 cfs	II	III	III
751 - 1000 cfs	II	III	III
1001 - 1250 cfs	II	III	III
1251 - 1500 cfs	II	III	IV
1501 - 1750 cfs	II	III	IV
1751 - 2000 cfs	II	IV	IV
2000+ cfs	III	IV	IV

(1) Whitewater is rated universally on a difficulty scale of I-VI with specified rating criteria. The international whitewater rating system classifications are as follows:

Class I: Still or moving water with few (if any) riffles or obstructions.

Class II: Small rapids with waves up to 3 feet high and obvious clear channels not requiring scouting.

Class III: Powerful rapids with waves up to 5 feet high. Some maneuvering required to avoid obstacles. (Generally speaking, Class III is the upper limit for commercial rafting, except in very large, wide-open rivers, and Class III is the upper limit for open canoes except in very rare circumstances.)

Class IV: Long, difficult rapids requiring intricate maneuvering in turbulent water. Scouting often necessary. Rescue difficult.

Class V: Extremely difficult, extremely violent rapids, requiring difficult and precise maneuvering to avoid numerous serious obstacles. Rescue difficult at best and impossible at worst. The Class V designation is reserved for those rapids which only a tiny minority of paddlers can run safely (or at all).

Class VI: The most extreme whitewater. This classification is generally synonymous with unrunnable. (In Europe, it is common practice to downgrade a rapid from Class VI to Class V if someone succeeds in running it.)

Sources: Anderson and Hopkinson, 1987.
Tierney, 1988.

Poudre segments at various flow intervals. The outfitters collectively identified river flows of about 2400 cfs to be ideal, but felt that flows near 1900 cfs would still provide 100 percent of their rafting utility. The guides felt that flows below about 650 to 675 cfs offered no utility.

The survey results suggested that the principal reason commercial rafting passengers chose the Poudre was because it offered the best local site for the activity (38 percent of respondents). The water level in the river was cited as the primary reason for use by 31 percent of the respondents. River users were also asked to rate their degree of satisfaction with the river flow level at the time of their boating experience. The satisfaction responses were then linked with the actual river flows for the respective survey days. Regression analysis of these results ($r^2 = .67$; $p < .18$) produced a utility curve indicating that passengers would achieve 100 percent satisfaction at flows of about 2200 cfs. This analysis assumed that there was a linear relationship between increasing flow and satisfaction.

Kayakers included in the general survey responded that they chose their section of the river primarily because of flow levels (41 percent) and secondarily because it was the best local site for the activity (37 percent). Regression analysis ($r^2 = .34$; $p < .18$) of their perceptions of river flows, using the approach described above for rafting passengers, indicated that they would prefer flows in the area of 1850 cfs.

Historically, flows exceed 2000 cfs an average of about 13 days per year and exceed 1500 cfs less than 20 days per year (see Table 5.7). Flows exceeding 1000 cfs historically occur on about 42 days per year, on average. Comparing the historical flow data with the apparent preferences revealed through interviews and the survey indicates that actual flows are below ideal conditions during most of the whitewater season.

Analysis of the interviews with the six commercial whitewater outfitters indicated that the flow level providing the minimum utility was about 675 cfs. Consequently, this flow volume is considered to be the minimum flow necessary for rafting use, below which no rafting would occur. By this measure, interpolating the data from Table 5.7 indicates that there are an average of about 60 days per year on which rafting is possible. Extrapolation of the survey responses from kayakers suggests that the minimum usable flow for kayaking is about 250 cfs. Therefore, historical flows provide an average of about 100 usable days per year for kayaking.

The Poudre is a river which tends to separate users quite well on the basis of flows and provides opportunities appropriate for most users. Due to their respective desires for different flow levels, there is generally little competition and conflict among anglers and whitewater boaters because they prefer to use the river during different periods. Anglers tend to stop using the river when flows exceed 750 cfs, and commercial whitewater outfitters usually operate only when flows are near or above 750 cfs. Water clarity is also worst during the peak flow seasons, which further discourages fishing at times when most rafting occurs. The minor conflicts that do exist primarily result among anglers and kayakers, who use the river at much lower flow levels than commercial boaters.

5.2.3 Project Effects

Development of Stage 1 of the Cache la Poudre Project would have some adverse effects on existing recreation opportunities and activities without compensating mitigation. Depending upon user response and the nature of recreation development associated with the project, the project would also have positive effects through provision of new developed facilities and flatwater recreation opportunities. The following material describes the project effects that can be identified at this level of project planning. The effects are described with respect to the direction and magnitude of change from baseline conditions, but not the significance of these changes.

The effects assessment is divided into two main components: direct and indirect effects of the proposed project. Direct effects are those resulting directly from the displacement of existing recreation activities, primarily through replacement of a stream environment with a reservoir environment. Direct effects would occur, at least initially, within the primary study area. Indirect effects are from diminished utility of recreation activities downstream or in adjacent areas due to environmental changes resulting from the project. Indirect effects can also include off-site changes attributed to users displaced by the project. Indirect effects would generally occur outside of the primary study area but within the secondary study area. The distinction between direct and indirect effects is made purely for analytical and organizational purposes and does not to connote any less significance for indirect effects.

Section 5.2.3 is organized to separately address effects from the Grey Mountain and Poudre project configurations. In most cases, the effects for the two alternatives are very similar; therefore, the Poudre alternative is generally discussed in terms of incremental differences.

The effects discussed in this section are those that would occur without implementation of mitigation measures. Adverse effects of the project can be significantly reduced through the potential mitigation measures described in Section 5.2.4. The conclusions from Section 5.2.3 should therefore be considered to address gross effects. Potential net project effects after mitigation are discussed in Section 5.2.4.

5.2.3.1 Direct Effects

Several existing recreation opportunities would be displaced by development of a mainstem reservoir on the Cache la Poudre River. A number of activities that presently occur in the primary study area are dependent upon or closely oriented to the river. Transformation of the existing riverine recreation setting to a reservoir environment would preclude some of the activities that currently take place on or near the river, particularly stream angling and whitewater boating. Some other activities would be shifted to other locations, possibly along the new reservoir shoreline, or changed somewhat in character. These types of effects are described in the following paragraphs for the Grey Mountain and Poudre configurations of the proposed project. Effects on both developed and dispersed recreation are discussed. However, because dispersed uses are dominant in the directly affected area, most of the discussion addresses the key individual dispersed activities.

Grey Mountain Alternative

Developed Recreation.

The Grey Mountain Reservoir would inundate the existing Greyrock Mountain Trailhead. Other existing developed facilities in the primary study area, including the Picnic Rock access sites and the campground and picnic areas above Poudre Park, are beyond the inundation or construction zones and would not be directly affected. The Fort Collins filter plant site, where CDPOR proposes to develop a river access facility in 1989, is within the inundation zone. Assuming the facility is developed in the relatively near future, it would be displaced by the Grey Mountain alternative. This proposed facility would initially be similar in nature to the Picnic Rock access sites, and would include parking areas, picnic tables, a water supply, and an office and education center (Maurier, 1988). Plans for subsequent development include more parking and picnic sites, fishing access, vault restrooms, and construction of a pier for use by the handicapped. Implementation of these plans can be considered more speculative or distant in the future than the initial development proposal.

The Greyrock Mountain Trailhead facility consists of a parking lot, footbridge across the river, and trailhead register and information sign. These facilities would need to be replaced or relocated at another suitable site, as described in Section 5.2.4. Although little direct use occurs at the trailhead, the trail and a trailhead support an estimated 19,500 annual visits and 6500 annual RVDs. Once the trailhead is relocated and users become acquainted with the new location, trail use should be the same as pre-project levels. Hiking activity on the Greyrock Trail would be temporarily displaced during the period of trailhead reconstruction. It is assumed that at most one year of hiking use would be lost due to reconstruction; careful scheduling of trailhead reconstruction early in the project could avoid any significant temporary displacement.

Current recreation activity at the five private recreation cabins is presumed to be a long-term loss. Throughout the national forest system, such private recreation cabins are generally artifacts of old development practices that have long been discontinued. The forest plan does not explicitly prescribe management direction for existing recreation cabins, but it does indicate that special uses for wholly private purposes will not be encouraged (FS, 1984). It is therefore highly likely that the inundated cabins would not be relocated or rebuilt elsewhere on comparable sites. The five cabins account for approximately 1400 annual visits and 2700 RVDs, which would be a net loss to the project.

Dispersed Recreation.

Dispersed use would be affected through changes in recreation experience settings and displacement of dispersed recreation activities. The Grey Mountain Reservoir would inundate about 1650 acres of land and the existing Seaman reservoir. Approximately two-thirds of this acreage (1130 acres) provides a roaded open country recreation experience setting, while most of the remaining one-third (510 acres) is in the walk-in classification. Inundation zone acreages and approximate river mileages within the various recreation settings are summarized in Table 5.10. While the proposed reservoir would inundate areas of existing experience settings, the project would not represent a direct 1:1 loss of area within these settings. Because Highway 14 would be relocated in a similar alignment roughly parallel to the existing route, the project would effectively shift the roaded open country zone along the south side of the proposed reservoir uphill from its current location. This would convert some existing four-wheel[1] acreage into the roaded open country classification. Consequently, the net direct effect of the reservoir would probably be concentrated in the walk-in and four-wheel settings. The ultimate effect of the project on recreation settings would depend largely on the future management of the project reservoir, which is discussed in Section 5.2.3.2 with other indirect effects.

The principal dispersed recreation activities occurring in the primary study area are hiking, hunting, picnicking and general day use, sightseeing, angling, and whitewater boating.

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(1) The term "four-wheel" refers to the recreation experience setting classification and not necessarily to actual managed uses.

TABLE 5.10

Recreation Settings Within Inundation Zone,
Grey Mountain Alternative

	Highway Rural	Roaded Open Country	Four Wheel	Walk-in	Total
Land acres	10	1050	0	420	1480
Water acres 1/	0	80	0	90	170
Total	10	1130	0	510	1650
River Miles	0.5	7.0	0	5.5	13.0

1/ Existing Seaman Reservoir.

Source: Estimated by ORRA by applying recreation setting definitions to study area lands, and superimposing reservoir location.

Potential temporary displacement of hiking 100 RVDs or 100 visits annually (see Table 5.6). Little hunting is likely to occur on the lands that would be inundated by the Grey Mountain Reservoir, due to difficult access to the North Fork area and the proximity of the highway, residences, and other users along the mainstem area. It is therefore assumed that 10 percent of existing hunting use in the primary study area, equivalent to 10 annual RVDs and visits, would be displaced through development of the Grey Mountain Reservoir. This level of displacement is clearly a minor effect, and would not raise associated concerns over crowding in alternate areas used by the dispersed hunters.

Dispersed picnicking and general day use at informal recreation sites in the primary study area are also relatively low-intensity uses. Total activity of these types within the primary study area was estimated at 400 annual visits or 100 RVDs. Most or all of this activity is likely to occur at the informal Hole-in-Wall or Mad Dog Rapids site, just upstream of the Grey Mountain damsite, and at several sites between Poudre Park and the activity was discussed previously with respect to the Greyrock Mountain Trail. Hunting activity in the entire primary study area was estimated at filtration plant. Because all of these sites are within the Grey Mountain inundation zone, it is conservatively assumed that all of this activity would be displaced. However, it is quite possible that similar sites could be created or would develop over time where the relocated highway is close to the reservoir shoreline.

Project effects on sightseeing are more difficult to estimate because the precise nature of the attraction for these users is uncertain. If sightseers using the primary study area were visiting the area specifically to view the river and canyon scenery along this stretch of the Poudre, some reduction in sightseeing activity could reasonably be projected due to the alteration of this scenery by the project. Considering the many miles of both winding canyon and mountain valley scenery above Poudre Park, it is probable that a very large percentage of sightseers regard the lower canyon as only part of their overall recreational experience, and are passing through the area on their way to additional viewing opportunities further up the canyon. Further, the primary adverse visual effect of the project would be of limited viewing duration near the dam, while the reservoir would create additional visual variety. Consequently, the level of sightseeing activity on Highway 14 is not expected to be adversely affected by the project, although the value of the experience would likely be diminished somewhat for the most sensitive viewers. This conclusion is contingent upon proper relocation of Highway 14 with attractive vistas and maintenance of a reasonably full pool during the primary sightseeing periods. The quality of the sightseeing experience would decrease if these conditions did not occur, and some users could actually choose to avoid the area.

Due to their level of use and relationship to the project, the key recreation activities are angling and whitewater boating. As indicated in Table 5.10, the Grey Mountain Reservoir would inundate about 6.5 miles of river along the mainstem, virtually all of which is currently open to access and used for angling. A new fishery would no doubt be established in the project reservoir, but many anglers strongly prefer coldwater stream angling. Angling use in the primary study area below Poudre Park was estimated at 3300 visits and 1100 RVDs annually (see Table 5.6), although the distribution of this use along the river is not known with certainty. The 6.5 miles of river that would be inundated by

Grey Mountain Reservoir include about 65 percent of the wild trout water between the Monroe Diversion and the Poudre Valley Canal together with essentially all of the undesignated water from Poudre Park to the Monroe Diversion. Applying these percentages to existing angling use in the respective stream sections, the Grey Mountain alternative could be expected to displace up to about 2600 stream angling visits and 650 RVDs annually. Additional effects could occur through streamflow changes, as addressed under indirect effects.

Analysis of whitewater boating effects must be performed separately for the different segments of the river that are currently used for boating. The Grey Mountain alternative would clearly displace all whitewater use on the 2.3 mile Bridges run below Poudre Park. This river section accounts for an estimated 10 to 15 percent of total whitewater use in the primary study area, or 750 visits and about 125 RVDs annually (using a mid-range share of 12.5 percent).[1] The Bridges run is used by commercial outfitters, private rafters, and kayakers.

The Grey Mountain Reservoir would also inundate the upper half of the 2.8-mile Filter Plant run, from the Fort Collins inactive water filtration plant to Lower Picnic Rock. It is assumed that all commercial whitewater use (90 percent of total use) on this section would be displaced, as it would no longer be economically feasible for outfitters to offer 1.4-mile trips. This activity is estimated at 4050 visits and about 675 RVDs per year. Some private kayaking and rafting use would also be displaced, although some of these users would probably continue to use the shortened run due to its convenience and accessibility. For purposes of analysis, it is assumed that half of the private whitewater use, amounting to about 225 visits and 40 RVDs annually, would be displaced. Overall, 4300 annual visits (rounding upward) and 715 RVDs of commercial and private whitewater use of the Filter Plant run would be displaced.

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(1) To reflect the level of precision of the available use data, most estimates of existing visits and RVDs have been rounded to the nearest 100. Application of various percentages to these baseline figures to estimate displaced use results in proportional numbers in smaller increments, but this does not connote any greater precision.

Combined with the Bridges run, the total whitewater displacement effect is estimated at 5050 visits and 840 RVDs of use annually. This is more than 80 percent of current annual whitewater use in the primary study area. This displaced use may or may not be a net loss, depending on the response of the users and potential project mitigation measures. These aspects are discussed subsequently in Sections 5.2.3.2 and 5.2.4.

The direct effects of the Grey Mountain alternative on existing recreation activities are summarized in Table 5.11. The first two columns indicate changes in the number of RVDs and visits attributable to the project, as described previously in the text. Because one of the specific objectives of the present recreation studies was to quantify the economic value associated with changes in recreation use, the latter two columns address unit and aggregate values for each activity. The unit values per visit were selected as the most appropriate figures from the empirical research results reported in Walsh et al. (1988), updated to 1987 price levels and rounded to the nearest dollar. The annual value entries result from multiplication of the annual visits by the corresponding unit values.[1]

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(1) The authors elected to base value estimates on visits and unit values per visit, rather than on RVDs and RVD unit values. This is primarily because empirical results from most of the research in this subject area are reported in visit, activity day, or activity occasion units that represent participation during any part of a day, rather than for a specified length of period (the 12-hour RVD). Selection of the most appropriate unit values from a comprehensive review of such empirical data also provided a good locational and activity fit. This approach was considered preferable to the alternative, which would be the use of the programmatic region-specific unit values from the Forest Service RPA process.

TABLE 5.11

Direct Effects on Recreation Use, Grey Mountain Alternative

Resource/ Activity	Displaced Annual Use in RVDs	Displaced Annual Visits	Unit Value Per Visit[4]	Annual Value [5]
Developed Recreation				
Private Recreation Cabins[1]	2,700	1,400	$ 3.00	$4,200
Dispersed Recreation				
Angling	650	2,600	15.00	39,000
Hiking	6,500[2]	19,500[1]	16.00	312,000
Hunting	10	10	50.00	500
Picnicking	100	400	19.00	7,600
Sightseeing	0	0	--	
Whitewater Boating	840[3]	5,050[3]	19.00	95,950
	10,800	28,960		$459,250

(1) Privately owned facilities operated under special use permit, not available for public use.

(2) Project would inundate developed trailhead access site. Trailhead would require relocation, causing temporary displacement. Effect would be for at most one year.

(3) Project would inundate 3.7 miles of floatable river and existing put-in site.

(4) Selected from the unit values reported in Walsh et al., 1988 that are most representative of the recreation opportunities found in the study area. Walsh et al. provide a review of numerous empirical studies of unit values attributed to specific activities by recreationists, based on travel cost or contingent value (willingness to pay) methods. Unit values represent consumer surplus, the average value to the user net of actual participation costs. Reported figures have been escalated to 1987 dollars, using the GNP deflator, and rounded to the nearest dollar.

(5) Annual value figures result from multiplication of the number of visits for each activity by the unit value for that activity.

The total change indicated in Table 5.10 is an estimated annual initial loss of 10,800 RVDs and 28,960 visits. Based on the unit values per visit, this would represent an aggregate value of $459,250. However, this figure represents a maximum one-year loss, and not a recurring event, due to the inclusion of the hiking figures. Approximately 67 percent of the displaced visits and use value stems from the closure of the Greyrock Mountain Trailhead, which would be at most a 1-year event. It is very possible that this one-time loss would be much less than 19,500 visits with careful scheduling of trailhead reconstruction. The recurring annual displacement for this alternative would therefore be 9460 visits and $147,250. These figures represent initial displacement and gross losses attributable to the project. Net displacement and loss levels would depend upon user response and mitigative measures, as discussed in subsequent sections.

Poudre Alternative

Developed Recreation.

The direct effects of the Poudre alternative would be the same as the Grey Mountain alternative with respect to developed facilities. The Poudre Reservoir would also inundate the five FS recreation cabins, resulting in a permanent loss of 1400 visits and 2700 RVDs. The planned CDPOR Filter Plant river access site would also be inundated if it were developed prior to Stage 1 of the project.

Dispersed Recreation.

The current Greyrock Mountain Trailhead would be inundated by the Poudre Reservoir, potentially resulting in a 1-year loss of up to 19,500 hiking visits and 6500 RVDs. Visual differences between the two alternatives occur only because of location, and no change in effect on the level of sightseeing use is projected for the Poudre alternative.

Development of the Poudre site would result in a smaller total acreage loss, by 340 acres. The distribution of inundation zone acreage by recreation setting is indicated in Table 5.12. Compared to the Grey Mountain alternative, the acreage differential for the Poudre alternative is all in the roaded open country category. As indicated previously, however, the relocation of Highway 14 would lead to a shift in the roaded open country zone and a net loss of acreage with a walk-in setting.

TABLE 5.12

Recreation Settings
Within Inundation Zone,
Poudre Alternative

	Highway Rural	Roaded Open Country	Four Wheel	Walk-in	Total
Land acres	10	710	0	420	1140
Water acres [(1)]	0	80	0	90	170
	10	790	0	510	1310
River Miles	0.5	5.5	0	5.5	11.5

(1)Existing Seaman Reservoir.

Source: Estimated by ORRA by applying recreation setting definitions to study area lands, and superimposing reservoir location.

The land area between the Poudre and Grey Mountain damsites is close to the highway and two residences and is not likely to be used for hunting; therefore, the same level of hunting displacement has been assumed for the Poudre alternative. As indicated previously, this amounts to an estimated 10 annual visits and 10 RVDs.

The Poudre alternative would probably have less direct effects on dispersed picnicking, angling, and whitewater boating than the Grey Mountain alternative, due to the inundation of fewer miles of river. The Poudre Reservoir would inundate about 5 miles of the mainstem, or about 80 percent of the river mileage directly affected by the Grey Mountain Reservoir. In the absence of reliable data on the precise geographic distribution of users within the primary study area, this percentage has been applied to the Grey Mountain displacement effects on dispersed picnicking to estimate the effects from the Poudre alternative. Consequently, the Poudre Reservoir would be expected to displace 320 picnicking visits or 80 RVDs.

The Poudre alternative would inundate about 1.3 miles of wild trout water compared to 2.7 miles for the Grey Mountain alternative. Based on average per-mile use levels, this would correspond to 600 annual angling visits in the wild trout section. Combined with use of the river between Poudre Park and the Monroe Diversion, the total angling displacement would be an estimated 1900 visits and 630 RVDs.

Direct effects of the Poudre alternative on whitewater boating would be significantly less than those of the Grey Mountain alternative. The Poudre Reservoir would inundate the Bridges whitewater run, which would represent long-term displacement of approximately 750 annual visits and 125 RVDs. However, the Poudre alternative would leave the Filter Plant run essentially intact. The boating put-in site that CDPOR plans to establish at the existing water filtration plant location would not be available for future use, but the existing put-in sites and the 2.8-mile river section currently used for boating downstream of the Poudre damsite would be unaffected. It is therefore assumed that the existing whitewater use of the Filter Plant run would not be directly displaced by the Poudre alternative.

While continued full use of the Filter Plant run would be physically possible (irrespective of potential flow changes discussed in Section 5.2.3.2), it is conceivable that there would be some quantitative and qualitative changes in use. Some current boaters could choose not to use the Filter Plant run, or to use it less frequently, because they prefer not to start their river experience at the base of a dam. There is no current basis for predicting whether this would happen and assigning a numerical or percentage value to such a response. Convenience is a significant factor in use of this run and this factor would not change with development of the Poudre site. Whitewater user studies indicate that once on the water, users are more concerned with the boating experience than with their external surroundings (Maurier, 1987b). Further, some degree of development and visual modification is already apparent along the Filter Plant run, particularly near the put-in points. Given these considerations, it is expected that few boaters would stop or decrease their use due to the localized setting change caused by the Poudre alternative.

Although the Poudre alternative would not be expected to measurably change the level of use of the Filter Plant run, the quality of the recreation experience would probably be marginally decreased for some users. Again, this would be due to starting the boating experience at the base of a dam. Users who are highly sensitive to environmental modifications would register some degree of offense or displeasure at the presence of the dam. The intensity of this response would vary among individual users, as would the duration. However, the frequency and extent of this type of response is unknown, and these qualitative effects have not been incorporated into the measurement of project effects.

The direct effects of the Poudre alternative on all existing recreation activities are summarized in Table 5.13. The total change indicated in the table is an estimated initial annual displacement of 23,880 visits. This corresponds to 10,045 annual RVDs of use and an aggregate value of over $365,000. As for the Grey Mountain alternative, temporary displacement of hiking on the Greyrock Mountain Trail accounts for a very large proportion (over 80 percent) of the affected activity. Exclusive of this temporary change, the recurring annual effect would be 4380 visits valued at over $53,000.

A comparison of the direct recreation effects of the Grey Mountain and Poudre alternatives is provided in Table 5.14. Due to the heavy influence of the temporary potential hiking displacement, the effects for each alternative are presented with and without hiking effects. Including a 1-year hiking loss, the Grey Mountain alternative would displace nearly 29,000 annual visits compared to about 24,000 visits for the Poudre alternative. This represents a difference of over 5000 visits. Exclusive of hiking, the same differential would apply to the displacement of about 9500 visits for Grey Mountain versus 4400 for Poudre. In percentage terms, the Grey Mountain alternative would displace more than twice as many nonhiking visits as would the Poudre alternative. The annual economic value for directly affected recreation between the two projects is nearly $94,000. From Tables 5.10 and 5.12, it can be seen that the difference in effects on whitewater boating accounts for nearly 85 percent of the overall projected difference between the two alternatives.

TABLE 5.13

Direct Effects on Recreation Use,
Poudre Alternative

Resource/ Activity	Displaced Annual Use in RVDs	Displaced Annual Visits	Unit Value Per Visit[4]	Annual Value [5]
Developed Recreation				
Private Recreation Cabins [1]	2,700	1,400	$ 3.00	$4,200
Dispersed Recreation				
Angling	630	1,900	15.00	28,500
Hiking	6,500	19,500 [2]	16.00	312,000
Hunting	10	10	50.00	500
Picnicking	80	320	19.00	6,080
Sightseeing	0	0	--	0
Whitewater Boating	125 [3]	750 [3]	19.00	14,250
	10,045	23,880		$368,530

(1) Privately owned facilities operated under special use permit, not available for public use.

(2) Project would inundate developed trailhead access site. Trailhead would require relocation, causing temporary displacement. Effect would be for at most one year.

(3) Project would inundate 2.3 miles of floatable river.

(4) From Walsh et al., 1988. See previous discussion in text and Table 5.11.

(5) Annual value figures result from multiplication of the number of visits for each activity by the value for that activity.

5.2.3.2 Indirect Effects

Four key types of potential indirect effects on recreation resulting from development of the Cache la Poudre Project have been identified as a result of the Task 14 studies. One set of effects involves the off-site consequences caused by displaced users redirecting their recreational activities to alternative locations. Secondly, it is possible that the displacement of some current users would lead to use changes in nearby developed facilities not directly affected by the project, due to interaction patterns between different areas. The third kind of indirect effect includes qualitative or quantitative changes in downstream use attributable to project changes in the streamflow regime. Finally, indirect effects on future recreation opportunities and use patterns could result from the changes in experience settings caused by the project reservoir and its management. These indirect effects are described below for the Grey Mountain and Poudre alternatives.

Grey Mountain Alternative

Off-Site Effects of Displaced Uses

Users displaced by construction of the Grey Mountain alternative would include cabin lessees, anglers, hikers, hunters, picnickers, and whitewater boaters. Displaced users in these groups could react or be indirectly affected in several different ways.

TABLE 5.14

Comparison of Direct Recreation Effects, Grey Mountain and Poudre Alternatives

	RVDs	User Visits	Annual Value
Grey Mountain			
Total	10,800	28,960	$459,250
Excluding Hiking	4,300	9,460	$147,250
Poudre			
Total	10,045	23,880	$365,530
Excluding Hiking	3,545	4,380	$53,530
Difference			
Total	755	5,080	$93,720
Excluding Hiking	755	5,080	$93,720

At one extreme, a given individual or group of users could have an abundant choice of alternate locations for their chosen activity that would be perfect substitutes for study area recreation sites displaced by the project.

In such cases, the users could reasonably be assumed to shift their activity to new locations, at no net loss in their individual satisfaction or the aggregate level of activity. (This applies only when perfect substitutes are available.) At the other extreme, if no acceptable substitute locations existed the affected users would cease their activity and redirect their effort into other pursuits. This would result in a decrease in individual satisfaction and a net loss in the aggregate use level for this activity. An essentially continuous range of possible outcomes, representing various degrees of limitation on the availability of suitable substitute locations, would exist between these extremes.

Assessment of the secondary effects of displaced recreation activity must also consider conditions and users at the alternate locations, in addition to the displaced users themselves. The primary concern in this case would be whether additional use in the alternate locations would cause crowding and/or resource damage, which would decrease the quality of the experience for both new and existing users. This aspect of the displacement issue has been noted in the following discussion, although a thorough investigation of this issue for each activity and resource area was beyond the scope of the present studies.

Displaced Poudre recreation cabin users would face an extremely limited set of alternatives that are closely comparable to their existing resource. This is because the supply of private recreation cabins on National Forest land is relatively limited, compared to the total supply of recreation cabins and summer homes, and is not being increased. Assuming that existing policies would prevent relocation of the cabin users, they would be forced to replace their current opportunities through the private market. Specific options facing these users would include purchasing or constructing a second home, securing substitute lease arrangements for a privately owned unit, or renting a comparable unit for a given period of the year. The existing use data indicate that each cabin receives an average 280 visits per year. At an occupancy rate of 4 persons per visit, this would equate to 70 annual days of use per cabin. Renting would therefore not be a viable option unless the users decided to accept a much lower level of annual use.

A thorough inventory of alternatives available to the cabin users was not undertaken and was considered to be unnecessary. The supply of privately-owned recreation cabins and summer homes in comparable settings in Colorado probably numbers in the tens of thousands. While only a portion of this total would be available for purchase or lease at a given time, ample opportunities would clearly exist for the cabin users displaced by the project. The regional or local supply would be much smaller than the state total, but the existing supply in other reaches of the Poudre or other northern Front Range stream canyons should easily be able to accommodate demand for five additional units.

Up to 19,500 hiking visits on the Greyrock Mountain Trail would be displaced by development of the Grey Mountain alternative, depending upon the duration of the trail closure. As discussed in Section 5.2.2.1, that are are more than 60 hiking trails within the secondary study area and within 50 miles of Poudre Park. This would indicate that there are nominally many alternative trails available to hikers who would otherwise use the Greyrock Mountain Trail. Many of these trails probably offer a similar hiking experience; for example, 33 trails listed in Appendix Table B.138 are from 5 to 10 miles in length (compared to 7 miles for the Greyrock Trail) and 23 have an elevation gain of from 1500 to 2500 feet (compared to about 2100 feet for the Greyrock Trail). However, few of these trails would closely parallel the specific scenic and physical attributes of the Greyrock Trail. Most of the alternate trails are also located deeper in the mountains and have shorter use seasons, while the Greyrock Trail can generally be used all year except for brief intermittent winter periods.

If the Grey Mountain alternative is constructed, and the construction schedule prevented use of the trail during the summer, numerous acceptable alternatives could be found and no great loss in activity level or user satisfaction should be expected. Alternate trails would temporarily receive increased use, but the effect would not be noticeable to users unless the shifted Greyrock Trail use were concentrated on a small group of trails rather than dispersed among many trails. There would be fewer alternatives available if Greyrock Trail is closed in the spring or fall, but a smaller number of hikers would be affected. Due to the fact that only a short-term, temporary closure should be necessary and given the number of hikers displaced compared to available alternatives, the indirect consequences of the temporary closure of Greyrock Trail would be minor.

Hunting activity displaced by the Grey Mountain alternative is estimated at 10 visits or 10 RVDs per year. Use of this low magnitude would probably involve a very minor shift of activity. Users who would otherwise hunt in the affected area would logically follow the same access patterns in using the same general area, but would concentrate their activity within a slightly smaller acreage. However, provision for boating access on the proposed reservoir could have an additional effect on hunting patterns. Some current or new hunters in the area would likely use boats to gain access for hunting. This use would likely be concentrated within a relatively short distance of the shoreline due to the lack of easy foot access.

Dispersed picnicking and general day use generally occurs where there is road access to natural settings, particularly streams and lakeshores. Consequently, the set of alternative opportunities for dispersed picnickers displaced by the Grey Mountain alternative includes the undeveloped, public land portions of virtually all roaded stream valleys and road-accessible lakes in at least the secondary study area. This includes much of the upstream reach of the Poudre, the South Fork Poudre, the upper Laramie River, Buckhorn Creek, and portions of the Big Thompson River and other drainages to the south. No attempt has been made to assess qualitative differences between these alternative areas and existing undeveloped areas along the Poudre in the primary study area. Because numerous alternative opportunities exist, it is assumed that the displaced users would shift their activity to other locations. The key aspect of this shift is that alternate locations are likely to be more distant for the existing users, such as sites farther up the Poudre. The added travel distance would represent an inconvenience and a loss of utility for these recreationists.

The Grey Mountain alternative would inundate about 6.5 miles of the mainstem Poudre currently usable for angling, displacing an estimated 2600 annual angling visits. Angling on the North Fork of the Poudre in the primary study area is not presently allowed. Approximately half of the stream section that would be inundated on the mainstem has been designated as wild trout water, while the remainder is not specially designated. Other wild trout waters in Colorado are described in Section 5.2.2.1 and are indicated on Figure 5.5. Based on their location, the most likely alternative wild trout waters for displaced Poudre anglers include two other Poudre segments farther upstream and portions of the Laramie, Fraser, and South Platte Rivers as well as North St. Vrain and Tarryall Creeks. These stream reaches collectively provide 41.9 miles of wild trout fishing opportunities (see Appendix Table B.139).

Anglers who reside locally (primarily in the Fort Collins, Loveland, and Greeley areas) and use the reach of the Poudre that would be inundated would likely shift their activity farther upstream, to the Laramie River, or to North St. Vrain Creek. Such shifts would require additional travel time and distance for these users, which would represent a utility loss. Displaced anglers from the Boulder and Denver areas would likely use the North St. Vrain, Fraser, South Platte, and Tarryall wild trout waters as substitutes for the Poudre. Travel time and distance for these users would likely be the same as or less than the present travel time and distance to the Poudre. No attempt has been made to measure any quality differences among these angling resources, or the ability of the alternative stream reaches to absorb additional angling pressure.

Users who do not specifically desire or require wild trout waters for their fishing experience account for an unknown proportion of the use that would be displaced. These anglers would have a much larger set of alternative locations available, including virtually all fishable coldwater streams within a reasonable travel radius of their residences. This includes many streams in the secondary study area and nearby areas along the Front Range. While this group of anglers would have a rather broad range of choices for alternate locations, they would also likely realize a utility loss from having to travel farther to reach comparable fishing opportunities.

Alternative whitewater boating opportunities comparable to the Poudre are also rather limited, as described in Section 5.2.2.1. The closest alternate streams for users displaced from the Poudre would include the North Platte River, the Fraser River, Clear Creek, the South Platte River, and possibly the Williams

Fork and Blue Rivers (see Figure 5.6). These streams collectively have 101 miles of floatable river, as indicated from Appendix Table B.140. However, only the 24 miles of the Blue River and the 9 miles of the Williams Fork are rated as requiring an intermediate skill level, as is the Poudre at certain flows. The other streams in this group all have an expert whitewater rating. Whitewater boaters displaced from the Poudre to other rivers would have to travel considerable additional distances to reach comparable boating opportunities, particularly for boaters at the novice or intermediate skill level.

Some users could also shift their whitewater boating activity to upper reaches of the Poudre. Several sections of the river above Poudre Park have been identified as floatable. The Lower Mishawaka run just above Poudre Park (see Figure 5.7) in particular would be a potential area of increased use, as this run is currently used for commercial rafting and private boating.

Indirect Effects on Developed Facilities

Displacement of existing dispersed recreation activities along the Poudre would probably indirectly affect the level of use at some of the developed facilities in the primary study area. This effect would primarily involve whitewater boating activity that currently takes place at the Upper and Lower Picnic Rock access sites managed by CDPOR. Boaters using the Filter Plant run take out at one of these sites. Therefore, the displacement of 4275 annual whitewater visits on the Filter Plant run would cause a corresponding decrease in the total annual use of these two developed facilities. This would not be an additive effect, however, but merely two different aspects of the same displaced activity. The consequences of this effect would include lower utilization rates for the two Picnic Rock sites, lower revenues to CPDOR from site entrance fees, and perhaps less congestion or user competition for space at busy times. The revenue loss to CDPOR cannot be estimated because the user compliance rate of fee payment is unknown.

Streamflow Effects on Dispersed Activities

The Grey Mountain alternative could also change the character of downstream river use through changes in the streamflow pattern. In particular, the capacity of the river to support noncommercial whitewater boating on the remaining 1.4 miles of the Filter Plant run could be affected. This would generally occur through modulation of the natural extremes in flow levels, reducing the volume of the high flows that are most desired by whitewater boaters and potentially increasing the duration of moderate flows. The project flow pattern would also affect fish habitat and angling quality, although adverse effects would be less likely because the project would moderate existing flow extremes that are not desired by anglers.

Estimated minimum and maximum bounding release conditions were developed by the District (1988) for both project alternatives. The minimum bounding releases were comprised of the minimum releases needed to meet senior downstream water rights, spills, and expected minimum instream flow requirements. The maximum bounding release also included releases to the river of the water supply developed by the project. These bounding conditions were compared against the existing average streamflow pattern, as determined from USGS measurements at the canyon mouth, to estimate expected post-project changes in the streamflow pattern. These changes and the underlying flow pattern were compared to existing use patterns and user flow preferences to identify potential flow-related effects on existing recreation. The specific flow changes that were investigated were changes in the overall average daily and monthly flows, particularly during the May-July peak flow period, and the number of days with flows high enough to allow boating.

The historical river flow data presented earlier in Table 5.6 and discussed in Section 5.2.2.3 were summarized from measurements over a 25-year period of record from 1962 through 1986. The District simulations of bounding reservoir releases were based on a 30-year period of record from 1954 through 1983. In order to conduct analyses of daily flow patterns, it was necessary to convert the mean monthly flows estimated by the District into mean daily flow levels according to historical daily and monthly variation patterns. This dictated use of a common period of record for historical flows from the two sets of flow data. Therefore, the following comparisons of simulated with-project and historical conditions were based on the historical flow pattern over the 1962 through 1983 period. The historical flow conditions from this data set differ somewhat from the 1962-1986 data with respect to mean monthly flows and daily flow frequencies.

Historical daily flow records for the Poudre River indicate that flows typically increase from low winter levels by about mid-April and reach a peak of about 1800 cfs around June 15 (USGS, 1987). Flows begin to drop off again after June 30 and generally decline to typical low-flow levels by the end of September. On a monthly basis, the lowest mean monthly flow during the 1962-1983 period has been 27 cfs in January and the highest has been 1668 cfs in June. Historical mean monthly flows during this period have been over 100 cfs from April through September and over 700 cfs in May, June, and July. Mean monthly flows for June have generally been about twice those of May and July.

Historical and potential with-project mean monthly flows are compared in Table 5.15. (For convenience, releases for the Poudre alternative are also included in this table). The historical flows in this case are for the 1962-1983 period, common to the District simulations and the ORRA baseline data. With the minimum bounding release for the Grey Mountain alternative, mean peak-period flows would be reduced by approximately 310 cfs in June, 100 cfs in May, and would be increased by 40 cfs in July. The projected change in mean June flows represents a decrease of about 19 percent from the historical level. Maximum boundings release would cause smaller mean flow decreases of about 210 cfs in June and 40 cfs in May, and an increase of about 90 cfs in July. The June decrease would be a 13 percent change from the historical mean level.

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(1) District simulations of flow releases, in mean monthly cfs, were converted by ORRA to mean annual days by flow range according to historic pattern of daily variation for 1962-1983 period of record.

(2) Bold figures in table indicate approximate range of sufficient flows for whitewater rafting.

Source: USGS, 1987; District, 1988.

The Grey Mountain alternative would also cause some changes in the number of days per year within given flow intervals. A summary of annual days within specified flow ranges for historical and estimated with-project conditions is provided in Table 5.16.

TABLE 5.15

Historical and Simulated With-Project
Poudre River Mean Monthly Flows
(In Cubic Feet per Second Based on 1962-1983 Period of Record)

Month	Historic Flow	Grey Mountain Alternative, Minimum Releases	Grey Mountain Alternative, Maximum Releases	Poudre Alternative, Minimum Releases	Poudre Alternative, Maximum Releases
January	27	26	61	27	43
February	31	26	55	28	42
March	39	36	62	38	52
April	127	118	161	115	137
May	802	707	763	750	777
June	1668	1359	1462	1523	1574
July	783	745	872	767	829
August	281	275	381	279	331
September	106	102	172	102	136
October	67	59	101	61	82
November	46	39	75	41	59
December	30	29	64	29	46

Sources: USGS, 1987; District, 1988.

TABLE 5.16

Historical and Simulated With-Project Poudre River Mean Annual Days Within Specified Flow Ranges(1) (2)
(Based on 1967-1983 Period of Record)

Flow Range (cfs)	Historical	Grey Mountain Alternative, Minimum Releases	Grey Mountain Alternative, Maximum Releases	Poudre Alternative, Minimum Releases	Poudre Alternative, Maximum Releases
0-250	248	249	238	247	237
251-500	37	44	48	42	45
501-750	22	16	23	18	22
751-1000	8	12	9	10	9
1001-1250	12	12	12	13	13
1251-1500	10	32	18	15	15
1501-1750	20	0	17	20	24
1751-2000	8	0	0	0	0
2000+	0	0	0	0	0
Total	365	365	365	365	365

The estimated days for with-project conditions were derived by converting the simulated mean monthly flows into daily flow patterns using actual daily variations over the 1962-1983 period. The historical daily records for this period provided a daily flow curve. A new daily flow curve with project bounding release was established based on proportional differences in mean monthly flows between historical and with-project conditions. The net flow change for a given month was therefore distributed equally to all days of the month, maintaining the historical shape of the flow curve and the variation about the curve. It should be emphasized that the daily flow data are derived indirectly from simulated releases, and should not be interpreted as planned daily operations.

Table 5.16 illustrates the way in which Stage 1 of project would moderate extreme flows. The minimum bounding releases for the Grey Mountain alternative would result in 0 days per year with a flow above 1500 cfs, compared to an average of 28 days per year having flows above 1500 cfs during the historical period of record. However, the subsequent reservoir releases would result in 22 more days per year having flows in the 1000-1500 cfs range. Overall, the minimum bounding releases for the Grey Mountain alternative would produce an average of 56 days per year having flows above 750 cfs, very similar to the 58 days per year having flows above this level for historical conditions.

The maximum bounding releases for the Grey Mountain alternative would also yield 56 days per year having flows above 750 cfs, but the distribution by flow range would be different. The maximum bounding conditions would result in 0 days per year with flows over 1750 cfs. There would be 17 days per year having flows in the 1501-1750 cfs range, compared to 0 days with the minimum bounding releases and 20 days for historical conditions. The maximum bounding releases would also result in 18 days per year having flows in the 1251-1500 cfs range, versus an average of 10 days per year currently in this flow range.

As discussed in Section 5.2.2.2, the minimum usable flow for rafting is about 675 cfs. The figures from Table 5.16 indicate that either bounding release condition for the Grey Mountain alternative would result in a slight decrease (2 days per year) in the average annual days with usable flows for rafting, based on comparing the number of days having flows above 750 cfs. Therefore, non commercial rafting could still continue on the remaining 1.4 miles of the Filter Plant run. Kayakers are able to use much lower flows, requiring a minimum of about 250 cfs. The Grey Mountain maximum bounding releases would result in an increase of about 10 days per year with sufficient flows to allow kayaking, while the minimum bounding releases would provide essentially the same number of days above this flow as current conditions.

The actual response of whitewater users to streamflow effects would depend partly on changes in the number of usable days and partly on user perceptions of the utility of various flow levels. Interpretation of the survey responses indicates that kayakers in the survey sample prefer flows of about 1850 cfs. The mean flows in June under the minimum bounding releases would be about 73 percent of the preferred or maximum utility level, while historical mean flows would provide 90 percent of the preferred level. Historical flows during May and July are less than 45 percent of the preferred level. Minimum bounding releases for the Grey Mountain alternative would be up to 40 percent of the desired flow during these two months.

Compared to the survey response, mean June flows under the maximum bounding releases would be 79 percent of the kayakers' preferred flow. May and July flows for this condition would be 41 and 47 percent, respectively, of the preferred level. Maximum bounding releases in both July and August would be closer to the preferred level than historical flows, and above the minimum usable level for kayakers.

On balance, the indirect effects of the Grey Mountain alternative on whitewater boating represent a tradeoff between peak satisfaction levels (from higher water) and the total number of days with usable or reasonably high flows. For both noncommercial rafters and kayakers, either bounding release condition would create a decrease in the degree of satisfaction or utility that users would derive during the extreme peak flow periods. However, either release condition would approximately maintain the number of days on which boating would be possible, although these days would have relatively lower flows and satisfaction levels than preferred conditions.

The minimum bounding releases for the Grey Mountain alternative would result in a 5 percent decrease in whitewater boating capacity of the Filter Plant run as estimated by ORRA, based on the estimated change from historic flow levels. If this capacity change were reflected in actual use, this would result in a noncommercial whitewater boating decrease of about 25 annual visits valued at $475. This would be in addition to the 4275 displaced whitewater visits estimated previously as a direct effect. The potential indirect effect on whitewater boating from changes in streamflow associated with minimum bounding releases would clearly be minimal compared to the direct effect.

The maximum bounding releases would maintain reasonably high flows in June and would increase July and August flows over historical levels. Because higher and clearer flows would be maintained longer into the summer season, noncommercial use on the remaining 1.4 miles of the Filter Plant run could conceivably be increased. The positive change in capacity has been estimated at 5 percent, which is equivalent to about 20 annual visits. If reflected in actual use, the displaced 4300 visits estimated previously due to direct effects would be marginally reduced.

The survey results suggest that the maximum bounding releases could benefit anglers, who would prefer moderate flows during the warmer months. Anglers responding to the survey indicated a preferred flow of about 485 cfs. The maximum bounding releases would increase April, August, and September flows compared to the historical flows (see Table 5.15). The resulting flows would still be well below the preferred flow, but would range from about 30 to 70 percent higher than historical mean flows. The minimum bounding releases would be very similar to historical conditions in these three months, and would be expected to have little effect compared to historical conditions.

Both bounding release conditions would result in an increase in annual days with flows near the apparent preferred level for anglers. The maximum and minimum bounding releases would produce 48 and 44 days respectively, with flows in the 251-500 cfs range, compared to 37 days per year for historical conditions. All other things being equal, the overall demand for fishing might increase as a result of increasing the number of days within this flow range.

Reservoir Management

If boating use on the Grey Mountain Reservoir is allowed, the recreation setting of the surrounding land could be changed. Currently, the land surrounding the reservoir location has a walk-in recreation setting meaning that dispersed recreation users are not likely to experience the sights and sounds of motorized vehicles. Additionally, user densities are low. However, the addition of even small motorized boats on the reservoir could mean that users on land would be aware of motorized activities. The largest change could occur as acres with walk-in recreation setting are changed to acres having four wheel and roaded open country characteristics.(1) ORRA estimates that if wakeless boating (small horsepower fishing boats and sailboats) is allowed, a net increase of 510 roaded open country acres and 6770 acres of four wheel settings would result. This would be offset by decreases of 30 acres in the highway rural category and 7250 acres in the walk-in category.

Reservoir management that would allow larger-horsepower pleasure boats and water skiing would affect an estimated 10,420 acres of surrounding land. The recreation setting of the same 7250 walk-in acres would become roaded open country. Approximately 3130 acres of four wheel settings and 40 acres of highway rural settings would also be converted to the roaded open country category. Recreationists using the lands around the proposed reservoir could expect greater frequencies of encounters with other users and motorized boats.

There is no easy way to quantify the effects of the possible changes in recreation settings based on how users value their recreation experiences. In theory, many recreational users would place a higher value on experiences without the sights and sounds of motorized vehicles and with lower densities of other users. While the changes in recreation settings resulting from the reservoir could lower the recreational benefits per person, the added density of users could offset the net effect on total benefits.

Poudre Alternative

Off-Site Effects of Displaced Users

The indirect effects resulting from the displacement of current users if the Poudre alternative is constructed would be the same in nature and extent as identified previously for the Grey Mountain alternative. The same types of users would need to seek alternative locations for their present activities, and the set of alternative opportunities would be essentially the same as identified previously for each displaced activity. As indicated by the data in Table 5.14, however, the magnitude of the displacement and resulting off-site effects would be less for the Poudre alternative.

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(1) While the term "four wheel" was clearly developed in the original context in consideration of the land-based activities, the connotation should not prevent application of the term to water-based activities. The key concept in classifying experience settings is to distinguish among different levels of development and exposure to motorized travel.

Assuming displaced users would relocate rather than cease their activity, approximately 4800 fewer annual visits would be shifted geographically with development of the Poudre alternative. This would result in fewer additional visits at any given alternate site as compared to the Grey Mountain alternative. Displacement of use by the Poudre alternative would generally not be expected to cause noticeable increases in use pressure at off-site locations, because users would be displaced from relatively few sites and would generally have many alternative sites to choose from.

Whitewater boating could be a possible exception to this pattern. The Poudre alternative would displace all existing commercial and noncommercial whitewater boating on the Bridges run below Poudre Park. Given the relative scarcity of alternative rivers in the general area, most of these users (approximately 750 annual visits) would probably shift to other sections of the Poudre. The most likely choices would be downstream to the Filter Plant run and upstream to the Lower Mishawaka run above Poudre Park. The Lower Mishawaka run would be most comparable to the Bridges run in terms of boating experience, although the additional 4 miles of travel distance might prompt some users to shift to the Filter Plant run.

Current use at the Lower Mishawaka run is estimated at 750 visits annually (FS, 1988b) which approximately equals the use of the Bridges run that would be displaced. Consequently, the shifting of a large proportion of current Bridges use to the Lower Mishawaka run would represent a very large increase (up to 100 percent) relative to existing use. However, ORRA estimates that historical river flows in this 4-mile reach provide capacity for 4300 annual whitewater visits, assuming that adequate access facilities are provided. Accommodating the additional whitewater use on the Lower Mishawaka run would, therefore, be well within the river's capacity.

<u>Indirect Effects on Developed Facilities</u>

Because the Poudre alternative would not displace whitewater use on the Filter Plant run below the damsite, it would not cause a corresponding decrease in use at the Upper and Lower Picnic Rock take-out points. As with the Grey Mountain alternative, any displaced use that is shifted to other stream drainages could lead to minor reductions in use at upstream or downstream developed sites along the Poudre. Conversely, some dispersed users displaced by the Poudre alternative could choose to shift their activity to the closest suitable locations, which could be the developed CDPOR Picnic Rock sites or the FS sites above Poudre Park. These opposite influences should be approximately equal, and no significant indirect effects on developed facilities would be expected with the Poudre alternative.

Streamflow Effects on Dispersed Activities

The Poudre alternative could change the character of recreational use on downstream sections of the river. This alternative would leave the 2.8 mile Filter Plant section physically intact, but could significantly affect whitewater boating use, as well as angling through changes in streamflow patterns. Consequently, potential flow releases from the Poudre alternative were also analyzed to identify changes in flows and expected effects on recreational use.

Mean monthly and daily flow data for the minimum and maximum bounding releases for the Poudre alternative were previously included in Tables 5.15 and 5.16. With the minimum bounding releases, mean peak flows could be lowered about 150 cfs in June, 50 cfs in May, and 20 cfs in July. These changes are about half of the differences projected for the Grey Mountain alternative with minimum bounding releases. During the rest of the year flows would be very similar to mean historical flows. For maximum bounding releases, the mean monthly flow in June would be about 90 cfs less than the historical monthly mean. Flows in May would average only about 30 cfs lower than historical means. July and August flows would be about 50 cfs higher than historical flows.

Both bounding release scenarios for the Poudre alternative would cause some change in the distribution of days within given flow ranges. The mean total number of days that river flows were over 1750 cfs would decrease from 17 days to 0 days per year under either scenario. However, the mean total days that river flows would exceed 1500 cfs would be somewhat comparable at 28 days for the historical condition versus 20 days with minimum bounding releases and 24 days with maximum bounding releases. Other relevant figures include a total of

58 days per year above 750 cfs for minimum bounding releases and 61 days per year above 750 cfs for maximum bounding releases.

Based on the number of days per year having flows over 750 cfs, the Poudre alternative would maintain or slightly increase the number of usable days for rafting on the Filter Plant run. The minimum bounding releases would produce the same number of usable days compared to historical conditions, while the maximum bounding releases would create an average increase of 3 usable days per year. These changes could possibly lead to a minor increase in commercial and noncommercial rafting on the Filter Plant run. The maximum bounding releases would also produce an average of 10 additional usable kayaking days, based on the number of days per year with flows above 250 cfs.

Effects due to flow changes resulting from the Poudre alternative would be similar to but more favorable than effects resulting from the Grey Mountain alternative with respect to boater satisfaction. Kayaker responses from the 1988 field survey suggest that minimum bounding releases in June would be about 82 percent of the flow level they would prefer, compared to 90 percent of preferred flow for the historical mean. Minimum bounding releases during May and July would be 41 percent of the preferred level, a figure very close to that for historical flows. June flows, assuming maximum bounding releases would reach 85 percent of the kayakers' apparent preferred level.

According to commercial river outfitters, river flows near 2000 cfs offer 100 percent utility for rafting operations. Using regression analysis of outfitter interview data against historical daily flow patterns (rather than mean monthly flows), it was estimated that June flows historically provide a mean monthly utility of 87 percent compared to ideal conditions. The month of May provides a mean monthly utility of about 24 percent, and July about 22 percent. All other months have historically not had usable flows and have a mean monthly utility of 0 percent.

Minimum bounding releases for the Poudre alternative would provide mean monthly utilities for May, June, and July of 21, 81, and 21 percent, respectively, compared to maximum utility from ideal conditions. Maximum bounding releases would provide mean monthly utilities of 23, 82, and 24 percent for May, June, and July, respectively. These figures are only slightly less than the utility percentages for rafting provided by historical flows.

Survey results of commercial river passengers generally reflect the same perceptions as the commercial river outfitters in terms of river flow utility. Survey responses from passengers indicate that they perceive flows of about 2200 cfs as providing maximum satisfaction. The utility percentages for each release condition from the passengers' perspective would therefore be slightly less than the figures reported above.

Again, the maximum bounding release scenario for the Poudre alternative would represent to some extent a tradeoff between peak satisfaction levels and the number of usable days. Some boaters could choose not to use the Filter Plant run due to the minor decrease in peak flow levels and satisfaction. Conversely, some boaters might increase their frequency of use or new users might be attracted due to the increase in usable days. The minimum bounding release scenario would create a decrease in peak flows and satisfaction levels that would not be offset by an increase in the number of usable days.

Minimum bounding releases for the Poudre alternative would result in a decrease of 1 percent in the whitewater boating capacity of the Filter Plant run as estimated by ORRA, based on the estimated change from historic flow levels. If this capacity change were reflected in actual use (currently 4500 visits), a decrease of 45 annual boating visits valued at $855 would result. Maximum bounding releases are estimated to result in an increase of 7 percent in boating capacity, due to extending relatively high flows longer into the summer. If use increased in response to the capacity change, the Filter Plant run would receive an additional 315 boating visits per year valued at nearly $6000.

The indirect streamflow effects on whitewater boating of both alternatives are summarized in Table 5.17. The minimum bounding releases for each alternative would result in a projected decrease in boating capacity when compared to historic flows, while the opposite is true for the maximum bounding release scenario. The potential effect on visits would be greater for the Poudre alternative because the percentage capacity changes would apply to a larger base of visits.

It should be emphasized that all of the changes indicated in the table are potential changes based on capacity effects, and not actual visitation projections. A 1:1 correspondence between capacity and visitation changes might only be expected if existing use were at capacity. Because this is not the case, actual changes would be less than indicated by an unknown degree. Given this situation and the low magnitude of the potential changes, the primary conclusion is that indirect effects on whitewater boating should not be significant for either alternative.

Table 5.17

Indirect Effects on Whitewater Boating Due to Downstream Changes in Streamflow

Alternative/ Release Condition	Percent Change From Historic Flow Capacity	Change in Annual Visits	Value of Annual Visits
Grey Mountain(1)			
Minimum Releases	-5	-25	-$475
Maximum Releases	5	25	475
Poudre(2)			
Minimum Releases	-1	-45	-855
Maximum Releases	7	315	5985

(1)Figures applied to noncommercial boating on remaining 1.4 miles of Filter Plant run.

(2)Figures applied to commercial and noncommercial boating on entire 2.8 miles of Filter Plant run.

As for the Grey Mountain Alternative, angling could possibly benefit from the streamflow effects of the Poudre alternative. The maximum bounding releases would increase mean August and September flows above historic levels (see Table 5.15), although flows in these months would still be well below the 485 cfs preferred by anglers sampled during the field survey. The minimum bounding release would slightly decrease mean August and September flows, compared to historical conditions. The minimum and maximum bounding releases would result in 42 and 45 days per year, respectively, with flows in the 251-500 cfs range (see Table 5.16). This would represent an increase of up to 22 percent over historical conditions with an average of 37 days in this flow range.

Reservoir Management

Boating management options for the Poudre Reservoir would have very similar effects on recreation settings to those described previously for the Grey Mountain alternative. Users of recreation settings on surrounding lands that are currently characterized by low user densities and lack of motorized use would become subject to the sights and sounds of motorized boats. User densities and the frequency of contacts with other users would also increase.

The area covered by the alternative Grey Mountain and Poudre reservoirs would be the same except for approximately 300 acres between the two damsites. When the area of surrounded lands affected by the change in settings is considered, the acreage quantities and distribution are nearly identical. Therefore, changes in recreation setting acreage for the Poudre alternative would closely approximate the changes in acreage for the recreation setting Grey Mountain alternative previously reported. To summarize, wakeless boating management would affect about 7000 acres, primarily by shifting walk-in acreage to the four wheel and roaded open country setting categories. Management for power boating would affect the recreation setting on about 10,000 acres. In this case, the shift would be from walk-in and four wheel settings to the roaded open country category.

5.2.3.3 Comparison of Effects

The quantifiable direct and indirect effects of the Grey Mountain and Poudre alternatives are summarized in Table 5.18. As indicated previously, direct displacement of recreation settings would vary between the project alternatives by approximately 300 acres, with all of the difference reflected in the roaded open country category. In either case, management of the reservoir for power boating (the most likely scenario) would lead to large acreage shifts from four-wheel and walk-in settings to roaded open country settings.

Either project alternative would result in the loss of 1400 visits per year at private recreation cabins, representing the only adverse effect on developed recreation. Either alternative would also temporarily displace 19,500 hiking visits on the Greyrock Mountain Trail. Beyond these similarities, the substantive differences between the two projects all involve direct effects on angling, picnicking, and whitewater boating. The Grey Mountain alternative would have greater effects on all three activities.

Compared to the Poudre alternative, the Grey Mountain alternative would result in the loss of 700 additional angling visits, 80 dispersed picnicking visits, and about 4300 whitewater boating visits per year. The differential effect on whitewater boating is by far the most significant among these activities, accounting for 85 percent of the total difference in direct effects on recreation use between the two alternatives.

5.2.4 Mitigation

The general rationale for development of new recreation facilities associated with water resource projects is to replace existing opportunities lost because of the project and to develop new opportunities made possible by the project. Consequently, water project recreation development typically involves both mitigation and enhancement actions. Ideally, it would be technically and economically feasible for project mitigation to provide in-kind replacement of stream-oriented recreation equivalent to the opportunities displaced, as well as to develop facilities to accommodate demand for reservoir recreation.

TABLE 5.18

Summary Comparison of
Direct and Indirect Effects

Recreation Opportunity	Existing Conditions	Project Effects, by Alternative: Grey Mountain Direct	Grey Mountain Indirect	Poudre Direct	Poudre Indirect
Recreation Setting (ROS) (in acres)					
Highway Rural	5,000	-10	-40 (2)	-10	-40 (2)
Roaded Open Country	14,500	-1,130	10,420 (2)	-790	10,100 (2)
Four Wheel	3,100	0	-3,130 (2)	0	3,060 (2)
Walk-in	11,300	-510	-7,250 (2)	-510	-7,000 (2)
Total	33,900	-1,650 (1)	N/A	-1,310 (1)	N/A
Developed Recreation Facilities (Visits)					
Campgrounds	400	0	0	0	0
Picnicgrounds	3,600	0	0	0	0
Private Recreation Cabins	1,400	-1,400	0	-1,400	-1,400
River Access Sites	52,300	0 (3)	0	0 (3)	0
Total	57,700	-1,400		-1,400	-1,400
Dispersed Recretaion Activities (Visits)					
Angling	4,700	-2,600	0	-1,900	0
Hiking	19,500	-19,500 (4)	0	-19,500 (4)	0
Hunting	100	-10	0	-10	0
Picnicking	400	-400	0	-320	0
Sightseeing	207,000	0	0	0	0
Whitewater Boating	6,000	-5,050	-25 (5)	-750	-45 (5)
Total	237,700	-28,960	-25	-23,880	-45

(1) Figure represents land within inundation zone.

(2) Indirect effects on recreation settings represent shifting among setting classifications with reservoir management for power boating.

(3) Probable changes in use are reflected in whitewater boating figures.

(4) Effect on hiking represents 1-year closure for trailhead relocation, not a long-term change.

(5) Indirect effect on whitewater boating represents maximum change in activity due to downstream changes in streamflow. These changes are additive with direct effects on whitewater boating.

A preliminary investigation of potential mitigative measures for recreation effects was conducted associated with construction of Stage 1 of the Cache la Poudre Project. The primary objective of this effort was to determine the significance of recreation mitigation on overall project feasibility. A secondary objective was to address the feasibility of replacing the existing opportunities that would be lost, and of providing recreation development at the proposed a reservoir which would have steep sides and relatively difficult access.

The basic approach to this mitigation assessment was to identify potential development actions that would provide aggregate use capacity sufficient to offset the expected direct and indirect effects of the project. In developing these potential development actions, primary emphasis was given to substitute opportunities that would closely approximate in nature and location the existing opportunities that would be lost or diminished. However, it was recognized that while it might be technically feasible to replace existing river recreation opportunities in terms of capacity, it might not be possible to completely duplicate the quality of the experiences provided by all of the original opportunities. This approach resulted in the identification of three general types of mitigative actions:

1. Relocation of existing or planned developed facilities that would be inundated;

2. Development of access facilities to support relocation of existing river uses to new upstream and downstream locations;

3. Construction of new access and use facilities at the reservoir to accommodate expected demand for flatwater boating, lake angling, and other reservoir-based activities.

It is possible to create various combinations of development actions that would have the potential to offset the expected direct and indirect effects of the Stage 1 project in terms of net recreation visits and their associated value. Use levels for existing opportunities have been quantified, within the limits of baseline data sufficiency, and typical unit values for the respective activities have been used to develop estimates of aggregate annual values. In developing new and replacement opportunities, the objective is to provide opportunities that would generate use of equivalent or greater value. While the unit values for with-project activities may in some cases be less than the unit values of displaced river-oriented uses, new development can support an aggregate product of use and value for new and relocated activities that would exceed the current aggregate value.

This preliminary assessment of mitigation was necessarily conducted in advance of future studies, which would include the preparation of a comprehensive recreation plan for the proposed project. This future effort would include a full evaluation of demand for various recreational activities, the specific physical constraints and opportunities at the project site, and the feasibility of specific mitigation options preliminarily considered herein. It would also include detailed cost estimates and development schedules. Because the present studies were conducted prior to this detailed planning effort, completion of this preliminary mitigation assessment required a number of assumptions concerning the actual ability to implement various actions. These assumptions are as follows:

1. Water releases from the project reservoir would mimic historical variations while maintaining estimated averages.

2. Alternative sections of the Poudre River identified for whitewater boating access improvements have not been used heavily (if at all) to date due to the lack of access facilities or to barriers across the river.

3. Whitewater boating use below Picnic Rock would be feasible and would attract current or new users, despite lower mean monthly flows on the river during some months and the different character of the land surrounding the river.

4. The characteristics of the reservoir would be such that coldwater fisheries would be maintained.

5. Sufficient unmet demand exists in the northern Front Range area for additional flatwater boating, reservoir fishing, and associated day and overnight use.

6. Reservoir operation patterns would be such that sufficient water levels for water-based recreation would be maintained during most years, the exception being during drought years.

7. Future detailed investigations of physical constraints and opportunities along the reservoir shoreline will identify suitable sites that are capable of supporting the reservoir recreation developments that are considered in this report.

8. Satisfactory agreements can be reached with all Federal, State and local agencies to permit relocation of existing facilities and construction of new facilities, based on compatibility with agency policies and management objectives. This includes any agreements necessary for operation of project recreation facilities by an agency other than the District.

These assumptions clearly incorporate some uncertainty as to development feasibility. The sources of this uncertainty include both resource capability and project operation characteristics, primarily relating to flow release conditions. These uncertainties will need to be investigated in detail during the future development of the project recreation plan. In order to develop a basis for the preliminary feasibility assessment of the two project alternatives, these assumptions are combined with available information on resource capability and project operation patterns to develop a number of mitigation options for each alternative.

Specific potential development actions associated with each alternative for Stage 1 of the project are identified in the following paragraphs. Preliminary cost estimates are included based on 1988 dollars, and more detailed information on the derivation of these estimates is provided in Appendix B. The development actions described below are considered to be the most likely and reasonable recreation development associated with Stage 1 of the project, based on the current level of study. These potential actions do not constitute final recommendations based on a comprehensive recreation plan, nor do they represent formal proposals advanced by the project sponsors.

A cautionary note concerning the development cost estimates is also warranted. The cost estimates presented herein are preliminary and conceptual in nature. Specific components and quantities are based on standard planning factors and assumed facility needs and layouts, rather than on-site investigation of actual requirements. No attempt is made to recommend precise locations for the facilities identified. Unit cost factors are derived from standard estimating guides, including R.S. Means (1988) and National Park Service (1986) guides. Cost factors from secondary sources are adjusted in many cases on the basis of recent actual experience, presumed differences in local conditions, or consultation with local sources. Wide discrepancies exist between a number of the unit cost factors obtained from various sources. There is also considerable variation in the way in which various entities develop cost estimates, particularly regarding allowances for contingencies and for planning, engineering, and administrative costs. Consequently, the present preliminary cost estimates provided in the following paragraphs may be revised considerably during the future recreation planning effort.

