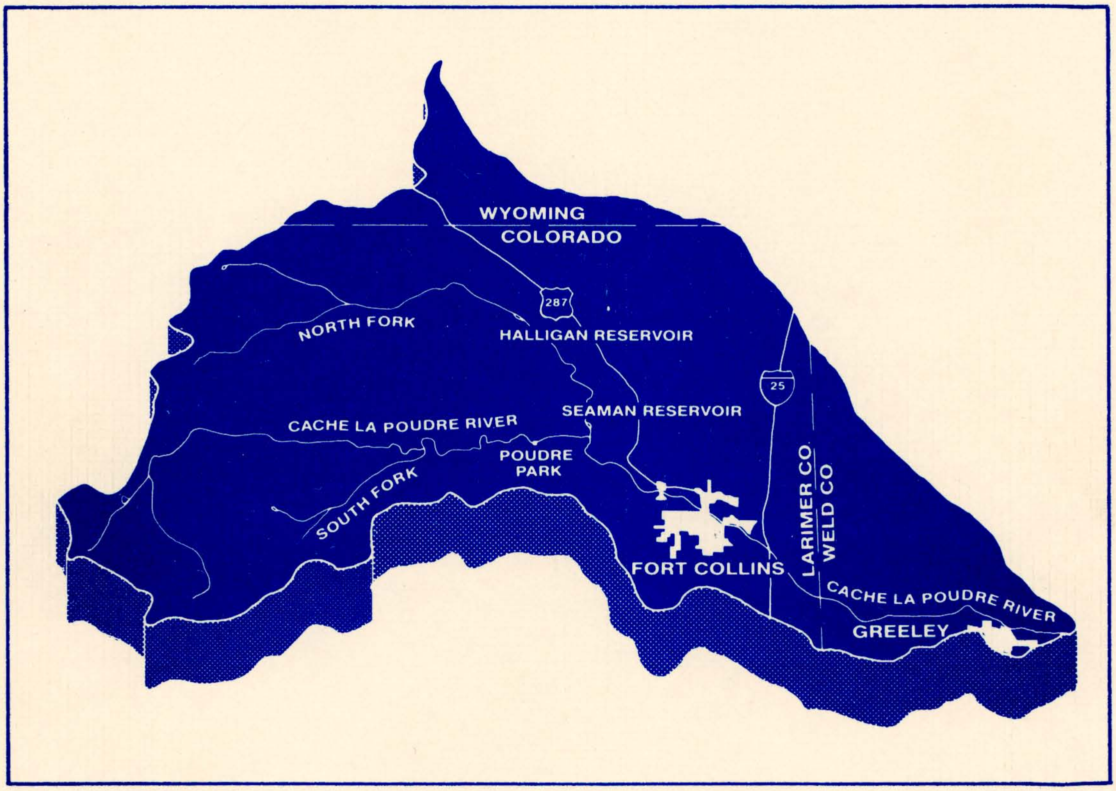
Cache la Poudre Basin Study

Final Report

Volume I



COLORADO WATER RESOURCES & POWER DEVELOPMENT AUTHORITY

1981

January 1987

HARZA ENGINEERING COMPANY CONSULTING ENGINEERS

January 30, 1987

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

Subject: Cache la Poudre Basin Study
Submittal of Volume I of the Final Report

Dear Mr. Kappus:

We are pleased to submit Volume I of a two volume Final Report on the Cache la Poudre Basin Study consistent with our contract dated June 7, 1985. Volume I contains findings from the Phase I portion of the Study which involved appraisal of available water resources and future demands. Volume II contains the findings from Phase II of the Study dealing with plan formulation, evaluation, and selection. A Summary Report on the entire study was issued in early January, 1987.

As described in Volume I, the Cache la Poudre Basin has sufficient water supply and storage facilities to satisfy water demand during a 1-in-10 year drought. However, water shortages will be experienced for more severe droughts. A 1-in-25 year drought, such as occurred in 1953 to 1956, will result in serious water shortages.

Municipalities and industry in the Basin are not presently subject to shortages because of policies which require acquisition of senior agricultural water rights as a prior condition for new urban development. To the extent that agricultural rights remain available for transfer, municipal and industrial water supplies should be adequate in the future.

Volume II describes the plan formulation and selection process. An extensive effort has been made to identify non-structural elements that could reduce the size and cost of structural measures needed to overcome water shortages. Shortages corresponding to a 1-in-25 year drought can be reduced by almost one-half with application of non-structural plan elements. Given the comparatively low cost of these measures, their importance cannot be over-emphasized.

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Two plans combining non-structural and structural elements have been recommended to the Authority as meriting further investigation. The preferred plan provides 274,000 acre-feet (af) of storage which, together with non-structural measures, could greatly reduce the effects of a 25-year drought. The plan includes construction of a 280-foot high roller-compacted concrete dam (Poudre) on the mainstem Cache la Poudre River just below the North Fork confluence, a 315-foot high rockfill dam (Glade) at an off-channel location about one mile north of Ted's Place, and a large pumped-storage hydroelectric facility. Twelve non-structural measures that involve conservation or better use of existing water resources are included in the plan. The direct cost of the structural elements of this plan, including the pumped-storage hydropower facility, is estimated to be $1.5 billion (January 1986 price level).

The alternative plan would provide about 156,000 af of storage in an initial stage which would provide an average annual yield of 29,000 af from native water and additional yields from Windy Gap and C-BT diversions. This plan includes construction of a 390-foot high concrete gravity dam on the mainstem at the Grey Mountain site, a large pumped-storage facility, and non-structural measures to conserve or better use available water resources. This plan could be expanded to 274,000 af of storage in the future. The direct cost of the structural elements of this plan, including hydroelectric power facilities, is estimated to be $1.3 billion.

Both plans include an 1800 megawatt pumped-storage hydroelectric project which could contribute significantly to payment of the water storage facilities if a market for this power develops in Colorado and adjacent states. Smaller pumped-storage facilities or staged construction of such facilities could be developed as market conditions dictate.

Both plans achieve an internal rate of return of approximately nine percent excluding inflation. Including inflation, these rates are on the order of 14 percent and are attractive in today's market place. However, to realize these rates of return, a market for this power must be identified.

Federal involvement in water project development has declined substantially. However, there may be future opportunities to facilitate financing of water projects with the joint development of pumped-storage hydropower in the Basin. A water project in the Basin may be financable through the sale of revenue bonds. Project implementation could be accomplished without pledging the local tax base.

We wish to express our appreciation for having had the opportunity to prepare the Basin Study. The scope and complexity of the assignment have made it a very interesting and challenging assignment for the Study Team.

We also wish to acknowledge the excellent support and guidance we have received from Blaine Dwyer P.E., your Project Manager, and from the Board. We look forward to any future opportunity to be of service to you.

Very truly yours,

R. J. Hunter, P.E.
Study Manager and
Vice President

FINAL REPORT

CACHE LA POUDRE BASIN WATER AND HYDROPOWER RESOURCES MANAGEMENT STUDY

VOLUME I

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Chapter 1

Introduction

1.0 INTRODUCTION

This report summarizes a 16-month-long study of water and hydropower resource development in the Cache la Poudre River Basin. The study was initiated by the Colorado Water Resources and Power Development Authority (Authority) in response to a study application from the Northern Colorado Water Conservancy District (NCWCD).

This introduction provides general study background, specific project objectives, and an overview of the study procedures. Authorization of the study and the role of the Authority are also described. The role of the public involvement program is discussed and the contributions of the Advisory Committee and the public are recognized. Finally, the organization of the Report is described.

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. To the north, a small portion of the Basin is situated in Wyoming, but is excluded from the present study. The Cache la Poudre River drains an area of almost 1,900 square miles consisting of two distinct components. The mountainous upper basin supplies the major surface water runoff from annual snowmelt. The lower basin is a plains area where the water is used by agriculture, municipalities, and industry.

The evolution of the Cache la Poudre Basin points to the importance of water resources and the need for the present Basin study. Since the area was originally settled, it has focused on agricultural production. As a result, extensive agricultural water supply systems have been developed to utilize the water resources of the Cache la Poudre River. The Cache la Poudre River is among the most carefully managed and controlled river systems in the western U.S. Partially because of these water supplies, northern Colorado is a top producer of corn, livestock and, historically, other agricultural commodities in Colorado and across the nation.

The sophisticated water supply system and the prosperous economy of northern Colorado were not achieved without considerable work and investment toward stabilizing water supplies during times of drought and flood. The facilities of the NCWCD and its role in the development of the Colorado-Big Thompson Project (C-BT) are prime examples of this commitment.

The NCWCD was formed in 1937, largely in response to the extended drought which was experienced in northern Colorado during the 1930s. Shortly after its formation, the NCWCD Board of Directors entered into a contract with the United States of America for the construction of the C-BT project. The project was to provide an average annual 310,000 acre feet (af) of supplemental water supplies and, secondarily, generate hydroelectric power. As part of this contract, the District promised to repay the United States $25 million over a 40 year period. Although the NCWCD boundaries only partially overlay those of the Basin, both the NCWCD and Basin interests have exhibited a tradition of vigilance and cooperation in optimizing use of their water resources.

1.2 PREVIOUS STUDIES

Intense interest in optimizing water resources has also been demonstrated by the numerous studies of the Cache la Poudre River Basin. These studies have explored a number of development possibilities and water resource issues.

U.S. Bureau of Reclamation (USBR) investigated the potential for additional water resource development on the Cache la Poudre River in 1928, 1954, 1959, and 1963. The 1963 USBR study focused on major structural facilities on the mainstem consisting of diversion dams, forebay reservoirs,and water conductors to produce conventional hydropower and to provide additional water supplies. The Idylwilde and Grey Mountain storage projects were identified in this USBR study.

In 1980, International Engineering Company performed a study of the Grey Mountain and Idylwilde projects which updated the USBR economic analysis, and identified environmental issues which had become important by 1980. Similar to the USBR study 20 years earlier, this work concluded that development was potentially viable and further feasibility analyses were desirable.

Water and conventional hydropower developments in the Cache la Poudre Basin were examined by Tudor Engineering Company in 1982 and 1983. As specified by the legislation authorizing the study, it was confined to the upper basin above the mouth of the Poudre Canyon. Non-structural measures and environmental issues were not addressed.

It is important to note that none of these previous studies considered the potential benefits of pumped-storage hydroelectric power.

Constraints on the previous studies and recent developments in the Basin have limited the applicability of these planning efforts to the current circumstances. Important developments include:

- The National Environmental Policy Act (NEPA). This act requires an in-depth examination of all environmental impacts and issues associated with most major water resource and power development projects prior to construction. NEPA requires public hearings and balanced evaluation of conflicting interests.

- The changing market for water. In recent years, northern Colorado cities have grown considerably while the agricultural community has experienced unfavorable economic conditions. It has become apparent that new municipal and industrial water supplies are obtainable from certain local farmers who must often sell their water rights because of financial difficulties. However, agriculture is still the largest water user in the Basin and remains an important factor in the socio-economic stability of the region. In fact, Weld County for the past decade has been one of the top ten counties in the U.S. in terms of agricultural production.

- The changing market for power. Previous studies included load growth projections which, in retrospect, were unrealistically high. Learning from these past projections, much more conservative demand assumptions are incorporated in this study.

- The diminished Federal role. The Federal government has recently indicated a declining interest in providing financial support for water resources development. As a result, funding will necessarily come from project beneficiaries and state or local governments.

- Existence of a project proponent. Energy Research Development Associates (ERDA) has publicly announced a plan to develop a major hydroelectric pumped-storage project in the Basin. Although ERDA is conducting their own studies and marketing efforts, the general layout and design parameters of ERDA's project have been considered in the Cache la Poudre Basin Study.

- Wild and Scenic River Designation. In the early 1980s, environmental groups vigorously opposed the idea of any dam in Poudre Canyon. In response to this, area Congressman Hank Brown brought contending factions together and forged an important compromise. This legislation is discussed in more detail in the closing paragraphs of this subsection.

- Recreational needs. Recreational activities in the Cache la Poudre Basin have grown with the population and a desire for increased recreational opportunities including fishing and boating. Given the perceived values of water-based recreation, any opportunities for enhancement as well as potential losses should be carefully considered for prospective Basin water resource development.

The above considerations helped guide the present Cache la Poudre River Basin planning study. Previous studies and analyses have been used as a starting point, incorporating useful data and information where possible.

Given its significance, the Wild and Scenic River Designation deserves further explanation. Under the authority of the Wild and Scenic Rivers Act, the U.S. Forest Service issued a draft environmental impact statement and report of April 8, 1980 relative to the upper 84 miles of the River Basin from the headwaters to the canyon mouth. Late in 1983, the Forest Service recommended 30 miles of wild river, 32 miles of recreational river, and no designation for the river segment encompassed in the proposed Idylwilde and Grey Mountain Reservoir sites.

Both environmental and and development interests were critical of this recommendation, prompting a period of protracted compromise and negotiation. The key element of the compromise included the elimination of three potentially viable reservoir sites, including Idylwilde. In return, eight miles in the lower canyon area were not designated as Wild and Scenic and may, therefore, be considered for future water development. Congressman Brown and Senator William Armstrong introduced identical bills for the purpose of designating the upper 75 miles of the Cache la Poudre River as a Wild and Scenic River. The bill was signed by President Reagan on October 30, 1986. Both "recreational" and "wild" river segments have been designated. The segments of the river designated as "recreational" will be managed to maintain existing road access, impoundments, and developments along the shore. Segments designated as "wild" will be managed to be free of impoundments, with shorelines remaining primitive, and generally accessible only by trails.

1.3 STUDY AUTHORIZATION AND THE ROLE OF COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

In 1981, the Colorado General Assembly enacted Senate Bill 19 which created the Colorado Water Resources and Power Development Authority. The specific requirements of the Colorado Water Resources and Power Development Authority Act are documented in Title 37, Colorado Revised Statutes 1973, as amended, parts 37-95-101 through 37-95-114. The Authority, by law, is a political subdivision of the state and not an agency of state government. Members of the Authority are appointed by the Governor with confirmation by the Senate. There are nine members of the Authority, eight of which represent the major drainage basins in Colorado, and the ninth represents the City and County of Denver.

The General Assembly created the Authority for the primary purpose of aiding in the planning, design, financing and construction of water and hydroelectric power projects that will put Colorado's water supplies to beneficial use. To implement this, the Authority has been empowered, under the specific guidelines in the law, to issue revenue bonds for funding of such projects.

The Cache la Poudre Basin Water and Hydropower Resource Management Study (the Study) was authorized on March 18, 1985 by the Authority Board of Directors in response to an application submitted by the NCWCD. On June 7, 1985, the Authority entered into a contract with Harza Engineering Company to provide lead consulting services for the Study. Harza subcontracted with four other firms to provide specialty services: Leonard Rice Consulting Water Engineers (hydrology, water supply, and water rights), Browne, Bortz & Coddington (water and power demands, economics, and finance), Tom Pitts and Associates (environmental evaluations), and Morton W. Bittinger (groundwater).

1.4 STUDY OBJECTIVE

The chief objective of this study is to define that combination of water and hydropower resource management alternatives, both structural and non-structural, which will provide for the efficient and environmentally sound development of the water and hydropower resources of the Cache la Poudre Basin. The study has been performed in such a manner as to become an important component of a potential South Platte Basin management plan.

This is a basin-wide study and it has focused on identifying alternatives that will satisfy basin-wide needs. There are several potential small projects that may be attractive for specific, smaller scale, purposes. These smaller projects were considered in the plan element identification and evaluation activities. Although they may not be evaluated as alternative plans to meet the basin-wide needs, there is considerable technical, economic, and environmental data concerning them in the Task 7 Summary Report and in the Final Report.

The Study was conducted at a prefeasibility level of evaluation. It has been performed in sufficient detail to distinguish the major differences between alternative plans, provide a preliminary indication of viability for each alternative, and determine if feasibility studies are justified.

Following completion of a prefeasibility study, one or more plans could be selected for further, more detailed analysis in feasibility level studies. Feasibility studies would include detailed geologic and geotechnical investigations, application for permits and licenses, environmental studies, and financing arrangements. Final design for a selected project would follow. The prefeasibility study is the first step in a complex process leading to the construction of a water resources project.

The Study was composed of two phases. The first phase addressed the potential need for water development in the Basin, while the second phase identified and evaluated various structural and non-structural alternatives to enhance water supplies. The prefeasibility study concluded with selection of preferred water development plans and a recommendation that a complete feasibility study be initiated by one or more of the project beneficiaries.

The detailed feasibility study, if conducted, would focus on the preferred plans and the key issues associated with potential development. For example, potential markets for hydropower would be examined along with recreational development possibilities and further utilization of groundwater resources. The level of detail would be suitable to support regulatory processes such as NEPA, to obtain permits and licenses, and to provide the foundation for an investment decision.

1.5 STUDY PROCESS

1.5.1 Structure of the Study

The study procedures were defined in the "The Plan of Study" (POS) prepared by the Authority and the consulting team. The POS identifies each phase and the corollary tasks and the subtasks to be completed. Table 1.1 identifies the phases and the tasks.

TABLE 1.1

Cache la Poudre Basin Study
Phases and Tasks

Phase	Task No.	Description
Phase I	1	Data Assembly and Review
	2	Description of Existing Water Supply Systems
	3	Regional Hydrologic Assessment for Water Resource Development
	4	Demand Projections
	5	Analysis of Regional and Basinwide Supply and Demand
	6	Baseline Description of the Study Area and Phase I Report
Phase II	7	Identification of Plan Elements
	8	Plan Formulation and Evaluation
	9	Selection of Preferred Plan
	10	Final Report (Including Scope of Work for Phase III Feasibility Study)

The results of this study have been documented in detailed reports for each task, accompanied by an abbreviated executive summary. A draft report also was prepared to summarize Phase I. The Final Report presented herein covers both Phases I and II.

1.5.2 Performance of the Study

At the outset, the Cache la Poudre Basin Study attempted to maximize the use of previous reports and data supplied by others. For example, a considerable amount of hydrologic data was obtained from the Water Commissioner for the Poudre River Basin. Previous basin studies were reviewed, extracting data and other information applicable to the present effort. Population forecasts, land use studies, and non-structural water resource analyses prepared by local planning agencies were extensively utilized. The St. Vrain Basin study recently published by the Authority was also used in a number of instances. The information provided in the Cache la Poudre Basin Study is intended to be the best currently available information suitable for use in a prefeasibility study.

In a prefeasibility level basin planning effort, there will be gaps in available information and some areas of relative uncertainty. In instances where definitive information was lacking, the assumptions for developing estimates were clearly identified and evaluated. In areas of greater uncertainty, such as forecasts of future conditions, a range of possibilities has been provided. The intent has been to bound the range of likely future conditions that can reasonably be expected to occur. The next level of feasibility analysis can explore the critical issues and areas of uncertainty in greater depth.

At critical junctures in this Study, analyses have been performed to assess the validity of interim or final conclusions. These analyses tested key assumptions and explored alternatives where appropriate. For example, a comparatively small-scale water resource and hydropower development has been analyzed to reflect uncertain market prospects for water and hydropower. In respecting the various uncertainties associated with a study of this nature, there has been a conscious attempt toward conservative estimates.

1.6 PUBLIC INVOLVEMENT

A public involvement program was developed and carried out consistently through the study period. The objectives of the program were:

- To inform the public about the study process, purpose, and need;
- To invite public comment, input, and suggestions during the study process; and
- To involve a broad based Advisory Committee to provide review and direction throughout the Study.

To accomplish these objectives, the public involvement program included Advisory Committee meetings, small study group meetings, and public meetings.

1.6.1 The Advisory Committee

The Cache la Poudre Basin Study Advisory Committee is comprised of representatives from 30 organizations that, taken together, present a broad range of interests relevant to the water resources of the Cache la Poudre Basin. The intent was to make sure that interested parties were aware of the study progress and interim results in time for the study team to incorporate their advice and concerns. The Advisory Committee members are listed in Table 1.2. The Advisory Committee was notified at the conclusion of each task and phase that a draft summary document was available at the data repositories (also listed in Table 1.2) and that a meeting to discuss its findings would be held. At that time, each advisor was sent a draft executive summary of the task report and was encouraged to offer questions and comments at the meetings. The dates and subjects of these meetings are listed in Table 1.3.

TABLE 1.2

Public Involvement
Advisory Committee Representatives

AUDUBON SOCIETY
Pat Sousa

BUREAU OF RECLAMATION
Roger Weidelman

CITY OF GREELEY
Mark Rybus

CITY OF FORT COLLINS
Gerry Horak/Dennis Bode

COLORADO DIVISION OF PARKS AND OUTDOOR RECREATION
Joe Maurier

COLORADO WATER CONSERVATION BOARD
Bill McDonald

COLORADO WATER RESOURCES & POWER DEVELOPMENT AUTHORITY
W.D. Farr

CONSERVE OUR POUDRE
Neeland Siebring

COLORADO FARM BUREAU
Francis Bee/Dale Peterson

COLORADO OPEN SPACE COUNCIL
Norm Mullen

COLORADO RIVER OUTFITTER ASSOC.
Pat Tierney

COLORADO STATE UNIVERSITY
E.V. Richardson

FT. COLLINS CHAMBER OF COMMERCE
Bernie Cain

FORT COLLINS-LOVELAND WATER DISTRICT
SOUTH FORT COLLINS SANITATION DISTRICT
Michael DiTullio

GREELEY CHAMBER OF COMMERCE
Dan Tindall

LAKE RECREATION
John McFarlane

LARIMER COUNTY COMMISSIONER
Court Hotchkiss

NORTHERN COLORADO WATER CONSERVANCY DISTRICT
Larry Simpson

PRESERVE OUR POUDRE CITIZENS GROUP
Chuck Wanner

POUDRE CANYON RESIDENT
Bruce Berends

SIERRA CLUB
Tim Johnson

SOUTH PLATTE WATER COALITION
Jim Park

STATE DIVISION OF HIGHWAYS
Al Chotvacs/Doug Rames

STATE DIVISION OF WILDLIFE
Pete Barrows

STATE ENGINEER'S OFFICE
Jack Neutze

THE CACHE LA POUDRE WATER USERS ASSOCIATION
Bob Stieben

TROUT UNLIMITED
Richard Hamilton/Vance Vorndum

U.S. ARMY CORPS OF ENGINEERS
Col. John Coats/Gregory Moore

U.S. FOREST SERVICE
Milt Robinson

TABLE 1.2 (continued)

Data Repositories

COLORADO STATE UNIVERSITY LIBRARY, FORT COLLINS
Fred Schmidt, Document Librarian

FORT COLLINS PUBLIC LIBRARY, FORT COLLINS
Bob Copeland, Reference

GREELEY PUBLIC LIBRARY, GREELEY
Janet Johnston, Head Librarian

NORTHERN COLORADO WATER CONSERVANCY DISTRICT, LOVELAND
Brian Werner

UNIVERSITY OF NORTHERN COLORADO LIBRARY, GREELEY
Mary Alm

COLORADO WATER RESOURCES & POWER DEVELOPMENT AUTHORITY, DENVER
Judy Kriss, Administrative Office Manager

TABLE 1.3

Cache la Poudre Basin Study
Advisory Committee and Public Meetings

	Date	Meeting
1.	May 28, 1985	Full Advisory Committee on Plan of Study
2.	August 6, 1985	Public Meeting on Introduction to Study
3.	September 12, 1985	Subgroup on Environmental Issues
4.	October 8, 1985	Full Advisory Committee on Tasks 1 and 2
5.	October 17, 1985	Subgroup on Water Demands (Task 4)
6.	October 24, 1985	Subgroup on Water Supply and Hydrology (Task 3)
7.	December 19, 1985	Full Advisory Committee on Task 4
8.	March 4, 1986	Full Advisory Committee on Task 3
9.	April 8, 1986	Subgroup on Supply and Demand (Task 5)
10.	April 22, 1986	Subgroup on Tasks 7a, 8a and 8b
11.	May 8, 1986	Subgroup on Task 8c
12.	May 13, 1986	Full Advisory Committee on Task 5 and Task 6
13.	May 29, 1986	Full Advisory Committee and Public Meeting on Task 6, Phase I
14.	July 28, 1986	Full Advisory Committee Meeting on Tasks 7 and 8c
15.	September 3, 1986	Full Advisory Committee on Task 8
16.	September 10, 1986	Subgroup on Environmental Studies
17.	September 23, 1986	Full Advisory Committee on Task 9
18.	September 30, 1986	Full Advisory Committee on Task 9
19.	November 13, 1986	Full Advisory Committee and Public Meeting on Final Report

The Advisory Committee provided indispensible direction throughout the course of the effort. Given the wide range of interests represented on the Advisory Committee, it is not reasonable to expect that a unanimous consensus be obtained in an effort of this magnitude. However, the contribution of these individuals has resulted in a comprehensive evaluation of the conflicting interests and their efforts are gratefully acknowledged.

1.6.2 Small Study Groups

Subgroups of the Advisory Committee were formed to explore a number of key issues encountered in performing the ten study tasks. They included water supply, water demand, environmental considerations and plan formulation. Selection of participants for the small study groups was based upon their indicated preference and upon their interest and knowledge of the particular topic. The insights provided to the study team from these small groups was significant. Special thanks are extended to these individuals.

1.6.3 Public Meetings

In addition to the 19 Advisory Committee meetings, all of which were open to the public, three special public meetings were held during the course of the study. A meeting was held at the beginning of the study effort to explain the study process, introduce the participants, and ascertain particularly sensitive issues. The second public meeting was held at the conclusion of Phase I. Its purpose was to explain the Phase I findings, progress to date, and Phase II activities. The final public meeting was held on November 13, 1986 to present the study conclusions and supporting information. Drafts of this summary report were provided to Advisory Committee members and the data repositories prior to the final public meeting.

Considerable efforts were made to publicize the time and location of the public meetings through the media. In addition, two newsletters were prepared and distributed. As alternative plans for structural facilities were developed and presented to the Advisory Committee, public attention increased dramatically. The last two meetings were each attended by approximately 150 people. The patience, support, and cooperation of all those who participated is thankfully acknowledged.

1.7 REPORT ORGANIZATION

The Final Report is organized into thirteen chapters in two volumes:

Volume I

Chapter 1 - INTRODUCTION
Chapter 2 - BASIN SETTING
Chapter 3 - WATER RESOURCES
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The technical discussions in Chapter 3, 4, 5, and 7 are supported by four technical appendices: Appendix A - Streamflow and Transbasin Diversion Data: Appendix B - Data on Water Supply Systems of the Basin; Appendix C - Data on RIBSIM Model Development and Calibration; and Appendix D - Data Supporting Water Supply and Demand Analysis. Appendix E - Geology provides geologic data acquired to support the formulation and evaluation of alternative plans.

Chapter 2

Basin Setting

2.0 BASIN SETTING

2.1 LOCATION

The Cache la Poudre River Basin is located in north central Colorado, as shown on Figure 2.1, on the eastern slope of the Continental Divide. The Laramie and Medicine Bow mountain ranges form the western boundary of the Basin. In the mountainous region, the southern boundary of the Basin is formed by the Mummy Range and Rocky Mountain foothills which separate the Cache la Poudre Basin from the adjacent Big Thompson River Basin. The Big Thompson River drainage bounds the Cache la Poudre to the south in the plains area. To the north, the Basin boundary is formed in the high plateau region of southern Wyoming. The Basin to the east is bounded by the Lone Tree Creek drainage. The Cache la Poudre River joins the South Platte River near the City of Greeley and has a total mainstem length of about 120 miles. About 80 percent of the Basin in Colorado is located in Larimer County with the remainder in Weld County. A small portion of the northern part of the Basin is located in Wyoming. Runoff from this portion of the Basin is small but was considered in the supply analyses. Water diversions, if any occur in the Wyoming portion of the Basin, are reflected in the gage records for stations in the Colorado portion of the Basin.

2.2 PHYSIOGRAPHY

The Cache la Poudre River drains a total area of 1890 square miles (sq. mi.) in Colorado and Wyoming, above its confluence with the South Platte River near Greeley. The Basin is divided into two distinct geographical units -- the mountainous upper basin which has an area of about 1050 sq. mi. and the lower basin which has an area of about 840 sq. mi. Sharp hogback ridges separate the upper basin from the lower basin. The lower basin is within the Colorado Piedmont portion of the Great Plains. Most of the runoff in the Basin occurs in the upper basin comprising the mainstem Cache la Poudre River and its major tributaries the North Fork (570 sq. mi.) and the South Fork (90 sq. mi.). Most of the water use occurs in the lower basin (plains) for irrigated agriculture and for M&I supplies. Sub-basins are discussed further in Chapter 3.0.

Basin elevations range from 4600 feet at the South Platte confluence to 13,560 feet at Hagues Peak. The elevations in the North Fork sub-basin range from 5550 to 11,000 feet (South Bald Mountain). Elevations in the South Fork sub-basin range from 6570 to 13,400 feet (Rowe Peak).

The major drainage feature of the lower basin is Boxelder Creek which has a drainage area of about 290 sq. mi.

2.3 CLIMATE

The climate of the Basin is extremely variable locally in response to variations in topography. The climate of the mountainous upper basin is characterized by colder temperatures and a short growing season typical of the Colorado mountain regime, as shown in Table 2.1. The lower basin, comprised of relatively flat plains, experiences warmer temperatures, less precipitation, and has a longer growing season.

Most of the precipitation in the upper Basin occurs in the form of snow in the fall and winter. Scattered thunderstorms contribute a small amount to the total annual runoff. Precipitation in the lower basin is usually erratic and unevenly distributed. Based on Fort Collins records, maximum precipitation in the lower basin normally occurs in May, as shown on Figure 2.2. Average precipitation ranges from 12 to 40 inches per year, as shown on Figure 2.3.

Precipitation in the lower basin is sufficient to support a light cover of native grasses and shrubs. Winter grains can be grown; however, successful agriculture is almost totally dependent on irrigation.