5.2.4.1 Grey Mountain Alternative

Replacement of Developed Facilities

Greyrock Mountain Trailhead

The Greyrock Mountain Trailhead and the initial portion of the trail would be inundated by the proposed mainstem reservoir and would need to be replaced. It is assumed that the trailhead could be relocated in Hewlett Gulch north of Poudre Park, which is about 1 mile west of the current location. Replacement trailhead development would include a 30-space, paved parking lot with parking barriers, signing, and a trailhead register. This level of development is identical to the existing trailhead facility. A re-graded and graveled access road of about 0.5 mile would be required. Approximately 1 mile of new trail would also be needed to connect the new trailhead with the existing route. These facilities could be provided at an estimated total cost of $105,000 (1988 dollars). This relocation would have the added benefit of improving safety for trail users because hikers currently have to walk across Colorado Highway 14 to reach the trail.

Whitewater Boating Facilities

CDPOR currently plans to develop a new put-in site at the upstream end of the Filter Plant run in 1989, as previously described. This new facility would also be inundated by the Grey Mountain alternative, and a substitute site would need to be developed. An appropriate location for this facility is described subsequently with respect to relocation of whitewater activities. The relocation of the Filter Plant river access site would cost an estimated $50,000, assuming that a 25-car parking lot, double vault toilet, and launching area would be provided to accommodate peak demand.

Replacement of Dispersed Opportunities

Angling Access

The fishing access lost through inundated river mileage could be mitigated through development of new fishing access points along the river. Four new access sites would be needed to replace the existing informal sites between the Grey Mountain damsite and Poudre Park. Each access site would consist of an unpaved, graded pullout and parking area next to the river. Each site is estimated to cost a maximum of $15,000, for a total cost of $60,000 for all four sites. The exact location of the access sites would need to be determined in consultation with Federal and State agencies following decisions as to how fishing productivity in the river would be mitigated. The fishing access sites would also provide opportunities for dispersed picnicking in an informal setting.

Whitewater Boating - Bridges Run

Displacement of whitewater boating from the Bridges run could be offset by increased use of the Lower Mishawaka run above Poudre Park. The Lower Mishawaka run provides challenging rapids comparable to the Bridges run in a very similar setting, although users would have to travel about 4 miles farther up the canyon.

This reach of the river would not be affected in any way by the construction or operation of the reservoir. Consequently, the estimated capacity of the section is based on historical river flows. ORRA estimates that this section could accommodate up to about 4300 user visits annually if adequate access facilities were provided. This figure is based on typical overall water quantity and velocity conditions during the year, variation in optimal boat spacing with changes in velocity, and the 4-mile length of the run.

In order to facilitate this relocation, a new put-in site near Mishawaka and a new take-out site near Poudre Park would need to be constructed. Facilities at these access sites should include parking for about 25 vehicles, double vault toilets, signing, and site preparation for launching areas. Preliminary estimates of facility costs amount to $50,000 per site, or a total of $100,000.

To implement this development, an agreement would have to be reached with the Forest Service, as the sites would probably be on national forest lands. The Forest Service would review such a proposal to see if it were compatible with the future management plan for the Wild and Scenic River. The agency would also need to decide whether new facilities could be located on Forest Service lands. If this were not possible, additional costs would be necessary to purchase access to the river from private individuals, either by fee title or easement.

Minor modification of stream channel characteristics to enhance whitewater boating above the Filter Plant run has been informally discussed in the past. This activity would involve removing obstacles in or overhanging the stream channel that represent hazards to boaters. These obstacles include abandoned bridges, old pilings or abutments and, in some cases, boulders that make navigation particularly difficult. Such channel modification could be investigated in the future as a way to improve boating opportunities upstream on the Poudre for users displaced from the Bridges or Filter Plant runs. However, this action would require careful evaluation to ensure that it would be permissible within the Wild and Scenic River corridor, and would not create significant loss of aquatic habitat. Cost estimates for this activity have not been developed.

Whitewater Boating - Filter Plant Run

In order to further mitigate the loss of the 2.8-mile Filter Plant run, a new 4-mile run from Picnic Rock downstream could be considered. The existing Upper and Lower Picnic Rock river access sites could be used as put-in sites rather than take-out sites, and a new take-out site would be constructed in the area of the Watson Lake state fish hatchery. This could be the appropriate location for a new facility to replace the Filter Plant access site proposed for development in 1989. The new access site would be comparable to those described earlier for the Lower Mishawaka run. It would provide parking for approximately 25 cars, a double vault toilet, a launching area, and signing. The cost for these facilities is estimated to be approximately $50,000.

A further development option for a new boating run to Watson Lake would be to construct a new river access site near the base of Grey Mountain Dam. This would facilitate use of an additional 1 mile of river between the dam and Upper Picnic Rock. Providing an access site at the dam could be important to maintain noncommercial use on the remaining part of the Filter Plant run. It would also allow boaters the option of a slightly longer run to Watson Lake and provide a short stretch of higher water before boaters encountered the first of the diversions. A disadvantage for such a site would be that it might decrease the utilization rates for the existing Picnic Rock river access sites. A cost of approximately $50,000 is estimated to construct a new put-in facility below the Grey Mountain Damsite.

Effective use of the river downstream from Picnic Rock would also require the construction of boat chutes to allow boaters to safely float over existing water diversion structures spanning the river. Up to four of these boat chutes would be required between Picnic Rock and the proposed take-out near Watson Lake. Although the cost of these structures would vary somewhat, because each diversion structure presents a different set of conditions, it is estimated that modification of each diversion structure would require approximately 200 yd^3 if material area at a unit cost of $100 per yd^3. Therefore, the preliminary cost for each boat chute is approximately $40,000, resulting in a total cost for all four of about $100,000.

A new Picnic Rock-Watson Lake whitewater run is suggested as the most logical and feasible option to provide an additional substitute opportunity for the Filter Plant run. Development of this run would result in new river use capacity that would be somewhat greater than the existing level of use on the Filter Plant run. It is acknowledged that this run would not fully offset existing use in the sense of providing a comparable experience, especially under the minimum release option. Flows below Picnic Rock are significantly reduced by the water diversions in this reach, and would provide a considerably different whitewater experience than the existing Filter Plant run. However, enhancement of the Lower Mishawaka run would offset this loss.

Estimated historical mean monthly flows for the Picnic Rock - Watson Lake section of the river are 725 cfs in May, 1384 cfs in June, and 811 cfs in July (see Appendix B). These figures were derived by adjusting the Filter Plant historic flow data to reflect reduced flows resulting from the downstream diversions. Mean monthly flows for the Grey Mountain alternative for minimum bounding releases would be 630 cfs in May, 1015 cfs in June and 773 cfs in July. Corresponding figures for maximum bounding releases are 686 cfs in May, 1178 cfs in June, and 900 cfs in July.

The Picnic Rock - Watson Lake section of the river typically has 57 days per year with flows above 750 cfs (see Appendix B). This is comparable to the number of usable rafting days for the Filter Plant run. However, the historical flows below Picnic Rock average only 4 days per year above 1500 cfs and 0 days above 1750 cfs. The corresponding numbers for the Filter Plant run are 28 days and 8 days. Existing conditions on the Watson Lake section clearly provide much less of the high-flow experience desired by rafters during a typical year. Minimum bounding releases from for the Grey Mountain alternative would provide an estimated 55 days with flows above 750 cfs, with an average of 4 days above 1250 cfs and 1 day above 1500 cfs. Maximum bounding releases would yield an annual average of 59 days above 750 cfs, 18 days above 1250 cfs and 2 days above 1500 cfs.

These figures indicate that rafting use on a Watson Lake run would be physically possible, and would likely occur in the absence of the existing Filter Plant run if the appropriate access facilities were provided. However, a Watson Lake run would provide rafters with considerably less excitement and satisfaction than they currently receive on the Filter Plant run. Historic flows below Picnic Rock would provide outfitters with about 69 percent of maximum utility in June, based on their ideal flow of 2000 cfs. Releases with the Grey Mountain alternative would provide 51 or 59 percent of maximum utility in June (see Appendix B). This would represent a measurable decrease from existing typical conditions on the Filter Plant run, where historic flows provide a mean utility of 87 percent during June. Commercial raft passengers and kayakers would have similar perceptions about the level of river flows below Picnic Rock, based on their survey responses concerning the Filter Plant run.

The flow and utility differences indicate that it would be unreasonable to expect all of the existing Filter Plant use to be relocated to a new Watson Lake boating run. However, the Watson Lake run would have the capacity to absorb all of the displaced use from the Filter Plant run, which was estimated previously at nearly 4300 annual visits and over 700 RVDs. The capacity of the potential Watson Lake run is estimated by ORRA at slightly more than 4700 annual visits for minimum bounding releases and 5200 visits for maximum bounding releases. These visit quantities correspond to about 1100 and 1200 RVDs, due to the slower river velocity and longer travel time below Picnic Rock. For purposes of estimating net with-project effects, it is assumed that annual use would be only 35 percent of capacity during initial operation for maximum releases and 30 percent of capacity for minimum bounding releases. This corresponds to 1290 annual visits with the minimum release option and 1505 visits with the maximum bounding release option.

<u>Whitewater Boating Summary</u>

<u>Reservoir Development</u>

Horsetooth Reservoir, Carter Lake, and Boyd Lake are all presently used to capacity at peak times during the summer months. The Grey Mountain Reservoir could, therefore, be viewed by boaters and anglers as an attractive opportunity and another alternative to distribute regional lake-oriented use. Depending upon the management of the reservoir and the nature of regional demand, it is also possible that development at the reservoir could attract new users who would represent a net increase in regional recreation activity of this type.

Due to the demand presumed likely, it was assumed for this study that recreation development would occur on the mainstem reservoir. Depending on experience settings, large reservoirs typically provide for boating, fishing, camping, and picnicking. Consequently, it was assumed that these activities would be desired at the proposed Poudre mainstem reservoir, and that facilities to support these activities would likely be provided. Development options for reservoir recreation accordingly include boat launching access, campgrounds, and picnic areas. Bank fishing along the reservoir shoreline is also expected, but can occur without any specific developed facilities.

Generic facility components and layouts for these options were developed in order to derive quantities needed for cost estimates. However, actual or candidate locations for these potential facilities were not selected, as this would require detailed field investigation of terrain, vegetation, access, and other considerations beyond the scope of the present studies. Consequently, the technical, environmental, and economic feasibility of the subject facilities has not been established, but has been assumed for the purpose of developing preliminary cost estimates. Future studies may indicate that the suggested level of reservoir development is not feasible due to physical or institutional constraints. If this occurs, substitute development opportunities may need to be identified.

Reservoir Boating

Developed boat launching access would clearly be required in order to utilize much of the recreation potential of the mainstem reservoir. The access facility envisioned for this purpose would include a paved boat launching ramp, parking for cars and boat trailers, toilets, signing, and miscellaneous equipment. A short access spur from Highway 14 was also assumed to be necessary. As a minimum, a boat ramp with four launch lanes would be required. This would provide approximately half of the launching capacity that currently exists at

Carter Lake or Horsetooth Reservoir. Parking needs associated with a facility of this size are estimated at space for 80 cars with trailers and 40 additional cars at one time. The total cost for all of the components of this facility is estimated to be about $395,000.

The maximum recreation capacity of the Grey Mountain Reservoir would depend upon management policies and the mix of users attracted to the facility. The various recreation experience settings represent differing levels of acceptable use intensity, as measured in acres-per-boat space requirements. The boating capacity of the Grey Mountain Reservoir was estimated using planning factors ranging from 10 to 30 acres per boat for the experience setting acreages derived for the reservoir (see Section 5.2.3.2). Other key capacity factors included a 120-day use season, occupancy rates of 3.5 people per boat for power boating or water skiing, 3 people per boat for fishing, a mean visit duration of 4 hours, and a daily turnover rate of 2. Using these capacity factors and a wakeless boating management option, the maximum capacity of the reservoir was estimated at 90,000 boating visits per year. The greater use intensity associated with management for power boating resulted in a capacity estimate of about 128,000 annual boating visits, assuming a user mix evenly divided between power boating, water skiing, and boat fishing.

The level of actual reservoir utilization, as a proportion of maximum capacity would depend upon the capacity of the access facilities provided. Typical boat ramp capacity is 40 to 50 launches per lane per day. At 40 launches per lane, the 4 lanes assumed for the boat launch facility would provide capacity for about 530 boating visits per day and approximately 64,000 visits per year over a 120-day season. This would be the maximum theoretical annual capacity for the reservoir boating access facility.

Actual use of developed recreation facilities rarely approaches maximum theoretical capacity, primarily due to the concentration of use on weekends at most facilities and locations. Given the high existing use rates for Horsetooth Reservoir, Boyd, and Carter Lakes, it was assumed that initial utilization of the Grey Mountain boating facility would be at a relatively high level of 30 percent of maximum theoretical capacity. This would correspond to 19,200 annual boating visits or 6400 RVDs. Because the facility capacity is not assumed to vary with reservoir management, this level of use would apply to either the wakeless or power boating management options.

Camping

A campground along or near the reservoir shoreline would represent a significant new recreation opportunity, as well as helping to enhance use of the boat launch. Experience at Horsetooth Reservoir and Carter Lake indicates that about 25 percent of the campers at these locations also use the reservoir for boating (McFarlane, 1988). For the purposes of this study, the campground is assumed to be a semiprimitive facility with 20 units. This is probably near the maximum size that would be consistent with site constraints along the accessible south shoreline of the reservoir, even though new public campgrounds tend to be considerably larger and developed to a higher level. The campground development is assumed to include a short access road, at-site parking, vault toilets, a drinking water supply, and signing and miscellaneous equipment. Total cost for this facility is estimated to be approximately $160,000.

A 20-unit campground along the reservoir would have a maximum capacity of 12,000 visits or 24,000 RVDs per year. This is based on a 5 PAOT capacity per site and a 120 day season. The initial utilization rate for this campground was assumed to be 20 percent of theoretical annual capacity. This resulted in a use estimate of 2400 visits and 4800 RVDs per year.

Picnic Grounds

Provision of a developed picnic area would provide mitigation for displacement of dispersed picnicking opportunities. It would also take advantage of an opportunity for developed picnicking in a setting not currently provided in the Poudre Canyon. Therefore, it has been assumed that a small picnic area would be constructed along the south shoreline of the reservoir. This facility is envisioned to include 10 standard picnic units, parking for 15 cars, a short access spur, a vault toilet, and signing and miscellaneous equipment. This development is estimated to cost approximately $60,000.

The same utilization rate as camping was assumed for the 10-site picnic area. Using a daily turnover rate of 2 (2 users per site per day) and the same season and PAOT factors as for the campground, this picnic area would also have an annual capacity of 12,000 visits. A 20 percent utilization rate would result in 2400 annual picnicking visits and 600 annual RVDs of use.

Shoreline Angling

Shoreline angling capacity is determined primarily by the length of available shoreline and the per-mile capability within the various experience settings. Acceptable people-at-one-time (PAOT) capacity levels were assumed to range from 1 angler per shoreline mile, for a semiprimitive setting with low capability, to 12 anglers per mile for a rural setting of moderate capability. Using the reservoir experience classifications developed previously and an average figure of 4 anglers per mile, total angling capacity along approximately 7 miles of accessible shoreline was estimated at about 10,000 visits per year. Assuming the initial utilization rate was at 20 percent of maximum capacity for the wakeless boating option, shoreline angling use would be about 2000 visits per year or 700 RVDs. Power boating would be less compatible with shoreline angling, particularly along the narrower portions of the reservoir. Consequently, a utilization rate of 10 percent of capacity was assumed for the power boating management option, resulting in an annual use estimate of 1000 visits or 300 RVDs.

5.2.4.2 Poudre Alternative

Replacement of Developed Facilities

As for the Grey Mountain alternative, the Poudre alternative would result in the need to replace the Greyrock Mountain Trailhead and the initial portion of the trail. Trailhead relocation is assumed to involve upgrading an existing road to a new trailhead and 30-car parking lot in Hewlett Gulch north of Poudre Park. The cost of this facility is estimated to be $105,000, as discussed previously.

Relocation would also be necessary for the Filter Plant river boating access site currently planned for development in 1989. Assuming that commercial outfitters would still be interested in providing whitewater trips on the Filter

Plant run following project construction, a river access site for whitewater boating could be developed near the base of Poudre Dam. The facilities developed at this site would include a 25-car parking lot, launching area, and double vault toilet, as described for comparable sites in Section 5.2.4.1. The estimated cost for a new river access site is $50,000.

Replacement of Dispersed Opportunities

The loss of fishing access to inundated river mileage could be mitigated through the development of new fishing access points along the river. The nature, cost, and siting process for these facilities would be the same as described previously for the Grey Mountain alternative. However, the Poudre alternative would leave one of the existing informal river access site intact that would be inundated by the Grey Mountain alternative. Consequently, only three new sites would likely be developed for the Poudre alternative, at a total cost of $45,000.

Mitigation of displaced whitewater use on the Bridges run could be accomplished in the same manner as for the Grey Mountain alternative, by developing access sites on the Lower Mishawaka run. New put-in and take-out sites, including 25-space parking lots and restrooms, would be developed near Mishawaka and Poudre Park. Using an estimated $50,000 cost to construct a river access site, the cost of these two sites is estimated to be $100,000.

As for the Grey Mountain alternative, an agreement would have to be reached with the Forest Service to implement this action. Such an agreement would require a determination that new access would be compatible with the Wild and Scenic River management plan, and that new facilities could feasibly be located on Forest Service lands. Otherwise, additional costs would be necessary to purchase access to the river from private landowners.

Because the Poudre alternative would not inundate the existing 2.8-mile Filter Plant run, no further mitigation for displaced whitewater use would be needed. However, relocation of the proposed Filter Plant access to a feasible site on project lands would be needed. Public lands do not have to be purchased by a public agency for a change in use.

Reservoir Development

Recreation development at the reservoir would presumably be the same for the Poudre alternatives as for the Grey Mountain alternative. The facilities and cost estimates reported previously for the Grey Mountain alternative would, therefore, also apply to the Poudre alternative. The only differences in reservoir recreation between the two alternatives would concern boating, shoreline angling use and capacity levels, because the Poudre Reservoir would be smaller by about 300 acres.

Using the planning factors described previously for the Grey Mountain Reservoir, the maximum boating capacity of the Poudre Reservoir is estimated to be about 76,000 annual visits for the wakeless management option and 102,000 visits for the power boating option. These figures are both above the facility-limited capacity of the assumed initial boating access development. Because the Poudre Reservoir would still be a significant boating attraction, the same facility utilization rate assumed for the Grey Mountain alternative would apply. This would result in initial boating use of approximately 19,200 visits and 6400 RVDs per year, equal to the projected use for the Grey Mountain alternative.

The smaller Poudre Reservoir would have fewer accessible shoreline miles available for angling than would the Grey Mountain Reservoir. Based on approximate lengths for the mainstem section of the reservoir, shoreline angling capacity and use was estimated at 75 percent of the corresponding levels for the Grey Mountain alternative. Annual capacity would therefore be about 7500 visits. Estimated initial use would be 1500 visits per year with wakeless boating on the reservoir and 750 visits with power boating.

5.2.4.3 Alternative Comparison and Evaluation of Mitigated Effects

The preceding discussion identified a total of seven major mitigation elements that were assumed to be associated with one or both of the Stage 1 project alternatives. These included relocation of the Greyrock Mountain Trailhead; provision for replacement of fishing access sites; development of new and replacement river access sites, primarily for whitewater boating; construction of boat chutes to facilitate boating downstream of Picnic Rock (for the Grey Mountain alternative only); and development of new boating, camping, and picnicking facilities at the proposed reservoir.

The estimated development costs for these facilities are summarized in Table 5.19. The total facilities costs for recreation mitigation for the Grey Mountain alternative are estimated to be $1,140,000. This is $225,000 higher than the corresponding estimate of $915,000 for the Poudre alternative. The difference between the two cost estimates results from the inclusion of four boat chutes, one more fishing access site, and one more river access site for the Grey Mountain alternative than for the Poudre alternative.

TABLE 5.19

Total Estimated Recreation Mitigation Costs, Grey Mountain and Poudre Alternatives

Cost Element	Grey Mountain Alternative	Poudre Alternative
Replacement Developed Opportunities		
Greyrock Trailhead	$105,000	$105,000
Replacement Dispersed Opportunities		
Fishing access sites	60,000	45,000
River access sites	200,000	150,000
Filter Plant	(50,000)	(50,000)
Lower Mishawaka	(100,000)	(100,000)
Grey Mountain Dam (optional)	(50,000)	--
Boat chutes	160,000	--
Reservoir Development		
Reservoir boating access	395,000	395,000
Reservoir campground	160,000	160,000
Reservoir picnic area	60,000	60,000
Subtotal, facilities	$1,140,000	$915,000
Facility operation, 20 years, undiscounted	$1,140,000	$915,000
Total	$2,250,000	$1,830,000

Operation and maintenance requirements for these facilities would add appreciably to the overall cost. Assuming that recurring operation and maintenance costs would equal 5 percent of total development costs per year, addition of undiscounted operation and maintenance costs for 20 years would double the nominal total cost for each alternative.

The development options proposed for consideration to replace lost opportunities and provide new opportunities would support changes in use levels for a variety of recreational activities. In some cases, these changes would partially or totally offset losses in activity attributable to the project, or even increase the capacity for some activities. In other cases, the increases would be in types of activities not presently occurring in the study area.

The net effects on recreation for the Grey Mountain alternative, incorporating the projected effects of the proposed development actions, are summarized in Table 5.20. The first column indicates the maximum annual direct and indirect losses estimated for this alternative, based on the discussion presented in Section 5.2.3. The temporary hiking losses resulting from the relocation of the Greyrock Trail, presumed to be for at most one year, have been omitted because they are not a long-term loss and could be completely mitigated with careful scheduling and planning. The second column represents the expected shifts in existing uses or the estimated activity levels of new uses associated with the proposed development actions. For conservatism, existing hunting, picnicking, and stream angling activity has been counted as a complete loss, even though displaced users would likely shift to alternative nearby opportunities in or very close to the primary study area. The indicated whitewater boating changes represent projected displaced whitewater use that would be shifted to other Poudre River reaches as a result of development actions. This includes an assumed complete shift of existing use on the Bridges run to the Lower Mishawaka run, although in reality some Bridges use might shift to a new Watson Lake run. The remainder of the table presents the accounting of losses against with-project changes in activity levels, as measured in visits and dollars. These figures reflect expected changes in whitewater boating use, but do not directly address corresponding capacity levels. It should be noted that development of improved access on the Lower Mishawaka run and provision for a new Watson Lake run would be approximately equal to the existing capacity.

The figures in Table 5.20 indicate that potential use associated with the proposed project development actions could be much larger than the direct and indirect losses attributable to the project. Initial annual use of the project recreation facilities was estimated at over 27,000 visits, based on relatively conservative utilization assumptions. This is nearly three times the 9460 total visits estimated to be lost through the Grey Mountain alternative. The resulting net change would be a gain of nearly of the project recreation facilities was estimated at over 27,000 visits, based on relatively conservative utilization assumptions. This is nearly three times the 9460 total visits estimated to be lost through the Grey Mountain alternative. The resulting net change would be a gain of nearly 17,600 annual visits worth more than $519,000. This net gain is possible because the development of new facilities would intensify use levels in the study area, and the reservoir would provide an opportunity for relatively large numbers of boating visits. With respect to use values, the available literature indicates that users have higher expenditures and higher implicit values associated with power boating compared to many other activities. The annual value of the reservoir boating component accounts for over 75 percent of the total net annual value change estimated for the Grey Mountain alternative. It should also be noted that the total recurring net value change of $519,000 is much greater than the maximum possible one-time loss of hiking activity and value.

A comparable summary for the Poudre alternative is presented in Table 5.21. The results of this analysis are similar to those for the Grey Mountain alternative. The total estimated use of new project facilities is somewhat lower at 25,500 annual visits. However, the Poudre alternative would have a much lower level of direct and indirect losses. Consequently, the projected net gain for the Poudre alternative of over 21,000 visits is larger than the Grey Mountain case by over 3500 visits. The total net value change is also correspondingly larger at nearly $584,000 per year, or about $64,500 more than for the Grey Mountain alternative. In addition to the value of the new uses, as described previously, the gross value increases of the Poudre alternative are reduced by a very low net whitewater boating loss.

As indicated in the introductory part of Section 5.2.4, a key objective of the investigation of potential mitigative measures was to address the influence of recreation on overall project feasibility. The costs associated with the potential recreation measures will need to be evaluated concurrently with other project costs to assess overall project economic and financial feasibility. On a technical basis, however, the preceding information indicates that aggregate post-project recreation capacity and use would likely be higher than current conditions with either to Grey Mountain or Poudre alternatives. Further, no key recreation opportunities would be completely displaced and not offset with substitute opportunities. Consequently, there do not appear to be any fatal flaws associated with the recreational aspects of the project.

TABLE 5.20

Potential Net Recreation Effects,
Grey Mountain Alternative

Resource/ Activity	Maximum Annual Direct and Indirect Loss, In Visits	Projected Annual With-Project Change[1] In Visits	Net Annual With-Project Change, In Visits	Unit Value[2]	Annual Value of Net Change
Private Recreation Cabins	1400	0	-1,400	$3.00	$-4,200
Stream Angling	2600	0	-2,600	15.00	-39,000
Hiking (long-term)[3]	0	--	--	16.00	--
Hunting	10	0	-10	50.00	-500
Dispersed Picnicking	400	0	-400	19.00	-7,600
Sightseeing	0	--	--	--	0
Whitewater Boating	5050 [4]	2,040 [5]	-3,010	19.00	-57,190
Filter Plant	(4300)[4]	0	(-4,300)	19.00	(-81,700)
Bridges	(750)	0	(-750)	19.00	(-14,250)
Lower Mishawaka	(0)	(750) [6]	(750)	19.00	(14,250)
Watson Lake	(0)	(1,290) [5]	(1,290)	19.00	(24,510)
Reservoir Boating	0	19,200	19,200	--	519,120
Boat Angling	0	(6,340)	(6,340)	19.00	(120,460)
Power/Skiing	0	(12,860)	(12,860)	31.00	(398,660)
Shoreline Angling	0	1,000 [8]	1,000	15.00	15,000
Camping	0	2,400	2,400	20.00	48,000
Developed Picnicking	0	2,400	2,400	19.00	45,600
Total	9460	27,040	17,580	--	519,230

(1) Generally includes minimum estimates of expected with-project use. Does not include relocation of displaced existing uses elsewhere within the primary study area.

(2) From Walsh et al. (1988).

(3) Excludes effect of possible temporary (one year or less) closure of Greyrock Mountain Trailhead.

(4) Includes minor reduction in use from indirect effects of streamflow changes, based on minimum release schedule.

(5) Based on projected use for minimum release schedule.

(6) Based on shifting all of existing Bridges use to Lower Mishawaka run.

(7) Reservoir boating annual value based on sum of values for boat angling and power/skiiing use.

(8) Based on lesser level of shoreline angling with reservoir management for power boating.

TABLE 5.21

Potential Net Recreation Effects,
Poudre Alternative

Resource/ Activity	Maximum Annual Direct and Indirect Loss, In Visits	Projected Annual With-Project Change[1] In Visits	Net Annual With-Project Change, In Visits	Unit Value[7]	Annual Value of Net Change
Private Recreation Cabins	1400	0	-1,400	$3.00	$-4,200
Stream Angling	1900	0	-1,900	15.00	-28,500
Hiking (long-term)[3]	0	--	--	16.00	--
Hunting	10	0	-10	50.00	-500
Dispersed Picnicking	320	0	-320	19.00	-6,080
Sightseeing	0	--	--	--	0
Whitewater Boating	800 [4]	750 [5]	-50	19.00	-950
Filter Plant	(50)[4]	(0) [5]	(-50)	19.00	(-950)
Bridges	(750)	(0)	(-750)	19.00	(-14,250)
Lower Mishawaka	(0)	(750) [6]	(750)	19.00	(14,250)
Watson Lake	(0)	(0)	(0)	19.00	(0)
Reservoir Boating	0	19,200	19,200	--	519,120 [7]
Boat Angling	0	(6,340)	(6,340)	19.00	(120,460)
Power/Skiing	0	(12,860)	(12,860)	31.00	(398,660)
Shoreline Angling	0	750 [8]	750	15.00	11,250
Camping	0	2,400	2,400	20.00	48,000
Developed Picnicking	0	2,400	2,400	19.00	45,600
Total	4380	25,500	21,120	--	583,740

(1) Generally, includes minimum estimates of expected with-project use. Does not include relocation of displaced existing uses elsewhere within the primary study area.

(2) From Walsh et al. (1988).

(3) Excludes effect of possible temporary (one year or less) closure of Greyrock Mountain Trailhead.

(4) Includes minor reduction in use from indirect effects of streamflow changes, based on minimum release schedule.

(5) Based on projected use for minimum release schedule.

(6) Based on shifting all of existing Bridges use to Lower Mishawaka run.

(7) Reservoir boating annual value based on sum of values for boat angling and power/skiing use.

(8) Based on lesser level of shoreline angling with reservoir management for power boating.

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5.2.5 Recommended Future Studies

The Task 14 recreation studies described above need to be supplemented with future studies, particularly relating to more complete plans for the development of project recreation facilities. As described in Section 5.2.4, the specific composition, siting, and feasibility of the assumed recreation facilities have not been fully investigated and will need detailed future analysis. Some areas of the baseline inventory and effects assessment could also benefit from further study. A number of recommended future activities in each of these functional areas are summarized below.

One of the potential weaknesses of the Task 14 inventory results described in Section 5.2.1 concerns projections of future activity levels, particularly for angling and whitewater boating. Reliable projections for these activities may be possible with additional use data and review of management directions that will result from current agency planning efforts. Consequently, three specific future inventory activities are suggested:

1. Review future Forest Service plans and studies - The Forest Service is currently preparing a management plan for the Cache la Poudre Wild and Scenic River and is involved in a study of a proposed national recreation area (NRA) along the lower river through and near the City of Fort Collins. The management plan will provide direction concerning permissible future levels of commercial whitewater boating use, which is a prerequisite for projecting total boating use. Both efforts, particularly the NRA study, could have significant implications for the project recreation effects assessment and mitigation planning. When completed, these efforts will need to be reviewed to identify any necessary corresponding changes in Task 14 results.

2. Additional field observations - Existing inventory data for angling and some other dispersed activities are relatively limited. Due to practical difficulties in conducting survey work along the river, a future field study based on observations of recreation behavior should be conducted. This study would entail a systematic sampling plan of informal sites along the river between the Grey Mountain Damsite and

Poudre Park. Results of this study would help to better establish baseline use levels.

3. Future use projections - The results of the prior two activities, supplemented by further analysis of growth trends and future use determinants, should be used to develop projections of future use levels for the activities affected by the project.

Any substantive changes in the inventory data would require corresponding updates in the project effects assessment. The discussion of expected effects in Section 5.2.3 also noted some areas of uncertainty with respect to future management of the project and surrounding lands. These two conditions result in a need for the following future studies of project effects:

1. Update effects assessment - Additional inventory activities could produce new information that would need to be incorporated into the analysis of project effects. In addition, the future development of more detailed project plans will require new or supplementary investigation of effects on recreation. Therefore, the Task 14 results will need to be updated in the future to be consistent with changes in baseline data or project characteristics.

2. Establish reservoir management - The Task 14 analysis of changes in dispersed recreation capacity addressed both wakeless boating and power boating management options for the proposed project reservoir. As discussed in Section 5.2.3, selection of a management regime for the reservoir can have a significant influence on recreation experience settings, capacity, and use intensity. Assessment of these effects would be simpler and more precise if intended future management were established through consultation with the appropriate resource agencies.

3. Reanalyze streamflow effects - A key data limitation identified in Section 5.2.1 was the level of detail concerning expected flow releases from the mainstem reservoir. The current studies used conversions to daily flows from simulated mean monthly flows to assess

streamflow-related effects on recreation. This analysis should be revised as more precise flow patterns for the mainstem reservoir releases become available. The need for using a longer period of record than the 1962-1983 period used initially should also be evaluated.

As discussed in Section 5.2.4, the preparation of a comprehensive recreation plan for Stage 1 of the proposed project is a significant future work requirement. Such a plan is needed for technical reasons, to expand on the preliminary and generic development options described above, as well as to comply with licensing requirements. The key components of the expected recreation planning effort are summarized as follows:

1. Prepare demand assessment - A complete investigation of regional and local recreation demand and supply conditions is required to support specific proposals for recreation development. This activity would result in the identification of specific recreation needs and provide for including elements in the project recreation plan that are consistent with those needs.

2. Conduct resource assessment - A thorough multidisciplinary assessment of land and water resources in the locations considered for recreational development is a necessary prerequisite to selection of specific proposed facilities and sites. This study would include detailed field and office investigations of soils, geology, topography, vegetation, aesthetics, and access conditions relative to potential recreational development options and sites. The result of this effort would be an assessment of resource capability to support the anticipated development.

3. Streamflow feasibility studies - In addition to supplementing the project effects studies, further detailed streamflow analyses for mitigation options would be appropriate. A key objective of these studies would be to confirm the feasibility and expected use of a new Watson Lake whitewater run. More precise data on project operations could also be used to determine if daily, weekly, and monthly flow

releases could be manipulated to enhance whitewater boating utility below either proposed damsite.

4. Select preferred development sites - The results from items 2 and 3 above should be combined with recreational development objectives, based on the effects and needs assessments, to select a set of preferred sites and recreational facilities for inclusion in the recreation plan. To provide flexibility, one or two alternate sites for each major recreational facility should also be identified.

5. Develop site plans - Specific plans for each proposed recreational facility need to be prepared. The products of this activity should include enlarged maps of the specific features proposed for each site, site layout drawings, component and equipment lists, and site capacity estimates.

6. Prepare detailed cost estimates - Detailed cost estimates need to be developed for each recreational facility. These estimates should be specific to the conditions at each site, and should reflect the construction cost experience of the entities likely to be involved in establishing facility design specifications and eventual construction.

7. Estimate future use of facilities - Realistic estimates of future use of the proposed recreational facilities should be developed through careful consideration of existing use patterns and trends, growth projections, and specific site attractions. These estimates should reflect the additional analyses discussed above, and could be considerably different from the estimates presented in Section 5.2.4.

8. Finalize development feasibility - The specific proposals for recreational facilities identified through items 4 and 5 above should be reviewed against the cost and future use estimates to determine if the facilities are economically feasible. If any proposed recreational facilities would be prohibitively expensive or would be under-utilized,

they should be replaced with suitable substitutes that would provide comparable opportunities.

9. Develop implementation plan - The final element of the recreation plan is the identification of construction and operations actions needed to implement the proposals. The implementation plan needs to establish a construction schedule for the recreation development, describe financing arrangements for construction and operation, identify the agency responsible for operating each facility, and summarize operation and maintenance requirements.

5.3 AESTHETICS

5.3.1 Overview

5.3.1.1 Study Objectives

The aesthetics studies of Task 14 focused on evaluating potential effects of the proposed Stage 1 Cache la Poudre Project on the existing aesthetic resources of the study area. The following were the specific objectives of the studies:

- Characterize the existing aesthetic resources;
- Assess the potential visual changes of the proposed project on aesthetic resources;
- Identify compatibility of the projected aesthetic effects with existing management designations for the area; and
- Identify potential mitigation measures and possible implications for project feasibility.

5.3.1.2 Study Area

The formal study area for aesthetics, as shown in Figure 5.3, was defined to ensure inclusion of any areas potentially visible from proposed project facilities. Therefore, the study area included a significant area of land beyond the affected viewsheds within the Poudre Canyon. For convenience in assessment and presentation, this area was divided into four segments that encompass the key viewsheds: Lower Poudre Canyon, the North Fork, the mainstem-North Fork confluence to Poudre Park segment, and the mainstem above Poudre Park. The aesthetic assessment indicated that the actual viewsheds that would be directly affected by the proposed project would be relatively confined by topography. The emphasis of the evaluation was, therefore, on landscapes visible from the river corridor itself. The remainder of the formally defined study area shown in Figure 5.3 was beyond the visual influence of the project and was not analyzed in detail in this assessment.

5.3.1.3 Methods

The aesthetic resource inventory for Task 14 involved collection and analysis of secondary data, supplemented by field reconnaissance. FS visual resource maps and forest planning documents were examined to determine inventoried visual conditions and planned visual management of the area. Topographic maps and the vegetation maps prepared to support the wildlife and botanical components of the Basin Study Extension were used to characterize existing landscapes and assess project effects. Study area field investigations were performed by Envirosphere and ORRA to assess the current setting and check the secondary data. A simple comparison of the existing landscapes and management plans with the project specifications available to date led to the assessment of project effects. Potential mitigation measures were identified to aid in the assessment of project feasibility.

The aesthetics studies utilized to a considerable extent the Visual Management System (VMS) employed by the FS to maintain visual quality in its management of national forestlands to meet multiple use demands. This system provides a framework for visual resources management, including characterization of baseline conditions, procedures for determining visual impacts, and the development of visual quality objectives (VQOs) to be incorporated with land management prescriptions. The purpose of this system is to attain the highest possible visual quality commensurate with management objectives for other resources. Under this system, forest landscapes are inventoried, mapped, and rated according to their visual quality (variety class), the public's concern for scenic quality (sensitivity level), and the viewing distance zones (foreground, middleground, and background) from travel routes and use areas. These ratings are then combined to derive VQOs that specify permissible degrees of visual modification resulting from management activities in a given area.

Variety class is a measure of a landscape's scenic value in terms of degrees of natural-appearing variety. Ratings range from variety class A, for landscapes with land and water forms considered to be distinctive, to variety class C for landscapes with minimal visual diversity (FS, 1974). Sensitivity levels are a measure of viewer concern for scenic quality, and are assigned to all visible areas as determined from observer positions along travel routes, at use areas, and on water bodies. Sensitivity levels 1, 2 and 3 are defined based on the proportion of viewers who have a major concern for visual quality (FS, 1974). In application, sensitivity levels are usually assigned on the basis of assumed proportions of all viewers who are in a given area for recreational purposes. Landscapes are also classified by distance from travel routes, water bodies, and use areas. There are three distance zones, with dividing lines based on topographic features and the amount of detail that can be observed.

The foreground is usually limited to areas within 0.25 to 0.5 mile from the observer, the middleground extends from foreground to 3 to 5 miles from the observer, and the background extends from middleground to infinity (FS, 1974).

Variety class and sensitivity level ratings are evaluated jointly to determine the degree of landscape modification permissible. One of five possible VQOs that specifies permissible modification is assigned to the various distance zones in all inventoried areas. The five VQO designations are as follows (FS, 1984):

1. <u>Preservation</u> (P) - Allows only ecological changes; management activities, except for very low visual impact recreation facilities, are prohibited. This designation applies to specially classified areas including wilderness.
2. <u>Retention</u> (R) - Management activities are not evident to the casual forest visitor. This VQO is often applied to foreground lands along major travel routes where there is heavy recreational travel.

3. Partial Retention (PR) - Management activities remain visually subordinate to the natural appearance of the landscape. Foreground areas along secondary travel routes, such as trails, often have this designation.

4. Modification (M) - Man's activities may dominate, but only as a natural-appearing composition when viewed from any distance. This designation is usually associated with resource extractions and development.

5. Maximum Modification (MM) - The least restrictive objective allowing man's activities to dominate. A natural-appearing composition must appear when viewed from a distance.

Accordingly, existing FS data provided a primary source of information for both existing landscape characteristics and visual resource management requirements. Additionally, the VMS impact analysis framework was considered in assessing project effects, although information required for a rigorous application of the VMS impact assessment methodology was not available. Topographic and vegetation maps provided key information to support the FS data. Field reconnaissance by consultant personnel supported the characterization of baseline conditions and portions of the assessment of the visibility of proposed project features. Specific methodological details beyond this overview are noted as appropriate in the technical discussion.

5.3.2 Existing Conditions

The existing aesthetic environment is described in the following paragraphs in three components: visual character, viewer characteristics, and visual resource management. Visual character entails an overview of the existing physical characteristics of the landscape based on land and water forms, vegetation, and topography. Variety class ratings and locations where these landscapes may be viewed are also addressed in this section. Viewer characteristics include the number and types of viewers and their presumed sensitivity to visual change. The visual resource management discussions address the current FS management within the study area.

Site-specific characterization of the entire study area with respect to these three components is limited by the extent of existing visual resources inventory information. Approximately two-thirds of the study area is within the national forest boundary and is generally addressed with respect to visual quality objectives in the forest plan (FS, 1984). However, detailed, accurate and up-to-date information on variety class, viewer sensitivity and distance zones was not uniformly available for these lands. The remainder of the study area is state, local government, or privately owned lands, none of which are mapped for their visual quality. Nonfederal lands are mainly located south of the river and in the easternmost portion of the study area. FS lands encompass most of the study area north of the mainstem and west of the North Fork. Generally, the visual characteristics of the nonfederal lands are similar to the FS lands except in the southeastern corner of the study area. That area is comprised of gently rolling hills and flat land used primarily for agricultural purposes.

5.3.2.1 Visual Character

The study area for the proposed Stage 1 Cache La Poudre Project is situated in the eastern foothills of the Rocky Mountains, west of Fort Collins, Colorado. The landscapes of the river canyon are characterized by undulating hills covered largely with mountain shrubs and grassland, particularly on south and west-facing slopes. Open and closed-canopy conifer forests are also common, particularly at higher elevations and on north- and east-facing slopes. These two conifer types collectively occupy about 40 to 45 percent of the acreage within the aesthetics study area. Elevations in the study area vary from a maximum of about 7600 feet at the top of Greyrock Mountain to a low of about 5200 ft near Ted's Place, providing up to 2400 ft of vertical relief within the study area. The canyon has moderately steep to steep (less than 50 percent) slopes. The canyon is narrow and V-shaped, with typically less than about 500 ft of relatively level land across the canyon floor. At the top of the canyon walls, typical distances between the flanking ridges are about 1 mile. The dominant landscape element in the project area is the Cache la Poudre River. Greyrock Mountain is also a prominent feature, although views of the mountain from the canyon are often limited.

The character of the actual waterway varies by location and over time. Intermittent large boulders and directional and gradient changes create variations in hydrology and waterway aesthetics. The river has alternating areas of rapids, riffles, and pools or slower-moving water, creating changes from rough to smooth water surfaces. These conditions change significantly with streamflow variations during the year. Extensive whitewater areas exist during the high runoff period of late spring-early summer. Flows decrease in late summer, causing the river to decrease noticeably in width and velocity. The river is also somewhat turbid at high flows and typically clear during the remainder of the year.

The FS has classified approximately 99 percent of its land within the primary study area as variety class B, common (FS, no date). A small area near the Greyrock Mountain Trailhead is classified as distinctive (variety class A). This area accounts for approximately 300 acres. Nonfederal lands within the study area are similar in appearance to FS lands. If classified, they would probably also be assigned primarily to the variety class of common.

Landscapes are generally viewed from travel routes, recreation sites, and developed areas. Travel routes within the study area are limited to Highways 14 and 287, secondary roads near Highway 287 and Poudre Park, and trails. The river itself is a travel route for whitewater boaters, but for most users is a series of recreation sites. Within the part of the canyon potentially affected by the proposed project, the travel route viewing locations include Highway 14, the river and river access sites, and the Greyrock Mountain Trail. These features were described previously in Section 5.2.2, and are shown in Figures 5.3 and 5.7. Views from these locations are summarized below. Views from Highway 14 and the river are quite similar because of close proximity, and no distinction is made between views from these features. Development within the study area is limited to individual cabins or homes in scattered locations and the rural community of Poudre Park. Virtually all development is located along Highway 14.

Highway 14 is well travelled by both vehicles and cyclists. Views along the highway vary in duration and scenic quality because of the winding nature of the road and the differing vegetation and topography of the canyon. Average travel speeds within the study area are probably between 30 and 40 miles per hour, considering speed limits and the frequency of curves. For the most part, viewer attention is drawn to the river and the adjacent riparian areas. However, several elevated segments of the road allow broader views of nearby topography. Viewing duration is generally short except at several informal turnout areas, at developed recreation sites above Poudre Park, from residences, and along the few straight stretches of the highway. Viewer position is almost always level with respect to the river, or inferior when viewing the canyon walls.

Lower Poudre Canyon

As defined for this study, the lower Poudre Canyon segment extends about 7 miles from the City of Fort Collins water filtration plant property, near the confluence with the North Fork, to the eastern edge of the study area. The landscape character of this section of the study area is varied. Elevations range from about 5180 ft at the river in the extreme southeastern corner of the study area to over 6300 ft along the canyon walls. An area of about 3 square miles west and northwest of Ted's Place is relatively flat land used primarily for agriculture (see Section 5.4.2), with some scattered development evident. The area is bordered on the east, west, and north by low, rolling hills covered mainly with shrubs and grassland. These hills include the ridges at the canyon mouth approximately 1.5 miles west of Ted's Place.

Near the proposed Grey Mountain Damsite (about 4 miles above the canyon mouth) the ridges forming the canyon walls are relatively high but are more rounded than those found farther up the canyon. The local vertical relief is about 900 ft. A photo of the immediate vicinity of this site is included as Figure 5.8 (see Figure 5.15 for a location map of all photos presented in Sections 3.2.1). The main vegetative cover in the area is mountain shrub and grassland, with some riparian trees adjacent to the river. The proposed Grey Mountain Damsite is located at the north end of a 0.5-mile section of straight highway that is one of the first straight portions of Highway 14 encountered by those traveling west. As indicated in the photo, the visual environment from the highway alignment is partially enclosed by the steep terrain and extends beyond the immediate canyon walls to the middleground zone. The FS visual resource information does not include this area, so landscape variety has not been classified.

The landscape character near the proposed Poudre Damsite is generally similar to that of the Grey Mountain site, but has several different elements. A photo of this site is included as Figure 5.9. Mountain shrub and rock/talus are dominant in the area, although there are a number of conifer trees along the western side of the canyon. The landscape shown in Figure 5.9 has been inventoried by the FS as variety class B, common. The view at this location is generally limited to the foreground. There is evidence of human modification, primarily from highway and water filtration plant construction, resulting in a variety of topographic lines that draw viewer attention in several directions. A nearby ridgeline, a cut slope, and the gentle incline of the background ridges provide a horizontal element to the landscape, in addition to the more vertical lines of the canyon walls.

The landscape character in the area between the two proposed damsites is dominated by the meandering quality of the river. Figure 5.10 presents a view from an informal river access site in this area. Visual variety in this area is also class B, common. Mountain shrub with interspersed patches of grassland, rock/talus, and sparse conifer forests are predominant in the area. Slopes above the right (west) bank tend to be less steep than those found on the left bank. Some human modification to the natural environmental is evident. Another informal parking area and river access spot is located on the river bend just upstream of the proposed Grey Mountain Damsite. There are two residences with associated outbuildings located in this area. Opposite one residence is a large gravel pit that visually contrasts with the surrounding landscape.

Viewing duration from the highway in the lower Poudre Canyon varies from short to medium. Several of the few straight stretches of Colorado 14 in the study area are located in this section. The longer segments of up to 0.5 mile allow the viewer to focus more intently on the surrounding landscape for up to about 1 minute and may increase expectations of what is to come. Several informal turnouts are available along this section of Highway 14 and allow for extended viewing. The remainder of the lower canyon has limited viewing duration where the road is more winding and viewers need to concentrate on driving.

North Fork

The North Fork drainage has three somewhat distinct areas. The lower portion near the confluence with the mainstem and Seaman Reservoir has several very pronounced bends in the river and canyon (see Figure 5.1 or 5.3). North of Seaman Reservoir, the river course is straighter and the flanking ridges are somewhat higher in elevation. At the northern end of the study area the North Fork flows more from the west and northwest and the landscape becomes more rolling and open.

Figure 5.11 is a photo of the confluence area and the lower canyon of the North Fork. Due to the course of the river relative to Highway 14 at this location, the view over the confluence (which is not actually visible from the highway) is toward the east. The north-facing slope on the right-hand side of the photo has relatively dense conifer vegetation. Slopes to the north and east are characterized by mountain shrub and grassland vegetation. Landscape variety in this location is class B, common. Foreground, middleground, and background views are possible from the elevated position of Highway 14 in this area. Seaman Reservoir is not visible due to intervening topography.

The east-facing slope of the North Fork Canyon above Seaman Reservoir is characterized by dense to moderately dense conifer forests on fairly steep slopes. The western slope is less steep and is characterized by mountain shrubs and grassland. The ridges forming the canyon walls rise to about elevation 6600 ft near the river, which is approximately 1100 ft above the level of Seaman Reservoir. Bonner Peak, elevation 6944 ft, is the most prominent landform to the east of the North Fork. Near the northern end of the study area, ridgetop elevations are slightly lower and the terrain is generally more rolling and open. Eagles Nest is the highest point in this area at elevation 6422 ft. The upper 2 miles of the North Fork drainage within the study area have virtually all mountain shrub and grassland vegetation, with scattered small areas of open-canopy conifer forest. The upper North Fork landscapes that have been inventoried by the FS are also variety class B, common.

The vast majority of the North Fork drainage within the study area is generally inaccessible to the public. The only road up the drainage intersects

Highway 14 at the filtration plant entrance, where a gate restricts access. This road is maintained by the cities of Fort Collins and Greeley and extends up to Seaman Reservoir. Light-duty roads leading west from U.S. 287 approach to within only about 1 mile of the North Fork. The upper end of the North Fork drainage within the study area is within the middleground viewing zone from the Redfeather Lakes road.

Views of the North Fork drainage are limited due to the lack of access. One of the most scenic views in the study area is the broad view of the lower North Fork and confluence area from an elevated (viewer superior) position along Colorado 14, as shown in Figure 5.11. The view from moving vehicles is limited in duration to a few seconds, but an undeveloped turnout exists at this curve. The remainder of the North Fork drainage is not visible to the average study area visitor. Portions of the drainage become visible from the top of Greyrock Mountain, but the river and Seaman Reservoir cannot be seen.

Confluence - Poudre Park

The landscape character along the mainstem of the Cache la Poudre River above the confluence varies considerably from the lower reaches already discussed. Conifer forests dominate the steeply sloped southern wall of the canyon, while the northern slopes are somewhat less steep and dominated by mountain shrubs with interspersed patches of conifers. There is also a narrow belt of conifers and riparian vegetation along most of the river in this section. Elevations in this reach vary from a low of 5374 ft near the confluence to 7613 ft at the top of Greyrock Mountain. Ridgetop elevations along the immediate stream canyon are generally in the 6400-6600 ft range, or about 1000 ft above the river level.

The disturbed area near the City of Fort Collins filtration plant extends from just above the proposed Poudre Damsite for approximately 0.5 mile upstream of the confluence with the North Fork. The mainstem makes a sharp horseshoe bend in this area. Much of the visible area within the bend is occupied by cleared areas and structures on the filtration plant site. The winding canyon is largely undeveloped from this point for about 4 miles to Poudre Park. However, there is an existing water intake structure (the Monroe Diversion) at one location, and a number of homes at scattered locations near Poudre Park.

Figure 5.12 is a photograph of a typical streamside view in this section of the canyon. This view is toward the east-northeast about 0.5 mile above the confluence and filtration plant. The photo foreground indicates streamside conifers along the north bank and the relatively dense conifer vegetation on the south wall of the canyon. The background features are east of the North Fork. The landscape variety class in this area is B, common.

Views along the mainstem near the filtration plant are dominated by the visual disturbance created by clearing and structures at the plant. The scenic view beyond the plant tends to lessen the foreground effect. The highway along the remainder of the mainstem up to Poudre Park offers fairly unobstructed views of the river as it meanders along the canyon. Highway 14 parallels the river along the steeper south bank, and turnouts are less common in this section. Because of the winding nature of the river and the road along this stretch, viewing duration is limited. Viewing distance up and down the canyon is also limited by the narrow, winding nature of the canyon.

The Greyrock Mountain Trail, which begins about 2 miles below Poudre Park, adds several aesthetically distinct features to the local visual setting. These include the trail steps and wooden bridge across the river, the adjacent river banks, and the trail itself. These features are shown in Figure 5.13. The trailhead area offers limited background viewing because of the dense vegetation near the river. However, the opportunity to linger on the bridge and obtain unobstructed views of the river is a popular aesthetic attraction. The bridge across the river provides a distinctive entrance and exit to the trail, and probably has positive effects on viewer expectations and conclusions.

The Greyrock Mountain Trail is itself a significant viewing location within the study area. Along the lower portion of the trail, the river is generally blocked from view by vegetation, but the river is audible. Approximately 0.5 miles from the trailhead, the trail begins its ascent into a secondary drainage. The middle portion of the main trail is flanked by ridges to the east and west that restrict views to the foreground. Most of the trail route is in open- or closed-canopy conifer forest, which also tends to limit views. The westward loop portion of the trail that passes through Greyrock Meadow has a ridgeline section that provides views over Hewlett Gulch and the area around Poudre Park, as well as other mountains to the west and south. More expansive views are possible from the top of Greyrock Mountain, as partially indicated in Figure 5.14. This view is toward the southeast, including the mainstem and North Fork drainages near the confluence area. The plains area, including numerous lakes, is visible in the distant background. All of the inventoried landscapes in this view have been categorized as variety class B, common. The Greyrock Mountain summit offers panoramic background views in the other compass directions as well, extending from the plains to the mountains at the Continental Divide.

The FS has assigned a variety class A, distinctive, rating to an area of approximately 300 acres near the Greyrock Mountain Trailhead. Most of this area is on either side of the river from about 0.5 to 1 mile upstream of the trailhead. The higher variety class is presumably due to the combined effects of the river characteristics, including rapids, and the rock and vegetation pattern of the canyon walls. This rating is limited to the foreground viewing distance from Highway 14 in this area.

Poudre Park - Mishawaka

The area along the mainstem Cache la Poudre River near and above Poudre Park is much more developed than the river sections described previously. Poudre Park is a tourist-oriented rural community of approximately 60 to 80 residences and commercial establishments located along the south bank of the river. Colorado 14 passes through the middle of town in one of the few locations in the study area where the highway diverges from the river. The canyon walls south of Poudre Park are forested and fairly steep. The northern wall of the canyon is dominated by steep, rocky slopes with mountain shrub vegetation. Elevations vary from 5676 ft in Poudre Park to over 7300 ft on ridges to the south. The upper slopes of the canyon walls, particularly north of the river, have less coniferous vegetation than the segment below Poudre Park. Some riparian vegetation provides a degree of landscape variety beyond the shrub and conifer cover. A FS campground and two picnic areas are located farther upstream in flat riverside areas. The small cluster of buildings at Mishawaka is just beyond the western edge of the study area.

Many canyon visitors pass through Poudre Park. Views from any location in town are limited by topography to about a mile or less in any direction. Above Poudre Park, the canyon becomes steeper and the highway is winding. Views are also limited in distance in this area. Visible landscapes are all classified as variety class B, common. Campgrounds and picnic sites give opportunities to increase viewing duration. Some informal turnouts exist, but views from these are limited by terrain and forest cover.

5.3.2.2 Viewer Characteristics

Detailed descriptions of viewer characteristics for the study area have not yet been developed, and will be considered as part of future studies. However, some general information on viewer numbers and sensitivity, based on existing available information, is provided below.

Viewer Numbers

Highway 14 provides the only access to the Poudre Canyon within the study area. It parallels or is in view of the mainstem Cache la Poudre River almost the entire length of the canyon. The route is highly travelled and carries an annual average of more than 1700 vehicles per day into or through the study area (CDH, 1982-87). Assuming an average of 3 people per vehicle, this level of traffic would correspond to 5100 travellers per day and over 1.8 million travellers per year through the study area. The sources of this traffic would include residents of the canyon, persons conducting commercial and administrative activities, and recreationists. The canyon does not have a large resident population, but there are several small communities located west of Poudre Park. The main recreational user groups within the study area are persons driving for pleasure, rafters and kayakers, hikers, campers, picnickers, and anglers.

Annual average visitation figures for these activities were reported previously in Tables 5.5 and 5.6. Sightseers represent the largest recreational user group, with an estimated 207,000 visits per year. An annual average of more than 300 cars a day use the highway for sightseeing, as estimated in Section

5.2.2.3. Not all of these vehicles stop within the study area, but all pass through it. An estimated 6000 whitewater boating visits annually occur on the river within the study area, most of which is in the lower Poudre Canyon on the 2.8-mile Filter Plant run. The Greyrock Mountain Trail currently receives about 19,500 recreation visits each year. Fishing is fairly dispersed but popular throughout the canyon, with the areas near informal parking areas receiving the most use. Current annual angling use in the primary study area is estimated at 4700 visits. Other dispersed uses account for about 500 visits per year.

The five developed recreation facilities in the study area (excluding the Greyrock Mountain Trailhead and private recreation cabins) also receive substantial use (see Figure 5.7 for locations). CDPOR estimates total annual visitation at the Upper and Lower Picnic Rock river access sites at over 52,000 visits per year (see Table 5.5). The Ansel Watrous Campground and the Diamond Rock and Poudre Park Picnicgrounds collectively have reported annual visitation of 4000 people.

Overall, the total developed and dispersed recreation figures from Tables 5.5 and 5.6 sum to over 295,000 visits per year. Aside from any accuracy limitations, this figure overstates the total number of annual visitors by double, counting people who engage in multiple activities (visits) during a single trip to the study area. Nevertheless, a large number of recreationists view study area landscapes during their recreational activities.

Local residents and pass-through travellers on Highway 14 account for the remainder of the daily or annual traffic. No specific breakdown between residents and nonresidents is available. The 1980 population of the two unincorporated zones of Larimer County that include the Poudre Canyon was reported at 580 permanent residents and 1395 seasonal residents (Larimer County Planning Department, 1985). The area of the canyon from Mishawaka to Ted's Place accounted for about 66 percent of the permanent residents and 52 percent of the seasonal residents. While local residents are small in number, compared to recreational visitors, most of the local residents would have a much higher travel and viewing frequency in the study area than the typical recreationist.

Viewer Sensitivity

Viewer sensitivity in the canyon was not addressed in the Task 14 field survey (it will be considered in future studies of the proposed project), but is presumed to be high. This results from many viewers being recreationists engaged in various pursuits, and recreationists have been shown to be relatively more sensitive to visual changes than pass-through travellers or people in the area for business purposes. Sensitivity may be higher in the lower portions of the canyon where first-time or infrequent visitors may have high expectations for scenic enjoyment.

The FS has classified all of the principal viewsheds within the study area as sensitivity level 1 (FS, no date). However, these sensitivity ratings are based on staff assumptions of visitor characteristics rather than on site-specific surveys or analysis of actual use. This means that at least 25 percent of all visitors are expected to have a major concern for scenic quality. Level 1 is the highest sensitivity level in the FS visual management system and reflects the relatively large proportion of total visitors to the area who are recreationists. A small parcel of less than 100 acres southwest of Poudre Park that is beyond the viewshed of the canyon is the only study area land classified as sensitivity level 2.

National forest land management planning incorporates visual quality objectives. The Land and Resource Management Plan for the Arapaho and Roosevelt National Forests (FS, 1984) provides the primary management direction for these lands. The current plan designates management areas as units of land to which a single management prescription is applied. Management prescriptions are sets of practices and intensities selected and scheduled for application on a specific area to attain goals and objectives desired for that area. The set of practices employed for any given management area includes a VQO designation. The 1984 plan designated FS lands in the study area as management areas 10D, 5B, and 3A, as indicated in Figure 5.16.

Management area 10D is a special area that was established to protect the character and values of the Poudre River corridor eligible for designation as a component of the National Wild and Scenic River System. This management area was established prior to the Wild and Scenic River legislation passed by Congress in October 1986 that designated 75 miles of the river above Poudre Park as wild or recreational river segments. For the remainder of the corridor below Poudre Park, the 10D designation is inconsistent with the legislative provision concerning possible water resource development in this reach of the river. Once area implementation plans are completed, designation of this area will probably change to management area 2B. Area 2B prescriptions emphasize rural and roaded natural dispersed recreation opportunities. This corresponds to current actual practices in the corridor below Poudre Park (Rankin, 1988). Partial retention (PR) is the VQO prescription for area 2B (FS, 1984). The plan directs that visual resources in these areas be managed to maintain or improve the quality of recreation opportunities. Management activities must harmonize and blend with the natural setting. Landscape rehabilitation is to be used to restore landscapes previously modified to a desirable visual quality. Enhancement aimed at increasing the positive elements of the landscape to improve visual variety is also prescribed.

Management area 5B provides emphasis on big game wildlife winter range. Modification is the VQO prescription for this area. However, management activities must not be evident or must remain visually subordinate in the foreground. Modifications may dominate in the middleground if they blend with the natural setting (FS, 1984).

A small portion of the study area surrounding the Greyrock Mountain Trail, which is considered to have a high visual sensitivity, is classified as management area 3A. This management area provides emphasis on semiprimitive nonmotorized recreation. According to the management requirements for this area, a VQO of partial retention (PR) should not be exceeded, and landscape rehabilitation should be implemented where PR is not being achieved (FS, 1984). Visual resources for this area are to be managed so that management activities are not visually evident or remain visually subordinate. The management prescriptions also direct that viewing opportunities should be enhanced and vegetation diversity be increased.

5.3.3 Project Effects

The construction and operation of Stage 1 of the proposed Cache la Poudre Project would have potentially adverse as well as positive effects on the existing aesthetic environment. Adverse effects would be both short-term, related to temporary construction activities, and long-term, associated with permanent project facilities and operations activities. Positive effects of the project would be related to the lake-oriented visual variety that would be created. The significance of those effects is determined by the compatibility of the landscape modifications with FS visual resource management objectives assigned to the public lands affected by the project's development and by the effect on viewing activity. The significance of the effect on viewing opportunities and experiences is influenced by the potential visibility of project elements (dam, powerhouse, transmission line, switchyard, etc.), viewing frequency, and viewer sensitivity factors (recreationists typically have a high concern for the visual resource environment).

The following discussions address the potential aesthetic effects that could result from the proposed project. Due to the lack of project specifications available at the time of this evaluation, only a preliminary estimation of potential effects can be provided. The visibility of project features was estimated from maps of project features, topography, and vegetation, and was supported by preliminary field observations and photographs from selected locations. More detailed mapping and field measurements will be needed to confirm or modify the resulting conclusions.

5.3.3.1 Landscape Change and Visibility

<u>Grey Mountain Alternative</u>

The proposed mainstem dam at the Grey Mountain site would span the lower Poudre Canyon approximately 2 miles below the confluence with the North Fork (see Figure 5.1). The dam would extend approximately 390 ft above the present river bed to a likely crest elevation of 5660 ft (Harza Engineering Company, 1987). The dam would be approximately 1500 ft (0.28 mile) wide at the crest and about 400 ft wide at the base. The dam would probably be a conventional concrete gravity dam or concrete arch dam. The powerhouse for the conventional hydroelectric development would be located at the base of the dam. As described in the 1987 Basin Study report, the outlet works and stilling basin would extend about 500 ft downstream from the base of the dam.

Construction of the dam would introduce geometric lines and forms that would visually dominate the landscape at the damsite. The strong horizontal-linear form of the dam's crest would contrast with the predominantly vertical or sloping lines of the moderately steep canyon walls (see Figure 5.8). The mass of the dam would also be prominent. The ridgetop elevations on either side of the damsite are about 6200 ft, or approximately 900 ft, above the riverbed. Consequently, the dam height would fill over 40 percent of the vertical space of the canyon at this location.

Color and texture contrast would likely be significant, although not as sharp as it would be in an area of heavily forested slopes. The canyon walls at the damsite are covered with low-growing mountain shrub and grassland vegetation that provides several tones of lighter colors. Boulders, bare rock outcrops, and scattered trees on the slopes and along the river introduce a degree of darker contrast. Viewed against this background, the relatively light gray color and smooth texture of the dam would present a noticeable contrast.

The existing visual environment at the site has been modified somewhat by human development but is primarily natural in appearance. Most of the modification is due to the presence of Highway 14. There are also existing wood-pole utility lines parallel to the highway. The dam and supporting facilities would be more prominent than these existing visual modifications and would represent a significant alteration of the local landscape.

The proposed Grey Mountain Dam would be viewed primarily by travellers on the relocated Highway 14. Dispersed recreationists along the river for approximately 0.5 mile downstream from the dam would also be able to view the structures, while the project would probably be screened from the views of users of the Picnic Rock developed sites further downstream. Northward views from the Lower Picnic Rock river access site, which is 1.4 miles downstream, are completely blocked by the canyon wall. Preliminary review of sight lines also indicates that recreationists at the Upper Picnic Rock site would probably not be able to view the dam. Even at the extreme northern end of this site, the ridge along the right (west) bank that forms the upstream bend in the river would appear to obstruct the view toward the damsite.

Analysis of the proposed highway realignment (see Figure 5.1) and the local topography suggests that views of the dam from the relocated Highway 14 would be likely for a distance of approximately 0.5 mile immediately south of the damsite. Motorists travelling up the canyon would probably begin to view the dam as they round a slight bend just north of Upper Picnic Rock, near the middle of Section 9 (see Figure 5.1 for the realignment location). The elevation of the new road at this location is estimated at approximately 5600 ft, which is about 60 ft below the elevation of the dam crest. Opposite the damsite, the road elevation would reach about 5800 ft, or more than 100 ft above the dam crest. Viewer position along this section of road would be essentially level initially and superior in elevation at the damsite. Consequently, the dam would probably be less dominant than if the viewer position were inferior. The highway realignment plan includes an option for a tunnel opposite the right abutment of the dam. Implementation of this option would eliminate the short section of road where motorists would pass directly by (and above) the dam at a distance of less than 300 ft.

The dam could also be visible at some locations along the relocated highway north of the dam, particularly for travellers approaching from Poudre Park. For approximately 1 mile to 0.5 mile north of the damsite, the proposed Highway 14 realignment would cross a sideslope area covered primarily by grassland and mountain shrub vegetation. The terrain and vegetation in this area would permit views toward the dam from a slightly elevated position. An area of mostly open-canopy conifer forest within 0.5 mile of the damsite would at least partially screen the closer views. Construction of the optional tunnels would reduce the highway section from which the dam might be visible by about 50 percent.

The number of viewers affected by this transitory view of the dam would be an average of approximately 5100 people (or viewer occasions) per day, or 1.8 million per year. This is based on the existing Highway 14 traffic levels reported previously. This viewer population would include local residents making regular or repeated trips through the canyon, business travellers, and recreationists travelling to various sites near the project or farther upstream. The overall visual sensitivity of these viewers is presumed to be relatively high, due largely to the proportion of recreationists.

Dispersed recreationists along the immediate downstream section of the river would also comprise a small portion of the viewer population. This use would include approximately 125 annual whitewater visits, assuming noncommercial rafting and kayaking continues in this location, and a small percentage of the 4700 annual study area fishing visits that would presently be accounted for by this 0.5-mile segment of wild trout water. These users are also assumed to have a high sensitivity to visual change.

During construction, the staging areas and borrow pits near the dam could be visually evident from some locations along the highway. Again, these construction activities would probably be visible to travellers approaching from Poudre Park as described above. Due to the expected middleground viewing distance and the elevated viewer position, these features would probably not be dominant. The borrow pits would be inundated by the filling of the reservoir and would not represent a long-term landscape modification.

The supporting facilities at and near the dam would add incrementally to the visual effect of the dam. The powerhouse, switchyard, and transmission lines near the dam would be visually subordinate to the dam itself, but would introduce additional geometric lines and forms to the landscape. The powerhouse exterior would be concrete and similar in appearance to the dam, while the switchyard and powerlines would have many metallic elements. An access road to the top of the dam has not been specifically proposed and might not be needed. If constructed, however, it would be evident on either slope of the canyon and would add to the visual complexity of the project. The outlet works and stilling basin would extend the visible features of the project about 500 ft downstream from the dam.

The switchyard and transmission facilities have not yet been sited. It is likely that the transmission line would be located along Highway 14 downstream from the dam and connect into the local grid system at the first suitable location. A transmission line along this route would be parallel to the existing Highway 14, which would no longer be used by the general public, for approximately the first 1.4 miles from the dam. The existing roadway and proposed transmission line would be separated from the relocated Highway 14 by up to 1000 ft near the dam and would be at a lower elevation than highway travellers. The transmission line would probably be noticeable but not prominent to these viewers. A transmission line using wood poles would represent less change from existing conditions and would be less noticeable than a line using lattice steel towers. This would also be the case on the eastern 3-mile section of Highway 14 that would not be relocated, where the transmission line would be adjacent and parallel to the roadway.

The Grey Mountain Dam would create a reservoir with a maximum surface area of about 1600 acres at the normal maximum water surface elevation of 5630 ft. When full, the reservoir would extend about 6.4 miles up the mainstem and about 6.5 miles up the North Fork. The maximum width of the reservoir would be about 1.3 miles near the current Seaman Reservoir, away from existing viewer locations. Along the mainstem, the reservoir would typically be 0.25 mile wide, but would range up to 0.5 mile wide near the dam. The visual character of most of the Grey Mountain Reservoir would be that of a relatively narrow water body framed by steep canyon walls. The south shoreline would be predominantly forested with conifers, while the slopes north of the mainstem arm would be mostly open mountain shrub areas.

The presence of a large water body in this setting would add a different landscape feature. The reservoir would increase the visual diversity of the landscape, and in that respect, represent a positive change. Viewers would likely react differently to this change, as some would prefer the visual environment of a lake while others would prefer a river setting.

Any significant fluctuation of the reservoir level would temporarily but directly affect the visual contrast created by the project. Exposed shorelines and bank scouring visible at low reservoir levels are assumed to be unappealing to most viewers. The frequency and duration of such drawdowns is somewhat uncertain at the present time, and would vary over time with natural streamflows.

A summary of information on expected reservoir surface levels, based on simulations of reservoir operations using historic flows over the 1954-1983 period of record, is provided in Table 5.22. For average conditions, the mainstem reservoir level would reach a peak in June and decline to annual minimum levels from October through December. Based on these historic flows, the mean reservoir level at the end of June would be 5586 ft, or 44 ft below the normal maximum water surface elevation. The average annual minimum level would be about 30 ft lower at elevation 5556 ft. The frequency columns in the table indicate that the reservoir would be full (within 5 ft of the normal maximum elevation of 5630 ft) at the end of June 33 percent of the time, or 10 out of 30 years. By August, this frequency decreases to 3 percent, or 1 in every 30 years. Conversely, the reservoir would also be at less than 5580 ft, or more than 50 ft below the normal maximum, in one-third of the years at the end of June. A drawdown of more than 50 ft would occur from September through March during half of the operating years, according to these simulations.

The primary location for viewing the proposed reservoir would be along the relocated Highway 14. The highway realignment would follow generally along the southern shoreline of the reservoir for approximately 6 or 7 miles, depending on whether tunnels are utilized in two locations. The highway would generally be within 200 to 600 lateral feet of the reservoir shoreline, as indicated in Figure 5.1, and would be closer to the shoreline in places. The relocated highway would be elevated above the level of the reservoir by up to 200 ft. Due to the superior (elevated) viewing angle and the coniferous vegetation along the southern slopes of the canyon, views of the reservoir would be at least partially obscured along most of this section of the highway.

TABLE 5.22

Simulated Reservoir Surface Levels[1]

Month	Mean End of Month Surface Elevation (ft)	Annual Frequency (Percent) Elevation 5625 ft or Above	Annual Frequency (Percent) Elevation Less Than 5580 ft
January	5560	13	53
February	5564	17	50
March	5569	17	50
April	5574	27	40
May	5577	30	37
June	5586	33	33
July	5577	13	43
August	5567	3	50
September	5562	3	50
October	5557	0	50
November	5556	0	53
December	5556	0	53

(1) Normal maximum water surface elevation for either Grey Mountain or Poudre alternative would be 5630 ft.

Source: District, 1988.

The mainstem arm of the reservoir would also probably be visible from the summit of Greyrock Mountain. Views from this location of the lower slopes of the canyon are possible directly to the south and south-southeast, which would appear to include parts of the upper 2 to 3 miles of the reservoir. The confluence area, the two alternative damsites, and the lower slopes of the entire North Fork drainage are obscured from Greyrock Mountain by intervening topography (see Figure 5.14).

Based on current use patterns, views of the reservoir would be limited to travellers on Highway 14 and hikers reaching the top of Greyrock Mountain.

Future recreational uses on and along the reservoir could develop, depending upon the provisions of the project recreation plan. Provision for boating on the reservoir or shoreline access from Highway 14 would significantly increase the number of people viewing the reservoir.

The relocation of Highway 14 would also create some visual effects associated with the project. Specific visual effects cannot be identified or assessed until more detailed engineering plans for the highway have been developed. In general, however, the realignment would create some additional landscape modification through right-of-way clearing, creation of cut and fill slopes in selected locations, and the visibility of the roadway itself. The most significant areas where views could be affected would include the developed recreation sites in the lower canyon and the Greyrock Mountain Trail. For example, the relocated highway would traverse the slope opposite and above the Upper Picnic Rock river access site at a distance of approximately 300 ft.

Poudre Alternative

The proposed mainstem dam at the Poudre site would span the lower Poudre Canyon approximately 0.3 miles downstream of the confluence with the North Fork. This site is just below the large horseshoe bend in the river at the location of the inactive Fort Collins water filtration plant. The dam would extend approximately 320 ft above the present riverbed, assuming the same crest elevation of 5660 ft as for the Grey Mountain Dam.[1] The dam would be approximately 1400 ft (0.27 mile) wide at the crest and 400 ft wide at the base. The width dimensions are nearly the same as the Grey Mountain Dam, although the Poudre Dam would be about 70 ft lower in height. This is what the Basin Study report states, but the District would not presently use roller-compacted concrete for this large of a structure.

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(1) The Basin Study final report (Harza Engineering Company, 1987) proposed a crest elevation of 5626 ft for Poudre Dam and a maximum normal water surface elevation of 5590 ft. Because current plans include a maximum normal water surface elevation of 5630 ft for the mainstem reservoir created by either alternative, the higher crest elevation has been assumed for the Poudre Dam.

The dam would probably be a conventional concrete gravity dam, and the outlet works and stilling basin would extend downstream about 650 ft from the base of the dam (Harza Engineering Company, 1987). The powerhouse for the hydroelectric plant would be located at the base of the dam as for the Grey Mountain alternative.

Landscape modification created by the Poudre Dam would result from the same visual contrast elements described previously for the Grey Mountain Dam. The dam would add a strong horizontal-linear form that would contrast with the sloping canyon walls and the ridge in the background north of the damsite. The local relief between the adjacent ridge tops and the riverbed is less than 700 ft; therefore, the dam would extend about halfway up the canyon walls. As compared to the Grey Mountain alternative, the relative mass of the Poudre Dam would be slightly larger in comparison to its immediate surroundings.

Color and texture contrast would also be somewhat higher at the Poudre Dam. There is considerably more coniferous vegetation at this site compared to the Grey Mountain site, resulting in both more texture and darker coloration at the existing scene. Again, a relatively light and smooth concrete dam would differ noticeably from the adjacent natural features.

The existing visual environment around the Poudre Damsite has already been modified significantly by human activity. In addition to the highway and adjacent utility lines, development of the Fort Collins water filtration plant resulted in clearing, modification of natural slopes, and the presence of structures and surrounding landscaping. There is also a residence located within 0.25 mile south of the damsite. However, these existing features would be inundated or removed as part of dam construction at this site and would not contribute to the degree of landscape change associated with the dam.

Overall, a dam at the Poudre site would probably be slightly more prominent within the surrounding visual environment than the Grey Mountain alternative. However, the actual visibility of the Poudre Dam could be considerably less. Motorists travelling up the canyon on the relocated Highway 14 would possibly begin to view the dam at a distance of about 0.75 miles to the south. For about the next 0.5 mile, the roadway would be oriented north directly toward the dam. There would be little coniferous vegetation in this location to screen views. However, the highway would be 100 to 200 ft above the dam crest at this point, and the viewer superior position and minor topographic variation along the canyon wall could block all or part of the dam from view. Consequently, views of the dam for westbound motorists might be limited to the last 0.25 mile before the dam, where the proposed realignment first curves to the west. The viewing angle in this section would also be downward, and by this point, the conifers near the damsite could provide some screening.

Travellers approaching from the west would have very limited views of Poudre Dam. The proposed highway realignment includes a large bend just west of the Poudre Damsite. The ridge forming this bend would block all views toward the damsite until motorists had rounded the bend, which would place the dam nearly opposite at a lateral distance of about 200 to 300 ft. Again, the roadway would be elevated above the dam crest by 100 ft or more, and trees near the damsite could block or screen views. Eastbound motorists would therefore have at most very brief views of Poudre Dam.

The above discussion was based on the longer, all-roadway relocation option for Highway 14. Use of the northerly tunnel option, in an east-west section about 0.5 mile south of the Poudre site, would further lessen potential views of Poudre Dam (see Figure 5.1). Westbound motorists would turn away from the dam into the tunnel at this point, and would at most be able to view the dam from 0.5 to 0.75 miles away. Eastbound travellers would never approach within 0.5 mile of the dam if this tunnel were used, and would not be able to view the dam from the highway.

In addition to highway users, Poudre Dam would also be visible to recreationists downstream along the river. Based on local topography and the course of the river, the dam would probably be visible within the first 0.5 mile downstream. The affected users would primarily be anglers and whitewater boaters. Angler numbers in this specific section of the river are unknown but would probably be a small percentage of the 3200 annual visits estimated for the primary study area. Current boating use on the Filter Plant whitewater run is approximately 4500 visits per year. These users are assumed to have a high sensitivity to visual change and would generally react adversely, to an unknown degree, to the visibility of the dam.

The remaining visual effects for the Poudre alternative would be very similar to those described previously for the Grey Mountain alternative, and little or no distinction is necessary. The powerhouse, switchyard, outlet works, and other supporting facilities would increase the complexity and extent of the visual effects of the Poudre Dam itself. The previous observations with regard to the project transmission line also apply to the Poudre alternative, although the line would be nearly 2 miles longer in this case. The borrow pits and staging areas would probably have limited visibility during the construction period due to the viewing conditions described previously. The smaller Poudre Reservoir would be visible along a shorter section of the relocated Highway 14 than would Grey Mountain Reservoir but would otherwise have the same characteristics and visual effects. No significant differences regarding the highway relocation are apparent for the two alternatives.

Summary Assessment

As indicated above, the assessment of visual effects presented herein is preliminary and based upon incomplete information concerning both existing conditions and the appearance of project facilities. Nevertheless, the available information has allowed identification of the qualitative degree of landscape contrast introduced by proposed project facilities, the locations where this contrast would be visible, and the number and types of viewers who would be experiencing these visual effects. Based on this level of information and analysis, there are no foreseeable aesthetic effects that would appear to influence the overall feasibility of the project.

5.3.3.2 Management Compatibility

In addition to the physical visual effects created by the landscape changes associated with the project, visual effects must be evaluated in terms of their relationship to FS management of visual resources. Both project alternatives were reviewed against the VQO prescriptions included in the land management designations of the 1984 Forest Plan, which were assumed to be the operative management direction.

Grey Mountain Alternative

The Grey Mountain Dam would straddle the eastern boundary of the Arapahoe-Roosevelt National Forest but would be more than 0.5 miles from the nearest Federal lands within the boundary. The dam and its supporting facilities would not be within foreground viewing distance of any national forestlands. Consequently, the key visual resource management issue for the Grey Mountain alternative would be the compatibility of the proposed reservoir with the VQO designations for the river corridor.

The mainstem reservoir would probably be located adjacent to lands assigned a partial retention VQO. The current 1984 Forest Plan designation of management area 10D, which is inconsistent with the provisions of the 1986 Wild and Scenic River legislation, includes a prescription for maintaining a retention VQO. However, the management area 2B designation that corresponds to current actual practice involves a partial retention visual prescription. Management area 3A around the Greyrock Mountain Trail also has a partial retention VQO, while a modification VQO is not to be exceeded on the remaining study area lands designated as area 5B.

Based on this VQO information, under existing management prescriptions the proposed reservoir would have to meet at least a partial retention condition within the foreground viewing zone. This condition requires that management activities remain visually subordinate to the natural appearance of the landscape, in the expected perception of the casual forest visitor. The proposed reservoir would probably have a natural appearance, and meet the partial retention VQO, during times when the reservoir was at or near the maximum normal water surface elevation. However, the exposed shorelines during the temporary periods when the reservoir was significantly below this level would represent a modification condition that would be inconsistent with the partial retention VQO. The timing and duration of this condition is indicated in Table 5.22 and the associated discussion.

Development of a reservoir on the mainstem and relocation of Highway 14 would change the location of travel routes and use areas. This would require development of new visual management system data to reflect the changed foreground, middleground, and background distance zones from the new viewing locations. The variety class assignments would also need to be reevaluated due to the presence of the reservoir. This would have little or no substantive influence on the visual effects of the project, as the various project features would still be within the foreground distance zone (0.5 mile) of primary travel routes and use areas. Modification of the visual inventory data would not necessarily require changes in the VQOs, although the FS would have this option.

Poudre Alternative

The Poudre Damsite is located in an area that has a retention VQO within the foreground viewing zone. If the area implementation planning process results in a management area designation of 2B for this area, as expected, the required VQO would probably be partial retention. In either case, the Poudre Dam would not meet the applicable VQO. Depending on the results of future detailed, site-specific analysis of sightlines and simulated dam appearance, the dam would probably represent either a modification or maximum modification condition. This would particularly be the case for potential foreground views of the dam for westbound travellers on the relocated Highway 14.

Management compatibility for other visual aspects of the Poudre alternative would otherwise be the same as described previously for the Grey Mountain alternative. The reservoir would meet the partial retention VQO when it was relatively full but would temporarily be inconsistent with this designation at times when significantly lower water levels exposed the reservoir shorelines. This condition would also apply to the VQO assigned to management area 3A around the Greyrock Mountain Trail, although the foreground distance zone from the relocated trail would not extend to the proposed reservoir. The Poudre alternative would be consistent with the modification visual prescription for the management area 5B designation that applies to most of the Forest Service lands in the study area.

5.3.4 Mitigation

Potential measures to mitigate adverse aesthetic effects were evaluated with respect to their possible influence on project feasibility. The effects assessment indicated that project development at either site would create significant landscape changes that would be exposed to considerable numbers of viewers. Particularly because compatibility with established FS visual quality objectives is involved, some degree of mitigation would be needed to reduce the level and extent of visual change.

Initially, the approach used to estimate aesthetic mitigation involved isolation of the key components of visual change and identification of possible treatments that would help proposed project features blend with the natural landscape. Most of the visual consequences of the project relate to the dam and reservoir and are essentially unavoidable with this type of project. Consequently, the potential mitigation measures are primarily architectural treatments and landscaping measures, such as screening, that would reduce rather than avoid visual contrast. In applicable locations, identification of measures would ideally be based on the level of mitigation needed to meet FS visual quality objectives. However, this will require detailed site-specific evaluations and review with the FS that cannot be accommodated within this phase of the study. Therefore, potential mitigative measures were identified on the basis of typical treatments related to the sources of visual contrast. Preliminary cost estimates for these measures, based on unit or percentage cost factors and the general engineering plans available, were also developed in order to identify a possible range of mitigation costs.

It is recognized that many treatments that would reduce aesthetic changes have effectively become standard construction practices through common use or regulation. Such standard construction measures are those practices that are typically performed on a project of this nature to minimize site disturbance or to guide cleanup and rehabilitation. Included are the use of best development practices to minimize the area disturbed in construction, avoid unnecessary clearing, and maintain vegetative screening buffers around construction sites and project structures. Standard practices also include revegetation of areas disturbed during construction, which is a uniform requirement. Because these actions are assumed to be required, they have not been identified as potential aesthetic mitigation measures. Costs for these measures can vary depending upon the nature and intensity of construction activities, but they are assumed to be incorporated into project construction cost estimates.

The potential aesthetic mitigation measures identified for Stage 1 of the proposed Cache la Poudre Project are special treatments related to particular design or location factors. For each measure identified below, a brief discussion of the nature of the treatment and its cost is provided. More complete investigation and evaluation of these measures will be required when detailed project plans are available.

One programmatic measure that can be effectively used to lessen aesthetic effects would be to develop an integrated architectural theme for the entire project. This would involve hiring an architectural contractor or designating an architectural representative to select uniform or similar structural treatments for the project facilities. Use of consistent structural forms, colors, and textures would help the project features blend with each other and the natural landscape. Extra effort could be required to ensure integration of these elements into the designs for individual facilities, and material and labor costs could be increased by adding nonstandard features. The cost of such a program could vary significantly with the management approach to the project and the aggregate effect of an extremely large number of individual decisions concerning construction materials and practices. Consequently, the incremental costs associated with this type of approach cannot be estimated at this time.

As part of an integrated architectural theme for the project, or as a separate measure, aesthetic mitigation could include texturing and tinting the face of the concrete dam and associated structures. This would cost an estimated $2 per square foot. Depending upon final dimensions, the total cost if implemented would likely be approximately $700,000 for the dam. Another element could be a powerhouse and switchyard design that would de-emphasize geometric lines and attempt to utilize the natural rock/talus formations near the damsites. Tinting the powerhouse and painting the switchyard to be compatible with the surrounding landscape would also lessen the visual contrast, at a small proportion of the cost for the dam. Landscaping and site rehabilitation costs could be minimized through appropriate structure design. While trees are often used to screen developments, there are relatively few trees apparent near the proposed damsites from the key viewing direction. This is particularly true at the Grey Mountain site. Consequently, contrast from introduced tall vegetation could be minimized with the use of ground contouring and rocks for screening views of the structures.

Some landscaping of project facilities would be necessary, however. Landscape treatment to lessen contrast and provide screening would likely involve planting appropriate native trees and shrubs and installing ornamental rock work in the primary facility area near the base of the dam. Based on assumed dimensions and unit costs for appropriate species, landscaping around the powerhouse, switchyard, and associated facilities would likely cost from $20,000 to $25,000.

Aside from treating structures and adding screening, the effects of other project features could be lessened through vegetation clearing practices. Feathering the edges of cleared rights-of-way and the reservoir banks to create irregular margins would create a more natural appearance. This would only be necessary in stands of forest or tall shrubs. If performed along with preconstruction clearing activities, no measurable cost would be added to the project. However, special clearing treatments after construction could cost up to $3000 per acre.

An additional area for potential mitigation is transmission line design and siting. If the line were located parallel to the existing Colorado 14, a nonobtrusive structure design would be desired along the approximately 3 miles of line east of the relocated highway section, where the line would be directly adjacent to the existing highway. The need for nonstandard structures and the available options would depend upon the line voltage, which is unknown. Standard single wooden poles could be used if the line were 138 kV or below, which would likely alleviate concerns over structure design. If the voltage required heavier structures, use of treated steel poles or comparable structures could increase the cost by roughly $30,000 per mile. The total cost of using special structures over a route of 3 to 3.5 miles could be about $100,000.

No attempt was made to identify potential aesthetic mitigation associated with the Highway 14 relocation or project recreation facilities, because insufficient planning information on these facilities was available for analysis. Highway construction in steep terrain can have significant visual effects, and many types of siting, design, or landscape treatments for these effects will need to be evaluated when more detailed plans have been developed. Similarly, analysis of potential aesthetic effects and mitigation will need to be a key component of the recreation planning effort scheduled for the next phase of study.

5.3.5 Recommended Future Studies

The results of the Task 14 aesthetics studies indicate that there are a number of unresolved issues that would benefit from future study. The characterization of existing conditions and analysis of project effects presented above is sufficient for the current conceptual level of project plans. However, more precise site- and facility-specific evaluation based on more detailed project plans will be needed to conclusively determine the magnitude and extent of all project aesthetic effects. In turn, this higher level of precision is necessary to identify all of the mitigation measures that might be required and fully determine the benefit that could be derived from each measure.

The recommended future aesthetics studies primarily involve assessment of project effects and evaluation of potential mitigation measures. Some additional baseline information will also be necessary to support the other activities. Appropriate future study activities in each of these areas are summarized below.

The baseline characterization of existing aesthetic resources developed for this report was partially incomplete, particularly with respect to lands in the North Fork drainage and outside the Roosevelt National Forest boundary. This is due to the current lack of access and viewing opportunities in the North Fork drainage, and the lack of existing visual inventories by agencies other than the FS. Most of the land that has not been fully characterized for visual attributes lies outside of the canyon viewsheds that would potentially be directly affected by Stage 1 of the proposed project. However, North Fork landscapes would become visible to many more viewers if the project were developed, assuming that some type of recreational access to the reservoir is provided. Further, the baseline characterization for the remaining national forest land in the study area is rather old, may not be fully consistent with existing management prescriptions, and has little information for two key characteristics. Consequently, the following five additional baseline characterization activities are recommended:

1. North Fork field inventory - A field study of the North Fork drainage should be performed to fully characterize the landscapes in this area and identify seen areas from various points on and along the proposed reservoir. This will involve securing access to the private and municipal lands within the drainage. The field crew should use extensive observations and photography to inventory landform and vegetative patterns, assess landscape variety, and determine distance zones.

2. General map and aerial photo review - A key assumption used in the visual analysis was that study area lands not inventoried by the FS had similar visual characteristics to inventoried lands. This assumption should be confirmed through a thorough review of maps and aerial photos covering the study area to identify any significant differences on non-inventoried lands. This would help to support conclusions regarding visual effects on lands south of the mainstem and around the Grey Mountain Damsite.

3. Visual absorption capability inventory - A key variable in conducting visual assessments is the visual absorption capability (VAC) of the subject landscapes. VAC is a measure of the landscape's ability to absorb visual contrast introduced by management activities. VAC information was not available for the current Task 14 studies, but should be developed for the study area in consultation with FS visual resource specialists. Development of this information will improve and help to refine the preliminary assessment of project effects.

4. Viewer sensitivity information - As noted in Section 5.3.2.2, site specific viewer sensitivity data for the Poudre Canyon are not available, and viewer sensitivity ratings for the various travel routes have been

applied through FS staff assumptions. Sensitivity data specific to the study area should be developed in future studies to increase the confidence and precision of the analysis of project effects. Several options exist for developing more detailed viewer sensitivity data, including application of more rigorous FS methods involving more detailed user data; an extensive literature review of visual preferences of recreationists and travellers in the Rocky Mountains in general; a mail or telephone survey of people in the northern Front Range region; or a field survey targeted on Highway 14 travellers and other users of the study area. These options will be explored further in future studies, and an acceptable method to better establish local viewer sensitivity will be selected.

5. Complete baseline inventory - Once the previous four items have been conducted, a complete update of the visual resource baseline will be possible and should be implemented. This will involve development of a complete and up-to-date inventory of all UMS elements, including variety classes, sensitivity ratings, and distance zones, for the study area. The future baseline inventory should also include measurement of existing visual diversity within the study area and preparation of seen-area (viewshed) maps, which indicate the geographic area visible from key viewpoints and travel routes.

As indicated above, a higher level of analysis will ultimately be needed for the assessment of project visual effects. This future work will generally involve more precise measurement of project effects, quantification of the degree of change, more specific investigation of the individual elements of visual contrast, and simulation of the appearance of key project features. Once more detailed project plans have been developed, the following additional aesthetics effects studies should be undertaken:

1. Field visibility measurements - The visibility analysis component for Task 14 was based primarily on review of mapped information on terrain, vegetation, and the location of project facilities relative to potential viewpoints. These results were supplemented by preliminary field

observations and photographs from selected locations that are currently accessible. In the future, detailed field measurements will be needed from various points along the proposed Highway 14 realignment. This will allow a conclusive determination of the visibility of project features from the principal viewing locations, and better identification of the likely influence of viewing angles, terrain, and vegetation on potential views. These field measurements would also provide for the preparation of seen area maps and viewing cross sections to better illustrate viewing conditions.

2. Project facilities graphics - Artists' renderings or photographic simulations will be needed to definitively establish the degree of contrast that would be created by the various project features. Simulated views of the dam and supporting facilities, reservoir, relocated highway, and transmission line from one or more key viewing locations should be prepared. This will require relatively detailed information on the dimensions and composition of these features. The slopes along the reservoir shoreline will need to be analyzed to depict the effect of temporarily exposed shorelines, for example. The simulated views will also need to illustrate the color and texture of the project facilities.

3. Quantitative contrast ratings - Once renderings or simulations have been prepared, they can be used to measure the degree of visual contrast on a quantitative scale. The FS VMS approach provides for such a quantitative analysis, allocating scale points for form, line, color, and texture contrast against the existing landscape. The contrast ratings can be used to objectively establish the magnitude of visual modification, and thereby lead directly to evaluation of potential mitigation.

4. General refinement and expansion - The existing analysis of visual effects is rather general because it is based on conceptual project plans. The development of more detailed project plans, such as facility layouts and specifications, will allow more specific estimation of visual

effects. This is particularly important for analysis of the highway relocation, where information on right-of-way and roadway widths, paving material, and cut and fill slopes is needed to fully address the visual effects of the highway. The visual analysis must also consider future plans for project recreation facilities with respect to visual modifications created by these facilities and landscapes seen by recreationists at new sites.

The additional project effects studies are a prerequisite for comprehensive evaluation of aesthetic mitigation. The existing discussion of potential mitigation is based on typical treatments for the types of visual effects identified. Design and development of project facilities should be coordinated with more specific evaluation of individual facilities and visual components. For example, where possible, project facilities should be sited to take advantage of topography to screen views from key travel corridors and observation points, or place facilities in middleground and background viewing zones. Structures can be camouflaged by color, texture, and pattern matches with their specific visual surroundings. Areas of site disturbance and construction cuts and fills should be limited due to slow vegetative recovery in dry, steep landscapes.

These types of mitigation analyses require relatively detailed engineering plans that will be developed in the future. The final determination of appropriate mitigation will require three additional activities designed to focus on the specific elements of visual contrast created by the project. These activities are described below.

1. Comprehensive effect/mitigation matrix - The refined and expanded effects analysis should be used to develop a comprehensive matrix identifying each specific effect component and corresponding potential mitigation. The matrix would presumably be organized according to individual project components (dam, reservoir, etc.). The matrix would identify viewing locations and distances from which each feature would be visible, and the number and types of viewers. A key element of the matrix would be the identification of the specific source(s) of visual contrast--form or mass, line, relief patterns, color, texture, reflectiveness,

etc.--associated with each project feature. One or more potential mitigation treatments for each source of contrast for each feature could then be identified, along with associated costs and the degree of contrast reduction. These treatments could involve siting, structure design, site preparation or construction methods, materials, and landscaping.

2. Evaluation of potential measures - The matrix data and the contrast ratings should be used to conduct a thorough evaluation of each potential mitigation measure. The contrast ratings can establish the degree of visual change that would be subject to mitigation, while the viewer information could indicate the significance of each effect. The level of contrast reduction that would be provided by each candidate mitigation measure could then be evaluated against these factors to qualitatively determine the benefit derived from implementing each measure. These results should then be compared to the cost of each measure to judge whether implementation would be warranted.

3. Review conclusions with agencies - Agency consultation will be a key component of all future project studies, as it has been in the past. However, agency review of mitigation is particularly important for aesthetics because the FS must provide input concerning the level of mitigation that would be consistent with visual quality objectives. While the future studies will be largely quantitative, determination of whether a given level of mitigation would achieve a retention or partial retention VQO is still a subjective evaluation. Therefore, close coordination with the FS will be needed during the above activities to resolve project consistency with VQOs.

5.4 LAND USE

5.4.1 Overview

5.4.1.1 Study Objectives

The overall objective of Task 14 was to perform an assessment of project effects on recreation, aesthetics, and land use, along with corresponding potential mitigation measures to further evaluate project feasibility. Specific objectives for the land use studies included establishing a pre-project baseline for existing land ownership, land use and management, resource productivity, and development trends. This information was to be used to identify direct land use effects of the proposed project, based on displacement of existing resources by project facilities. These effects were to be identified separately for the different ownership, use and management, and productivity concerns. An additional objective of the effects assessment was to estimate potential indirect effects associated with further land development triggered by the project. Finally, potential measures that would mitigate adverse effects were to be identified and evaluated in terms of their likely influence on project feasibility.

5.4.1.2 Study Area

The study area for land use is the primary study area for Task 14 shown in Figure 5.3. The study area consists of approximately 53 square miles (34,000 acres) of land situated in the eastern mountains of the Front Range and the adjoining foothills. It extends westward from U.S. Highway 287 approximately 10 miles at the widest point and about 9 miles in the north-south direction. The study area includes the canyons of both the mainstem and North Fork of the Cache la Poudre River, and the initial segment of Highway 14. Developed areas include the vicinity surrounding Ted's Place, at the junction of Highways 287 and 14, and the community of Poudre Park. Land in the study area is owned or administered by the FS, the State of Colorado, two municipal governments, and multiple private parties. Land use within the study area includes agriculture, grazing, big game habitat management, developed and dispersed recreation, and small areas of residential uses concentrated along major roadways. Agricultural use is limited to a small area in the southeastern corner of the study area, east of the mouth of Poudre Canyon. Existing land resources are described in more detail in Section 5.4.2.

The study area boundaries for land use were established to account for all reasonably foreseeable land use effects, both direct and indirect. The study area extends at least 2 miles beyond the upstream limits of the proposed mainstem reservoir and provides similar coverage along the reservoir shorelines. These boundaries encompass all areas that would be directly affected by proposed project facilities, including the relocated Highway 14. Because the study area also includes a considerable shoreline margin, it also represents the area within which project-induced development would be expected to occur.

5.4.1.3 Methods

The major functional activities involved in the land use studies included an inventory of existing conditions, assessment of project effects, and identification of potential mitigation measures. Land use information collected and analyzed for the inventory included public and private ownership; existing land uses by category; productivity of resource lands within the study area; constraints represented by wetlands, floodplains, and prime or unique farmland; and recent trends in regional and local land development. In general, this information was collected through review of literature, including maps, and contacts with appropriate agencies. The Larimer County Planning Department provided the bulk of the information collected, particularly with respect to private lands. The Forest Plan for the Roosevelt National Forest (FS, 1984) provided baseline information on national forest lands, which was supplemented by interviews with resource specialists and additional Forest Service file data. A significant study addressing urbanization trends in the northern Colorado Front Range, sponsored by the U.S. Department of Agriculture and Colorado State University (Anderson, 1984), was used as a primary source with respect to local development trends. File data from the Larimer County Planning Department also included significant information on subdivisions and other activities on private lands.

The assessment of direct effects was conducted largely as a locational analysis utilizing project maps and aerial photography. Maps of the proposed project features, including dams, inundation areas, and relocated travel routes, were superimposed over baseline land use and ownership maps. Existing resources that would be displaced were identified, and effects were quantified by calculating the number of acres displaced by the project for each appropriate category. Volume, value, or other appropriate productivity measures associated with these areas were also identified, where possible, and the displacement effects were evaluated in local and regional context.

Indirect project effects were assessed in a more subjective manner. Identification of the degree to which the proposed Stage 1 Cache la Poudre Project might generate spin-off land development represents a judgment of potential market reaction. Information on recent development trends and their underlying causal factors, primarily physical characteristics and land development controls, was used as the basis for this judgment. Project land management and access attributes were evaluated to determine if they were capable of creating a significant shift from recent trends. For comparison purposes, experience with development near similar local reservoirs was also investigated.

5.4.2 Existing Conditions

The inventory of existing conditions considered four different issues. The existing distribution of land ownership among various public and private parties is described in Section 5.4.2.1. The use and management of study area lands are discussed in Section 5.4.2.2. This includes actual uses in practice, management designations or programs for public lands, and regulatory controls on private lands. Section 5.4.2.3 provides information on the productivity of study area timber and range land, and development constraints represented by floodplains, wetlands, and prime agricultural lands. A summary of regional and local development trends is presented in Section 5.4.2.4.

5.4.2.1 Land Ownership

The study area includes Federal, state, and local government lands as well as lands owned by private individuals. Distribution of current land ownership within these four categories is indicated in Figure 5.17 and Table 5.23. General information on acreage and location is provided in the following paragraphs for each type of jurisdiction. This discussion of land ownership is primarily based on U.S. Bureau of Land Management land status maps (BLM, 1981), the Roosevelt National Forest map published by the FS (FS, 1985), and Cache la Poudre Project boundary maps showing property owners (District, no date).

TABLE 5.23

Land Ownership Within Primary Study Area

Ownership Class	Approximate Acreage	Percent of Total
Federal (FS)	13,720	40
State	5,410	15
State Land Board	(4,740)	(14)
CDOW	(400)	(1)
Municipal	640	2
Fort Collins	(400)	(1)
Greeley	(240)	(1)
Private	14,420	43
TOTAL	33,920	100

Sources: Bogart, 1988
BLM, 1981
FS, 1985
District, no date

Federal Government

All Federal lands within the study area are national forest lands administered by the FS. The study area straddles the eastern boundary of the Roosevelt National Forest. Most of the national forest land is located in the northern and western portions of the study area, west of the North Fork and north of the mainstem. Of the 33,920 total acres in the study area, 40 percent or approximately 13,720 acres are managed by the FS. This acreage represents 1.7 percent of the 788,055 acres of Roosevelt National Forest lands (FS, 1984).

Most of the national forest lands are contiguous, forming an arc approximately 2 miles deep and extending about 8 miles wide from southwest to northeast in the study area. There are some smaller, noncontiguous parcels, particularly near the mainstem-North Fork confluence and the northeastern portion of the study area. FS lands generally occupy steeper slopes and uplands above the 6000 ft elevation. Based on Figure 5.17, FS lands occupy about 33 percent of the banks along the Poudre River in the study area. This includes 3 miles along the North Fork above Seaman Reservoir, 3 miles along the mainstem west of Poudre Park, and 2.5 miles along the mainstem below Poudre Park.

State of Colorado

Land owned by the State of Colorado is concentrated in the eastern and southeastern portions of the study area. Approximately 5140 acres, or 15 percent of the study area, is administered by the State Land Board and the CDOW within the DNR. Another DNR agency, CDPOR, operates facilities on certain State-owned lands.

The State Land Board controls the majority of the state-owned land in the study area. These lands are situated in one large block and two smaller blocks. The large block is comprised of about 3800 acres east of the North Fork and mainstem Poudre River, north of Highway 14. Much of the western edge of this land is along the river banks. A smaller State Land Board parcel is located along and just west of the North Fork, and includes about 300 acres. The other parcel is a section (640 acres) located south of the river near the mouth of the canyon. This parcel is not small compared to CDOW land holdings.

CDOW administers two tracts of land in the study area, occupying more than 400 acres. The largest tract is located along the mainstem near the canyon mouth and includes the CDPOR access sites at Picnic Rock described in Section 5.2.2. This area also includes several individual parcels held in fee title or perpetual easement totaling approximately 320 acres. The other parcel is just north of the confluence and includes 85 acres adjacent to Seaman Reservoir.

Collectively, these State lands include about 3.5 miles of the Poudre River within the study area. This includes about 1 mile along the North Fork and 2.5 miles along the mainstem below the confluence. The State lands in the study area represent the majority of all State lands in the Cache la Poudre Basin. State land within the Basin upstream of the study area is limited to several small parcels, none of which is larger than one section (BLM, 1981). Several other large parcels of State land exist elsewhere in Larimer County, including extensive CDOW lands northwest of the study area (Larimer County Planning Department, 1985).

Local Governments

Both the City of Fort Collins and City of Greeley own lands associated with water resource developments along the North Fork and mainstem of the Cache La Poudre River. The City of Fort Collins property consists of approximately 400 acres situated at the confluence of the North Fork and the mainstem and upstream along the mainstem. This property is the site of an inactive water filtration plant, formerly used to treat diversion, is still active (to Horsetooth Plant) municipal and industrial water for Fort Collins. The City of Greeley owns approximately 160 acres along the mainstem Poudre River below the canyon mouth, in the extreme southeast corner of the study area. A filtration plant for the Greeley water system is located on this property. Greeley also owns an 80-acre parcel on the North Fork north of Seaman Reservoir.

These municipal government lands occupy about 4.5 miles of the banks along the Poudre River within the study area. The Greeley properties have slightly less than 1 mile of frontage on the mainstem and 0.5 mile on the North Fork. Due to the configuration of the river, the relatively small Fort Collins parcels include about 2.5 miles of frontage on the mainstem and 0.5 mile on the North Fork.

Private Lands

Private landholders own the remainder of the study area lands and constitute the largest proportion of the total acreage. The study area includes about 14,420 acres of private lands, which is 43 percent of the total area. Most of the land south of the mainstem Cache la Poudre and in the southeastern corner of the study area is in private ownership. There also is considerable private acreage in the northern portion of the study area, particularly around Bonner Peak and Eagle's Nest. Based on ownership maps for the reservoir area and adjacent lands (District, no date), private parcels range in size from over 640 acres to 1 or 2 acres. Most of the smaller parcels are situated in the southeastern corner of the study area and along the mainstem Poudre, primarily in the subdivisions identified on Figure 5.17. Larger parcels exist in the northern and easternmost portions of the study area.

Approximately 37 percent of the Poudre River within the study area flows through private lands. This is the largest proportion of river bank ownership, but the percentage is lower than the private share of total study area acreage. Privately owned river frontage includes about 3 miles below the North Fork confluence, 2.5 miles adjacent to and downstream from Poudre Park to the confluence, and 4 miles along the upper North Fork.

5.4.2.2 Land Use and Management

A variety of land uses exist within the study area. Natural resource uses such as wildlife habitat, forestry, and livestock grazing predominate in all but the southeast corner of the study area. The southeast corner contains relatively small areas of agricultural, residential, commercial, and industrial land uses. Residential developments also exist at several locations in the Cache la Poudre Canyon, with the largest of these being the community of Poudre Park. Poudre Park is located about 15 miles west of Fort Collins on State Highway 14. A more detailed discussion of each of these land uses, organized according to jurisdiction, is provided in the following paragraphs.

<u>Forest Service</u>

Approximately 60 percent of the study area is within the administrative boundary of the Roosevelt National Forest. However, only two-thirds of the land within the administrative boundary is Federal land managed by the Forest Service. These Federal lands are intermixed with considerable acreage of private holdings, which are primarily in ranching use.

The Roosevelt National Forest was administratively combined with the Arapaho National Forest in the 1970s, and the two forests are administered from the Forest Supervisor's Office in Fort Collins. Two ranger districts have jurisdiction within the study area. The Poudre River mainstem forms the boundary between the Estes-Poudre Ranger District south of the river and the Redfeather Ranger District to the north. The Estes-Poudre Ranger District manages all recreational activities and facilities in the canyon.

Under the provisions of the National Forest Management Act of 1976, management direction for FS lands is provided through a forest-wide planning process. The

Arapaho-Roosevelt National Forest is currently managed according to the general guidance of a Land and Resource Management Plan adopted in 1984 (FS, 1984). This plan designates management areas within the administrative boundary of the forest, although management prescriptions are actually applied only to Federal lands. The 1984 plan establishes three management area designations within the study area identified as 3A, 5B, and 10D. Figure 5.18 shows the current locations of each management designation.

The majority of the FS land is upland from the river and is in management area 5B. This area designation includes approximately 11,000 acres, which is about 80 percent of all FS land within the study area. The 5B management designation emphasizes wildlife habitat, specifically big game winter range. Management of wildlife within 5B areas is a joint effort with the CDOW. Recreation opportunities associated with area 5B can include seasonal motorized and nonmotorized recreation. Vegetative management prescriptions for such areas can include fire treatment to improve forage quality. Generally, only temporary roads are permitted in these areas. Livestock grazing is permitted on 5B lands, which overlap with two separate grazing allotments within the study area. Although livestock grazing is compatible with wildlife, grazing is managed to favor wildlife habitat (FS, 1984).[1]

Management area 10D is situated alongside the mainstem of the Cache La Poudre River, extending an average of approximately one-quarter mile from the river bank on either side. Approximately 1500 acres are covered by this designation. Management area 10D was assigned to protect the river as a special area eligible for designation as a National Wild and Scenic River. This designation predated the Wild and Scenic River legislation passed by Congress in October of 1986, which designated 75 miles of the Poudre above Poudre Park as wild or recreational river segments. The 1986 legislation also directed that the designation of the upstream reaches not be used to prohibit the development of water impoundments and associated facilities on the segment below Poudre Park.

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(1) This discussion is based on general management prescriptions for area 5B as reported in the Forest Plan. Specific prescriptions for individual areas are being developed in the area planning process.

The FS is developing area implementation plans to provide more detailed prescriptions for activities within the various management areas (Rankin, 1988). Through this planning process, it is evident that the 10D area below Poudre Park will be redesignated so as not to conflict with the Wild and Scenic River legislation. The most likely new designation is 2B, which provides management emphasis on dispersed recreation for roaded natural and rural recreation opportunities. These areas are also maintained to provide wildlife and fish habitat diversity and improvement of domestic livestock grazing opportunities. Trail construction and maintenance are prescribed to provide for a high level of day use. The management regime for 2B corresponds to actual current practice within the lower portion of the river corridor previously designated as 10D (Rankin, 1988).

Management area 3A encompasses the Greyrock Mountain Trail on the south slopes of Greyrock Mountain north of the river, except for the lower trail segment within the river corridor. The area includes approximately 700 acres managed to provide emphasis for nonmotorized recreation. Motorized vehicles are permitted for administrative use only in 3A designations; however, snowmobiles may be allowed on routes designated as open to snowmobile use. Due to snow depth and frequency, this activity does not occur in the Greyrock Mountain Trail area.

<u>State of Colorado</u>

Much of the State land in the study area is held by the State Land Board. No management plan or formally prescribed management regime for these lands has been prepared to date (Sabi, 1988). Study area lands held by the State Land Board are generally under 10-year leases for grazing purposes. Funds generated from these lands go into the K-12 school trust fund to help finance public school programs.

The northerly parcel of CDOW land is known as the Spangler-Lentz property. This property is primarily big game range lands that are critical to wildlife survival in severe winters. Other CDOW upland areas are also managed as critical winter range. Most of the CDOW lands located along the river are used to provide access for fishing and other recreation uses. Management plans for these CDOW lands are currently being prepared (Bogart, 1988).

The CDPOR manages recreation facilities on two parcels of State land. These facilities are the Lower and Upper Picnic Rock river access sites. They provide parking, restroom, and picnic facilities for river-oriented recreation. Both of these sites are within the area of CDOW ownership near the canyon mouth, and are described in Section 5.2.2.

Local Government Lands

Both the City of Fort Collins and the City of Greeley have municipal water supply facilities within the study area. The City of Fort Collins owns a water filtration plant situated at the confluence of the North Fork and mainstem. This plant was taken out of service in 1987 (Smith, 1988). Diversion structures at this site are still operated to provide water to the City's remaining treatment and distribution system. Alternative uses for the property have been proposed by other parties, but final plans for the property remain indefinite at this time. While municipal water supply is the formal use of these lands, areas along Highway 14 are accessible to the public and are used informally for recreation. The City of Fort Collins has posted signs at existing informal access sites on City land to indicate which water-based activities are not permitted, due to water quality considerations.

The City of Greeley owns land within and along Seaman Reservoir and has a water filtration plant along the mainstem Poudre near U.S. Highway 287. Public access to these lands is restricted and they are essentially not used for recreation.

Private Lands

The extensive privately-owned land areas within the study area are the result of past settlement patterns. The Poudre Canyon was primarily settled by ranchers developing the river bottom and mountain meadows (FS, 1984). Some mining occurred in the upper valleys, but this did not have a significant effect on development levels or patterns. Timber was harvested to meet local needs and to supply nearby railroads. Recreation resorts developed in the upper Poudre

Canyon in the early 1900s. As transportation improved, more summer homes were built and people began commuting to jobs outside the canyon. Today, four subdivisions consisting of summer cabins and homes occupy areas along and near the river within the study area. Other private lands in the study area are used primarily for grazing and ranching.

The four subdivisions in the study area are named Poudre Park, Yauger's, My Camp, and McMurray Ranch Estates. All but McMurray Ranch Estates are situated along the Poudre River (see Figure 5.17 for subdivision locations). Data on the size and number of lots for these subdivisions were provided by the Larimer County Planning Department (Kadera, 1988). Estimates of the number of developed lots were made from review of aerial photographs and tax assessment maps.

Poudre Park subdivision includes four tracts dating from the 1920s and encompasses the entire community of Poudre Park. The four tracts contain a total of 111 lots, of which 46 have been built upon. Yauger's first and second subdivisions have a total of 13 lots, of which none have been developed. My Camp is located just downstream from Yauger's first subdivision, and has 45 lots of which 9 have been developed. McMurray Ranch Estates is the most recent subdivision, approved in 1972. This subdivision is located outside of Poudre Canyon in relatively open country about 1 mile from the junction of Highways 14 and 287. McMurray Ranch Estates covers 129 acres, and 12 of the 15 lots have been developed.

The characteristics of these subdivisions reflect changes in development patterns over time. All of the subdivisions along the river within the canyon are relatively old, dating from at least 1918 (Kadera, 1988). Larimer County records indicate that the last of the river subdivisions was approved in 1955. These older subdivisions all have small parcels, ranging from an average of 0.22 acres per lot (9600 square feet) for one of the Poudre Park subdivisions to 2.26 acres per lot for My Camp. In contrast, McMurray Ranch Estates has an average lot size of 8.59 acres. The latter subdivision is on more developable property, in terms of physical constraints, and is indicative of the recent trend of ranchette-style rural residential development.

Other study area private lands, outside of the subdivisions, generally have larger parcels and relatively few residences. District maps of property within or adjacent to the project boundary identify a total of 84 nonsubdivision private land parcels comprising more than 7800 acres (District, no date). These maps cover only two-thirds of the study area. However, they should provide a good overall representation and include virtually all of the private lands divided into smaller parcels, because these parcels appear to be concentrated near the river. Based on the number of relatively small parcels indicated on the map, it is evident that considerable parcel-splitting has occurred in the past on lands downstream from Poudre Park for about 3 miles, primarily to the south of the river and extending back from the river for up to a mile. Numerous parcels of land in this vicinity are generally from 10 to 20 acres in size. The size of these parcels probably indicates that they were platted and sold as recreational or second-home property, because they are too small to be used for grazing. The lack of structures on these properties probably reflects physical constraints on development. Most of this land is steeply sloping, forested land along the southern wall of the canyon that would be expensive to develop. Some larger parcels remain in this area as part of ranch properties and are used primarily for grazing.

The project boundary maps also indicate that considerable parcel-splitting has occurred along the eastern margin of the study area, particularly in the vicinity of Bonner Peak. Approximately 30 smaller parcels in this area appear to be intended for eventual rural residential development or second-home sites, as are adjoining lands just east of the study area. The typical size of these parcels is 40 acres, which is considerably larger than most of the tracts in the canyon.

Land in the North Fork portion of the study area is still used primarily for ranching. This area includes several private land parcels of at least 160 acres, many of which are mingled with FS lands allocated to grazing. One rancher in this area owns four separate parcels totaling approximately 1600 acres. Another nearby ranch includes about 1000 acres within the northeastern corner of the study area.

All private lands within the study area are subject to the land use controls of Larimer County, as well as some State of Colorado regulations that constrain development. Larimer County has a recently adopted comprehensive land use plan and zoning ordinance. The plan provides general guidance and overall land-use designations for various areas of the county, indicating where concentrated development may occur (Legg, 1988). Zoning provides site-specific designations for permitted uses and development density, as well as additional rules for the development process. All individual development proposals must comply with the plan designations and zoning code, and many are subject to additional technical reviews depending on site conditions. County subdivision or planned unit development regulations also apply to many developments based on location, size, and density characteristics.

The Larimer County Plan designates the entire study area as rural (Larimer County Planning Department, 1988). This designation is intended to provide necessary space for agriculture and other low-intensity uses and limit residential land divisions to a maximum of four parcels. The La Porte urban area extends to within about 1 mile of Ted's Place and is the closest higher-intensity designation to the study area. Other designations that can be used in the undeveloped portions of the county are "mountain residential community" and "mountain resort." Two mountain residential community designations have been made in the Redfeather Lakes area, as well as other small locations nearer to the urban area of the county.

The zoning designation for the entire study area is Zone O - Open (Legg, 1988). The open zone has a minimum lot size of 10 acres. The four subdivisions and other small parcels along the Poudre River and Highway 14 predate the zoning code and do not conform to the lot size requirements. Permitted uses within the open zone include single family dwellings, golf courses, livestock auction facilities, veterinary clinics, specialized group homes, nurseries, farm and garden buildings, and community halls (Larimer County Planning Department, 1986). Trailer parks, campgrounds, summer camps, mining, and utility stations are permitted by special review.

Despite the minimum 10-acre lot size for the open zone, current State regulations effectively limit development in such areas to a lower intensity. Residential parcels served by individual water wells must be at least 35 acres in size by State regulation (Legg 1988). Therefore, new 10-acre lot developments in the open zone could only be permitted if municipal water service or a package water supply system is provided. The cost of either option is sufficiently high that such development would probably be economically infeasible.

5.4.2.3 Key Land Resources

The distribution and abundance of various land-based resources influence both the magnitude of project effects and the development potential of the project area. Constraints to development include the 100-year floodplain, wetlands, and important farmlands. These features have special regulatory protection and must be evaluated in project licensing and environmental review processes. The utilization and quality of forest and range lands is also important to assess because the project has the potential to displace these resources and create production losses. These resources are described below, and locational information is presented in Figures 5.18 and 5.19.

Floodplains

A floodplain area extends along virtually the entire length of the Poudre River in the study area, but it covers very little area in the canyon (see Figure 5.19). The 100-year floodplain, as mapped on Flood Insurance Rate Maps (FIRM), is a small strip of land along the banks of the North Fork and the mainstem Poudre down to the canyon mouth (U.S. Department of Housing and Urban Development, 1979[1]. The floodplain is no wider than about 700 feet within the canyon and is generally considerably narrower. The floodplain widens below the canyon to about 2000 ft for a distance of 1 mile, then broadens again to a width of about 1 mile at the southern edge of the study area. The banks along Seaman Reservoir are also considered to be within the 100-year floodplain. In total, an estimated 600 acres of the study area are within the 100-year floodplain.

Wetlands

Little flat land exists in the study area due to the mountain and foothill topography. Because the area is also dry, few wetlands are found. Botanical studies for the Cache la Poudre Project identified three wetlands (excluding Seaman Reservoir) in the study area, which are indicated in Figure 5.19 (Envirosphere Company, 1988). One small wetland is found in Greyrock Meadow at about elevation 6700 ft. Another small wetland is located along the North Fork at the northern edge of the study area. The largest area of wetlands is located in the southeastern corner of the study area. The Poudre River floodplain area described above, occupying about 250 acres, is classified as wetland. An intermittent band of wetlands also follows the course of Owl Creek, which is parallel to U.S. 287. In all, wetlands encompass approximately 500 acres within the study area.

Important Farmlands

Most of the study area is rugged land with little agricultural potential other than for cattle grazing. However, the southeast corner of the study area contains over 1000 acres of irrigated farmland. Approximately one half of this irrigated land is considered prime farmland under the Federal Farmland Protection Policy Act (7 CFR 658; SCS, 1979). This land is situated in three areas west of Highway 287. Another two areas of about 100 acres each, one located along the North Fork and one off Highway 287 in the south, are not cultivated but would be considered prime if irrigated (SCS, 1979). Several other areas totaling approximately 600 to 700 acres are classified as farmland of statewide importance. Most of this land is adjacent to the prime farmland in the southeastern corner of the study area.

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(1) Current floodplain maps for the local area were requested from the Federal Emergency Management Agency (FEMA). In response to this request, the 1979 flood insurance rate maps were received during early 1988. During the preparation of this report it was learned that FEMA had updated these maps to 1987 conditions. The differences between the 1979 and 1987 floodplain maps are unknown but should be investigated in further study.

Timber and Range Lands

Coniferous forest occupies about 40 to 45 percent of the study area. Closed-canopy forest is more typical at higher elevations and on the southern side of the canyon, while more open forest exists on adjacent slopes that are somewhat drier and more exposed. Extensive areas of mountain shrub vegetation and grasslands, particularly in the northern and eastern portions of the study area where elevations are generally lower.

Timber resources in the study area are generally not of commercial value. Only about one-half of the Roosevelt National Forest is currently available, capable, and suitable for timber harvest, according to FS definition (FS, 1984). In order to meet this definition, an area must be outside wilderness, have a stand growth capability of greater than 20 cubic feet per acre per year, and be on stable landforms. In general, the timbered lands within the study fall short of the biological and land stability criteria. Trees within the study area are also relatively small, averaging below standard commercial sizes with an average diameter of 4.9 inches (Envirosphere Company, 1988). Because of these factors, commercial timber activities are concentrated in the more productive stands in more moist areas near the Continental Divide. The FS has no plans for timber sales in the study area (Rankin, 1988). Timber that is removed from lands with management area 5B designation is typically cleared for big game winter range enhancement or is cut for firewood fuel purposes, rather than as part of commercial timber operations.

Range lands in the study area vary in productivity and use. Most of the designated FS grazing allotments extend beyond the study area boundaries and range in size from 2,500 acres to 10,000 acres, including private lands (Friedlander, 1988). The three grazing allotments in the Estes-Poudre Ranger District south of Highway 14 include Young's Gulch, Hill Gulch, and Lewstone (see Figure 5.18 for location of grazing allotments). Hill Gulch is an allotment of about 1300 acres that is vacant due to general impracticability for grazing management and its competing suitability for big game use. The Lewstone allotment covers about 5800 acres and supports 15 animal unit months (AUM). It has resource use conflicts due to cattle infringement upon Highway 14, and few cattle were reported to be in the area. The Young's Gulch allotment includes about 3000 acres and provides 199 AUM of forage. Young's Gulch is grazed by yearling cattle, and about 71 head of cattle use the allotment. Most of the allotments are utilized from June to September.

Two grazing allotments are located north of Highway 14 on the Red Feather Ranger District. The 2900-acre Hewlett Gulch allotment is currently vacant due to poor water sources and overgrazing in the past (Englebert, 1988). FS records indicate that 1372 of 2880 acres in this allotment are suitable for grazing and are classified as fair range. The Greyrock-Griffith allotment is the largest in the study area, encompassing approximately 10,000 acres of which most is within the study area boundary. About 5870 acres of the allotment are reported as suitable and open to grazing, with about 4000 acres or roughly 40 percent of the allotment reported as unsuitable. The condition classification of the Greyrock-Griffith allotment designates only 35 of the 5870 suitable acres as good range and the remainder as fair range. The record of use for this allotment indicates about 135 head of cattle graze the range in an average year, and the forage quantity is 610 AUM.

As of 1984, there were more than 350,000 acres of suitable range on the Arapaho-Roosevelt National Forest, and grazing was permitted on about 273,000 acres (FS, 1984). The total forage quantity was more than 80,000 AUM. These figures include the Pawnee National Grassland, which accounts for about three-quarters of the Forest range resource and helps to support a grazing-dependent local economy. The active grazing allotments in the study area include a total of nearly 19,000 acres and provide 824 AUM of forage. These quantities represent a very small proportion, about 1 percent, of the total Forest grazing resource in the Arapaho-Roosevelt National Forest as measured in AUM.

Comparable data on privately owned grazing lands in the study area were not assembled because these lands are concentrated in the northern portion of the study area beyond the inundation zone. Range productivity on these lands is likely to be equivalent to or slightly better than the Forest Service lands, because the private lands are generally on less severe slopes that support more extensive grassland vegetation.

5.4.2.4 Development Trends and Potential

This section presents a characterization of recent nonurban growth in and around the study area, and an evaluation of future development potential, to provide a baseline for assessment of project-related effects. First, a summary of regional growth patterns is provided to indicate the general direction of market forces in recent years. Development in the local area is also related to the overall regional trend. A second subsection provides a summary review of the potential for future development in and near the study area, based on local opportunities and constraints.

<u>Recent Regional and Local Development</u>

The northern Front Range region of Colorado has been a rapid growth area for the last 25 to 30 years. As a result of rapid population growth since the 1960s, large amounts of rural lands in Boulder, Larimer, and Weld Counties have been converted to urban uses. The following summary of this regional development trend is based on an analysis of land conversion undertaken by the U.S. Department of Agriculture, Economic Research Service and the Colorado State University Cooperative Extension Service (Anderson, 1984). The study only addresses growth through 1983, but provides a reasonable picture of the overall trend of the last few decades.

From 1960 to 1983, a total of 840 subdivisions covering over 54,000 acres were platted in the three northern Front Range counties. As indicated in Table 5.24, well over half of these subdivisions were located in Larimer County. In rough proportion to the number of subdivisions in the region, Larimer County also accounted for 52 percent of all subdivision lots and 61 percent of the total acreage.

TABLE 5.24

Urbanization of Rural Lands,
1960-1983

County	Number of Subdivisions	Number of Lots	Acres
Boulder	266	11,318	13,966
Larimer	477	16,637	32,755
Weld	97	3,843	7,317
Total	840	31,798	54,038

Source: Anderson, 1984

Most of the subdivision activity took place in flatland areas on the plains, largely around the existing urban centers. For example, an estimated 46 percent of the converted acreage was initially irrigated cropland. However, considerable subdivision activity also occurred in foothill and mountain areas. Mountain subdivisions were recorded separately from rural subdivisions through 1972. These data indicated a total of 180 mountain subdivisions, including 7760 lots and 17,951 acres, were platted in the region from 1960 through 1972; 55 percent of these subdivisions, with 68 percent of the acreage, were located in Larimer County. Mountain subdivisions represented about 35 percent of all subdivision activity during this period and accounted for about 52 percent of the total subdivision acreage.

A number of factors have influenced the subdivision and land conversion process. In addition to the normal market forces, water supply considerations have been particularly important. Specifically, a number of rural-domestic water systems were created during the 1960s in response to a Farmers Home Administration rural water supply program. This freed rural residential development from sole reliance on domestic wells, transporting water, or expensive connections to municipal water systems. Particularly in areas farther from municipal supplies, this had a major impact because development of adequate domestic wells is difficult in most of this region (Anderson, 1984).

The regulatory environment was also a strong contributing factor to the rapid subdivision activity of the 1960s. Planning and zoning controls generally were not applied to rural areas until the early 1970s, so there were few regulations to limit subdivisions before this time. Many of the earlier subdivisions would not have been permitted under current planning and zoning guidelines. Probably as a result, there has been a more recent movement toward replatting older subdivisions to make them more attractive to current buyers (Anderson, 1984), presumably by increasing parcel sizes.

The pace of new subdivision creation slowed in Boulder and Weld Counties during 1973-1983, but remained relatively high in Larimer County. However, changing preferences and a variety of economic conditions that translate into higher costs have slowed actual housing development except in the plains area of Boulder County (Anderson, 1984). The balance of supply versus demand for rural lots is not precisely known. However, the inventory of subdivided but undeveloped lots probably represents many years of demand. Development constraints such as geologic hazards and utility costs have limited development, and the local second home market appears to be relatively inactive (Legg, 1988). Because many subdivisions have seen no sales or development activity, Larimer County instituted a minor program to vacate subdivisions that were inactive over a period of years (Anderson, 1984).

The local area has not been significantly affected by the regional development trend. As noted previously, three of the four existing subdivisions within the study area were all platted prior to 1955. The most recent subdivision was McMurray Ranch Estates, which was formed in 1972 (Kadera, 1988). This subdivision can be considered part of the regional rural land conversion phenomenon, but is the only such case in the study area. The maps provided by Anderson (1984) also identify only four other recent subdivisions, including two upstream from Poudre Park and two others several miles south of the study area.

Local Development Potential

Development potential in a given area is generally determined by demand, opportunities, and constraints for development. Demand for various types of development is based on a variety of economic factors including population and household growth, interest rates, and discretionary income levels. Demand for a highly localized area is determined largely by market forces within a larger region, making supply more variable on a site-specific basis. The assessment of development potential in the study area is therefore based on the opportunities and constraints that shape supply. Constraints can include physical limitations, such as geologic and wildfire hazards, and mechanisms imposed by local authorities, such as zoning and floodplain regulations. Opportunities for development involve the basic supply of available land, as conditioned by ease of access and nearby availability of utilities and services.

The inventory of private lands described in Sections 5.4.2.2 and 5.4.2.3 represents the initial set of development opportunities in the study area. Overall, the private land base includes approximately 15,000 acres of land, which can be considered nominally available because it is in private ownership. In the absence of adopted or announced plans to dispose of any public land holdings, it is reasonable to assume that no public lands in the study area are available for development.

Actual or realistic development opportunities are considerably less than the total private land base, due to the availability of access, water supplies, and sanitation. Road access to most of the study area is limited. The only paved roads are Highway 14 and a small segment of Highway 287. Gravel or dirt roads reach the periphery of the study area in the northeast, east, and south, but several entire sections of private land are not served by any road. Water supply is limited to individual wells, except in the extreme southeastern corner of the study area. None of the study area is closer than about 2 miles to existing sewer service. Therefore, none of the private lands in the area are fully serviced, and only a small proportion has reasonable proximity to water service. Overall, the lack of water and the high cost of providing services have severely limited development to date and will probably continue to restrict opportunities for development.

On the constraint side, there are several physical factors that limit development in the study area. These can include wetlands, floodplains, and prime farmlands, as described in Section 5.4.2.3, as well as geologic hazards, wildfire hazards, and wildlife habitat. In general, the presence of such constraints will trigger a special technical review of proposed development and will often require additional study and mitigation plans (Larimer County Planning Department, 1985). In some cases the hazards are so severe that the cost of mitigation would be prohibitively expensive.

By State statute, geologic hazards include landslides, rockfalls, mudflows, debris fans, unstable or potentially unstable slopes, ground subsidence, and expansive soil and rock (Larimer County Planning Department, 1985). Geologic hazard maps for portions of the county indicate that approximately half of the study area has "moderate" geologic hazards, while none of the study area is in the "severe" hazard category. There are few severe hazard areas countywide, and the moderate hazards generally occur on floodplains, in stream canyons, and in the foothill and eastern mountain areas. The moderate hazard portions of the study area include the entire canyon of the Poudre mainstem, which covers a belt about 2 miles wide, plus the floodplain below the canyon and the steeper areas west of the North Fork. The Larimer County Hazard Area Regulation requires on-site study of these hazards, which may require modifications to initial development plans.