TABLE 2.1

Climatic Conditions in the Basin

Characteristics	Lower Basin	Upper Basin[5]
Average Temperature (°F)	48.5[1]	35
Average Precipitation (inches)	12.7-14.5[2]	25
Growing Season (days)	175-185	90
Snowfall (inches)[3]	48[4]	100

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[1] For 1951-80 period. Average at Fort Collins is 48.5°F and average at Greeley is 48.6°F.
[2] Greeley (12.7 inches) and Fort Collins (14.5 inches); 1951-80 period.
[3] Included in precipitation total and based on information in Tudor Study (1983).
[4] At Fort Collins (Tudor, 1983).
[5] Tudor, 1983.

2.4 GEOLOGY

The bedrock in most of the Basin area is part of the Precambrian metamorphic basement complex forming the core of the Colorado Front Range. This basement complex includes metasedimentary rock mixed with granitic rock, granite and biotite gneiss and schist, amphibolite, and large bodies of intrusive igneous rock, such as granite or granodiorite. The area is one of youthful topography consisting of deep, V-shaped canyons incised into an old erosional surface that forms the broad, upland foothills located between the plains and the main mountain ranges to the west.

Along the eastern margin of the upper basin, a series of sedimentary beds have been upturned and folded by mountain building episodes that formed the Rocky Mountains. These sedimentary rocks consist of sandstone, siltstone, shale, and limestone ranging in age from Pennsylvanian to Cretaceous. The hard, resistant sandstone and limestone beds form sharp, hogback ridges that trend north-south along the edge of the Front Range. The interbedded shale and siltstone units usually form valleys or gentle slopes.

The Precambrian igneous and metamorphic rocks are jointed and faulted to varying degrees of intensity, but in general the rock is hard, exceptionally strong, and fairly massive. No geologic features have yet been found that would have an adverse effect on any of the potential water project developments considered in earlier studies. More foundation exploration and treatment is expected to be needed for structures founded on sedimentary rock in comparison to structures founded on the igneous or metamorphic rocks.

2.5 LAND RESOURCES

The U.S. Department of Agriculture, Soil Conservation Service (SCS), has identified and located the prime farmlands of Colorado which are considered to be of national importance. Prime farmlands in Colorado have adequate and dependable water supply for irrigation, favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. Categories of farmlands considered to have statewide importance include: (1) irrigated lands that are not prime because of susceptibility to wind erosion, high water table conditions and/or salt problems, and other factors; (2) irrigated land with inadequate water supply; and (3) high potential dry cropland that could become prime land with irrigation. Other land categories include land having soils that could become prime if irrigated, urbanized land, water-covered land (permanent water bodies such as lakes and reservoirs), and other land not fitting into any of the above categories.

Mapping of farmlands was performed by the SCS in cooperation with the Colorado State University (CSU) Experiment Station. Data contained on the "Important Farmlands of Colorado" mapping for Larimer and Weld Counties is summarized in Table 2.2.

TABLE 2.2

Farmlands in Larimer County and Weld County[1]
in 1979

Category	Larimer County	Weld County	Total
Prime	99,000	365,000	464,000
Irrigated (Not Prime)	15,560	118,000	133,560
High Potential Dry Cropland[2]	20,000	417,000	437,000
Prime If Irrigated	30,600	323,000	353,600
Urban Land	59,840	28,300	88,140
Total Land in County	1,689,600	2,581,120	4,270,720

(1) From mapping entitled "Important Farmlands of Colorado" prepared by the SCS and the CSU Experiment Station, 1979. Aerial photography of 1975-76; edited 1979.

(2) Generally these lands meet the soils requirements for prime farmland and would become prime if irrigated.

Note: Total land in County is not the sum of individual categories listed above the total because other land uses have not been included as line items.

There currently are about 197,600 acres of land irrigated by ditch systems obtaining their water supply from the Cache la Poudre River. About 30 percent of this irrigated land is estimated to be located outside of the topographic limits of the Basin on its eastern boundary. An additional 21,400 acres of land within the Basin are irrigated from non-Basin water sources, primarily the Big Thompson River. The general location of lands currently being irrigated by ditch systems obtaining water from the Basin is shown on Figure 2.4. The extent of the irrigated lands shown on Figure 2.4 is based on the irrigated area in 1980 (Tudor, 1983). Some land has gone out of irrigation since then, as described in Chapter 6.

Water, not land, has been the resource limiting the development of additional irrigated agriculture in the region. As described in Chapter 6, extensions of the North Poudre Ditch system could serve over 100,000 acres of land that are categorized as prime lands if irrigation water were made available. Conversion from traditional surface irrigation methods to sprinkler systems also could increase the amount of irrigated lands because more steeply sloped lands could be irrigated.

A variety of crops are grown on the lands irrigated from the Cache la Poudre River. Dominant are feedcrops, such as corn, alfalfa, and pasture, which support the local feedlot industry. Sugarbeets were once an important crop but the sugar processing plants in the region suspended operations by the early 1980's. Winter wheat is the dominant crop on the non-irrigated lands of the Basin and pasture is a common interim land use on lands being converted from agricultural to urban uses.

2.6 WATER RESOURCES

Both the surface and ground water resources of the Basin have been developed to provide water for municipal, industrial, and agricultural use. More detailed descriptions of the Basin's water resources are provided in Chapter 3.

2.6.1 Surface Water Resources

The surface water resources of the Basin are from two basic sources -- native runoff derived primarily from snowmelt in the mountainous upper basin and transbasin imports. The transbasin imports include water from the Laramie, Colorado, and North Platte River Basins on the west slope of the Continental Divide which enter the Basin at various locations along its western boundary and the Colorado-Big Thompson (C-BT) and Windy Gap Projects which obtain water from the Colorado River Basin. The C-BT Project and the Windy Gap Project (using C-BT facilities) bring water into the lower Basin via conveyance facilities to Horsetooth Reservoir and from there to the Cache la Poudre River.

The annual native runoff from the Basin, at the mouth of Poudre Canyon or the Canyon Gage, is estimated to be 275,600 af for the 1951-80 historic study period. This estimate is based on recorded streamflows adjusted for the effects of imports, diversion, and reservoir storage above the Canyon Gage. The total surface water resources of the Basin average about 409,000 af per year when imports are included, as shown in Table 2.3. This estimate excludes additional Windy Gap and C-BT imports that will be brought into the Basin if additional storage is provided in the Basin. Additional Windy Gap and C-BT deliveries have been conservatively estimated at 24,000 af per year based on analyses performed by the NCWCD.

TABLE 2.3

Average Annual Surface Water Supply of the Basin

Source	Period	Average Amount (af/yr)
Native Runoff	1951-80	275,600
Upper Basin Imports	1951-80	37,900[1]
C-BT Project	1953-80	88,500[2]
Windy Gap	(3)	24,000
Big Thompson Imports to Greeley	1985	7,000
	Total	433,000

[1] Excludes Bob Creek Ditch and Columbine Ditch which were closed down in 1956. Delivery from these ditches averaged 417 af per year for the 1951-56 period.

[2] Does not include additional C-BT and Windy Gap deliveries through the C-BT system that could be made available with storage in the Basin.

[3] Began operation in mid-1985. A delivery of 24,000 af is expected by users in the Basin. Storage will be needed to make this a firm supply.

Native runoff occurs primarily in the months of May, June, and July due to snowmelt. The high mountain region, comprising about 15 percent of the total upper drainage area of 1050 sq. mi., accounts for about 50 percent of the native runoff from the upper basin (Tudor, 1983).

Based on available data, surface water quality in the upper portion of the Basin is considered to be excellent. Throughout the Basin, current chemical water quality is within the limits established by the use classifications assigned by the Colorado Water Quality Control Commission (CWQCC) for the various stream segments. Biological data on benthic organisms and fish are available for several stations in the lower basin but these show extreme variations. These variations do not correlate with specific seasons and locations along the river. The North Fork can carry high sediment loads. Greeley reports that water in Seaman Reservoir often is exchanged for C-BT water because of high sediment concentrations.

Sensitive areas with respect to water quality are identified below:

- Points of diversion are sensitive areas because water quality at these points need to be maintained at levels suitable for the uses of the diverted water.

- The CWQCC has identified "High Quality Class 1" stream segments within Rocky Mountain National Park.

- Protection of water quality in the mountainous area is important to local governments who have expressed concern over intensive recreational use possibly causing deteriorating water quality downstream.

2.6.2 Ground Water Resources

The primary ground water resources are in the shallow, alluvial aquifers underlying the Cache la Poudre River, Boxelder Creek, Spring Creek, and Lone Tree Creek. Annual pumpage in 1985 from wells in the study area, which includes wells located outside the Basin but relying on surface supplies from the Basin for aquifer recharge, is estimated to be about 126,000 af from about 1500 wells. The primary use of ground water is to supplement surface water supplies for irrigation. Most well owners also have surface water supplies. The withdrawal of ground water from aquifers connected to the river is regulated, at least in part, by Plans for Augmentation that protect the senior rights of surface water users from injury by junior appropriators of ground water. These Plans also establish the rights of these junior appropriators to withdraw tributary ground water when adequate supplies are available.

There are seven aquifers of importance within and adjacent to the Basin. These aquifers receive most of their recharge from irrigation water supplied by diversions from the Cache la Poudre River. The total storage in these aquifers is estimated to be over 400,000 af.

Water levels in the aquifers currently are fairly stable indicating a balance between pumping and recharge. Water quality is variable with location. The variation follows a pattern closely related to the amount of use and reuse of ground water as it migrates from upper to lower portions of the aquifers. TDS concentrations range from 1000 to 2000 mg/l and hardness from 500 to 2800 mg/l. Selenium concentrations in excess of State and Federal standards have been found in water samples taken near the Town of Wellington.

2.7 VEGETATION

The Basin covers portions of four vegetative regions -- the grasslands, montane, subalpine, and alpine tundra regions and supports native vegetation common to these regions. Specific plant types within the vegetative regions are identified in Chapter 8. There are several plant species of concern in the Basin including:

Under review for Federal protective status	-	Larimer aletes Colorado Butterfly plant Bell's twinpod
Plants of State concern	-	White upland aster Purple cliffbrake Feverfew

There also are 10 plant associations that reportedly occur in the Basin which are rare or extremely rare in Colorado. As described in Chapter 8, the locations of these associations and those plants of concern at Federal and State levels have been mapped.

2.8 FISH AND WILDLIFE

The Basin supports abundant and diverse communities of fish and wildlife which, in turn, help to support the intensive recreational activity that now occurs in the Basin.

2.8.1 Aquatic Resources

The Cache la Poudre River upstream of Fort Collins includes an extensive cold water fishery of dramatically varying quality from one section to another, due to wide variations in available habitat, regulations, and sportsfishing uses. In general, cold water habitat for salmonid species (trout) is fair to good when streamflows are sufficient. Natural winter streamflows are minimal, however, and overwintering habitat in the canyon is severely reduced. Many fish do not survive the winter period. Fishing pressure is extreme throughout the mainstem canyon. The primary salmonid species in the canyon is rainbow trout, with lesser populations of native Greenback cutthroats in the upper tributaries and

German brown trout in the lower canyon areas and downstream of the canyon mouth.

In the upper basin, Greenback cutthroat trout exist at several locations. A population of pure stock occurs in the South Fork near Pingree Park, and this segment of the river is rated by federal and state standards as Class I, "unique" and "irreplaceable." This species is listed as "threatened" under the Federal Endangered Species Act and sportsfishing is presently prohibited. There are no species of fishes on the federal listings of endangered and threatened species that occur, or might be expected to occur, in the waters of the lower Cache la Poudre River. The State of Colorado has listed three warmwater species which do occur in the Poudre and its tributaries as species of special concern. These include the Iowa darter, common shiner, and river carpsucker. These three species are peripheral in Colorado but are widespread elsewhere.

An extensive game fish management program is conducted by the Colorado Division of Wildlife (CDOW) on the Cache la Poudre River upstream of the mouth of the canyon. With the exception of the "wild trout sections", the river is heavily stocked with rainbow trout.

The State operates two hatchery and rearing facilities in support of the cold water fisheries program in the upper Cache la Poudre River basin. One is the fish hatchery at Watson Lake and the other is a rearing unit above Rustic in the upper basin. Wild trout areas, covering a total stream length of 12 miles, are not stocked, and fishing with artificial lures only is allowed in these waters. The lower mainstem of the Cache la Poudre River below the mouth of the canyon is not stocked by CDOW, and no attempts are made to manage this segment of the river as a game fishery.

The eight-mile stretch of the mainstem river from Poudre Park downstream to the canyon mouth includes 4.7 miles of stream designated as "Wild Trout" water. This is not, however, a high-quality cold water fishery, by either federal or state standards, as discussed in Chapter 8.

The numerous irrigation reservoirs in the lower basin support warm water fisheries dominated by yellow perch, several centrarachids (black and white crappie, green sunfish, and largemouthed bass), and bullhead catfish. Many of these reservoirs are managed as fishery habitats through agreements between reservoir owners and the CDOW or private groups.

Horsetooth Reservoir to the west of Fort Collins is an important recreational fishery resource with public access. The reservoir is stocked annually with rainbow trout, walleyes, kokonee salmon, and some lake trout and brown trout.

2.8.2 Wildlife

Certain species of mammals are important because of recreation and economic value, sensitivity to disturbance, large home ranges, and low reproductive rates. These species include bighorn sheep, American elk, mule deer, pronghorn antelope, and white-tailed deer. Bighorn sheep are perhaps of greatest importance. In the Basin, bighorn sheep reportedly occur along much of the main Poudre Canyon west of Greyrock Mountain. American elk is considered by many to be the most important game animal in Colorado. Elk are distributed widely throughout the Poudre Basin. Both bighorn sheep and elk are sensitive to human activity particularly in terms of barriers to movement and loss of winter ranges.

Mule deer are widespread throughout the Basin but tend to be of less concern because of better adaptability to human activity. There are, however, similar concerns with regard to impediments to seasonal movements. Whitetail deer are present in the Basin in small numbers. Other species in the region include mountain lion and black bear. Closest mapped concentrations of these species are in the Big Thompson River Basin. A total of 61 mammal species are listed in the Scenic and Wild River Environmental Impact Statement (USFS, 1982) as usually found in the study area.

The birds of the Basin include raptors, upland game birds, water birds, and small birds. The study area supports two raptorial species that are endangered -- the American peregrine falcon and the bald eagle. Golden eagles and other raptors are widespread and fairly common in the Basin and generally are more tolerant of man's activities. Osprey are considered to be rare in Colorado and this species is present in the study area.

Upland game birds (blue grouse, pheasant, and turkey) and water birds (ducks, geese, grebes, loons, wading birds, and shore birds) are common in the area. Ducks, geese, and game birds are important because of their recreational value. White pelicans, a species considered threatened by the State, use several plains reservoirs as feeding habitat. The Cache la Poudre River and many reservoirs in the Basin are habitat for the great blue heron. The great blue heron has communal nesting areas on the plains of eastern Larimer County. There are 95 species of small birds reported to exist in the study area.

Other fauna of interest are the Rocky Mountain wood frog, which in Colorado is limited to the North Platte and Laramie River drainages, including the Chambers Lake area, the sandhill fritillary butterfly which occurs along the river near Timnath, and the smokey-eyed brown butterfly reportedly sighted near LaPorte. The wood frog generally is considered to be threatened species and the two butterfly species are limited in their abundance.

2.9 RECREATION

The Basin possesses diversified recreational opportunities that attract thousands of visitors annually. The key attractions of the upper basin include the Cache la Poudre River itself and the scenic views, camping, and fishing opportunities along the river and associated with the Roosevelt National Forest. Fishing also is popular at the numerous upper mountain lakes and reservoirs and along many of the tributaries of the Cache la Poudre River. Many hiking trails are available throughout the upper basin.

During certain times of the year the river provides excellent conditions for white-water boating, including rafting and kayaking. Most of the upper basin is within the Roosevelt National Forest, and parts of this area are designated as Wilderness Areas. The mainstem Cache la Poudre from Poudre Park upstream and the South Fork, excluding the potential Rockwell dam and reservoir area, are designated as Wild and Scenic. Both "wild" and "recreational" river segments are included in the designation, as discussed in Chapter 8. Legislation authorizing the Wild and Scenic River designation was signed by President Reagan in October 1986. Hunting for big game and upland game birds are important seasonal activities in the upper basin and certain areas of the lower basin.

Primary recreational opportunities in the lower basin include flat-water recreation on numerous plains reservoirs, particularly Horsetooth Reservoir. The plains reservoirs offer warm-water fishing opportunities and waterfowl hunting opportunities as well. Developed parks and recreational facilities exist in most of the cities and towns of the lower basin. Lory State Park and Boyd Lake State Recreation Area are important State-operated recreational facilities in the lower basin.

2.10 LAND USE

The principal land uses of the Basin include open space and recreational use in the upper basin, with limited urban-type developments, and agricultural land use in the lower basin. As population grows in the major municipal centers of the lower basin, land once in agricultural use is being converted to urbanized uses. The changes in land use in the Basin from 1970 to 1985 are identified in Table 2.4, which demonstrates the decline in agricultural land use. About 90 percent of the agricultural land being urbanized is irrigated land.

Land use in the upper basin is primarily Federally-owned wooded areas and grasslands, including the Roosevelt National Forest and several Wilderness Areas. Small population centers and limited irrigated agricultural areas in the upper basin are not expected to change during the 1985 to 2020 planning horizon.

2.11 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

The Larimer County and Weld County region has a 1985 population of 332,000 of which about 204,000 reside within the Cache la Poudre Basin. Approximately three-fourths of the 1985 Basin population resides in the Fort Collins Area (92,200 persons) and the Greeley Area (66,000 persons) which are the major manufacturing centers of the Basin. Major employers in the Fort Collins and Greeley areas include two universities, several light and high-tech manufacturing plants, food processing facilities, medical and health care facilities, and local government. The remainder of the Basin is rural in character with agriculture being the dominant employment outside of the major urban centers. There are several small towns scattered throughout the Basin with populations ranging from 30 to about 5600 persons.

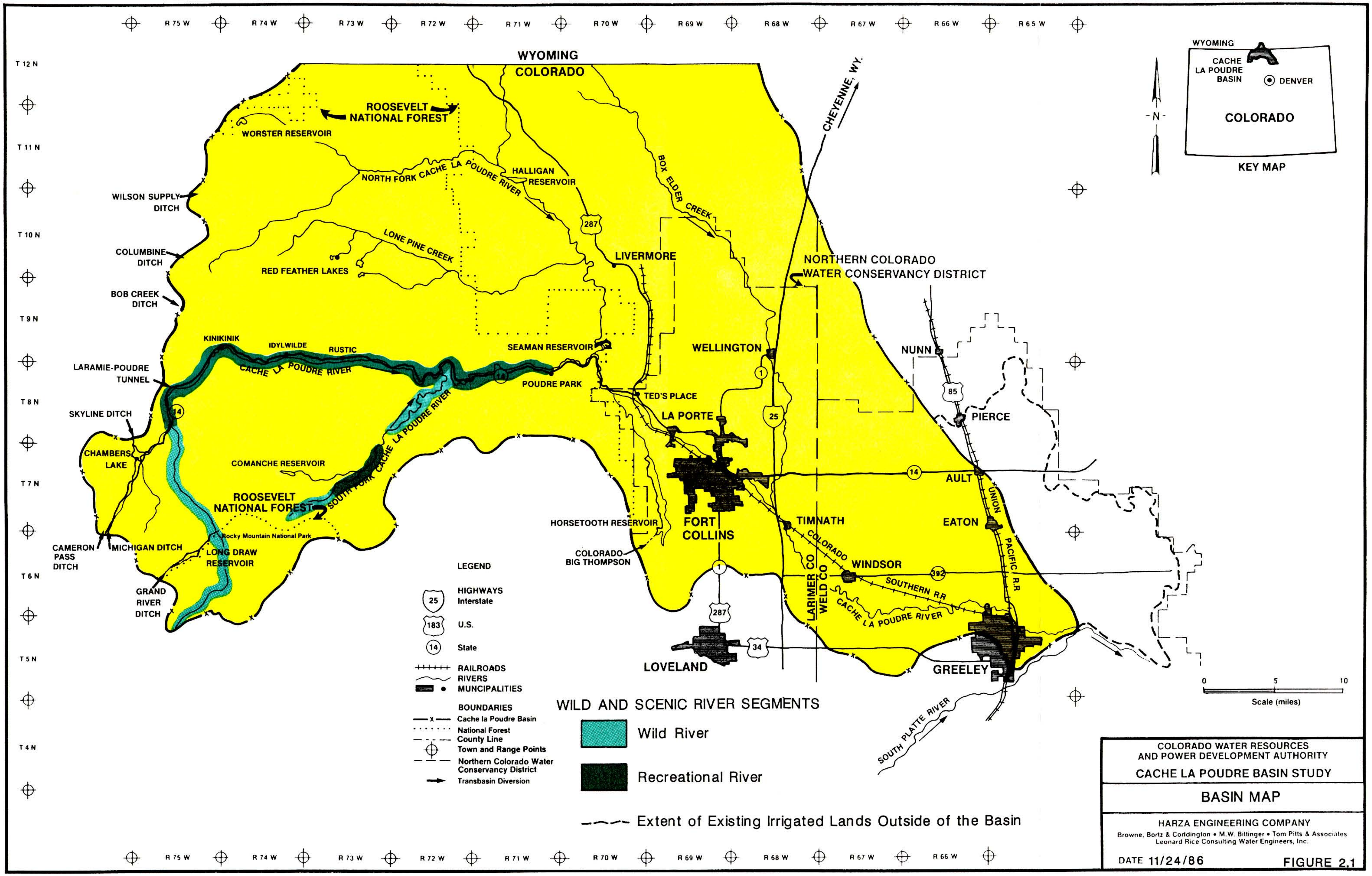
TABLE 2.4
Land Use in the Basin, 1970 to 1985
(Area in Acres)

Land Use Category	1970	1980	1985
Agricultural			
Irrigated Land[1]	260,100	227,100	219,000
Non-Irrigated and Idle	477,400	474,200	473,300
Sub total	737,500	701,300	692,300
Urbanized Municipal and Industrial	17,000	34,300	40,000
Rural Subdivision	7,900	26,800	30,100
Sub Total (Lower Basin)	762,400	762,400	762,400
Upper Basin	421,600	421,600	421,600
Total Basin	1,184,000	1,184,000	1,184,000

(1) Includes lands served by existing irrigation systems extending outside the topographic limits of the Basin.

The economic base of the Larimer and Weld County region is strong as demonstrated by the relative diversity of employers. Unemployment rates have been consistently lower than the averages for Colorado and the U.S. Population and economic growth were dramatic in the 1960s and 1970s. In recent years growth has slowed but the region continues to attract new industries and residents.

Agriculture continues to be an important part of the regional economy and of the State economy as well. The total value of agricultural production in the region increased from $655 million in 1974 to $916 million in 1982. This growth, however, was due primarily to inflation. Livestock products represent about 85 percent of the agricultural products sold.



BASIN MAP

FIGURE 2.1

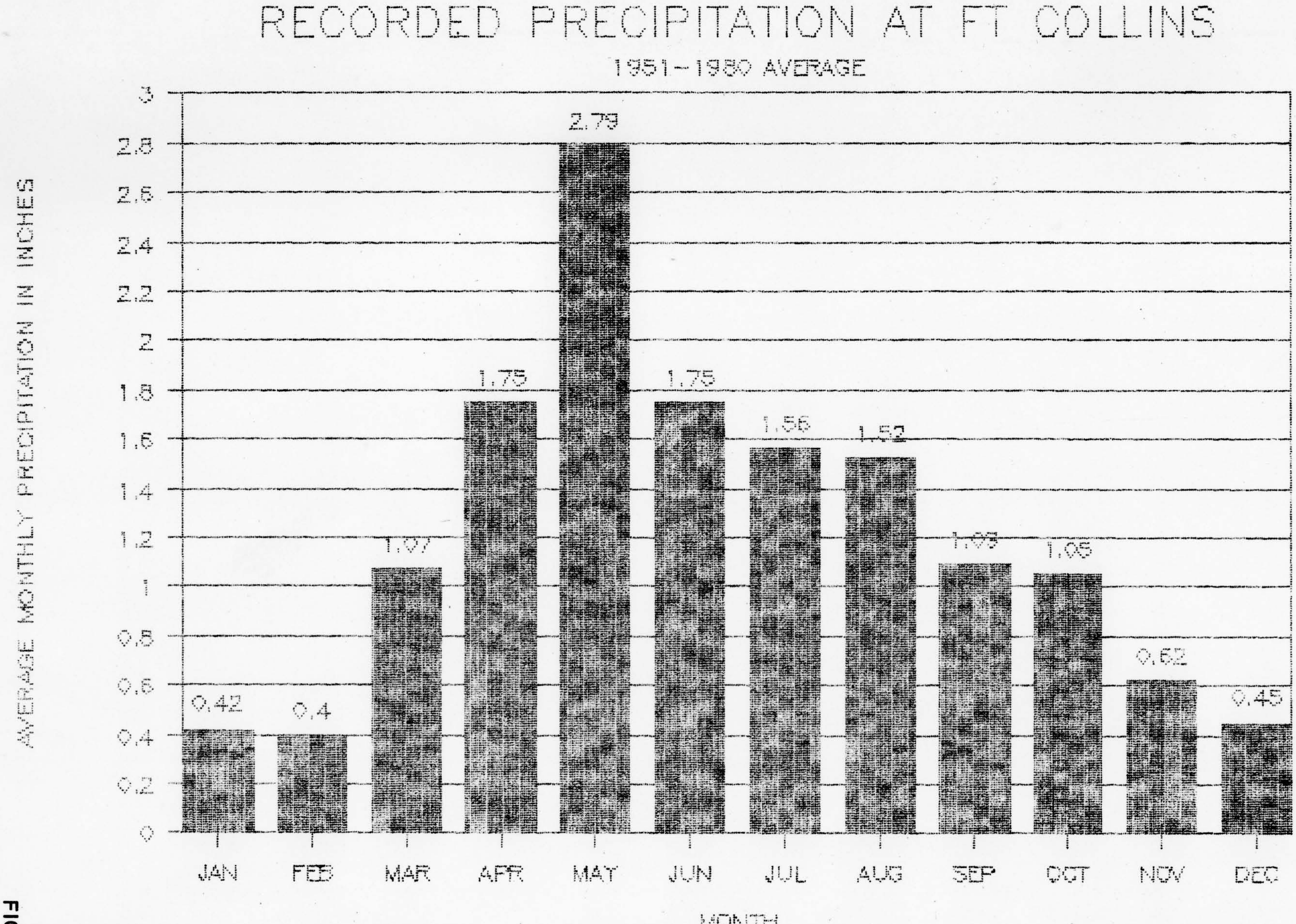
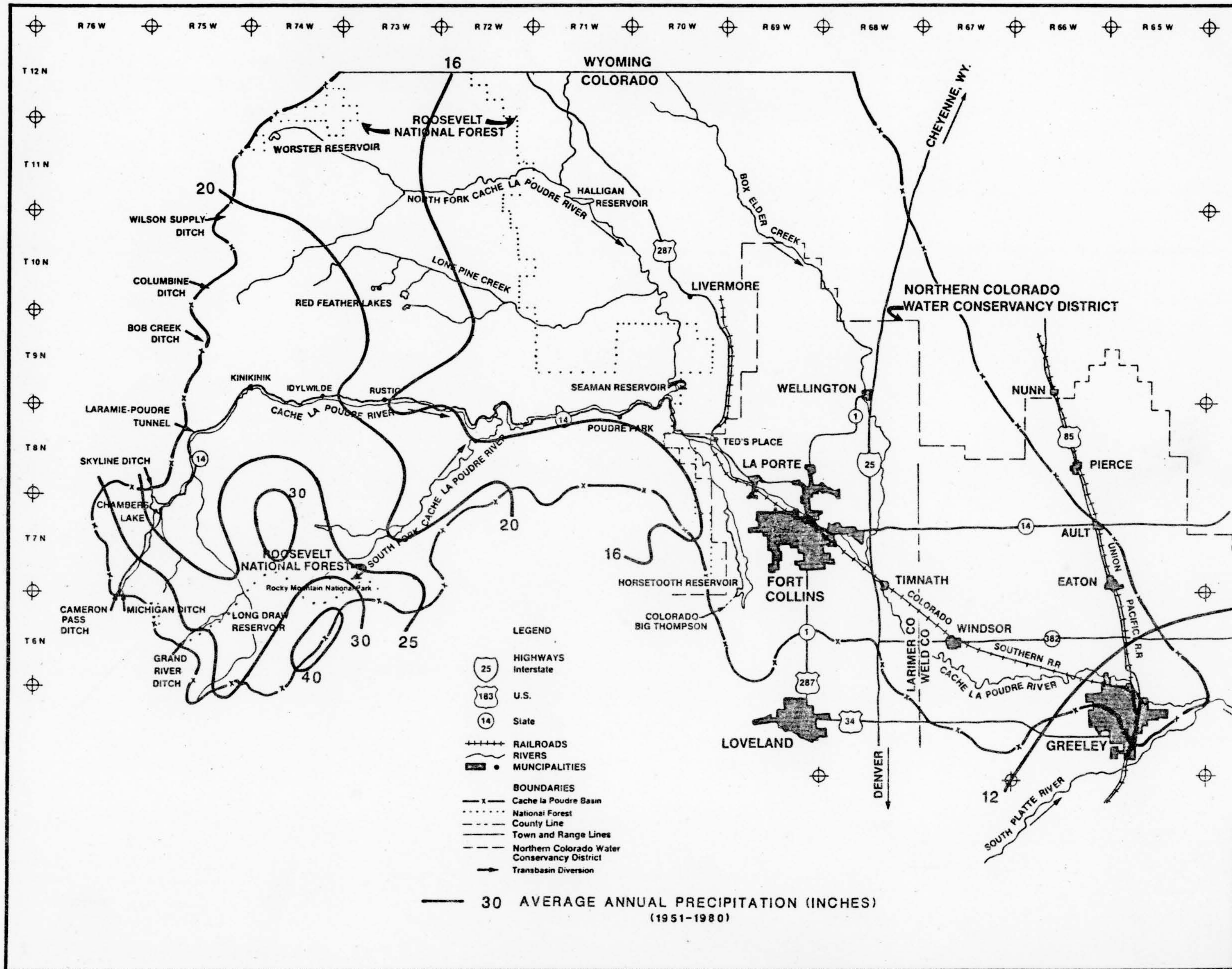


FIGURE 2.2

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY	CACHE LA POUDRE BASIN STUDY DATE: SEP 1985	HARZA ENGINEERING COMPANY Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates Leonard Rice Consulting Water Engineers, Inc.