The Colorado State Forest Service has identified wildfire hazards associated with five fuel types and has prepared inventory maps of these conditions for most of Larimer County (Larimer County Planning Department, 1985). These maps indicate that about 75 percent of the study area has moderate or severe wildfire hazard. Virtually the only locations that are free of this hazard include approximately 7000 acres of private and State land in the southeastern part of the study area and about 1200 acres of ranch land in the northern end of the study area. The remainder of the study area has a generally patchy pattern of moderate and severe hazards, although there is a fairly extensive area of severe hazard near Bonner Peak. The county hazard regulation mandates that mitigation plans be prepared for all development proposals in wildfire hazard areas. The Colorado State Forest Service fuel type classification indicates that mitigation potential is limited in severe hazard areas, and development should be avoided in these areas.

Significant wildlife habitats in Larimer County have been mapped by CDOW. According to a Larimer County Planning Department (1985) publication, CDOW has also developed a checklist to use in reviewing development proposals using these maps to identify potential conflicts with wildlife habitat. However, specific contacts on this subject with both agencies failed to provide clarification on this process or confirmation that it is currently being applied in development review. It is therefore assumed that there is no systematic habitat review, but that CDOW might object to specific proposals on a case-by-case basis. Habitat values within the study area, primarily big game range, would likely present conflicts with future development of at least some private lands.

These constraints clearly reduce the supply of available or readily developable land and limit the potential development intensity on the land that is actually available. The precise effect on future development could only be determined through parcel-specific analysis of site conditions, which is beyond the scope of this study. However, the existence of constraints can be used to qualitatively assess the likelihood of development in a general area and the likely development intensity.

Two avenues of development are conceivable for private lands within the study area. One would be residential construction on existing small parcels and further division of larger parcels within the provisions of the current zoning. The second avenue would be to implement a planned-unit development. A planned-unit development is a complete, integrated package of facilities and services, including water, sewer, electricity, and a means of fire protection. This type of development in the study area would be very unlikely from a market standpoint, due to the distance from existing services and the cost of packaged service plants. From a regulatory standpoint, the Larimer County Plan discourages residential development in the mountains and foothills unless it is part of a planned-unit development (Larimer County Planning Department, 1988). Implementing a planned-unit development in the open zone, which includes the entire study area, would require a rezoning for the property in question. Given the direction of the plan and the need to demonstrate that all service and constraint problems would be resolved, the probability that rezoning would be approved is low.

Under current zoning, therefore, low-intensity development is the most logical occurrence. The maximum possible development level can be calculated from the available land base and the intensity restrictions. The existing subdivisions in the study area include 270 acres and 184 lots. An estimated 67 of these lots have already been developed, leaving 117 nominally available for development if all current building requirements could be met.

The remaining 15,200 acres (approximately) of private lands include at least 24 parcels of less than 20 acres, according to District project property maps. Again, if current building requirements could be met, these properties could accommodate a theoretical maximum of 24 homes given the current 10-acre lot minimum. The balance of about 15,050 acres, currently in parcels of 20 acres or more, could support a maximum of 1505 10-acre lots if all land could be subdivided to the smallest possible units. Combining all three categories, the hypothetical maximum level of new development in the study area would be 1646 homes.

This hypothetical maximum is highly exaggerated due to the State well requirements, which effectively impose a 35-acre minimum lot size for new plats in most of the study area. Treating undeveloped subdivision lots and parcels less than 70 acres in the same fashion as above, which still overstates the number of lots that would actually be developable, up to 178 35-acre lots could be created in the study area. An additional 144 10-acre lots could be created in the southeastern part of the study area, where water service exists or could reasonably be extended. Adding the subdivision lots, 35-acre lots, and 10-acre lots, a realistic maximum of 439 undeveloped lots could be created. This would be reduced to 367 if it were assumed that the two largest existing ranches would remain in operation and not be divided into 35-acre lots. This figure represents a more realistic upper bound on the number of new lots that could be created for future development. The service and constraint factors described earlier would probably significantly reduce the number of lots platted and slow the rate of development on both new and existing lots.

5.4.3 Project Effects

The effects assessment includes potential direct land use effects resulting from the project as well as identifiable indirect or induced effects. Estimation of direct land use effects is based on a superposition of the project construction and operation features on land use and land ownership maps. From this process, acres of land which would be displaced due to inundation were calculated. Indirect land use and ownership effects, such as possible stimulation of development near the reservoir, were evaluated in light of the development potential discussed in Section 5.4.2.4. Experience with comparable local areas such as Horsetooth Reservoir and Carter Lake was also reviewed as a check on the initial assessment.

The direct land use effects are presented first and are discussed separately for the Grey Mountain and Poudre alternatives. Because the Poudre Reservoir would be slightly smaller than the Grey Mountain Reservoir, direct effects from displacement would be less for the Poudre alternative. Indirect effects are expected to be similar for each alternative and are not distinguished separately.

5.4.3.1 Direct Land Use Effects

The development of large water projects creates several types of direct land use effects. The greatest land use effect from a large reservoir is land lost to inundation. Local residences, roads, and utilities are also often inundated and must be relocated. Dam construction can involve extensive clearing and grading, and borrow pits or quarries for construction materials are usually required. Clearing and grading are also usually required for construction staging areas and support facilities such as powerhouses and switchyards, which require additional land areas. Project access roads and transmission lines also create corridors that can displace existing uses.

Grey Mountain Alternative

The mainstem reservoir formed by the Grey Mountain alternative would cover a surface area of 1600 acres at the normal maximum water surface elevation of 5630 ft. In order to provide a reasonable shoreline buffer zone, the project boundary has been established at the 5680-ft contour around the reservoir and approximately one-quarter mile downstream from the damsite, as indicated on project boundary maps (District, no date). Access for project purposes to all of the land within this boundary, totaling approximately 2240 acres, would be acquired by purchase or special use permits as part of the project. The distribution of this acreage by ownership is indicated in Table 5.25. As indicated in the table, all ownership classes would be affected, but most of the land involved falls under Federal and State ownership.

Existing management of lands within the project boundary would be changed, and existing uses would be physically affected. The existing Highway 14 would be used for access to the base of the dam, so acreage required for new access would be limited. A short spur road to the top of the dam might be constructed, although this would not be a requirement. Assuming such a road were constructed for a distance of about 0.5 mile with a 50-foot right-of-way, an additional 3 acres would be required for new access.

The national forest lands that would be directly affected by the project along the mainstem are primarily within the previously designated management area 10D that will be redesignated to conform with the 1986 Wild and Scenic River legislation. As indicated in Section 5.4.2.2, these lands are currently used and managed largely for dispersed recreation. The North Fork arm of the reservoir would inundate area 5B lands managed for big game habitat. These habitat losses have been addressed in the chapter on wildlife resources. There are no FS administrative facilities or roads within the inundation zone. The Greyrock Mountain Trailhead is the only recreation facility that would be displaced, as described under recreation effects.

TABLE 5.25

Grey Mountain Alternative
Land Ownership Within Project Boundary

Ownership Class	Acreage	Percent of Total
Federal (FS)	710	32
State	660	29
Local	330	15
Private	540	24
Total	2240	100

Sources: BLM, 1981
FS, 1985
District, no date.

Because no timber sales are planned for FS lands within the study area, there would be no actual effect on national forest timber management. About 25 to 30 percent of the total inundation area is coniferous forest (see Chapter 2, Wildlife Resource Studies). However, the national forest portion of this land is limited to a relatively small mainstem stretch downstream of Poudre Park. The Grey Mountain alternative would have a minor effect on Forest Service range management or use. A very small area of the Lewstone allotment would be inundated, estimated at about 200 acres. Approximately 800 acres or 8 percent of the large Greyrock-Griffith allotment would be inundated as well. Assuming the inundated land is of equal capacity to the remainder of the allotment, the range loss would represent at most 50 AUM.

The State of Colorado lands that would be directly affected include virtually all of the CDOW's Spangler-Lentz tract and about 500 acres of State Land Board property. Inundation of the CDOW lands would represent a loss of big game habitat, as addressed in the chapter on wildlife resources. The State Land Board acreage is used primarily for grazing. The per acre range capacity lost through inundation is probably comparable to that indicated above for FS lands. Based on the capacity of the Greyrock-Griffith allotment, this would indicate a loss of approximately 30 AUM.

In total, approximately 1500 acres of Federal and state land leased for grazing may need to be replaced if the proposed project is developed. The total range capacity of these lands is estimated at approximately 80 AUM. This represents less than 10 percent of the total range capacity of the primary study area, and is equivalent to about 0.1 percent of the total Arapaho-Roosevelt National Forest range capacity.

The municipal acreage that would be directly affected consists primarily of the Fort Collins property around the City's inactive filtration plant at the mainstem-North Fork confluence. Since this plant was taken out of service in 1987, the project would not displace any existing water treatment operation. The City has retained the option of possible future reactivation or emergency use, which would no longer exist if the project were constructed. Alternative future uses of the property would also be precluded.

In magnitude, direct effects from the Grey Mountain alternative would be greatest on private lands. The Yauger's and My Camp subdivisions are within the project boundary, and most of these tracts would be inundated. Portions of an additional 29 private parcels would also be within the project boundary and would need to be acquired. While many of these private parcels have not been developed, there are a number of homes or seasonal cabins near the river along the mainstem, plus two ranch/farmsteads just south of the confluence area. Based on review of aerial photographs, an estimated 60 to 70 residential structures (including outbuildings) would be inundated, plus about 10 buildings at the filtration plant.

A considerable segment of Highway 14 would have to be relocated, as several miles of this road currently follow the river in areas that would be inundated. Utilities along the highway, including Poudre Valley Rural Electric Association power lines and buried telephone cables, would also have to be relocated. A preliminary evaluation of one basic alternative for Highway 14 realignment along the south shore of the reservoir has been conducted (see Figure 5.1). This plan has two options, since tunnels might be employed at two locations. The alignment presently being considered would diverge from the existing route near the Lower Picnic Rock access site, crossing to the south side of the river and turning north on a 2-mile grade of about 5 percent. The route would then turn west about 0.5 mile south of the mainstem-North Fork confluence area and follow the shoreline of the proposed reservoir another 3.8 miles into Poudre Park on a grade of about 1 percent. The total length of this realignment would be 5.8 miles. One option of the plan allows for two tunnels, about 1500 feet and 2000 feet long, located opposite the Grey Mountain Damsite and at the westward turn toward Poudre Park, respectively. The other option involves contoured road segments rather than tunnels at these locations. If the optional road segments are used, the total realignment would be 6.8 miles long.

Most of the relocated highway would be within the project boundary, but several segments would extend outside the boundary. This would occur in the initial segment below the project and where the new highway would cut across project boundary curves created by the irregular reservoir shoreline. Assuming the highway would have a 100-foot-wide right-of-way, the relocation would require 12 acres of land per mile, or slightly more than 80 acres total for the longer realignment option. About half of this land lies outside the project boundary. Due to terrain characteristics and elevation above the river, these additional lands receive little use except for grazing.

Development of the project would also require construction of a transmission line from the project switchyard to the nearest point on the existing grid. Alternative routes for the transmission line have not been identified. The most likely alternative would be to parallel the existing Highway 14 alignment, which would require little additional right-of-way and probably no effective land conversion. Assuming a 75-foot right-of-way, the transmission line easement would require about 30 acres. Some of this land probably overlaps existing easements along Highway 14.

Project effects on floodplains, wetlands, and prime or important farmlands would be limited. Development of a dam and reservoir would clearly enlarge the floodplain along the inundated area, but in a controlled manner that would not be a detriment to remaining land uses. Wetlands within the study area are located along the margins of the study area and would not be affected by project features. Prime or important farmlands are located well to the north of the proposed reservoir or in the southeastern corner of the study area and would not be converted to other uses. The maximum possible effect on these farmlands would be the installation of a few transmission towers, which would occupy minimal acreage.

Poudre Alternative

The Poudre alternative would result in a slightly smaller mainstem reservoir than the Grey Mountain alternative, resulting in an inundation area of approximately 1350 acres at the normal maximum water surface elevation of 5630 ft. The project boundary for the Poudre alternative would include approximately 1800 acres, with an ownership distribution similar to the Grey Mountain alternative. The project boundary would include approximately 620 acres of land in Federal ownership, 550 acres in State ownership, 320 acres in municipal ownership, and about 390 acres in private ownership. The same land uses as for the Grey Mountain alternative would be affected, except for about 380 acres south of the Poudre damsite that is mostly undeveloped. Because the direct land use effects of the Poudre alternative would be very similar to those of the Grey Mountain alternative, they can be summarized briefly in terms of incremental differences from the effects postulated for the Grey Mountain alternative.

The Poudre Dam and reservoir would affect the same types and uses of national forest land. Approximately 100 acres of the Lewstone grazing allotment would be within the project boundary, which is 200 acres less than for Grey Mountain. Effects on CDOW lands would be the same, although the Poudre alternative would require about 110 fewer acres of land controlled by the State Land Board. The inactive Fort Collins filtration plant would still be inundated, as would much of the City's surrounding property.

Private land effects between the two alternatives differ only with respect to one ranch/farmstead located between the two damsites. Part of this property would be within the project boundary for the Poudre alternative, but the buildings would not be inundated by the Poudre Reservoir. The smaller reservoir would still displace about 60 to 70 structures along the mainstem.

The same Highway 14 realignment described earlier has been assumed for the Poudre alternative. The transmission line route would be approximately 2 miles longer than for the Grey Mountain alternative, but could still parallel Highway 14.

5.4.3.2 Indirect and Induced Land Use Changes

Through the creation of a reservoir and possible changes in access characteristics, either project alternative could cause indirect changes in the way the surrounding land is used. Based on existing conditions and knowledge of project plans, however, it does not appear that such effects would be significant. The proposed reservoir would cover lands currently managed for grazing or dispersed recreation, but these uses would continue along the reservoir and on adjacent lands. There would be a locational shift in certain management zones, but the presence of a reservoir would not require large-scale management redesignations.

Changes in access patterns would also be minimal, at least with respect to road access. Lands along the North Fork are presently not open to public access. Restricted access is expected to continue even if recreational plans associated with the mainstem reservoir are developed and implemented. Provision for boating on the reservoir would allow access by boat to points along the reservoir shoreline, from where users could travel by foot if desired. Due to the steep terrain and lack of trails, however, such use would not likely disperse very far from the shoreline. Along the mainstem, there are no existing secondary roads or trails that would be intersected by the relocated highway. Consequently, extensive new access to currently unused areas would not occur as a result of the project.

With either alternative, the mainstem reservoir could conceivably stimulate recreation and residential development nearby. In the Poudre Canyon, access problems and geologic hazards would limit the opportunity for these types of development to occur along the shoreline. Due to the steep topography along the south side of the proposed reservoir, and lack of access along the north side, little development can be expected. In order to better assess the potential for induced development, private lands within the study area were divided into five separate areas for a more detailed review.

The northern tier of the study area near Eagles Nest Mountain contains about 3000 acres of private land, including four entire sections (3, 4, 5, and 6) along a line running east to west. This area is a minimum of 4 miles from the nearest water service area and is much farther from sewer service. Road access is limited to light-duty roads (dirt or gravel) on the east and west sides of Section 6, although the paved Redfeather Lakes Road is within 0.5 mile in places. Most of this area has moderate geologic hazards and moderate-to-severe fire hazard potential. There is a relatively large hazard-free area along the northern edge, although some of this land is important farmland or wetland. Most of these lands are currently in larger ranch holdings and are likely to remain so. Access toward the northern end of the proposed reservoir could be possible through this area. However, shoreline development would still not be possible due to the project buffer zone along the reservoir.

In the east central part of the study area near Bonner Peak, parts of five sections include approximately 1900 acres of private land. All of this acreage is within 1 to 3 miles of Highway 287, although not all parcels have road access. Light-duty roads extend south and east from Highway 287 to near the summit of Bonner Peak. This area is at least 3 miles from the nearest water service area and 7 miles from existing sewer service. This area is relatively free from geologic hazards, but has extensive wildfire hazard potential, much of it in the severe category. The area also provides good mule deer habitat. The Bonner Peak area has already been divided into 24 parcels of 40 acres or less, and an additional 17 40-acre parcels (or 19 35-acre parcels) could be created from the existing larger tracts if land division continued. Little development has occurred to date on these parcels. The area is oriented toward the east and would not have views of the proposed mainstem reservoir. Therefore, the project would not likely represent a significant development stimulus in this area.

Approximately 3400 acres on parts of six sections in the southeast corner of the study area were identified as private lands. Most of these lands are serviced by Highway 14 or 287, and road access is the best within the study area. The easternmost sections are currently served by water, and the closest sewer service is within 2 miles. This area is free of wildfire and geologic hazards, except for some floodplain areas. There are approximately 500 acres of prime irrigated farmland plus 600 to 700 acres of important farmlands, which could limit actual development potential in this area. Overall, the terrain, hazard, and service conditions indicate that this area has the highest development potential in the study area. Development to 10-acre lot intensity, or even subdivision development, could be possible. However, any development that would occur here would probably be attributable to general regional development trends rather than specific effects from the project.

The southern side of the canyon along the mainstem has about 4500 acres of privately-owned land in nine sections. Most of this land is within 1 to 2 miles of Highway 14, but side roads do not provide access to lands away from the highway. The nearest utility service is at least 3 miles for water and 6 miles for sewer. Virtually all of the area has geologic hazards and moderate or severe wildfire hazard. Past land divisions have created about 25 small parcels, aside from the existing subdivisions along the river, but virtually none appear to have been developed. Overall, the area has low potential for future development due to steep slopes, a north aspect, and various hazards.

The Long Draw area, in the northwest portion of the study area north of Greyrock Mountain, includes about 1700 acres of private land in parts of six sections. Access to this region is very poor, as there are no existing roads other than an old jeep trail southeast from the Eagles Nest area. Utility service is more than 10 miles distant. Most of the area has moderate geologic hazards and moderate or severe wildfire hazard. Overall, private lands in the Long Draw area appear to have very low development potential.

Based on this assessment of development potential, the proposed project would not be expected to stimulate significant new development in the local area. This conclusion appears to be consistent with past development experience near

Horsetooth Reservoir and Carter Lake. The Horsetooth area has public water and sewer service and fire protection, but most of the existing development occurred during or prior to the 1960s when few development controls existed (Legg, 1988). A more recent development proposal near the reservoir was not implemented, largely due to the presence of geologic hazards and high building costs. Lack of an adequate water supply has virtually precluded recent development around Carter Lake (Legg, 1988). Most developed uses in this area are relatively old and would not meet current state and local development requirements.

5.4.4 Mitigation

The adverse land use effects identified in Section 5.4.3 would require mitigation as part of the project. To summarize the effects assessment, a variety of direct changes were identified, but no measurable indirect or induced changes attributable to the project are expected. The direct effects generally involve the displacement of existing land uses by the project facilities and the relocation of Highway 14. These effects include inundation of lands developed for residential, water supply, or ranching purposes, and the loss of a small amount of grazing capacity.

The conceptual approach for mitigation of land use effects is simple and straightforward, because virtually all land use effects would be mitigated through the acquisition of land rights. Privately owned lands that would be affected by actual components of the project would be acquired at fair market value by the District. Technically, land acquisition costs are basic project costs rather than actual mitigation costs. Because land costs have already been accounted for in the preliminary evaluation of economic feasibility, these costs will not be counted as a cost of mitigation required for land use effects.

In order to provide an indication of potential land acquisition costs, a brief investigation of land values in the study area was conducted. Generally, homes or cabins on small lots with river frontage range from $50,000 to $100,000 in value (Macy, 1988), although some individual properties can have much higher values. Based on current listings, undevelopable parcels can be priced at about $750 per acre. However, higher values of $1200 or $2000 per acre for various land types were used previously in estimating mitigation costs for wildlife habitat replacement.

Given the magnitude of the projected land use effects, and the mitigation of these effects through acquisition of the land or user rights, the land use aspects of the project would not have a negative effect on overall project feasibility.

5.4.5 Recommended Future Studies

The results of the Task 14 land use studies indicate that there are no major unresolved issues requiring future study. Data acquired for the land use inventory were generally sufficient in extent, currency, subject nature, and accuracy. The issues related to project effects that were identified at the outset of the studies were satisfactorily addressed.

While there are no major issues requiring further study, selected improvements should be incorporated with subsequent studies in related disciplines. These potential actions involve three specific topics, as described below:

1. Land ownership data - The existing land ownership data are sufficient for this phase of study, but should be updated and validated in future work. This would involve confirming existing ownership data, comprised primarily of BLM, FS and District maps, against current county tax assessment maps. As an added check, detailed FS and/or BLM land records could be reviewed. Any changes made through this effort should be reflected in revised project maps and acreage data.

2. Developed land use data - Estimates of residential and other land uses that would need to be acquired for the proposed project were based on analysis of aerial photographs and spot field checking. A complete field inventory should be undertaken to update and confirm the number of structures that would be displaced and their specific location.

3. Floodplain extent - The Task 14 investigation of floodplains was based on maps are being updated. The most current Federal Emergency Management

Agency floodplain maps should be obtained and reviewed against the existing maps to determine if reevaluation of associated land use issues is necessary.

It is possible that new issues could arise as project plans continue to develop. For example, concerns over public access to currently remote areas could develop if the project recreation plan proposed facilities in such areas. Alternatively, significant changes in current project engineering plans could be adopted and alter the location or extent of estimated land use effects. Such changes would clearly require the reevaluation of project land use issues.

5.5 SUMMARY

This section of the report summarizes the key results described previously for recreation, aesthetics, and land use issues, respectively.

5.5.1 Recreation

Recreation studies for Stage 1 of the proposed Cache la Poudre project were conducted at both a local and a regional scale. Recreation resources and activities within a primary study area including lands within a few miles of the proposed project facilities were analyzed in considerable detail. More general studies were conducted over a broader area essentially coinciding with Larimer County, and in selected cases for resources beyond the county boundaries. Existing recreation opportunities and use levels within the study area were characterized on the basis of agency inventory data, generally available literature, and personal contacts with authoritative sources. Project effects were estimated through a systematic process in which the direct and indirect effects of each project alternative were assessed for each recreational activity or resource.

The Cache la Poudre Canyon provides a wide variety of recreational resources and is a popular area for many activities. The most notable recreation attraction in the surrounding region is Rocky Mountain National Park, which is located south of the Poudre Canyon. The canyon is surrounded by lands and waters of the Arapaho-Roosevelt National Forest that offer many opportunities for hiking, angling, sightseeing, and other forms of dispersed recreation opportunities. The FS, NPS, CDPOR, and Larimer County collectively operate dozens of developed recreation facilities in the region that support camping, picnicking, boating, swimming, and other activities. Approximately 75 miles of the Poudre River above Poudre Park have been designated as components of the national Wild and Scenic River system, providing another significant regional attraction.

The primary study area has a similar variety of recreational resources as offered regionally. The FS operates a campground and two picnicgrounds upstream of Poudre Park, and a trailhead and five private recreation cabins below this community. These facilities receive approximately 4000 annual visits. Two existing river access sites near the canyon mouth operated by CDPOR provide additional facilities for day-use activities. Use of these sites totals over 50,000 visits per year. Much of the land adjacent to Highway 14 and the river is accessible to the public for dispersed recreation. By volume, the most popular recreational activity within the study area is sightseeing, which accounts for an estimated 207,000 visits per year. Other major activities include hiking on the Greyrock Mountain National Recreation Trail (19,500 annual visits), whitewater boating on several sections of the Poudre River (6000 visits), and stream angling (4700 visits).

The Grey Mountain alternative for Stage 1 of the proposed project would adversely affect a number of these activities. The proposed mainstem reservoir would flood the Greyrock Trailhead, possibly forcing a temporary closure and temporary loss of hiking activity. Whitewater boating on the Bridges and Filter Plant runs would be displaced, as would angling along approximately 6.5 miles of wild trout water and undesignated fishing waters. Overall, the Grey Mountain alternative would displace a total of 9460 annual user visits, excluding hiking, valued at over $147,000. Loss of an estimated 5050 whitewater boating visits would account for most of this direct effect. Projected angling losses amount to 2600 annual visits. Indirect effects of this alternative through downstream flow changes might increase the whitewater boating loss slightly, but would probably not have an adverse effect on desired flow levels for angling.

The Poudre alternative would displace less than half the amount of long-term annual visits predicted for the Grey Mountain alternative. The primary difference in displacement effects relates to whitewater boating. The Poudre alternative would also inundate the Bridges whitewater run, but would leave the more heavily used Filter Plant run essentially intact and floatable. The total recurring losses projected for the Poudre alternative are 4380 annual visits valued at over $53,000. Angling would be most affected by this activity, with an estimated 1900 visits per year displaced to other locations. Altered streamflows with the Poudre alternative could indirectly lead to an additional annual loss of about 50 whitewater boating visits, as a worst case.

The Task 14 recreation studies included identification of potential development options to mitigate recreation losses and take advantage of opportunities provided by the mainstem reservoir. Proposed recreation facilities that would address these objectives were developed, along with preliminary cost estimates. These facilities include relocation of the Greyrock Mountain Trailhead, new and replacement river access sites for boating and fishing, boat chutes at diversion dams to provide a new whitewater run, and facilities at or near the proposed reservoir to support boating, camping, and picnicking. The total development cost of these assumed facilities was estimated at $1,140,000 for the Grey Mountain alternative and $915,000 for the Poudre alternative. Annual operations and maintenance costs over a 20-year period would probably equal the development costs in nominal terms.

Based on estimates of potential use of these new facilities, either alternative could result in a net increase in projected annual visitation in the study area. The proposed mainstem reservoir would be a resource providing a large capacity for boating, fishing, and other lake-oriented activities. The higher use intensities associated with a higher level of recreation development would be able to more than offset the adverse direct and indirect effects of the project. The proposed whitewater boating opportunities would also be able to mitigate much of the lost activity on the Bridges and/or Filter Plant runs. Overall, the projected net change for the Grey Mountain alternative would be a gain of nearly 17,600 annual visits. Using similar development assumptions, a net increase of over 21,100 visits could be associated with the Poudre alternative. In view of the ability to provide a significant degree of mitigation for displaced activities and enhancement for both existing and new uses, the recreational effects of the project should not have an adverse effect on overall project feasibility.

The recreation component of this report identifies a number of recommended future studies. Baseline data should be supplemented with additional field observations of recreational activity, and should be updated based on current FS planning efforts. The key needs in analyzing project effects are more detailed data on project flow releases and expanded information on project characteristics. The most significant future activity needed is the preparation of a comprehensive recreation plan for the project. This effort would include a full evaluation of resource opportunities and constraints, development needs, site-specific development feasibility and plans, and reliable cost estimates.

5.5.2 Aesthetics

Task 14 studies for aesthetics were conducted within the primary study area defined for recreation, which provided a substantial buffer around the viewsheds that could potentially be affected by the project. Existing visual resources within this area were characterized on the basis of FS inventory data, slope and landform information from topographic maps, vegetation mapping conducted for other Basin Study Extension tasks, and preliminary field observations and photography. Expected project effects from the Grey Mountain and Poudre alternatives were assessed according to the degree of landscape change that would occur, and the visibility of this change. The compatibility of the appearance of project features with the visual management objectives of the FS was also reviewed.

The visual character of the Cache la Poudre Canyon varies somewhat along different segments of the river. Virtually all of the study area is situated within foothill and mountain terrain. The river is generally flanked closely by steep to moderately steep canyon walls that rise from 700 to 1600 ft above the river elevation. Higher peaks such as Greyrock Mountain and Bonner Peak rise noticeably above the surrounding ridges and are the dominant landforms. Low-growing mountain shrub and grassland are the predominant vegetation types in the study area, particularly on south-facing slopes. Open- or closed-canopy conifer forest covers about 25 percent of the area. There also are significant areas of bare rock along the canyon walls. Virtually all of the study area that has been inventoried by the Forest Service for visual quality has been characterized as variety class B, common.

Highway 14, which parallels the Cache la Poudre River, is the primary viewing location. The highway serves residents of the canyon, recreationists using resources in the study area or upstream, and motorists passing through for business purposes. Total traffic on Highway 14 averages approximately 1700 vehicles per day, which equates to about 5100 people per day or 1.8 million people per year. The local resident population ranges up to nearly 1400 people at seasonal peaks. Estimates of recreation visits within the study area total approximately 290,000 per year. Sightseeing accounts for over two-thirds of this recreational activity. Other key recreational user groups include hikers, whitewater boaters, campers, picnickers, and anglers. Most of the activity is dispersed use occurring on or along the river throughout the study area, although there are several developed recreation sites above Poudre Park and near the canyon mouth. The sensitivity of these viewers to visual change is presumed to be high, as indicated by the assignment of sensitivity level 1 to virtually all Forest Service lands within the primary study area.

Construction of the proposed Grey Mountain Dam would introduce landscape changes and visual contrast that would dominate the visual environment in the area of the damsite. The contrasting elements of the dam and associated facilities would include strong geometric lines and forms, a relatively large mass spanning the canyon, and a lighter color and smoother texture than the adjacent canyon walls. This visual change would be viewed primarily by travellers on relocated Highway 14. Motorists travelling up the canyon would view the dam for a distance of approximately 0.5 mile immediately south of the damsite. Travellers in the opposite direction would probably be able to view the dam at a distance of 0.5 to 1 mile. Level or superior viewing positions in both locations would lessen the magnitude of the visual effect, while terrain and vegetation would at least partially screen the views from north of the dam. In addition to views from the highway, dispersed recreationists on and along the river would be able to view the dam for up to about 0.5 mile downstream.

The visual change created by the proposed reservoir would be larger in area, extending more than 6 miles upstream from the damsite to near Poudre Park. The portions of the reservoir visible from Highway 14 would appear as a narrow lake flanked by steep canyon walls. The reservoir would increase the visual diversity of the study area, although viewers would likely have divided preferences for lake versus river settings. The primary adverse visual effect of the reservoir would result from exposed shorelines at times when the reservoir level was below the normal maximum water surface elevation of 5630 ft. Simulations of reservoir levels based on historical streamflows indicate that the reservoir level would be more than 50 ft below the normal maximum level from September through March in at least half of the operating years. The reservoir would be at higher levels during the peak spring-summer recreational season. The elevated position of Highway 14 near the reservoir shoreline and intervening coniferous vegetation would lessen the visibility of the reservoir to highway travellers.

Other project features would create lesser visual effects. The project transmission line, which presumably would parallel the existing Highway 14, would be visible but not prominent from the relocated highway. However, it would also be adjacent to the highway for approximately 3 miles east of the relocation area. Highway relocation itself would create some additional landscape modification that would be visible from the new highway and from the river and reservoir.

The visual effects of the Poudre alternative would be very similar to those of the Grey Mountain alternative. The contrast elements would be the same, although the Poudre Dam would be somewhat more noticeable locally due to greater color and texture contrast with the existing landscape. However, this difference would be more than offset by limited views of the Poudre Damsite from the relocated Highway 14. Views of the dam would be possible for at most 0.75 mile to the south, and might be limited to 0.25 mile. In either case, the visual prominence of the dam would be limited by a superior viewing angle and intervening trees. Travellers approaching the dam from the west would have very transitory views as they passed opposite and above the dam. Virtually all views of the Poudre Dam would be eliminated if an optional highway tunnel near the damsite were constructed.

Both alternatives would create a degree of inconsistency with the current management of visual resources by the FS. The Grey Mountain Damsite is not on or immediately adjacent to any national forest lands. Consequently, the compatibility of the dam with FS visual quality objectives (VQOs) is not an issue. The mainstem reservoir created by either alternative would not meet the assigned partial retention VQO at times when the reservoir level was significantly below the normal maximum water surface elevation. The Poudre Damsite has a retention VQO within the foreground viewing zone, while construction of the dam would represent either a modification of maximum modification condition.

A number of potential mitigation measures that could be implemented for either alternative were identified. These measures were based on common use for the types of visual effects identified, and not on detailed site-specific analysis of simulated project appearance and treatments that would ensure compatibility with the FS VQOs. These potential measures include texturing and tinting the concrete used in the dam and other structures, landscaping to provide screening, feathering the edges of clearings, and use of low-contrast transmission line structures. If implemented, the total cost of the aesthetic mitigation measures identified would probably be less than $1 million. Based on the existing level of information on aesthetic resources, effects and mitigation potential, it appears that the aesthetic aspects of the proposed project should not have an adverse influence on overall project feasibility.

Recommended future aesthetics studies were also identified. The recommendations addressed needs for additional baseline information, more detailed analysis of project effects, and further evaluation of appropriate mitigation. Briefly, the primary baseline data need is for more complete characterization of currently unseen landscapes in the North Fork drainage. This would require both field observation and more intensive map study. Future impact analysis activities should include artist's renderings or photographic simulations of the most noticeable visual features, particularly the dam and reservoir. These tools could be used to provide a more precise determination of visual effects. A thorough review of these results with the Forest Service would then enable detailed evaluation of specific mitigation measures that would be appropriate within the visual resource management system.

5.5.3 Land Use

Land use studies were undertaken to characterize existing land use patterns and assess the effects of the two project alternatives on land use in the lower Cache la Poudre Canyon. The primary study area established for recreation and aesthetics was used to account for potential project-related land use effects. Data were collected through review of planning documents and agency contacts, primarily from the Larimer County Planning Department and Arapaho-Roosevelt National Forest. Other data sources included aerial photography, feasibility reports, and development studies characterizing growth in Larimer County.

The major potential shoreline land owners within the 34,000-acre study area include the FS, Colorado State Land Board, and multiple private individuals. Approximately 40 percent of the study area is national forest land and 43 percent is owned by private individuals. Other land owners with river frontage include the CDOW, City of Fort Collins, and City of Greeley. There are four subdivisions in the study area, most of which are only partially developed. Other private lands within the study area are used for livestock grazing, permanent and second residences, and recreation.

Over 60 percent of the study area is within the administrative boundary of the Roosevelt National Forest, primarily north of the mainstem Poudre River. Most of this land is managed to protect big game habitat, although grazing is permitted. Three active grazing allotments occupy a major portion of the study area. Areas along the river are managed primarily for dispersed recreation usage. State lands are primarily used for grazing purposes, although CDOW lands provide big game winter habitat and access for recreation. The cities of Fort Collins and Greeley own water treatment facilities along the Poudre River within the study area.

An analysis of land-based resource productivity and development constraints revealed that much of the flatter, river bottom lands are within the 100-year floodplain, are wetlands, or constitute prime agricultural land or farmland of statewide importance. Most of the study area is also in areas of geologic and wildfire hazards, primarily due to the steep topography. Timber productivity is low, and commercial timber activities do not exist. Grazing lands were found to generally be of fair quality. The largest FS grazing allotment, the Greyrock-Griffith allotment, covers much of the study area and is also situated along much of the river frontage. A review of recent development trends indicated that in the last 25 years a marked increase in the conversion of rural agricultural lands into rural homesites has taken place in the surrounding region. However, no new subdivisions have been created in the study area since 1972. Any proposal for a new subdivision would be expensive because a full range of utilities and services would have to be provided. Continued parcel splitting and some rural residential development could occur, but would be restricted to low density by zoning and domestic water well regulations.

The two alternative damsites considered for the mainstem reservoir would inundate developed properties on the flatter riverside areas in the canyon. The two alternatives would require acquisition or easements for approximately 1800 to 2200 acres of land. Approximately one-third of the land needed for project development would consist of FS lands, one-third would be State Land Board holdings, and the remainder would be divided between municipal lands and private holdings. Most of the municipal land is at the site of an inactive water treatment facility owned by the City of Fort Collins. Two of the four existing subdivisions would be inundated along with an estimated 60 to 70 homes, cabins, and outbuildings. The two project alternatives differ very little with respect to displaced developed land uses; the Poudre alternative would not require acquisition of one of the two ranch/farmstead properties located between the two damsites. Several utilities and Colorado Highway 14 would require relocation. Most of the land required for the mainstem reservoir is used for grazing. Displacement of this activity would affect approximately 1500 acres and 80 AUM of range capacity.

The proposed project would shift some dispersed recreational activity onto some lands not currently managed for that purpose, but would not require significant changes in land management. Little change in access patterns would occur from the location of the reservoir and new access resulting from the proposed project. Therefore, no significant indirect land use effects are expected. Given similar access conditions and the constrained development potential of study area lands, the project would not be expected to cause a noticeable increase in residential development within the study area.

Lands or land use rights needed for project features, including highway relocation and transmission lines, would be acquired as part of the project. These land acquisition costs are part of the project capital cost and do not represent additional costs for land use mitigation. Consequently the land use effects would not have any separable effect on the economic feasibility of the proposed project. Further, the non-economic aspects of the land use effects should also not adversely influence overall project feasibility.

5.6 REFERENCES

Aiken, R. 1985. Public Benefits of Environmental Protection in Colorado. Colorado State University. Fort Collins, Colorado. Unpublished master's thesis.

Alden, Howard R. 1989. Personal communication. Colorado State University, Recreation Resources Department and private recreation consultant. Letter to Karl Dreher, Northern Colorado Water Conservancy District, June 1989.

Anderson, F. and A. Hopkinson. 1987. Rivers of the Southwest: A Boater's Guide to the Rivers of Colorado, New Mexico, Utah, and Arizona. Pruett Publishing. Boulder, Colorado.

Anderson, R.L. 1984. Urbanization of Rural Lands in the Northern Colorado Front Range - 1955 to 1983. Natural Resource Economics Division, Economic Research Service, USDA in cooperation with Colorado State University, Cooperative Extension Service. Fort Collins, Colorado.

BLM (U.S. Bureau of Land Management). 1981. Fort Collins, Colorado, 1:100,000 Scale Topographic map, Surface/Mineral Management Status. U.S. Department of the Interior, Bureau of Land Management. Denver, Colorado.

Boddie, C. and P. Boddie. 1984. The Hiker's Guide to Colorado. Falcon Press. Billings, Montana.

Bogart, D, 1988. Personal communication. Colorado Department of Natural Resources, Division of Wildlife, Fort Collins, Colorado. Letter to Chris E. Lawson, Envirosphere Company, March 1988.

CDH (Colorado Division of Highways). 1982-1987. Colorado State Traffic Volume Map. Annual. Denver, Colorado.

CDOW (Colorado Division of Wildlife). 1988a. Big Game Harvest. Colorado Department of Natural Resources, Division of Wildlife. Denver Colorado.

CDOW (Colorado Division of Wildlife). 1988b. Colorado Fishing Map. Colorado Department of Natural Resources, Division of Wildlife. Denver, Colorado.

CDOW (Colorado Division of Wildlife). 1987. Colorado Fishing Season Information. Colorado Department of Natural Resources, Division of Wildlife. Denver, Colorado.

CDOW (Colorado Division of Wildlife). 1985. Poudre Creel Census Summary. Colorado Department of Natural Resources, Division of Wildlife, Fort Collins, Colorado. Unpublished.

CDPOR (Colorado Division of Parks and Outdoor Recreation). 1988a. Backup Information for Budget Request to Legislature. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, Denver, Colorado. Unpublished.

CDPOR (Colorado Division of Parks and Outdoor Recreation). 1988b. Regional Manager Monthly Reports, Northern Region Facilities, April-September, 1988. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, Northern Region, Fort Collins, Colorado. Unpublished.

CDPOR (Colorado Division of Parks and Outdoor Recreation). 1986. Statewide Comprehensive Outdoor Recreation Plan. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation. Denver, Colorado.

CDPOR (Colorado Division of Parks and Outdoor Recreation). No date. Colorado State Parks. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation. Denver, Colorado

Colorado Tourism Board. 1988. Guide to Colorado Natural Resource Recreation. Denver, Colorado.

Daubert, J.T. and R.A. Young. 1979. Economic Benefits from Instream Flow in a Colorado Mountain Stream. Colorado Water Resources Research Institute, Completion Report No. 91. Colorado State University. Fort Collins, Colorado.

District (Northern Colorado Water Conservancy District). 1988. Tables 1-48, Monthly Pre- and Post-Project Simulated Cache la Poudre River Flows, and Mainstem Reservoir End of Month Water Surface Elevation in Feet. Northern Colorado Water Conservancy District, Loveland, Colorado. Unpublished.

District (Northern Colorado Water Conservancy District). No date. Cache la Poudre Water and Power Project Boundary Map, 5 sheets. Northern Colorado Water Conservancy District, Loveland, Colorado. Unpublished.

Englebert, J. 1988. Personal communication. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Red Feather Ranger District, Fort Collins, Colorado. Personal visit with C.E. Lawson (Envirosphere Company), February 1988.

Envirosphere Company. 1988. Botanical Resource Studies for Cache la Poudre Basin Study Extension, Draft Report. Prepared for Colorado Water Resource and Power Development Authority, Denver, Colorado. Unpublished.

FS (U.S. Forest Service). 1988a. An Analysis of the Outdoor Recreation and Wilderness Situation in the United States: 1989-2040. A technical document supporting the 1989 RPA Assessment. Draft. U.S. Department of Agriculture, Forest Service, Washington, D.C.

FS (U.S. Forest Service). 1988b. Commercial Whitewater Guide Permittee Records. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Unpublished.

FS (U.S. Forest Service). 1982-1986. Recreation Information Management (RIM) System Data on Developed and Dispersed Recreation Use. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Unpublished.

FS (U.S. Forest Service). 1985. Roosevelt National Forest. U.S. Department of Agriculture, Forest Service and U.S. Government Printing Office. Denver, Colorado.

FS (U.S. Forest Service). 1984. Land and Resource Management Plan, Arapaho and Roosevelt National Forests and Pawnee National Grassland. U.S. Department of Agriculture, Forest Service. Fort Collins, Colorado.

FS (U.S. Forest Service). 1982. Recreation Information Management (RIM) System Data, Acreage by Recreation Opportunity Spectrum (ROS) Classification. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Unpublished.

FS (U.S. Forest Service). 1979. The Recreation Opportunity Spectrum: A Framework for Planning, Management, and Research. General Technical Bulletin PNW-89. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Portland, Oregon.

FS (U.S. Forest Service). 1974. National Forest Landscape Management, Volume 2, Chapter 1: The Visual Management System. Agricultural Handbook Number 462, U.S. Department of Agriculture, Forest Service. Washington, D.C.

FS (U.S. Forest Service). No date. Visual Management System Inventory Data and Visual Quality Objective Designations. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Unpublished.

Ferguson, G. 1988. Walks of the Rockies. Prentice Hall Press. New York, New York.

Field, D.R. and K. Martinson. 1986. Water-based Recreation Participation. In: A Literature Review. The President's Commission on Americans Outdoors. Washington, D.C.

Fletcher, J.E. 1984. Sales of Boats, Motors, and Trailers as an Index to Water-based Recreation. In: Carlton S. Van Doren, ed. Statistics on Outdoor Recreation: Part 2, the Record Since 1956. Resources for the Future. Washington, D.C.

Friedlander, J. 1988. Personal communication. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Estes-Poudre District, Fort Collins, Colorado. Personal visit with C. Lawson (Envirosphere Company). February 1988.

Hagen, M. 1987. Hiking Trails of Northern Colorado. Pruett Publishing. Boulder, Colorado.

Hartmann, L.A., H.R. Freilich, and H.K. Cordell. 1988. Trends and Current Status of Participation in Outdoor Recreation. Unpublished manuscript.

Harza Engineering Company. 1987. Cache la Poudre Basin Water and Hydropower Resources Management Study, Final Report (Two volumes) Prepared for the Colorado Water Resources and Power Development Authority, Denver, Colorado.

Interagency Whitewater Committee. 1985. River Information Digest. Washington, D.C.

Kadera, A. 1988. Personal communication. Memo from A. Kadera, Subdivision Administrator, Larimer County Planning Department, to R. Legg, Development Processing Administrator, Larimer County Planning Department, Fort Collins, Colorado. February 1988.

Kelly, J.R. 1987. Recreation Trends Toward the Year 2000. Management Learning Laboratories. Champaign, Illinois.

Larimer County Planning Department. 1988. Larimer County Land Use Plan. Fort Collins, Colorado.

Larimer County Planning Department. 1986. Comprehensive Zoning Resolution, October 1986. Fort Collins, Colorado.

Larimer County Planning Department. 1985. Larimer County Profile, A Background Report for the Citizens Plan Review Committee. Fort Collins, Colorado.

Legg, R. 1988. Personal communication. Larimer County Planning Department, Fort Collins, Colorado. Personal visit with C. Lawson (Envirosphere Company), February 1988.

Lowe, D. and R.L. Lowe. 1973. Northern Colorado Hiking Trails. Touchstone Press. Beaverton, Oregon.

Macy, M. 1988. Personal communication. Van Schaack Realty, Fort Collins, Colorado. Telephone conversation with K. Gilbert (Envirosphere Company), November 1988.

Maurier, J. 1988. Personal communication. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, Northern Region, Fort Collins, Colorado. Personal visit with P. Reed (ORRA), September 1988.

Maurier, J. 1987a. Personal communication. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, Northern Region, Fort Collins, Colorado. Letter and data summary to C. Lawson (Envirosphere Company), November 17, 1987.

Maurier, J. 1987b. Personal communication. Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, Northern Region, Fort Collins, Colorado. Personal visit with K. Dreher (District), B. Dwyer (Authority), C. Lawson (Envirosphere Company) and P. Reed (ORRA), October 1987.

McFarlane, J. 1988. Personal communication. Larimer County Parks Department, Loveland, Colorado. Personal visit with P. Reed (ORRA), September 1988.

National Park Service. 1986. Construction Cost for FY 1989. Class C, Conceptual Estimating Guide. U.S. Department of the Interior, National Park Service, Denver Service Center, Branch of Estimating. Denver Colorado.

National Park Service. 1985. National Park Statistical Abstract. U.S. Department of the Interior, National Park Service, Denver Service Center, Statistical Office. Denver, Colorado.

President's Commission on Americans Outdoors. 1986. Report and Recommendations to the President of the United States. Washington, D.C.

Rankin, B. 1988. Personal communication. U.S. Department of Agriculture, Forest Service, Arapaho-Roosevelt National Forest, Estes-Poudre Ranger District, Fort Collins, Colorado. Personal visit with C. Lawson and M. Prewitt (Envirosphere Company). February 1988.

R.S. Means Company, Inc. 1988. Means Site Work Cost Data, 1989. 8th Annual Edition. Kingston, Massachusetts.

SCS (Soil Conservation Service). 1979. Important Farmlands of Larimer County, Colorado. U.S. Department of Agriculture, Soil Conservation Service and Colorado State University Agricultural Experiment Station. Fort Collins, Colorado.

Sabi, T. 1988. Personal communication. Colorado State Land Board, Denver, Colorado. Telephone conversation with K. Gilbert (Envirosphere Company). November 1988.

Smith, M. 1988. Personal communication. City of Fort Collins, Department of Natural Resources, Water and Sewer Utilities, Fort Collins, Colorado. Telephone conversation with C. Lawson (Envirosphere Company). December 1988.

Sorg, C. and J. Loomis. 1984. Empirical Estimates of Amenity Forest Values: A Comparative Review. General Technical Report RM-107. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

Stohlquist, J. 1982. Colorado Whitewater: A Guide to the Difficult Rivers and Streams of the Rocky Mountain State Region. Colorado Kayak Supply. Boulder, Colorado.

Tierney, P. 1988. Personal communication. Adrift Adventures, Fort Collins, Colorado. Personal visit with P. Reed (ORRA), August 1988.

Tierney, P. 1980. The 1980 Colorado Whitewater Boating Use and Economic Impact Study. Prepared for the Colorado River Outfitters Association and Western River Guides Association by Environmental Research and Technology, Inc.. Fort Collins, Colorado.

U.S. Bureau of Reclamation. 1988. Summary Statistics. Volume 1. Water, Land, and Related Data. U.S. Department of the Interior, Bureau of Reclamation. Washington, D.C.

U.S. Department of Housing and Urban Development. 1979. Flood Insurance Rate Map, Larimer County, Colorado, Unincorporated Areas. Community Panel Numbers 080101-0100, 0116, 0129-0131, 1004-0147. U.S. Department of Housing and Urban Development, Federal Insurance Administration. Washington, D.C.

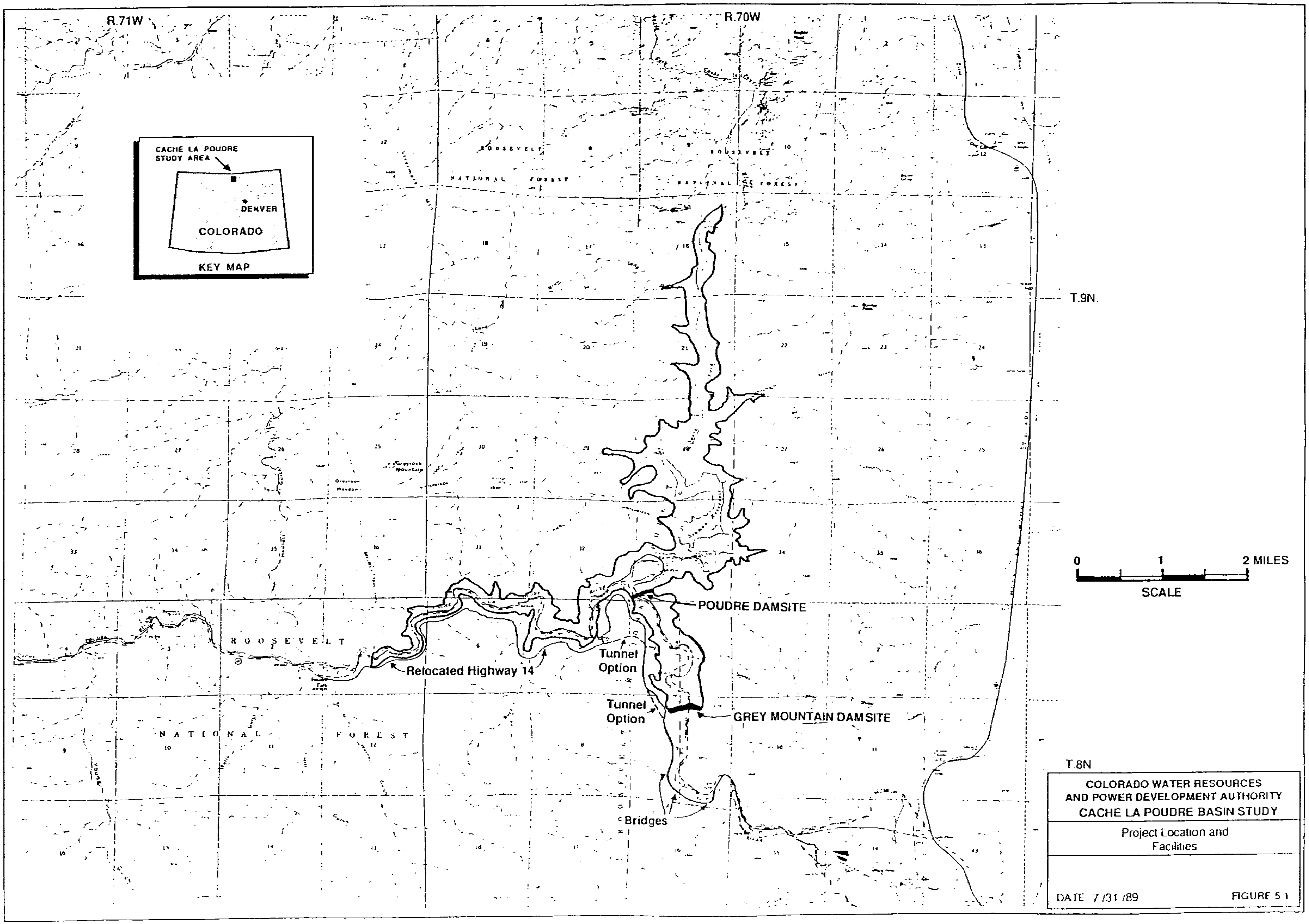
USGS (U.S. Geological Survey). 1987. USGS Water Resources Data for Colorado, Part 1: Surface Water Records, 1962-1986. U.S. Department of the Interior, Geological Survey. Denver, Colorado.

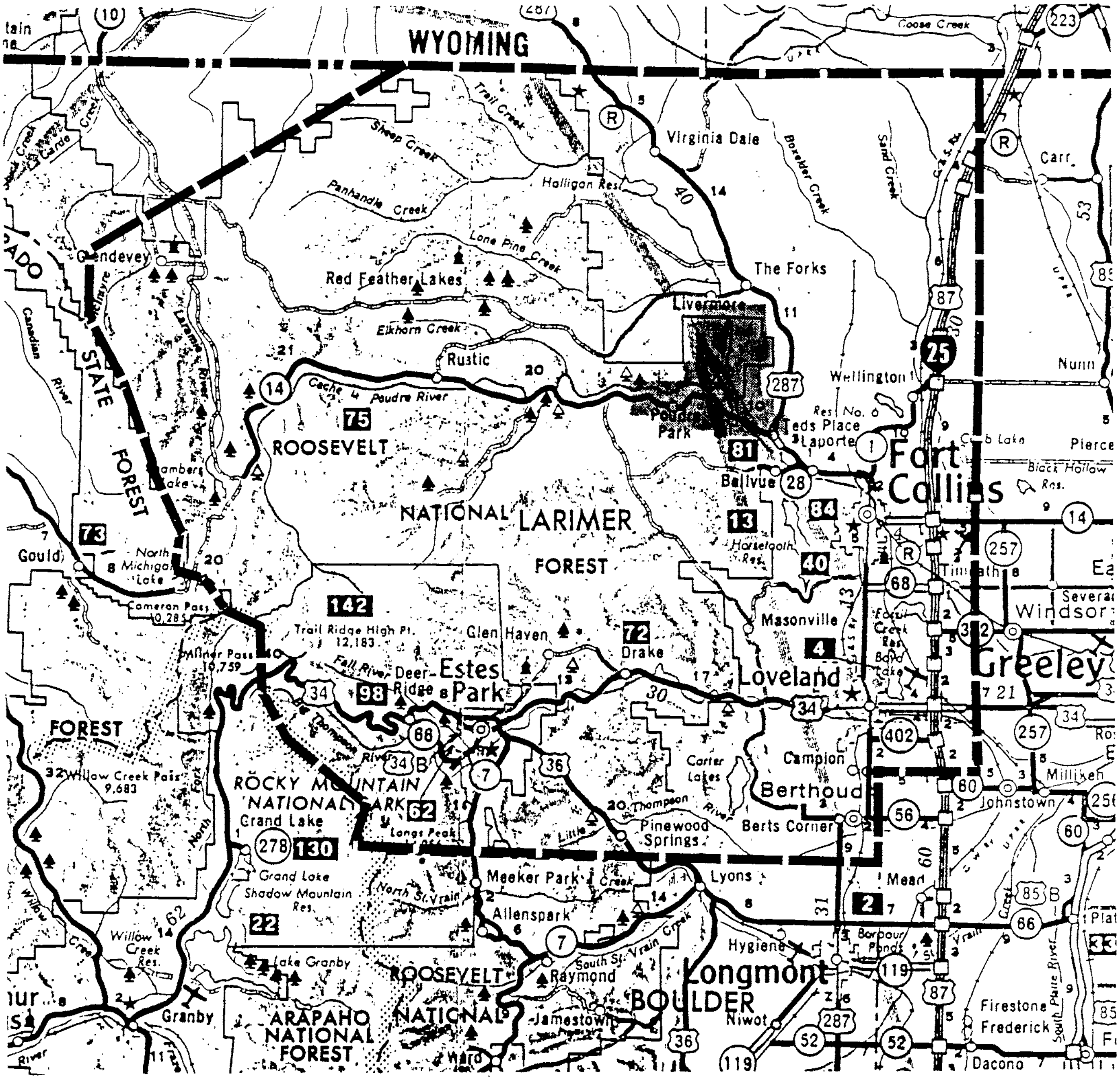
Walsh, R.G., D.M. Johnson, and J.R. McKean. 1988. Review of Outdoor Recreation Demand Studies with Non-Market Benefit Estimates, 1968-1988. Colorado State University. Fort Collins, Colorado.

Walsh, R.G. 1986. Recreation Economic Decisions. Venture Publishing Company. State College, Pennsylvania.

Walsh, R.G. and L.O. Gilliam. 1982. Benefits of Wilderness Experiences for Excess Demand at Indian Peaks. Western Journal of Agricultural Economics. July.

Wheat, D. 1983. The Floater's Guide to Colorado. Falcon Press. Billings, Montana.


R.71W
R.70W
CACHE LA POUDRE STUDY AREA
DENVER
COLORADO
KEY MAP
T.9N.
ROOSEVELT
NATIONAL FOREST
0
1
2 MILES
SCALE
POUDRE DAMSITE
Relocated Highway 14
Tunnel Option
Tunnel Option
GREY MOUNTAIN DAMSITE
Bridges
T.8N
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
Project Location and Facilities
DATE 7/31/89
FIGURE 5 1



PRIMARY STUDY AREA

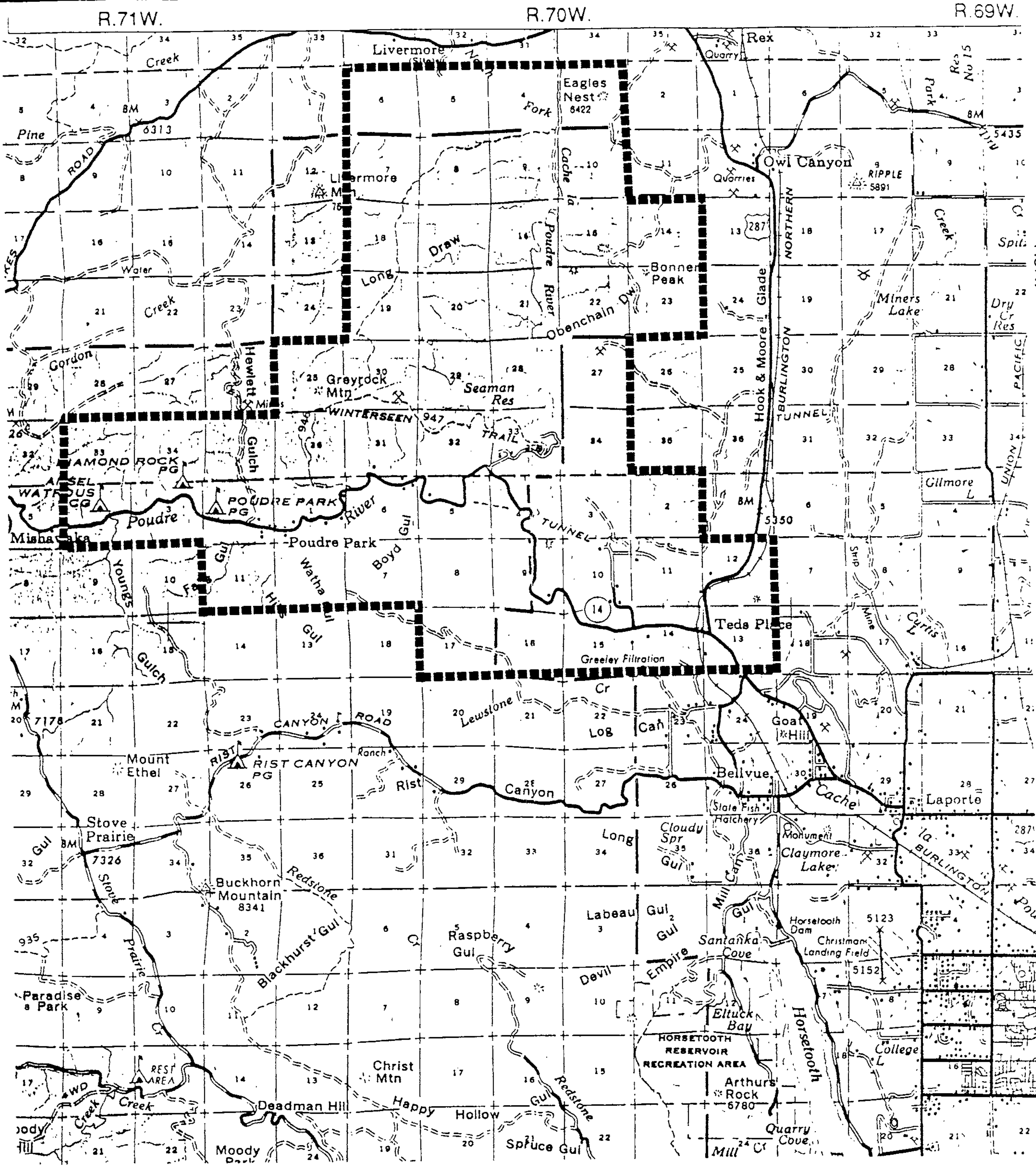
SECONDARY STUDY AREA

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

Recreation Study Areas

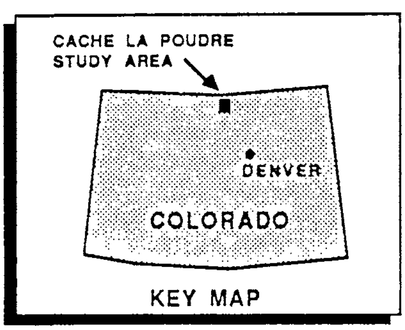
DATE 7 /31 /89

FIGURE 5.2



1 0 1 2 3 4 5

SCALE 1/2" = 1 MILE



STUDY AREA BOUNDARY

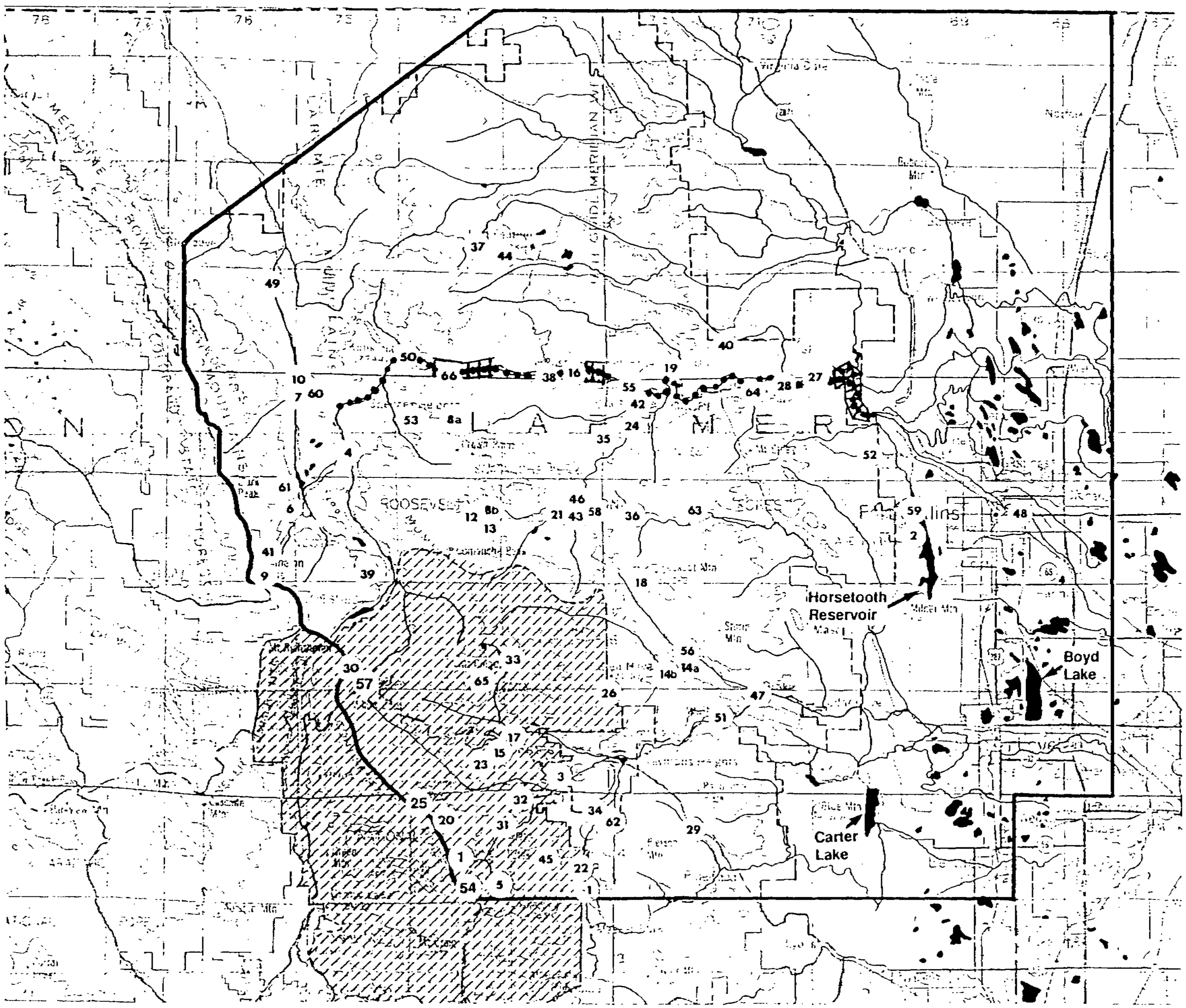
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

Primary Study Area
(Recreation, Aesthetics, and Land Use)

DATE 7 /31 /89

FIGURE 5.3



CACHE LA POUDRE PROJECT SECONDARY STUDY AREA

- NATIONAL PARK AREA
- WILD TROUT WATER
- NATIONAL FOREST BOUNDARY
- RUNNABLE RIVER
- RIVERS & LAKES
- 12 HIKING TRAIL (see table)

Refer to Appendix Tables B.41, B.42 and B.43 for Details and Source on Hiking Trails, Wild Trout Water, and RunnableRivers, Respectively

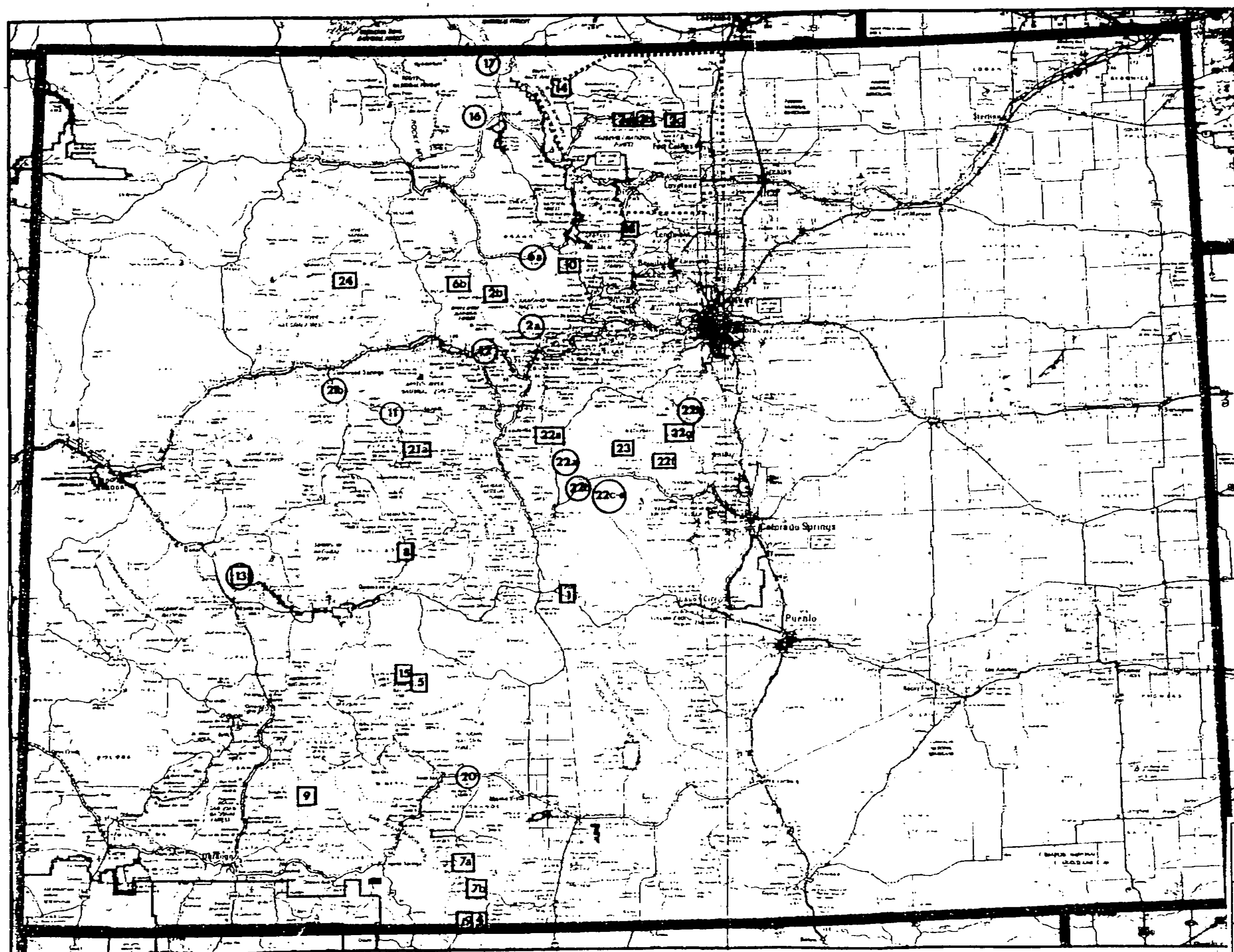
0 6 12 MILES
SCALE

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

Existing Recreation Resources, Secondary Study Area

DATE 7/31/89

FIGURE 5.4



GOLD MEDAL TROUT WATER

WILD TROUT WATER

SECONDARY STUDY AREA

MAP#	GOLD MEDAL/ WILD TROUT WATERS
1.	Arkansas River
2.	Blue River
3.	Cache la Poudre
4.	Cascade Creek
5.	Cochetopa Creek
6.	Colorado River
7.	Conejos River
8.	East River
9.	Emerald Lakes
10.	Fraser River
11.	Fryingpan River
12.	Gore Creek
13.	Gunnison River
14.	Laramie River
15.	Los Pinos Creek
16.	North Delaney Butte Lake
17.	North Platte River
18.	North St. Vrain
19.	Osier Creek
20.	Rio Grande
21.	Roaring Fork River
22.	South Platte River
23.	Tarryall Creek
24.	Trapper's Lake

(See Appendix Table B 42 for Further Information)

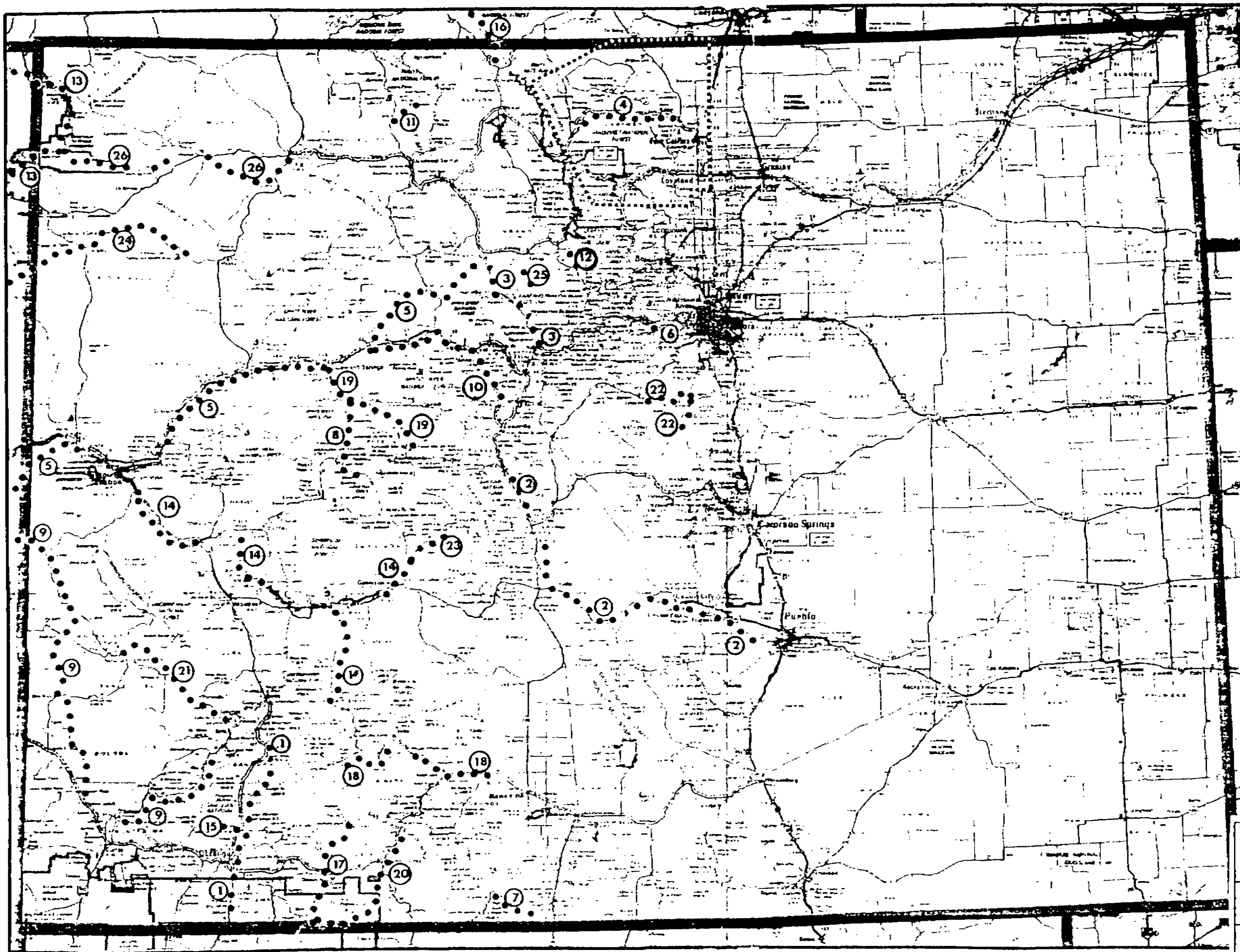
Sources: CDOW, 1987, 1988

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

Colorado Gold Medal and Wild Trout Water

DATE 7/31/89

FIGURE 5.5



MAP#	RIVER
1.	Animas River
2.	Arkansas River
3.	Blue River
4.	Cache la Poudre
5.	Colorado River
6.	Clear Creek
7.	Conejos River
8.	Crystal River
9.	Dolores River
10.	Eagle River
11.	Elk River
12.	Fraser River
13.	Green River
14.	Gunnison River
15	Hermosa Creek
16.	North Platte
17.	Piedra River
18.	Rio Grande
19.	Roaring Fork
20.	San Juan River
21.	San Miguel River
22.	South Platte
23.	Taylor River
24.	White River
25.	Williams Fork
26.	Yampa River

(See Appendix Table B.43 for further information)

Sources: Interagency Whitewater Committee, 1985. Wheat, 1983.

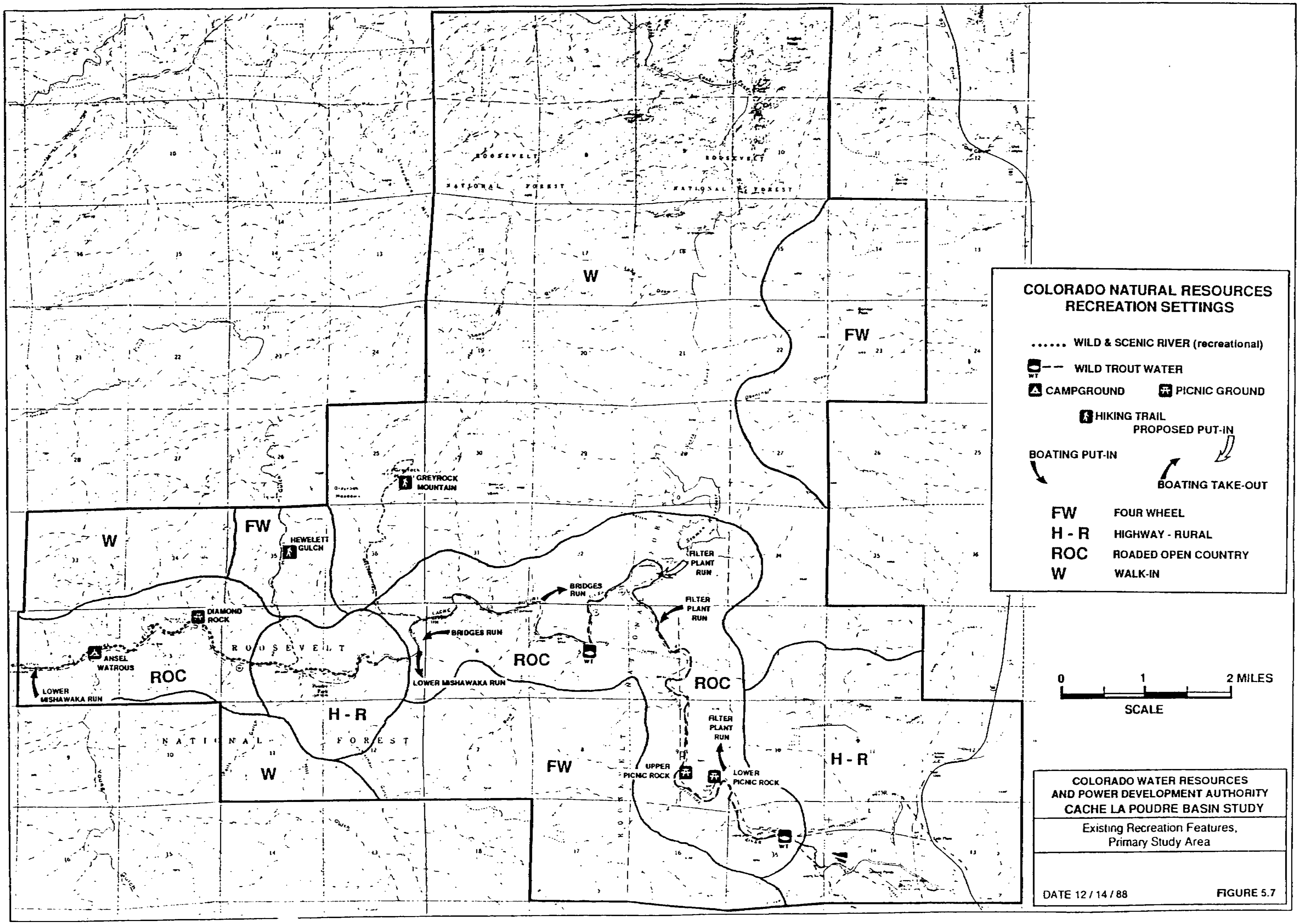
...... SECONDARY STUDY AREA

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

Floatable Whitewater Rivers in Colorado

DATE 7/31/89

FIGURE 5.6



COLORADO NATURAL RESOURCES
RECREATION SETTINGS
WILD & SCENIC RIVER (recreational)
WILD TROUT WATER
CAMPGROUND
PICNIC GROUND
HIKING TRAIL
PROPOSED PUT-IN
BOATING PUT-IN
BOATING TAKE-OUT
FW FOUR WHEEL
H - R HIGHWAY - RURAL
ROC ROADED OPEN COUNTRY
W WALK-IN
0 1 2 MILES
SCALE
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
Existing Recreation Features,
Primary Study Area
DATE 12 / 14 / 88
FIGURE 5.7
ROOSEVELT
NATIONAL FOREST
W
FW
ROC
H - R
GREYROCK MOUNTAIN
HEWELETT GULCH
DIAMOND ROCK
ANSEL WATROUS
LOWER MISHAWAKA RUN
BRIDGES RUN
FILTER PLANT RUN
UPPER PICNIC ROCK
LOWER PICNIC ROCK

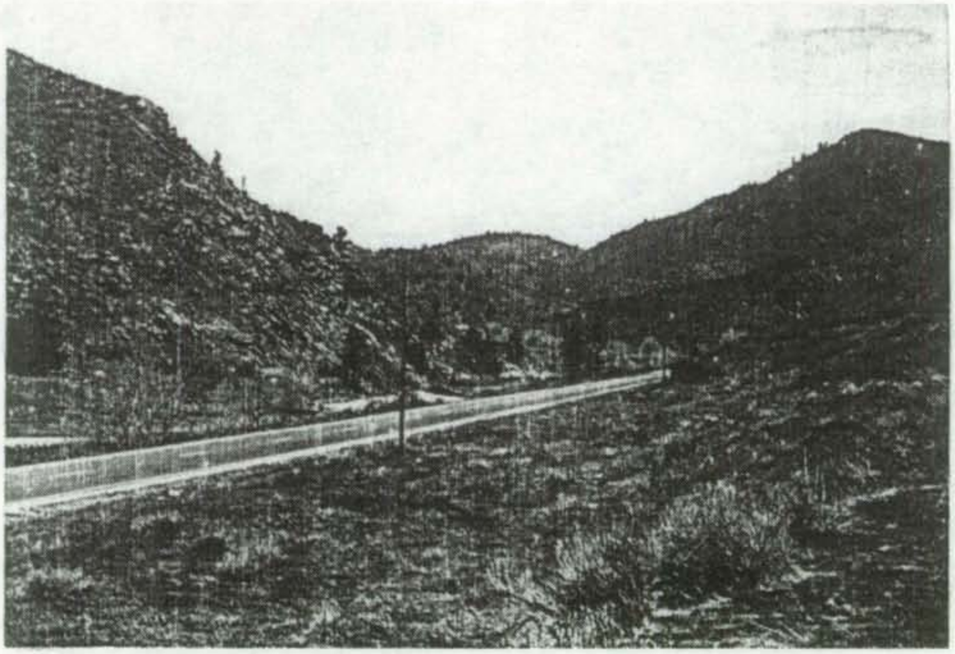


FIGURE 5.8 UPSTREAM VIEW NORTHWEST TOWARD GREY MOUNTAIN DAM SITE.

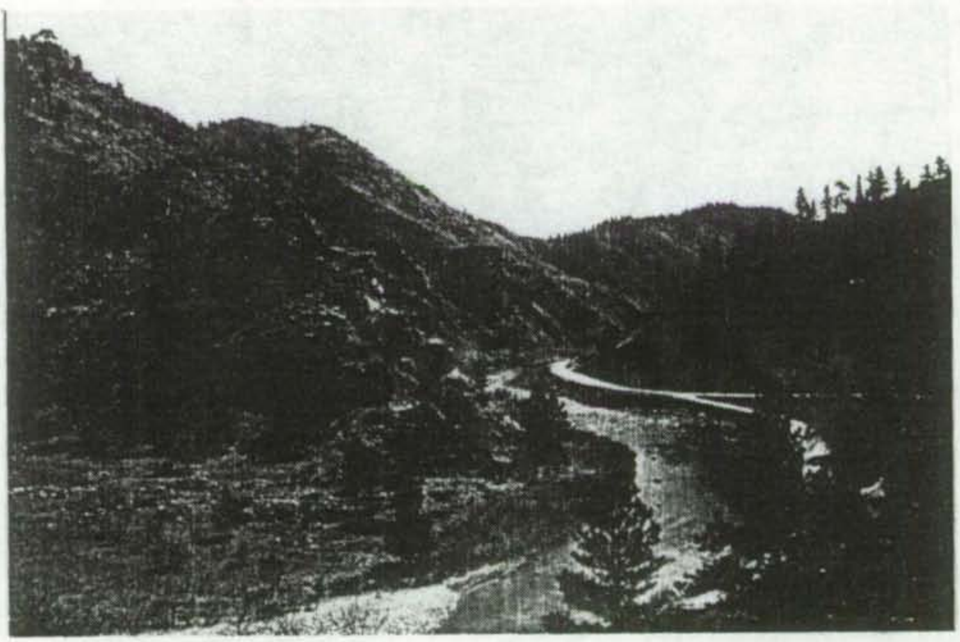


FIGURE 5.9 DOWNSTREAM VIEW SOUTHEAST TOWARD POUDRE DAM SITE.

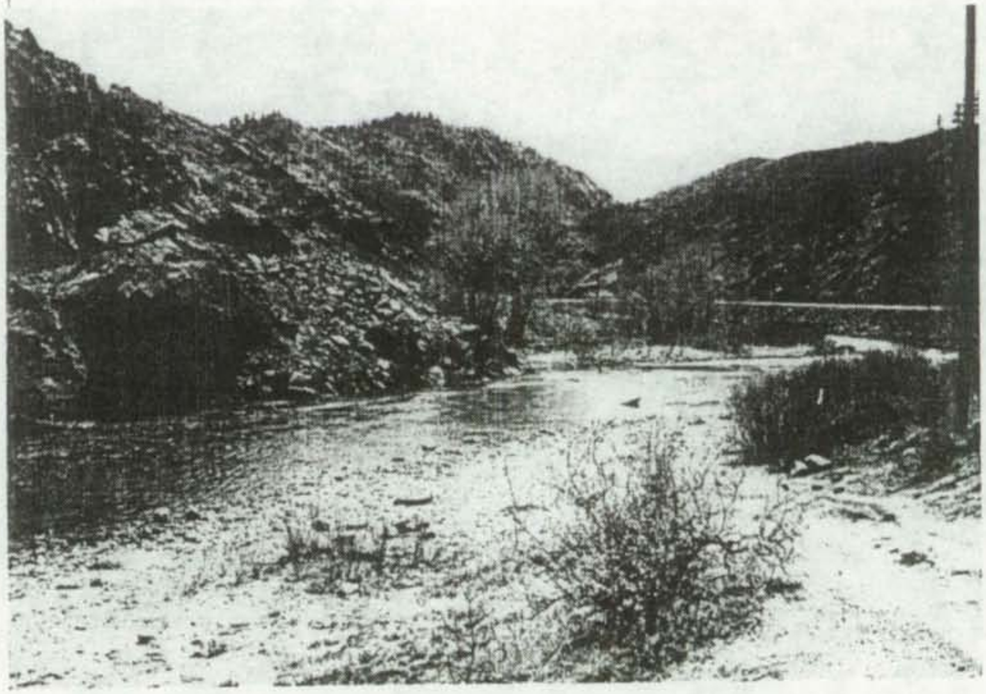


FIGURE 5.10 DOWNSTREAM VIEW AT INFORMAL RIVER ACCESS SITE BETWEEN GREY MOUNTAIN AND POUDRE SITES.

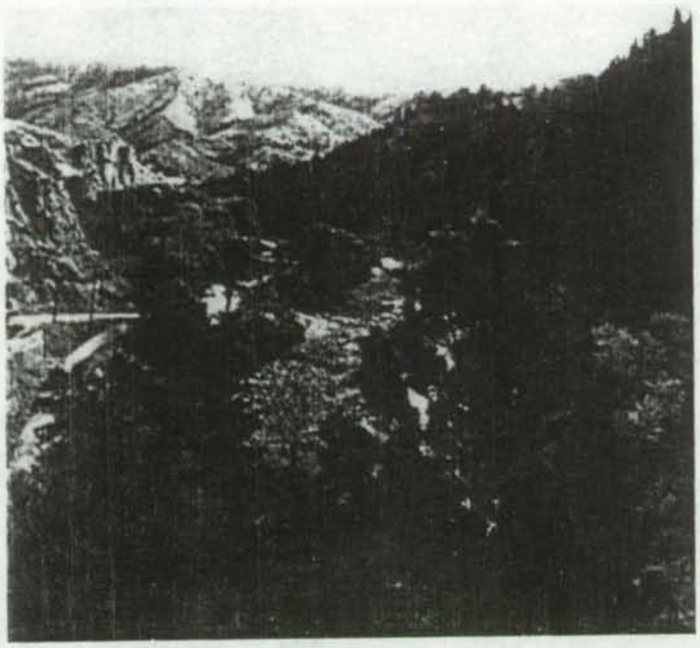


FIGURE 5.11 UPSTREAM VIEW TOWARD NORTHFORK / MAINSTEM CONFLUENCE, NEAR FT. COLLINS FILTRATION PLANT.

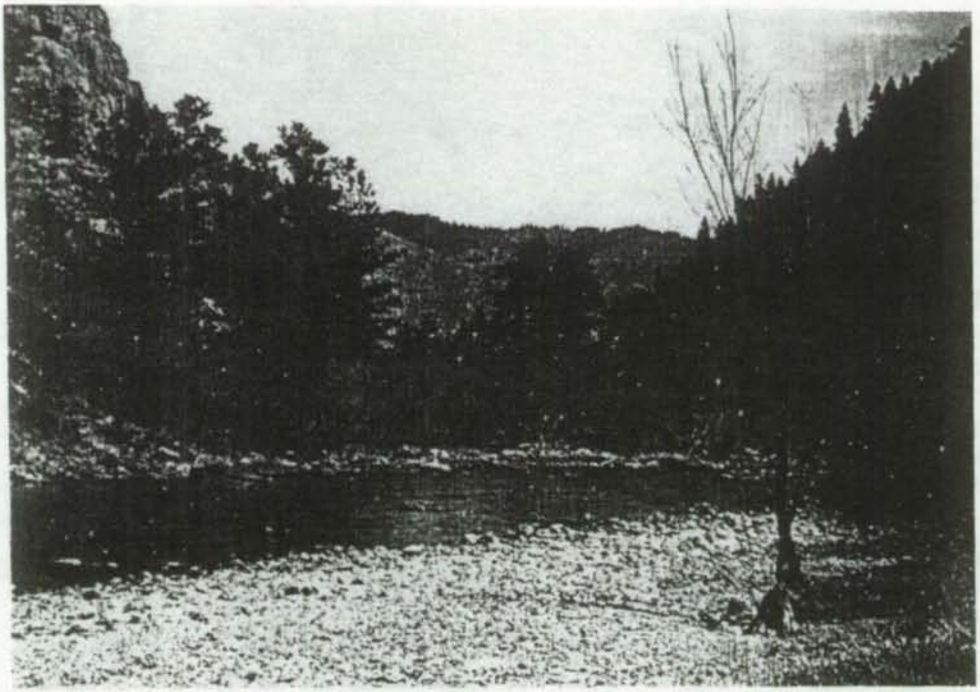


FIGURE 5.12 DOWNSTREAM VIEW OF MAINSTEM 1/2 MILE ABOVE POUDRE DAM SITE.

FIGURE 5.13 DOWNSTREAM VIEW OF GREY ROCK TRAILHEAD BRIDGE ACROSS MAINSTEM.

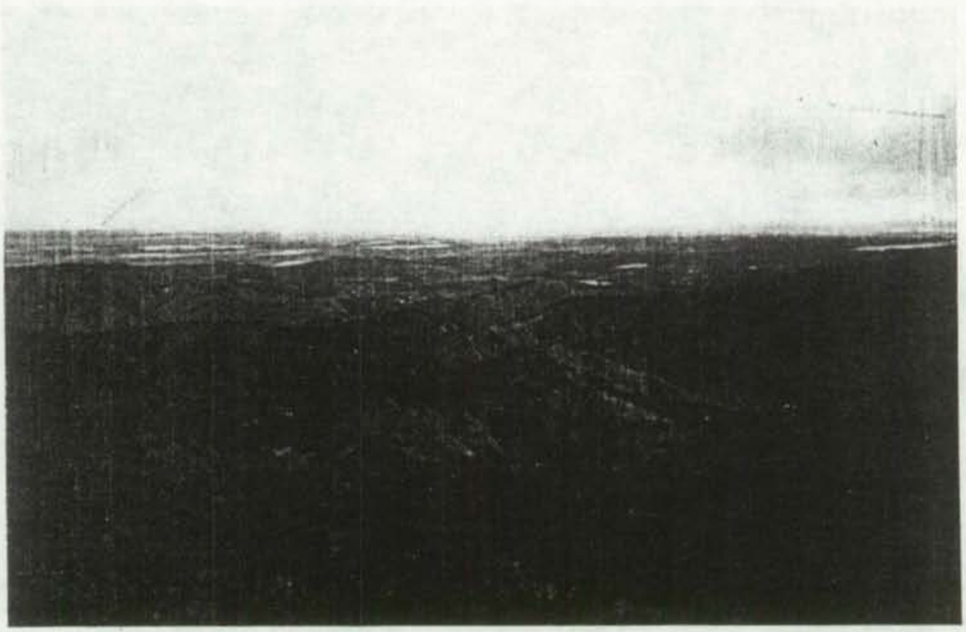
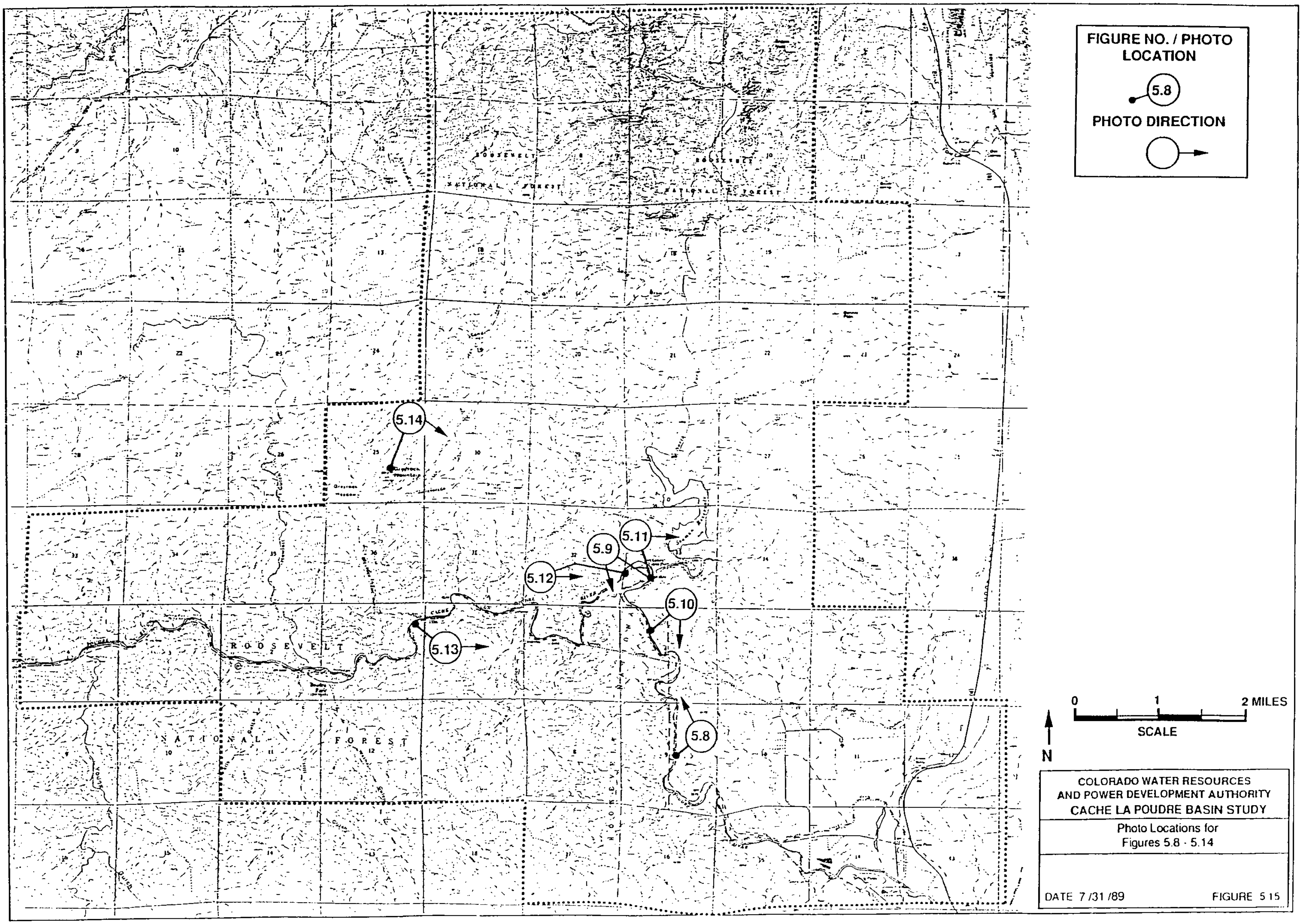


FIGURE 5.14 VIEW OF THE NORTHFORK (MIDDLE LEFT) AND MAINSTEM (MIDDLE RIGHT) DRAINAGES FROM THE TOP OF GREYROCK MOUNTAIN.

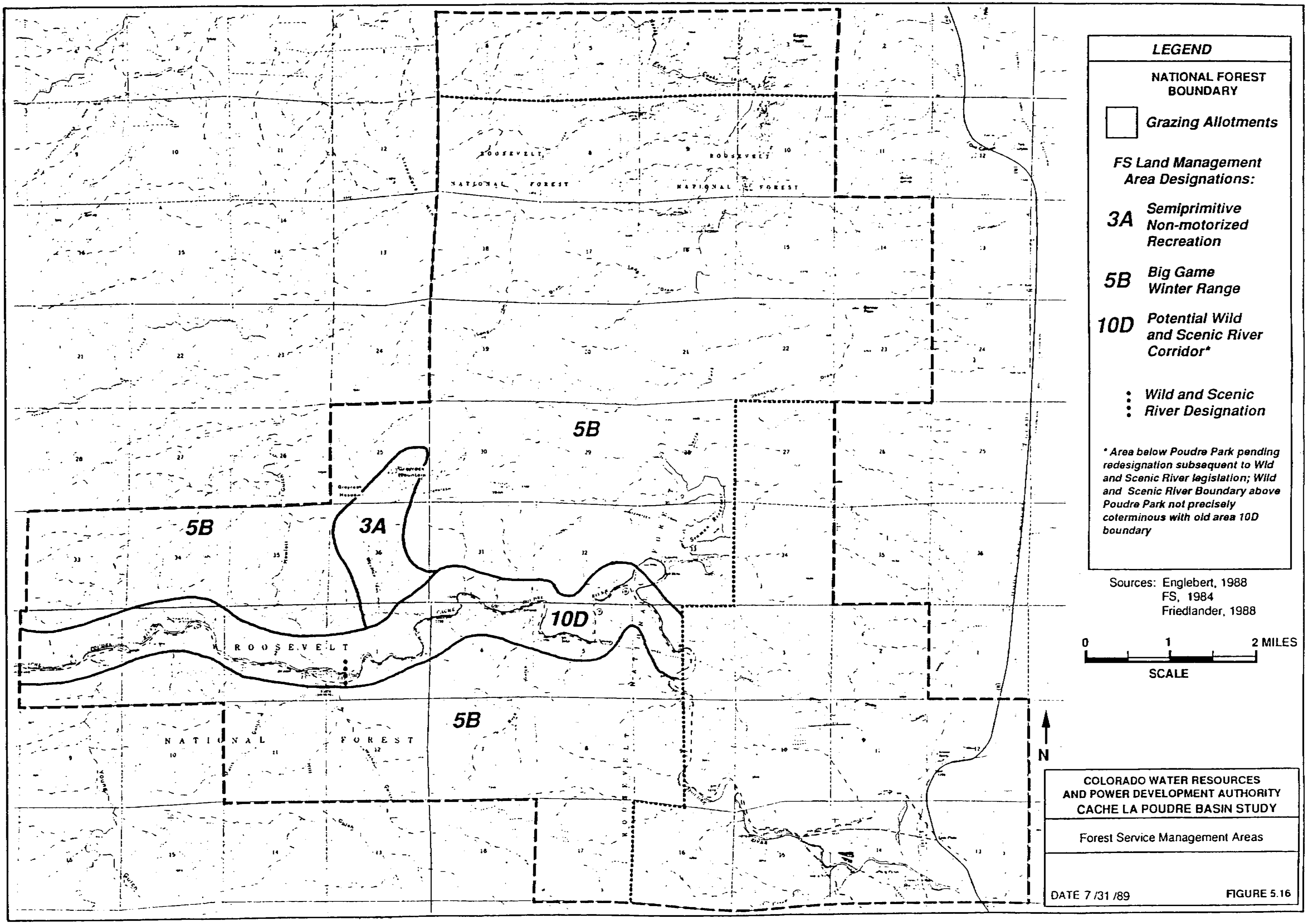


COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY

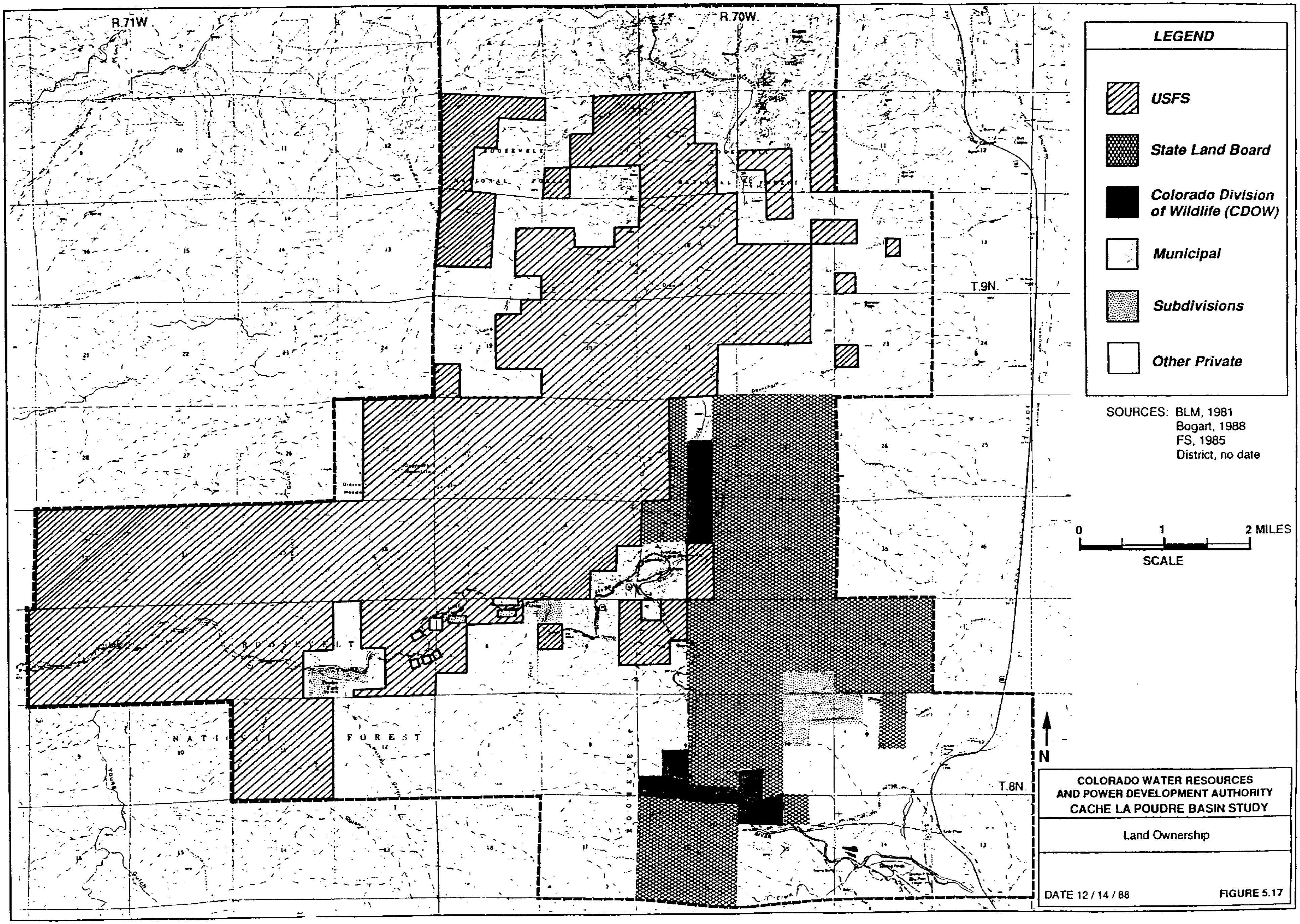
Photo Locations for Figures 5.8 - 5.14

DATE 7/31/89

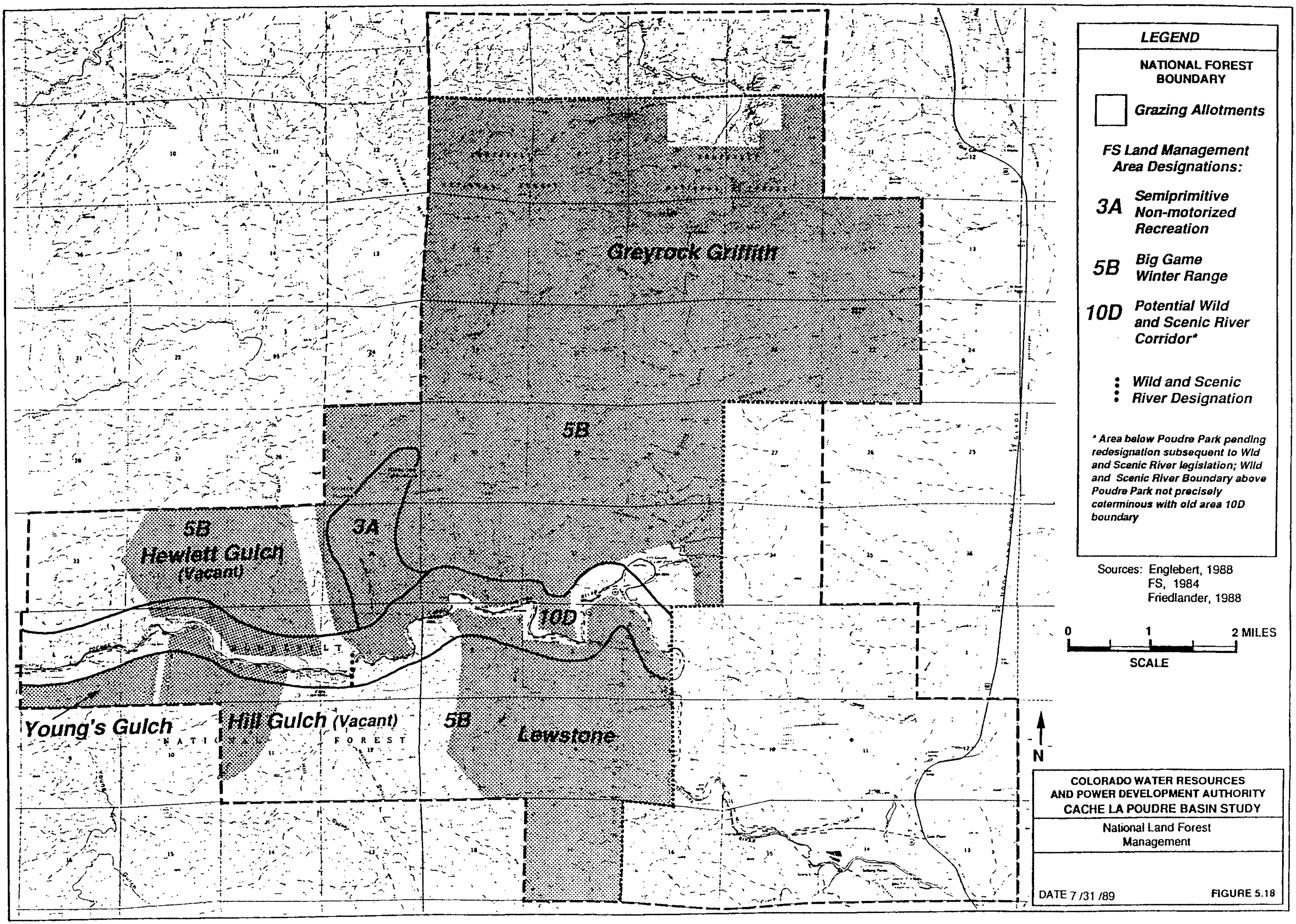
FIGURE 5.15

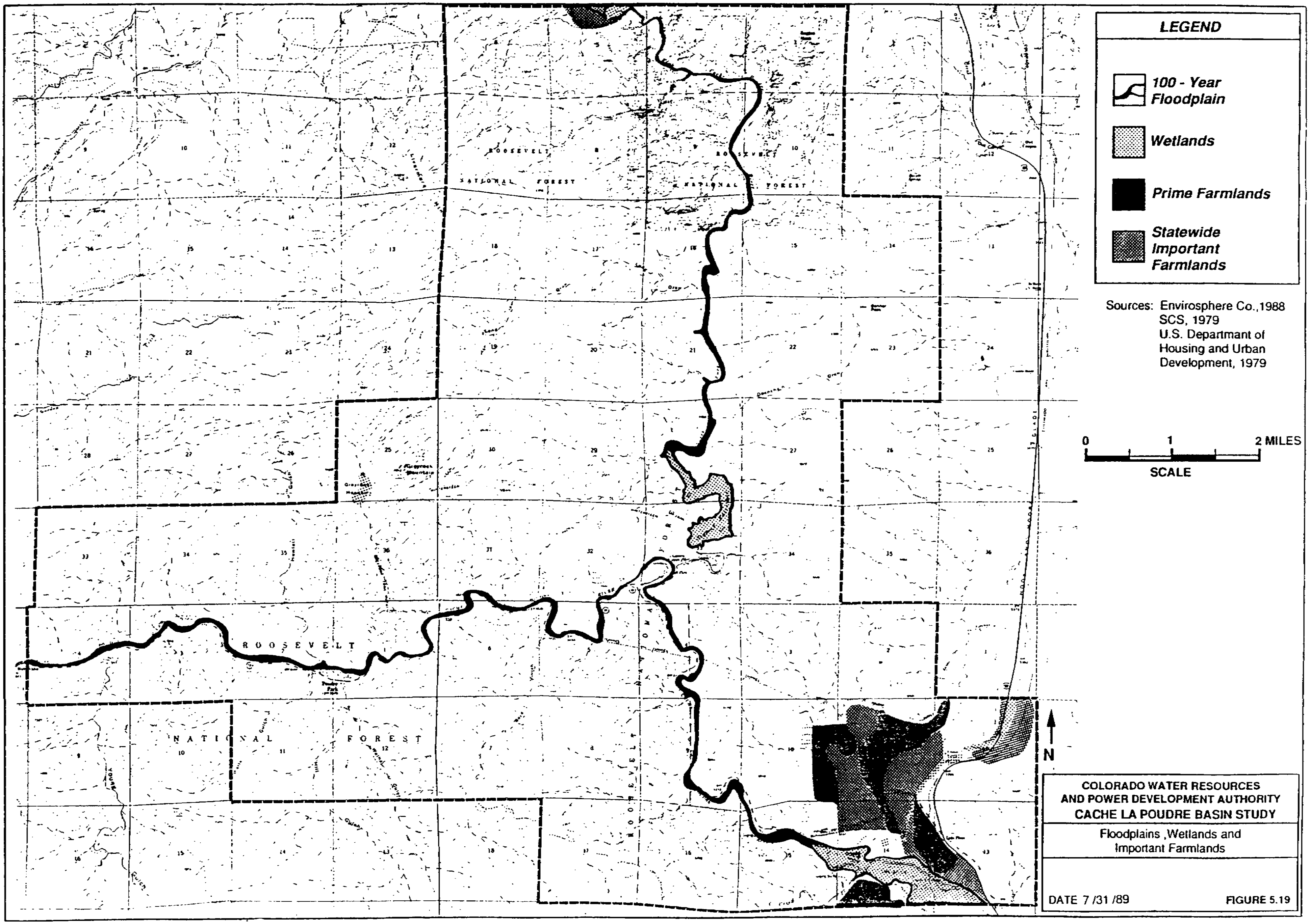


LEGEND
NATIONAL FOREST BOUNDARY
Grazing Allotments
FS Land Management Area Designations:
3A Semiprimitive Non-motorized Recreation
5B Big Game Winter Range
10D Potential Wild and Scenic River Corridor*
Wild and Scenic River Designation
* Area below Poudre Park pending redesignation subsequent to Wld and Scenic River legislation; Wild and Scenic River Boundary above Poudre Park not precisely coterminous with old area 10D boundary
Sources: Englebert, 1988
FS, 1984
Friedlander, 1988
0 1 2 MILES
SCALE
N
5B
3A
10D
ROOSEVELT NATIONAL FOREST
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
Forest Service Management Areas
DATE 7 /31 /89
FIGURE 5.16



R.71W
R.70W
T.9N.
T.8N.
ROOSEVELT NATIONAL FOREST
LEGEND
USFS
State Land Board
Colorado Division of Wildlife (CDOW)
Municipal
Subdivisions
Other Private
SOURCES: BLM, 1981
Bogart, 1988
FS, 1985
District, no date
0
1
2 MILES
SCALE
N
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
Land Ownership
DATE 12 / 14 / 88
FIGURE 5.17


LEGEND
NATIONAL FOREST BOUNDARY
Grazing Allotments
FS Land Management Area Designations:
3A Semiprimitive Non-motorized Recreation
5B Big Game Winter Range
10D Potential Wild and Scenic River Corridor*
Wild and Scenic River Designation
* Area below Poudre Park pending redesignation subsequent to Wild and Scenic River legislation; Wild and Scenic River Boundary above Poudre Park not precisely coterminous with old area 10D boundary
Sources: Englebert, 1988
FS, 1984
Friedlander, 1988
0
1
2 MILES
SCALE
N
Greyrock Griffith
5B
3A
10D
5B
Hewlett Gulch
(Vacant)
Young's Gulch
Hill Gulch (Vacant)
5B
Lewstone
NATIONAL FOREST
COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
National Land Forest
Management
DATE 7 /31 /89
FIGURE 5.18



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

Floodplains ,Wetlands and Important Farmlands

DATE 7 /31 /89

FIGURE 5.19

CHAPTER 6.0

WILDLIFE
RESOURCES
STUDIES

6.0 WILDLIFE RESOURCE STUDIES

6.1 INTRODUCTION

The wildlife resource studies focused on determining effects of the proposed project on game and non-game terrestrial resources and the vegetative and topographic features which comprise their habitat. The objectives of the study were to: (1) characterize wildlife use of the existing environment; (2) assess the potential effects of the proposed project on wildlife; (3) identify possible mitigation measures; and (4) prepare a preliminary estimate of the costs required to mitigate potential impacts. The Habitat Evaluation Procedure (HEP) (Schamberger and Farmer, 1978) was used to characterize the wildlife habitat and assess project effects. The HEP also provided a foundation for mitigation by quantifying the project effects and, therefore, defining the amount and type of mitigation needed. Application of HEP was supplemented by information from the literature, particularly for characterizing habitat for species of special concern identified in the project area by the state and federal wildlife agencies.

The wildlife resource studies comprised was Task 15 of the 1987-1988 Cache la Poudre Basin Study Extension funded by the Colorado Water Resources and Power Development Authority. Task 15 activities were organized in the following subtasks:

Subtask	Description
15a	Literature Review
15b	Cover Type Inventory
15c	Population Studies
15d	Habitat Evaluation
15e	Mitigation Planning
15f	Task Report

Included in Subtask 15e was a preliminary feasibility evaluation, whereby the mitigation costs and environmental sensitivity of the wildlife resources were evaluated in terms of their effect on preliminary project feasibility. This report contains a framework for determining these mitigation costs.

The wildlife resource studies were supported by botanical resource studies (Task 12 of the Basin Study Extension). Detailed methods and results of the botanical resource studies are documented in Section 3.0.

The 1987-88 wildlife resource studies were managed by John J. Brueggeman of Envirosphere Company, Bellevue, Washington, with assistance from M. Colleen McShane, A. David Every, and Ron W. Tressler also of Envirosphere. Eric Berg of Wildlife Management Consultants, Fort Collins, Colorado provided assistance in the field.

Acreage summaries and the color map of the cover types in the study area were produced by Northwest Cartography Inc. of Seattle, Washington. Assistance in gathering cover type field data and evaluating various HEP methods was provided by personnel from the U.S. Fish and Wildlife Service (FWS), Colorado Division of Wildlife (CDOW) and USDA Forest Service (FS). Additional field assistance was provided by the Northern Colorado Water Conservancy District (District) and the Colorado Water Resources and Power Development Authority (Authority).

6.2 STUDY AREA

The District is considering several potential damsites along the mainstem of the Cache la Poudre River. Based on preliminary engineering studies, the preferred damsites for providing a mainstem reservoir are the Grey Mountain 1, Grey Mountain 2, and Poudre sites (Figure 3.1). The Grey Mountain 1 site is located approximately 2.5 miles downstream from the confluence of the mainstem and the North Fork of the Cache la Poudre River. The resulting reservoir would extend approximately 7.5 miles up the mainstem to the town of Poudre Park and approximately 7.5 miles up the North Fork, including the area currently inundated by Seaman Reservoir. The normal maximum reservoir water surface elevation would be 5,630 ft above mean sea level (MSL) and the elevation at maximum flood level would be 5,640 ft MSL. The reservoir formed by dam construction at the Grey Mountain 1 site would inundate about 1,600 acres at normal maximum pool. The Grey Mountain 1 site is the mainstem dam site identified in the FERC preliminary permit granted to the District in September, 1985 (FERC Project No. 9290).

The Grey Mountain 2 damsite is located approximately one-half mile upstream from the Grey Mountain 1 site. This site is identified in the Cache la Poudre Basin Water and Hydropower Resources Study Report (Harza, 1987). Both the normal maximum reservoir water surface elevation and the water surface elevation at flood stage would be the same for a reservoir formed by a dam at the Grey Mountain 2 site as for a reservoir formed by constructing a dam at the Grey Mountain 1 site. In other words, the inundation area resulting from construction of a dam at the Grey Mountain 2 site would be entirely contained within the inundation area resulting from a dam at the Grey Mountain 1 site. Therefore, project effects on wildlife resources for Grey Mountain 1 would be larger than for Grey Mountain 2, representing an upper bound for the Grey Mountain alternatives. Consequently, wildlife studies were conducted for the Grey Mountain 1 alternative only, and all references to "Grey Mountain" in the documentation for wildlife resources studies refer to the Grey Mountain 1 project configuration.

The Poudre damsite alternative is located less than one-half mile downstream from the confluence of the mainstem and the North Fork near the junction of State Highway 14 and the road to Seaman Reservoir. The Poudre Reservoir would extend approximately 5.5 miles up the mainstem and 7.5 miles up the North Fork. The water surface elevations of the Poudre Reservoir at normal maximum and flood level would be the same as for the Grey Mountain alternatives. The Poudre Reservoir would inundate 1,350 acres at normal maximum pool which is 250 acres less than the Grey Mountain Reservoir 1 at normal maximum pool.

The boundary of the study area for the Grey Mountain and Poudre alternatives was defined in consultation with the FWS, FS, and CDOW personnel. The study area included the land potentially impacted by the mainstem Cache la Poudre reservoir, land that could be impacted by projects under future consideration (Glade Reservoir and Poudre Forebay), and a border area for potential mitigation (Figure 6.1). The project areas for the Grey Mountain and Poudre alternatives included the lands that would be inundated by the proposed reservoirs as well as a buffer zone that extends 40 ft in elevation above the maximum reservoir water surface elevation at flood stage (5,640 ft). The buffer zone was established to account for impacts resulting from construction activities such as clearing land, temporary buildings, construction, roads, etc.

The Grey Mountain project area covered approximately 2,400 acres of land between elevation 5,250 ft and elevation 5,680 ft along the mainstem and North Fork of the Cache la Poudre River. The Poudre project area covered approximately 2,000 acres of land between elevation 5,340 ft and elevation 5,680 ft along the mainstem and North Fork.

The study area outside the two project areas included over 37,000 acres. It ranged from an elevation of about 5,200 ft at Hook and Moore Glade to an elevation of approximately 7,500 ft at Grey Rock Mountain. The entire study area was in Larimer County, Colorado, and covered 39,489 acres. Approximately one-half of the area was within the Arapaho and Roosevelt National Forests.

6.3 METHODS

6.3.1 Inventory of Threatened and Endangered Wildlife and Species of Special Interest

6.3.1.1 Literature Survey

Wildlife species of special interest were identified by the FWS, CDOW, and FS. The wildlife species of interest identified by agency consultation included prominent big game animals, raptors, and species particularly sensitive to development. In addition, wildlife species potentially using the study that are classified as federally threatened or endangered were identified by FWS. An inventory was conducted to describe use of the study area by these species and assess potential effects resulting from the proposed development. This inventory in combination with the HEP analyses provided a comprehensive summary of the wildlife and their habitats in the study area.

Data on wildlife species of special interest were derived from sources of available information and from field studies conducted in 1986 and 1987. Studies conducted prior to June 1987 were part of earlier efforts sponsored by the District (Berg, 1986). These studies plus the published and unpublished literature were primary sources of information. Scientific journals, reports, and field notes prepared by the CDOW, Colorado State University (Department of Fisheries and Wildlife), FS, and FWS were reviewed and summarized. This information was supplemented by computer searches of the Colorado Wildlife Resources Information Service and Scientific Collection databases for the project vicinity. In addition, regional biologists and resource managers from the local wildlife agencies and universities were consulted on specific topics. For several species, information from these sources was supplemented with data from field surveys.

6.3.1.2 Field Surveys

Field surveys were conducted for bald (Haliaeetus leucocephalus) and golden eagles (Aquila chrysaetos). The bald eagle is listed by the FWS as an endangered species in Colorado. These surveys were requested by the CDOW, FS, and FWS because of the sensitive status of these species in Colorado and throughout the United States.

Bald eagle surveys were conducted each week from late October 1986 to late March 1987. This period corresponded to the normal length of occupancy of bald eagles in Colorado. Survey effort was concentrated along the North Fork where bald eagles have been reported to congregate. Fewer surveys were conducted along the Poudre mainstem since bald eagle use of this area is limited because of its proximity to State Highway 14. The survey procedure involved one person searching the rivers and upland areas of the project area from a vehicle or on foot during the early morning or late evening. Data were collected on number, distribution, and potential roost sites.

Aerial surveys were conducted by helicopter on May 8, 1987 and May 25, 1988, to locate golden eagle and other raptor nests in the study area. Each survey involved about 1.5 hr of helicopter time. The survey routes were planned by the FWS and CDOW, with the purpose of locating all potential nesting habitat within and near the study area. Active golden eagle nests identified during the 1987 survey were later visited on foot to determine exact locations and elevations. Elevations were determined with a hand-held altimeter and locations were plotted on USGS topographic maps. Prey remains and fecal samples were collected from three nest sites for food habits analysis. The analysis was conducted by the Composition Analysis Laboratory at Colorado State University.

6.3.2 Habitat Evaluation

The FWS's Habitat Evaluation Procedure (HEP) was used to determine the net effect of the Grey Mountain and Poudre alternatives on wildlife and their habitat (FWS, 1980). This procedure was chosen through consultation with natural resource agencies because of the lack of existing information on the wide variety of wildlife inhabiting the study area and the impracticality of conducting wildlife population studies to develop a comprehensive database. The procedure's advantages are: (1) data are collected in a standardized manner that can be compared between various points in time to determine changes in conditions (i.e., pre-impoundment vs. with-impoundment); (2) it is a habitat-based approach that is less affected by natural variability than population-based approaches; and (3) it was developed by FWS specifically for assessing wildlife impacts from siting reservoir and thermal power projects. The HEP has been applied to wildlife studies throughout the United States and results have been reported in a number of scientific journals (Urich and Graham, 1983; Rhodes, et al., 1983; Schamberger and Farmer, 1978) and technical reports (Brueggeman et al., 1986; 1988).

The HEP provides a measure of overall habitat quantity and quality for a given evaluation species under specified conditions (typically with and without the project or action being assessed). The final HEP comparisons are based on Habitat Units (HUs) which are the product of the surface area of the habitat under consideration and a habitat quality factor for the given evaluation species. The habitat quality factor is known as a Habitat Suitability Index (HSI) which ranges from 0.0 to 1.0. The HSI is calculated from a model that combines and weights the quality of various habitat components of the species in question. The overall process of determining the quantity and quality of habitat that would be affected by the project is as follows:

(1) First, the species habitat components are determined through consultation with agency personnel, specialists, and from literature accounts. Examples of habitat components are cover type, specific available vegetation, distance from cover, browse height, etc. Data on these habitat components are collected from field measurements, maps, aerial photographs, or literature.

(2) Second, for each habitat component, Suitability Curves are developed which reflect species' preferences for various values of the habitat component. Examples of curves for three mule deer habitat components are shown in Figure 6.2.

(3) Next, measured values for the habitat components are located on the x-axis of their respective curves to determine their Suitability Indices (SI) from the y-axis.

(4) The Suitability Indices of the various habitat components are weighted according to a model (determined during the consultation process) to develop a composite HSI value for the evaluation species in the given habitat type. The HSI (scaled between 0.0 and 1.0) is then multiplied by the surface area of a given habitat to determine HUs for that habitat type.

(5) HUs for all habitat types are summed for existing or without-project conditions and for with-project conditions.

(6) Lastly, HUs are averaged over the life of the project to account for potential changes in habitat quantity and quality due to succession, fire, and project construction or modifications. This process is described in detail in Section 6.3.2.7. The net average annual impact of the project is determined by comparing Average Annual Habitat Units (AAHUs) for with- and without-project conditions. For the Cache la Poudre Project, AAHUs were compared between with- and without-project conditions for both the Grey Mountain and Poudre alternatives to determine the net effect of both alternatives on the wildlife habitat. Consequently, application of the HEP to the Cache la Poudre Project provided a numeric measure of habitat lost or gained for selected wildlife resulting from the proposed Grey Mountain and Poudre project alternatives.

The series of steps involved in applying the HEP to this study are presented in the following subsections as listed below:

- Selection of an evaluation team;
- Inventory of vegetation cover types or habitats;
- Selection of evaluation species;
- Identification of life requisites for evaluation species;
- Field measurements of habitat parameters;

- Assignment of HSIs and calculation of HUs;
- Selection of target years and calculation of AAHUs

6.3.2.1 Selection of Evaluation Team

The application of the HEP requires the formation of an evaluation team comprised of representatives from the federal and state resource agencies and the project sponsor. The responsibility of the team is to mutually define the approach for completing each step of the HEP. This team concept ensures input by the agencies into the design and execution of the study. Moreover, it minimizes future conflicts between the agencies and project sponsor about the outcome of a study, since their representatives are key participants in the study. Consequently, the study culminates in a product that is acceptable to the project proponent and the resource agencies.

For the Cache la Poudre Project, letters were sent to the FWS, CDOW, and the FS inviting participation in the HEP study. All of these agencies agreed to participate. Representatives from the participating agencies along with those from the District and Envirosphere Company that comprised the team included:

Karl Dreher - Northern Colorado Water Conservancy District
Ann Hodgson - Colorado Division of Wildlife
Ronell Finely/Bill Noonan - U.S. Fish and Wildlife Service
Steve Mighton/Dennis Lowry - U.S. Forest Service
Jay Brueggeman, Colleen McShane, and Dave Every - Envirosphere Company

Meetings were held throughout the study period to define each step in the HEP. The decisions reached at each meeting were documented in formal letters prepared by Envirosphere and sent to the team members. Meeting minutes were reviewed by each participant and revised to reflect their comments. Each member then signed the letter before Envirosphere executed the decisions. This procedure confirmed that decisions reached at a meeting were acceptable to the respective agencies. Letters documenting team members agreement as representatives of their agencies on decisions followed in the application of the HEP to the Cache la Poudre Project are provided in Appendix C.

6.3.2.2 Vegetation Cover Type Inventory

The cover type inventory is an integral step in the HEP since it defines and quantifies types of wildlife habitat. Wildlife habitat is defined as a distinct combination of vegetation and physical factors that provide one or more life requisites for wildlife species. Vegetation cover types are commonly used to represent the habitat types because many of the physical features of wildlife habitats are related to cover.

The purposes of the cover type inventory for the Cache la Poudre Project were to classify, map, quantify, and describe the cover types in the study area in order to evaluate the net effects of the proposed project alternatives on wildlife habitat. The following steps were used to inventory the cover types: (1) select a cover type classification system, (2) map cover types, (3) calculate cover type areas and produce a cover type map, and (4) describe the cover types. A detailed description of each step of the cover type inventory is provided below.

Cover Type Classification System Selection

The cover type classification system for the Cache la Poudre study was selected by the HEP team. The classification for the upland cover types was based on the classification of vegetation series used in the Roosevelt National Forest Plan (FS, 1984). The system described by Cowardin et al. (1979) was used to classify wetland cover types. The organization of the hierarchical classification system was patterned after Anderson et al. (1976). Sixteen cover types were identified in the study area (Table 6.1).

TABLE 6.1
Cover Types of the Cache La Poudre Study Area

Closed Canopy Conifer Forest	Riparian Forest
Open Canopy Conifer Forest	Riparian Shrub
Pinyon Pine Forest	Riparian Grassland
Mountain Shrub	Palustrine Marsh/Meadow
Grassland	Palustrine Pond
Rock/Talus	Lacustrine
Agriculture	Riverine
Developed	
Disturbed	

Cover Type Mapping

Cover types were classified and delineated on aerial photographs of the study area. The steps followed in this process were:

Aerial Photograph Selection

The most recent aerial photographs of the study area were taken on October 4, 1986 by the District. These photographs were black and white stereo pairs scaled at 1:12,000. All cover typing was done on mylar overlays using the 1986 aerial photographs. Supplemental information was provided by color infrared aerial photographs from the FS. These photographs were taken in September 1984 at 1:24,000 scale and were used primarily to identify riparian and wetland cover types. Other sets of aerial photographs available from state and federal agencies were reviewed but were not suitable for cover typing due to the age, scale, or quality of the photography.

Photo Interpretation

Aerial photographs were acquired in stereo pairs so that a three dimensional view obtained with a mirror stereoscope could be used for more accurate interpretation. One set of aerial photographs covering the study area was overlaid with mylar drafting film. The study area boundaries, as determined by the HEP team, were marked on the mylar overlays, and the outline of each cover patch or polygon was delineated. A symbol, specific to each cover type, was marked on the mylar within each polygon. The minimum mapping unit agreed on by the HEP team was one acre for riparian and wetland types and five acres for upland types.

Two photo interpretation aids were developed to enhance the accuracy and consistency of the results. The primary aid was a systematic key that defined the photo characteristic of each cover type (Table 6.2). The key was developed by using the aerial photos to define the range of photo characteristics of a particular cover type.