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

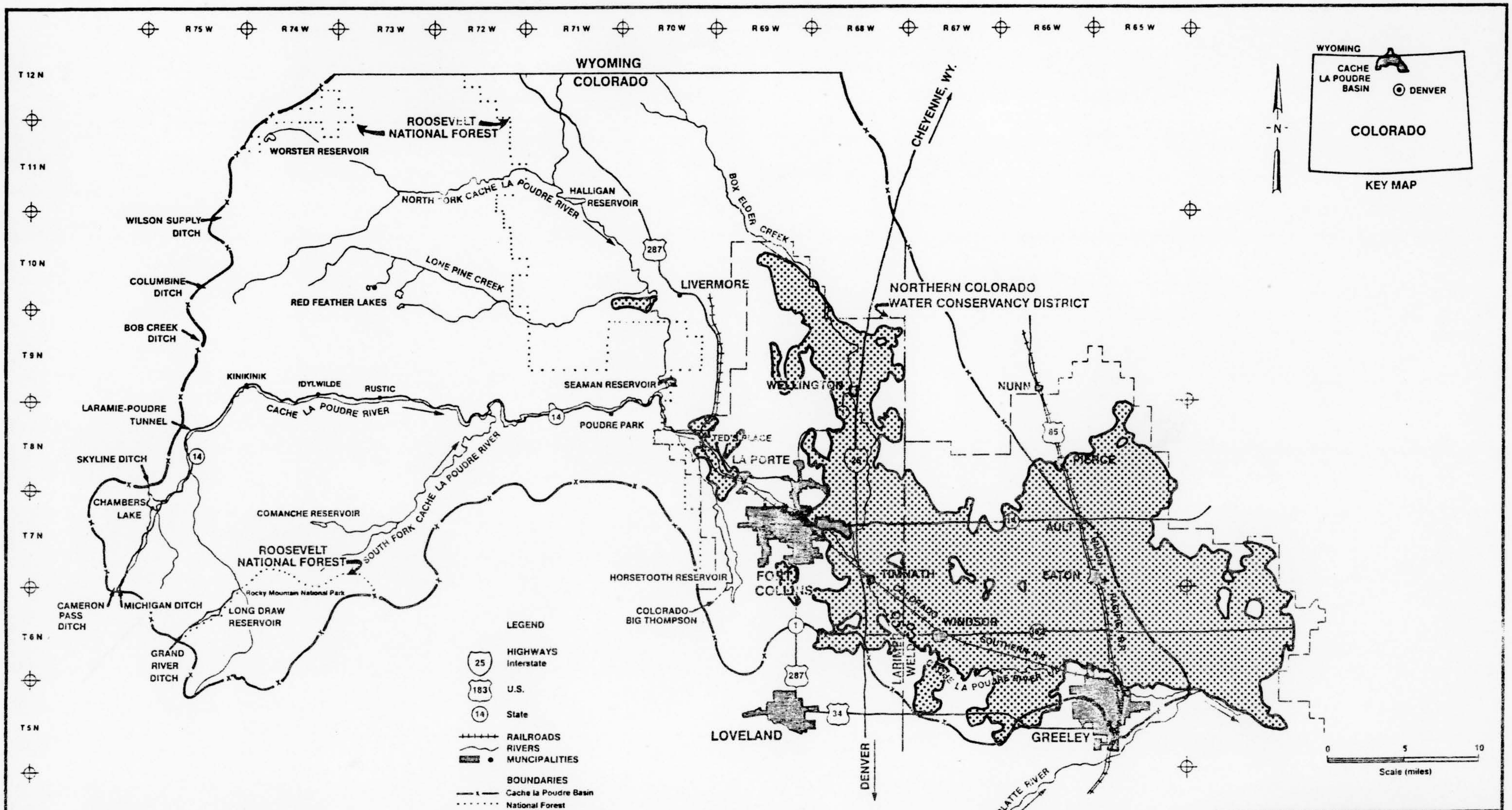
CACHE LA POUDRE BASIN STUDY

ANNUAL PRECIPITATION

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE 9/13/85 FIGURE 2.3



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

IRRIGATED LANDS

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE 12/2/86 FIGURE 2.4

Chapter 3

Water Resources

3.0 WATER RESOURCES

3.1 INTRODUCTION

This chapter describes the water resources of the Basin, including: basic surface water hydrology as it relates to planning for water management; the operations of the transbasin diversions which import water to the Basin; water rights considerations; and the ground water resources of the Study Area. The streamflow data provided in this chapter and in the supporting technical appendices were used to develop the hydrologic simulation model of the Basin's water systems described in Chapter 5. This comparison provided an understanding of the historic water supply situation in the Basin. The simulation model initially was used to compare the current water supply with water demand as reflected with Basin agricultural conditions prevailing in 1970. The simulation model then was used as described in Chapter 7, to compare current water supply with both current and projected future water demand.

Flood estimates presented in this chapter, including Probable Maximum Floods (PMF) and flood frequency relationships at various locations in the Basin, were obtained from previously published reports. Currently recommended procedures were applied to prepare new PMF estimates, as described in Chapter 11 of this report.

The level of detail of the hydrologic data collection and analysis, and associated model activities, is considered to be adequate to support prefeasibility level study of water management options. More detailed water supply, flood, and sediment studies would be needed to support a feasiblity-level study of a selected development plan or plans.

3.2 SURFACE WATER HYDROLOGY

The majority of the Basin's water supply is derived from rainfall and snowmelt in the upper basin and from transbasin imports. The latter source of supply is discussed in Section 3.3. Water currently is not exported directly from the Basin. Water does flow out of the Basin in four ditch systems that originate within the Basin. The derivation of native flows originating in the upper basin is described in this section.

3.2.1 Flow Records

Nine stream gages have been installed over the years to measure flows on the Cache la Poudre and its tributaries, as shown on Figure 3.1. Of these, only two, at the Mouth of Poudre Canyon (Canyon Gage) and at Greeley, have long continuous periods of record through the present. Average, maximum, and minimum recorded streamflows at the gaging stations are given in Table 3.1. Gaging station records for the 1951-80 period are provided in Appendix A, Tables A.1 through A.9.

Daily and monthly flow data are available from these gaging station records. The records include the effects of transbasin imports of water, reservoir storage, and diversions located above the gaging stations. Monthly data on reservoir storage volumes and diversions are available; therefore, it is possible to estimate the native flow that occurred within the Basin during the 1951-80 historic study period.

3.2.2 Native Flow Estimates

As defined for this report, native flows are those that occur from rainfall and snowmelt within the Basin above the Canyon Gage, unaffected by the major activities of man and excluding flow derived from transmountain or transbasin imports. Native flows (sometimes referred to as virgin flows) were estimated for the 1951-80 period for the Cache la Poudre River at the Canyon Gage and for the North Fork at the Livermore Gage just below Seaman Dam.

TABLE 3.1
Summary of Streamflow Records

Stream and Location	Drainage Area (sq. mi.)	Record[1]	Streamflow (1000 af/yr)[2] Avg.	Max.	Min.
Cache la Poudre near Rustic	199	1957-68	166.3	264.5	9.4
Fall Creek near Rustic	364	1961-73	4.6	6.2	3.0
Little Beaver Creek near Idlywilde	0.9	1961-73	0.8	1.1	0.4
Little Beaver Creek near Rustic	12.3	1961-73	5.8	8.6	2.9
South Fork near Rustic	90.3	1957-79	44.2	71.7	8.0
North Fork near Livermore	568	1951-65	32.1	94.0	2.3
Cache la Poudre at Mouth of Canyon	1055	1951-80	225.1	429.8	92.5
Cache la Poudre near Greeley	1850	1951-80	99.8	356.9	22.8
Cache la Poudre at Fort Collins	1127	1975-80	107.8	298.7	30.0

(1) Within 1951-80 historic study period selected for the Cache la Poudre Study. Records maintained by the U.S. Geological Survey.
(2) Includes transbasin imports of water and effects of diversions.

Note: Gage locations are shown on Figure 3.1.

Because the Livermore Gage record stopped in 1965, correlations with the Canyon Gage were made to extend the Livermore Gage record from 1966 through 1980 based on native flow estimates for the overlapping gage record period (1951-65). Native flows for both gages were estimated as follows:

Native Flow = Gage Flow - Imports + Diversions from the River + or - Change in Reservoir Storage

Monthly native flows for the Canyon Gage and Livermore Gage are provided in Tables A.10 and A.11 in Appendix A, respectively, for the 1951-80 historic study period. The average native flow at the Canyon Gage for the 1951-80 period is estimated to be 275,600 af per year. The native flow for the North Fork at Livermore averaged about 64,000 af per year for the same period. The native flow estimates for the Canyon Gage (Table A.10 in Appendix A) are essentially the same as those derived for the Fort Collins drought study (Resource Consultants, 1985) with the exception of refinements made in adjusting for diversions by the Poudre Valley Canal and the fact that the Fort Collins drought study was based on water years rather than calendar years.

3.2.3 Historic Modeling Period Selection

The historic modeling period for the Cache la Poudre Study was selected based on a review of estimated native flows for the 1884 through 1983 period at the Canyon Gage. The native flows were determined for the Fort Collins drought study [(1)] by Resource Consultants, Inc. (1985). Other factors also were considered such as the availability of diversion and water use records, inclusion of drought period(s) in the study period, consistency with previous studies in the Basin and studies of adjacent basins, public perceptions of the study period, and the desirability of having recent years in the period to make best use of the most reliable data relating to water supply and demand.

A 73-year period of record (1911-83) was selected for the statistical analysis of native flows at the Canyon Gage. Records from the 1884-1910 period were excluded from the analysis because of the doubts regarding the

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[(1)] The flows from this study were used because it was considered desirable and efficient to select the study period prior to initiating the extensive data collection effort, thereby allowing concentration of the data collection effort on a specific time period.

accuracy of these records. The initial analyses consisted of determining departures from the mean annual flow (288,000 af for the 1911-83 period) using 10-year running averages. Cumulative departures from the mean then were used to identify periods of 30 years or more for which average runoff approximated the long-term average. The 1916-46 and 1951-83 periods were identified as potential study periods based on this analysis.

Statistical analyses were performed on both of these periods and for the 1911-83 period to determine standard deviations, coefficients of variation, and skewness coefficients. Both the 1916-46 and 1951-83 periods were found to be statistically comparable to the long-term record. Because 1983 was an abnormally high runoff year, analyses for the 1911-82 period also were performed. It was found that inclusion of 1983 in the period increases average runoff by about 6000 af over the average for the 1911-82 period. Statistical analyses also were prepared for the 1951-80 period because this period was used for a similar water management study for the nearby St. Vrain Basin. The statistical data indicated that the 1951-80 period also would be suitable in that it is representative of long-term average conditions.

Annual precipitation records at Fort Collins for the 1889-1983 period and for the three potential study periods (1916-46, 1951-83, and 1951-80) were subjected to similar statistical analyses. It was found that all three study periods would be representative of long-term average conditions in terms of precipitation at Fort Collins.

All three potential study periods also contain both high flow and drought periods of extended duration. The 1916-46 period was eliminated from consideration for the study period because records of water diversions and usage for this period are not as plentiful and accurate as the more recent years. Also, the more recent periods have greater meaning to the public who are able to relate personally to events occurring since 1951. The 1951-83 period includes an abnormally high runoff year, 1983. Inclusion of the above-average period at the end of the study period would increase average flow over the period and might result in slightly different interpretations of results.

The 1951-80 period was selected as the study period. The use of this period for the Cache la Poudre Basin Study provides conservative results in the proposed hydrologic/water supply modeling activities described in Chapter 5. The critical water supply and demand relationships are formed in the 1950s and 1960s and are not dependent on the 1981-83 period. Also the 1951-80 period has the additional advantages of being an even 30-year period and corresponds to the study period used for the St. Vrain Basin Study.

3.2.4 Floods

The highest recorded "natural" discharge of the Cache la Poudre River was 12,000 cfs at the Canyon Gage. This flow occurred on May 21, 1901. On May 31, 1930, a peak discharge of 10,200 cfs was recorded. The following day a peak flow of 1270 cfs was recorded at the Greeley gage. The maximum discharge recorded at Greeley was 4220 cfs in June of 1917. A peak discharge of 21,000 cfs was observed at the Canyon Gage caused by failure of Chambers Lake Dam in June 1918. Most floods in the Cache la Poudre Basin have been caused by rainfall adding to snowmelt runoff in June. Severe flooding can occur from rainfall alone as occurred during the 1976 Big Thompson flood in an adjacent basin. Flood peaks build rapidly in the upper basin due to steep terrain. The time to peak runoff is estimated to be 3.5 hours for the Cache la Poudre River near Poudre Park for a 100-year event. The time to peak flow at Windsor is estimated to be 15.5 hours for the same event (COE, 1981).

3.2.4.1 Flood Frequency

The COE (1981) developed flood discharge frequency relationships at 16 locations within the Basin. These relationships were based on a simulation model for the upper basin and synthetic unit hydrographs for the lower basin. Results for selected locations are given in Table 3.2.

TABLE 3.2
Flood Frequency Relationships
(Estimates by COE)

Location	Drainage Area (mi^2)	Peak Discharge (cfs) 10-Year	100-Year	500-Year
North Fork Cache la Poudre				
u/s Halligan Dam	354	3,440	14,980	32,120
d/s Halligan Dam	354	1,980	9,260	22,790
At Mouth	566	2,490	11,830	26,940
Lone Pine Creek				
At Mouth	87	1,260	4,810	9,510
Cache la Poudre River				
Just u/s North Fork	422	5,230	17,700	37,040
At Canyon Mouth	1,055	7,000	17,400	31,000
d/s Boxelder Creek	1,537	17,700	28,500	42,000
At Greeley	1,890	3,100	9,400	16,800

Source: COE, 1981

Attenuation of flood peaks is evident particularly between Boxelder Creek and the confluence with the South Platte River. This attenuation is caused by floodplain storage. Halligan Reservoir has a pronounced effect on flood peaks on the North Fork.

3.2.4.2 PMF Estimates

An analysis was prepared by Tudor Engineering (1983) of all major floods occurring along the Front Range and of two inflow design flood estimates (Halligan Reservoir and Seaman Reservoir). A plot of discharge vs. drainage was prepared using the historic floods and design flood estimates. Based on this plot a Creager C of 150 was selected for computing inflow design floods for storage project planning (Tudor, 1983). Using a C-value of 150, the following relationships between discharge and drainage area are obtained:

Drainage Area (sq.mi.)	Peak Inflow Flood Discharge[1] (cfs)	Unit Runoff (cfs/sq.mi.)
50	124,000	2,480
100	184,000	1,840
500	418,000	840
1,000	569,000	570

(1) Peak Discharge (Q) = $46CA^{(0.89A^{-0.048})}$; where C = Creager C-value = 150 and A = drainage area in square miles.

The Creager-C method commonly is used for reconnaissance-level planning involving comparison of developments at several sites.

PMF estimates for selected storage sites were developed for the current Study using criteria for probable maximum precipitation (PMP) estimates contained in Hydrometeorological Report 55 (HMR 55). This report was published in 1984 by the National Oceanic and Atmospheric Administration (NOAA), the COE, and the USBR. Procedures for PMF estimating were those normally associated with prefeasibility-level evaluations. As indicated in Chapter 10, PMF estimates using the PMP estimated from HMR55 are less than those shown which are based on the Creager-C method.

3.2.5 Sediment

A 1976 study reported on by International Engineering Company (IECO, 1980) indicated that Seaman Reservoir on the North Fork Cache la Poudre River was about 25 percent full of sediment. This volume reduction occurred during the 1948-76 period and is equivalent to a rate of about 0.2 af per year per sq. mi. of drainage area (about 566 sq. mi.) above the dam. Estimates of sedimentation in Halligan Reservoir are not known to be available. The sedimentation rates are expected to be less on the mainstem Cache la Poudre River and on the South Fork because of conditions in their sub-basins. A 1965 study by the USBR assumed 0.1 af per sq. mi. per year for a potential reservoir site near Idylwilde in the upper basin on the mainstem (Tudor, 1983).

Sedimentation problems are known to exist at some of the lower basin (plains) reservoirs. Several smaller reservoirs no longer are used because of lost storage space. Unfortunately, surveys have not been performed to determine the amount of storage lost in these plains reservoirs. Sediment accumulates in the plains reservoirs because ditches convey sediment-laden water for short-term storage. Soil erosion from adjacent agricultural lands tributary to the reservoirs also contributes to lost storage capacity.

3.2.6 Droughts

Drought is being defined for the Cache la Poudre Basin Study as a year or series of consecutive years of below average native runoff at the Canyon Gage. A long dry period containing a single year of above average runoff is considered to be two separate droughts. The selected historic study period (1951-80) contains six drought periods ranging in length from one to four years as indicated in Table 3.3.

TABLE 3.3
Droughts Occurring in the 1951-1980
Historic Study Period

Drought Period	Duration (yrs)	Total Deficit[1] (af)	Average Deficit (af/yr)
1953-56	4	437,500	109,380
1959-60	2	78,000	39,000
1963-64	2	225,100	112,550
1966-69	4	257,000	64,250
1972	1	56,100	56,100
1975-77	3	253,800	84,600

(1) Sum of amounts below long-term (1884-1983) average native runoff at the Canyon Gage of 286,980 af per year during the identified drought period.

The historic study period does not include the 1931-37 drought which had a duration of 8 years and a total deficit of 540,000 af. In terms of deficit, this drought is representative of a 1-in-50 year event. In terms of duration, this drought is representative of a 1-in-100 year event. The study period does contain the 1953-56 drought which had a duration of 4 years and a total deficit of 437,500 af. This drought is representative of a 1-in-25 year event and contains the driest year on record, 1954, in terms of native runoff at the Canyon Gage.

Other, more-severe drought events can be simulated by adjusting the runoff amounts in selected years. For example, a 1-in-50 year drought can be simulated by replacing the flow in 1965 with that which occurred in 1964. This increases the total deficit to 548,000 af and increases the duration of drought to 6 years. A 1-in-100 year drought event can be simulated in the selected historic study period by replacing the flow occurring in 1965 with that which occurred in 1954, the driest year on record. The duration of this simulated drought is 7 years and the total deficit is 650,000 af. These parameters are representative of a 1-in-100 year drought event.

There are many definitions of drought and misunderstandings regarding the frequency of occurrence of drought events are common. The drought definition selected for this Study was considered to be straightforward and understandable by the public. The City of Fort Collins adopted the same definition for its recent drought study (Resource Consultants, Inc., 1985).

Frequency is a statistical measure of the likelihood of an event of a given magnitude occurring. As indicated above, both the drought duration and total deficit during the drought period are considered in estimating the frequency of droughts. A 1-in-25 year drought is an event that on average, over the long term, is not expected to occur more often than once in a 25-year period or more often than four times during a 100-year period.

3.3 TRANSBASIN IMPORTS OF WATER

The native flows originating in the Cache la Poudre Basin are supplemented by transbasin water imports from the North Platte River Basin, the Laramie River Basin, and the Colorado River Basin. Together, the transbasin imports bring an average of 157,000 af into the Basin each year, as shown in Table 3.4. The imports, when additional Windy Gap and C-BT imports are included, may increase the total surface water supply on average by 54 percent from approximately 275,600 af (average native flow at the Canyon Gage for the 1951-80 historical study period) to approximately 433,000 af per year. Opportunities exist to increase deliveries of water from the C-BT and Windy Gap facilities provided that additional storage is provided in the Basin. Transbasin diversion data are provided in Appendix A (Tables A.12 through A.19) for the 1951-80 period.

Irrigation water from the Big Thompson River Basin, the next basin south of the Cache la Poudre Basin, reaches the study area via the Louden Ditch and Greeley-Loveland Canal. About 14,400 acres in the Basin are irrigated by these ditches. Water demands for irrigating these lands are not included in the demand analyses described in Chapter 6. Return flows from the lands irrigated by these ditches were accounted for in the simulation modeling described in Chapters 5 and 7. During 1969-84, the City of Greeley imported an average of 4120 af per year from the Big Thompson River Basin for municipal use. Greeley currently imports about 7000 af per year.

3.3.1 Imports to the Upper Basin

3.3.1.1 North Platte River Basin

Water is diverted to the Basin from the North Platte Basin through the Michigan Ditch and the Cameron Pass Ditch. The North Platte River Decree allocates water between Colorado and Wyoming and specifies the amount which

TABLE 3.4
Transbasin Imports to the Basin

Source of Imported Water	Period of Record(1)	Average Delivery (af/yr)
Transbasin Imports into Upper Basin		
From North Platte Basin		
Cameron Pass Ditch	1951-80	123
Michigan Ditch	1951-80	929
From Laramie Basin		
Wilson Ditch	1951-80	2,177
Columbine Ditch(2)	1951-56	(105)
Bob Creek Ditch(2)	1951-56	(312)
Laramie-Poudre Tunnel	1951-80	15,618
Skyline Ditch	1951-80	1,931
From Colorado Basin		
Grand River Ditch	1951-80	17,107
Transbasin Imports into Lower Basin(3)		
C-BT Project	1953-80	88,500
Additional Windy Gap and C-BT(4)	(5)	24,000
Big Thompson Imports to Greeley	1985	7,000
Total		157,385

Note: Imports from the Big Thompson River Basin for irrigation of lands in the Poudre Basin are not included in this tabulation.

(1) Within 1951-80 historic study period.

(2) Not operational now but reportedly could be brought back into operation. Amounts are not included in the total.

(3) Water diverted from the Colorado River Basin by the C-BT and Windy Gap Projects is delivered into the Basin to Horsetooth Reservoir via the Horsetooth Supply Canal.

(4) Conservative estimate of additional Windy Gap and C-BT deliveries developed by the NCWCD, as described in Chapter 5.

(5) Windy Gap began operation in 1985.

may be exported to the South Platte River Basin. The Decree, entered by the Supreme Court on October 8, 1945, limits diversions to any other river basin in Colorado to 60,000 af in any consecutive 10-year period.

The Cameron Pass Ditch diverts water from the Michigan River, a tributary to the North Platte, through Cameron Pass to Joe Wright Creek in the Cache la Poudre Basin. The water is stored in Joe Wright Reservoir and Chambers Lake until needed. The Water Supply and Storage Company owns the Cameron Pass Ditch.

The Michigan Ditch was acquired from North Poudre Irrigation Company by the City of Fort Collins in 1971. It was rehabilitated by the City beginning in 1977. As with Cameron Pass Ditch, Michigan Ditch diverts from the Michigan River through Cameron Pass into Joe Wright Creek and Joe Wright Reservoir.

3.3.1.2 Laramie River Basin

Five transbasin diversions bring water from the Laramie Basin into the Cache la Poudre River. The Laramie River Decree limits the exports of water out of the basin within Colorado. This decree, entered in 1957, allows Colorado users to divert no more than 49,375 af of water annually from the Laramie River, of which only 19,875 af per year may be exported from the basin.

The Wilson Supply Ditch diverts water from Sand Creek and Deadman Creek and delivers it to Sheep Creek in the Cache la Poudre Basin. Diversions from Deadman Creek are subject to the Laramie River Decree, but diversions from Sand Creek are not. The Ditch is owned by the Divide Reservoir and Canal Company.

The Columbine and Bob Creek Ditches, owned by the City of Greeley, have not been operated since 1957, when they were shut down by court order in Wyoming vs. Colorado, 289, U.S. 573. However, the ditches are not on the

1984 Colorado State Engineer's Abandonment List. Columbine Ditch diverted from Deadman Creek to the North Fork of the Cache la Poudre River. Bob Creek Ditch diverted from Nunn Creek to Roaring Fork, a tributary of the Cache la Poudre River.

The Laramie-Poudre Tunnel is operated by the Water Supply and Storage Company in conjunction with the Skyline Ditch, which is owned by the same company. The tunnel receives water from Laramie River tributaries through the Rawah Ditch system and transports it to the Cache la Poudre River eight miles downstream from Chambers Lake. The Skyline Ditch diverts from the Laramie River and a tributary to Chambers Lake. Since 1957, it has exchanged some water for diversion through the tunnel.

3.3.1.3 Colorado River Basin

The Grand River Ditch diverts water from the Colorado River Basin to the Cache la Poudre Basin. Although, historically, Colorado River water rights in Colorado have not had diversions curtailed for the benefit of compacts, future water availability may be affected by two compacts--the 1922 Colorado River Compact, which apportions the river flow between the states in the upper and lower basins, and the 1948 Upper Colorado River Basin Compact, which apportions the flows allocated to the upper basin States. A 1944 Mexican Water Treaty may also affect Colorado River water availability in Colorado.

The Grand River Ditch intercepts runoff along the west side of the Continental Divide, through the 15-mile long North Feeder, which diverts from a number of streams and gulches and the two-mile long South Feeder, which diverts from Speciman Creek. The Ditch transports water through Poudre Pass, discharging it to Long Draw Reservoir. The ditch and reservoir are owned by the Water Supply and Storage Company.

3.3.2 C-BT Project

The C-BT Project was constructed by the USBR during the 1938-56 period and became fully operational in the 1957 irrigation season. Water delivered to the Basin by C-BT facilities is administered by the NCWCD. The NCWCD recently took over the operation of the C-BT facilities from the USBR except for the project power facilities which will continue to be operated by the USBR. C-BT water enters the Basin via the Horsetooth Supply Canal. Water is stored in Horsetooth Reservoir. In an average year, about 88,500 af of water is delivered to the Basin. C-BT water is sold according to a quota system to owners of C-BT units. The quota system is established each year based on expected yields which are variable depending on hydrologic conditions in the Colorado River Basin. Water delivered to an owner of C-BT units cannot be reused by that owner. The water must be returned to the river for use by downstream owners of C-BT units.

3.3.3 Windy Gap Project

The Windy Gap Project was constructed by the Municipal Subdistrict of the NCWCD and was completed in 1985. The Municipal Subdistrict originally contracted with six entities--the cities of Boulder, Greeley, Longmont, Loveland, and Fort Collins and the Town of Estes Park for purchase of the Windy Gap water. Each had a one-sixth allotment and each allotment is 8000 af (total of 48,000 af). The Platte River Power Authority (PRPA) subsequently acquired one-half of the Loveland and Estes Park allotments and the entire Fort Collins allotment. PRPA, therefore, will have a total allotment of 16,000 af. With Greeley, the total allotment to the Basin is 24,000 af. The half allotments remaining with Loveland and Estes Park and the full allotments of Boulder and Longmont account for the remaining 24,000 af.

Windy Gap water is transported into the Basin through C-BT facilities. Unlike C-BT, Windy Gap water can be reused by its owners. The import of Windy Gap water is subject to conveyance capacity limitations in the C-BT system. In order to provide a firm yield of Windy Gap water each year, additional storage will be needed in the Poudre Basin. This is discussed further in Chapter 5.

3.4 WATER RIGHTS CONSIDERATIONS

This section contains a general discussion of water rights and related issues. System operation under these rights is described in Chapter 4.

3.4.1 Direct Flow and Storage Rights

The water resources of the Cache la Poudre Basin (former Water District 3) and all of Colorado are administered by the State Engineer in accordance with water rights established under Colorado's doctrine of prior appropriation. Under this doctrine the first individual who puts a water source to beneficial use may establish the first (highest priority) right to the future use of the water from that source. Subsequent priorities for use of water from the same source then are established by the sequence of further appropriations. Water courts issue decrees which provide the legal right to divert and beneficially use water under a specified priority. Types of water rights include direct flow rights and storage rights. Tributary ground water (i.e., ground water connected to surface supplies) essentially is treated as surface water, in terms of appropriation and adjudication.

The day-to-day administration of the water resources of the Basin is the responsibility of the Water Commissioner for the Basin who reports to the Division Engineer. The South Platte River Basin is Water Division 1 within Colorado. The Division Engineers report directly to the State Engineer.

The State Engineer is charged, under State statute, with facilitating "maximum water utilization". This is achieved through the use of certain administrative options that enable more beneficial water use than could be achieved under strict adherence to water right priorities. However, these options are employed in a manner such that adjudicated water rights are not injured. The key administrative options are "out-of-priority" storage and exchanges of water. Storing water out of priority maximizes use of the most efficient reservoirs by minimizing evaporation and seepage losses. Exchanges normally involve a downstream senior right holder using water stored in an upstream junior right holder's reservoir while the junior right holder diverts water from the river under the senior right holder's direct flow water right.

Specific direct flow and storage rights are described in Chapter 4. There are several important storage decrees that are conditional as shown in Table 3.5 These are important in evaluating a potential new storage project in the Basin because these rights would be senior to any new filing.

Application by the NCWCD for surface water rights for the Glade Reservoir Feeder Tunnel, Cache la Poudre Forebay and Afterbay Reservoirs, and Glade Reservoir are on file in Water Division 1. These facilities are part of a multi-purpose plan of development under study by the NCWCD. The applications state an appropriation date of June 14, 1985 and claim the following amounts:

Glade Reservoir Feeder Tunnel - 6000 cfs
Cache la Poudre Forebay - 50,000 af
Cache la Poudre Afterbay - 89,600 af
Glade Reservoir - 500,000 af

The forebay structure is the upper reservoir for a proposed pumped-storage hydroelectric development located on a small tributary to the mainstem Cache la Poudre River near Greyrock Mountain. The afterbay is the lower reservoir located on the mainstem in the vicinity of the previously noted Grey Mountain site near the Mouth of the Poudre Canyon. Glade Reservoir is an off-channel facility near Owl Canyon which would be supplied by water diverted from the mainstem through the feeder tunnel.