TABLE 6.2
Key to the Cover Types of the
Cache La Poudre Project

Step	Proceed to Step:	Cover Type
1.a. Land	2	
1.b. Permanent water	13	
2.a. Lands where man's disturbance dominates	3	
2.b. Lands where "natural character" prevails	5	
3.a. Lands where vegetative cover is essentially removed or activity essentially precludes wildlife use (mines, quarries, dams, highways) . . .		Disturbed
3.b. Developed areas with enough vegetative cover to provide habitat value (greater than 20 percent) .	4	
4.a. Residential/commercial areas		Developed
4.b. Cropland or improved pasture		Agriculture
5.a. Non-vegetated areas (cover less than 10 percent trees, less than 20 percent shrubs, less than 30 percent herbs)		Rock/Talus
5.b. Vegetated areas	6	
6.a. Uplands (not including wetlands or riparian areas)	7	
6.b. Lands along streams or with saturated soils at least part of the year and with vegetation clearly responding to higher water availability (i.e., wetlands and riparian areas)	10	
7.a. Forested areas (greater than or equal to 10 percent tree cover)	8	
7.b. Non-forested areas (less than 10 percent tree cover)	9	
8.a. Open forest on low foothills where pinyon pines dominate		Pinyon Pine Forest
8.b. Open canopy forest usually dominated by ponderosa pine (10 to 60 percent tree cover) usually with shrub understory		Open Conifer Forest

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TABLE 6.2 (Continued)
Key to the Cover Types of the Cache La Poudre Project

Step		Proceed to Step:	Cover Type
8.c.	Closed canopy conifer forest, dominated by ponderosa pine or Douglas fir (greater than 60 percent canopy closure)		Closed Canopy Conifer Forest
9.a.	Shrub cover greater than or equal to 20 percent . . .		Mountain Shrub
9.b.	Grass dominated (less than 20 percent shrubs)		Grassland
10.a.	Lands supporting hydrophytic vegetation, with saturated soils a majority of the growing season (wetlands - Palustrine)	11	
10.b.	Lands along water courses, usually within the floodplain, with vegetation responding to higher water availability at least part of the year (Riparian)	12	
11.a.	Wetlands with greater than 50 percent shallow open water at least part of the growing season (often impounded)		Palustrine Ponds
11.b.	Wetlands dominated by persistent emergent vegetation, with less than 50 percent open water		Palustrine Marsh/Meadow
12.a.	Greater than 10 percent tree cover (either deciduous or conifer)		Riparian Forest
12.b.	Without trees, dominated by shrubs (greater than 20 percent shrub cover)		Riparian Shrubland
12.c.	Without trees and with less than 20 percent shrub cover		Riparian Grassland

TABLE 6.2 (Continued)
Key to the Cover Types of the
Cache La Poudre Project

Step	Proceed to Step:	Cover Type
13.a. Streams (including gravel bars and flood scour zones)		Riverine
13.b. Lakes or reservoirs		Lacustrine
13.c. Ponds (less than 20 acres and less than 2 meters deep)	See 11a	

The quantitative definitions (i.e., percent tree cover, percent shrub cover) of each cover type in the key were developed from the literature. During development of the key, ground verification was conducted to confirm the quantitative definition and specific photo characteristics associated with each cover type. As an additional aid, grid patterns (transparencies with rectangular grids of varying density) were used to estimate the proportion of tree or shrub cover as defined in the photo interpretation key. The key and grid facilitated the ability of the photo interpreter to consistently identify each cover type patch or polygon and delineate its boundaries. For purposes of this report, a cover type patch is defined as a polygon.

Verification of Cover Typing

The initial photo interpretation of cover types was done by one photo interpreter and then checked by a second photo interpreter. The typing was also reviewed by the HEP team. Mapping for the entire study area was verified by a combination of low altitude overflights and on-the-ground checking during the 1987 spring and summer field sampling.

Data Transfer to Orthophoto Maps

Complete orthophoto coverage (1:24,000 scale) of the study area was obtained from the U.S. Geological Survey. The information mapped on aerial photos was transferred to overlays on the orthophotos to correct for angular distortion inherent in aerial photos. This procedure provided an accurate data base for determining the area of each cover type and producing a map.

Map Production and Acreage Calculation

The HEP team decided that a Geographic Information System (GIS) should be used to map and calculate the area of each cover type. A GIS is a computer database management system with the capabilities of resource mapping, accounting, and analysis. The following four steps were required:

Digitizing

The GIS used for this project was an arc-based topological system that stored line data as a series of arcs (line segments). Entering data from a map into the GIS requires digitizing, a mechanical process that involves tracing a line with a computer "mouse". The line is broken into a series of segments or arcs that are then stored in the GIS. Using the mylar data sheets from the orthophoto quadrangle maps the polygon boundaries were digitized. Each polygon in the study area was assigned a unique identifying number that associated it with a specific quadrangle map. The symbol identifying the cover type of each polygon was plotted by the GIS on a map and associated with the polygon number in the digital database. The digital database provided a complete record of the area and cover type of each polygon. These data provided the basis for the HEP.

Map Registration and Checking

The data from separately digitized mylars were linked by the GIS into a single project-wide data set that could be presented at a variety of map scales. This was accomplished by digitizing a master control grid from the USGS 1:24,000 quadrangle orthographic maps. The control grid consisted of section corners and other identifiable land features. A set of working maps or edit plots (line maps with symbols) at 1:24,000 scale was produced for both pre-impoundment and the projected post-impoundment conditions showing the habitat symbol associated with each polygon. The maps were then checked against the original photo-interpreted data to confirm that each polygon had the proper cover type.

Area Calculations

A computer software program was run with the GIS to calculate the area of each polygon and produce summary statistics for pre-impoundment and post-impoundment periods. The data were reported by cover type.

Map Production

The final habitat map was photographically produced using the USGS 1:24,000 quadrangle maps as the base map. Edit plots, registered to the quadrangle maps, were produced by the GIS at 1:25,000 scale for the final map. This scale was chosen so that the final map would be a manageable size. The computerized data were then used to generate the color separation negatives needed to produce a color map.

6.3.2.3 Selection of Evaluation Species

Seven species were selected by the HEP team for evaluation in the Cache la Poudre study area: four bird and three mammal species. These species represented both aquatic and terrestrial animals associated with the range of forested and non-forested habitats in the study area. The species selected were:

- Song Sparrow
- Western Meadowlark
- Black-capped Chickadee
- Great Blue Heron
- Abert Squirrel
- Mule Deer
- Beaver

These species were selected using the following systematic process developed by the HEP team: (1) compile a comprehensive list of species in the study area; (2) rate each species in the study area using five selection criteria; (3) evaluate the capability of the top-ranked species to fulfill the objectives of the HEP; and (4) select the final seven evaluation species. This decision-making process combined technical data with the knowledge of the HEP team to formulate a list of species that best reflected the potential impacts of the proposed project on wildlife.

A list of 328 species of wildlife was compiled for the study area (Appendix Tables D.2 and D.3). The composition included 223 species of birds, 78 species of mammals, and 27 species of amphibians and reptiles. Each species was associated with one or more cover types in the study area and a life form. A life form is a term for grouping species having similar feeding and reproductive habitat requirements (Thomas et al., 1979). Associating species with cover types was necessary to assess wildlife impacts from habitat changes potentially caused by the project. Associating species with life forms was needed to evaluate impacts on groups of species with similar habitat requirements or guilds. This stage in the species selection process permitted the HEP team to examine which species and species guilds would best reflect changes in the study area habitats.

The second stage in the selection process involved ranking the wildlife species found in the study area according to the following five criteria: (1) seasonality; (2) abundance; (3) availability of information; (4) status of HEP model; and (5) versatility (Appendix Table D.2). Information for these criteria was obtained from the sources used to compile the species list. Seasonality was evaluated in order to rate species use of the study area. Use was rated high for species that were annual residents, moderate for winter or summer residents, and low for migrants. Annual residents were rated highest because all of their life requisites are completed in the study area. Conversely, migrants were rated low because only a part of their life requisites are obtained in the study area and impacts from the project may be less severe than for residents. For example, the Abert Squirrel was rated high because it is an annual resident and project impacts could affect feeding, cover, and breeding habitat.

Abundance was used to judge a species prominence in the study area. Prominence was rated according to four categories: abundant, common, uncommon, and rare. Abundant species received the highest rating since they were considered to be the most successful in the study area. Rare species were considered to be least successful and project impacts on regional populations of rare species would be lower than species more suited to the habitats in the study area. For example, the Black-capped Chickadee was rated abundant in the study area because suitable habitat was available, whereas elk were considered rare because the habitat was not particularly suitable for them. Species that were federally listed as threatened or endangered were excluded from this evaluation and treated separately by the HEP team.

Availability of information for species in the study area was used to identify the state-of-knowledge. This criterion was rated high if site-specific information was available for a species, low if information had been collected near the study area, and zero if no or only general information was available. This criterion was considered important because there had to be sufficient information available about a species in order to assess the impacts of the project on it. The assessment would be most accurate for species where site-specific data were available and least accurate for species where there was little or no data. For instance, deer were rated high because site-specific information was available, whereas the river otter was rated low because there was very little information on this species.

Species occurring in the study area were also rated according to the availability and status of a HEP model. A species was rated high if a final model was available, moderate if the model was a draft, low if the model was preliminary, and zero if there was no model. This criterion was included because the HEP for this study was designed to incorporate existing models rather than develop new models. Furthermore, confidence in the results would be highest for species with final models, since they have been reviewed by the FWS.

Lastly, species were rated according to their versatility. Versatility was based on the number of plant communities and successional stages used by a species for breeding and feeding. Single cover type species were considered to be specialists in their habitat use patterns. These species would be less likely to adjust to a loss of habitat and more likely to respond to a gain in habitat. Conversely, multi-cover species were considered to be generalists in their habitat use patterns. These species would be less responsive to habitat changes and more adaptable. Consequently, specialist species like the Abert Squirrel would be more directly affected by changes in ponderosa pine forest characteristics than generalists species like the Black-capped Chickadee.

The numeric values assigned for each evaluation criterion were summed to derive a single value for each species. The HEP team evaluated the capability of the top-ranked species in each life form to fulfill the objectives of the HEP. These objectives were to select a set of species that represented: (1) birds, mammals, and reptiles or amphibians; (2) different guilds present in the study area; (3) primarily specialists but also several generalists to reflect juxtaposition of habitats; (4) major feeding strategies (carnivore, herbivore, insectivore); (5) all prominent or sensitive habitats in the study area; and 6) changes in habitat from without-impoundment to with-impoundment conditions.

The seven evaluation species selected by the HEP team that most closely met the study objectives are described below:

Song Sparrow

The Song Sparrow (Melospiza melodia) is a specialist that reproduces and feeds in areas of low, dense shrub cover adjacent to streams, ponds, and marshes (Verner and Boss, 1980). The Song Sparrow represents a guild of species that requires dense shrubs near water to meet their life requisites. The red-wing blackbird (Agelaius phoeniceus), MacGillivray's warbler (Oporornis tolmiei), and yellow warbler (Dendroica petechia) represent this guild. Changes in the quantity and structure of riparian habitat in the study area would be reflected by the Song Sparrow.

Western Meadowlark

The Western Meadowlark (Sturnella neglecta) is a specialist that breeds and feeds in open grasslands and pastures. This species requires relatively low, dense grass cover with an abundance of perch sites (tall forbs, fences, trees, etc.) (Verner and Boss, 1980). The Western Meadowlark represents the guild of species that primarily use grasslands to meet their life requisites and includes the savannah sparrow (Passerculus sandwichensis) and horned lark (Eremophila alpestris). Changes in the quantity and quality of grasslands and pasture in the study area would be reflected by the Western Meadowlark.

Abert Squirrel

The Abert Squirrel (Sciurus aberti) is a specialist that reproduces and feeds primarily in ponderosa pine forests. This species feeds almost entirely on the seeds, inner bark of twigs, terminal buds, and staminate flowers of ponderosa pine trees (Patton, 1975). Nesting occurs in stands of uneven aged ponderosa pine trees with interlocking crowns (Patton, 1975). This species was selected to reflect changes in the quantity and quality of the ponderosa pine forest in the study area.

Great Blue Heron

The Great Blue Heron (Ardea herodias) is a generalist that feeds primarily on aquatic prey and nests in a variety of open forest habitats. This species will feed on a variety of prey but prefers fish (Short and Cooper, 1985). Wetlands and sloughs are the most common foraging areas but riverbanks, riprapped banks, mudflats, and rivers are also used. Forested areas near water are preferred nesting sites for this species (Short and Cooper, 1985). The Great Blue Heron was selected to reflect the changes in habitat resulting from conversion of a river to a reservoir.

Black-capped Chickadee

The Black-capped Chickadee (Parus atricapillus) is a generalist that forages from the ground to the tops of trees and reproduces in small snags in a variety of forest habitats (Schroeder, 1983). The Black-capped Chickadee represents a group of species, including the brown creeper (Certhia americana) and mountain chickadee (Parus gambeli), that use relatively small cavities for nesting and a wide variety of habitats for feeding. Changes in the quantity and quality of forested areas will be reflected by the Black-capped Chickadee.

Mule Deer

Mule Deer (Odocoileus hemionus hemionus) are the most common large game species in the study area. The study area provides winter habitat for this species although a portion of the herd uses the area year around (Loveless, 1967). Deer are generalists and utilize a variety of forest and shrub habitats for food and cover. Deer will reflect changes in quantity, juxtaposition, and quality of these habitats in the study area.

Beaver

The Beaver (Castor canadensis), a highly specialized aquatic fur-bearer, feeds primarily on herbaceous vegetation near or in water. The beaver requires a permanent water supply and trees and shrubs of a diameter suitable for use as food and cover (Allen, 1983). The response of this species to habitat changes will be similar to the American dipper (Cinclus mexicanus) and other aquatic fur-bearers including the river otter (Lutra canadensis) and muskrat (Ondatra zibethica). Originally, the American dipper was included as an evaluation species.

However, the HEP team later decided to eliminate the dipper from the analysis because loss of riverine habitat will be represented by the Beaver and by the aquatic and in-stream flow studies that have been conducted in the study area. Consequently, changes in the quantity and quality of riverine, riparian, and palustrine habitats in the study area will be reflected by the Beaver.

6.3.2.4 Identification of Life Requisites for Evaluation Species

Life requisites selected by the HEP team for the seven evaluation species are presented in Table 6.3. Life requisites represent critical elements of habitats that are required by a species to complete its life cycle and survive. These elements are broadly defined as water, food, escape cover, thermal cover, and reproductive cover. The quantity and quality of these elements determine the capacity of an area to support wildlife. Typically, the life requisite in lowest abundance or quality limits the growth of a population.

The life requisites for the evaluation species were obtained from the species models. The HEP team associated the life requisites with habitats used by each species. The life requisite(s) considered by the HEP team to be most limiting to the growth of a population in the study area provided the basis for assessing impacts for the evaluation species. For instance, since the study area provides winter habitat for deer, winter food and cover life requisites were evaluated for this species. Conversely, since Song Sparrow and Western Meadowlark summer in the study area, reproductive cover and summer forage were evaluated for them. This approach is the standard process used in the HEP to confine an impact assessment to those life requisites most limiting the population growth of key wildlife species.

6.3.2.5 Habitat Parameter Measurements

Sampling Design

The nearly 40,000 acres in the study area were divided into four zones to account for variation in habitat characteristics due to elevation: (1) elevation 5,180 to 5,680 ft, (2) elevation 5,680 to 6,280 ft, (3) elevation 6,280 to 6,880 ft, and (4) elevation 6,880 to 7,420 ft. The area potentially impacted by the Grey Mountain and Poudre alternatives was in Zone 1. Zone 1 was further divided into three aspect categories (north, southeast, west). Zones 2, 3, and 4 were not divided into aspect because of the large area, highly varied topography, and the uncertainty of their availability for mitigation. Because Zone 1 would be directly impacted by the proposed project, it was narrowly defined to more accurately quantify habitats used by the evaluation species and to reduce the influence of environmental variability on the habitat quality measurements. Habitats were quantified in the other three zones in order to comprehensively characterize wildlife habitat in the entire study area. The zones also were examined for possible use in mitigation.

A total of 184 sampling sites were randomly distributed in 122 polygons across the four elevational zones in the study area to measure the habitat quality for the seven wildlife evaluation species (Table 6.4 and Figure 6.3). Within the combined Grey Mountain and Poudre project areas, 82 sites were randomly distributed in 56 polygons as follows: 25 sites in 17 polygons on south slopes, 28 sites in 19 polygons on north and west slopes, and 29 sites in 20 polygons on east slopes. The other 66 polygons were located outside the project areas: 36 sites in 22 polygons in Zone 1, 26 sites in 18 polygons in Zone 2, 18 sites in 12 polygons in Zone 3, and 22 sites in 14 polygons in Zone 4. Nearly half of the polygons sampled were allocated to the project areas because of the importance of characterizing the habitats to be affected by either proposed project alternative. The number of polygons allocated to each elevation zone outside the project areas was based on the size of the area in each zone and the complexity of cover types. Zone 1 outside the project areas had the largest acreage and most diverse cover types, so it was allocated the highest number of polygons. The other three zones had much smaller areas and fewer cover types.

Five sites were sampled in three polygons for each cover type in the project areas and each elevation zone outside the project areas. One polygon contained three sites, and two polygons contained single sites. The measurements in the polygon with three sites provided information on the local variability of the structural characteristics in a given cover type. The measurements among the three polygons provided information on the spatial variability within the cover type for the project areas and each zone. Sampling intensity was adjusted downward for poorly represented cover types and upward for abundant cover types such as shrublands and upland forests. The small amount of area in poorly represented (riparian and palustrine types) cover types generally limited sampling to a single site in each polygon.

TABLE 6.3

Life Requisites for the Wildlife Evaluation Species
for the Cache la Poudre Project

Species Common Name	Cover Types Closed Canopy Conifer Forest	Open Canopy Conifer Forest	Pinyon Pine	Mountain Shrub	Rock/ Talus	Grass- land	Agri- culture/ Pasture	Riparian[3]	Riverine	Lacu- strine	Palu- strine[4]
Mule Deer	WF,WC[1]	WF,WC	WF,WC	WF,WC	---[2]	WF	WF	WF,WC	---	---	---
Western Meadowlark	---	---	---	---	---	F,R	F,R	---	---	---	---
Song Sparrow	---	---	---	---	---	---	---	R,C,F[5]	---	---	---
Abert Squirrel	F,C	F,C	---	---	---	---	---	---	---	---	---
Great Blue Heron	---	---	---	---	---	---	---	R	F	F	F[7]
Black-capped Chickadee	F,R	F,R	---	---	---	---	---	F,R[6]	---	---	---
Beaver	---	---	---	---	---	---	---	WF	W	W,WF	W,WF[7]

(1) F = Food; C = Cover; WF = Winter Food; WC = Winter Cover; R = Reproduction; W = Water.

(2) Dash (--) signifies that the cover type does not meet any of the species' life requisites.

(3) Includes riparian forests, shrubs, and grassland.

(4) Includes palustrine pond and marsh/meadow.

(5) Only riparian forest and shrub types provide suitable habitat.

(6) Only riparian forests provide suitable habitat.

(7) Only palustrine ponds provide suitable habitat.

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TABLE 6.4

Number and Distribution of Sites Sampled in Polygons for Each Cover-Type in the Cache la Poudre Project Study Area [1]

Sampling Locations	Closed Canopy Conifer Forest	Open Canopy Conifer Forest	Mountain Shrub	Grassland	Agriculture	Riparian Forest	Riparian Shrubland	Riparian Grassland	Palustrine Marsh/Meadow	Total
PROJECT AREAS										
Mainstem South										
Polygons	3	3	3	3	--[2]	5	--	--	--	17
Sites	5	5	5	5	--	5	--	--	--	25
Mainstem North/West										
Polygons	1	3	3	3	--	5	3	1	--	19
Sites	3	5	5	5	--	5	3	2	--	28
Mainstem East										
Polygons	3	3	3	3	--	3	3	2	--	20
Sites	5	5	5	5	--	3	3	3	--	29
Subtotal										
Polygons	7	9	9	9	--	13	6	3	--	56
Sites	13	15	15	15	--	13	6	5	--	82
OUTSIDE PROJECT AREAS										
Zone 1										
Polygons	--	3	3	3	3	5	3	--	2	22
Sites	--	5	5	5	7	5	5	--	4	36
Zone 2										
Polygons	3	3	3	3	--	3	3	--	--	18
Sites	5	5	5	5	--	3	3	--	--	26
Zone 3										
Polygons	3	3	3	3	--	--	--	--	--	12
Sites	5	5	5	3	--	--	--	--	--	18
Zone 4										
Polygons	6	6	1	1	--	--	--	--	--	14
Sites	8	8	3	3	--	--	--	--	--	22
Subtotal										
Polygons	12	15	10	10	3	8	6	--	2	66
Sites	18	23	18	16	7	8	8	--	4	102
TOTAL STUDY AREA										
Polygons	19	24	19	19	3	21	12	3	2	122
Sites	31	38	33	31	7	21	14	5	4	184

(1) Pinyon Pine and Palustrine Pond types were not sampled because they were present only outside the project areas and would not be affected by either the project alternative. Riverine and lacustrine cover types were not sampled because the measurements required could be obtained from maps, aerial photographs or the literature.

(2) Dashes signify that the cover type was not sampled because it was either absent or present in very small amounts.

Consequently, the sampling program was designed to quantify the quality of cover types for wildlife in the project areas and the study area and to estimate the variability of the measurements used to derive the quality values.

A 25 m x 25 m quadrat was established at each sampling site in a given polygon for measuring the cover type characteristics. The site was located by randomly selecting one quarter of a polygon marked on an aerial photograph, pacing 55 m in a direction perpendicular to the point of entry, and then 10 m in a randomly chosen direction. The end point represented the first corner of the quadrat. The quadrat was oriented by randomly selecting the first side of the quadrat and flipping a coin to determine the location of the adjacent side. Additional quadrats, required in polygons with multiple sampling sites, were established by pacing 50 m in a random direction from a randomly chosen corner of the previous quadrat. Quadrats were replaced by a 50 m transect line in herbaceous and shrubland cover types because this type did not require density measurements. A 50 m transect line was also used in riparian forest types because the areas were frequently too narrow to randomly place a quadrat or were small enough to sample the entire polygon.

These procedures were adjusted for small polygons. Small polygons were entered from the most accessible point and the 55 m distance to the sampling site was reduced to 30 m to accommodate the quadrat. The distance between multiple quadrats was also reduced in small polygons. Sampling sites were rejected if they were less than 20 m from the edge of the polygon, in a disturbed area, or in a non-representative cover type inclusion.

Field Sampling

The habitat parameters measured in each cover type were defined by the HSI models for the seven evaluation species (Appendix F). Habitat parameters were measured during August 10-14 and August 17-21, 1987. This time period closely corresponded to the peak of vegetal growth when habitat quality was near optimal for most wildlife. Two teams of three to four people collected habitat parameter data during the ten-day field period which represented over 600 hours of sampling effort.

Three basic sampling procedures were used to measure the habitat parameters: (1) quadrat; (2) line intercept; and (3) plot frame (Appendix Tables D.8 and D.9). A quadrat (25 m x 25 m or 0.0625 ha) was used for tree density measurements. Tree and shrub heights and the diameters of live and dead trees were also measured within the quadrat. Density was determined from visual counts, tree height from a combination of measures taken with a clinometer (vertical angles) and range finder (horizontal distance), and tree diameter at-breast-height (dbh) from a diameter tape. Shrub height was measured with a graduated rod.

The line-intercept procedure was used for measurements of tree and shrub canopy cover (Canfield, 1941). Measurements were made along a tape on two adjacent, randomly selected 25 m sides of the quadrat. Percent cover was estimated by measuring the distance between the outer boundaries of tree and shrub canopies along the tape and calculating the proportion of the total length of tape represented by each parameter.

A 0.1 m^2 plot frame was used for herbaceous cover and height measurements (Daubenmire, 1959). The frame was placed every 5 m along two sides of a quadrat to estimate percent cover. A meter stick was used to measure height of herbaceous material in the plot. Measurements of tree, shrub, and downed woody material were recorded to the nearest 10 cm, percent herbaceous cover to the nearest 5 percent, and shrub height to the nearest 10 cm.

In addition to field sampling, distance between various cover types were measured from maps to calculate interspersion indices needed for the Deer model (Appendix Table D.5). Application of the Beaver, Great Blue Heron, and Deer models also required map measurements to determine the proportion of each cover type within specified distances adjacent to roads, rivers, or other waterbodies (Appendix Table D.6). Although field and map measurements were taken in metric units, the HEP software is based on acres so English units are used for discussing cover type area throughout this report.

6.3.2.6 Assignment of Habitat Suitability Indices and Calculation of Habitat Units

Data Summarization

A computer software program called PCFOCUS (Information Builders Inc., 1982) was used for data summarization and statistical analysis. The mean of each parameter was calculated by polygon (Appendix Tables E.2 through E.4). Parameters having single values, such as percent tree canopy cover, could not be expressed as a mean except where multiple sites were sampled in a polygon. The mean value of each parameter was also determined for each cover type in a stratum by summing the polygon values and dividing by the sample size. The variability around the mean was expressed by the standard error and coefficient of variation. These statistics were calculated to describe the variability of the data entered into the mathematical models to determine the habitat quality (Appendix Tables E-6 through E-9).

Habitat Suitability Indices and Habitat Units

HSI models have been developed by the FWS or other research institutions for each of the evaluation species chosen for the Cache la Poudre study (Appendix F). These models define the parameters that were measured in the field to determine habitat suitability for a given species. An SI was determined for each parameter by assigning the mean polygon value calculated from field measurements a quality value (0.0-1.0) from an SI graph for a particular species HSI model. The graph relates an x-axis parameter value to a y-axis habitat quality value to derive the SI. Each of the HSI models contains an equation or set of equations which mathematically combines the SIs for all the parameters into an index of overall habitat suitability for a given species. A software package called HSI (FWS, 1987) was used to assign SI values and calculate the average HSI for each cover type. The HSI values were weighted by the area of each cover type in a zone and aspect within the project areas for the Grey Mountain and Poudre alternatives. HSIs were calculated separately for the two alternatives for without-project and with-project conditions.

An HU is a combined measure of both the quality and quantity of habitat available to a given species. HUs for a particular habitat type were calculated by multiplying the HSI by the area (in acres) of the habitat type. The HUs for each habitat type used by that species were then summed by life requisite to obtain the total number of HUs available for conditions with-and without-project for the Grey Mountain and Poudre alternatives.

6.3.2.7 Assignment of Target Years and Calculation of Average Annual Habitat Units

Target Years

The HEP requires estimating the change in HUs over the life of the project due to natural or man-caused disturbance. This is accomplished by weighting intervals of time bracketed by target years. Target years represent events when major changes occur in the habitat quantity or quality. These events typically correspond to the construction, operation, and modification of a water storage project. Other events may include fire, logging, grazing, or development which alter the normal sequence of plant succession. Although succession is a continual process, incremental changes are difficult to calculate for each year. Consequently, successional changes are often represented by one or two distinct target years depending on the project length and cover types involved.

Target years were defined for both the Grey Mountain and Poudre project alternatives. Both configurations were assumed to have identical schedules of development. The initial target year (TY0) always represents the year before disturbance, while TY1 through N are the sequential periods of major change. The last target year is the end of the initial project life. Four target years were selected for the proposed project by the HEP team. TY0 was 1993, the estimated year FERC would grant a license to construct the project. TY1 was 1994, the estimated year before the start of construction and TY12 was 2005, or the estimated year of full project operation. The interval between 1994 and 2005 included the start of construction in 1995, completion of construction in 2000, and full pool operation in 2005. The year in which full pool is reached would depend primarily on hydrological conditions. Based on historic records, the District estimated that from one to ten years, or an average of five years, would be required to achieve full pool. The last target year (TY50) represented 2043, or the 50-year end of the initial license period.

The HEP team did not establish target years for succession, logging, fire, grazing, or other disturbance. This decision was based on: (1) the slow rate of succession; (2) the virtual absence of logging; (3) the FS policy of fire suppression; (4) the long history of livestock grazing; and (5) the uncertainty of future recreational, industrial, or residential development in the study area. The HEP team agreed that these events did not warrant assigning target years because they did not represent major quantifiable changes in habitat except for development. Development was excluded because the type, rate, and location cannot be accurately determined at this time. However, these events are fully discussed in Section 6.4.1.4.

Average Annual Habitat Units

AAHUs were calculated to determine the average annual net impact of the alternative projects on the evaluation species. The HSIs and associated habitat areas were used to calculate HUs for each target year which were then averaged over the life of the project to obtain AAHUs. This averaging procedure was accomplished by using the FWS's "HEP Accounting" procedure (FWS, 1985) which involves the following equation:

$$AAHUs = \sum_{i=T_2-T_1}^{n-1} T_2 - T_1 \quad \left(\frac{A_2H_2 + A_1H_1}{3}\right) + \left(\frac{A_1H_2 + A_2H_1}{6}\right) \quad /P$$

where:
- T_1 = first year of time interval
- T_2 = second year of time interval
- A_1 = habitat area at first target year
- A_2 = habitat area at second target year
- H_1 = HSI at first target year
- H_2 = HSI at second target year
- P = project life
- n = number of target years
- i = time interval in years

6.4 RESULTS

6.4.1 Description of Existing Environment

6.4.1.1 Wildlife

A variety of wildlife including birds, mammals, amphibians, and reptiles inhabit the study area. A literature review and a survey of resource agency staff resulted in very little available site-specific information on game or non-game birds and mammals, and no information on reptiles or amphibians, except for a general species and distribution list for Colorado (Hammerson, 1982). Roberts (1983) conducted winter and summer bird surveys along the proposed Grey Mountain Reservoir site and found higher bird densities in riparian habitats than in upland habitats. Baldwin (1976) maintained a 25-year record of bird species observed during spring and summer around the confluence of the mainstem and North Fork of the Cache la Poudre River and recorded 95 species. The District conducted a preliminary small mammal trapping study covering the mainstem, Glade, and Greyrock areas and identified eight species (Berg, 1986). While these sources of information are useful for developing a comprehensive species list of wildlife, the available information is insufficient for adequately describing use of the study area by wildlife other than threatened or endangered and special interest species.

Because of the insufficient amount of information and the impracticality of conducting wildlife population studies to develop a comprehensive database, the resource agencies in cooperation with the District decided that the HEP was a suitable alternative to describe and assess wildlife use of the area. HEP is a habitat-based approach where indicator species are selected to reflect the habitat use patterns of a broader variety of species. Since wildlife species are dependent on habitat, proper application of HEP provides a comprehensive evaluation of wildlife use in the Cache la Poudre study area. The results of the HEP are described in Section 6.4.2.

Threatened and Endangered Species

Five species that potentially occur in the study area have been listed by the FWS or CDOW as threatened or endangered. The bald eagle, peregrine falcon (Falco peregrine), and least tern (Sterna antillarum), are designated by both FWS and CDOW as endangered species. The piping plover (Charadrius melodus) is listed as a threatened species by both agencies, and the river otter is designated by the CDOW as an endangered species in Colorado. A species is designated endangered by the Federal government when the species requires protection throughout its geographic range to prevent extinction. A species is designated endangered by a state such as Colorado when the species requires protection to prevent extinction in that state. The protected status of these species requires descriptions of their use of the project area.

An estimated 600 to 700 bald eagles winter in Colorado (Craig, 1988). Bald eagles arrive in Colorado during October and depart to breeding areas in Canada during March (Lockhart, 1988). Ten pairs of eagles reportedly nest in Colorado (Craig, 1988; Lockhart, 1988). The closest nesting site to the project area is Fort Morgan, which is 30 to 40 miles east of the study area.

Surveys conducted in the study area indicated that at least seven bald eagles winter on the mainstem and North Fork of the Cache la Poudre River (Table 6.5). Bald eagles were observed between October and March with the highest numbers being observed in February (Figure 6.4). Bald eagles were encountered on the river during 25 of the 35 survey days. Use of the river was most consistent during November through February when eagles were observed on more than 70 percent of the survey days (Figure 6.5). Bald eagles were distributed throughout the river system, but most (52 of 59 observations) were on the lower portion of the North Fork where they fed on fish stranded in pools created by the release of water from Seaman Reservoir.

Bald eagles observed in the study area may occasionally roost along the Cache la Poudre River (Table 6.5). Bald eagles were observed perched in a mixed conifer stand along the mainstem across from the Fort Collins Filtration Plant well after sunset on three different days. Two to three eagles were observed in this stand. Roost sites are important because they provide thermal radiation cover which reduces the heat loss for eagles and improves their fitness to survive the winter (Stallmaster and Gessaman, 1984). Consequently, these surveys showed that bald eagles consistently used Grey Mountain and Poudre project areas throughout the late fall to early spring, and may intermittently roost in the project areas near the confluence of the mainstem and North Fork of the Poudre River.

Little information is available on the peregrine falcon, least tern, piping plover, and river otter in the study area. The upper Poudre Canyon is mapped as hunting and nesting habitat for the peregrine falcon (CDOW, 1978).

TABLE 6.5

Number of Bald Eagles Observed on the Mainstem and North Fork of the Cache la Poudre River Between October 2, 1986 and March 30, 1987

Date	Time[1]	Seaman Reservoir	Seaman Reservoir-to Mainstem	Mainstem	North Fork above Seaman Reservoir[2]	Comment
10/21/86	AM	0	0	0		
10/28/86	AM	1	0	0		
11/4/86	PM	0	2	0		
11/7/86	AM	0	0	0	1	
11/11/86	PM	0	4	0		
11/14/86	PM	0	3	0		
11/19/86	AM	0	0	1		
11/29/86	PM	0	5	0		
12/4/86	AM	0	1	0		
12/8/86	PM	1	3	0		Roosting[3]
12/14/86	AM	0	2	0		
12/17/86	AM	0	0	0		
12/18/86	AM	0	1	0		
12/27/86	PM	1	1	0		
12/28/86	AM	0	2	0		
12/31/86	PM	0	2	0		Roosting[3]
1/1/87	AM	0	5	0		
1/9/87	AM	0	2	0		
1/10/87	AM	0	1	0		
1/11/87	PM	0	3	0		Roosting[3]
1/14/87	PM	0	0	0		
1/23/87	AM	0	0	0		
1/27/87	AM	0	1	0		
1/31/87	AM	0	1	0		
2/2/87	PM	0	1	0		
2/4/87	PM	0	1	0		
2/5/87	AM	0	1	0	2	
2/8/87	AM	0	7	0		
2/12/87	PM	0	2	0		
2/18/87	PM	0	0	0		
2/26/87	PM	0	0	0		
3/3/87	AM	0	0	0		
3/12/87	AM	0	1	0		
3/24/87	AM	0	0	0		
3/30/87	AM	0	0	0		

(1) AM = Sunrise to 8:00 a.m.
PM = 3:30 p.m. to sunset.

(2) The North Fork above Seaman Reservoir was inconsistently surveyed because of its inaccessibility.

(3) Date when eagles were observed roosting across from water filtration plan between Seaman Reservoir and the mainstem on the North Fork of the Cache la Poudre River.

An active nest site exists near Kinikinik, which is about 25 miles west of the study area. There have been unconfirmed sightings of peregrine falcons in the lower canyon, which has been identified by the CDOW as hunting habitat for this species. There have, however, been no confirmed sightings, and it is unlikely any nesting occurs in the study a··a (Craig, 1988).

The least tern and piping plover are rare migrants in Colorado (CDOW, 1978). There has been one confirmed observation of each of these species in Larimer County outside the study area and no recorded nest sites (CDOW, 1978).

The river otter, a state endangered species, has been observed on the Cache la Poudre River outside the study area. The occurrence of the river otter was recently confirmed along the Cache la Poudre River in Fort Collins (Schoonveld, 1986). The presence of otters in the Cache la Poudre River combined with their reported trait of traveling long distances within river systems (Field, 1970) indicates that this species may use the study area. However, the CDOW (1978) has not designated any "essential" river otter habitat in the Poudre River Basin.

<u>Species of Special Interest</u>

Big game species and raptors, particularly the golden eagle, were identified by the CDOW, FWS and FS as species of special interest for the Cache la Poudre project. Raptors are of special interest because they: (1) often have very specific nesting habitat requirements; (2) require large areas for feeding; (3) are top carnivores and therefore reflect impacts to small mammals, birds, reptiles, or fish; (4) are sensitive to disturbance, particularly during nesting; and (5) receive high public interest. Big game species are of special interest because they use a wide variety of cover types to meet their life requisites and are also of high public interest.

<u>Golden Eagle</u>

A literature review indicated little is known about the distribution and abundance of golden eagles in the study area. Discussions with the CDOW (Craig, 1988) indicated that seven active and two historic (nest sites that show no sign of use within the past two years) eagle nests may occur within eight miles of the confluence of the North Fork and the mainstem of the Cache la Poudre River.

TABLE 6.6

Active Golden Eagle Nest Site Characteristics[1]

Location	Habitat Type	Elevation (Ft MSL)	Distance from Reservoir[2] (miles)
North Fork #1	Rock/Talus	6,110[3]	0.1
North Fork #2	Rock/Talus	6,140[4]	0.2
Owl Canyon	Rock/Talus	5,740[4]	3.7
Glade	Rock/Talus	5,750[4]	2.2
Hewlett Gulch	Rock/Talus	7,100[3]	2.6

(1) Refer to Figure 6.6 for map showing locations.

(2) Distance in miles from the Poudre or Grey Mountain reservoir as estimated from topographic maps.

(3) Elevation measured using altimeter.

(4) Elevation estimated from USGS topographic maps.

A winter density of 0.2 golden eagles per km^2 was estimated for the study area (Roberts, 1983). Since information on the current distribution and status of golden eagles is not available, surveys were conducted in 1987 and 1988 to locate nest sites in the study area. The data presented in this report are from the 1987 survey. Results of the 1988 survey were not available from the FWS as of the writing date for this report.

Five active and four alternate (nest sites that have been occupied within the past two years but are not currently used) golden eagle nests were identified during the helicopter survey conducted on May 8, 1987 (Table 6.6 and Figure 6.6).

One active and one alternate nestwere located just outside the study area about one mile northeast of Owl Canyon. Of the 7 nest sites in the study area, two active and two alternate nests were along the North Fork. All other nests were at least 1.5 miles away from either project area (Figure 6.6). One of the alternate nests along the North Fork was within 100 ft of an active nest on the east side of the river at an elevation of 6,140 ft, which is approximately 440 ft above the river. The other alternate nest was 0.25 miles north of an active nest on the east side of the river. The elevation of the active nest was 6,110 ft (450 ft above the river) and although the alternate nest site was not visited on foot, its elevation was greater than that of the closest active nest. The nests outside the project areas ranged from 5,740 to 7,100 ft elevation. All the nests were located on cliff faces in the rock/talus cover type (Table 6.6). As determined by the cover type inventory, rock/talus occurs in 89 distinct polygons and represents 263 acres in the study area.

At the request of the CDOW, pellets were collected from the golden eagle nests identified in the survey, and a food habits analysis was conducted. The purpose of this analysis was to identify golden eagle prey species to determine the importance of different cover types in the project area as golden eagle feeding habitat. Based on the results of the food habits analyses, golden eagles nesting in the study area feed on a wide variety of prey (Table 6.7). Twenty genera of mammals, five orders of birds, fish, and snake remains were found in 30 pellet samples collected from three eagle nest sites. The results are consistent with the findings of other studies in the western United States, and indicate that jack rabbits (53 percent of the samples contained jack rabbit) and other small mammals, including squirrels and prairie dogs, are important components of the diet (Brown and Amadon 1968; Olendorff 1973; 1976). Prairie dogs, passerine birds, and grouse were especially common in samples from the North Fork nest site. These results suggest that the golden eagles nesting in the study area feed primarily in open upland cover types and less frequently in forested

TABLE 6.7

Composition of Prey Collected from Three Golden Eagle Nests

Taxa	North Fork Nest #2 (n = 14)[1] Freq.	% Freq.	Owl Canyon Nest (n = 7)[1] Freq.	% Freq.	Glade Nest (n = 9)[1] Freq.	% Freq.	Total (n = 30)[1] Freq.	% Freq.
Mammals								
elk (Cervus)	2	14	0	0	0	0	2	7
red-backed vole (Clethrionomys)	1	7	2	29	0	0	3	10
prairie dog (Cynomys)	6	43	2	29	2	22	10	33
chipmunk (Eutamias)	3	21	0	0	1	11	4	13
sagebrush vole (Lagurus)	1	7	1	14	0	0	2	7
jack rabbit (Lepus)	6	43	5	71	5	56	16	53
marmot (Marmota)	2	14	1	14	0	0	3	10
vole (Microtus)	2	14	3	43	2	22	7	23
weasel (Mustela)	0	0	0	0	1	11	1	3
woodrat (Neotoma)	2	14	0	0	0	0	2	7
deer (Odocoileus)	2	14	2	29	1	11	5	17
sheep (Ovis)	2	14	1	14	1	11	4	13
mouse (Peromyscus)	5	36	1	14	4	44	10	33
harvest mouse (Reithrodontomys)	0	0	3	43	1	11	4	13
shrew (Sorex)	1	7	1	14	1	11	3	10
ground squirrel (Spermophilus)	3	21	3	43	3	33	9	30

(a) n = number of castings in sample collected at each nest (casting is defined as prey remains regurgitated in the form of a pellet).

(b) Two of the four castings contained Dendrogapus obscurus (blue grouse)

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TABLE 6.7 (Continued)

Composition of Prey Collected from Three Golden Eagle Nests

Taxa	North Fork Nest #2 (n = 14)(1)		Owl Canyon Nest (n = 7)(1)		Glade Nest (n = 9)(1)		Total (n = 30)(1)	
	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.
Mammals (Continued)								
cottontail rabbit (*Sylvilagus*)	1	7	0	0	1	11	2	7
pine squirrel (*Tamiasciurus*)	5	36	3	43	2	22	10	33
pocket gopher (*Thomomys*)	1	7	0	0	0	0	1	3
jumping mouse (*Zapus*)	0	0	0	0	2	22	2	7
Birds								
ducks and geese (Anseriformes)	1	7	0	0	2	22	3	10
dove (Columbiformes)	0	0	1	14	1	11	2	7
grouse and quail (Galliformes)	4	29 (2)	1	14	0	0	5	17
passerines (Passeriformes)	6	43	1	14	2	22	9	30
woodpeckers (Piciformes)	1	7	0	0	1	11	2	7
Unidentified Aves	1	7	0	0	0	0	1	3
snake (Reptilia)	1	7	0	0	0	0	1	3
fish (Pisces)	1	7	0	0	0	0	1	3

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and riparian types. This analysis was to be used to develop a habitat model for the golden eagle. However, the HEP team later decided not to include the golden eagle as an evaluation species for the Cache la Poudre project because the survey results provided adequate information of the use of the study area by this species.

Other Raptors

A variety of other raptors potentially inhabit the study area. Information on their use of the study area, however, is largely lacking. Osprey (Pandion haliaetus), prairie falcon (Falco mexicanus), and red-tailed hawk (Buteo regalis) occur in or near the study area. Ospreys nest south of the study area near Fort Collins, but none have been reported in the study area. Ospreys typically nest on the broken tops of large trees along rivers and particularly along reservoirs where they feed on fish. Prairie falcons have been reported to nest in the study area outside the Poudre River Canyon (Craig, 1986). Based on previous observations three nests are suspected along the rimrock east of Highway 287 at Hook and Moore Glade and one in the vicinity of Greyrock Mountain. However, the exact locations and use of these nesting areas by prairie falcons have not been confirmed. Red-tailed hawks also nest in the study area but none have been observed in the vicinity of the proposed project (Figure 6.6). Three active nests were found during the May 8, 1987 and May 25, 1988 helicopter surveys. The three nests were all within 2 miles of Owl Canyon; two nests were immediately west of Highway 287 and one was east of the highway. Other raptors that probably nest in the study area, because they are prominent in the Poudre Basin, are the American kestrel (Falco sparverius), rough-legged hawk (Buteo lagopus), and great-horned owl (Bubo virginianus) (Craig, 1986; Roberts, 1983).

Bighorn Sheep

Bighorn sheep (Ovis canadensis) were historically distributed the entire length of the Cache la Poudre River Canyon (Goodsen, 1980). The herd was migratory, moving from high elevation summer ranges to low elevation winter ranges. Bighorn sheep disappeared from the lower canyon near the proposed reservoir site by the early 1900's and no other sightings were reported after 1935 in the upper canyon (Simmons, 1961). Bighorn sheep were reintroduced to the upper Poudre Canyon in 1946 (Moser, 1962).

Three bighorn sheep herds currently occur along or near the Cache la Poudre River (Figure 6.7). One herd of approximately 255 animals inhabits the area from Joe Wright Creek downstream to Big Narrows, which is approximately six miles west of Poudre Park (Rocky Mountain Bighorn Society, 1984). A second herd, estimated at 40 to 50 bighorn sheep, uses the lower canyon mainly from Big Narrows east towards Hewlett Gulch. The populations of these two Poudre River Canyon herds are increasing, and there seems to be some movement of animals between these two herds (Bear, 1979). A third herd of approximately 15 to 20 animals inhabits the Lone Pine Creek area, about eight miles north of Big Narrows (Goodsen, 1980). The areas occupied by these animals consist of steep, open grasslands, or shrublands that are close to escape terrain (steep, rocky areas) (Simmons, 1961; Tilton and Willard, 1982; and Wakelyn, 1984).

The limited information available on bighorn sheep in the Poudre region suggests that small numbers of sheep may seasonally inhabit the study area. Sheep have been observed in the study area along the mainstem and North Fork during late winter and early spring. They have been primarily observed on steep, rock/talus slopes but probably transit through other habitats. There is no information available to suggest that the study area provides critical lambing habitat or that the animals migrate across the Cache la Poudre River. The animals observed in the study area are probably from the herd that occurs between Big Narrows and Hewlett Gulch (Berg, 1987).

<u>Mule Deer</u>

Mule deer are common in the study area. Most mule deer in the Cache la Poudre Basin are migratory, moving from lower elevation (6,000 to 8,500 ft) winter ranges to higher elevation (greater than 8,500 ft) summer ranges (Anderson, 1972) (Figure 6.7). Deer generally leave the winter ranges in late April to early May and move up in elevation as vegetation green-up progresses (Siglin, 1965). Most deer from the Cache la Poudre herd were on their summer range near Long Draw Reservoir by the second week of June (Dorrance, 1965). Deer generally leave the high elevation summer range before the third week of October (Dorrance, 1965). Although during mild autumn seasons, deer stay on high elevation transition ranges until snow accumulation forces them to move down (Loveless, 1967). About 20 percent of the total wintering population is nonmigratory and remains at lower elevations year-round (Loveless, 1967). Migration (mass movement of animals) does not occur in the lower Poudre Canyon, but deer gradually move between summer and winter ranges depending on the severity of the winter (Schoonveld, 1986). Consequently, while mule deer inhabit the study area year-long, the greatest use is between approximately November and April.

The size of the mule deer population wintering in the Cache la Poudre Basin was estimated at 9,196 animals in 1962-63 and 10,460 animals in 1964-65 (Medin, 1976). CDOW conducted a helicopter census along the lower Cache la Poudre River during the winters of 1985-87. Mule deer densities were estimated from these censuses at 52 deer per square mile during 1985-86 and 62 deer per square mile during 1986-87 in the winter concentration area along the North Fork of the Poudre River. During a January 1984 aerial survey conducted by the CDOW, 636 mule deer were counted in the winter concentration area. Based on these counts, the total deer population wintering along the lower Poudre River was estimated at 800 to 1,000 animals, or about 10 percent of the almost 10,000 deer wintering in the Basin (Schoonveld, 1986).

Deer primarily use south-facing brushy slopes and open timber areas during winter (Loveless, 1963, 1967). Approximately 73 percent of the deer wintering at Sevenmile Creek (15 mi west of study area) were in south-facing shrub communities, 13 percent were in open timber stands, 11 percent were in drainage channels, and 3 percent were in heavy timber stands (Loveless, 1963, 1967). Deer wintering at Stevens Gulch (6 mi west of project area) preferred shrub communities and open timber stands (Dorrance, 1965). North slopes and valley bottoms received the lowest use because of their exposure to more severe weather. A similar pattern of aspect and habitat use by deer would be expected in the study area.

Mule deer forage during the winter consists of approximately 75 percent browse, 15 percent forbs, and 10 percent grasses and other plant materials (Medin, 1976). The most important winter browse species on the Poudre River ranges are fringed sagebrush (Artemesia frigida), antelope bitterbrush (Purshia tridentata), mountain mahogany (Cercocarpus montanus), and skunkbrush sumac (Rhus trilobata). The mountain shrub community is the most important deer habitat during winter because of the abundance of preferred browse plants (Loveless, 1967). Summer diets of the Cache la Poudre mule deer generally contain less browse and more forbs than winter diets, which is typical of mule deer throughout the Rocky Mountains (Wallmo and Regelin, 1981).

Cache la Poudre mule deer breed mainly in November and December on the winter range (Anderson and Medin, 1967). Approximately 96 percent of Poudre mule deer conception dates are between November 17 and December 22 (Medin, 1976). The peak of fawning is between June 12 and June 25, approximately 203 days after conception (Dorrance, 1965). There is no current information available on the population structure or recruitment rate of the Poudre River deer population. However, data from a five-year study conducted from 1961-1965 indicate that the population had good reproductive success (Anderson, 1972; Medin, 1976).

The information summarized above shows that the study area provides winter range for mule deer. Deer use appears to be highest east and west of the North Fork of the Cache la Poudre River which is largely undisturbed by roads. The mountain shrub and open canopy forest, particularly on the south-facing slopes, are the primary deer foraging areas. These areas are used predominantly between November and April, after which most of the deer move to higher elevations outside the study area. A smaller proportion of the wintering deer population inhabit the project area year-long.

6.4.1.2 Cover Type Inventory

Cover Type Descriptions

There were 16 wildlife cover types identified in the 39,489-acre study area that consisted of three upland forest types, three riparian types, two wetland types, three upland non-forested types, two water types, and three disturbed types (Table 6.8). The distribution of these types was influenced by a west to east moisture gradient in the study area. The dry eastern portion of the study area was dominated by grasslands. The western portion was at higher elevation, had more topographic relief, and was dominated by conifer forests. The central portion of the study area represented a transition area and was dominated by shrublands. The cover types and their distribution in the study area are illustrated in Exhibit I (found in the map pocket on the back cover of this report).

TABLE 6.8

Area of Cover Types Within and Outside the Grey Mountain and Poudre Project Areas

Cover Type	Study Area[1]		Grey Mountain Project Area[1]		Outside Grey Mountain Project Area [1]	Poudre Project Area[1]		Outside Poudre Project Area [1]
	Area (ac)	Percent	Area (ac)	Percent	Area (ac)	Area (ac)	Percent	Area (ac)
Closed Canopy Conifer	5,526	14.8	234	9.8	5,293	218	11.5	5,309
Open Canopy Conifer	6,790	17.2	396	16.5	6,394	321	16.9	6,470
Pinyon Pine Forest	178	0.5	0	0.0	178	0	0.0	178
Mountain Shrub	13,469	34.1	972	40.6	12,497	698	36.9	12,771
Grassland	10,276	26.0	334	13.9	9,942	269	14.2	10,007
Rock and Talus	264	0.7	22	0.9	242	14	0.7	250
Agriculture	968	2.5	0	0.0	968	0	0.0	968
Developed	158	0.4	9	0.4	149	8	0.4	150
Disturbed	974	2.5	125	5.2	849	108	5.7	866
Riparian Forest	388	1.0	75	3.1	312	62	3.3	326
Riparian Shrub	121	0.3	17	0.7	104	13	0.7	108
Riparian Grassland	16	0.04	9	0.4	7	8	0.4	8
Palustrine Marsh/Meadow	53	0.1	0	0.0	53	0	0.0	53
Palustrine Pond	53	0.1	0	0.0	53	0	0.0	53
Riverine	178	0.4	127	5.3	51	99	5.2	79
Lacustrine (existing)	77	0.2	77	3.2	0	77	4.0	0
TOTALS	39,489		2,397		37,092	1,895		37,596

(1) Project area includes inundation area (maximum flood pool level of 5,640 feet) and a 40 ft buffer zone to 5,680 ft elevation.

Twelve cover types, representing 1,895 and 2,400 acres, were found in the Poudre and Grey Mountain project areas, respectively (Table 6.8 and Figure 6.8). Upland Forest, Shrubland, and Grassland were the dominant cover types and composed approximately 80 percent of the project areas. Seaman Reservoir, Riparian, Riverine, and Rock/Talus types represented approximately 14 percent of the project areas. Five percent of the project areas was classified as developed or disturbed. Palustrine (Marsh/Meadow and Pond), Agriculture, and Pinyon Pine Forest types were not in either of the project areas but they were in the study area. Each of the cover types represented within and outside the Grey Mountain and Poudre project areas is described below.

Upland Forested Cover Types

Three upland forested cover types were identified in the study area: Closed Canopy Conifer; Open Canopy Conifer; and Pinyon Pine. These types represented over 31 percent of the study area. Open and Closed Canopy Conifer Forests represented 28 and 26 percent of the Grey Mountain and Poudre project areas, respectively. There was no Pinyon Pine Forest in either of the project areas. Each of these cover types is described below.

- Closed Canopy Conifer Forest: The Closed Canopy Conifer Forest type was defined as forests dominated by ponderosa pine (Pinus ponderosa) or Douglas-fir (Pseudotsuga menziesii) with more than 60 percent tree canopy cover based on aerial photograph interpretation. Closed Canopy Conifer Forest occupied 14 percent of the study area, all in the western half. About one-third of the areas sampled were dominated by ponderosa pine, one-third by Douglas-fir, and one-third were mixed. Douglas-fir-dominated stands occurred in slightly moister microclimates, usually on steep, north-facing slopes. Ponderosa pine and Rocky Mountain juniper (Juniperus scopulorum) were often intermixed with Douglas-fir in these areas, particularly in younger stands (Hess and Alexander, 1986). Ponderosa pine was the climax tree species on drier sites. Understory vegetation in dense stands of Closed Canopy Conifer was usually sparse. Common understory components in the Closed Canopy Forest included mountain mahogany, bitterbrush, currants (Ribes sp.), ninebark (Physocarpus monogynus), Montana wheatgrass (Agropyron dasystachya), mountain muhly (Muhlenbergia montana), spike fescue (Leucopoa kingii), and Ross' sedge (Carex rossii).

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The Closed Canopy Conifer Forest represented about 234 and 218 acres (10 percent) of the Grey Mountain and Poudre project areas, respectively. A total of 98 percent of this cover type was south of the mainstem and east of the North Fork of the Cache laPoudre River. Average tree canopy cover was 63 percent (excluding two samples that fell in open inclusions). Ponderosa pine was dominant over Douglas-fir in more than 80 percent of the sites sampled in the project areas.

Closed Canopy Conifer Forests occupied about 14 percent of the acreage outside the project areas. Tree, shrub, and herbaceous cover was similar to that measured in the project areas. However, Douglas fir was dominant over ponderosa pine in most of the sites sampled outside the project areas. The project areas were at the lowest edge of the elevational range of this species, and moist sites favoring Douglas fir were less common than at the higher elevations outside the project areas.

- Open Canopy Conifer Forest: The Open Canopy Conifer Forest type was defined as forests dominated by conifer other than pinyon pine with 10 to 60 percent tree canopy cover based on aerial photo interpretation. This type occupied 17 percent of the study area. Ponderosa pine was the dominant tree species. Rocky Mountain juniper, Douglas-fir, and occasionally pinyon pine were associated species. Open Canopy Conifer Forests were primarily on south, east, or west facing slopes where the sites were drier than north-facing slopes which were mainly occupied by Closed Canopy Conifer Forests. The open canopy of this cover type promoted a relatively high understory cover of shrubs, usually dominated by mountain mahogany. Other common shrubs were bitterbrush, chokecherry (Prunus virginiana), wild plum (P. americanus), skunkbrush, currants, snowberry (Symphorocarpos sp.), rabbitbrush (Chrysothamnus nauseosus), and ninebark. Grasses were also a significant component of the understory, and three to nine species were identified in each stand sampled. Forb cover was generally sparse and diverse.

Open Canopy Conifer Forest represented 396 and 321 acres (16 percent) of the Grey Mountain and Poudre project areas, respectively. A total of 56 percent of this cover type in the project areas was east of the North Fork and 27 percent was south of the mainstem. Average tree canopy cover was

18 percent, and ponderosa pine was the dominant tree. Average herbaceous canopy cover was 7 percent, and shrub canopy cover was 20 percent. These values show that the tree, shrub, and herbaceous canopy of this type was open.

Open Canopy Conifer Forest occupied about 17 percent of the land outside the project areas, primarily in the northwestern portion of the study area. Average tree, shrub, and herbaceous canopy cover outside the project areas were similar to that sampled in the project areas.

o Pinyon Pine Forest: There were 178 acres of Pinyon Pine (Pinus edulus) Forest associated with a limestone formation in the northeastern quarter of the study area. This is the northern-most Pinyon Pine Forest in Colorado (Weber, 1976). Pinyon pine was the dominant species, but the stands usually included a few ponderosa pine and Rocky Mountain juniper. Mountain mahogany was the dominant understory shrub, and the herbaceous cover was sparse. There was no Pinyon Pine Forest in either of the project areas.

Non-Forested Upland Habitats.

Three upland, non-forested cover types were identified in the study area: Mountain Shrub, Grassland, and Rock/Talus. These types represented over 60 percent of the study area and 55 and 52 percent of the Grey Mountain and Poudre project areas, respectively.

o Mountain Shrub: The Mountain Shrub cover type was defined as areas with more than 20 percent shrub cover and less than 10 percent tree cover. It represented 13,469 acres or 34 percent of the study area and was the most abundant cover type. This cover type occupied almost every aspect or slope. Larger shrubs and higher canopy cover were characteristic of mesic sites, generally found on north-facing slopes. Drier sites or ones with poor soil structure had sparser cover and smaller shrubs. The dominant species was mountain mahogany, but in swales and along draws, skunkbrush and wild plum sometimes formed dense thickets. Other shrub species were wax currant (Ribes cereum), chokecherry, ninebark, snowberry, rabbitbrush, and boulderberry. A wide variety of grass and forb species were also found in this cover type. Cheatgrass (Bromus tectorum) often dominated areas disturbed by grazing, and sunflower (Helianthella sp.) was common in sites where the shrub canopy cover was sparse. Cactus (Opuntia sp. and Pediocactus simpsanii) and several semi-shrub plants such as wild buckwheat (Eriogonum sp.), snakeweed (Gutierrezia sarothrae), and fringed sage (Artemisia frigida) were also frequent components of the Mountain Shrub cover type.

The Mountain Shrub cover type represented about 972 and 698 acres (about 40 percent) of the Grey Mountain and Poudre project areas, respectively. A total of 80 percent of the Mountain Shrub was north of the mainstem and along both sides of the North Fork. Shrub canopy cover averaged 35 percent, and herbaceous canopy cover averaged 34 percent. These values show that the vegetation in this type was relatively open because of moderate densities of shrub and herbaceous plants.

Mountain Shrub occupied about 34 percent of the land outside the Grey Mountain and Poudre project areas, respectively. Average shrub and herbaceous canopy cover was similar to that within the project areas.

- Grassland: The Grassland cover type was defined as upland areas with more than 30 percent herbaceous cover, less than 20 percent shrub cover, and less than 10 percent tree cover. It excluded cultivated, disturbed, or developed areas. This type represented about 10,276 acres or 26 percent of the study area. The grassland type included a wide variety of grass and forb species. Dominant grasses were blue grama (Bouteloua gracilis), needle grasses (Stipa sp.), wheatgrasses (Agropyron sp.), bluegrass (Poa sp.), bluestem (Andropogon sp.), and brome (Bromus sp.).

  Grasslands represented 334 and 269 acres (14 percent) of the Grey Mountain and Poudre project areas, respectively. A total of 86 percent of this type was north of the mainstem and along both sides of the North Fork. Herbaceous cover averaged about 50 percent, and the composition was about 80 percent grass and 20 percent forb. Much of the Grassland identified along the mainstem was on disturbed areas along Highway 14 that were revegetated with weedy species.

Grasslands represented about 25 percent of the land outside the project areas. The majority of the Grassland outside the project areas was in the eastern one-third of the study area below 5,700 ft. Average herbaceous canopy cover and grass/forb composition was similar inside and outside the project areas.

o Rock and Talus: The Rock and Talus cover type was defined as rock outcrops with less than 10 percent tree cover, less than 20 percent shrub cover, and less than 30 percent herbaceous cover. This cover type represented 264 acres (0.6 percent) of the study area and was usually found on steep slopes. Prominent rock types in the study area included granite at Grey Rock, limestone near Hook and Moore Glade, and metamorphic and igneous rocks of Precambrian age along the river canyon. Vegetative cover was sparse but included trees, shrubs, grasses, and forbs in crevices of rocks. Cliffbush (Jamesia americana) was the most prominent shrub and alumroot (Heuchera bracteate) was a prominent herbaceous species.

The Rock and Talus cover type represented about 23 and 14 acres (1 percent) of the Grey Mountain and Poudre project areas, respectively. It was primarily distributed along the bases of cliffs near the river. Rock and Talus occupied less than 1 percent of the land outside project areas. The majority of this cover type outside the project areas was represented by high cliffs and the peak of Grey Rock Mountain.

Riparian Cover Types.

Riparian cover types were distinguished from upland types by their close association with streams and rivers. Riparian cover types in this study were defined as adjacent to water courses where seasonal flooding influences plant productivity and composition (Roberts, 1983). Riparian vegetation was found along permanent and ephemeral streams, including springs and washes. Three types of riparian cover types were identified in the study area: forest-, shrub-, and grass-dominated. Riparian cover types occupied 1.3 percent of the study area and 104 and 82 acres (4 percent) of the Grey Mountain and Poudre project areas, respectively.

o Riparian Forest: The Riparian Forest cover type was defined as streamside vegetation with more than 10 percent tree canopy cover. This type represented 383 acres (1 percent) of the study area. Individual patches of Riparian Forest were usually small, averaging about 1.7 acres. The most prominent tree species in Riparian Forest areas was either plains or narrowleaf cottonwood (Populus sargentii and P. anguotifolia), but peach-leaved willow (Salix amygdaloides), box-elder (Acer negundo), ponderosa pine, Douglas-fir, Rocky Mountain juniper, hackberry (Celtis occidentalis, alder (Alnus tenuifolia), and river birch (Betula fontinalis) were also found. Shrubs were diverse in the understory and included chokecherry, wild plum, snowberry, skunkbrush, willow (Salix sp.), golden currant (Ribes aureum), wild rose (Rosa sp.), and poison ivy (Toxicodendron rydbergii). Vines, including western virgin's bower (Clematis ligusticifolia) and wild grape (Vitis vulpina) were common. Herbaceous understory cover was usually high and included a wide variety of grasses and forbs such as bluegrass, reed-canary grass (Phalaris arundinacea), redtop (Agrostis gigantea), sedges (Carex sp.), rushes (Juncus sp.), goldenrod (Solidago sp.), stinging nettle (Urtica dioica), hounds tongue (Cynoglossum officinale), milkweed (Asclepias arenaria), ragweed (Ambrosia psilostachya), thistle (Cirsium sp.), and mint (Mentha sp.).

The Riparian Forest cover type occupied about 75 and 62 acres (3 percent) of the Grey Mountain and Poudre project areas, respectively. The Riparian Forest was adjacent to the Cache la Poudre River, the most important permanent natural water source in the study area. Average tree canopy cover was 47 percent and average shrub cover was 23 percent. Shrub height averaged 2.3 meters, almost a meter taller than shrubs in upland cover types. Riparian Forest areas were often severely grazed by cattle because of their proximity to water, high herbaceous cover, and structural diversity.

The Riparian Forest type occupied about 1 percent of the land outside the project areas. Tree canopy cover averaged 70 percent and shrub cover averaged about 7 percent. Shrub cover was lower than in the project areas probably because most of the streams outside the project areas are ephemeral. The higher tree canopy cover in Riparian Forests outside the project areas may be an artifact of the difficulty of defining the boundaries of riparian areas adjacent to ephemeral streams.

- Riparian Shrub: The Riparian Shrub cover type was defined as streamside vegetation with less than 10 percent tree cover and more than 20 percent shrub cover. This type represented 121 acres (0.3 percent) of the study area. Common shrubs were hawthorn (Crataegus succulenta), wild plum, chokecherry, coyote willow (Salix exigus), snowberry, and skunkbrush. Many of the vines, forbs, and grasses common in Riparian Forest were also found in Riparian Shrub habitats.

  Riparian Shrub represented 17 and 13 acres (0.7 percent) of the Grey Mountain and Poudre project areas, respectively. Shrub canopy cover averaged 69 percent and herbaceous cover averaged 64 percent, suggesting the vegetation was moderately dense. Much of this habitat type was disturbed by grazing.

  The Riparian shrub type occupied only 0.3 percent of the land outside the project areas. Shrub canopy averaged 60 percent cover outside the project areas, and herbaceous canopy cover averaged 34 percent. These values are lower than in the project areas, probably because most of the streams outside the project areas were only seasonally wet.

- Riparian Grassland: This type was defined as streamside vegetation with more than 30 percent herbaceous cover, less than 20 percent shrub, and less than 10 percent tree cover. This type was found in only a few locations which represented about 16 acres in the study area. These patches were generally on flat areas next to river bends where silt had been deposited. These sites were dominated by herbaceous plants. Dominant grasses were Kentucky bluegrass (Poa pratensis), smooth brome (Bromus inermus), red top, and timothy (Phleum pratense). Other grasses, sedges, and rushes were common, as were forbs such as thistle, sweet-clover (Melilotus sp.), mullein (Verbascum thapsus), stinging nettle, clover (Trifolium sp.), goldenrod, scouring rush (Equisetum sp.), and ragweed. Shrub cover was low, and consisted primarily of coyote willow, snowberry, and wild rose.

About half the Riparian Grassland in the study area (8 to 9 acres) was in the project areas. Herbaceous cover averaged 64 percent, and 79 percent of the herbaceous cover was grass. Tree and shrub cover were less than one percent. Because of its proximity to water and the high palatability of herbaceous cover, this cover type was heavily grazed by cattle throughout the study area.

Palustrine or Wetland Cover Types

Wetlands were areas dominated by plants adapted to growing on seasonally saturated soils (Cowardin et al., 1979). Two wetland types were identified in the study area: Palustrine Marsh or Meadow and Palustrine Pond. They represented about 106 acres or 0.3 percent of the study area. There were no wetlands in the Grey Mountain or Poudre project areas.

- Palustrine Marsh and Meadow: The Palustrine Marsh and Meadow cover type was defined as herbaceous vegetation restricted to perennially wet sites associated with low or flat areas adjacent to springs or seeps. There were about 53 acres (0.1 percent) of this type in the study area. The largest patch of Palustrine Marsh/Meadow was in Grey Rock Meadow. Smaller patches were found on the eastern portion of the study area. This type was dominated by sedges, red top grass, mannagrass (Glyceria sp.), foxtail barley (Hordeum sp.), timothy, bluegrass, rushes, cattails (Typha latifolia), and bulrushes (Scirpus sp.). Common forbs were smartweed (Polygonum sp.), watercress (Rorippa nasturtium-aquaticum), sticktights (Bidens sp.), water parsley (Oenanthe sarmentosa), and willow herb (Epilobium sp.). The herbaceous cover was generally high because water was plentiful during the growing season.

- Palustrine Pond: The Palustrine Pond cover type consisted of shallow ponds with little emergent vegetation. There were 13 ponds in the study area, representing about 53 acres. Most of the ponds were man-made impoundments that served as water sources for cattle. The largest one was a settling pond for a cement operation. Several of these ponds were perennially wet and others were dry by the end of summer.

Riverine

The Riverine cover type included the mainstem and the North Fork of the Cache la Poudre River. It consisted of the river, pools, riffles, cliff bases, boulders, and sand bars within the normal high water mark. There were about 178 acres (0.4 percent) of the Riverine cover type in the study area. The Riverine cover types represented 99 and 127 acres (56 and 71 percent) of the Poudre and Grey Mountain project areas, respectively.

Lacustrine

The only Lacustrine (lake) cover type in the study area and the project areas was Seaman Reservoir. Seaman Reservoir occupies 150 acres at full pool and about half that at normal maximum drawdown (77 acres). Only the area of Seaman Reservoir at normal maximum drawdown represents permanent water and only this acreage was classified as Lacustrine. The 73 acres in the drawdown area were classified as Disturbed. The reservoir has little rooted or emergent vegetation because of fluctuations in water level.

Developed Types

Developed cover types were defined as areas where man's activities dominated the landscape. These represented about 5 percent of the study area and 134 and 115 acres (6 percent) of the Grey Mountain and Poudre project areas, respectively. Three developed types were identified in the study area.

- Agriculture: Agriculture occupied 968 acres (2.5 percent) of the study area. None of this cover type was identified in the Grey Mountain or Poudre project areas. Agricultural areas were at low elevations (below 5,400 ft) in the southern part of the study area. The predominant crops were alfalfa and pasture grasses. All other crops combined occupied less than 10 acres. All areas with signs of active cultivation were labeled as Agriculture even though some were not being cultivated at the time of this study.

- Developed: Developed land was defined as areas other than agricultural with human use as a dominant factor, but with some vegetative cover. Developed areas included residences with yards and outbuildings. This type occupied about 158 acres in the study area and 9 and 8 acres in the Grey Mountain and Poudre project areas, respectively.

- Disturbed: Disturbed land was defined as areas with little or no vegetation as a result of intensive human activity. Disturbed areas included roads, canals, mines, industrial sites, and the drawdown zone of Seaman Reservoir. This type represented about 974 acres (2.5 percent) of the study area when Seaman Reservoir was at normal maximum drawdown. Disturbed lands occupied 108 and 125 acres (5 percent) of the Poudre and Grey Mountain project areas, respectively. About 60 percent of this type in the Grey Mountain project area was the drawdown zone of Seaman Reservoir. For the Poudre project area, about 71 percent of the disturbed land was in this drawdown zone. Most of the remaining disturbed areas were along the mainstem.

Disturbance and Ecological Succession

The major sources of disturbance to wildlife habitat in the study area include fire, logging, grazing, and development. Succession is the natural process of change in the habitat that follows a disturbance event. HEP requires adjusting the habitat quantity and quality for man-caused and natural disturbances. The adjustment provides a more accurate measure of the value of wildlife habitat for determining the net impact of the project during the 50-year license period.

Fires occur every year in the study area. Lightning fires are probably more frequent than man-caused fires (Biastock, 1988). The fires, though fairly frequent, have been relatively small because there is a fire suppression policy for the National Forest, private, and State lands. On the 2.3-million-acre Arapahoe and Roosevelt National Forests, about 65 fires per year burn a total of 1,064 acres (FS, 1984). The fires commonly occur in open areas along ridge tops, and are low in intensity. Many plant species in the study area, such as ponderosa pine, mountain mahogany, and rabbitbrush, are adapted to fire and will survive low intensity burns.

Fires in the area are surface fires that remove the understory but seldom kill forest stands. They remove or thin the above-ground parts of grasses, forbs, shrubs, and young ponderosa pines. The vegetation that grows after such a fire is mainly composed of annual grasses and forbs whose seeds survive in the soil, perennials that sprout from underground parts, and the plants that survive the fire. Fires are generally not sufficiently intense to kill the larger ponderosa pine trees. Fire-adapted shrubs such as mountain mahogany resprout from underground parts. Vegetation will usually reestablish quickly to the type that burned. Consequently, the HEP Team decided not to consider fire in this evaluation because small, low-intensity fires characteristic of the study area would not have a long-term influence on the vegetation over the life of the project.

Timber harvesting has not been of major importance in the study area since before the turn of the century. There have been no timber sales on National Forest land in the study area (Winkler, 1988). A small number of trees have been harvested on private land, some of which was probably removed because of a mountain pine beetle outbreak south of the Cache la Poudre River (Winkler, 1988). Timber harvesting, therefore, has had only a minor effect on wildlife habitat in the study area, and the harvest rate is not expected to change in the foreseeable future. The HEP Team decided to exclude timber harvesting from this evaluation.

Cattle grazing has historically been extensive in the study area. After the Forest Service reduced grazing allotments and tightened control of the length of the grazing period in the early 1960s, overgrazing on Federal lands was less widespread. Since grazing policies have not changed substantially in more than 20 years, the HEP Team decided to exclude the effect of grazing in the habitat evaluation.

Little information exists concerning development trends in the study area. However, much of the study area is in the National Forest or includes lands owned by the State of Colorado. It is unlikely that privately owned land will be developed in parcels less than 35 acres because of present state laws. Therefore, the rate of industrial, residential, and recreational development associated with and without the proposed project is expected to be low over the term of the 50 year license.

The rate of plant succession in the study area is very slow because of the arid climate. Changes in successional stages from grassland to shrubland or shrubland to forest require long periods of time. Moreover, factors responsible for reversing succession (i.e., logging, fire, grazing) do not apply to the study area except for development which is expected to be slow. Since the rate of succession is slow and there are few factors to interrupt long-term successional trends, the HEP team decided to exclude succession from the evaluation.

Because of these factors, the results of the HEP documented in this report do not incorporate habitat changes from fire, logging, grazing, succession, or development. The HEP team decided that the small size of fires, small amount of logging, long-term history of grazing, and slow rate of succession would not differentially influence wildlife habitat whether or not the project was built. Likewise, the rate of development is expected to be low and similar for with and without project conditions. Development was not included in the HEP because it will occur slowly, and differential impacts are not significant.

6.4.2 Effects Assessment

As described in previous sections, the HEP was used to determine potential effects of the Poudre and Grey Mountain alternatives on wildlife habitat. The HEP combines measures of habitat quality and quantity into a single value termed a Habitat Unit (HU). HUs are compared between conditions with-the-project and without-the-project to determine the net effects. The quantity of wildlife habitat affected by the proposed project was derived from the cover type inventory. The cover type inventory also described the structure and characteristics of the habitats. Habitat quality for the seven wildlife species selected by the HEP team was derived from field measurements of these habitat characteristics. These quality and quantity measures were combined into HUs to determine the effects on the set of evaluation species. Effects were also evaluated for species of special concern. This assessment of effects on wildlife and their habitat is provided in the following sections.

6.4.2.1 Effects on Wildlife Habitats (Habitat Evaluation)

For each species, project effects, as defined by the HEP (Habitat Evaluation Procedures), are expressed as AAHUs (Average Annual Habitat Units). However, HSI (Habitat Suitability Index) values are also reported as an indicator of habitat quality in the project area and in the entire study area. HSI values are reported for each cover type that provides habitat for the Black-capped Chickadee, Song Sparrow, Western Meadowlark, and Abert Squirrel. These species are able to feed and reproduce in a single cover type, thus the quality of each cover type used is reported. The acreage and HSI for each cover type in the two project areas (by aspect), in the land outside the project areas (by elevation zone) in the total study area were used to calculate average HSI values for these three areas. Conversely, habitat quality cannot be reported by cover type for the Great Blue Heron, Mule Deer, and Beaver. These species use a variety of different cover types to meet their feeding, cover and reproductive requirements. Habitat quality is dependent on the quality, amount, and interspersion of the required cover types. As a result, HSI values often differ between with- and without-project conditions and are reported for these conditions for both the Grey Mountain and Poudre alternatives. All acreages are from Appendix Tables D.10-D.12. HSI values for the project areas (by aspect), and for the land outside the project areas (by elevation zone) are from Appendix G.

The results of the HEP analysis show that the Grey Mountain and Poudre alternatives would have negative effects on all seven evaluation species (Table 6.9). Losses, expressed as AAHUs, would be highest for Mule Deer; intermediate for Black-capped Chickadee, Abert Squirrel, and Western Meadowlark; and lowest for Song Sparrow, Great Blue Heron, and Beaver. The areas affected by either of the project alternatives provide relatively high quality (HSI=0.67 to 1.0) habitat for the Beaver and Song Sparrow; moderate quality (HSI=0.33 to 0.66) habitat for the Mule Deer, Western Meadowlark, and Black-capped Chickadee; and low quality (HSI=0.0 to 0.32) habitat for the Great Blue Heron and Abert Squirrel (Figure 6.9). Habitat quality for these species was similar for the Grey Mountain and Poudre project areas as well as for the land in the study area outside the project areas. The effects of the Grey Mountain and Poudre alternatives on these species are described below.

Black-capped Chickadee

The Black-capped Chickadee was chosen as an evaluation species because it represents birds that reproduce in small cavities and forage from the ground to the top of the forest canopy. The year-round food supply for the Black-capped Chickadee is primarily associated with foraging in trees (Brewer, 1963). Optimum habitat consists of forests with 50 to 75 percent tree canopy closure and overstory trees at least 15 m tall (Schroeder, 1983). The Black-capped Chickadee can only excavate cavities in soft, rotten wood, and the preferred nesting sites are snags between 10 and 25 cm (Odum, 1941a,b; Brewer, 1963). The HEP team decided to evaluate the three forest cover types in the study area, since they met the habitat requirements for the Black-capped Chickadee.

The study area provided moderate quality (HSI=0.37) habitat for the Black-capped Chickadee (Table 6.10). Habitat quality was similar within the project areas for both the Grey Mountain and Poudre alternatives. Habitat quality was higher in the project areas (HSI=0.46) than outside the project areas (HSI=0.37). In the project areas, habitat quality was moderate for Closed Canopy Forest (HSI=0.51), low for Riparian Forest (HSI=0.30), and zero for Open Canopy Forest (HSI=0.0). Closed Canopy Conifer and Riparian Forests with south or east facing slopes consistently provided higher quality habitat (HSI=0.34 to 1.00) than did sites on west-facing slopes

TABLE 6.9

Net Effects of Cache la Poudre Project on Wildlife Habitat[1]

Evaluation Species	Study Area without the Project	Study Area with Grey Mountain Dam			Study Area with the Poudre Dam		
	AAHUs	AAHUs	Net Change	Percent Change	AAHUs	Net Change	Percent Change
Mule Deer	25,530	24,433	-1,097	-4.3	24,623	-908	-3.6
Western Meadowlark	5,588	5,410	-177	-3.2	5,447	-140	-2.5
Black-capped Chickadee	4,554	4,431	-123	-2.7	4,443	-111	-2.4
Abert Squirrel	1,690	1,598	-92	-5.4	1,602	-88	-5.2
Beaver	127	51	-75	-59.1	56	-70	-55.1
Song Sparrow	359	301	-58	-16.2	313	-46	-12.8
Great Blue Heron	91	62	-29	-31.9	59	-32	-35.2

(1) Impacts are expressed as AAHUs.

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TABLE 6.10

Average HSI Values for the Black-capped Chickadee

Location (1)(4)	HSIs Closed Canopy Conifer Forest	Open Canopy Conifer Forest	Riparian Forest	Weighted Average
Grey Mountain Project Area				
East	0.33	0.00	0.19	0.32
South	0.67	0.00	0.31	0.61
North/West	1.00	0.00	0.34	0.42
Weighted Average (1)(4)	0.51	0.00	0.30	0.46
Poudre Project Area				
West	0.33	0.00	0.19	0.32
North	0.67	0.00	0.31	0.62
South/East	1.00	0.00	0.34	0.42
Weighted Average (1)(4)	0.50	0.00	0.21	0.45
Outside Project Areas (2)	0.51	0.26	0.24	0.37
Study Area (3)	0.51	0.24	0.24	0.37

(1) Weighted average is based on the area of each cover type, by aspect, in the project area. Differences in average HSIs for the two project areas are due to different acreages, by aspect, in each project area.

(2) HSIs are weighted averages of the HSIs and acreage of each cover type, by elevation band, outside the project areas.

(3) HSIs are weighted averages of the HSIs and acreage inside and outside the project areas.

(4) Open Canopy Conifer was not considered Black-capped Chickadee habitat in the project areas (HSI=0.00). Consequently, it was not factored into the weighted average calculations for the project areas.

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(HSI=0.19 to 0.33). Microclimatic conditions, possibly due to lower soil moisture typical of east and south-facing slopes, may have contributed to higher tree mortality in these areas and resulted in more snags for Black-capped Chickadee nesting. Conversely, aspect did not seem to influence tree mortality in Open Canopy Forests which lacked suitable nesting sites for chickadees.

Habitat quality for cover types outside the project areas was similar to that within the project areas, except for the Open Canopy Conifer Forest (Table 6.10). Open Canopy Conifer sites outside the project areas, particularly those at higher elevations, contained enough snags to provide at least minimal nesting habitat for the Black-capped Chickadee. The primary factor responsible for poor quality Black-capped Chickadee habitat throughout the entire study area was the low number of suitably-sized snags for nesting.

Construction of Grey Mountain Dam would result in a net loss of 123 AAHUs of Black-capped Chickadee habitat from the study area (Table 6.11, Appendix H). Construction of the Poudre Dam alternative would cause a net loss of 111 AAHUs. These losses would be primarily due to the inundation or disturbance of approximately 218 to 234 acres, respectively, of Closed Canopy Conifer Forest.

Song Sparrow

The Song Sparrow was chosen as an evaluation species because it represents birds that reproduce and feed in shrubs and make extensive use of riparian areas and wetlands (Verner and Boss, 1980). Optimal habitats for the Song Sparrow are areas adjacent to water with scattered groups of dense shrubs (FWS, 1978). Preferred foraging areas are low shrub thickets with abundant clearings (Tompa, 1964). Nesting areas must have abundant perch sites elevated above the shrub canopy (Miller, 1942). The HEP team decided to evaluate riparian shrub and forest cover types because they met the habitat requirements for the Song Sparrow.

TABLE 6.11

Summary of AAHUs for the Black-capped Chickadee (1)

Cover Type	Without Project AAHUs	With Project AAHUs	Net Change AAHUs
Closed Canopy Conifer			
Grey Mountain	2805.85	2702.34	-103.51
Poudre	2805.85	2711.66	-94.19
Open Canopy Conifer			
Grey Mountain	1650.45	1650.45	0.00
Poudre	1650.45	1650.45	0.00
Riparian Forest			
Grey Mountain	98.01	78.56	-19.46
Poudre	98.01	81.56	-16.45
Total			
Grey Mountain	4554.31	4431.35	-122.96
Poudre	4554.31	4443.67	-110.64

(1) See Appendix H for calculations of Habitat Units and Average Annual Habitat Unit.

The study area provided relatively high quality habitat (HSI=0.71) for the Song Sparrow (Table 6.12). Habitat quality was essentially the same for both the Gray Mountain and Poudre project areas. Habitat quality was similar within (HSI=0.75) and outside the project areas (HSI=0.70). In the project areas, habitat quality was higher for Riparian Shrub (HSI=0.83) than for Riparian Forest (HSI=0.73). Aspect did not have a significant effect on habitat quality, since most riparian areas are generally narrow and along stream corridors, where aspect does not influence microclimatic conditions. Habitat quality outside the project areas was similar to that within the project areas for all cover types (Table 6.12). Elevation did not appear to influence habitat quality for the Song Sparrow. The primary factor limiting the quality of Song Sparrow habitat in the entire study area was shrub density.

Construction of Grey Mountain Dam would result in a net loss of 58 AAHUs of Song Sparrow habitat from the study area. Construction of the Poudre alternative would cause a net loss of 46 AAHUs (Table 6.13, Appendix H). These losses would be primarily due to the inundation of approximately 75 to 92 acres, respectively, of the Riparian Forest and Shrub habitats in the study area.

Western Meadowlark

The Western Meadowlark was chosen as an evaluation species because it represents birds that feed and reproduce in open grasslands and pastures (Verner and Boss, 1980). Optimal habitats are grasslands with an abundance of perch sites provided by rocks, grass stems, or other elevated structures. Preferred nesting areas have abundant perch sites, no shrub cover, and an average grass/forb canopy height of 12 to 35 cm (Schroeder and Sousa, 1982). The HEP team decided to evaluate agriculture and grassland cover types since they met these habitat requirements for the Western Meadowlark.

The study area provided moderate quality (HSI=0.50) habitat for the Western Meadowlark (Table 6.14). Habitat quality was essentially the same for both the Grey Mountain and Poudre project areas. Habitat quality was higher in the project areas (HSI=0.60) than outside the project areas (HSI=0.50). In the project areas habitat quality was similar for upland (HSI=0.60) and Riparian (HSI=0.57) Grasslands. There was no Agriculture in the project areas. Aspect did not have a significant effect on habitat quality for the Western Meadowlark. Since most grasslands were generally in areas with low slopes, aspect had little influence on microclimatic conditions. Riparian Grasslands along the north and west sides of the project areas provided higher quality Meadowlark habitat than those along the east or south sides. The lower quality of Riparian Grassland along east and south sides was probably the result of human disturbance from recreation along the mainstem. Most of the Riparian Grasslands on north and west sides were along the North Fork and were less disturbed. Habitat quality of Upland and Riparian Grasslands outside the project areas was similar to that within the project areas (Table 6.14). Agriculture habitat quality was low. The primary factor responsible for limiting habitat quality in the study area was less than optimal herbaceous canopy cover.

Construction of Grey Mountain Dam would result in a net loss of 177 AAHUs of Western Meadowlark habitat from the study area (Table 6.15, Appendix H). Construction of the Poudre alternative would cause a net loss of 140 AAHUs. These losses would be primarily due to the inundation or disturbance of approximately 269 to 335 acres, respectively, of Grassland habitat.

Great Blue Heron

The Great Blue Heron was chosen as an evaluation species because it represents birds that forage in water and reproduce in large trees adjacent to water. Preferred foraging areas are shallow water areas of rivers, wetlands, and reservoirs with small fish, although Herons will feed elsewhere (Bayer, 1978; Burleigh, 1958). Herons generally nest in colonies, particularly in forested sites within 250 m of water. The tree species is not as important as its height and distance from human activity (Miller, 1943). Optimal habitat consists of areas with large trees for nesting that are free of human disturbance and in close proximity to shallow water with available prey (Short and Cooper, 1985). The HEP Team agreed to evaluate the Riparian and Open Canopy Conifer forests within 250 m of water as potential nesting habitat because they met the habitat requirements of the Great Blue Heron. The HEP team also agreed to evaluate the Riverine and Lacustrine cover types in the study area as potential foraging habitat.

Under without-project conditions, Great Blue Heron nesting and forage habitat quality was evaluated only for the North Fork. The mainstem area was too disturbed by Highway 14 to provide habitat for this species. Under with-project conditions, nesting habitat quality was evaluated for the Open Canopy Conifer and Riparian Forest within 250 m of the entire reservoir shore at normal maximum pool level (elevation 5,630 ft MSL). Forage habitat quality for the Heron was evaluated only for the North Fork portion of the proposed reservoir, since the sides of the reservoir along the mainstem area will be too steep to provide enough shallow water required for Heron forage habitat.

TABLE 6.12

Average HSI Values for the Song Sparrow

Location	HSIs		
	Riparian Forest	Riparian Shrub	Weighted Average (1)
Grey Mountain Project Area			
East	0.70	0.83	0.75
South	0.69	0.74	0.69
North	0.77	0.83	0.80
Weighted Average(1)	0.73	0.83	0.75
Poudre Project Area			
East	0.70	0.83	0.75
South	0.69	0.74	0.69
North	0.77	0.83	0.78
Weighted Average(1)	0.74	0.83	0.76
Outside Project Areas(2)	0.66	0.82	0.70
Study Area(3)	0.67	0.82	0.71

(1) Weighted average is based on the area of each cover type, by aspect, in the project area. Differences in average HSIs for the two project areas are due to different acreages, by aspect, in each project area.

(2) HSIs are weighted averages of the HSIs and acreage of each cover type, by elevation band, outside the project areas.

(3) HSIs are weighted averages of the HSIs and acreage inside and outside the project areas.

TABLE 6.13

AAHU Summary for the Song Sparrow[1]

Cover Type	Without Project AAHUs	With Project AAHUs	Net Change AAHUs
Riparian Forest			
Grey Mountain	260.07	214.02	-46.05
Poudre	260.07	222.73	-37.35
Riparian Shrub			
Grey Mountain	98.76	87.09	-11.67
Poudre	98.76	90.02	- 8.74
Total			
Grey Mountain	358.83	301.11	-57.72
Poudre	358.83	312.74	-46.09

(1) See Appendix H for calculations of HUs and AAHUs.

8983a

TABLE 6.14

Average HSI Values for the Western Meadowlark

Location	HSIs Grassland	Riparian Grassland	Agriculture	Weighted Average[1]
Grey Mountain Project Area				
East	0.58	0.51	---[4]	0.58
South	0.65	0.51	---	0.65
North	0.59	0.87	---	0.59
Weighted Average[1]	0.60	0.57	---	0.60
Poudre Project Area				
East	0.58	0.51	---	0.57
South	0.65	---	---	0.65
North/West	0.59	0.87	---	0.59
Weighted Average[1]	0.59	0.58		0.58
Outside Project Areas[2]	0.51	0.51	0.34	0.50
Study Area[3]	0.51	0.55	0.34	0.50

(1) Weighted average is based on the area of each cover type, by aspect, in the project area. Differences in average HSIs for the two project areas are due to different acreages, by aspect, in each project area.

(2) HSIs are weighted averages of the HSIs and acreage of each cover type, by elevation band, outside the project areas.

(3) HSIs are weighted averages of the HSIs and acreage inside and outside the project areas.

(4) Dashes indicate that cover type was absent.

8983a

TABLE 6.15

AAHU Summary for the Western Meadowlark[1]

Cover Type	Without Project AAHUs	With Project AAHUs	Net Change AAHUs
Grassland			
Grey Mountain	5,250.86	5,078.77	-172.09
Poudre	5,250.86	5,114.03	-136.83
Riparian Grassland			
Grey Mountain	7.72	2.53	-5.19
Poudre	7.72	4.42	-3.31
Agriculture			
Grey Mountain	328.93	328.93	0.00
Poudre	328.93	328.93	0.00
Total			
Grey Mountain	5,587.51	5,410.23	-177.28
Poudre	5,587.51	5,447.38	-140.13

(1) See Appendix H for calculations of HUs and AAHUs.

Since nesting and forage habitats both must be present for herons to successfully reproduce, the quality of each habitat was combined into a single HSI value for each alternative.

The study area provided relatively low habitat quality for the Great Blue Heron (Table 6.16). Habitat quality was similar for with-project (HSI=0.26, 0.28) and without-project (HSI=0.32) conditions for both the Grey Mountain and Poudre alternatives. The factor most responsible for poor quality Heron habitat in the study area was the large distance between potential and active heron colonies. Reservoirs or rivers with appropriate feeding and nesting habitat that are more than 25 km from an active rookeries are not readily colonized (Short and Cooper, 1985). The nearest active Great Blue Heron colony is at Fossil Creek Reservoir which is more than 25 km from the study area.

Construction of Grey Mountain Dam would result in a net loss of 29 AAHUs of Great Blue Heron habitat from the study area (Table 6.16, Appendix H). Construction of the Poudre Dam alternative would cause a net loss of 32 AAHUs. These would be due primarily to the loss of the shallow water feeding areas and the inundation of most of the Riparian Forest in the study area. Although Grey Mountain Reservoir would be larger than the Poudre Reservoir, the loss of Great Blue Heron habitat would be less. Grey Mountain Reservoir would have more shoreline and consequently, more nesting habitat.

Mule Deer

The Mule Deer was selected as an evaluation species because it represents mammals that use a wide variety of cover types. Furthermore, the study area is part of the Cache la Poudre Basin which provides winter range for a herd of about 10,000 Mule Deer (Schoonveld, 1986). Mule Deer require three kinds of habitat: forage; hiding cover; and thermal cover. Forage is primarily provided by brushlands where browse is preferred to forbs or grasses (Thomas et al., 1976). Stands of conifer or dense evergreen shrubs 250 to 500 m wide provide optimal hiding and thermal cover for Mule Deer (Thomas et al., 1976). Optimal Mule Deer winter range is assumed to be 60 percent forage and 40 percent cover (FWS, 1982). Slope, aspect, road density, and average snow depth, however, affect the quality of deer winter range.

The HEP team decided to evaluate all terrestrial cover types in the study area as Mule Deer habitat except the Palustrine, Rock/Cliff, Disturbed, and Developed types. Forest types were assumed to provide winter cover habitat for Mule Deer, while Shrublands, Grasslands, and Agriculture (pastures) were assumed to provide winter forage habitat. The HEP team also agreed that slope, aspect, and roads influenced deer use of an area. The team decided to exclude slopes greater than 80 percent from the HEP analyses since they have no habitat value for deer.

This modification to the model was derived from a study that found deer rarely used areas with slopes greater than 80 percent (Ganskopp and Vavra, 1987). The team also decided to downweight north- facing slopes in the project areas. North-facing slopes usually

TABLE 6.16

Summary of HSI Values and AAHUs for the Great Blue Heron(1)

	Without Project(2)(3)		With Project(2)(3)		Net Change
Location	HSI	AAHUs	HSI	AAHUs	AAHUs
Grey Mountain	0.32	90.89	0.26	61.64	-29.25
Poudre	0.32	90.89	0.28	59.33	-31.56

(1) See Appendix H for calculations of HUs and AAHUs.

(2) HSI values are a combination of the quality of both the feeding (Open Canopy Conifer and Riparian Forest) and forage (Riverine and Lacustrine) habitats in the project areas and are therefore not reported by cover type.

(3) HSI values are dependent on the amount of each cover type in the study area used for feeding and reproduction and therefore differ between with and without project conditions.

accumulate more snow and retain it longer than other aspects. Observations by CDOW biologists suggest that deer use of north-facing slopes in the Cache la Poudre Basin is about 20 percent less than other slopes during winter (Hodgson, 1988). East, west, and south facing slopes and slopes between 0 and 79 percent were not weighted in the analysis, since they were assumed to be equally available to wintering deer.

Roads have been shown to significantly influence deer use of adjacent areas (Thomas et al., 1976; Rost and Bailey, 1979). A study on the east slope of the Colorado Rockies indicated that deer use of shrublands was three times greater beyond 300 m from a road than within 100 m of a road. Deer use of forested areas was less influenced by roads (Rost and Bailey, 1979). The HEP team agreed to downweight the habitat value of areas within 100 m and 100 to 200 m of State

Highway 14 and U.S. Highway 287. Values were weighted from data reported by Rost and Bailey (1979) that compared average pellet group densities for these distance intervals (Table 6.17). Because roads affect deer use of shrublands differently than forests, different values were developed to weight the quality of each cover type. The weighted values derived for forests were applied to all forest cover types and the values for shrublands were applied to all appropriate non-forest types.

The study area provided moderate to high quality habitat for Mule Deer (Table 6.18). Winter cover habitat quality (HSI=0.75) was higher than forage habitat quality (HSI=0.68). Habitat quality was essentially identical for both the Grey Mountain and Poudre project areas and outside the project areas. Habitat quality was determined for each cover type and weighted by area to derive the average HSI for cover and forage in the project areas, outside the project areas, and the study area.

Nine cover types provided winter forage habitat for Mule Deer and six of these also provided winter cover habitat (Appendix H). The habitat quality of winter cover for Mule Deer ranged from 0.33 to 1.00 HSI. Closed Canopy Conifer provided the highest quality winter cover (HSI=0.77 to 1.00), while the other upland forest types provided intermediate

TABLE 6.17

Values Used to Weight Habitat Quality for Mule Deer Within 200 m of Roads

Distance From Road	Forest Cover Types: Number of Deer Pellet Groups[1]	Forest Cover Types: Weight[2]	Shrublands and Open Cover Types: Number of Deer Pellet Groups[1]	Shrublands and Open Cover Types: Weight[2]
0 - 100 m	2.5	0.50	3.5	0.32
100 - 200 m	4.0	0.80	9.0	0.82
Greater than 200 m	5.0	1.00	11.0	1.00

(1) As reported by Rost and Bailey (1979)

(2) Weights for distances less than 200 m are the proportion of pellet groups counted for that distance divided by the number of pellet groups counted at distances greater than 200 m. The HEP team assumed that deer use was not influenced in areas beyond 200 m from the road.

TABLE 6.18

Average HSI Values for Mule Deer

Location	HSIs: Food (1)	HSIs: Winter Cover (2)
Grey Mountain Project Area		
East	0.63	1.00
South	0.49	0.49
North	0.91	0.58
Weighted Average (3)	0.70	0.71
Poudre Project Area		
East	0.61	1.00
South	0.39	0.60
North	0.91	0.59
Weighted Average (3)	0.72	0.75
Outside Project Areas (4)	0.68	0.75
Study Area (5)	0.68	0.75

(1) Winter feeding habitat quality for the Mule Deer is dependent on the quality, interspersion and amount of cover types providing forage. Consequently, HSIs are not calculated by cover type.

(2) Winter cover habitat quality for the Mule Deer is dependent on the quality, interspersion and amount of cover types providing winter cover. Consequently, HSIs are not calculated by cover type.

(3) Weighted average is based on the area of each cover type, by aspect, in the project area. Differences in average HSIs for the two project areas are due to different acreages, by aspect, in each project area.

(4) HSIs are weighted averages of the HSIs and acreage of each cover type, by elevation band, outside the project areas.

(5) HSIs are weighted averages of the HSIs and acreage inside and outside the project areas.

quality (HSI=0.58 to 0.80). The Shrubland and Riparian Forest types provided the lowest quality winter cover habitat (HSI=0.33 to 0.56). The primary factor responsible for limiting the quality of winter cover habitat in the study area was less than optimal evergreen shrub or conifer cover.

The quality of winter forage habitat for Mule Deer ranged from 0.14 to 1.00 HSI. Shrubland types had the highest quality forage (HSI=0.74 to 1.00) and Closed Canopy Conifer consistently had the lowest (HSI=0.14 to 0.20). Winter forage quality for the other cover types was variable (HSI=0.20 to 0.43). The primary factor responsible for limiting the quality of forage habitat in the study area was the availability of palatable deer browse in the forested cover types.

Aspect and roads had a significant influence on habitat quality in the project areas. Winter forage and cover habitat quality was lowest on the south side of the project areas primarily because of aspect (north-facing slopes were down-weighted by 20 percent) and disturbance from Highway 14. Forage habitat quality on the north/west side of the project areas was the highest because the dry soils on these slopes (south and east facing) are more suitable for growing shrubs (52 percent) than dense forests which shade out winter deer browse. The lower quality of winter cover habitat on south and east-facing slopes was due to the small area of conifer forest (20 percent). Conversely, west-facing slopes were nearly 40 percent forested and provided optimal winter cover for Mule Deer.

HEP requires using the most limiting life requisite to evaluate effects. Since winter forage habitat quality was more limiting (lower HSI) in the study area than winter cover habitat quality, the AAHUs for the forage life requisite were used to evaluate the effects of the Grey Mountain and Poudre alternatives on deer. Construction of Grey Mountain Dam would result in a net loss of 1,097 AAHUs of Mule Deer habitat from the study area (Table 6.19,

TABLE 6.19

Summary of AAHUs for the Mule Deer[1]

Life Requisite	Without Project AAHUs	With Project AAHUs	Net Change AAHUs[2]
Winter Forage			
Grey Mountain	25,530.07	24,432.73	-1,097.34
Poudre	25,530.07	24,622.56	-907.51
Winter Cover			
Grey Mountain	28,331.63	27,242.72	-1,088.91
Poudre	28,331.63	27,367.29	-964.34

(1) See Appendix H for calculations of HUs and AAHUs.

(2) Since winter forage habitat quality was most limiting in the study area (HSI=0.68), the AAHUs for forage were used to evaluate the effects of each project alternative.

Appendix H). Construction of the Poudre Dam alternative would cause a net loss of 908 AAHUs. These losses will be primarily due to the inundation or disturbance of 698 to 972 acres of Shrubland in the study area.

Abert Squirrel

The Abert Squirrel was chosen as an evaluation species because it serves as an indicator of wildlife species affected by the loss of ponderosa pine forests from the project. Optimal habitat for the Abert Squirrel is uneven-aged stands of ponderosa pine trees with crowns that interlock. Preferred feeding areas have several large (greater than 21 cm dbh) ponderosa pine trees. Preferred nesting areas have relatively dense stands of ponderosa pine trees with crowns that interlock and an average dbh of over 28 cm. The HEP team decided to evaluate the

Open and Closed Conifer Forest cover types because they met the habitat requirement of the Abert squirrel.

The study area provided low quality (HSI=0.13) habitat for the Abert Squirrel (Table 6.20). Habitat quality was essentially the same for both the Grey Mountain and Poudre project areas. Habitat quality was similar inside (HSI=0.17 and 0.19) and outside (HSI=0.13) the project areas. In the project areas, habitat quality was low for both Open and Closed Canopy Forest (HSI=0.12 to 0.20). Forests on west-facing slopes consistently provided higher quality habitat than did sites with other aspects. Microclimate conditions, possibly associated with the higher moisture typical of west-facing slopes with adequate soil, may have contributed to growing denser stands of larger trees in this area. North-facing slopes also typically have higher soil moisture but in the project areas the slopes with a northern aspect were very steep and rocky and may not be conducive to tree establishment and growth. South-facing slopes were typically dry, and those in the project areas supported only a few small patches of forest. Habitat quality outside the project areas was similar to that within the project areas for both cover types. Elevation had no noticeable effect on Abert Squirrel habitat quality. Tree size and basal area were responsible for the poor quality of Abert Squirrel habitat in the entire study area. In upland forest sites, tree basal area and diameter were generally too low to provide nesting habitat for this species.

Construction of Grey Mountain Dam would result in a net loss of 92 AAHUs of Abert Squirrel habitat from the study area (Table 6.21, Appendix H). Construction of the Poudre Dam alternative would cause a net loss of 88 AAHUs. These losses would be primarily due to the inundation or disturbance of approximately 538 to 630 acres of upland forest.

TABLE 6.20

Average HSI Values for the Abert Squirrel

Location	HSIs		
	Closed Canopy Conifer Forest	Open Canopy Conifer Forest	Weighted Average
Grey Mountain Project Area			
West	0.25	0.35	0.31
North	0.00	0.00	0.00
South/East	0.00	0.00	0.00
Weighted Average(1)	0.12	0.20	0.17
Poudre Project Area			
West	0.25	0.35	0.31
North	0.00	0.00	0.00
South/East	0.00	0.00	0.00
Weighted Average	0.13	0.23	0.19
Outside Project Areas(2)	0.10	0.16	0.13
Study Area(3)	0.10	0.16	0.13

(1) Weighted average is based on the area of each cover type, by aspect, in the project area. Differences in average HSIs for the two project areas are due to different acreages, by aspect, in each project area.

(2) HSIs are weighted averages of the HSIs and acreage of each cover type, by elevation band, outside the project areas.

(3) HSIs are weighted averages of the HSIs and acreage inside and outside the project areas.

Beaver

The beaver was chosen as an evaluation species because it serves as an indicator of wildlife species affected by the loss of Riverine and Riparian habitat when a reservoir replaces a free-flowing river. Optimal beaver habitats are wetlands, ponds, and streams having a slope gradient below six percent and a small annual water fluctuation. Reservoirs with extreme water fluctuations are not used by beaver because their burrows become exposed part of the year (Slough and Sadleir, 1977). Preferred foraging habitats are wetlands, ponds, or streams adjacent to dense stands of small trees and moderately dense shrubs dominated by aspen, willow, cottonwood, or alder (Allen, 1983). Since beavers are herbivorous and will forage up to 200 m from water, the quality of beaver habitat depends on the wetland and also forage composition and density within 200 m (Allen, 1983). Similarly, the quality of riverine and lacustrine habitats depends on the adjacent riparian or upland cover types meeting the forage requirements of the beaver.

The HEP team decided to evaluate only the mainstem and North Fork rivers and adjacent lands as beaver habitat. The ponds in the study area are used for irrigation and they dry-up during part of the year. Similarly, the pool level of the proposed reservoir could be significantly lower during drought years. The HEP team agreed that Seaman Reservoir, the ponds in the study area, and the proposed reservoir are unsuitable beaver habitat because of existing or proposed fluctuations in water levels.

Studies of beaver habitat suggest that slope and roads limit the availability of food (Rutherford, 1964; Slough and Sedleir, 1977; Hoover and Wills, 1984). A study in California found no active beaver colonies in streams adjacent to slopes greater than 30 percent (Beier and Barrett, 1987). In addition, areas bordering or bisected by highways act as barriers for beaver to access food (Slough and Sadleir, 1977). Consequently, the HEP team agreed to evaluate beaver habitat for only those segments of the Cache la Poudre River adjacent to slopes less than 40 percent and not crossed by Highway 14.

TABLE 6.21

Summary of AAHUs for the Abert Squirrel[1]

Cover Type	Without Project AAHUs	With Project AAHUs	Net Change AAHUs
Closed Canopy Conifer			
Grey Mountain	570.26	545.75	-24.51
Poudre	570.26	545.75	-24.51
Open Canopy Conifer Forest			
Grey Mountain	1,120.18	1,052.60	-67.58
Poudre	1,120.18	1,056.51	-63.67
Total			
Grey Mountain	1,690.44	1,598.35	-92.10
Poudre	1,690.44	1,602.26	-88.18

(1) See Appendix H for calculations of HUs and AAHUs.

Under without-project conditions, the study area provided quality beaver habitat (HSI=0.71) (Table 6.22). Approximately 70 percent of the area within 200 m of the Cache la Poudre River was available to beaver for feeding and the quality of this habitat was optimal. Almost 30 percent of area within 200 m of the river was eliminated as beaver forage habitat because it was along Highway 14 or on steep slopes. Therefore, the primary factor responsible for limiting the quality of beaver habitat in the study area was the amount of area available for feeding.

Construction of the project will eliminate all beaver habitat in the project areas. A small amount of Riverine habitat will remain in the study area outside the project areas. Under with-project conditions, forage habitat quality will be limited in the remaining Riverine habitat. The quality of the feeding habitat in the area remaining after construction of Grey Mountain Dam is expected to be relatively high (HSI = 0.78). More feeding habitat would be available if Poudre Dam were constructed, but its overall quality would be moderate (HSI = 0.59) because of the influence of slope and roads on the remaining area.

TABLE 6.22

Summary of HSI Values and AAHUs for the Beaver(1)

Location	Without Project(2) HSI	Without Project(2) AAHUs	With Project(2) HSI	With Project(2) AAHUs	Net Change AAHUs
Grey Mountain	0.71	126.56	0.78	51.25	-75.31
Poudre	0.71	126.56	0.59	56.22	-70.34

(1) See Appendix H for calculations of HUs and AAHUs.

(2) HSI values are a combination of the quality of both the feeding and cover habitats in the project areas and are therefore not reported by cover type.

Construction of Grey Mountain Dam would result in a net loss of 75 AAHUs of beaver habitat from the study area (Table 6.22, Appendix H). Construction of the Poudre alternative would cause a net loss of 70 AAHUs. These losses would be primarily due to the inundation of 128 and 100 acres, respectively, of Riverine habitat in the study area.

6.4.2.2 Effects on Threatened and Endangered Wildlife and Species of Special Interest

Assessment of project effects on wildlife species of concern can only be made where there is a direct loss of habitat. Indirect effects are not possible to determine with a high degree of certainty. Moreover, assessing the capacity of a species to adjust to the development of the proposed reservoir is not possible since the predictions cannot be substantiated by data. Indirect impacts on wildlife species of concern will have to be determined through discussions with appropriate resource agencies, and the resulting mitigation negotiated on a species-specific basis.

Although this study was not designed to evaluate wildlife populations but rather wildlife habitat, some limited assessment of effects can be stated for species for which we have data.

<u>Threatened and Endangered Species</u>

<u>Bald Eagle</u>

The proposed reservoir would inundate trees currently used by bald eagles for perching and intermittent roosting at night. The loss of these trees would affect at least seven bald eagles observed wintering in the project areas. These eagles represent approximately 1 percent of the 600-700 bald eagles wintering in Colorado. Effects on bald eagles would be the same for both the Grey Mountain and Poudre alternatives. A Biological Assessment and close coordination with FWS will be required for this species under Section 7(c) of the Endangered Species Act (1973). Depending on the results of the Biological Assessment, a formal FWS Section 7(c) consultation may be required.

<u>Peregrine Falcon, Least Tern, Piping Plover, and River Otter</u>

There is no information available on use of the project areas by these species to evaluate effects. Information, however, is available to suggest the project areas are not regularly or intensively used by these species.

Species of Special Interest

Golden Eagle

The proposed reservoir would not flood the five active and four alternate golden eagle nests located in the study area. The two active nests along the North Fork would be 0.2 miles from the proposed reservoir while the other three active nests would be over 2 miles from the proposed reservoir. The two nests along the North Fork would be visible from the proposed reservoir but they would be over 400 ft above the maximum pool elevation, and access by people would be difficult.

Although the proposed project would not inundate any known golden eagle nests, it would reduce the amount of available foraging and nesting habitat. Approximately 14 and 22 acres of rock/talus habitat would be inundated by the Poudre and Grey Mountain alternatives, respectively. All the nests in the study area are in the rock/talus cover type, but whether the habitat that would be inundated would otherwise be suitable for additional nests cannot be determined. In addition, approximately 1,310 and 1,734 acres of potential foraging habitat would be inundated by the Poudre and Grey Mountain alternatives, respectively. Foraging habitat includes mountain shrub, rock/talus, grassland, and open canopy conifer. Although these cover types are available for foraging, the quality of the prey base for golden eagles in available areas is not known.

The proposed project would affect golden eagles to some degree, primarily by reducing the foraging area available to the local population. However, effects on golden eagles would be the same for both the Grey Mountain and Poudre project alternatives.

Mule Deer

The proposed reservoir would inundate approximately 1,500 to 2,000 acres of mule deer winter range. This represents about 5 percent of the winter range within the study area. The impact would, however, be particularly important during severe snow years when deer concentrate in the Poudre Canyon. The reduced amount of winter range could increase grazing pressure on the remaining range areas which could affect the physical condition of the animals.

The proposed reservoir could also interfere with mule deer movement patterns on the winter range. Mule deer currently winter on both sides of the Cache la Poudre River, particularly along the North Fork. The reservoir could alter the distribution of deer by increasing the travel distance around the reservoir to the area east and south of the river. Deer may, consequently, respond to the reservoir by increasing the intensity and period of use in the area north and west of the river. The area east and south of the river would probably also be used, but possibly not until the other portions of the winter range have been heavily browsed by the animals. Heavy browsing may reduce the quantity and potentially affect the physical condition of the animals. Another potential effect from the proposed project could occur when the reservoir freezes during winter periods. Deer can fall through thin ice during freezeup or become trapped on ice during the spring thaw (Martin et al., 1985).

The results of the HEP determined the quality and quantity of mule deer habitat that would be inundated by the project. The HEP results, however, do not account for secondary effects that may change mule deer use patterns elsewhere in the study area. These effects should be determined through consultation with the resource agencies and included in species-specific mitigation. Effects on deer would be similar for both the Grey Mountain and Poudre project alternatives.

Bighorn Sheep

Small numbers of bighorn sheep have been infrequently observed in the study area from late winter to early spring. This suggests that the study area is not an important bighorn sheep range, but it does provide habitat to a small number of animals. The importance of the area to these animals is not possible to determine from the available data. The effects of the project, however, to the populations of bighorn sheep associated with the Poudre River Canyon will not be significant (i.e., will not reduce the reproductive viability of the populations), since their ranges are largely outside the study area and their migration routes will not be interrupted by the proposed reservoir.

6.5 DISCUSSION

In general, the effects of reservoirs on wildlife include: (1) loss of habitat; (2) disturbance; (3) disruption of migration routes; and (4) direct mortality due to clearing or flooding. The major effects of the Cache la Poudre

Project on wildlife would be loss of habitat (Figure 6.8). Grey Mountain Dam would inundate or alter approximately 2,305 acres of habitat including 972 acres of Shrubland, 630 acres of Upland Forest, 334 acres of Grassland, 127 acres of Riverine, 101 acres of Riparian, and 22 acres of Rock and Talus. Poudre Dam would affect approximately 1,701 acres of habitat including 698 acres of Upland Forest, 539 acres of Shrubland, 269 acres of Grassland, 99 acres of Riverine, 82 acres of Riparian, and 14 acres of Rock and Talus. Regional impacts would be greatest for the Riparian and Riverine habitats which are generally not abundant and are presently vulnerable to development and recreation. There are no designated wetlands in the project areas.

Effects on upland forest habitat in the study area were evaluated by using the Abert Squirrel, Black-capped Chickadee, and Mule Deer as indicator species. The Open and Closed Canopy Conifer Forests in the Grey Mountain and Poudre project areas provide high quality winter cover habitat for the Mule Deer. Mature Closed Canopy Conifer Forests also provide moderate quality feeding and nesting habitat for the Black-capped Chickadee. This species depends on snags usually present in mature forest stands to complete its life cycle. The Closed Canopy Conifer Forest, dominated by ponderosa pine, provides the only habitat used by the Abert Squirrel, but the quality is relatively low because of low basal area and small tree size. Loss of Upland Forests would also affect other animals dependent on these forests for food, cover and reproduction. Representative species that require conifer trees for food include the dark-eyed junco (Junco hyemalis), evening grosbeak (Coccothraustes vespertina), Swainson's thrush (Cartharus ustulata), and mountain chickadee. Species that require snags for reproduction include the mountain chickadee, white-breasted nuthatch (Sitta carolinensis), northern flicker (Colaptes auratus), and Lewis' woodpecker (Melanerpes lewis). The proposed Grey Mountain Dam would affect 234 acres of Closed Canopy Conifer which represents a loss of 123 AAHUs for the Black-capped Chickadee and 92 AAHUs for the Abert Squirrel. Construction of Poudre Dam would impact 217 acres of Closed Canopy Conifer and result in a loss of 111 AAHUs for the Black-capped Chicadee and 88 AAHUs for the Abert Squirrel. Other species dependent on Upland Forests, including Mule Deer, would also be affected by the project.

Effects on Shrubland habitat in the study area were evaluated by using the Mule Deer as an indicator species. Shrublands in the Grey Mountain and Poudre project areas provide high quality Mule Deer winter forage habitat, except along the mainstem where Highway 14 significantly reduces deer use. The Shrublands in the project areas have a high proportion of shrubs palatable to deer that provide important winter forage. Loss of this habitat will impact the Mule Deer and other species dependent on Shrublands for food, cover, and reproduction. Shrublands support a wide variety of small mammals, reptiles, and birds such as the rufous-sided towhee (Pipilo erythrophthalmus) and several species of sparrow. The construction of Poudre or Grey Mountain dams would affect approximately 698 or 972 acres of Shrubland, respectively, which represents a loss of habitat for all species dependent on this type. The effects on Shrublands and other foraging areas from the Grey Mountain or Poudre alternatives would result in the loss of 1,097 or 908 AAHUs, respectively, of Mule Deer winter forage habitat.

Effects on Grassland habitat in the study area were evaluated by using the Mule Deer and the Western Meadowlark as indicator species. The Grey Mountain and Poudre project areas provide moderate quality Meadowlark habitat. The Meadowlark requires a dense grass canopy for nesting cover and depends on the insects associated with this habitat for food. Grasslands in the project areas provide moderate quality forage habitat for Mule Deer. Data collected in the Cache la Poudre area indicate that deer prefer Grasslands for foraging and resting at night (Kufeld, 1986). Loss of this habitat type would impact the Western Meadowlark, Mule Deer, and other animals dependent on Grasslands for food, cover, and reproduction. Grasslands support a wide variety of small mammals such as the grasshopper mouse (Onychomys leucogaster), deer mouse (Peromysus maniculatus), long-tailed vole (Microtus longicaudus), pocket mouse (Perognathus sp.), and golden-mantled ground squirrel (Spermophilus latoralis). These small mammals are common prey species for several raptors including the red-tailed hawk, rough-legged hawk, and golden eagle. Consequently, raptors are also dependent on Grasslands for food. Construction of the Poudre or Grey Mountain projects would affect approximately 269 or 333 acres, respectively, of Grassland which represents a loss of 140 or 177 AAHUs of Western Meadowlark habitat. Also affected would be the Mule Deer, and other species associated with this habitat type.

Effects on Riparian shrubland and forest habitats in the study area were evaluated by using the Song Sparrow as an indicator species. The Grey Mountain and Poudre project areas provide high quality habitat for the Song Sparrow, particularly in areas that have not been disturbed by grazing and recreation. This species requires dense shrubs adjacent to water for feeding and nesting. Regionally, riparian areas comprise a small amount of acreage but provide habitat to a wide variety of wildlife (Roberts, 1983). Other species dependent on this habitat include the yellow warbler, striped skunk (Mephitis mephitis), grey catbird (Dumetella carolinensis), and western kingbird (Tyrannus verticalis). Construction of the proposed Poudre or Grey Mountain project would affect 82 or 92 acres of Riparian Shrubland and Forest, respectively, which represent a loss of 46 or 58 AAHUs for the Song Sparrow and other species dependent on this habitat.

Effects on Riverine habitat in the study area were evaluated by using the Beaver and Great Blue Heron as indicator species. The Grey Mountain and Poudre project areas provide moderate quality beaver habitat. Beaver use the river proper for travel and escape cover. The adjoining riparian habitat provides food from plants such as willow, alder, and other shrubs or small trees. Conversely, the Great Blue Heron uses the river for feeding and the adjacent riparian and upland forests for nesting. The project areas provide low habitat quality for the Heron. Loss of river segments affect the Beaver and Great Blue Heron, as well as other animals dependent on the river for food, cover, and reproduction. Representative mammals include mink (Mustela vison), river otter, and raccoon (Procyon lotor) which feed on fish. Representative birds include dipper, kingfisher (Ceryle alcyon), and common merganser (Mergus merganser) which feed in the water and reproduce in the adjacent riparian cover. Rivers in the region comprise a small amount of area but provide habitat to a variety of wildlife. Construction of the Poudre or Grey Mountain alternatives would affect approximately 99 or 127 acres of river, respectively, which represents a loss of 70 or 75 AAHUs for beaver and 32 or 29 AAHUs for the Great Blue Heron, respectively. Other species associated with the riverine-riparian complex, will also be affected by the loss of available habitat.

None of the species evaluated by the HEP were positively affected by the proposed project. However, a number of species, particularly water birds, may benefit from the reservoir. Migrating waterfowl may use the reservoir as a resting area during the fall or spring, depending on the water level. The reservoir may also provide seasonal habitat for coots, rails, sandpipers, gulls, and ospreys.

In summary, both the Grey Mountain and Poudre project areas provide moderate to high quality habitat for five of the seven species evaluated by the HEP and their associated guilds. Disturbance from historical grazing, recreation, roads, and housing developments influenced the quality of the habitat available in the project areas for all the evaluation species except the Black-capped Chickadee and Abert Squirrel. Although construction of the project would have significant effects on local wildlife habitats, the effects will be much less severe in a regional context except for the Riparian and Riverine habitats. These two habitats are regionally important because they support a high diversity of wildlife and are currently represented by a small amount of area. Specialists, such as the Beaver, Song sparrow, and Abert Squirrel, depend on specific cover types to meet their life requisites and would be more affected by the proposed project than generalists.

The habitat quality provided by the Grey Mountain and Poudre project areas is similar for all the species included in the HEP. In general, effects on wildlife from construction of Grey Mountain Dam will be greater than those from the Poudre alternative because of the larger amount of acreage affected (Figure 6.10). The larger size of Grey Mountain Reservoir (2,397 acres versus 1,895 acres) would result in greater habitat losses for all species, with the exception of the Great Blue Heron. The longer shoreline of the Grey Mountain Reservoir would provide more nesting habitat for this species than would the Poudre Reservoir. The HEP results do not account for secondary effects that may change wildlife use patterns in the study area. These effects should be determined through consultation with the resource agencies and included in site-specific mitigation.

6.6 MITIGATION

6.6.1 Conceptual Mitigation Plan

Preparation of a mitigation plan requires resolution of at least the following four issues: (1) mitigation debt; (2) compensation; (3) period for fulfilling debt; and (4) monitoring program. Mitigation policies of Colorado state and federal resource agencies do not clearly address these issues. Consequently, resolution must be achieved through negotiations of each issue to obtain a mitigation plan that is satisfactory to the District and resource agencies. These negotiations have not been initiated on the Cache la Poudre Project as of the writing of this report. The purpose of this section, therefore, is to provide a framework for discussion of the development of a mitigation plan with the resource agencies that is acceptable to FERC.

The first issue requiring resolution is the mitigation debt. The HEP was used to determine the project effects on wildlife habitat. The net effect, defined as net AAHUs, is the basis for establishing the mitigation debt. The debt can be expressed in three forms of mitigation commonly used to balance effects: in-kind, out-of-kind, and trade-off. In-kind mitigation, or replacement of lost habitat with habitat of similar type and quality, is normally preferred by the resource agencies. Replacement of lost habitat with habitat of a different type is out-of-kind mitigation. Acquisition of unusual, unique, or scarce habitats to replace regionally abundant habitat represents one application of out-of-kind mitigation accepted by resource agencies. The last and most broadly defined form of mitigation is trade-off mitigation. Trade-off mitigation is replacement of wildlife habitat losses with benefits gained from recreation, fisheries, or other resources provided from the project. The final mitigation debt is a negotiated decision that combines all three forms of mitigation.

A second issue requiring resolution is the degree to which the mitigation debt for each habitat unit must be repaid. This compensation may be lower, higher, or equal to the area of habitat lost by the project depending on the importance of the habitat to wildlife. Numeric values should be assigned to each unit of habitat acquired by the District to reduce the mitigation debt. Compensation values should be defined for wildlife habitat deemed: (1) critical; (2) rare or unusual; (3) threatened by future development; and (4) high quality. Critical habitat may include areas vital to the survival of a wildlife population such as deer winter range. Rare or unusual habitat may include wetlands, riparian communities, or unique complexes of wildlife habitat. Habitats threatened by future development may include areas vulnerable to disturbance by industrial, residential, or recreational development. Other areas may contain high quality wildlife habitat that fall outside these categories but offer little opportunity for improvement through mitigation. Compensation for protecting these categories of habitat through acquisition may be higher than other categories and may result in more costly habitat improvement programs.

The third issue requiring resolution is the period to fulfill the mitigation debt. This period could range from a few years to the 50-year term of an initial FERC license. Intermediate benchmarks should be established to identify years to complete components of the mitigation plan. The interval of years between benchmarks will depend on the magnitude of the mitigation debt, the availability of suitable replacement habitat, and the process followed for acquiring property and securing financing. Property acquisition could take the form of purchase, lease, easements, or other types of agreements. Acquisition agreements must be coordinated with local governmental entities since purchase of lands may marginally impact a jurisdiction's tax base. Consequently, a reasonable amount of time must be available for the District to fulfill the mitigation debt, but benchmarks must also be established to document the progress realized by the District toward canceling the debt.

The fourth issue requiring resolution is the monitoring program. Once properties have been acquired for mitigation, a long-term biological program should be established to monitor effectiveness of the mitigation. The monitoring program should contain at least the following elements: (1) management goals; (2) sampling plan; (3) schedule; and (4) costs. The management goals should clearly define the purpose of the management which may include habitat manipulation or protection to achieve or maintain high quality wildlife habitat for a species or group of species. The goals should be quantifiable in order to monitor the success of management. A sampling plan should be formulated that identifies the habitat characteristics requiring measurement and defines the sampling design, sampling procedures, and acceptable levels of statistical significances to detect change in habitat quality. A schedule should be prepared to identify the interval of time and the season of the year required to field monitor mitigation. Annual labor and equipment costs should be incorporated into cost estimates for the monitoring program.

Preparation of a mitigation plan and determination of the associated costs to complete mitigation will require resolution of at least these four issues. The issues will have to be discussed with the resource agencies and negotiated by the District. Several meetings will be required to negotiate a site-specific mitigation plan that balances the project effects on wildlife habitat.

Steps have been taken during the studies described in this report to initiate the mitigation and negotiation processes. These steps included: (1) delineation of a potential area for mitigation; (2) measurement of habitat quality; and (3) calculation of AAHUs. The HEP team selected an area adjacent to the project areas for potential mitigation. In addition to lands that may be required for future stages of the Cache la Poudre Project, this area comprised almost 33,000 acres or almost 5 times the amount of area potentially affected by combined stages of the project. The area was mapped into a GIS, typed by habitat, and enumerated by habitat area. Habitat characteristics were measured in the field and the AAHUs were calculated for the seven evaluation species selected for the effects assessment. The information presented in this report was developed to provide a basis for discussing mitigation alternatives with appropriate resource agencies. Consequently, the detailed studies completed for the study area should expedite the mitigation and negotiation processes by concentrating discussions on implementation issues rather than steps to develop baseline data.

6.6.2 Preliminary Cost Estimates For Mitigation

The following section describes preliminary cost estimates for wildlife mitigation associated with the proposed Poudre and Grey Mountain alternatives. These preliminary costs will be incorporated into total cost estimates for the two project alternatives to further evaluate economic feasibility. Final costs and mitigation actions can not be determined until the steps described in Section 6.6.1 are completed.

The Poudre and Grey Mountain alternatives for forming the proposed mainstem reservoir will effect approximately 1,900 and 2,400 acres of wildlife habitat, respectively (Table 6.8). The 33,000 acres of land in the study area, but outside the project areas for the Stage 1 project as well as future project stages, will be targeted for possible mitigation. Mitigation for project effects should concentrate on improving the habitat quality to increase the capacity of the remaining habitats to support wildlife. This section, therefore, describes potential mitigation actions and costs which would balance the debts for the Poudre and Grey Mountain alternatives given the information presently available.

The approach used to estimate mitigation costs was based on maximizing the habitat quality of the land inside the study area but outside project areas. Potential improvement of the habitat quality was derived for the seven evaluation species since they were chosen by the HEP team to reflect wildlife use of each habitat type in the study area. Each evaluation species represented a broader group of species or guilds characteristic of a specific habitat type or set of habitat types. Calculation of the potential habitat quality and resulting area required for mitigation of wildlife effects involved the following steps: (1) identification of the current HSI outside the project areas from the present studies; (2) determination of the differences between the current HSI and 1.0 (optimal) to derive the maximum potential change in HSI achievable through habitat improvement; and (3) determination of the area required for mitigation by dividing this difference or delta (%) into the total AAHUs affected by the projects for each evaluation species. Since this procedure assumes that optimum habitat quality can be obtained from mitigation, the costs presented in this section are considered preliminary estimates only.

The mitigation debt is summarized in Table 6.23. The table identifies the amount of area required to balance the effects for each evaluation species by habitat type assuming that the HSI can be increased to 1.0 through habitat improvement. Improvements should be aimed at the habitat characteristics or parameters described in the HSI models offering the greatest opportunity for improvement. Improvement for most species should involve application of standard mitigation actions followed by wildlife agencies.

Mitigation costs and actions are described below for each habitat type. This approach was taken because multiple species occurred in certain habitat types. Consequently, more than one species could benefit from a single mitigation action such as fencing from livestock. This approach also assumed that habitat types would be obtained in the proper juxtaposition and configuration for multicover species (i.e., deer). Costs of the various mitigation actions were primarily obtained from Elmblad (1988) and based on actual mitigation efforts. Costs of land were obtained from local real estate companies. Separate costs were used for lands near the Poudre River ($2,000 per acre) compared to those away from the Poudre River ($1,200 per acre). Irrigation costs were provided by the Army Corps of Engineers from an existing mitigation project (Christianson, 1988). Fencing/gating costs were provided by the U.S. Forest Service.

6.6.2.1 **Closed Canopy Forest**

If the Grey Mountain Dam alternative is constructed, approximately 211 acres of Closed Canopy Forest would have to be acquired outside the project area to balance habitat losses to wildlife. Construction of the Poudre Dam alternative would require acquisition of 191 acres to offset habitat losses. Areas obtained should include a configuration and vegetation characteristics similar to those that would be affected by the project. Particular emphasis should be placed on acquiring areas containing the Closed Canopy Forest type with a high potential for improvement such as sites disturbed by domestic grazing or human activities. Over 5,000 acres of this type occur outside the project areas in the study area for potential mitigation.

The Black-capped Chickadee, Abert Squirrel, and Mule Deer were the species selected by the HEP team to evaluate project effects on wildlife in Closed Canopy Forest. Approximately 191 to 211 acres of Closed Canopy Conifer Forest would have to be improved for Black-capped Chickadee to offset effects of the project. This represents the maximum amount of Closed Canopy Forest required for any of the three species. Black-capped Chickadee represents species that excavate nests and forage in trees. The number of snags in this type was generally the key factor in limiting the habitat quality for this group of wildlife. Improvements to the Closed Canopy Forest could include placement of next boxes. Nest boxes are effective for providing nesting sites until forests sufficiently mature to naturally provide snags. Once snags are available in the sufficient numbers to provide optimum quality for cavity nesting wildlife, the nest boxes should no longer be necessary. Other mitigation actions include killing mature trees to create snags, but this could reduce habitat quality for other groups of wildlife.