TABLE 3.5
Important Conditional Storage Decrees and Filings

Reservoir	River	Storage Amount (af)	Appropriation Date	Adjudication Date
South Platte Basin:				
Narrows[1]	So. Platte	718,147	9/57	7/70
Hardin[2]	So. Platte	350,570	6/63	3/70
Narrows[2]	So. Platte	100,000	7/75	6/78
Hardin	So. Platte	841,500	12/81	Pending
Cache la Poudre Basin:				
Little So. Fork[3]	So. Fork Cache la Poudre	4,550	9/62	12/72
Rockwell	So. Fork Cache la Poudre	4,900	10/51	12/77
Sheep Creek[4]	Sheep Creek	532	12/77	9/79
Grey Mountain	Cache la Poudre	220,000	5/80	Pending
Idylwilde	Cache la Poudre	180,000	5/80	Pending

(1) Contested.
(2) Portion of larger project.
(3) Common site with Rockwell Reservoir.
(4) Would utilize exchange rights.

3.4.2 Alternate Points of Storage

A new reservoir in the Basin, located above the existing plains reservoirs, could serve as an alternate point of storage for one or more of the plains reservoirs. A Water Court decree would be needed to accomplish this. Benefits attributable to better water management could be achieved under this arrangement because of reduced evaporation and seepage losses and greater operational flexibility in terms of exchanges of water among right holders.

3.4.3 Plans for Augmentation

Another factor important to water rights in the Basin are Plans for Augmentation which cover the withdrawal of water from ground water aquifers connected hydraulically to surface water supplies. Legislation passed in 1969 (Water Right Determination and Administration Act of 1969) requires that each large capacity well be included in an approved Plan for Augmentation, which usually necessitates each well owner (or group of owners) to estimate the amount of water he will pump from each well (or group of wells). The purpose of the 1969 Act was to bring wells diverting ground water tributary to surface streams into the same priority system as surface water diversions. In general, wells are very junior in priority to surface rights and a strict administration of the wells in the priority system would result in their curtailment most of the time. The Plan for Augmentation approach allows each well owner to provide replacement or augmentation water to the stream at times senior rights would otherwise be "calling out" his well, thus keeping the senior rights from being injured while still allowing the junior rights to continue to divert.

3.5 GROUND WATER

Ground water is an important resource in the Cache la Poudre study area. For ground water discussions, the study area is defined as the topographic Basin plus that area outside and east of the Basin which receives irrigation water from ditches supplied by the Cache la Poudre River. These ditches are the Larimer County, Larimer and Weld, Greeley No. 2, and Ogilvy which together serve about 67,000 acres of land outside the topographic Basin.

Development of the ground water resource began in 1885; however, the greatest well construction occurred in the 1930's and 1950's when drought conditions prompted farmers to find additional sources of supply to supplement short surface water supplies. There were nearly 600 wells in the study area by 1940 and 1300 by 1959. There are now about 1600 wells in the study area. Very little well construction has occurred since 1965 due primarily to the fact that the aquifers are nearing full development but also because of legal restrictions. There are very few wells in the upper basin.

3.5.1 Occurrence of Ground Water

Virtually all of the wells in the study area tap the seven aquifers shown on Figure 3.2. These aquifers are:

- Cache la Poudre valley fill and terrace deposits;
- Boxelder Creek valley fill deposits;
- Lone Tree Creek valley fill deposits;
- Spring Creek valley fill deposits;
- Buckeye terrace pediment deposits;
- Crow Creek valley fill deposits; and
- Harmony terrace pediment and fan deposits.

Well locations are shown on Figure 3.3.

3.5.2 Saturated Thickness

The aquifers of the study area are shallow. The thickest aquifer is the Boxelder Creek valley fill. A saturated thickness map (Hurr and Schneider, 1975) shows saturated thicknesses ranging from 40 to over 80 feet in the Boxelder Creek valley fill and up to about 30 feet in the Buckeye Terrace aquifer. Saturated thickness maps have not been published for other aquifers in the study area. The lower portion of the Spring Creek/Lone Pine Creek valley fill is believed to have saturated thicknesses from 40 to 60 feet. Generally all of the other aquifers have saturated thicknesses of less than 40 feet.

3.5.3 Depth to Water

Depth to water normally ranges between a few feet to about 40 feet depending on the well location, season, and intensity of pumping. Depth to water maps have not been prepared for aquifers in the Basin; however, records are available from the USGS for several observation wells. Water levels in these observation wells are available from about 1940 to the present time. A downward trend in water levels occurred until 1957. The lowering of ground water levels was as much as 35 feet rendering many wells useless because of the limited saturated thicknesses of the aquifers. Water levels recovered rapidly when C-BT water was introduced into the Basin in the mid-1950's. Water levels now are stabilized, indicating a good balance between withdrawals and recharge.

3.5.4 Ground Water Storage and Recharge

Total ground water storage is estimated conservatively to be in excess of 400,000 af. Storage in individual aquifers is summarized below:

Aquifer	Aquifer Storage (af)
Boxelder Creek	100,000[1]
Buckeye Terrace	30,000[1]
Spring Creek and Lone Tree Creek	125,000
Harmony Terrace	25,000
Crow Creek	40,000
Cache la Poudre	100,000
Total	420,000

[1] From Hurr and Schneider, 1977. Other storage volumes are more approximate.

Recharge occurs primarily from irrigation applications and seepage from ditches and reservoirs. Because water levels are remaining fairly constant, recharge is about equal to annual pumpage.

3.5.5 Ground Water Quality

The only data on ground water quality known to be available in the study area is for the Boxelder Creek aquifer. The quality of the ground water in this aquifer varies considerably with location but follows a pattern closely related to the amount of ground water use and reuse. TDS and hardness concentrations are lowest in the upper portions of the aquifer and highest in the lower portion. Concentrations of TDS range from 1000 to 2000 mg/l and hardness from 500 to 2300 mg/l. High concentrations of selenium, up to .044 mg/l, have been found near Wellington. State and Federal standards specify a maximum of .01 mg/l for drinking water supplies. Boron concentrations ranging from 0.15 to 0.5 mg/l have been found in selected water samples. Water quality indicators in the ground water of the Boxelder Creek aquifer are shown on Figure 3.3, based on information published by Hurr and Schneider (1977).

3.5.6 Pumpage Estimates

Pumpage in 1985 from wells located under ditch systems in the study area was about 127,000 af based on pumpage records for wells covered under augmentation plans (which averaged 78 af per well) and an assumed average pumpage by the wells adjudicated in 1953 of 100 af per year per well. It has been assumed that pumpage during 1980 was equivalent to that for 1985. The annual variation in pumpage then was estimated based on pumping energy consumption figures for each year as a percentage of the 1980 energy consumption. Estimated pumpage in 1985 under each ditch system is shown in Table 3.6.

3.5.7 Conjunctive Use Opportunities

The historic role of ground water in the Basin has been to supplement surface water supplies. Most irrigators having wells also have rights to

TABLE 3.6

Estimated 1985 Pumping Under Ditch Systems[1]
(in Acre-Feet per Year)

Ditch System	Inside Basin	Outside Basin	Total
North Poudre	19,600	--	19,600
Larimer County	11,200	21,180	32,380
Larimer & Weld	17,340	14,250	31,590
Greeley No. 2	11,750	20,700	32,450
Lake	2,390	--	2,390
Jackson	440	--	440
Larimer County No. 2	570	--	570
New Mercer	10	--	10
Pleasant Valley & Lake	40	--	40
Arthur	510	--	510
Boxelder	220	--	220
Greeley No. 3	1,610	--	1,610
Ogilvy	--	2,300	2,300
	65,680	58,430	124,110
Est. pumpage above ditches	--	2,510	2,510
Total			126,620

[1] Estimate prepared 1/30/86.

surface supplies and, because of the interrelationships between the surface and ground water supply systems, a certain amount of unplanned conjunctive use already occurs. Recharge of the aquifers of the lower basin results primarily from the application of irrigation water and seepage from ditch systems supplied from surface water sources of supply.

A key element in planning for enhanced conjunctive use is the concept of safe yield. Although there are many definitions of safe yield, the most appropriate for the Cache la Poudre Basin is considered to be the amount of water that can be withdrawn from the aquifer without producing an undesired result, such as unwanted lowering of the water table, degradation of water quality, reduction of streamflows, or other effects.

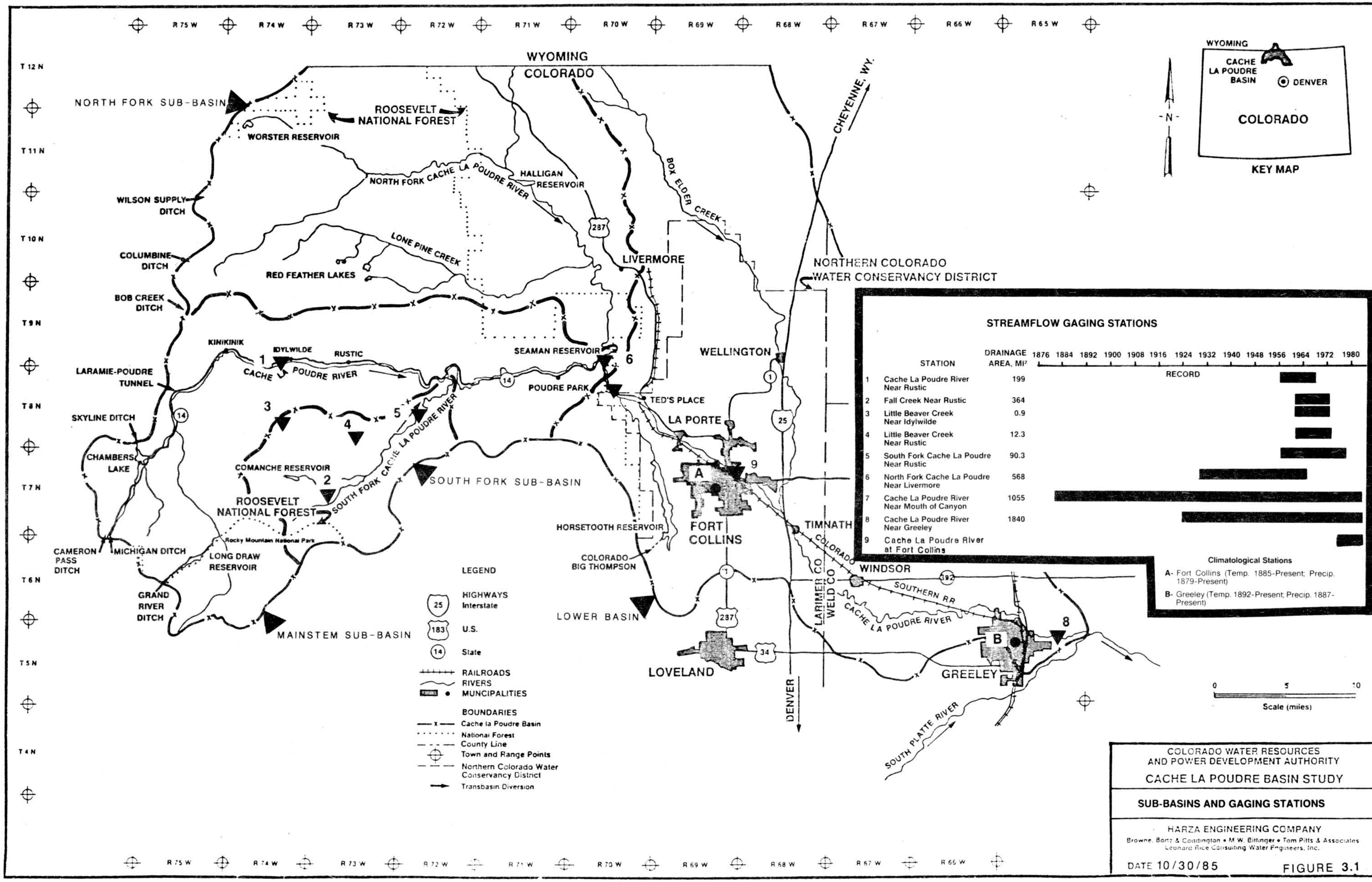
The safe yield of the study area aquifers is estimated to be 110,000 af which is the average annual pumpage for the last 26 years when water levels in the aquifers have remained constant. This yield is highly dependent on continued application of irrigation water obtained from surface sources of supply in the same ways and amounts as historically applied.

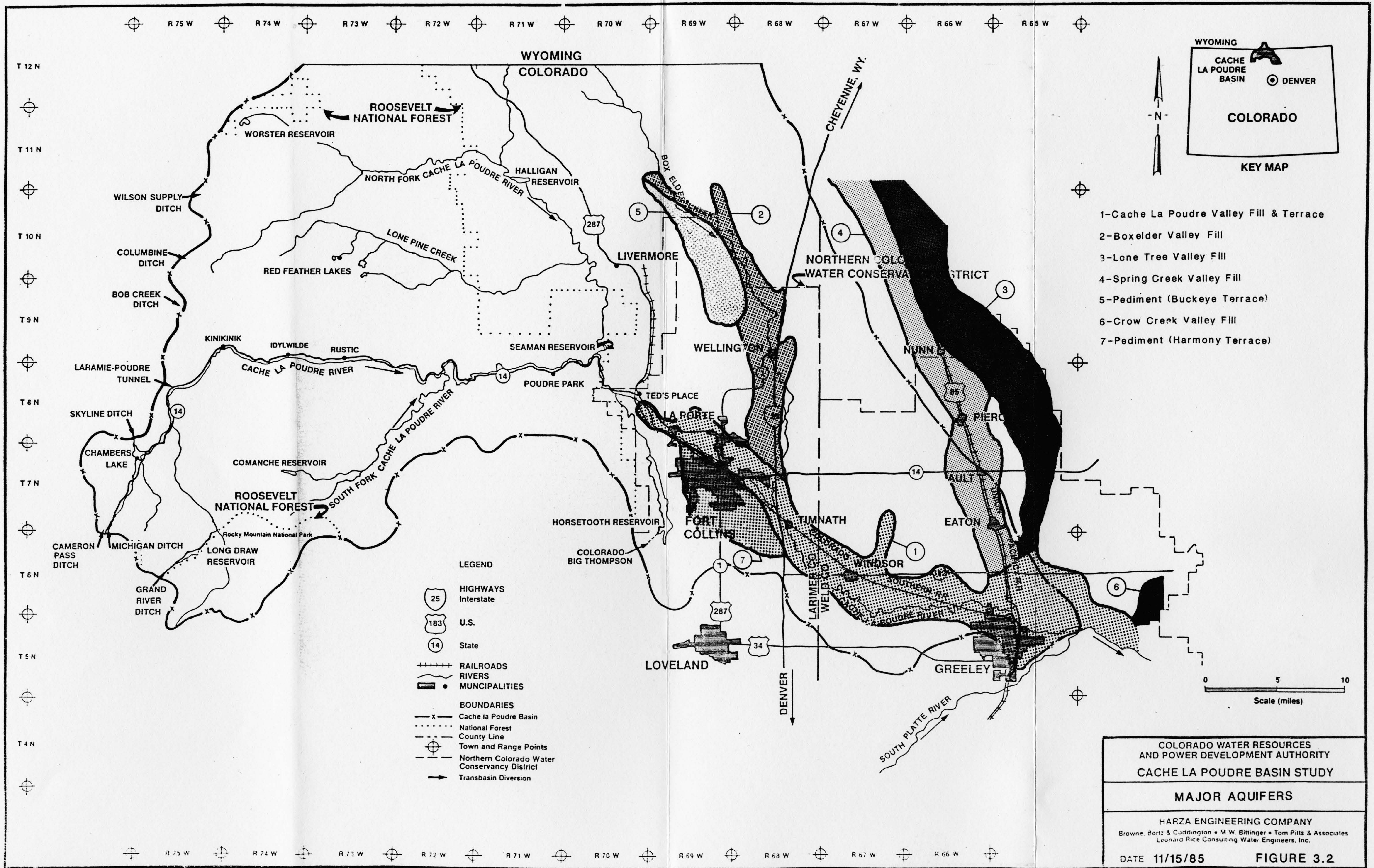
Additional pumping from the aquifers probably would affect streamflows. Further development of the aquifers, above present pumping levels, is legally restricted unless additional water is pledged as augmentation water. Reduction in pumping below present levels probably would not cause material improvement in ground water quality. Therefore, the present use of ground water in the Basin is believed to be at a reasonable safe yield level.

Efficient recharge would be important for any recharge operation. An ideal recharge operation would involve transferring water from surface water storage reservoirs during the Fall and Winter months. This would provide relatively sediment-free water for the recharge operation and enable certain surface reservoirs to be used more effectively. Various legal considerations will need to be addressed including transfer of storage rights from surface reservoirs to ground water reservoirs and modifying existing Plans for Augmentation or preparing new Plans.

Of all the questions that need to be resolved in implementing a planned conjunctive use program, including legal, economic and institutional questions, the one which may be the most difficult could be that of water quality. The increased use of ground water may increase the water quality degradation rate.

Because of the ground water quality problem, any planned conjunctive use operation should include, in its long-range plans, techniques to improve ground water quality. In fact, such planning should be involved in any long-range basin planning if even the existing ground water utilization is to be maintained. The concept that the aquifer storage space is as much of a valuable natural resource as the water contained in that storage space needs to prevail. Conjunctive use is a key element in the selected plan for future water management in the Basin and was incorporated in each alternative plan studied. Because conjunctive use does not involve large investments and involves enhancing the utilization of an already developed resource, it is considered to be an non-structural plan element, as described in Chapter 10.


WYOMING
COLORADO
NORTH FORK SUB-BASIN
ROOSEVELT NATIONAL FOREST
WORSTER RESERVOIR
NORTH FORK CACHE LA POUDRE RIVER
HALLIGAN RESERVOIR
WILSON SUPPLY DITCH
LONE PINE CREEK
RED FEATHER LAKES
COLUMBINE DITCH
BOB CREEK DITCH
LIVERMORE
BOX ELDER CREEK
CHEYENNE, WY.
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
KINIKINIK
IDYLWILDE
RUSTIC
SEAMAN RESERVOIR
WELLINGTON
LARAMIE-POUDRE TUNNEL
CACHE LA POUDRE RIVER
POUDRE PARK
TED'S PLACE
LA PORTE
SKYLINE DITCH
CHAMBERS LAKE
COMANCHE RESERVOIR
SOUTH FORK CACHE LA POUDRE RIVER
SOUTH FORK SUB-BASIN
ROOSEVELT NATIONAL FOREST
Rocky Mountain National Park
HORSETOOTH RESERVOIR
FORT COLLINS
TIMNATH
CAMERON PASS DITCH
MICHIGAN DITCH
LONG DRAW RESERVOIR
COLORADO BIG THOMPSON
WINDSOR
COLORADO SOUTHERN RR
GRAND RIVER DITCH
LOWER BASIN
LARIMER CO
WELD CO
CACHE LA POUDRE RIVER
MAINSTEM SUB-BASIN
LOVELAND
GREELEY
DENVER
SOUTH PLATTE RIVER
LEGEND
HIGHWAYS
Interstate
U.S.
State
RAILROADS
RIVERS
MUNCIPALITIES
BOUNDARIES
Cache la Poudre Basin
National Forest
County Line
Town and Range Points
Northern Colorado Water Conservancy District
Transbasin Diversion
WYOMING
CACHE LA POUDRE BASIN
DENVER
COLORADO
KEY MAP
N
STREAMFLOW GAGING STATIONS
STATION
DRAINAGE AREA, MI²
1876 1884 1892 1900 1908 1916 1924 1932 1940 1948 1956 1964 1972 1980
RECORD
1 Cache La Poudre River Near Rustic 199
2 Fall Creek Near Rustic 364
3 Little Beaver Creek Near Idylwilde 0.9
4 Little Beaver Creek Near Rustic 12.3
5 South Fork Cache La Poudre Near Rustic 90.3
6 North Fork Cache La Poudre Near Livermore 568
7 Cache La Poudre River Near Mouth of Canyon 1055
8 Cache La Poudre River Near Greeley 1840
9 Cache La Poudre River at Fort Collins
Climatological Stations
A- Fort Collins (Temp. 1885-Present; Precip. 1879-Present)
B- Greeley (Temp. 1892-Present; Precip. 1887-Present)
0 5 10
Scale (miles)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
SUB-BASINS AND GAGING STATIONS
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 10/30/85
FIGURE 3.1



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

MAJOR AQUIFERS

HARZA ENGINEERING COMPANY

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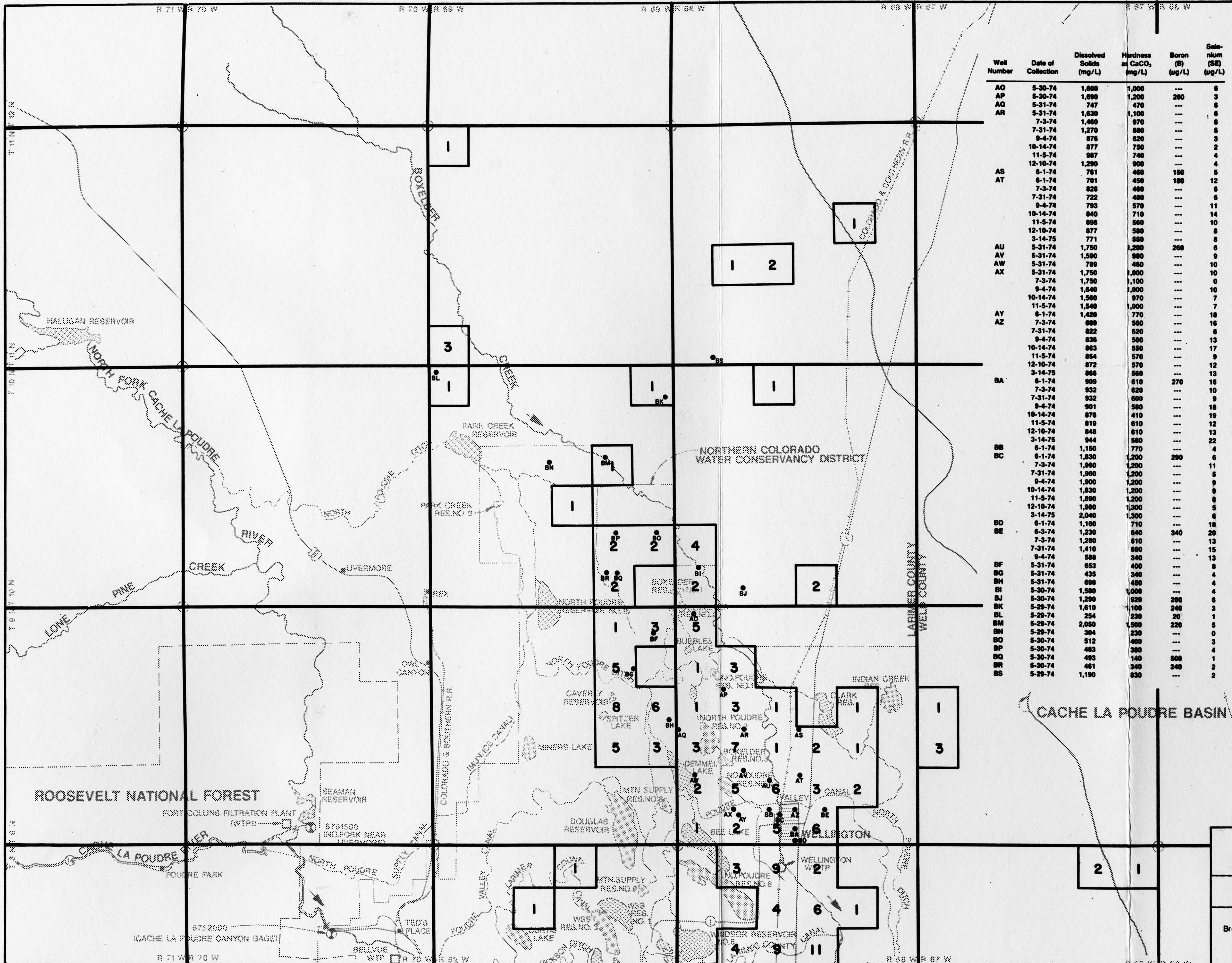
Leonard Rice Consulting Water Engineers, Inc.

DATE 11/15/85 FIGURE 3.2



Well Number	Date of Collection	Dissolved Solids (mg/L)	Hardness as $CaCO_3$ (mg/L)	Boron (B) (µg/L)	Selenium (SE) (µg/L)
AO	5-30-74	1,600	1,000	---	6
AP	5-30-74	1,690	1,200	260	3
AQ	5-31-74	747	470	---	6
AR	5-31-74	1,630	1,100	---	6
	7-3-74	1,460	970	---	6
	7-31-74	1,270	880	---	5
	9-4-74	876	620	---	3
	10-14-74	877	750	---	2
	11-5-74	987	740	---	4
	12-10-74	1,290	900	---	4
AS	6-1-74	761	460	150	5
AT	6-1-74	701	450	180	12
	7-3-74	828	460	---	6
	7-31-74	722	480	---	6
	9-4-74	793	570	---	11
	10-14-74	840	710	---	14
	11-5-74	898	560	---	10
	12-10-74	877	580	---	8
	3-14-75	771	550	---	8
AU	5-31-74	1,750	1,200	260	6
AV	5-31-74	1,590	980	---	9
AW	5-31-74	789	460	---	10
AX	5-31-74	1,750	1,000	---	10
	7-3-74	1,750	1,100	---	0
	9-4-74	1,640	1,000	---	10
	10-14-74	1,560	970	---	7
	11-5-74	1,540	1,000	---	7
AY	6-1-74	1,420	770	---	18
AZ	7-3-74	699	560	---	16
	7-31-74	822	520	---	6
	9-4-74	836	560	---	13
	10-14-74	863	550	---	17
	11-5-74	854	570	---	9
	12-10-74	872	570	---	12
	3-14-75	866	560	---	13
BA	6-1-74	909	610	270	16
	7-3-74	932	620	---	10
	7-31-74	932	600	---	9
	9-4-74	901	580	---	18
	10-14-74	876	410	---	19
	11-5-74	819	610	---	12
	12-10-74	848	610	---	13
	3-14-75	944	580	---	22
BB	6-1-74	1,150	770	---	4
BC	6-1-74	1,830	1,200	290	6
	7-3-74	1,960	1,200	---	11
	7-31-74	1,960	1,200	---	5
	9-4-74	1,900	1,200	---	9
	10-14-74	1,830	1,200	---	9
	11-5-74	1,890	1,200	---	8
	12-10-74	1,980	1,300	---	5
	3-14-75	2,040	1,300	---	6
BD	6-1-74	1,160	710	---	18
BE	6-3-74	1,230	640	340	20
	7-3-74	1,280	610	---	13
	7-31-74	1,410	690	---	15
	9-4-74	588	340	---	13
BF	5-31-74	653	400	---	8
BG	5-31-74	435	340	---	4
BH	5-31-74	698	450	---	4
BI	5-30-74	1,580	1,000	---	4
BJ	5-30-74	1,290	920	280	6
BK	5-29-74	1,610	1,100	240	3
BL	5-29-74	254	230	20	1
BM	5-29-74	2,050	1,500	220	5
BN	5-29-74	304	230	---	0
BO	5-30-74	512	400	---	3
BP	5-30-74	483	380	---	4
BQ	5-30-74	493	140	500	1
BR	5-30-74	461	340	240	2
BS	5-29-74	1,190	830	---	2

COLORADO WATER RESOURCES
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CACHE LA POUDRE BASIN STUDY

WELL LOCATIONS AND WATER QUALITY INDICATORS

HARZA ENGINEERING COMPANY
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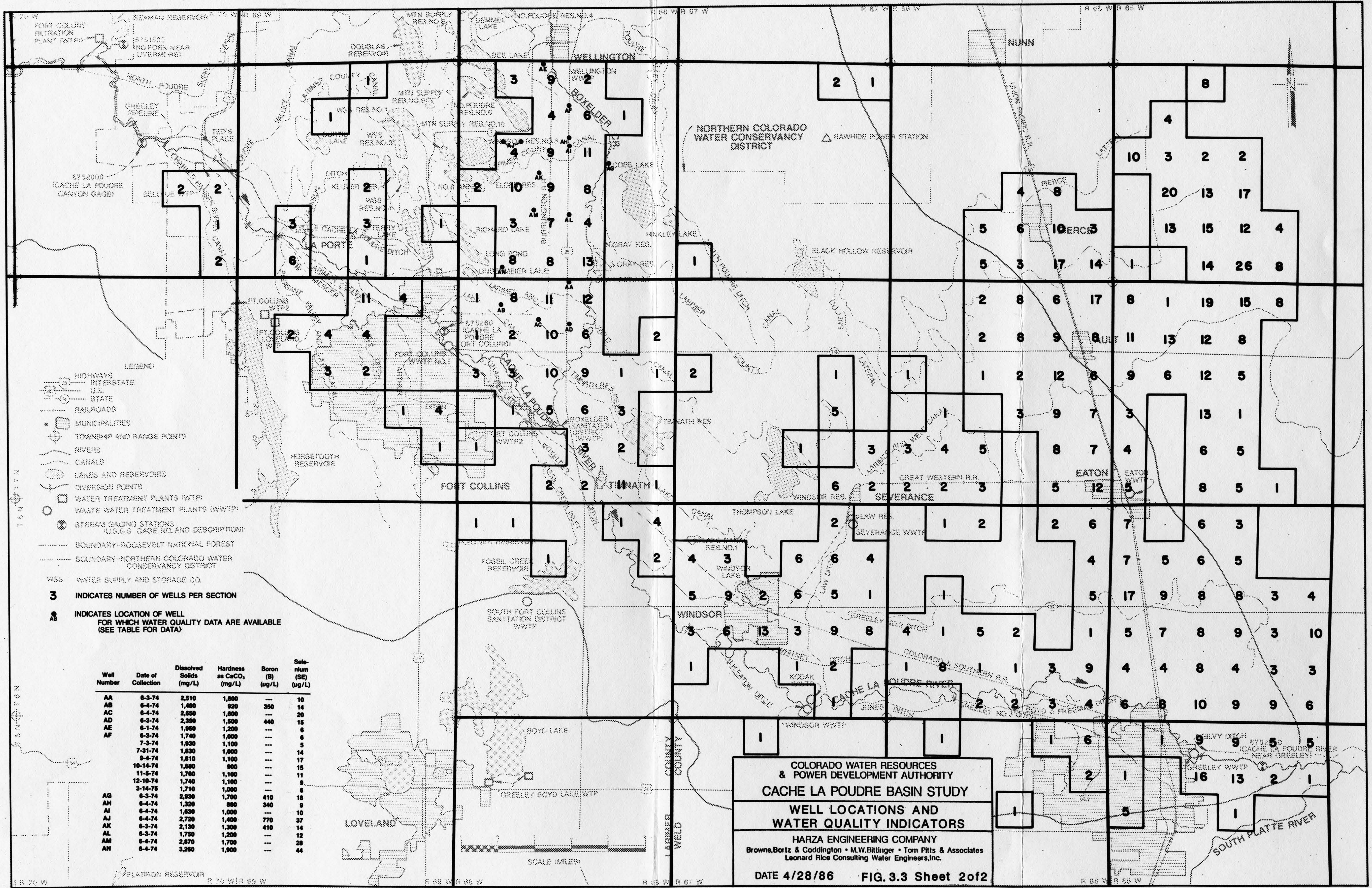
Leonard Rice Consulting Water Engineers,Inc.