TABLE 6.23

Area Estimated to Balance Project Effects on Wildlife Habitat

Habitat Type/ Location	Area Available (Acres)	Black-capped Chickadee			Song Sparrow			Western Meadowlark			Great Blue Heron			Mule Deer[5]			Abert Squirrel			Beaver		
		ΔHSI[2]	Acres[3]	AAHU[4]	ΔHSI	Acres	AAHU	ΔHSI	Acres	AAHU	ΔHSI	Acres	AAHU	ΔHSI	Acres	AAHU	ΔHSI	Acres	AAHU	ΔHSI	Acres	AAHU
Closed Canopy Forest																						
Grey Mt.	5,293	0.49	211	104	--	--	--	--	--	--	--	--	--	0.84	49	41	0.90	28	25	--	--	--
Poudre	5,308	0.49	191	94	--	--	--	--	--	--	--	--	--	0.84	45	38	0.90	28	25	--	--	--
Open Canopy Forest																						
Grey Mt.	6,394	--	--	--	--	--	--	--	--	--	--	--	--	0.67	164	110	0.84	81	68	--	--	--
Poudre	6,470	--	--	--	--	--	--	--	--	--	--	--	--	0.67	130	87	0.84	76	64	--	--	--
Mountain Shrub																						
Grey Mt.	12,496	--	--	--	--	--	--	--	--	--	--	--	--	0.20	4,025	805	--	--	--	--	--	--
Poudre	12,771	--	--	--	--	--	--	--	--	--	--	--	--	0.20	3,325	665	--	--	--	--	--	--
Grassland																						
Grey Mt.	9,942	--	--	--	--	--	--	0.49	351	172	--	--	--	0.69	148	102	--	--	--	--	--	--
Poudre	10,007	--	--	--	--	--	--	0.49	280	137	--	--	--	0.69	120	83	--	--	--	--	--	--
Riparian Forest																						
Grey Mt.	312	0.56	25	19	0.34	135	46	--	--	--	--	--	--	0.79	31	24	--	--	--	--	--	--
Poudre	326	0.56	21	16	0.34	109	37	--	--	--	--	--	--	0.79	25	20	--	--	--	--	--	--
Riparian Shrub[6]																						
Grey Mt.	104	--	--	--	0.18	67	12	--	--	--	--	--	--	0.02	653	13	--	--	--	--	--	--
Poudre	108	--	--	--	0.18	50	9	--	--	--	--	--	--	0.02	613	12	--	--	--	--	--	--
Riparian Grassland																						
Grey Mt.	7	--	--	--	--	--	--	0.49	10	5	--	--	--	0.73	3	2	--	--	--	--	--	--
Poudre	8	--	--	--	--	--	--	0.49	6	3	--	--	--	0.73	3	2	--	--	--	--	--	--
Riverine																						
Grey Mt.	51	--	--	--	--	--	--	--	--	--	0.68	43	29	--	--	--	--	--	--	0.22	341	75
Poudre	79	--	--	--	--	--	--	--	--	--	0.68	47	32	--	--	--	--	--	--	0.31	226	70

(1) Assumes that habitat quality can be improved to an optimum condition.

(2) ΔHSI equals the potential for improving habitat quality of lands in the study area outside the project boundaries from the current value to the optimal value.

(3) Acres equals the estimated number of acres to achieve the number of AAHUs necessary to balance the loss of AAHUs. Acres were calculated by dividing the AAHU by the HSI.

(4) AAHU equals the estimated number of AAHUs to balance the loss in AAHUs to wildlife habitat from the projects if constructed.

(5) The distribution of AAHUs by habitat type is an estimate since the total loss of AAHUs for mule deer was derived by combining habitat types into forage or cover and weighting them by area, slope, aspect, and road disturbance.

(6) Potential for habitat improvement is too low to justify mitigation of representative areas of this habitat type that would exist if the project is constructed.

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The Abert Squirrel represents a group of species that requires mature stands of Closed Canopy Forest dominated by ponderosa pine. Approximately 25 acres of the total Closed Canopy Forest area acquired for mitigation would have to be dominated by ponderosa pine to offset the effects of the project on this group of wildlife. Improvement actions beyond the protection of existing areas through land purchase would be impractical. Habitat quality is a function of the size and density of trees, which are controlled by climate and soil conditions. These variables cannot be readily manipulated artificially. Consequently, the only mitigation action considered appropriate at this time is the purchase of timbered areas which would otherwise be commercially harvested or developed. Preservation of such areas will provide the opportunity for the forest to mature and develop high quality habitat for species dependent on older-aged stands of ponderosa pine.

The Mule Deer represents a group of species that forage in the understory of Closed Canopy Forest. Approximately 45 to 60 acres of the total Closed Canopy Forest type acquired for mitigation would have to be improved for Mule Deer and related wildlife to offset the effects of the project. The primary mitigation action suggested would be to manage domestic animal grazing or human activity to obtain optimal wildlife use of the area. This may include excluding or reducing livestock grazing to provide high quality forage for deer. Control of grazing would probably require fencing of lands if there are not existing barriers. Fences are available that exclude livestock but not deer or other wildlife from an area. Similarly, roads can be gated and locked to control access of vehicular traffic on secondary roads. These actions would reduce disturbance to deer and their habitats. Some additional actions may be necessary to stimulate understory growth including limited thinning of young timber to open the tree canopy.

The estimated cost for mitigating the loss of Closed Canopy Forest habitat type at the Grey Mountain alternative is $40,636 compared to $36,926 for the Poudre alternative (Table 6.24).

Table 6.24

Estimated Mitigation Costs for Closed Canopy Forest

Item	Grey Mountain Project (211 ac)	Poudre Project (191 ac)
Purchase Land ($1,200 per acre)	$ 25,320	$ 22,920
Fence/Gates ($2,400 per mile)	2,656	2,546
Nest Boxes ($12 per box at 5 boxes per acre)	12,660	11,460
Total	$ 40,636	$ 36,926

6.6.2.2 **Open Canopy Forest**

If the Grey Mountain Dam alternative is constructed, approximately 164 acres of Open Canopy Forest would have to be acquired outside the project area to offset effects on wildlife. Construction of the Poudre Dam alternative would require acquisition of approximately 130 acres to balance wildlife habitat losses. Over 6,000 acres of Closed Canopy Forest occur in the study area for potential mitigation.

The Abert Squirrel and Mule Deer were the species selected by the HEP team to evaluate project effects on wildlife in the Closed Canopy Forest type. Mitigation actions suggested for wildlife represented by these two species in the Closed Canopy Forest type would also apply to the Open Canopy Forest. Fencing of land and gating of roads would increase the habitat quality of the understory vegetation for deer and other species. This could be done for the entire 164 acres and 130 acres of mitigation for the Grey Mountain and Poudre alternatives, respectively. Moreover, approximately 80 acres of the total area acquired would have to be dominated by ponderosa pine and protected from harvest to offset the effects of the projects on wildlife represented by the Abert Squirrel. Mitigation efforts should be directed at acquiring forest stands which are deemed vulnerable to disturbance or provide a reasonable opportunity for improvement through the aforementioned mitigation actions.

The estimated cost for Open Canopy Forest mitigation for the Grey Mountain alternative is $201,660, compared to $160,327 for the Poudre alternative (Table 6.25).

6.6.2.3 **Mountain Shrub**

If the Grey Mountain Dam alternative is constructed, approximately 4,025 acres of Mountain Shrub habitat would have to be acquired to offset the effects on wildlife habitat. Construction of the Poudre Dam alternative would require acquisition of 3,325 acres of this habitat to balance project effects. Over 12,000 acres of Mountain Shrub habitat currently exist in the study area for possible mitigation.

Table 6.25
Estimated Mitigation Costs for Open Canopy Forest

Item	Grey Mountain Project (164 ac)	Poudre Project (130 ac)
Purchase Land ($1,200 per acre)	$ 196,800	$ 156,000
Fence/Gates ($2,400 per mile)	4,860	4,327
Total	$ 201,660	$ 160,327

The Mule Deer was selected by the HEP team to evaluate effects of the proposed project on Mountain Shrub habitat. The Mule Deer represents wildlife that forage in the shrub and understory vegetation of this habitat. Opportunities to improve the quality of this habitat type would be limited since the quality is already relatively high. The primary action suggested to improve quality would be to exclude or control grazing by livestock. Livestock have reduced the herbaceous canopy and compete with species such as deer for forage. Fencing the areas from livestock would, therefore, improve the quality of this habitat to wildlife dependent on this habitat type. In addition, gating of secondary roads would control vehicular traffic and reduce disturbances to Mule Deer and other species. Furthermore, mitigation should include acquisition of areas having southern or eastern exposures and low to moderate slopes near the proposed reservoir, in order to offset the effects on Mule Deer with areas recognized by CDOW as preferred winter range.

The estimated cost for Mountain Shrub mitigation for the Grey Mountain alternative is $4,854,075, compared to $4,011,881 for the Poudre alternative (Table 6.26).

6.6.2.4 Grassland

If the Grey Mountain Dam alternative is constructed, approximately 351 acres of Grassland habitat would have to be acquired to compensate for effects on wildlife habitat. Construction of the Poudre alternative would require acquisition of 280 acres to offset effects on wildlife. Approximately 10,000 acres of this habitat type is present in the study area for possible mitigation.

The Western Meadowlark and the Mule Deer are species selected by the HEP team to evaluate effects of the project on wildlife in the Grassland habitat type. These species represent wildlife that forage or nest in grasslands. The quality of Grassland habitat could be increased by improving the herbaceous (grass and forb) cover which has been reduced largely by livestock grazing. Mitigation actions most likely to increase herbaceous cover should include fencing to exclude livestock, burning, fertilizing, and seeding the existing Grassland habitat. Lands obtained should target grasslands with a high potential for improvement such as those that have been heavily grazed by livestock.

Table 6.26
Estimated Mitigation Costs for Mountain Shrub

Item	Grey Mountain Project (4025 ac)	Poudre Project (3325 ac)
Purchase Land ($1,200 per acre)	$ 4,830,000	$ 3,990,000
Fence/Gates ($2,400 per mile)	24,075	21,881
Total	$ 4,854,075	$ 4,011,881

The estimated cost for mitigating loss of Grassland habitat type is $478,224 for the Grey Mountain alternative, compared to $378,955 for the Poudre alternative (Table 6.27).

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6.6.2.5 Riparian Forest

If Grey Mountain Dam alternative is constructed, approximately 135 acres of Riparian Forest would have to be acquired to offset the effects on wildlife habitat. Construction of Poudre Dam alternative would require the acquisition of 109 acres of this habitat to mitigate the project effects. Over 300 acres of this habitat is available in the study area for potential mitigation.

The Song Sparrow, Black-capped Chickadee, and Mule Deer were selected by the HEP team to evaluate the effects of the proposed project on wildlife in the Riparian Forest habitat type. Mitigation should focus on protecting the existing habitat. Riparian habitat occurs in close association with the river and the resulting lush vegetation makes it highly preferred forage for livestock. Moreover, its proximity to the river makes it attractive to people for camping and other forms of recreation. Consequently, much of the area comprising this habitat type is very disturbed, and protection should improve the quality of the cover and forage for understory species represented by the Song Sparrow and Mule Deer. Removing livestock through fencing should permit the vegetation to recover. Removing human disturbances will be difficult except in locations where roads can be gated.

Table 6.27
Estimated Mitigation Costs for Grassland

Item	Grey Mountain Project (351 ac)	Poudre Project (280 ac)
Purchase Land ($1,200 per acre)	$ 424,800	$ 336,000
Fence/Gates ($2,400 per mile)	7,050	6,275
Burn ($16 per acre)	5,664	4,480
Fertilize ($40 per acre)	14,160	11,200
Seed ($75 per acre)	26,550	21,000
Total	$ 478,224	$ 378,955

Mitigation for cavity nesting species represented by the Black-capped Chickadee would involve placement of nest boxes in the Riparian Forest. This forest type does not have a sufficient density of snags to provide optimum habitat for cavity nesting wildlife. Nest boxes could be used to supplement the existing snags to achieve optimum habitat quality. Nest boxes would be removed as the stands age and snag density naturally approaches an optimum condition for wildlife. Removal of nest boxes would decrease annual maintenance costs.

The estimated cost for Riparian Forest mitigation is $282,509 for the Grey Mountain alternative compared to $228,502 for the Poudre alternative (Table 6.28).

6.6.2.6 **Riparian Shrub and Grassland**

Approximately 17 and 13 acres of Riparian shrub habitat would be affected if the Grey Mountain or Poudre alternatives were constructed, respectively. Although over 100 acres of this habitat type occurs outside the project area for possible mitigation, the habitat quality is currently near optimum condition for the evaluation species selected by the HEP team. Consequently, mitigation costs would be disproportionately high for a small improvement of habitat quality.

Consequently, mitigation should center on the establishment of Riparian Shrub habitat in new areas. Placement and irrigation of suitable plants would be necessary to establish new areas of this habitat type. Sites with relatively flat topography and seasonally moist soils should be targeted for irrigation. These sites could be cleared of vegetation, fertilized, seeded, or planted, and configured for irrigation. Plants should be riparian species including willow and other native species. Irrigation should continue until plants are old enough to be naturally sustained. It is estimated that 21 to 26 acres, irrigated for 2 to 5 years, should be sufficient for mitigation. Approximately 8 to 9 acres of the total area should also be planted with grasses to offset the effects on the Riparian Grassland habitat type from the project, since the amount of this type that would remain in the study area if the projects were built is too small to fulfill the mitigation requirements. These newly established areas of habitat should be initially fenced from deer and permanently fenced from livestock to ensure that plants develop and become self-sustaining for the life of the project.

Table 6.28

Estimated Mitigation Costs for Riparian Forest

Item	Grey Mountain Project (135 ac)	Poudre Project (109 ac)
Purchase Land ($2,000 per acre)	$ 270,000	$ 218,000
Fence/Gates ($2,400 per mile)	4,409	3,962
Next Boxes ($12 per box at 5 per acre)	8,100	6,540
Total	$ 282,509	$ 228,502

The estimated cost for mitigating the Riparian Shrub and Grassland habitat types is $222,935 for the Grey Mountain alternative compared to $180,239 for the Poudre alternative (Table 6.29).

6.6.2.7 **Riverine**

If the Grey Mountain Dam alternative is constructed, approximately 344 acres of Riverine habitat would have to be acquired to offset the effects on habitat for aquatic furbearers and other river-related wildlife. Construction of the Poudre Dam alternative would require acquisition of 226 acres to compensate for project effects. The amount of area potentially available for mitigation, however, is insufficient, since less than 80 acres of Riverine habitat would exist in the study area if either project alternative was constructed.

The Beaver and Great Blue Heron were selected by the HEP team to evaluate effects of the project alternative on Riverine habitat. These species represent wildlife that require riparian habitat in association with a river. The Beaver was selected to target species that utilize the shrub vegetation layer, while the Great Blue Heron was selected to focus on species that nest in mature trees in riparian habitat. Since these habitat associations would be uncommon if either project alternative is constructed, the mitigation options would be largely limited to those of improving or establishing riparian habitat as identified in subsection 6.6.2.6.

Table 6.29

Estimated Mitigation Costs for Riparian Shrub and Grassland

Item	Grey Mountain Project (26 ac)	Poudre Project (21 ac)
Purchase Land ($2,000 per acre)	$ 52,000	$ 42,000
Fencing ($2,400 per mile)	1,935	1,739
Irrigate ($6,500 per acre)(1)	169,000	136,500
Total	$ 222,935	$ 180,239

(1) Cost includes irrigation system, site preparation, plant material, plus a contingency for 30 percent plant mortality. Costs were provided by the U.S. Army Corps of Engineers based on irrigation systems it operates for wildlife mitigation (Christianson, 1988).

Wildlife represented by the Beaver and Great Blue Heron would benefit from the proposed mitigation actions for Riparian Shrub and Forest habitats located near waterbodies. Benefits would be greatest if the sites selected for mitigation were closely associated with the free-flowing sections of the river that would occur outside the project areas. Some benefit would also occur to wildlife at sites located along the proposed reservoir, particularly where the water depth near riparian habitat is sufficiently shallow for wading birds to feed. Riparian habitat located away from waterbodies such as the ephemeral streams at Hook and Glade would not be suitable for mitigation because the habitat would not fit the habitat configuration affected by the project. Completion of offsetting the mitigation debt for wildlife associated with Riverine habitat may be possible by improving habitat for other species such as bald eagles and osprey which utilize the Riparian Forest-water complex of habitats.

As discussed in Section 6.4.1.1, Bald Eagles winter along the Poudre River in the project areas. Osprey have also been observed along the river, outside the study area during the summer, and they probably use the river in the project areas. These species utilize the river for foraging and typically perch on large trees with dead tops situated along the river. Several mitigation actions could be implemented to improve habitat for these species, since studies have shown that bald eagles and ospreys will use reservoirs (Brueggeman et al., 1988). Perching sites could be established by topping live trees or placing artificial structures (i.e., poles with crossbars) along the reservoir. These structures or tree tops would also provide a platform for osprey to nest. It is recommended that ten new perching/nesting sites be established to supplement the large trees that would border the reservoir if either project alternative is constructed.

The estimated cost for Riverine mitigation is $1,000 for either the Grey Mountain or Poudre alternatives.

6.6.2.8 **Monitoring Programs**

A monitoring program should be established to evaluate the mitigation plan selected for implementation. It is estimated that $50,000 would be necessary for monitoring each year for the first five years of operation, and for every fifth year thereafter for the following twenty years. Monitoring should then be performed every tenth year for the remaining 50-year assumed life of the FERC license. The total cost of the monitoring program is estimated to be $550,000.

6.6.2.9 **Summary**

In summary, the total estimated cost for wildlife mitigation is $6,631,039 for the Grey Mountain alternative and $5,547,830 for the Poudre alternative (Tables 6.30 and 6.31). Mitigation costs could possibly be substantially reduced if land could be leased instead of purchased.

Table 6.30

Total Estimated Wildlife Mitigation Costs

Habitat Type	Grey Mountain Project	Poudre Project
Closed Canopy Forest	$ 40,636	$ 36,926
Open Canopy Forest	201,660	160,327
Mountain Shrub	4,854,075	4,011,881
Grassland	478,224	378,955
Riparian Forest	282,509	228,502
Riparian Shrub and Grassland	222,935	180,239
Riverine	1,000	1,000
Monitoring Program	550,000	550,000
Total(1)	$ 6,631,039	$ 5,547,830

(1) Does not include escalation.

Table 6.31

Summary of Estimated Wildlife Mitigation Costs

Item	Grey Mountain Project	Poudre Project
Purchase Land	$5,798,920	$4,764,920
Fence/Gate	44,985	40,730
Nest Boxes	20,760	18,000
Irrigation	169,000	136,500
Burn	5,664	4,480
Fertilize	14,160	11,200
Seed	26,550	21,000
Perching/Nesting Structures	1,000	1,000
Subtotal	6,081,039	4,997,830
Monitoring Program	550,000	550,000
Total(1)	$ 6,631,039	$ 5,547,830

(1) Does not include escalation.

6.7 REFERENCES

Allen, A.W. 1983. Habitat suitability index models: Beaver. U.S. Fish Wildl. Serv. FWS/OBS-82/10.30 Revised. 20 pp.

Anderson, A.E. 1972. Summary of results of the Poudre deer study. W-105-R, Colo. Div. Wildl. 23 pp.

Anderson, A.E. and D.E. Medin. 1967. The breeding season in migratory mule deer. Colorado Game Fish and Parks Dept. Game Info. Leafl., No. 60, 4 pp.

Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A Land Use and Land Cover Classification for Use with Remote Sensor Data. U.S. Geological Survey Professional Paper 964.

Baldwin, P.H. 1976. Summary of birds recorded in the vicinity of the Fort Collins Filter Plant, 1952 to 1976. Unpubl. Rep. Dept. Zool., Colo. St. Univ., Ft. Collins.

Bayer, R.D. 1978. Aspects of an Oregon estuarine great blue heron population. Wading birds. Natl. Audubon Soc. Res. Rep. 7L213-217.

Bear, G.D. 1979. Evaluation of bighorn transplants in two Colorado localities. Colo. Div. Wildl. Spec. Rep., No. 45 12 pp.

Berg, E. 1986. Summary report of the fall 1986 terrestrial studies for the Cache la Poudre Water and Power Project. Prepared for the Northern Colorado Water Conservancy District. Loveland, Colorado.

Biastock, Bill. 1988. Personal communication. U.S. Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Telephone conversation with A.D. Every (Envirosphere Co.), January 29, 1988.

Brewer, R. 1963. Ecological and reproductive relationships of black-capped and Carolina chickadees. Auk 80(1):9-47.

Beier, P. and R.H. Barrett. 1987. Beaver habitat use and impact in Truckee River Basin, California. J. Wildl. Manage. 51(4):794-799.

Brown, L., and D. Amadon. 1968. Eagles, Hawks and Falcons of the World, Parts 1 and 2. McGraw-Hill Book Co., New York, NY. 945 pp.

Brueggeman, J.J., A.D. Every, and M.C. McShane. 1986. Wildlife Habitat Studies, Cowlitz River hydro project. Prepared for City of Tacoma Light Division.

Brueggeman, J.J, M.C. McShane, A.D. Every, J.A. Knutzen, and R.W. Tressler. 1988. Study of Skagit Dams original impacts on wildlife and fish habitats and populations. Prepared for Seattle City Light.

Burleigh, T.D. 1958. Georgia birds. Univ. Oklahoma Press, Norman. 76 pp.

Canfield, R.H. 1941. Application of the line-intercept method in sampling range vegetation. J. For. 39:388-394.

Christianson, C. 1988. Personal communication. U.S. Army Corps of Engineers, Washington. Telephone conversation with G. Green (Envirosphere Co.), August 1988.

Colorado Division of Wildlife. 1978. Essential habitat for threatened and endangered wildlife in Colorado. Denver, Colorado. 84 pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Botanical Services Program, FWS/OBS-79/31.

Craig, G. 1986. Personal communication. Colorado Division of Wildlife, Fort Collins Colorado. Telephone conversation with E. Berg (Wildlife Management Consultants), November 1986.

Craig, G. 1988. Personal communication. Colorado Division of Wildlife, Fort Collins, Colorado. Telephone conversation with J.J. Brueggeman (Envirosphere Co.), January 1988.

Crane, M.F. 1982. Fire ecology of Rocky Mountain Forest habitat types. Final Report to USDA Forest Service, Region Two. Contract No. 43-82X9-1-884.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33:43-46.

Dorrance, M.J. 1965. Behavior of Rocky Mountain mule deer on winter and summer ranges. M.S. Thesis. Colo. St. Univ., Ft. Collins. 136 pp.

Elblad, W. 1988. Personal communication. Colorado Division of Wildlife, Colorado. Telephone conversation with J.J. Brueggeman (Envirosphere Co.), August 1988.

Field, R.J. 1970. Winter habits of the river otter in Michigan. Michigan Academician. 3:49-58.

Fish and Wildlife Service. 1978. Habitat suitability index models: Song sparrow in deciduous woodlands, Ecoregion 2410, Draft. U.S. Dept. Int., Fish Wildl. Serv.

Fish and Wildlife Service. 1982. Habitat suitability index models: Mule deer. Draft. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS.

Fish and Wildlife Service. 1985. A users manual for HEP accounting program for microcomputer users, version 2. Fort Collins, Colorado.

Fish and Wildlife Service. 1987. Micro-HSI version 2 users manual. National Ecology Center, Fort Collins, Colorado.

Forest Service. 1984. The Arapaho and Roosevelt National Forests Land and Resource Management Plan. Rocky Mountain Region, USDA Forest Service.

Ganskopp, D. and M. Vavra. 1987. Slope use by cattle, feral horses, deer, and bighorn sheep. Northwest Science 61(2):74-81.

Goodsen, N.F. 1980. Bighorn sheep in north-central Colorado: Past, present, and future. Pages 190-209. In: Proc. of the Biennial Symposium of the North America Wild Sheep and Goat Council.

Hammerson, G.A. 1982. Amphibians and reptiles in Colorado. Colo. Div. of Wildl., Denver. 130 pp.

Harza. 1987. Cache la Poudre Basin study and hydropower resources report. Prepared for the Colorado Water Resources and Power Development Authority. Denver, Colorado.

Hess, Karl, and Robert R. Alexander. 1986. Forest vegetation of the Arapaho and Roosevelt National Forests in Central Colorado: a habitat type classification. USDA Forest Service Research Paper RM-266, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Hodgson, A. 1988. Personal Communication. Colorado Division of Wildlife. Fort Collins, Colorado. Telephone Conversation with J.J. Brueggeman (Envirosphere Co.), February 12, 1988.

Hoover, R.L. and D.L. Wills, ed. 1984. Managing forested lands for wildlife. Colorado Division of Wildlife in Cooperation with USDA Forest Service, Rocky Mountain Region, Denver, Colorado. 459 pp.

Information Builders Inc. 1982. FOCUS User's Manual, 1982 Edition, Information Builders Inc., New York, NY.

Johnston, Barry, C. 1987. Plant Associations of Region Two, Edition 4, USDA Forest Service, Rocky Mountain Region, R2-ECOL-87-2, Lakewood, Colorado.

Kufeld, R.C. 1986. Winter habitat selection and activity patterns of mule deer in Front Range shrubland and forest habitats. CDOW Wildlife Report Project 01-03-047.

Laven, R.D., P.N. Omi, J.G. Wyant, and A.S. Pinkerton. 1980. Interpretation of fire scar data from a ponderosa pine ecosystem in the central Rocky Mountains, Colorado. In: Proc. of the Fire History Workshop, Tucson, Arizona. USDA Gen. Tech. Rep. RM-81. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colorado.

Lockhart, M. 1988. Personal communications. U.S. Fish and Wildl. Serv. Grand Junction, Colorado. Telephone conversation with J.J. Brueggeman (Envirosphere Co.), February 1988.

Loveless, C.M. 1963. Ecological characteristics of a selected mule deer winter range. Colo. Coop. Wildl. Res. Unit, Final Rep. of Environ. Studies. U.S. Atomic Energy Comm. 318 pp.

Loveless, C.M. 1967. Ecological characteristics of a deer winter range. Colo. Game, Fish and Parks Dept., Tech. Publ. No. 20. 124 pp.

Marr, John W. 1967. Ecosystems of the east slope of the Front Range in Colorado. University of Colorado Studies, Series in Biology, No. 8. 134 pp. University of Colorado Press. Boulder, Colorado.

Martin, R.C., L.A. Mohrhoff, J.E. Chaney, and S. Sather-Blair. 1985. Status review of wildlife mitigation at Columbia Basin hydroelectric projects, Idaho facilities. Final report. Idaho Department of Fish and Game and Fish and Wildlife Service, Boise, Idaho.

McCullough, S. n.d. Habitat suitability index models: Abert squirrel. Colorado State University, Fort Collins, Colorado.

Medin, D.E. 1976. Modelling the dynamics of a Colorado mule deer population. Ph.D. Thesis. Colorado State Univ., Fort Collins. 167 pp.

Miller, A.H. 1942. Habitat selection among high vertebrates and its relation to intraspecific variations. Am. Nat. 76:25-35.

Miller, R.F. 1943. The great blue herons: the breeding birds of the Philadelphia region (Part II) Cassinia 33:1-23.

Moser, C. 1962. The bighorn sheep of Colorado. Colo. Game and Fish Dept., Tech. Bull. No. 10, 49 pp.

Odum, E.P. 1941a. Annual cycle of the black-capped chickadee - I. Auk 58(3):314-333.

Odum, E.P. 1941b. Annual cycle of the black-capped chickadee - II. Auk 59(4):499-531.

Olendorff, R.R. 1973. The ecology of the nesting birds of prey of northeastern Colorado. Int. Biol. Program Grassland Biom. Tech. Rep. 211, 233 pp.

Olendorff, R.R. 1976. The food habits of North American golden eagles. Am. Midl. Nat. 95(1):231-236.

Patton, D.R. 1975. Abert squirrel cover requirements in southwestern ponderosa pine. USDA Forest Service Research Paper RM 145. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Ramaley, F. 1927. Colorado Plant Life. University of Colorado Press. Boulder, Colorado.

Rhodes, M.J., T.J. Cloud, and D. Haag. 1983. Habitat evaluation procedures for planning surface mine reclamation in Texas. Wildl. Soc. Bull. 11:222-232.

Roberts, L.D. 1983. Riparian habitat in the proposed Grey Rocks reservoir. M.S. Thesis. Colo. St. Univ., Ft. Collins. 135 pp.

Rocky Mountain Bighorn Society. 1984. A guide to sheep hunting in Colorado. Denver, CO.

Rost, G.R. and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. J. Wild. Manage. 43(3);634-641.

Rutherford, W.H. 1964. The beaver in Colorado, its biology, ecology, management and economics. Technical Publication Number 17. Game Research Division. Colorado Game, Fish, and Parks Department.

Schamberger, M. and A. Farmer. 1978. The habitat evaluation procedure; their application in project planning and impact evaluation. Trans. N. Am. Wildl. and Nat. Resour. Conf. 45:274-283.

Schoonveld, G. 1986. Personal communications. Senior Biologist. Colorado Division of Wildlife, Fort Collins, Colorado. Telephone conversation with E. Berg (Wildlife Management Consultants), November 1986.

Schroeder, R.L. 1983. Habitat suitability index models: Black-capped chickadee. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.37. 12 pp,

Schroeder, R.L. and P.J. Sousa. 1982. Habitat suitability index models: Eastern meadowlark. U.S. Dept. Int., Fish and Wildl. Serv. FWS/OBS-82/10.29.

Short, J.L. and R.J. Cooper. 1985. Habitat suitability index models: Great blue heron. U.S. Fish and Wildl. Serv. Biol. Rep. 82(10.99). 23 pp.

Siglin, R.J. 1965. Seasonal movements of mule deer in the Cache la Poudre drainage. M.S. Thesis, Colo. St. Univ., Ft. Collins, CO.

Simmons, N.M. 1961. Daily and seasonal movements of Poudre River bighorn sheep. M.S. Thesis. Colo. St. Univ., Ft. Collins. 179 pp.

Slough, B.G., and R.M.F.S. Sadleir. 1977. A land capability classification system for beaver (Caster Canadensis). Can. J. Zool. 55(8): 1324-1335.

Stallmaster, M.V., and J.A. Gessaman. 1984. Ecological energetics and foraging behavior of overwintering bald eagles. Ecological Monographs. 54:407-428.

Thomas, J.W., R.J. Miller, H. Black, J.E. Rodick, and C. Maser. 1976. Guidelines for maintaining and enhancing wildlife habitat in forest management in the Blue Mountains of Oregon and Washington. Trans. N. Am. Wildl. Nat. Resour. Conf. 41:452-476.

Thomas, J.W. 1979. Wildlife habitats in managed forests: The Blue Mountains of Oregon and Washington. U.S. Department of Agriculture, Forest Service. Agriculture Handbook No. 554. 512 pp.

Thomas, J.W., R.J. Miller, H. Black, J.E. Rodiek, and C. Maser. 1976. Guidelines for maintaining and enhancing wildlife habitat in forest management in the Blue Mountains of Oregon and Washington. Trans. N. Am. Wildl. Nat. Resour. Conf. 41:452-476.

Tilton, M.E., and E.E. Willard. 1982. Winter habitat selection by mountain sheep. J. Wildl. Manage. 46:359-366.

Tompa, F.S. 1964. Factors determine the numbers of song sparrows, Melospiza melodia (Wilson), on Mandarte Island, British Columbia, Canada. Actu. Zool. Fenn. 109:1-73.

Urich, D.L. and J.P. Graham. 1983. Applying habitat evaluation procedures (HEP) to wildlife area planning in Missouri. Wildl. Soc. Bull. 11:215-221.

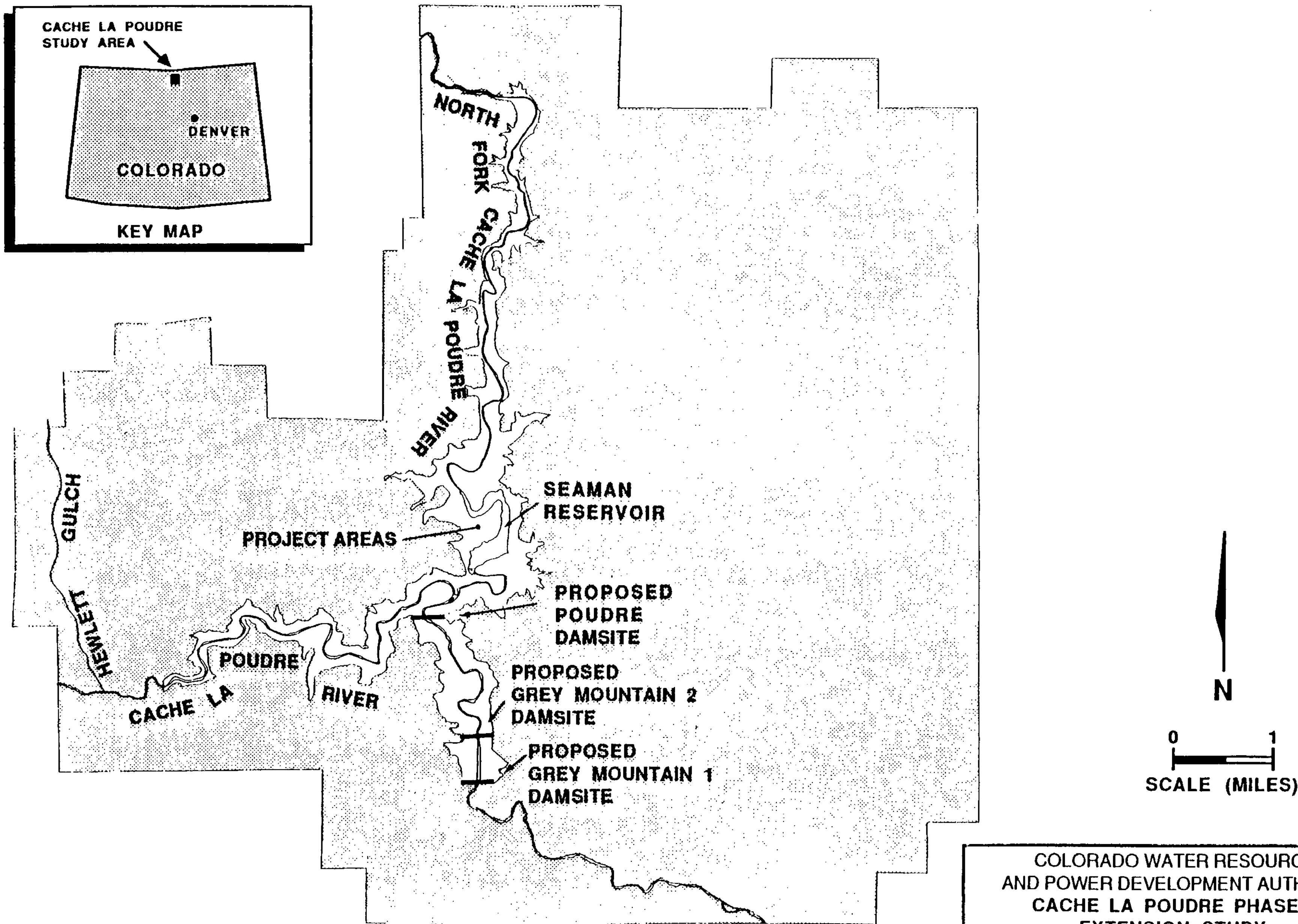
Verner, J. and A.S. Boss, technical coordinators. 1980. California wildlife and their habitats: Western Sierra Nevada. Gen. Tech. Rep. PSW-37, 439 p. Pacific Southwest Forest and Range Exp. Stn. Forest Serv., U.S. Dep. Agric., Berkeley, Calif.

Wakelyn, L.A. 1984. Analysis and comparison of existing and historic bighorn sheep ranges in Colorado. M.S. Thesis. Colo. St. Univ., Ft. Collins. 274 pp.

Wallmo, O.C. and W.L. Regelin. 1981. Rocky Mountain and intermountain habitats. Part 1. Food habits and nutrition. Pages 387-398. In: Wallmo, O.C. (ed.) Mule and black-tailed deer of North America. Univ. Neb. Press, Lincoln, 605 pp.

Weber, W.A. 1976. Rocky Mountain flora. Colorado Associated University Press. Boulder, Colorado.

Winkler, F. 1988. Personal communication. U.S. Forest Service, Arapaho-Roosevelt National Forest, Fort Collins, Colorado. Telephone conversation with A.D. Every (Envirosphere Co.), February 4, 1988.



GREY MOUNTAIN 1 DAMSITE
IS DEFINED IN PRELIMINARY PERMIT

GREY MOUNTAIN 2 DAMSITE IS DEFINED
IN CWRPDA BASIN STUDY (Harza, 1987)

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

STUDY AREA

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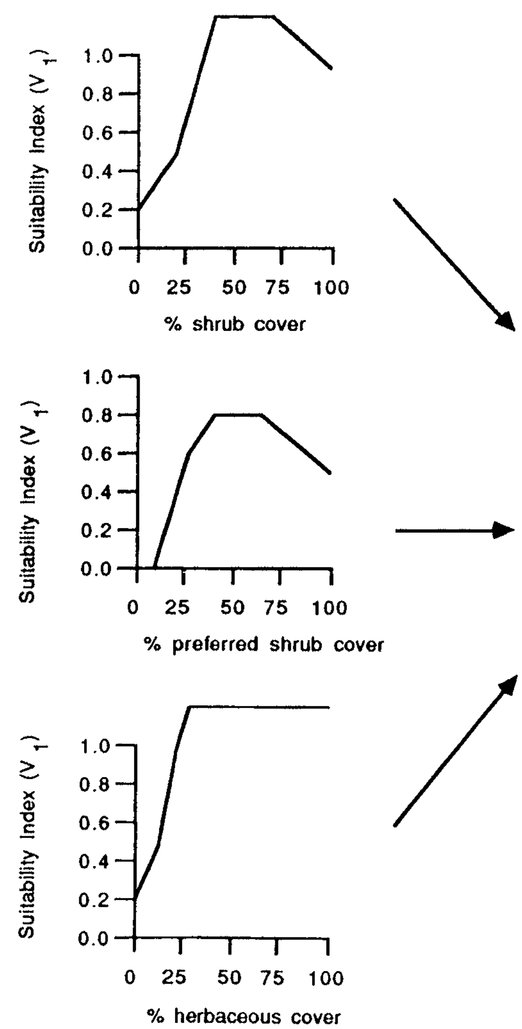
FIGURE 6.1

FIELD DATA | SUITABILITY INDEX CURVE | HSI CALCULATION

SHRUB COVER (V_1)

COVER OF SHRUBS PREFERRED BY MULE DEER (V_2)

HERBACEOUS COVER (V_3)



$$HSI = \frac{3(V_1 \times V_2)^{1/2} + V_3}{4}$$

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE PHASE I EXTENSION STUDY

EXAMPLE OF HABITAT SUITABILITY INDEX DETERMINATION (MULE DEER)

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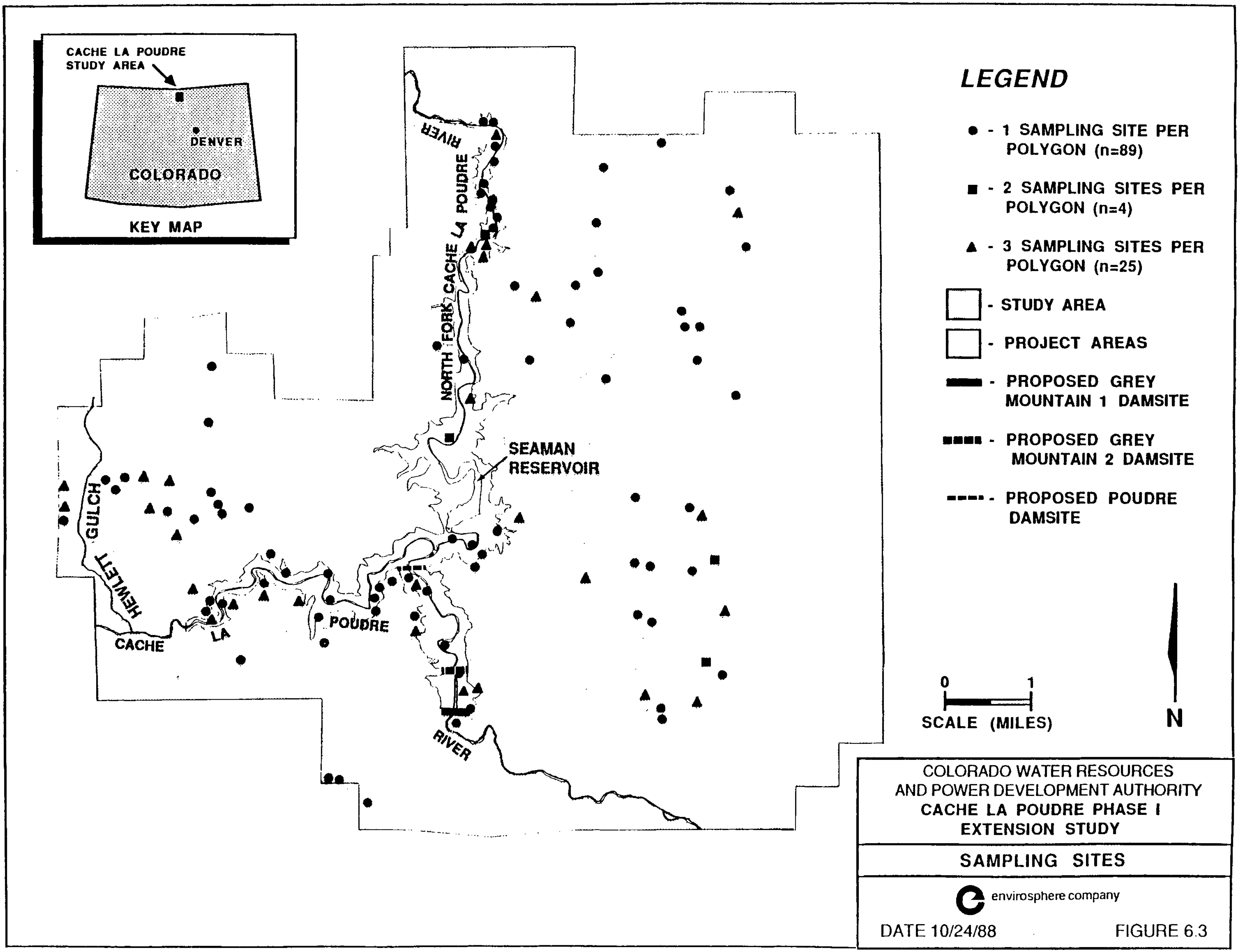
FIGURE 6.2



COLORADO WATER RESOURCES
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CACHE LA POUDRE PHASE I
EXTENSION STUDY

SAMPLING SITES

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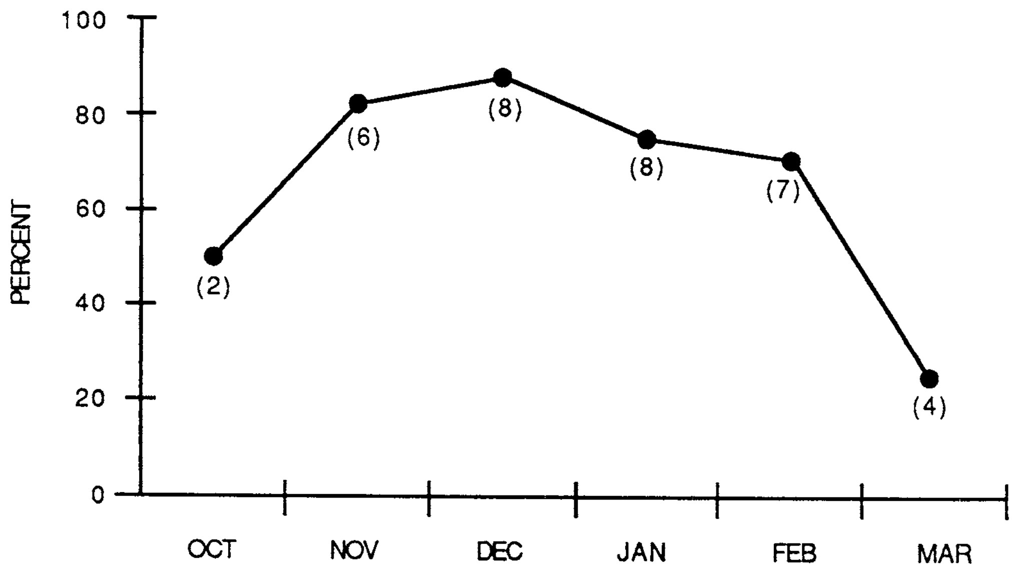

Parenthesis designates number of survey days.

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE PHASE I EXTENSION STUDY

PERCENT OF SURVEY DAYS BALD EAGLES WERE OBSERVED ON THE MAINSTEM AND NORTH FORK OF THE CACHE LA POUDRE RIVER

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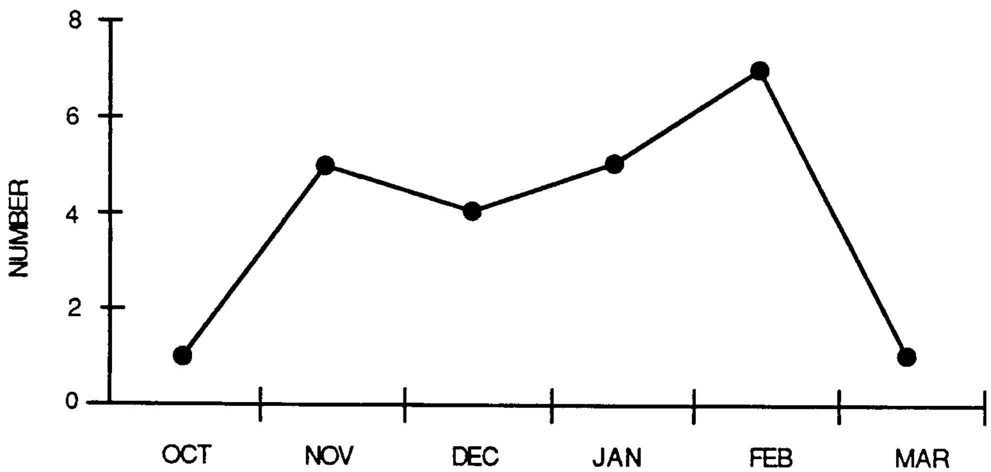
FIGURE 6.4



COLORADO WATER RESOURCES
AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE PHASE I
EXTENSION STUDY

MAXIMUM NUMBER OF BALD EAGLES
OBSERVED ON THE MAINSTEM AND NORTH FORK
OF THE CACHE LA POUDRE RIVER, 1986-1987

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DATE 10/24/88

FIGURE 6.5

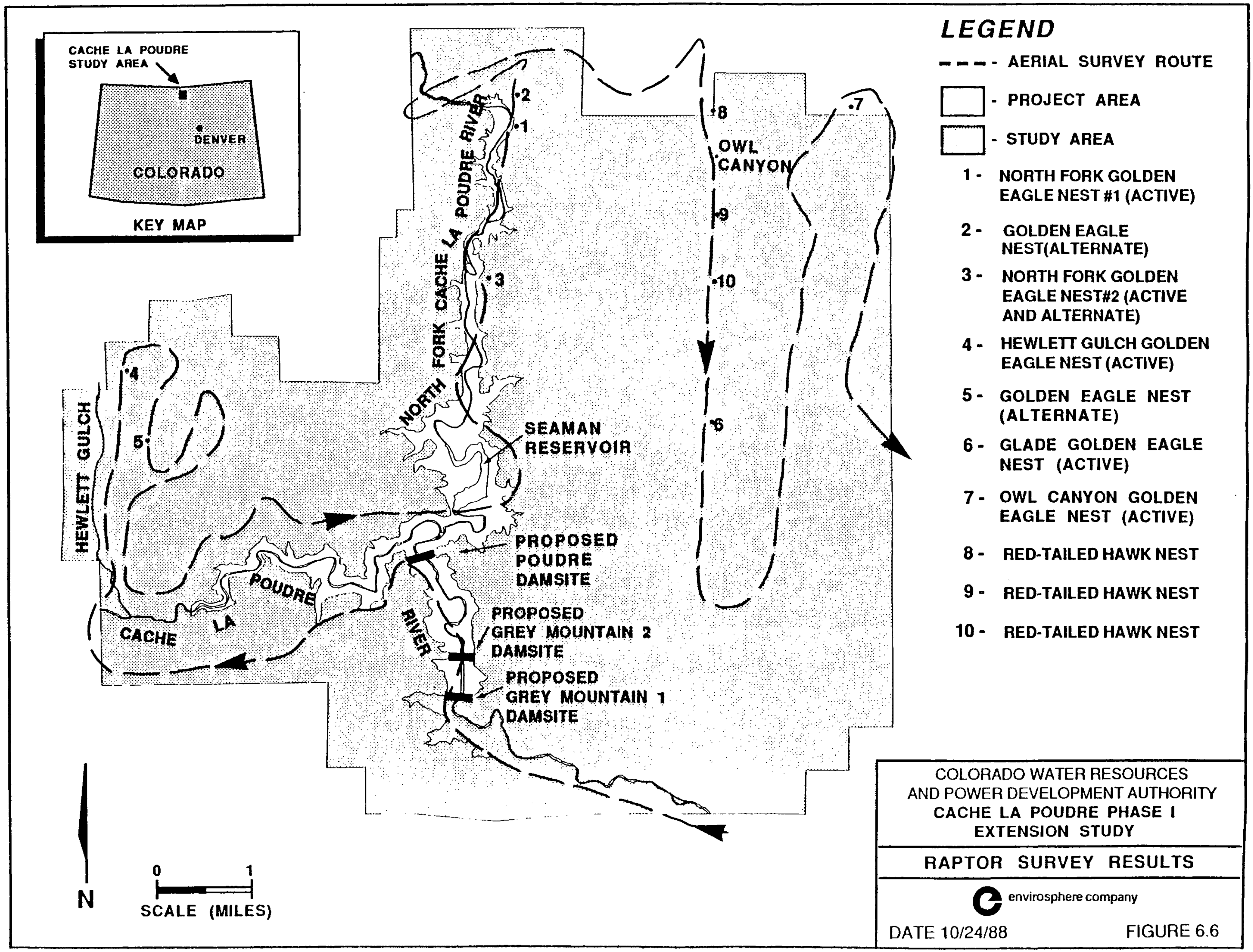
CACHE LA POUDRE STUDY AREA
DENVER
COLORADO
KEY MAP
LEGEND
AERIAL SURVEY ROUTE
PROJECT AREA
STUDY AREA
1 - NORTH FORK GOLDEN EAGLE NEST #1 (ACTIVE)
2 - GOLDEN EAGLE NEST(ALTERNATE)
3 - NORTH FORK GOLDEN EAGLE NEST#2 (ACTIVE AND ALTERNATE)
4 - HEWLETT GULCH GOLDEN EAGLE NEST (ACTIVE)
5 - GOLDEN EAGLE NEST (ALTERNATE)
6 - GLADE GOLDEN EAGLE NEST (ACTIVE)
7 - OWL CANYON GOLDEN EAGLE NEST (ACTIVE)
8 - RED-TAILED HAWK NEST
9 - RED-TAILED HAWK NEST
10 - RED-TAILED HAWK NEST
NORTH FORK CACHE LA POUDRE RIVER
OWL CANYON
SEAMAN RESERVOIR
HEWLETT GULCH
PROPOSED POUDRE DAMSITE
PROPOSED GREY MOUNTAIN 2 DAMSITE
PROPOSED GREY MOUNTAIN 1 DAMSITE
CACHE LA POUDRE RIVER
N
0
1
SCALE (MILES)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE PHASE I EXTENSION STUDY
RAPTOR SURVEY RESULTS
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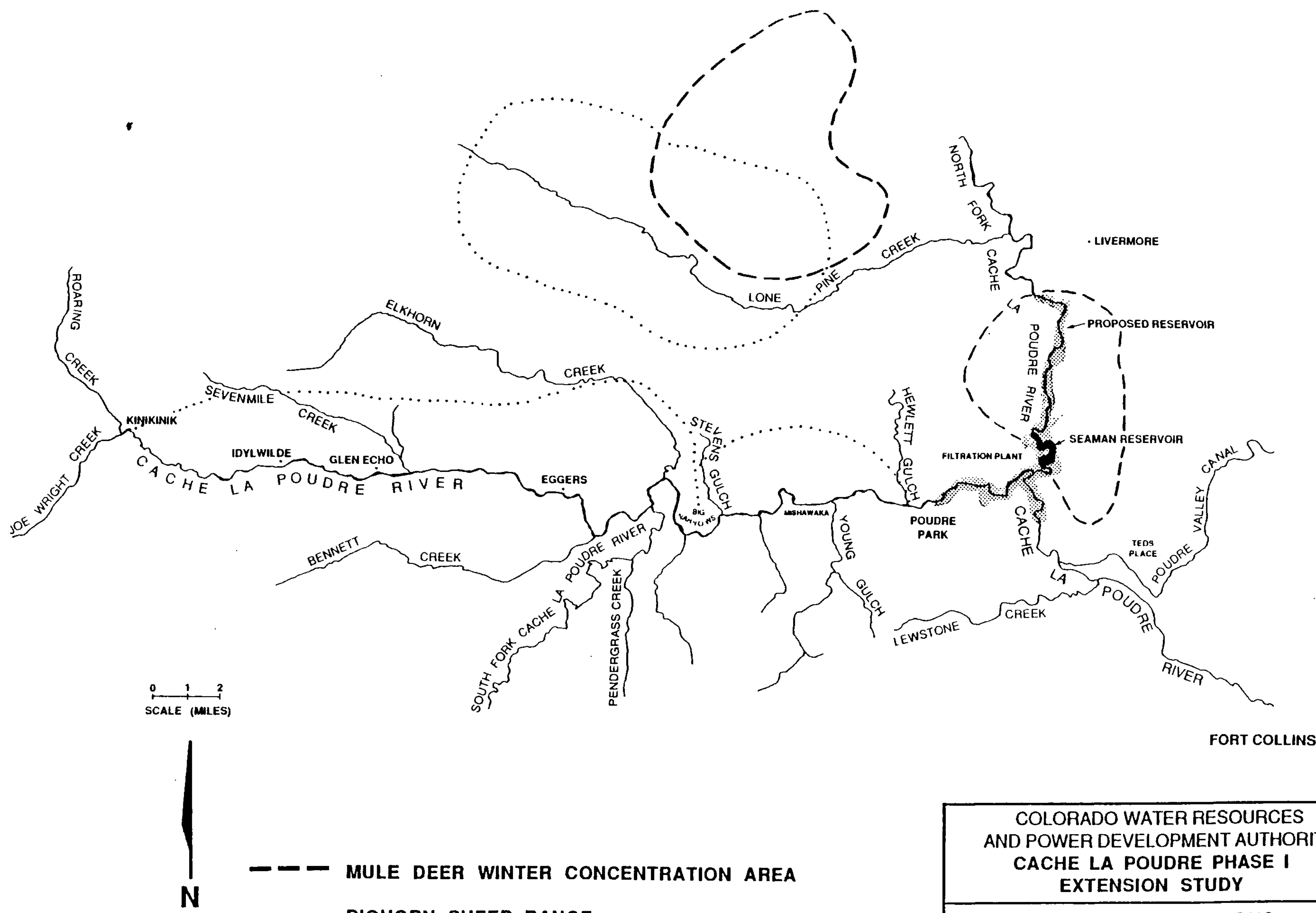
FIGURE 6.6



MULE DEER WINTER CONCENTRATION AREA

BIGHORN SHEEP RANGE

(All boundaries are approximate)

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

BIG GAME LOCATIONS

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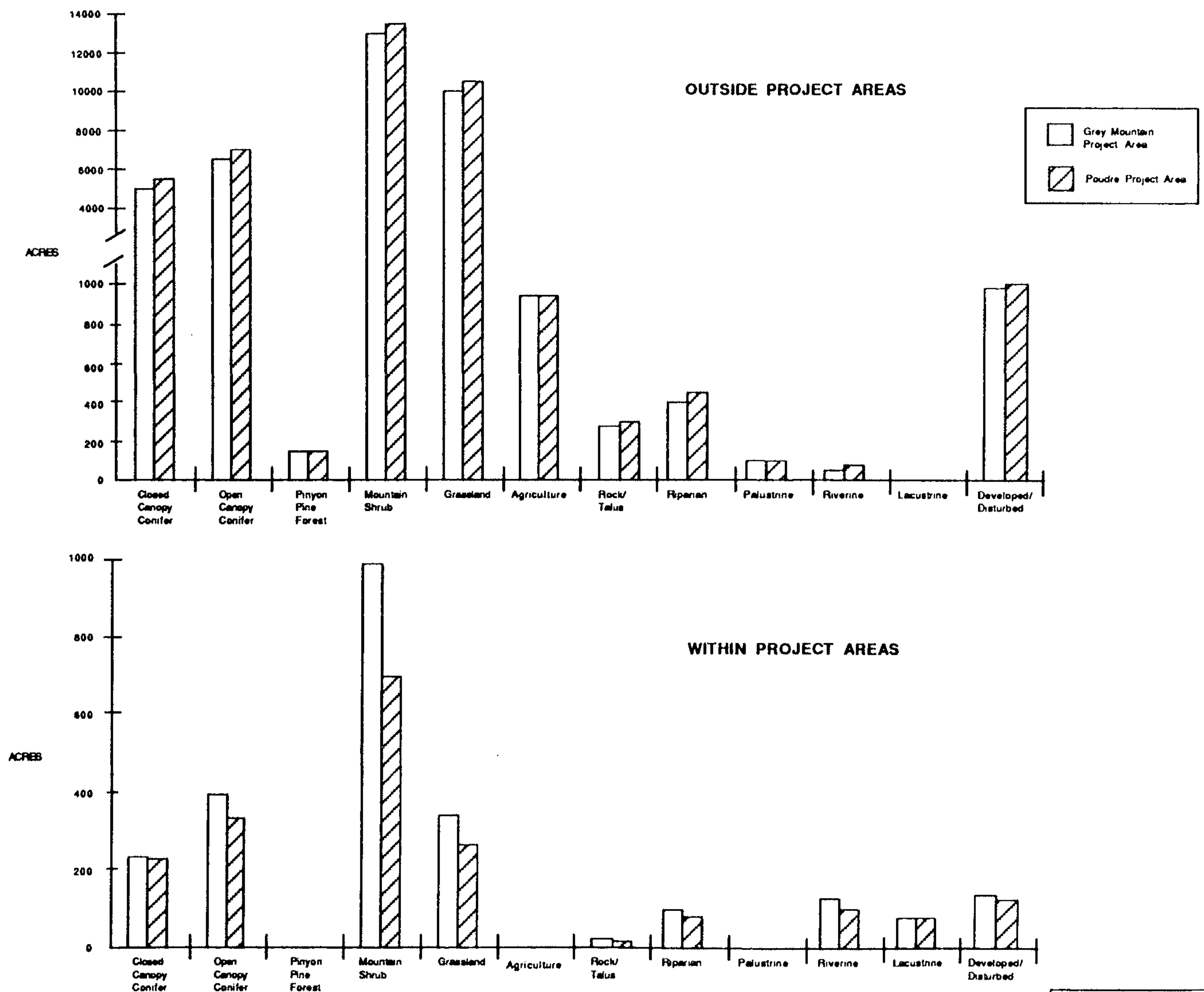
FIGURE 6.7



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AREA OF EXISTING HABITATS WITHIN AND OUTSIDE THE PROJECT AREAS

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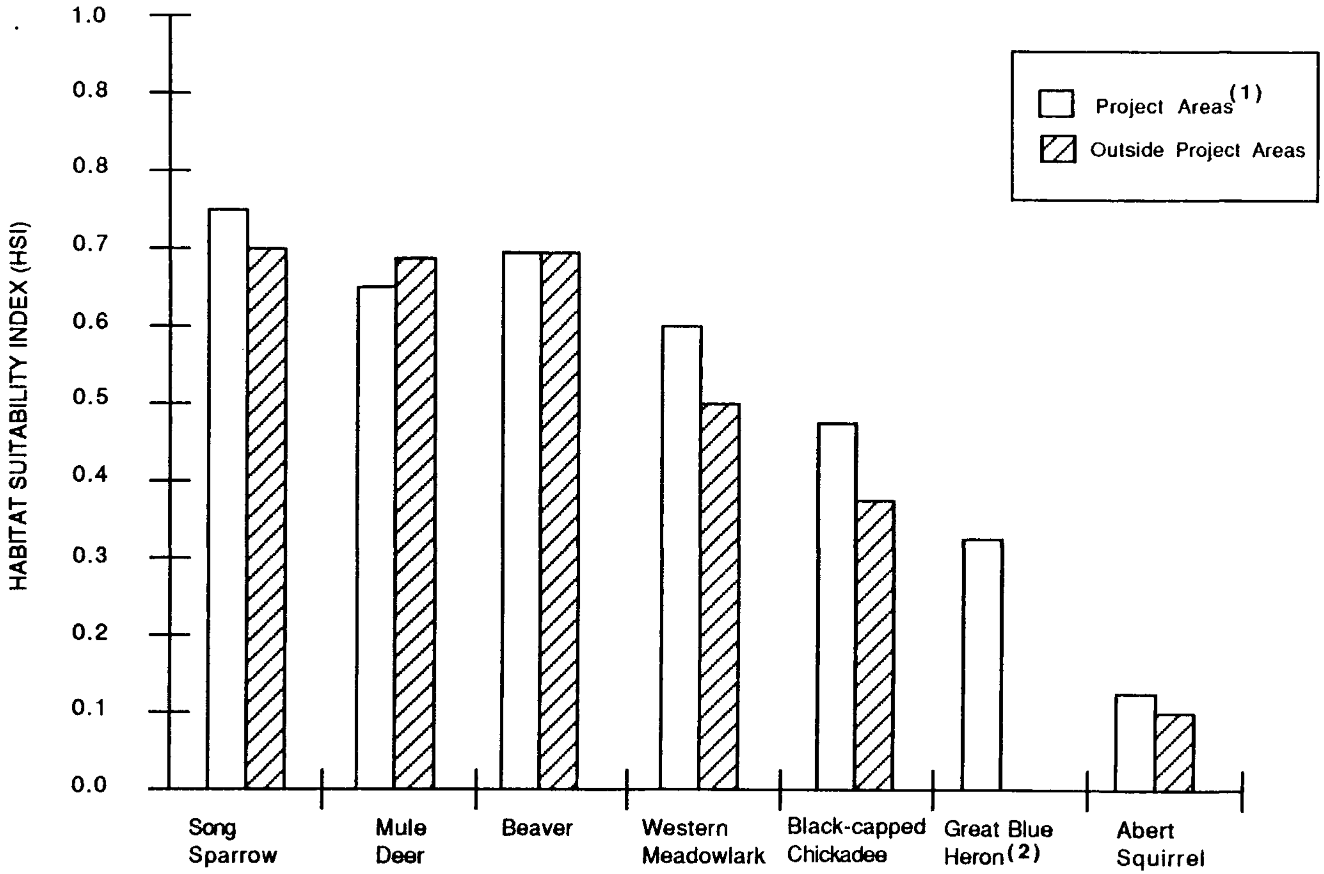
FIGURE 6 8



(1) Habitat quality is essentially identical for all species in both the Grey Mountain and Poudre project areas
(2) No Great Blue Heron habitat outside project areas

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CACHE LA POUDRE STUDY AREA HABITAT QUALITY

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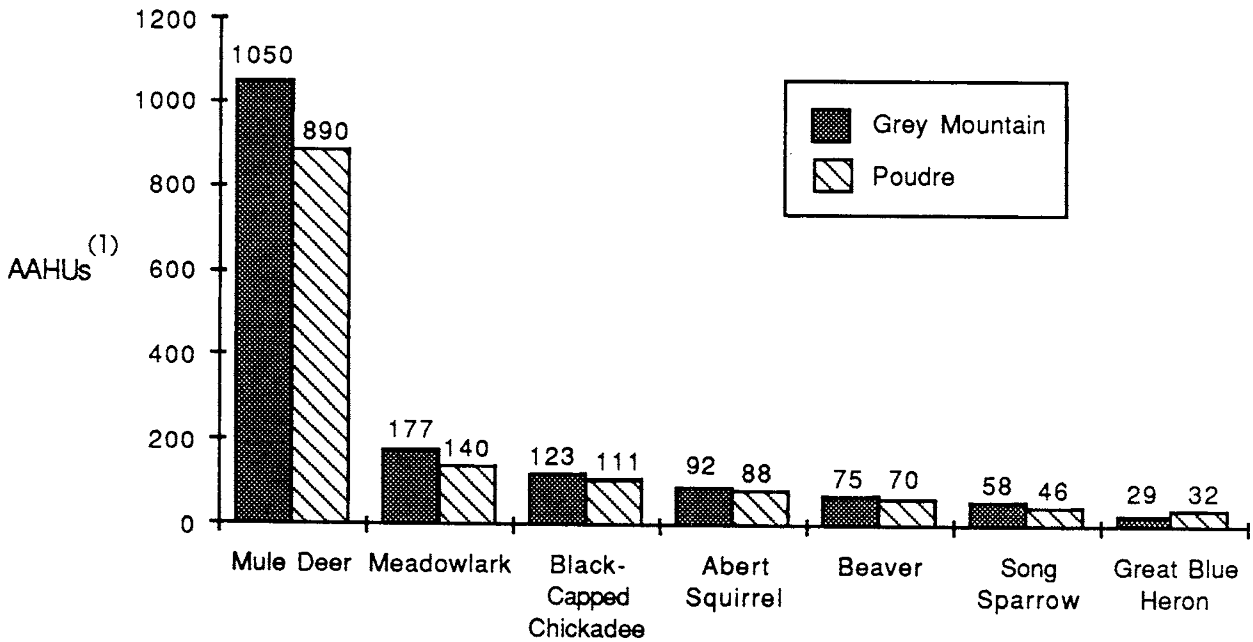
FIGURE 6.9



(1) Exact number of AAHUs for each species is indicated for each alternative

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COMPARISON OF NET EFFECTS FROM THE GREY MOUNTAIN AND POUDRE ALTERNATIVES

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FIGURE 6.10