DATE 4/28/86 FIG. 3.3 Sheet 1of2



Well Number	Date of Collection	Dissolved Solids (mg/L)	Hardness as $CaCO_3$ (mg/L)	Boron (B) (µg/L)	Selenium (SE) (µg/L)
AA	6-3-74	2,510	1,600	---	10
AB	6-4-74	1,480	920	350	14
AC	6-4-74	2,650	1,600	---	20
AD	6-3-74	2,390	1,500	440	15
AE	6-1-74	1,950	1,200	---	6
AF	6-3-74	1,740	1,000	---	6
	7-3-74	1,930	1,100	---	5
	7-31-74	1,830	1,000	---	14
	9-4-74	1,810	1,100	---	17
	10-14-74	1,680	900	---	15
	11-5-74	1,760	1,100	---	11
	12-10-74	1,740	1,100	---	9
	3-14-75	1,710	1,000	---	6
AG	6-3-74	2,930	1,700	410	18
AH	6-4-74	1,320	880	340	9
AI	6-4-74	1,630	1,000	---	10
AJ	6-4-74	2,720	1,400	770	37
AK	6-3-74	2,130	1,300	410	14
AL	6-3-74	1,750	1,200	---	12
AM	6-4-74	2,870	1,700	---	28
AN	6-4-74	3,260	1,900	---	44

COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

WELL LOCATIONS AND
WATER QUALITY INDICATORS

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DATE 4/28/86 FIG. 3.3 Sheet 2of2

Chapter 4

Existing Water Supply Systems

4.0 EXISTING WATER SUPPLY SYSTEMS

4.1 GENERAL

This chapter presents an inventory and description of the physical and administrative systems by which water is stored, delivered, treated and distributed to users in the Basin. The physical systems include those for municipal and industrial (M & I) and agricultural water. Water and wastewater treatment plants and irrigation ditches and reservoirs in the lower basin are shown on Figure 4.1.

In 1984, the most recent year for which complete data is available, water was supplied to an estimated 240,000 inhabitants and 219,000 acres of irrigated lands in the lower basin. Population and irrigated lands in the upper basin are both very small and do not materially alter the above estimates.

Water supply is obtained from runoff occurring in the Basin, from transmountain diversions, and from the Colorado-Big Thompson (C-BT) Project. Transbasin water from the Windy Gap Project, which is delivered through C-BT facilities, was made available to the Basin in 1985. During the historic study period (1951 to 1980), the average annual total supply has been close to 450,000 af. Surface water supplies are augmented from shallow, alluvial aquifers. These aquifers are recharged largely by surface water through irrigation operations.

Water usage from all sources is optimized through a complex but efficient system of direct water rights and exchanges under the administrative control of the Water Commissioner.

Data presented in this chapter and in Appendix B were obtained from published reports, records maintained by the Water Commissioner and others, and from conversations with water users and administrators in the Basin.

4.2 MUNICIPAL AND INDUSTRIAL WATER SYSTEMS

4.2.1 General

The major cities in the Basin are Fort Collins and Greeley, both of which have their own water supply systems. Towns and smaller communities in the basin, including Windsor, Wellington, Ault, Eaton, LaPorte, Timnath, Severance, Rosedale, and Garden City are supplied by either Fort Collins, Greeley, or one of the rural domestic water districts in the Basin. The locations of major water and wastewater treatment facilities are shown on Figure 4.1.

4.2.2 Fort Collins

The service area for Fort Collins roughly comprises the city boundaries, the West Fort Collins Water District area, and the town of LaPorte. Supply is derived from five direct flow decrees on the Poudre River, 11,237 units of C-BT water, and shares in several irrigation companies. Irrigation company shares not needed for meeting current municipal demands are leased back to farmers. Most of these shares have been acquired through the City's policy of requiring developers to turn over to the City sufficient water to meet the needs of the new developments. Water rights and shares are tabulated in Appendix B (Table B.1).

The City owns Joe Wright Reservoir which has a usable capacity of nearly 6500 af and also owns 1200 af in Meadow Creek Reservoir in the Michigan River Basin to provide replacement for out-of-priority Michigan Ditch diversions.

Two raw water treatment plants serve the City. Plant No. 1, located in the Poudre Canyon, receives water from a pipeline with an intake located on the North Fork Poudre River. Plant No. 1, which was constructed in 1904, is scheduled to go out of service in 1986 when a 20 million gallon per day (mgd) expansion of Plant No. 2 is completed. Plant No. 2, located in

Soldier Canyon at Horsetooth Reservoir, receives water directly from that reservoir. Its present capacity is 24 mgd. Two existing pipelines from Plant No. 1 and a new section of pipeline will deliver raw water from the Cache la Poudre River to Plant No. 2.

Treated water demand has increased greatly over the past 25 years reaching a record of about 18,000 af in 1984. Current per capita consumption in Fort Collins is about 190 gallons per capita per day (gcd), excluding raw water used for irrigation. Total water demand, including raw water for irrigation, was about 28,800 af in 1985. Monthly treated water production for the period 1951-1980 is presented in Appendix B, Table B.2.

The City has two wastewater treatment plants. Plant No. 1 is located at Highway 14 and Riverside Avenue. It has a capacity of 5 mgd and discharges into the Poudre River between Coy Ditch and the Timnath Reservoir inlet. Present average daily flow is 4.2 mgd. Plant No. 2 with a capacity of 16 mgd is located at the northern end of the East Drake Road. Its average daily output currently is 8.9 mgd.

Monthly discharge rates for Plants 1 and 2 are presented in Appendix B, Tables B.3 and B.4.

4.2.3 Greeley

The service area for Greeley includes the city limits to the north and east, and an area which comprises Evans, Garden City, and Rosedale to the south. The western limit of the service area extends outside of the city limits. The service area may change as new lands are annexed to the City. Annexed lands are required to have water rights.

Greeley has two water treatment plants -- Bellvue and Boyd Lake. The Bellvue Plant near the town of Bellvue receives water from the Greeley pipeline which has its intake near the mouth of the Poudre Canyon. The Boyd Lake Plant, at the south end of Boyd Lake, is supplied with water obtained from Greeley-Loveland Irrigation Company shares, and both direct flow rights and storage rights in Horseshoe and Boyd Lakes and Lake Loveland. C-BT shares occasionally are diverted through the Boyd Lake Plant. Both plants are in good condition. The Bellvue Plant has a capacity of 30 mgd, only about half of which is being used for treatment at the present time. The Boyd Lake Plant has a capacity of 24 mgd and planning is underway for expansion to a total of 40 mgd.

As shown in Table B.5 (Appendix B), the City's water supply comprises direct flow rights from the Cache la Poudre River, shares in ditch companies, 18,687 shares in C-BT, 80 shares in Windy Gap, wells, and storage rights in several reservoirs. Water from Milton Seaman Reservoir is used mainly for exchange for direct flow or C-BT water and for replacement of overdraws. High sediment concentrations at certain times in Seaman Reservoir limits use of this source of water in the Bellvue Filtration Plant. High mountain reservoir water is usually exchanged with the North Poudre Irrigation Company for C-BT water. Barnes Meadow Reservoir water is normally reserved for winter releases to assure divertable flow at the Bellvue Treatment Plant.

Water demand has increased 75 percent over the past 16 years, reaching about 21,300 af in 1984. Current water consumption averages 288 gcd. The reason for this high per-capita use in comparison to Fort Collins is not known precisely; however, the difference probably is due to differing lot sizes, socio-economic factors, and historical pricing policies. Monthly production for both plants is presented in Appendix B, Tables B.6 and B.7.

Two wastewater treatment plants are in operation in Greeley. The First Avenue Wastewater Treatment Plant handles municipal wastewater. Discharge is into the Poudre River upstream from Ogilvy Ditch. Present output is between 6 and 7 mgd. Expansion of facilities, scheduled for completion in 1985, will bring plant capacity to 12 mgd. The second plant, located about 8 miles east of the City on Lone Tree Creek, receives waste activated sludge from the First Avenue Plant and wastewater from the Monfort Meat Packing Plant in Greeley. Monthly discharges for both wastewater plants are presented in Appendix B, Tables B.8 and B.9.

4.2.4 Windsor

Windsor's population of 4590 (1984) is supplied with treated water by the Fort Collins-Loveland Water District in exchange for C-BT water. Raw water is stored in Horsetooth Reservoir. The town can store 2 million gallons of treated water. Conservation measures are not in effect at the present time. All taps are metered and average comsumption is 140 gcd. There are no intensive water users in the Windsor system.

Windsor is anticipating water shortages. Water rights owned by the town are insufficient to supply potable demand and the town must purchase supplemental water. Another factor limiting the supply of water is Windsor's contract with the Fort Collins-Loveland Water District. This contract provides for a maximum delivery of 2 mgd. Historically, Windsor has experienced a peak demand of about 1.4 mgd. Because peak demand periods happen concurrently in Fort Collins and Loveland, the Fort Collins-Loveland Water District has been strained to deliver even 1.4 million gallons per day to Windsor. In the event of a water shortage, Windsor has a standing agreement with Kodak to exchange C-BT units owned by Kodak for ditch water. The C-BT water would then be treated at Fort Collins Plant No. 2 and sent to Windsor.

The town treats its own municipal wastewater and the domestic waste from the Kodak plant in a treatment plant located on the Poudre River south of the town. The present flow is about 0.75 mgd.

4.2.5 Wellington

Wellington's population of 1450 (1984) is supplied by the North Poudre Canal via Waiverly Ditch in the summer and from North Poudre No. 3 Reservoir in winter. Prior to 1984, Wellington's M & I demands were supplied by well water which continues to supplement irrigation needs. A one mgd treatment plant went into operation in 1984. The town has one million gallons of treated water storage capacity and operates a water softening facility.

Since 1984, all taps have been metered in compliance with requirements of the Farmers Home Loan Administration which helped finance the new water treatment plant. Per capita daily use is 153 gallons. There are no major water users in the system.

The town's wastewater is treated in lagoons south of town. Effluent is discharged to Boxelder Creek. The present flow rate is approximately 0.13 mgd.

4.2.6 Timnath

Timnath's population of 202 (1984) is supplied by the Fort Collins-Loveland Water district. There are no storage facilities. The distribution system normally operates at 70-80 percent of capacity and all taps are metered. The system has no major water users. Wastewater disposal in Timnath is by individual septic systems.

4.2.7 Severance

Severance has a population of 105 people (1984). The North Weld Water District provides treated water directly to the distribution system. There is no storage facility for either raw water or treated water. All taps are metered.

Wastewater is treated in lagoons south of town. The present discharge is about 0.01 mgd to Law ditch which flows to the Poudre east of the town of Windsor.

4.2.8 Rosedale

Rosedale has a population of 34 people. Treated water is supplied by the City of Greeley. All taps are metered. There are no major water users.

4.2.9 Garden City

The City of Greeley supplies treated water to a population of 125 people (1984). All taps are metered. There are no major water users.

4.2.10 Eaton

Eaton's population is 2020 people. The town owns C-BT units and shares of North Poudre Irrigation Company. Raw water is stored in Horsetooth Reservoir and treated for the North Weld Water District at Fort Collins Plant No. 2. In 1984 the town converted to the District supply from a well water system. The system includes storage capacity for 1.5 million gallons of treated water. All taps are metered. System leakage is about 18 percent. Average use is 271 gcd.

Wastewater is treated at a facility east of town. The present effluent flow of about 0.28 mgd is discharged to Eaton Draw, a tributary to the Poudre near Greeley.

4.2.11 Ault

Ault has a population of 1092. In exchange for Big Thompson and North Poudre water rights, the North Weld Water District supplies treated water. Treated water is stored in a 500,000 gallon tower. All taps are metered. system leakage is about 18 percent. There are no major water users. Daily per capita use is 163 gallons.

Wastewater is treated in evaporation lagoons. There is no discharge from these lagoons.

4.3 WATER DISTRICTS AND WATER ASSOCIATIONS

Water districts are created by petition and referendum. They may be formed in part or all of any municipality or county, and have all the powers of municipalities with respect to the purpose for which they are formed.

These may include powers to tax, issue bonds, establish service charges, and serve users outside district boundaries.

Much of Larimer and Weld Counties is served by rural-domestic water districts as shown in Figure 4.2. These districts were organized in the 1960s to provide water to rural areas without adequate supplies under programs sponsored by the Farmer's Home Administration (FHA). Some districts became too large for FHA financing and reorganized as special districts, which cover large areas and may accommodate the addition of many water users. Other rural systems were organized as water associations, which have small service areas and a limited number of customers.

4.3.1 Fort Collins - Loveland Water District

Service Area:	About 60 square miles including the towns of Windsor and Timnath.
Population Served:	About 15,000
Water Sources:	4798 units of C-BT water.
Facilities:	• 1/3 owner of Soldier Canyon Raw Water Treatment Plant • 160 miles of pipeline; 3 to 24 inch diameter
Operation:	Raw water is delivered from Horsetooth Reservoir to the Soldier Canyon Treatment Plant. About 3170 af were treated for the District in 1984.

4.3.2 East Larimer County Water District (ELCO)

Service Area:	About 75 square miles.
Water Sources:	• 2814 shares of C-BT • 342.25 shares of North Poudre Irrigation Company
Facilities:	• 1/3 owner of Soldier Canyon Raw Water Treatment Plant. • Two pipelines from Plant to District. • 24 inch with 7.4 mgd capacity • 14 inch with 2.5 mgd capacity

Operation:

- North Poudre Irrigation shares are exchanged for C-BT units owned by North Poudre Irrigation Company. C-BT units are delivered from Horsetooth Reservoir to the Treatment Plant. In the 1983-84 irrigation year, ELCO delivered 2231 af of treated water.
- Wastewater returns to the Boxelder Waste Water Treatment Plant average 750,000 gpd. The plant discharges into Boxelder Creek.
- ELCO currently is enlarging delivery capacity to the Northern Colorado Water Association to 500 gallons per minute (gpm).

4.3.3 Northern Colorado Water Association (NCWA)

Service Area: About 60 square miles.

Population Served: About 2400

Water Sources:

- 2 wells, 15 miles north of Wellington
  Well No. 1 - 400 gpm
  Well No. 2 - 200 gpm (being reconditioned to decreed 359 gpm)
- 38 shares of North Poudre Irrigation Company
- 2 units C-BT

Facilities:

- Wells as described above
- 160 miles of pipeline

Operation: Wells serve the northern part of the service area. ELCO treats and delivers 2 C-BT and 10 North Poudre Irrigation Company (NPIC) shares to a 100,000 gallon storage tank. ELCO and NCWA are currently enlarging delivery capability to receive the remaining 28 shares of NPIC water. The annual amount pumped is not recorded but it is believed to be about 300 af.

4.3.4 West Fort Collins Water and Sanitation District

Service Area: About 30 square miles.

Population Served: About 4000

Water Sources:
- 1110 units of C-BT
- 30 shares North Poudre Irrigation Company

Facilities:
- Delivery facilities for 2.5 mgd
- 2 - 100,000 gallon storage tanks
- 1 - 50,000 gallon storage tank

Operation: Treated water is received from City of Fort Collins Plant No. 1 through internal exchange of C-BT units. In 1984, 147.8 million gallons were delivered.

4.3.5 North Weld County Water District

Service Area: More than 300 square miles

Population Served: About 9000

Water Sources:
- 2153 units of C-BT
- 427.5 shares of North Poudre Irrigation Company

Facilities:
- 1/3 owner of Soldier Canyon Raw Water Treatment Plant
- 24 inch main to District's system (capacity about 7 mgd with pump stations)

Operation: C-BT and North Poudre Irrigation Company shares delivered to Soldier Canyon Plant. North Poudre Irrigation Company shares are exchanged for C-BT water owned by North Poudre. Delivery in 1985 was about 1020 million gallons.

4.3.6 Spring Canyon Water and Sanitation District

Service Area: 2.5 square miles

Population Served: About 1000 people

Water Sources:	• 43 units of C-BT • 7.5 shares in North Poudre Irrigation Company	
Facilities:	200,000 gallon per day raw water treatment plant on South Shoreline Road, southwest of Horsetooth Reservoir.	
Operation:	Water is obtained from Charles Hanson Feeder Canal 1000 feet upstream from discharge to Horsetooth Reservoir. North Poudre shares are exchanged for C-BT units owned by North Poudre.	

4.4 WATER CONSERVANCY DISTRICTS

Water conservancy districts are quasi-municipal corporations formed by State legislation for the conservation of water resources and to promote the greatest beneficial use of water. Conservancy districts may levy property taxes or collect assessments, contract for the construction of water supply and distribution facilities, acquire water rights, and operate facilities. The districts have the power of eminent domain and may contract with water users for delivery of water.

4.4.1 Northern Colorado Water Conservancy District

The Northern Colorado Water Conservancy District (NCWCD) was formed in 1937 as an agency for promoting, financing, contracting for construction, and administering a supplemental water supply for water users in Northern Colorado. The District includes 25 communities and nearly 1,500,000 acres of land in the irrigated agricultural areas in the vicinity of the St. Vrain, Big Thompson, Cache la Poudre, Boulder and Platte Rivers from near Platteville to the Colorado-Nebraska border. Figure 4.3 shows the NCWCD boundaries and their relationship to the Cache la Poudre Basin.

The NCWCD is governed by a board of directors appointed by the District Court of Colorado. Funding for the NCWCD comes from a one mill ad valorem tax on properties within the boundaries, and from revenue received for the rental of water. The NCWCD operates and maintains the water conveyance facilities associated with the C-BT Project.

The C-BT Project diverts surplus waters from the headwaters of the Colorado River and imports them into the Big Thompson River, a tributary to the South Platte River. The project consists of a series of pumps, turbines, reservoirs and conveyance facilities, as shown in Figure 4.3. Water is captured in Willow Creek Reservoir and pumped for storage to Lake Granby. The Willow Creek Reservoir water and the water captured by Lake Granby is then pumped to Shadow Mountain Lake and Grand Lake. Water is subsequently released into the Alva B. Adams Tunnel and delivered to the east slope, by gravity flow, to Mary's Lake and then to Lake Estes. From Lake Estes, the water is conveyed via pipeline to Flatiron Reservoir. At this point, a portion of the water is delivered north to Horsetooth Reservoir in the Cache la Poudre Basin and the remaining portion is pumped south to Carter Lake.

Full operation and official deliveries of C-BT Project water began in the 1957 irrigation season. However, water was delivered to the Basin as early as 1952 according to diversion records.

The hydropower generation facilities on the east slope portion of the C-BT Project are located at Mary's Lake (8.1 MW installed capacity), Lake Estes (45 MW), Flatiron Reservoir (63 MW), Big Thompson (4.5 MW), and Pole Hill (33.25 MW). Also, there is a reversible pumping unit (8.5 MW) located at Flatiron Reservoir from which water can be pumped to Carter Lake. When the flow is reversed, the pump acts as a turbine and generates electricity. Water is also released from Flatiron to flow by gravity to Horsetooth Reservoir, through the Charles Hansen Supply Canal. The NCWCD has assumed responsibility for the operation and maintenance of the entire project with the exception of power facilities which remain the responsibility of the U.S. Bureau of Reclamation.

The amount of water delivered each year to an owner of C-BT units varies according to the need for supplemental water. One unit of C-BT water is defined as 1/310,000th of the annual water supply produced by the C-BT Project. Each year, the NCWCD Board of Directors declares a quota for delivery of water upon demand by the owners of certified C-BT units. The quota has varied from 100 percent (1.0 af per unit) in a dry year, when the demand for supplemental water contained in storage is high, to around 60 percent (0.6 af per unit), in wet years when the demand for supplemental water is lower. In past years, the Bureau of Reclamation attempted to deliver as much water to the east slope as possible every year, but the NCWCD only distributed the water according to its demand forecasts. In some years, an initial quota may be revised upward to meet actual demands for supplemental water.

During the 1953-80 period, water deliveries to the Cache la Poudre Basin from Horsetooth Reservoir have ranged from a low of approximately 53,000 af in 1979 to a high of about 140,000 af in 1954, based on diversion records maintained by the Water Commissioner. The average delivery was 88,500 af.

Water delivered to owners of C-BT units can only be used once by that owner, that is, the irrigation return flow must be allowed to return to the river system to be used by downstream C-BT unit owners. Specifically, "the right is reserved on behalf of the District to capture, recapture, use and reuse the .... added supply so often as it may appear at the stream intake headgates of ditches and reservoirs serving lands within the District". The return flow water shall be "allocated only to the irrigable lands within the District already being partially supplied with water for irrigation .... provided no such captured, recaptured or return flow water shall be taken and held as supplying any appropriation or decreed priority of any such ditch or reservoir". (Bureau of Reclamation, 1938.)

Horsetooth Reservoir is the controlling reservoir for deliveries to the Cache la Poudre River. When water users call for their C-BT water, the NCWCD releases water from Horsetooth Reservoir into the Charles Hansen Supply Canal, which discharges to the Cache la Poudre River. A few users divert from the Hansen Supply Canal before it reaches the river, and some releases are also made from one of the Horsetooth Reservoir saddle dams (Soldier Canyon Dam) to Colorado State University and two water filtration plants. North Poudre Irrigation Company diverts Poudre River water upstream of the Hansen Supply Canal outlet and releases its C-BT water to the river.

4.4.2 Municipal Subdistrict of the NCWCD

The Municipal Subdistrict of the NCWCD was organized on July 6, 1970. Under the provisions of the Water Conservancy Act, a subdistrict thus formed is an independent and separate conservancy district with the same legal standing and powers as the parent district. The Subdistrict was formed for the purpose of developing a supplemental water supply, the Windy Gap Project, for use by the participating municipalities or their assignees.

In 1975, the Subdistrict entered into individual water allotment contracts with the Cities of Boulder, Greeley, Longmont, Loveland, Fort Collins, and the Town of Estes Park. The Platte River Power Authority subsequently acquired one-half of the allotments of Loveland and Estes Park, and the entire Fort Collins allotment. Each water allotment contract provides that a specified share of water developed by the Subdistrict through Windy Gap is allocated to the owner of the contract, for which the owner will pay annually a corresponding share of the Subdistrict's annual costs related to the Windy Gap Project.

The Windy Gap Project began operation in 1985. It consists of a diversion dam on the Colorado River and associated conveyance facilities to transport the diverted water to Lake Granby. Further conveyance is through C-BT Project facilities. The Windy Gap facilities include:

- Windy Gap Reservoir - formed by a diversion dam located on the Colorado River with 320 af live storage capacity, a surface area at normal maximum pool of 160 acres, maximum height of 25 feet and a spillway capacity of 32,400 cfs (one-half of the probable maximum flood).

- Pumping Plant - located on the right abutment of the diversion dam, with four pumps, each rated at 150 cfs, for 600 cfs total capacity.

- Windy Gap-Lake Granby Pipeline -- a 9-foot diameter, 30,000-foot long pipeline.

- Lake Granby Inlet Works - the Windy Gap Project connects with an existing inlet facility to Lake Granby, of which 600 cfs capacity is reserved for Windy Gap water.

During the months of April through July, it is anticipated that flows of the Colorado River will be high enough to allow diverting up to 600 cfs in priority under the Subdistrict's water rights. These water rights are: Civil Action No. 1768, 300 cfs, priority date 6-22-1967; Case No. W-4001, 100 cfs, priority date 7-9-1976; and Case No. 80CW108, 200 cfs, priority date 4-30-1980; all conditional.

Deliveries to the project's participants are based upon the number of units owned and allotted according to the water allotment contract. One unit is defined as 1/480th of the water supply annually produced by Windy Gap and made available by the Subdistrict. The average supply is estimated to be 48,000 af per year. Boulder, Greeley and Longmont each own 80 Windy Gap units (8000 af), Estes Park and Loveland each own 40 units (4000 af), and the Platte River Power Authority owns 160 units (16,000 af).

Water yield from Windy Gap units will be variable as with C-BT units. The water can be used for municipal, domestic, irrigation or industrial purposes. Unlike C-BT water, the water from Windy Gap may be reused by its owners.

4.4.3 Central Colorado Water Conservancy District

The Central Colorado Water Conservancy District (CCWCD) was formed in 1964 for the purpose of conserving, developing, stabilizing, and acquiring supplies of water for domestic, irrigation, power, industrial and other beneficial uses. The District contains nearly 100 square miles along the South Platte River.

The involvement of the CCWCD in the Poudre Basin is minimal. In the past, it has leased water from the Greeley No. 3 Irrigation Company. During 1981 through 1983, the CCWCD leased approximately 1000 to 2000 af per year. No water was leased in 1984, and 1985 it leased 7.5 shares of Greeley No. 3 Ditch water for augmentation to the South Platte River. CCWCD has no members in the Cache la Poudre Basin, even though part of the District's boundary is in the Basin.

CCWCD has a 12.5 percent interest in the Narrows Project, which could eventually affect the Poudre Basin if it is built and a river call placed on the Cache la Poudre River to meet a senior right on the South Platte.

CCWCD is interested in storage in the Poudre River Basin and is in the market for acquiring water rights along the Poudre River.

4.5 ALLUVIAL WELL AUGMENTATION ORGANIZATIONS

4.5.1 Ground Water Management Subdistrict of the CCWCD

In 1973, a Ground-water Management Sub-District of the CCWCD was formed. The Sub-District was created to coordinate and administer a plan for augmentation for junior priority wells in the South Platte River Basin within Adams, Morgan and Weld Counties.

4.5.2 Ground-Water Appropriators of the South Platte

The Ground-Water Appropriators of the South Platte (GASP) is a non-profit corporation that acquires and develops water for owners of junior wells in the South Platte River Basin that are subject to curtailment by the State Engineer. GASP's purpose is to appropriate, buy, manage, own and lease water rights that can be released to the South Platte River to reduce the injury to senior appropriators caused by the out-of-priority pumping by GASP members.

GASP pumpage accounts for nearly 28,000 of the 83,300 af pumped annually under augmentation plans within the study area. Most of the remainder of the annual pumpage is by members of the Cache la Poudre Water Users Association. The majority of the 3000 wells within GASP are located along the South Platte River from Fairplay to Julesburg.

GASP reports to the State Engineer the amount of water it owns or has leased; the State Engineer orders the actual releases for augmentation. GASP has not made releases in the Poudre Basin in the past few years.

4.5.3 Cache la Poudre Water Users Association

The Cache la Poudre Water Users Association dates back to the early years of irrigation on the river. It was reorganized to its present structure in 1936. The Association was formed to organize water users, mediate conflicts, and maximize water use by development of exchanges. In recent years, it has expanded its activities to include participation in legislation and monitoring of developments which could have an impact on water users in the basin.

The Association is the assignee and managing agency for the water rights involved in the Cache la Poudre Augmentation Plan decreed in Case No. W-7921-75. The augmentation plan is designed to integrate the use of the ground and surface waters of the Cache la Poudre Basin. Under the plan, owners of 499 wells may divert under various direct flow water rights as alternate points of diversion. The direct flow rights are owned by the 17 mutual ditch companies on the river. As assignee, the Association may assign others the rights to divert.

Ditch company priorities may be diverted by the wells when all or part of the rights are not being diverted for direct flow. The wells may also divert under their own appropriations when they are in priority. The 499 wells in the augmentation plan are located west of Highway 85. Water applications are limited to lands irrigated at the time of the decree. A further limitation is that no well outside the boundaries of the NCWCD may divert under the rights of the ditch company which owns C-BT units. This provision is to conform to the contract between NCWCD and the United States Government which requires C-BT water to be used within NCWCD boundaries. Presently, the North Poudre Irrigation Company and the Whitney Ditch are included in this limitation.

4.6 INDUSTRIAL WATER SYSTEMS

4.6.1 General

Industrial water users in the Cache la Poudre Basin vary considerably with respect to water sources, water uses and wastewater systems. This section of the report identifies major water users whose water systems are not entirely contained within the water and/or wastewater system of a municipality. Kodak-Colorado Division and the Platte River Power Authority are the major users active at the present. Future water use by a brewery planned by Anheuser-Busch, Inc., has been considered.

Although the sugar beet factories in the basin no longer operate, they are briefly discussed herein from a historical perspective. Monfort Meat Packing receives its water supply from the City of Greeley, but its wastewater is discharged separately.

Various industries in the Basin discharge wastewater to the streams, but these discharges are small. Examples of minor industries include sand and gravel quarries, fish hatcheries, and manufacturing involving non-contact cooling water. Feedlots are classified by the Colorado Department of Health as point-source discharges, but all wastewater and runoff must be contained on-site. Other industries in Fort Collins and Greeley are served by the cities for both water supply and wastewater treatment.

4.6.2 Kodak

Kodak has a plant located southwest of the town of Windsor. Water is used for industrial and domestic purposes as well as crop land irrigation on Kodak property.

Kodak's water resources include 4588 units of C-BT owned directly and 2400 units through ownership of North Poudre Irrigation Company shares. At the present time these shares are being rented back to North Poudre Irrigation Company. In addition Kodak holds shares in several ditch companies which yield about 5700 af and 3 shares (60 af) in Fossil Creek Reservoir. Kodak also has 100 percent ownership of Law Ditch which has a capacity of about 6 cfs. Law Ditch is being used for lawn and agricultural irrigation.

The water rights used for agricultural purposes are diverted at their decreed headgates. Water from Fossil Creek Reservoir is released to the river and subsequently diverted by one of the agricultural rights. About 2900 acres of land at the plant site are leased to farmers.

Plant production and domestic water is diverted from the Greeley Pipeline and occasionally from Greeley's Boyd Lake Filtration Plant. Water usage at the plant remains fairly constant at 1.0 to 1.2 mgd.

Domestic and industrial wastewaters are treated separately. The domestic waste is collected and treated with the town of Windsor's municipal wastewater. Effluent is discharged to the river just upstream of the Law Ditch. Some of Kodak's industrial wastewater is pre-treated at the plant before being combined with the main waste stream. The industrial water is then treated in aerated lagoons located immediately north of the Windsor Plant. Treated industrial effluent is discharged directly to the Poudre River.

Wastewater effluent discharge from industrial treatment is about 1.1 mgd, with a seasonal variation of 0.8 to 1.4 mgd. Kodak's domestic wastewater contributes approximately 0.12 mgd to the Windsor Plant.

4.6.3 Platte River Power Authority

The Platte River Power Authority (PRPA) operates the Rawhide Energy Station, a coal-fired power plant in the Poudre Basin, about 20 miles north of Fort Collins and three miles west of Interstate 25. PRPA provides electric power to the Cities of Estes Park, Fort Collins, Longmont and Loveland. It is wholly owned by the four cities, but is a separate entity and a political subdivision of the State of Colorado. Water is used at the plant site for cooling, irrigation, and domestic purposes.

The main water source for PRPA is a reuse plan by which it pumps sewage effluent from the City of Fort Collins or Long Draw Reservoir water (Water Supply and Storage Company) to Rawhide Reservoir and replaces it one-for-one with C-BT or Windy Gap water. It is also possible to pump water from the Fossil Creek Reservoir inlet by arrangement with the North Poudre Irrigation Company. Rawhide Reservoir has a capacity of approximately 16,800 af.

PRPA has 2200 units of C-BT water, 160 units of Windy Gap water, and a junior direct flow right on the Cache la Poudre River, as well as decrees for storage in Rawhide Reservoir. A summary of PRPA water rights from the State Engineer's Tabulation is provided below:

Name	Amount	Appropriation Date	Adjudication Date
Rawhide Pipeline	15.5 cfs	12/31/1977	12/31/1977
Rawhide Reservoir	13,600 af	12/31/1977	12/31/1977
Rawhide Reservoir 1st Enlargement	4,200 af	1/31/1979	12/31/1979

There are two pumping stations for water supply. A small station with a capacity of less than 10 cfs is located at Soldier Canyon Dam at Horsetooth Reservoir. Water is pumped from this location through a 10-inch pipeline to the Rawhide site for potable water use. The second, with a capacity of about 16 cfs, pumps effluent from the Fort Collins Wastewater Treatment Plant No. 2 or from the Fossil Creek Reservoir inlet through a 24-inch pipeline to Rawhide Reservoir. This water is used for cooling purposes. The 24-inch pipeline to the reservoir crosses and has the capability of delivering water to Lake Canal, Larimer & Weld Canal, Larimer County Canal, Poudre Valley Canal, and North Poudre Canal.

PRPA's reuse plan specifies it can only use effluent derived from "new" imported water obtained as a result of rehabilitation of the Joe Wright-Michigan Ditch System by Fort Collins and the Long Draw-Grand River System by the Water Supply and Storage Company. The imported water is exchanged into Horsetooth Reservoir for first use by Fort Collins. The sewage effluent is then diverted by PRPA, and a corresponding amount of water is given to the City and/or the Water Supply and Storage Company from C-BT or Windy Gap sources. Prior to the use of Windy Gap water, beginning in 1985, payment was made in dollars rather than water.

About 4200 af per year is diverted and is totally consumed. About 700-800 af of this amount is diverted at Soldier Canyon Dam for potable use; the remainder is diverted at the Fort Collins Wastewater Treatment Plant.

The operational objective is to keep a fairly constant water level in Rawhide Reservoir. Inflows to the reservoir (water demands) are fairly constant throughout the year. PRPA is required to release 100 af per year to the Cache la Poudre River to compensate for lost inflow when a small drainage was dammed for Rawhide Reservoir. The release is performed at the Water Commissioner's request, from Horsetooth Reservoir or by foregoing diversion. In actual practice, this is a bookkeeping arrangement.

Sewage from domestic use at the Rawhide Plant is treated on-site in a zero-discharge facility.

4.6.4 Sugar Beet Industry

The sugar beet industry was a seasonal user of water in the Cache la Poudre Basin, with factories at Eaton, Fort Collins, Greeley and Windsor.

Some of the factories were consolidated with others, and all factories are now closed. The Greeley and Eaton plants are discussed in the following paragraphs to provide background. Information was derived from the 1977 South Platte River Study by the Corps of Engineers (COE, 1977).

At the Eaton factory, well water was delivered to a pond. The pond, located on Eaton Draw, also received natural drainage and condenser water from the plant. The mixed water was then pumped to the main factory supply tank. Domestic water was on a separate system. Eaton Draw received the wastewater discharge. Annual water delivery was 1,200 af in 1975, the last year of operation. Waste discharge had decreased to 980 af that year due to recycling.

At the Greeley plant, river water was diverted into a pond used to supply the beet transport flume. Water from the well and the City supply was used for juice extraction, washing and domestic needs. Wastewater was discharged to the Serpentine Ditch east of the plant for irrigation to the Cache la Poudre River. Annual delivery was 2100 af in 1975 when this plant was also closed. Waste discharge was 880 af in that year.

4.6.5 Monfort Meat Packing

Monfort of Colorado is a meat packing operation located a few miles north of the City of Greeley on Highway 85. The packing plant has been operational since 1960.

The City of Greeley supplies some of the water for the plant, with the remainder pumped from the Company's five wells. Water is used for both process water and cooling; well water is used for non-potable uses. During 1970 to 1975, water delivered to the plant declined from 3760 af to 3030 af, but consumption remained constant at approximately 850 af. The plant's wastewater is discharged to lagoons operated by the City of Greeley near Lone Tree Creek. Present wastewater discharge is about 1.0 mgd, or 1120 af per year. Before the Lone Tree Creek Treatment Plant was built in 1973, Monfort's wastewater was discharged to the Greeley Sewer System.

4.6.6 Anheuser Busch Brewery

Anheuser Busch, Incorporated (ABI), is constructing a brewery in the northeast portion of Fort Collins. Water will be used for the brewery process as well as domestic purposes. At the present time, ABI planners anticipate brewery start-up in the late 1980's.

According to an agreement between the City of Fort Collins and ABI, water will be furnished to the brewery by the City of Fort Collins in exchange for an ABI dedication of water rights to the City. This strategy is similar to the water dedication policy which Fort Collins requires from land developers. ABI is acquiring water rights in the North Poudre Irrigation Company, the Water Supply and Storage Company, and the C-BT Project for dedication to the City. The water rights being acquired by ABI typically have been used as supplemental irrigation water supplies in the Cache la Poudre Basin.

ABI also anticipates a source of water may need to be acquired for augmentation purposes. Comparisons are being made of historic depletions associated with the water rights ABI is acquiring and potential ABI depletions. The adverse impacts of the ABI water use on other Cache la Poudre water users will be addressed in an augmentation plan now being formulated. Studies are being conducted into the viability of various sources of augmentation water.

Water rights on wells were also obtained by ABI with the acquisition of the potential brewery plant site. These wells were historically used to irrigate crops on the plant site.

Plans currently are being developed for pipelines to deliver water from the City of Fort Collins to the proposed brewery. Current planning efforts indicate the ultimate operation of the brewery may require water deliveries (for the brewery process and domestic uses) of approximately 4200 af per year. The demand will remain fairly constant from month to month. Initial planning anticipates approximately 14 percent of the water deliveries will be directly used in the product, 9 percent will be lost to evaporation, 64 percent will become wastewater to be applied at a land application site, and the remaining 13 percent will become wastewater delivered to Fort Collins Wastewater Treatment Plant No. 2.

4.7 AGRICULTURAL WATER SYSTEMS

The largest water use in the Cache la Poudre Basin is for irrigation. Irrigation companies (ditch companies) manage the diversion, conveyance and storage facilities. According to the Water Commissioner, there are over 200 ditches including small mountain ditches, but about 30 main ditches divert about 97 percent of the water used in the basin, with four major companies controlling over 60 percent of the diversions. (The terms ditch and canal relate to a man-made channel for conveying water from the source of supply to the location(s) of use. The terms are used interchangeably.) The four major companies are the North Poudre Irrigation Company, the Water Supply and Storage Company, the Larimer and Weld Irrigation Company and the New Cache la Poudre Irrigation Company. Major agricultural water systems are shown on Figure 4.1. The general location of existing irrigated lands is shown on Figure 2.4.

Historic diversions presented in Appendix B are tabulated as "All Sources for All Uses". The sources may be one or more of the following: direct flow decrees, reservoir water, C-BT water, transbasin imports and exchanges. Uses are irrigation and storage.

4.7.1 North Poudre Irrigation Company

The North Poudre Irrigation Company (NPIC) is the northernmost irrigation ditch system. It serves about 34,000 acres in Larimer County, north of Fort Collins. NPIC plays a major role in the Poudre River exchange system.

Water sources for the ditch are C-BT water and direct flow and storage rights on the North Fork and mainstem of the Cache la Poudre River. The company owns 40,000 C-BT units. Since the NPIC diversions are upstream of the Horsetooth Reservoir Outlet, C-BT units must be utilized by exchange. Direct flow water rights are diverted from the North Fork through the North Poudre Canal and from the mainstem through the Munroe Gravity Canal, also called the North Poudre Supply Canal. The direct flow rights, their priorities, and decreed amounts are listed in Appendix B, Table B.10.

NPIC owns 25 storage reservoirs, which also are summarized in Appendix B, Table B.10. The larger reservoirs (Halligan, Park Creek, and Fossil Creek) are used for storage and exchange, while the smaller ones are used primarily for regulation.

The company owns no wells, but some farmers in the system service area use wells for supplemental irrigation.

In addition to the water sources discussed above, the company has water rights in a few ditches transferred partially or entirely in the sale of the Joe Wright Reservoir-Michigan Ditch System to the City of Fort Collins. The ditches, known as the South Side Ditches, are the Arthur, New Mercer, Larimer County No. 2 and Josh Ames. The rights were acquired by Fort Collins through its policy of water assignments from developers. The Josh Ames rights were entirely transferred and are diverted at the headgate of the North Poudre Canal. The other ditches were only partially transferred. NPIC diverts the rights up to a given volume limit, after which the rights revert to their original claimants.

Surface water diversion facilities are the North Poudre Canal on the North Fork and the Munroe Gravity Canal (North Poudre Supply Canal) on the mainstem. There are Parshall flumes at all of the headgates and a recorder at the Munroe Canal diversion point. The condition of all facilities is reported to be good.

The condition of NPIC reservoirs is variable depending on their age and location. Reservoirs on the North Fork and Boxelder Creek have problems with siltation. Several are no longer used and others are being rehabilitated. Major improvements have been made since 1975 to North Poudre Reservoirs 3 and 5, Hinkley Lake, Smith Lake and Fossil Creek Reservoir.

Stutchell and Boxelder No. 1 have been silted in. Clarks Lake has lost about 75 percent of its capacity due to silt, but is scheduled for rehabilitation. Bubbles Lake, Spitzer Lake and North Poudre Reservoir No. 6 are used very little due to dam safety or outlet works problems. Flood control dams, which have been placed on Sand, Coal, Indian and Boxelder Creeks, are expected to alleviate the problem of high sediment inflow to the reservoirs during floods.

Each Spring, the Board of Directors evaluates the water supply situation for the coming irrigation season and declares a "dividend", which establishes the amount of water delivered to each share. The irrigation season generally runs from about April 20 to September 20, depending on weather conditions. If no calls for water delivery have been received by May, the Board may appropriate "penalty water". The penalty refers to a restriction that the water must be run within a given time period, usually two weeks. The penalty water is intended to encourage shareholders to begin irrigation and to make storage space available in company reservoirs to capture high river flows and exchange Horsetooth (C-BT) water. Diversions by the North Poudre Canal and Munroe Gravity Canal are summarized in Tables B.11 and B.12 in Appendix B.

The storage season is generally November 1 through April 1, but storage begins as soon as irrigation ends if river flow is available. The Water Commissioner fills reservoirs by elevation, not priority; the higher reservoirs are filled first. If all reservoirs are not filled in a given year, water is distributed to the proper owners later.

Exchanges are made to assure a constant water supply. Most of NPIC's exchanges involve C-BT shares in Horsetooth Reservoir. One exchange is practiced almost continuously during the irrigation season. To enable Munroe Gravity Canal diversions, releases of NPIC's C-BT water are made at the Charles Hansen Canal for replacement.

The most important late-season exchange takes place with the City of Greeley when river flow is low and other ditch companies are not running enough water to allow the direct exchange between Horsetooth and the Munroe

Gravity Canal. The City releases water from its mountain reservoirs for diversion by NPIC. Releases of NPIC water in Horsetooth Reservoir then are made to Greeley. Another important exchange is the delivery of Worster Reservoir water (Divide Canal and Reservoir Company) to Halligan Reservoir. NPIC then delivers C-BT water to Windsor Reservoir Company ditches. (The Windsor and Divide Companies are closely related.) Other exchanges are made with Fossil Creek Reservoir in which other irrigation companies assign C-BT units to NPIC in return for Fossil Creek water in order to minimize conveyance losses.

NPIC estimates conveyance losses are 16 percent system-wide. The Company has no drainage system. Return flows seep down-gradient and are intercepted by other canals, chiefly the Poudre Valley Canal and Larimer County Canal.

4.7.2 New Cache la Poudre Irrigation Company/Cache la Poudre Reservoir Company

These two entities are separate companies, but integrate their operation such that the irrigation company manages direct flow deliveries and the reservoir company manages reservoir deliveries. About 36,000 acres were estimated to be served in 1985 by the companies through the Greeley No. 2 Canal and Timnath Reservoir. Some of this land is located outside the topographic limits of the Basin.

The companies own direct flow rights in the Greeley No. 2 Canal and storage rights in Timnath Reservoir (also known as Cache la Poudre Reservoir). The companies own about 11,000 C-BT units and have shares in Fossil Creek Reservoir and Windsor Reservoir, as well as an arrangement with the Kern Reservoir and Ditch Company to use Windsor Lake as an equalizing reservoir. Direct flow rights for Greeley No. 2 Canal and storage decrees for Timnath Reservoir are given in Appendix B, Table B.13.

There are two river headgates, one for the canal and one for the reservoir. The reservoir inlet is located about one mile downstream of the

Fort Collins Wastewater Treatment Plant No. 1 and the Canal headgate is located upstream of the Town of Windsor.

Timnath Reservoir has an estimated capacity of 10,000 af with a surface area of about 720 acres. In 1977, the companies rebuilt the dam to comply with State dam safety regulations. The reservoir outlet discharges to the Greeley No. 2 Canal and to the Lake Canal. The Lake Canal Company owns about ten percent of Timnath Reservoir.

The irrigation season usually begins about the 1st to the 15th of May and ends between September 10th and 20th. Reservoir storage usually begins October 1st. Allocation of system water is based on shares. Eight shares equals one "right". The Board of Directors meets in early Spring to decide the number of days of flow each right is allowed from the reservoir. Ditch water is distributed equally to all shares as it is available. Monthly diversions by Greeley No. 2 Canal are summarized in Table B.14 in Appendix B.

River water is used in the ditch whenever possible. After high flows are over, usually around mid-July, reservoir water and exchanges are used. The companies exchange C-BT units for water in Fossil Creek and Windsor Reservoirs to minimize the conveyance loss on delivery of the C-BT water. In another exchange, river water divertable by the senior Greeley No. 2 Canal is taken by the junior Larimer and Weld Canal. The Larimer and Weld company then releases water from its Windsor Reservoir directly to the Greeley No. 2 Canal.

The companies recently estimated system losses at 38 percent based on some measurements. Since the Greeley No. 2 Canal is the southernmost major canal on the north side of the river, return flows are to the Cache la Poudre River.

4.7.3 Water Supply and Storage Company/Jackson Ditch Company/Tunnel Water Company

The Water Supply and Storage Company (WSS) supplies about 48,800 acres in Larimer and Weld Counties based on 1985 estimates of irrigated area. Some of this land is outside the topographic limits of the Basin. The company owns controlling rights in the Jackson Ditch Company and the Tunnel Water Company. The operation of all the companies is intermingled and some persons are stockholders in more than one company. The Tunnel Water Company operates the Laramie-Poudre Tunnel, a transbasin diversion from the Laramie River.

The company owns direct flow rights in the Larimer County Canal, four transbasin diversions, and storage rights in eleven reservoirs. The company owns only about 60 to 70 C-BT units, but individual stockholders own about 6500 units which are delivered by the company. WSS participates in the Platte River Power Authority reuse plan, whereby Platte River uses "newly captured" water from the Long Draw-Grand River Ditch System and then returns about 1890 af of Windy Gap water to WSS credit in Horsetooth Reservoir.

The company owns no wells, but many are owned by individual stockholders and are used for supplemental irrigation. Direct flow rights and storage rights are given in Appendix B, Table B.15.

The headgate for the Larimer County Canal is located on the Cache la Poudre River, a few miles downstream of the mouth of the Canyon. The ditch has a total length of over 100 miles and terminates at a point about 10 miles north of Eaton. The Jackson Ditch diverts about 12 miles downstream of the Larimer County Canal near Bellvue and terminates at Long Pond, a WSS Reservoir. The Jackson Ditch is also known as the Dry Creek Ditch. All ditch facilities are in very good condition.

Chambers Lake and Long Draw Reservoir are high mountain reservoirs located near the Continental Divide and owned by WSS. Chambers Lake is fed by Joe Wright and Trap Creeks and Fall River. The lake also receives water from the Michigan and Skyline Ditches, both transmountain diversions from the Laramie River. Long Draw Reservoir is fed by the Grand River Ditch, a transbasin diversion from the Colorado River. Chambers Lake Reservoir is kept 45 feet below its design level because of stability problems with the dam.

The WSS plains reservoirs are used for supply, equalization and exchange. Rocky Ridge Reservoir, Kluver Reservoir, and WSS Reservoir Nos. 3 and 4 are located such that some of the contents may be used directly in the Larimer County Canal, but the contents below a certain elevation must be exchanged for Douglas Reservoir water with the Larimer and Weld Irrigation Company through the Jackson Ditch and Long Pond. Curtis Reservoir and Richard Lake release water to the Larimer and Weld Canal through Long Pond in exchange for Douglas Reservoir water. Lindenmeier Lake releases water to the river for diversion by the Greeley No. 2 Canal in exchange for mountain water from the New Cache la Poudre Irrigation Company. Black Hollow Reservoir is used as a holding pond for storage of excess water and for supply to the lower end of the ditch.

Planting begins in April, but rapid growth and the need for irrigation usually does not occur until the 10th or 15th of May. Early demand for water, before the river is high enough, is satisfied from storage. After the river flow reaches about 1700 cfs, demands can be supplied by direct flow rights and C-BT. Water is stored all year, whenever water is available. Reservoir water is used for irrigation whenever needed. The transbasin diversions begin as soon as possible and are continuous except for short periods. Exchanges are used whenever desired to optimize water usage. Diversions generally end by mid-September although sugar beets required some irrigation into October.

Deliveries to stockholders are on the basis of shares. C-BT units are converted to equivalent shares of WSS stock based on the quota declared by units along with WSS water with the assessment of a 10 percent loss charge and a labor charge. Water is run only on the demand of the majority due to head requirements for differing elevation headgates. Table B.16 summarizes the operation of the Larimer County Canal and Table B.17, the operation of Jackson Ditch. These tables are in Appendix B.

Canal seepage is estimated by the company at 10 percent. Reservoir contents are used to absorb and offset some of the system losses by collection of seepage. Losses from WSS facilities accrue to the Larimer and Weld System.

4.7.4 Larimer and Weld Irrigation Company

The Larimer and Weld Irrigation Company operates the Larimer and Weld Canal, which diverts from the Cache la Poudre River near Fort Collins. Some of the 55,000 acres of land served by the canal is located east of Ault and is outside the topographic Basin. The company's operation is associated with the Windsor Reservoir and Canal Company and the Divide Canal and Reservoir Company. The companies were not willing to provide any information to the Study Team; therefore, information contained herein is from secondary sources.

As of 1969, the companies owned no C-BT units, but some are probably owned by individual shareholders. Direct flow rights and storage decrees for the companies are given in Appendix B, Table B.18.

The Poudre Valley Canal diverts near the mouth of the canyon. Douglas Reservoir and Cobb Lake are filled through the canal. Although the Horsetooth Reservoir outlet, the Charles Hansen Canal, is on the other side of the river, the Poudre Valley Canal receives C-BT water directly through the Windsor Extension of the Hansen Supply Canal. It should be noted here, that land use studies have identified lands under service by the Poudre Valley Canal which are actually served by the North Poudre system. The Poudre Valley Canal does not directly serve irrigated lands.

Douglas Reservoir, Reservoir No. 8, No. 8 Annex and Cobb Lake have outlets to the Larimer County Canal, owned by Water Supply and Storage Company, to facilitate exchanges. Reservoir No. 8 and Elder Reservoir also can supply water to the Larimer and Weld Canal. Windsor Reservoir, known as Big Windsor to distinguish it from the smaller Windsor Lake, is located far south of the Poudre Valley Canal System, under the Larimer and Weld Canal. Because the reservoir is south of the three companies' facilities, it is used primarily for exchange with Greeley No. 2 Canal, owned by New Cache la Poudre Irrigation Company.

Terry Lake is filled through the Terry Lake Inlet, which branches off the Little Cache la Poudre Ditch. The Little Cache Ditch diverts from the river near LaPorte. The Terry Lake Outlet discharges to the Larimer and Weld Canal. The Larimer and Weld Canal diverts water from the Cache la Poudre River about one mile northwest of Fort Collins. It can also receive water exchanged with Water Supply and Storage Company through a connection with Long Pond Reservoir. The canal irrigates extensive areas in both Larimer and Weld Counties. The ditch terminates outside the Cache la Poudre Basin, about 10 miles east of the Town of Eaton.

Worster Reservoir is located on Sheep Creek in the North Fork Sub-basin within Larimer County, near the divide between the Cache la Poudre and Laramie River Basins. In addition to the natural drainage of Sheep Creek, the reservoir receives water from the Wilson Supply Ditch, a transbasin diversion from the Laramie River. Worster Reservoir, also known as Eaton Reservoir, is primarily used by exchange with the North Poudre Irrigation Company for C-BT units.

Water is distributed to Larimer and Weld shareholders on the basis of "rights". Four shares of stock is equivalent to one right, which at full water supply is 25 days of water at 1.44 cfs, or 72 af. The actual number of days water is run is dependent on water availability. Because the Larimer and Weld direct flow priorities are fairly junior, the water supply is not dependable late in the season. Diversions are summarized in Tables B.19 and B.20 in Appendix B.

4.7.5 Greeley Irrigation Company

The Greeley Irrigation Company operates the Greeley Canal No. 3. The canal diverts water on the south side of the Poudre River upstream of Greeley. The canal is approximately 9 miles long and runs southwest through the City of Greeley. There are 525 shares in the mutual ditch company and

419-149/180 shares are issued. The City of Greeley is reported to own about 3/8 of the Canal No. 3 decreed amount.

The direct flow water rights decreed to Greeley Canal No. 3 are listed below.

Name	Amount (cfs)	Appropriation Date	Adjudication Date
Canal #3	52.0	4/01/1870	4/11/1882
Canal #3 1st Enlargement	41.0	10/01/1871	4/11/1882
Canal #3 2nd Enlargement	63.13	7/15/1872	4/11/1882
Canal #3 3rd Enlargement	16.67	5/15/1873	4/11/1882

The company also owns 60 units or 1377 af of Fossil Creek Reservoir water.

The Greeley No. 3 Canal headgate is located on the south side of the Poudre River upstream from Greeley. The capacity of the canal is reported to be 200 cfs.

Water is diverted to Canal No. 3 beginning around April 15 and continuing until about October 1. Late season diversions are supplemented by Fossil Creek Reservoir shares. The conveyance loss in the canal is reported to be five percent. The historical (1951-80) diversions are summarized in Table B.21 in Appendix B.

4.7.6 Lake Canal Company

Lake Canal is located on the north side of the Cache la Poudre River in both Larimer and Weld Counties. The approximate length of the ditch is 16 miles and the 1985 service area is estimated to be 6000 acres. Storage is provided by four reservoirs which are located along Boxelder Creek. The ditch company is a common carrier ditch, with 260 shares issued.

The Lake Canal Company owns three direct flow rights, several storage rights and receives ground water from several drains. The direct flow water rights have been developed from information supplied by the Lake Canal Company, from data contained in the storage and ground-water rights from the

State Engineer's Water Rights Tabulation, and from a diagram of ditch and reservoir systems developed by Morton Bittinger & Associates. Direct flow rights are shown in Appendix B, Table B.22. Storage and ground-water rights information was not made available.

The Cache la Poudre River is the decreed source for the direct flow rights totaling 163.29 cfs and for the Lake Canal Reservoir No. 1. The Lake Canal Collection and Drain Tiles 1-4 water rights are decreed as wells with an underground source. The Gray Reservoirs are decreed from Boxelder Creek. Boxelder Creek is also decreed as an alternate point of diversion for Lake Canal Reservoir No. 1.

The Lake Canal headgate is located on the north side of the Poudre River in Section 2, Township 7 North, Range 69 West. The headgate reportedly can divert the decreed amount which is about 160 cfs. A Parshall flume is used to measure the diversions. The condition of the headgate is reported to be good.

Storage facilities associated with the Lake Canal system consist of four reservoirs - Lake Canal Reservoir No. 1, North Gray Reservoir, South Gray Reservoir and Gray Reservoir No. 3. The Lake Canal Reservoir No. 1 is located below the Lake Canal Ditch in Section 7, Township 6 North, Range 67 West. The Gray Reservoirs are located east of Boxelder Creek above Lake Canal in Section 34, Township 8 North, Range 68 West. The total storage capacity of the reservoirs is about 2000 af with approximately 1500 af of active contents. The reservoir facilities are reported to be in good condition.

The Lake Canal system reportedly has always received an adequate supply of water. The historical diversions for Lake Canal are summarized in Table B.23 in Appendix B. The diverted amount is proportioned among shareholders according to the number of shares owned. Some shareholders also own C-BT units, which the Lake Canal Ditch Company will deliver. The normal operating season is from May 15 to September 25. The C-BT shares are normally delivered in the months of July, August and September.

The storage reservoirs are filled during the months of January through May. The reservoirs are operated with no carryover storage and have a release pattern of 50 percent in June, 30 percent in July and 20 percent in August. A 10 percent delivery loss is also used when delivering storage water.

The return flows from the irrigated land are to Boxelder Creek and to other irrigation ditches located below Lake Canal.

4.7.7 New Mercer Ditch Company

Water is diverted to New Mercer Ditch from the south side of the Poudre River near LaPorte. The ditch has a length of about 11 miles extending from the river southeast to Mail Creek. The Company has issued 145.6 shares.

The New Mercer Ditch Company owns five direct flow water rights which are summarized below:

Priority	Name	Amount (cfs)	Appropriation Date	Adjudication Date
25	New Mercer (N.M.)	7.03[a]	10/01/1876	4/11/1882
33	New Mercer	4.17	9/01/1869	4/11/1882
47	N.M. 1st Enlarg.	8.33	10/10/1871	4/11/1882
49	N.M. 2nd Enlarg.	15.00	7/01/1873	4/11/1882
98	N.M. 3rd Enlarg.	50.47[b]	2/15/1880	4/11/1882

Notes:
[a] Originally decreed for 10 cfs, 2.97 cfs has been abandoned.
[b] Originally decreed for 136 cfs, 85.53 cfs has been abandoned.

The source for the five rights is the Cache la Poudre River and the rights are decreed for irrigation use.

The New Mercer Ditch Company does not own or lease any outside water. the C-BT water carried in the ditch for stockholders is individually owned and totals 1332 C-BT units. The C-BT water is diverted from the Poudre River.

The New Mercer Ditch headgate is located near LaPorte on the south side of the Poudre River. The ditch can carry the decreed flow of 85 cfs. A Parshall flume near the headgate is used to measure diversions.

The New Mercer Ditch Company reportedly receives an inadequate water supply at times, usually in the latter part of July or anytime the river is below about 800 to 900 cfs. The company prefers to divert river water before C-BT water due to economics. The historical diversions are summarized in Table B.24 in Appendix B.

The diverted amount is proportioned among shareholders according to the number of shares owned. Historically, the delivery per share was about 30 af. The typical diversion season is from May 1st to October 1st. C-BT water is delivered when the ditch is out of priority, as described above. The Water Commissioner charges a one-percent loss for delivery of the C-BT water to the ditch. The ditch company does not charge any conveyance loss for C-BT water or river water because the ditch picks up drainage water through the City of Fort Collins.

During the past 15 years, about 25 percent of the irrigated land has been taken out of production due to encroachment of urban development from the City of Fort Collins. Approximately 14,000 acres of land receive irrigation at the present time. The return flows from the irrigated land return to Spring Creek and Mail Creek.

4.7.8 Boxelder Ditch Company

Boxelder Ditch is located south of the Poudre River in Larimer County, just east of Fort Collins. The ditch is approximately five miles long. The ditch company is a mutual ditch company and has 64 shares.

The Boxelder Ditch Company owns three direct flow water rights decreed for irrigation use which total 52.76 cfs, as shown below:

Priority	Name	Amount (cfs)	Appropriation Date	Adjudication Date
15	Boxelder Ditch	32.50	3/01/1866	4/11/1882
23	Boxelder Ditch	8.33	5/25/1867	4/11/1882
30	Boxelder Ditch	11.93	7/01/1868	4/11/1882

These water rights have not been in any transfer or modification proceedings, nor are they part of an augmentation plan.

The Boxelder Ditch headgate is located on a small channel braid south of the Poudre River, near the Fort Collins No. 2 Wastewater Treatment Plant. A dam in the main channel is used to divert water through the braid to the headgates. The headgate capacity is reported to be consistent with the decreed capacity.

The Boxelder Ditch usually receives an adequate water supply. Diverted water is delivered to shareholders as they want it, unless a short supply dictates delivery according to shares owned. There is no conveyance loss charged to the shareholders. Typically, the irrigation season is from May 15 to October 1. Table B.25 in Appendix B summarizes the 1951-1980 Boxelder Ditch diversions.

Return flows from the irrigated lands are channeled back to the river by several drains. The ditch ends at the Poudre River south of Timnath.

4.7.9 Irrigation Water Used Outside the Basin

Four irrigation ditches which divert water from the Cache la Poudre River serve lands both inside and outside the Cache la Poudre Basin. Based upon a 1970 land use study (CSU, 1973), Table 4.1 shows the percentage of irrigated lands served by each ditch which lies outside the Cache la Poudre Basin.

Also, according to the CSU land use study, about 14,400 acres of land within the Cache la Poudre Basin are irrigated with water diverted from the Big Thompson River through the Louden and the Greeley and Loveland Ditch systems.

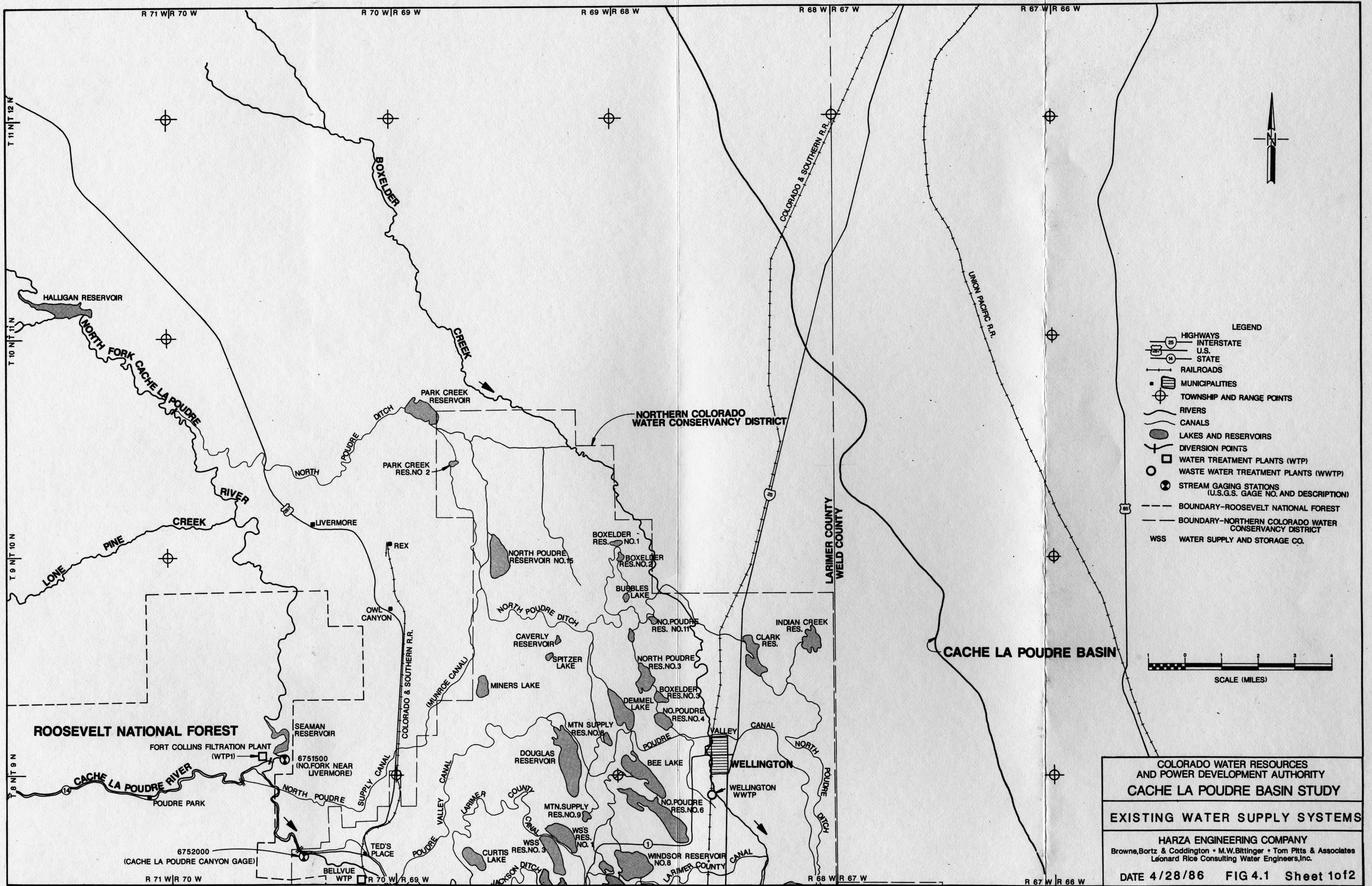
TABLE 4.1

Lands Irrigated by Cache la Poudre Ditch Systems
Outside of the Poudre Basin, 1970

Canal or Ditch	Total Irrigated Area (acres)	Irrigated Area Outside Basin (acres)	Percentage Outside Basin
Larimer County	50,800	17,800	35
Larimer and Weld	67,900	32,400	48
Greeley No. 2	42,500	14,900	35
Ogilvy	2,650	2,500	94
	Total	67,600	

4.7.10 Small Irrigation Systems

In addition to the irrigation systems described in Sections 4.7.1 through 4.7.9, there are other smaller systems irrigating lands within the study area. These systems include the Little Cache la Poudre Ditch, Josh Ames Ditch, Coy Ditch, Whitney Ditch, Ogilvy Ditch, Pleasant Valley and Lake Canal, Arthur Ditch, Chaffee Ditch, B. H. Eaton Ditch, Jones Ditch, and the Boyd and Freeman Canal. As noted in Section 4.7.9, most of the Ogilvy Ditch service area is located outside the topographic limits of the Basin. Historic diversions by these ditches are provided in Appendix B in Tables B.26 through B.36. The combined 1985 service area of the 11 ditch systems listed above is estimated to be 11,200 acres, about 5 percent of the total irrigated area.



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

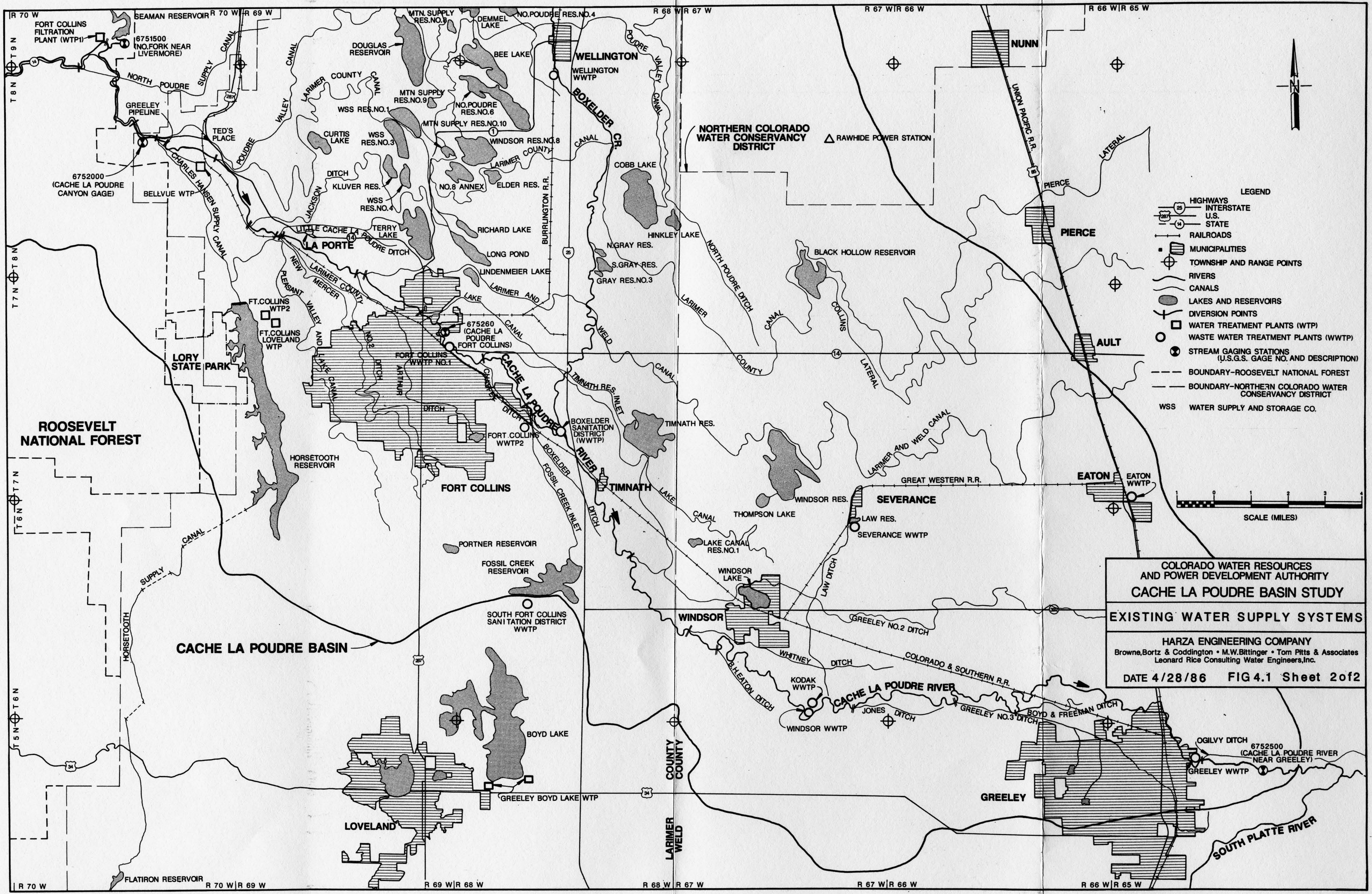
CACHE LA POUDRE BASIN STUDY

EXISTING WATER SUPPLY SYSTEMS

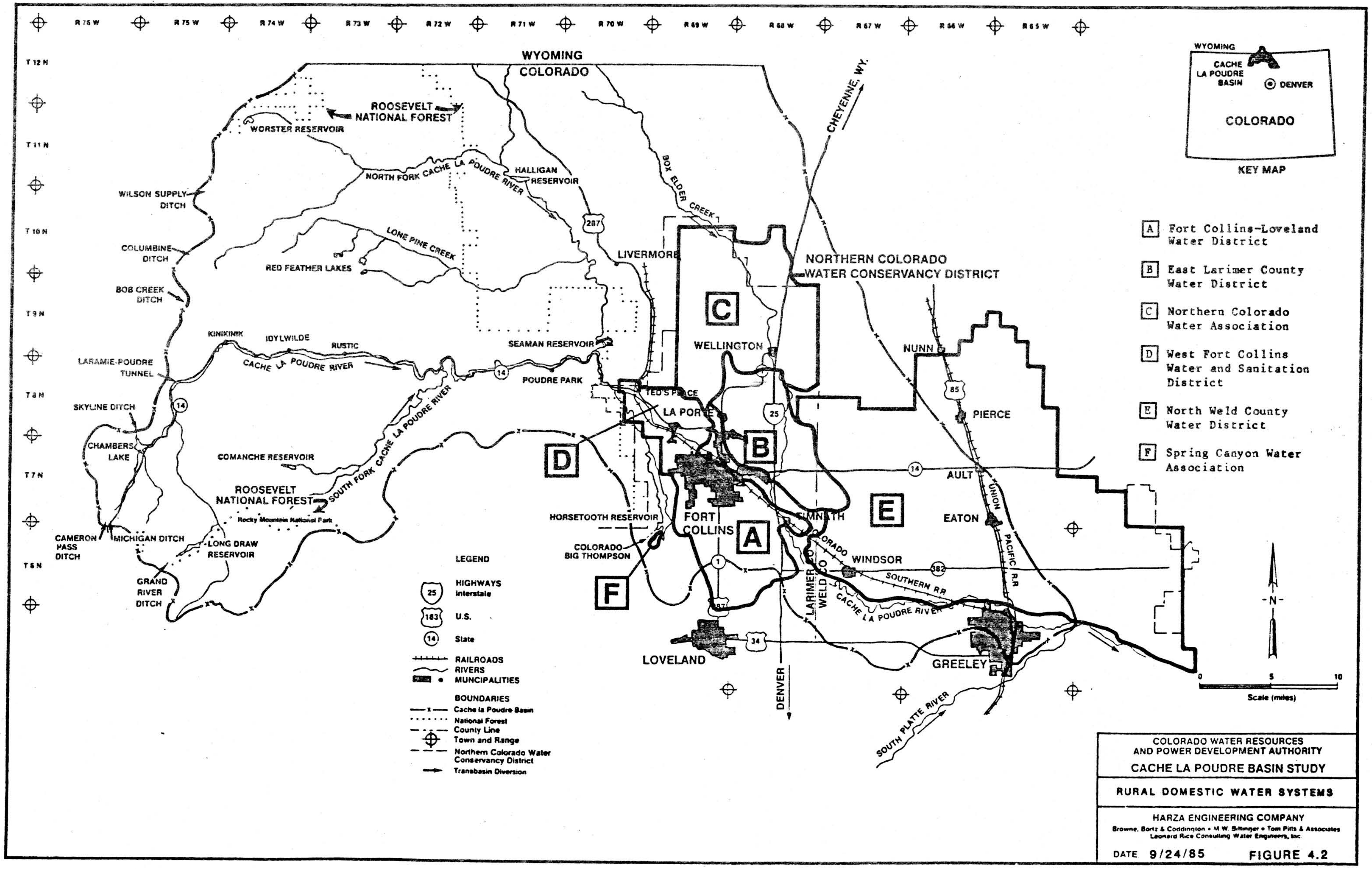
HARZA ENGINEERING COMPANY

Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

DATE 4/28/86 FIG 4.1 Sheet 1of2



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
EXISTING WATER SUPPLY SYSTEMS
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 4/28/86
FIG 4.1 Sheet 2of2
LEGEND
HIGHWAYS
INTERSTATE
U.S.
STATE
RAILROADS
MUNICIPALITIES
TOWNSHIP AND RANGE POINTS
RIVERS
CANALS
LAKES AND RESERVOIRS
DIVERSION POINTS
WATER TREATMENT PLANTS (WTP)
WASTE WATER TREATMENT PLANTS (WWTP)
STREAM GAGING STATIONS (U.S.G.S. GAGE NO. AND DESCRIPTION)
BOUNDARY-ROOSEVELT NATIONAL FOREST
BOUNDARY-NORTHERN COLORADO WATER CONSERVANCY DISTRICT
WSS WATER SUPPLY AND STORAGE CO.
SCALE (MILES)
ROOSEVELT NATIONAL FOREST
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
CACHE LA POUDRE BASIN
CACHE LA POUDRE RIVER
SOUTH PLATTE RIVER
FORT COLLINS
LA PORTE
WELLINGTON
NUNN
PIERCE
AULT
EATON
SEVERANCE
TIMNATH
WINDSOR
GREELEY
LOVELAND
LORY STATE PARK
FORT COLLINS FILTRATION PLANT (WTP1)
6751500 (NO.FORK NEAR LIVERMORE)
6752000 (CACHE LA POUDRE CANYON GAGE)
675260 (CACHE LA POUDRE FORT COLLINS)
6752500 (CACHE LA POUDRE RIVER NEAR GREELEY)
SEAMAN RESERVOIR
DOUGLAS RESERVOIR
HORSETOOTH RESERVOIR
BOYD LAKE
COBB LAKE
TIMNATH RES.
WINDSOR RES.
BLACK HOLLOW RESERVOIR
FOSSIL CREEK RESERVOIR
PORTNER RESERVOIR
FLATIRON RESERVOIR
RAWHIDE POWER STATION
LARIMER COUNTY
WELD COUNTY


WYOMING
COLORADO
ROOSEVELT NATIONAL FOREST
WORSTER RESERVOIR
NORTH FORK CACHE LA POUDRE RIVER
HALLIGAN RESERVOIR
WILSON SUPPLY DITCH
COLUMBINE DITCH
RED FEATHER LAKES
LONE PINE CREEK
BOB CREEK DITCH
LIVERMORE
BOX ELDER CREEK
CHEYENNE, WY.
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
WELLINGTON
NUNN
PIERCE
AULT
EATON
KINIKINIK
IDYLWILDE
RUSTIC
CACHE LA POUDRE RIVER
SEAMAN RESERVOIR
POUDRE PARK
LARAMIE-POUDRE TUNNEL
SKYLINE DITCH
TED'S PLACE
LA PORTE
CHAMBERS LAKE
COMANCHE RESERVOIR
SOUTH FORK CACHE LA POUDRE RIVER
ROOSEVELT NATIONAL FOREST
Rocky Mountain National Park
HORSETOOTH RESERVOIR
FORT COLLINS
TIMNATH
COLORADO BIG THOMPSON
CAMERON PASS DITCH
MICHIGAN DITCH
LONG DRAW RESERVOIR
GRAND RIVER DITCH
WINDSOR
COLORADO SOUTHERN RR
UNION PACIFIC RR
LARIMER CO
WELD CO
CACHE LA POUDRE RIVER
LOVELAND
GREELEY
DENVER
SOUTH PLATTE RIVER
A
B
C
D
E
F
LEGEND
HIGHWAYS
Interstate
U.S.
State
RAILROADS
RIVERS
MUNCIPALITIES
BOUNDARIES
Cache la Poudre Basin
National Forest
County Line
Town and Range
Northern Colorado Water Conservancy District
Transbasin Diversion
R 76 W
R 75 W
R 74 W
R 73 W
R 72 W
R 71 W
R 70 W
R 69 W
R 68 W
R 67 W
R 66 W
R 65 W
T 12 N
T 11 N
T 10 N
T 9 N
T 8 N
T 7 N
T 6 N
WYOMING
CACHE LA POUDRE BASIN
DENVER
COLORADO
KEY MAP
A Fort Collins-Loveland Water District
B East Larimer County Water District
C Northern Colorado Water Association
D West Fort Collins Water and Sanitation District
E North Weld County Water District
F Spring Canyon Water Association
N
0
5
10
Scale (miles)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
RURAL DOMESTIC WATER SYSTEMS
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 9/24/85
FIGURE 4.2

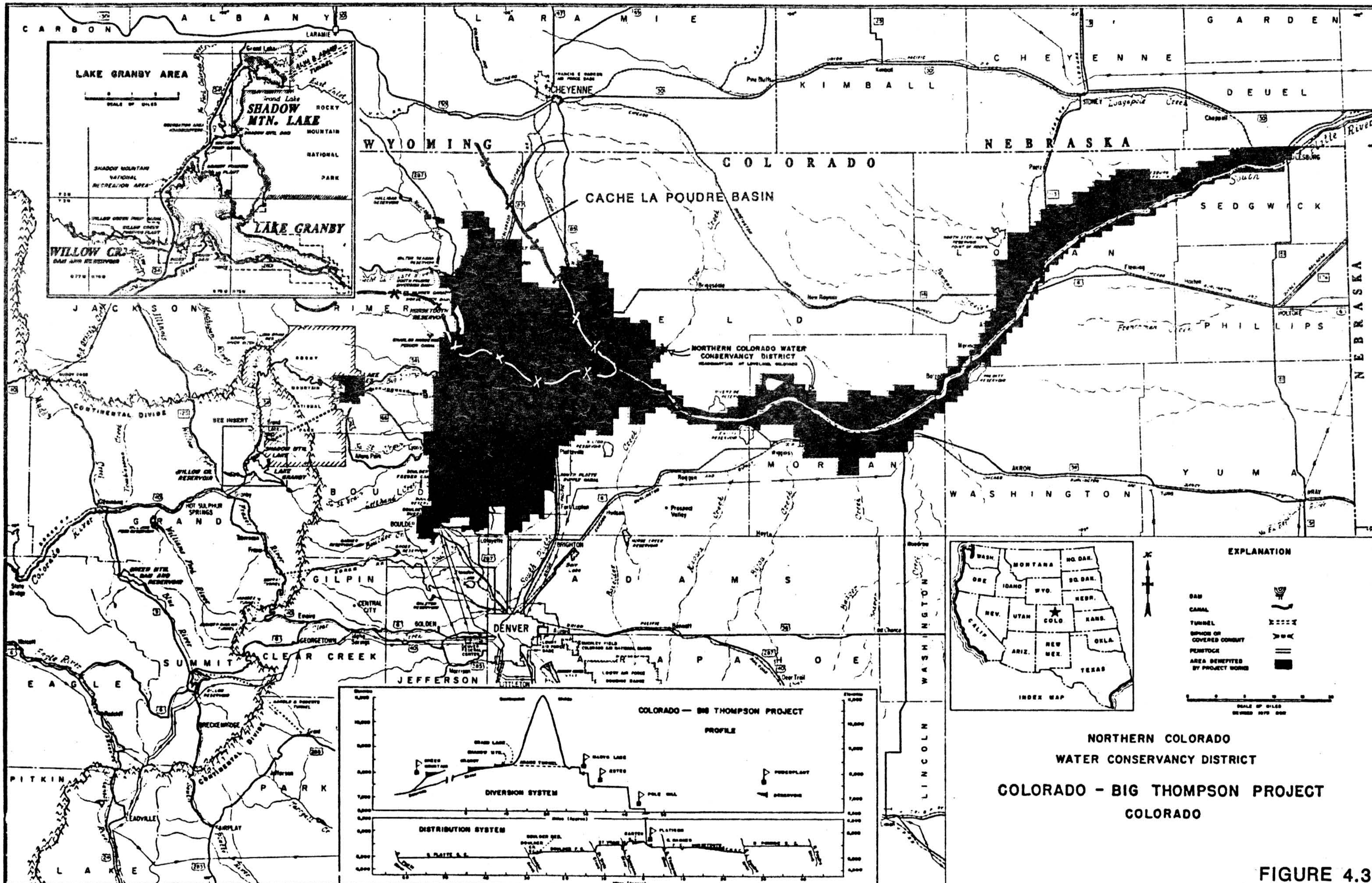

LAKE GRANBY AREA
SHADOW MTN. LAKE
LAKE GRANBY
WILLOW CR.
CACHE LA POUDRE BASIN
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
WYOMING
NEBRASKA
COLORADO
CHEYENNE
DENVER
BOULDER
COLORADO — BIG THOMPSON PROJECT
PROFILE
DIVERSION SYSTEM
DISTRIBUTION SYSTEM
EXPLANATION
INDEX MAP
NORTHERN COLORADO
WATER CONSERVANCY DISTRICT
COLORADO - BIG THOMPSON PROJECT
COLORADO

FIGURE 4.3

Chapter 5

Modeling of the Existing Water Supply Systems

5.0 MODELING OF THE EXISTING WATER SUPPLY SYSTEMS

5.1 INTRODUCTION

An assessment of the water supply systems of the Basin was made with the use of a computer program (model) that simulates their operation (Task 3 Summary Report, Harza, 1986). The model provides an effective means of understanding the operation of the existing complex water systems and was used to evaluate the adequacy of existing supplies to meet future water demands.

The surface water resources of the Basin are managed through a complex system of direct flow water rights, reservoir storage rights, and exchanges. Ground water also is relied on as a source of supply.

The system is administered by the Water Commissioner who, with the cooperation of water users and extensive prior experience, is able to allocate water very efficiently within the Basin. To the extent possible, the existing operating criteria applied in the Basin have been incorporated into the computer model. Procedures for incorporation were based on interviews with the Water Commissioner and the major water users and administrators in the Basin.

There are numerous tables of basic data and initial modeling results which were generated during Task 3. These tables are presented in Appendix C to this Phase I Report and are referenced at appropriate places in the text of this chapter.

5.2 SELECTION OF MODEL

The <u>R</u>iver <u>B</u>asin <u>Si</u>mulation <u>M</u>odel (RIBSIM) computer program was selected for modeling water supply and demand in the Cache la Poudre Basin Study. It was selected from a group of six candidate models through a systematic procedure of ranking the models against a specific set of evaluation criteria. Candidate models other than RIBSIM were: the MODSIM model; Hydrologic River Operation Study System model (HYDROSS); Integrated River System Operation Study (IRSOS); Stream-Aquifer Model for Management by Simulation Optimization (SAMSOM); and the Thaemert (or Bosley) Model. The selection process is described in detail in the Task 3 Summary Report (Harza, 1986). RIBSIM ranked highest in comparison to the other candidate models because of its availability within the short time frame for the Study and its understandability and usability without significant user training and debugging.

5.3 DESCRIPTION OF RIBSIM

RIBSIM is a computer tool for investigating water supply and demand relationships. The model is a traditional "bookkeeping" or accounting type model which superimposes water demands on a flow network. RIBSIM has been applied in investigating water supply and demands in the Colorado River Basin and the St. Vrain Basin within Colorado and river basins in Arizona.

The model was developed for use on IBM microcomputers and incorporates many of the desirable conceptual features of other river basin models. In RIBSIM, water demands can be direct flow rights, reservoir rights, or instream flows. The water is allocated according to user-assigned priorities. In the Cache la Poudre Basin, the priorities reflect the State Engineer's basin ranking of water rights. The model operates on a monthly basis which is considered to be adequate for a prefeasibility-level study.

The model allows water rights to obtain supplemental water from designated reservoirs or to have designated reservoirs provide exchange water to protect out-of-priority diversions. That portion of the diversion which is not consumed, such as return flows from ditch seepage and irrigation applications, can be distributed to several locations in the stream network. While surface runoff is assumed to return to the stream in the same month as the diversion, ground-water return flows to the river may be lagged in a delayed pattern specified by the user.

The model output includes the diverted amount for each water right, the volumes of water returned to the stream, the amounts involved in exchanges among water right holders, and reservoir end-of-month contents, evaporation, and seepage. The computer program allows calculation of water inflows and outflows for the purpose of determining the amount of water available for consumptive use in the Basin. Auxiliary programs included in the model allow summarization of output categories, such as irrigation diversions, return flows, municipal diversions, and other desired information.

5.4 MODIFICATION OF MODEL LOGIC

Several modifications to the basic model were made to adapt RIBSIM for the specific needs of the Cache la Poudre Basin Study. These modifications included:

- Increasing the model's capacity to accommodate more elements (more water rights, reservoirs, exports, etc.);

- Adding the ability to have more than one storage water right associated with a reservoir;

- Adding the ability to have more than one exchange reservoir associated with a water right;

- Providing calendar year operation in addition to operation on a water year basis;

- Adding a special routine to handle diversions by irrigation systems having multiple direct flow water rights and off-channel storage for direct use and exchange;

- Providing special logic which allows utilization of ground water reservoirs to obtain return flows prior to downstream senior rights; and

- Changing some model logic to allow more efficient program processing.

The most significant of these modifications are the special irrigation system routine and the special logic for the ground water reservoirs. These were added because of the complexity of the existing water systems and the close interrelationship between surface water supply and ground water pumping and recharge.

5.5 GENERATION OF MODELING INPUT DATA

5.5.1 Study Period for Modeling

The 1951-1980 period of historic record was selected for the Cache la Poudre Basin Study as described in Chapter 3.

5.5.2 Network Generation

The complex water systems of the Basin were translated into a simplified network which describes the movement of surface and ground water through the Basin and incorporates water control structures such as reservoirs, canals, and diversion structures, and water management procedures such as water exchanges, C-BT operations, and reservoir operations. Network development was based on interviews with water users and administrators in the Basin and prior experience on similar modeling assignments.

The network generation began with selection of the diversion structure/ditch systems, reservoirs, and exchanges to be included in the model. Diversion structures were selected based on their effect on the flows in the North Fork and Mainstem of the Cache la Poudre River. The model includes 29 diversion structure/ditch systems as shown in Table C.1 in Appendix C. Those systems which were understood, based on discussions with the Water Commissioner, to have relatively small effects on river flows were not included in the model.

Reservoirs were selected for inclusion in the model based on review of the functions of existing reservoirs and discussions with water users and the Water Commissioner. Recreational reservoirs that do not regulate flows, such as the Red Feather Lakes, privately owned reservoirs for which data were not available, and certain smaller reservoirs, were not included in the model. The 54 reservoirs selected for inclusion in the model fall into two general categories -- "operational" reservoirs or "exchange" reservoirs. Operational reservoirs are used to equalize flows on a ditch system. An exchange reservoir is one where the stored water cannot be used within the ditch system supplying water to the reservoir (System A) because of topographic constraints. Water stored in the exchange reservoir is transferred to a lower ditch system (System B). The water transferred out of System A is replaced by directly diverting additional water from the river into System A that would otherwise have remained in the river and been diverted by System B. Within the model, the 54 selected reservoirs were grouped into 20 composite reservoirs because of functional similarities within individual ditch systems (see Table C.2 in Appendix C). Exchanges included in the RIBSIM model are listed in Table C.3 in Appendix C.

The RIBSIM network developed for modeling the Cache la Poudre Basin is presented on Figure 5.1. Although the network remains complex, substantial simplification has been achieved while retaining the essential character of the overall system.

Major assumptions in development of the RIBSIM network included:

- A demand sector was included in the network for each ditch system to model internal water allocations within the system which operate without regard to priorities of other water rights in the Basin. The demand sector holds water transferred from a collection point receiving water from multiple water rights on the river. The demand sector contains irrigation system components that can be operated independently of water rights on the river. The demand sectors have been located at a point on the stream such that releases from exchange reservoirs can protect out-of-priority diversions.

- Timnath Reservoir and Fossil Creek Reservoir were modeled as on-channel reservoirs. (Timnath was assumed to be on the river at its reservoir inlet diversion point. Fossil Creek was assumed to be on-channel above the Greeley No. 2 Canal, the upstream-most point to which it can make exchange releases).

- Horsetooth Reservoir is divided into 28 small reservoirs each sized to store a particular ditch or M & I system's ownership or historical delivery of C-BT water. Water in these reservoirs is stored until the ditch or M & I system has a demand. At that time, water is released to the river.

- The high mountain transbasin diversions are set up to deliver an amount of water to the owner equal to his demand. Any amount of water greater than the demand is delivered to the river for the benefit of other users.

The development of flow network diagrams for the individual ditch systems in the model is demonstrated on Figures 5.2 and 5.3 which show, respectively, the water supply and return flows for the Larimer County Canal. On Figure 5.2, river rights 1 through 7 represent the direct flow rights to the Larimer County Canal. Water diverted under the respective priorities of each right is conveyed, with no loss, to an "All Sources, All Uses" (ASAU) demand node that is equivalent to the historic amount diverted from the river and includes water from native, foreign, and storage reservoir sources. Consolidation of water at one node after diversion from a variety of sources under different priorities allows the use of a single demand table rather than a demand table for each priority.

Direct flow rights are allowed to divert at their decreed rate (in cfs) until the total volume of the ASAU demand is attained. If the ASAU demand cannot be satisfied by direct flow rights, then water is imported from other sources. In the Larimer County Canal example, other sources are: transbasin imports from the Laramie-Poudre Tunnel, Skyline Ditch, Cameron

Pass Ditch, and Grand River Ditch; C-BT Project water; and storage water in the mountain reservoirs (Chambers Lake and Long Draw Reservoir).

Upon receiving water from any source, a 20 percent canal loss is taken from the amount diverted to the ASAU demand of which 95 percent is returned to the river. The remaining 5 percent of the canal loss is consumed by phreatophytes and evaporation. Of that portion which is returned, 11 percent is assumed to return as surface flow to the next downstream ditch, and the remaining 89 percent is assumed to be subsurface flow. In the Larimer County Canal example, the 11 percent canal loss is returned to the Larimer & Weld Canal and the subsurface flow is distributed as follows: 20 percent to the Boxelder Aquifer; 19 percent to the river via Black Hollow Drain; 19 percent to the Spring Creek Aquifer under the Larimer & Weld Canal; and 31 percent out of the basin to the Lone Tree Aquifer.

The remaining 80 percent of diversions from the ASAU Demand is delivered to the "To Irrigation" Demand located on the demand sector. At the "To Irrigation" Demand, a portion of the water is transferred to the "Total Demand" right, based on the Water Commissioner's historical records of water used for direct irrigation. The remainder is put into storage in WSS No. 1 Reservoir. When WSS No. 1 is full, it spills to WSS No. 2 Reservoir, which in turn spills to WSS No. 3 Reservoir. As noted on the figure, WSS No. 3 is also filled by diversions from Jackson Ditch, in excess of its "To Irrigation" Demand.

The Total Demand is based on the potential consumptive use of irrigation water for the irrigated lands under the canal. When the Total Demand is greater than the "To Irrigation" Demand, water must be supplied from other sources. The sources which attempt to satisfy the Total Demand for the Larimer County Canal are surface runoff from the Poudre Valley Canal, water from the operational reservoir WSS No. 1, and pumping from the Boxelder and Lone Tree Aquifers. Reservoirs WSS No. 2 and WSS No. 3 provide water indirectly by exporting to WSS No. 1 and by replacing out-of-priority diversions by the Larimer County river rights.

The Total Demand for the Larimer County Canal is modeled with a 70 percent farm headgate efficiency, forcing 30 percent of the water delivered to be lost immediately. The remaining water is available to meet the potential consumptive use. The 30 percent site loss becomes return flow as follows: 40 percent surface flow to the Larimer & Weld Canal, and the remainder subsurface flow distributed, 13 percent to Boxelder Aquifer, 13 percent to the river via Black Hollow Drain, 13 percent to Spring Creek Aquifer and 21 percent to the Lone Tree Aquifer outside the basin. Any water delivered to the Total Demand which is greater than the amount needed to satisfy the potential consumptive use also becomes return flow, which is directed to WSS No. 1 Reservoir and the Lone Tree Aquifer.

Basically, the approach demonstrated by this example can be applied to all the ditch systems modeled. Some of the smaller ditch systems do not have storage facilities, in which case the amount diverted by the ASAU Demand, less 20 percent for canal losses, is used entirely for irrigation and is directed to the Total Demand.

Additional information on modeling, a description of RIBSIM, and sample model output can be found in the Task 3 Summary Report (Harza, 1986).

5.5.3 Flow Base Generation

The streamflow data base for the model consists of recorded monthly flows at two USGS gages -- one on the North Fork just downstream from Seaman Reservoir (Livermore Gage) and one on the mainstem at the mouth of the Poudre Canyon (Canyon Gage). The record for the Canyon Gage covers the entire 1951-80 hydrologic study period; however, the record for the Livermore Gage is available only for the 1951-65 portion of the total study period. Both gage records were adjusted for the effects of imports, diversions, and changes in reservoir storage to develop records of native flows as shown in Appendix C, Tables C.4 and C.5. The adjusted gage records then were compared to develop statistical correlations needed to develop a record for the Livermore Gage record for the 1966-80 period. These correlations are shown in Table C.6 and the extended North Fork record in

Table C.7. The adjusted Canyon Gage record and the adjusted and extended Livermore Gage record provide the basic streamflow data for the model.

5.6 GENERATION OF OPERATIONAL DATA

5.6.1 Transbasin Imports from Mountain Diversions

Historic deliveries of water from the eight transbasin diversions supplying water into the mountainous upper basin were incorporated into the model. As indicated in Chapter 3.0, two of these diversions, Columbine Ditch and Bob Creek Ditch, currently are not operational. They imported water into the upper basin only during the 1951-56 period within the overall 1951-80 modeling period. Average recorded imports from these sources of water supply are provided in Table C.8 in Appendix C.

5.6.2 Imports from the Big Thompson River Basin

Water from the Big Thompson River is imported into the Cache la Poudre Basin by several ditches and by the City of Greeley as a source of municipal water supply. Return flows from the Loveland-Greeley Canal and Louden Ditch were included in the model. Average diversions by these ditches and return flows from these ditches are given in Table C.9. The amounts of water received by the City of Greeley from the Greeley-Loveland Canal and treated for municipal use are presented in Table C.10 in Appendix C. In 1984, Greeley received about 7000 af from the Big Thompson River Basin with the remainder of its supply obtained from the Cache la Poudre River Basin.

5.6.3 Reservoir Evaporation and Seepage

Net evaporation from the modeled plains reservoirs, having a total approximate surface area of 8850 acres was based on 1971-80 pan evaporation data and precipitation records at the Fort Collins Climatological Station. For the mountain reservoirs, 1956-71 pan evaporation and precipitation data at Estes Park were used to estimate evaporation from a total water surface area of 1490 acres. Net lake evaporation rates of 1.4 feet and 1.1 feet were determined for the April-October period for the plains reservoirs and the May-September period for the mountain reservoirs, respectively, based on a pan coefficient of 0.7. Reservoir evaporation rates were varied by month as input to the model as shown in Table C.11. Reservoir seepage was assumed to be included in the efficiency estimates used for each irrigation system.

5.6.4 C-BT and Windy Gap Deliveries

Historic deliveries of C-BT water into the Basin (Table C.12 in Appendix C) have been incorporated in the modeling activity. Future changes in the amount of C-BT deliveries and the deliveries from the Windy Gap Project will be dependent on a variety of factors.

The future deliveries of Windy Gap water to the Cache la Poudre Basin were based on estimates of annual yield prepared by the NCWCD. The amount of additional Windy Gap water could be conveyed through existing facilities to storage, if 124,000 af of new storage was available, was calculated to be an average of 24,000 af/yr. A similar calculation was made to determine the amount of additional water available from the C-BT Project. However, without performing operations studies, it was not clear whether there was sufficient conveyance capacity to convey all of the additional C-BT water and all of the additional Windy Gap water. Consequently, for the prefeasibility studies described in this report, it was decided to conservatively assume that only a total of 24,000 af/yr could be considered additional firm yield from both the C-BT and Windy Gap Projects. Water will be delivered when requested, up to an individual participant's entitlement. Water not delivered will revert to carryover storage held in common with all participants.

Probable average annual deliveries of Windy Gap water have been reported to be 8000 af for the City of Greeley and 16,000 af allotted for the Platte River Power Authority (PRPA). Of the 16,000 af allotted to PRPA, 4200 af will be delivered to the City of Fort Collins as part of their re-use contract. It is anticipated that the remaining 11,800 af will be available to other water users in the Basin through leasing or other arrangements with PRPA. Windy Gap water was not considered in modeling historical conditions in the Basin. During evaluation of present and future water supply and demand conditions, it was considered outside of the RIBSIM model.

Future deliveries of C-BT water were based on number of shares owned or leased under each ditch system in 1982 and the annual quotas declared by NCWCD for 1957-1980, and estimated by NCWCD for 1951-1956. C-BT water available for each system was calculated as the number of shares times the declared quota.

The estimated number of C-BT shares under each ditch system in 1982 is shown in Table C.13, and the annual quotas are shown in Table C.14.

5.6.5 Ditch Losses, Efficiencies, and Return Flows

Ditch systems were modeled with a 20 percent ditch loss (80 percent conveyance efficiency). Five percent of the 20 percent ditch loss is assumed to be consumed due to phreatophytes and evaporation. The remaining 95 percent of the 20 percent ditch loss is return flow to the river system. The assumed distribution of the return flow is 89 percent to subsurface flow and 11 percent overland flow to the next down-gradient ditch. Subsurface returns were modeled with a lag time if the ditch system was over an aquifer outside the Cache la Poudre Valley Fill Aquifer, which is located beneath and adjacent to the river.

Farm headgate efficiencies were applied as follows: 70 percent for the four largest ditch systems (North Poudre, Larimer County, Larimer and Weld, and Greeley No. 2 systems) and 60 percent for all other systems. These percentages represent the amount of ditch water reaching the farm headgate which is consumptively used by the crops. Therefore, the overall system efficiency for each ditch is the product of the farm headgate efficiency listed above and the 80 percent conveyance efficiency. Overall system efficiencies in the model are 56 percent for the four largest ditch systems and 48 percent for all of the other systems. The weighted overall system efficiency is estimated to be 55 percent because most of the irrigated land in the Study Area is served by the four largest ditch systems. The return flow for the four main systems was adjusted to return about 50 cfs as surface returns from one system to another, consistent with the Water Commissioner's observation, with the remainder being subsurface flow distributed to various locations. For the remaining ditch systems, 11 percent of the operation loss is surface flow to the next ditch and 89 percent is subsurface flow.

The locations of return flows (Appendix C, Table C.15) were determined by estimating the amount of irrigated land tributary to the major drainages in the Study Area or overlying the major aquifers. These include the Boxelder, Harmony Terrace, Spring Tree Creek, Lone Tree Creek aquifers and the Black Hollow, Eaton Draw, and Fossil Creek drainages. Return flows below the Greeley Gage occur because of irrigation of lands outside the Basin by the Larimer County Canal (35 percent outside of Basin), Larimer and Weld Canal (48 percent), Greeley No. 2 Canal (35 percent), and Ogilvy Ditch (94 percent). Municipal and industrial return flows occur at wastewater treatment plant locations.

5.6.6 Pumping From Alluvial Wells

Well pumping under each irrigation system was approximated from 1985 pumping records of wells included in the augmentation plans. Average pumpage from these wells was 78 af per year and this pumpage was assumed to be applicable to wells covered by the 1953 adjudication which are not in the augmentation plans. It was assumed that the 1980 pumpage was equal to 1985 pumpage. Pre-1980 annual pumpage then was estimated based on annual energy consumption for pumping which was obtained from utility companies (Table C.16). The variation in well pumpage during the irrigation season was based on estimates supplied by the Water Commissioner. The distribution of pumping is May - 12 percent, June - 16 percent, July - 29 percent, August - 32 percent, September - 11 percent. Pumping in other months reportedly does not occur. In the model, annual ground water pumping ranges from a high of

106,800 af in 1980 to a low of 40,600 af in 1961, as indicated by the data contained in Tables C.17 and C.18 in Appendix C.

5.6.7 South Platte Calls

The frequency and magnitude of calls on the Cache la Poudre River to satisfy diversion requirements by senior right holders on the South Platte were determined as part of the operational data for RIBSIM. Call data were obtained from the Division Engineer (Greeley) for the 1950-84 period. A computer analysis of these data was made to determine the number of days each year for which a call would be administered on Water District 3 (Cache la Poudre Basin) to meet a senior downstream right. The analysis was made for several different theoretical water rights in the Basin as defined by the priority (basin rank) of the water right. A relationship then was developed between basin rank and the percentage of time a call would affect that basin rank. This relationship is shown on Figure 5.4 and is summarized in Table C.19. The amount of water required to satisfy the call was assumed to be the historical gaged flow at Greeley if the call was on for the entire month. For periods when the call would not be in effect for the entire month, an analysis of daily flow records was made to obtain a volume for the month based on the number of days the call was in effect. Results from the South Platte call analysis are provided in Appendix C, Tables C.20 through C.24, which show the call amounts by month for the 1951-80 modeling period for five theoretical basin ranks.

5.6.8 Incorporation of Ground Water Into the Model

Ground water was incorporated into the model as a system of reservoirs located in the vicinity of the major aquifers of the Study Area. These are the Boxelder, Harmony Terrace, Spring Creek/Lone Tree Creek, and Cache la Poudre Valley Fill aquifers. These reservoirs were sized to account for estimated annual pumping and seepage volumes and were operated, within the model, like surface water reservoirs. Pumpage from the reservoirs was applied to potential consumptive use demands within individual ditch systems. The ground water reservoirs were filled by return flows from irrigated lands above the aquifers except in the case of the Cache la Poudre Valley Fill aquifer reservoirs which were refilled by river water prior to being filled by any surface water rights. Ground water outflow from the Basin, which passes through the Valley Fill aquifer and, therefore, is not measured by the Greeley streamflow gage, is estimated to be 10,000 af per year. This was considered in the model as a senior water right to prevent diversion of ground water by surface water rights.

5.6.9 Contribution of Precipitation to Basin Water Supply

The contribution of precipitation to water supply in the Basin was recognized during the model calibration activity. Procedures used to determine potential crop consumptive use requirements for irrigation water, such as the Blaney-Criddle and Jensen-Haise methods, account for the fact that precipitation, occurring during the growing season, reduces the irrigation water requirement. The amount of precipitation that is effective in meeting the consumptive use requirement of crops can be computed on a theoretical basis. This effective precipitation is deducted from the total crop consumptive use requirement when determining the net consumptive use requirement for irrigation water. In the basinwide analysis, the "non-effective" portion of total precipitation falling on an irrigated parcel in the growing season also can be available for crop consumptive use but at a later time and different location in the Study Area because of the processes of surface runoff and deep percolation. Surface runoff originating from non-effective precipitation occurring in the service area of one ditch system can be intercepted by downstream ditches and is available for diversion at farm headgates. Non-effective precipitation going into deep percolation replenishes ground water supplies and is available for withdrawal from existing wells in the study area.

For the water supply analysis, it was assumed that all non-effective precipitation during the March through October period would be "additional" precipitation contributing to the overall Basin water supply. By averaging effective precipitation over the modeling study period for the cropping pattern on irrigated lands contained in the simulation model, the additional precipitation available as a supply in the Basin because of non-effective precipitation, was estimated to be 6.29 inches in the March through October period. The depth of non-effective precipitation is a function of cropping pattern and, therefore, additional precipitation will vary as the cropping pattern changes. The volume of water supply available from additional precipitation is determined based on the amount of irrigated land. Table C.25 in Appendix C shows the 1970 historical irrigated area by ditch system.

5.7 CALIBRATION OF THE MODEL

Model calibration is an adjustment process performed on the computer in which input variables are adjusted until output from the model compares favorably with actual historical measurements of streamflows, water imports, and historic diversions. The 1974-80 period was selected for calibration because the records of diversions and system operation for this period are considered to be the most reliable. In addition to obtaining a model that reflects historic conditions, calibration aids in understanding the operation of the water supply system. Once the model was calibrated using historical data, it was used to compare available water supply with future water demands to identify potential water shortages.

5.7.1 Calibration Steps

The major steps in the calibration process for the RIBSIM model included:

- Assigning priorities for the utilization of different water sources to satisfy demands. Priorities in the model are (in order):

    1. Native flows are used first, then,
    2. Exchanges
    3. Foreign water other than C-BT
    4. C-BT water
    5. Mountain reservoir water.

- Setup of the model network including water rights, South Platte calls, ground water reservoirs, historic diversions, inflows, and seasonal operational data for each ditch and M & I system including losses, efficiencies, potential consumptive use, reservoir capacities, and return flows.

- Initial simulation run for the 1974-80 period followed by checks of the water balance, modeled vs. actual flows at Greeley and the Mouth of the Canyon, modeled vs. recorded diversions, and modeled return flows vs. those reported by the Water Commissioner.

- Adjustment of assumptions with respect to ditch losses, ditch system efficiencies, and return flows (amounts, locations, and timings).

- Reoperation of the model with adjustments and performance of new comparisons of modeled vs. actual flows and the other checks listed above.

Following calibration for the 1974-80 period, the model was operated for the entire 1951-80 historic study period. Some additional refinements to the model were made following this operation.

5.7.2 Comparison of Modeled vs. Actual Flows

Comparisons of modeled and actual (recorded) flows were made for the Canyon Gage and the Greeley Gage. The Canyon Gage comparison indicates the adequacy of the model in estimating inflows to the lower basin. Modeled flows at the Canyon Gage are within plus or minus five percent of the actual flow during each year of the 30-year historic study period (1951-80). Calibration to the Canyon Gage is shown on Figure 5.5. Recorded and modeled flows at the Canyon Gage for the 1951-80 modeling period are provided in Appendix C, Table C.26.

The Greeley Gage provides recorded flow data that can be used to evaluate the performance of the model in simulating the water system operations within the lower basin. The modeled flows at the Greeley Gage are within ±20 percent of the gaged flows in 20 years of the 30-year historic study period, and over the entire 30-year period the average annual modeled flow is 96 percent of the average annual gaged flow. Calibration at the Greeley Gage is considered to be fair but sufficiently adequate for a prefeasibility-level investigation, considering the complexity of the Basin and uncertainties regarding ground water pumping, system efficiencies, and the amount of water leaving the topographic Basin via four ditch systems. Calibration to the Greeley Gage is shown on Figure 5.6. Recorded and modeled flows at the Greeley Gage are shown on Table C.27 in Appendix C.

There are 8 years in the study period 1952-57, 1968, and 1978 in which the modeled flow for the year is significantly higher than the gaged flow at Greeley. The most likely reasons for these occurrences are listed below:

Problem	Most Likely Reason
Modeled flows higher than gaged flows in 1952-57.	Possibly low estimates of ground-water pumping and recharge.
Modeled flow 143 percent higher than gaged flow in 1968.	Reservoirs in the model study were full at the start of June and the high June flows could not be stored. Because of administrative practices, actual operation may have been different than modeled in months prior to June.
Modeled flow 124 percent higher flow than gaged flow in 1978.	Expected problem with recorded data. Flow data indicate a depletion of 72,400 af in June between the Canyon Gage and the Fort Collins Gage. The latter gage was established in 1975. This depletion is not consistent with recorded diversions between these gages.

Reducing the modeled flow in each of the above-noted years to the corresponding historic annual flow at the Greeley Gage would reduce the 30-year average annual modeled flow to 91 percent of the recorded flow at the Greeley Gage.

It was expected that modeled flows at the Greeley Gage would be lower than the actual flows because monthly rather than daily flow and diversion data were used. When using monthly data, the amount of diversion from the river can be overestimated because peak flows that might otherwise pass the diversion point are lumped into the average flow for the month.

On a monthly basis, the modeled flows at the Greeley Gage range from 61 to 128 percent of the actual flows for the model calibration period (1974-80). The model could be calibrated to more closely simulate actual flows at the Greeley Gage; however, adjustments required to accomplish this would tend to overestimate the amount of outflow from the Basin during dry years. At present, the model simulates dry year conditions reasonably well.

Given the accuracies of the various input data items, the RIBSIM model is considered to be sufficiently calibrated to the Poudre Basin for a prefeasibility-level study. The calibrated model was used to estimate water shortages under future demand conditions in the study area and to estimate the storable flows available in the Basin at various points along the river.

5.8 FORT COLLINS DROUGHT STUDY VS. MODELED STUDY PERIOD

A drought was defined for the Study as a single year or series of consecutive years of below average native runoff at the Canyon Gage. The cumulative amount by which the annual runoff is below average during the drought is termed the total deficit.

Consultants for the City of Fort Collins recently completed a drought study to aid in planning of drought emergency measures. That study (Resource Consultants, Inc., 1985) involved a complex hydrologic analysis including generation of fifty thousand years of stochastic streamflow records based upon statistical methods. Results from that study were compared to droughts contained in the 30-year historic study period (1951-80) being used for modeling activities in the Cache la Poudre Basin Study. This comparison suggested ways in which the historic study period could be modified to represent more extreme droughts than the estimated 1-in-25 year drought occurring in the 1950s. The 1950s drought contains the driest year (1954) on record in terms of native runoff. The two-year dry period of 1976-77 is considered to be a 1-in-10 year type event. The 1963 through 1969 period contains six dry years with 1965 being an above average year. Using this period with certain adjustments, the droughts shown in Table 5.1 were characterized using results from the Fort Collins drought study.

5.9 REGIONAL HYDROLOGIC ASSESSMENT

The regional hydrologic assessment is an interpretation of the simulation model results using historical demand levels for the 1951-80 period. The general operation of the water systems of the Basin is described in terms of diversions, imports to the Basin, return flows, and ground water use. Modeling of the Basin for present (1985) and future (year 2020) conditions is described in Chapter 7.

5.9.1 Diversions

The average annual modeled diversion from the Cache la Poudre River and the North Fork is about 441,000 af which compares very well with the recorded average annual diversion of about 443,000 af. About 62 percent of all diversions are made by four ditch systems -- Larimer and Weld Canal (79,700 af per year), Larimer County Canal (77,200 af per year), North Poudre Ditch (63,300 af per year), and Greeley No. 2 Canal (46,400 af per year). Modeled diversions are presented in Appendix C, Table C.28.

TABLE 5.1
Characterization of Droughts for Cache la Poudre Study

Return Period	Droughts Selected for Simulation in Fort Collins Study[1]		Cache la Poudre Study	
	Years	Total Deficit (af)	Years	Total[6] Deficit (af)
10-Yr			2	236,000[2]
20-Yr	3	360,000		
25-Yr			4	437,500[3]
50-Yr	6	550,000	6	548,000[4]
100-Yr	8	690,000	7	650,000[5]

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(1) Resource Consultants, Inc., 1985. Droughts and Their Effect on the Water Supplies For the City of Fort Collins, Colorado.

(2) Drought period 1976 through 1977.

(3) Drought period 1953 through 1956.

(4) Drought period 1963 through 1968, deficit obtained by replacing 1965 flow with that occurring in 1964.

Drought period 1963 through 1969, deficit obtained by replacing 1965 flow with that occurring in 1954.

(6) Total deficits computed using annual native flow estimates developed as described in Chapter 3.

5.9.2 Transbasin Imports

The RIBSIM model of the Basin simulates well the pattern of transbasin imports from the high mountain diversions; however, the amount of imports is less in the model than that which was imported historically. Modeled imports averaged 35,000 af per year (Table C.29) compared to the average recorded amount of 38,000 af per year. To account for this, the differences between the modeled amounts and the actual amounts of transbasin imports to the Basin were made available to the river to satisfy other water rights.

5.9.3 C-BT Imports

Modeled imports from the C-BT Project into the Basin match closely the historical imports (88,660 af per year vs. 88,800 af per year). C-BT imports normally begin in April and end in October. July and August are the peak months for use of C-BT water. The Larimer and Weld system (30,400 af per year), North Poudre system (19,200 af per year) and the Larimer County Canal (21,000 af per year) are the largest users of C-BT water. The Greeley No. 2 system obtains its C-BT allotment by exchange. Modeled average C-BT diversions are given in Table C.30 in Appendix C.

5.9.4 Ground Water Use

Ground water use in the model corresponds closely to the assumed historical amounts of pumpage. As shown in Table C.31, modeled pumpage is about 73,300 af per year on average (in the May through September period) with about 60 percent of the pumpage occurring in July and August.

5.9.5 Return Flows

Modeled return flows along the river are somewhat higher than those estimated by the Water Commissioner as shown in Table 5.2.

TABLE 5.2
Comparison of Estimated and Modeled Return Flows

River Reach			Modeled Return[1]	
From	To	Estimated Return	Average Annual	Peak
Month		(cfs)	(cfs)	(cfs)
Canyon	Larimer & Weld	10	8	28
Larimer & Weld	Greeley No. 2	50	74	147
Greeley No. 2	Greeley No. 3	50	68	151
Greeley No. 3	Greeley Gage	50	52	84

(1) Monthly modeled return flows for the 1951-80 period for the river reaches in Table 5.2 are provided in Appendix C, Tables C.32 through C.35.

Irrigation return flows downstream from the Greeley Gage occur from the Larimer County, Larimer and Weld, and Greeley No. 2 canals, Ogilvy Ditch, and wastewater flows from Greeley's Lone Tree Creek wastewater treatment facility. These out-of-basin flows average about 41,300 af per year with peak flows occurring in June and July, as shown in Appendix C, Table C.36.

Modeled flows from wastewater treatment plants on an average monthly basis are provided in Table C.37. In Table C.38 of Appendix C, a comparison is provided between modeled and reported wastewater treatment plant flows. Modeled 1980 plant flows compare favorably with recent average flows as reported by local agencies. However, in earlier years of the modeling period the comparison between modeled and reported flows is less favorable because of the increase in municipal water use over time.

5.9.6 Basin Water Balance

The total inflow to the Basin comprises native flow plus transbasin imports measured at the Canyon gage, plus the amounts diverted above the gage, imports from the C-BT System, imports from the Big Thompson River Basin, and a contribution from rainfall. As shown on Table 5.3, the modeled average annual inflow to the basin from these sources was 540,000 af over the 30-year modeling study period. The annual pumping from aquifers was considered as re-use of the total supply at the gage.

Outflows from the Basin include the flow at the Greeley gage, estimated ground-water underflow, and return flows that occur below the gage. These outflows totaled 147,000 af on an average annual basis for the 1951-80 modeling study period as indicated in Table 5.3. Subtracting outflows from inflows results in an average of 393,000 af per year of water available for meeting consumptive use needs in the Basin.

TABLE 5.3
Average Water Supply Under Historical Conditions
(Average for 1951-1980 Period)

	Average Flow (af/yr)
Modeled Inflows	
Canyon Gage	224,000
Diversions Above Gage	88,000
C-BT Imports	89,000
Big Thompson Imports	14,000
Additional Precipitation	125,000
Total Inflow	540,000
Modeled Outflows	
Greeley Gage	96,000
Ground Water Underflow	10,000
Out-of-Basin Returns	41,000
Total Outflows	147,000
Water Supply Available for Consumptive Use	393,000

The modeled inflow shown in Table 5.3 is an indication of the total water supply available to the Basin. Average inflow to the Basin during the 1951-80 period, based primarily on measurements, was 542,000 af per year, as shown in Table 5.4.

The spatial and time distribution of shortages under present and future levels of demand were investigated in Task 5 and results are provided in Chapter 7 for 1985 and possible future conditions in the Basin.

5.9.7 Storable Flows

A large portion of the surface water resources of the Basin have been developed for beneficial use by the M & I and agricultural sectors. However, some water flows out of the Basin in the high runoff months because of a lack of available storage space. Modeled flows leaving the Basin because of inadequate storage volume are estimated to average 40,000 af per year at the Canyon Gage, based on historical conditions during 1951 to 1980. As shown in Table C.39 in Appendix C, these flows generally occur in May and June, with only occasional occurrences in other months. Storable flow estimates for 1985 Basin conditions were not used in the reservoir operations studies to determine firm yields from new storage. Yields were estimated using the anticipated storable flows described in Chapter 7.

TABLE 5.4

"Measured" Inflows to the Basin

Source	Average Flow (af/yr)
Native Flow at Canyon Gage[1]	276,000
Transbasin Imports[2]	38,000
C-BT Imports[2]	89,000
Return Flows From Big Thompson[1]	14,000
Additional Precipitation[3]	125,000
Total Inflow	542,000

[1] From measurements.
[2] Estimated from measurements.
[3] Estimated.

Return flows produced in the lower basin also could be stored in the Cache la Poudre Basin. These flows, as estimated to occur at Greeley, are legally entitled to the Basin but they cannot be used because they occur too far downstream to be diverted by existing ditch systems. During the 1951-80 period, these flows were estimated to average about 40,000 af per year. Unlike storable flows at the Canyon Gage, which occur sporadically, the return flows occur fairly uniformly over time. However, determination of storable flows at Greeley is subject to greater inaccuracy.

5.9.8 Overall Basin Water Use Efficiency

There are two efficiency terms that are useful in describing water use in the Basin -- basin diversion efficiency and basin consumptive use efficiency. The product of these terms is the overall basin efficiency. Basin diversion efficiency can be defined as the ratio of the water diverted for use to the water available for diversion. For the Cache la Poudre Basin, the water available for diversion on a historical basis includes the native flow at the mouth of the Canyon and all transbasin imports, including the mountain diversions and C-BT deliveries. The computation of basin diversion efficiency for historic conditions in the Poudre Basin is shown below based on averages for the 1951-80 period:

Water Available for Diversion	
Native Flow at Canyon(1)	276,000 af
Transbasin Imports	39,000
C-BT Imports	89,000
Historic Divertable Water Supply	404,000 af
Water Not Diverted (2)	40,000 af
Water Diverted	364,000 af
Basin Diversion Efficiency(3)	90%

(1) See Chapter 3, Section 3.2.2.
(2) From RIBSIM storable flow analysis.
(3) (Water diverted divided by historic divertable water supply) X 100.

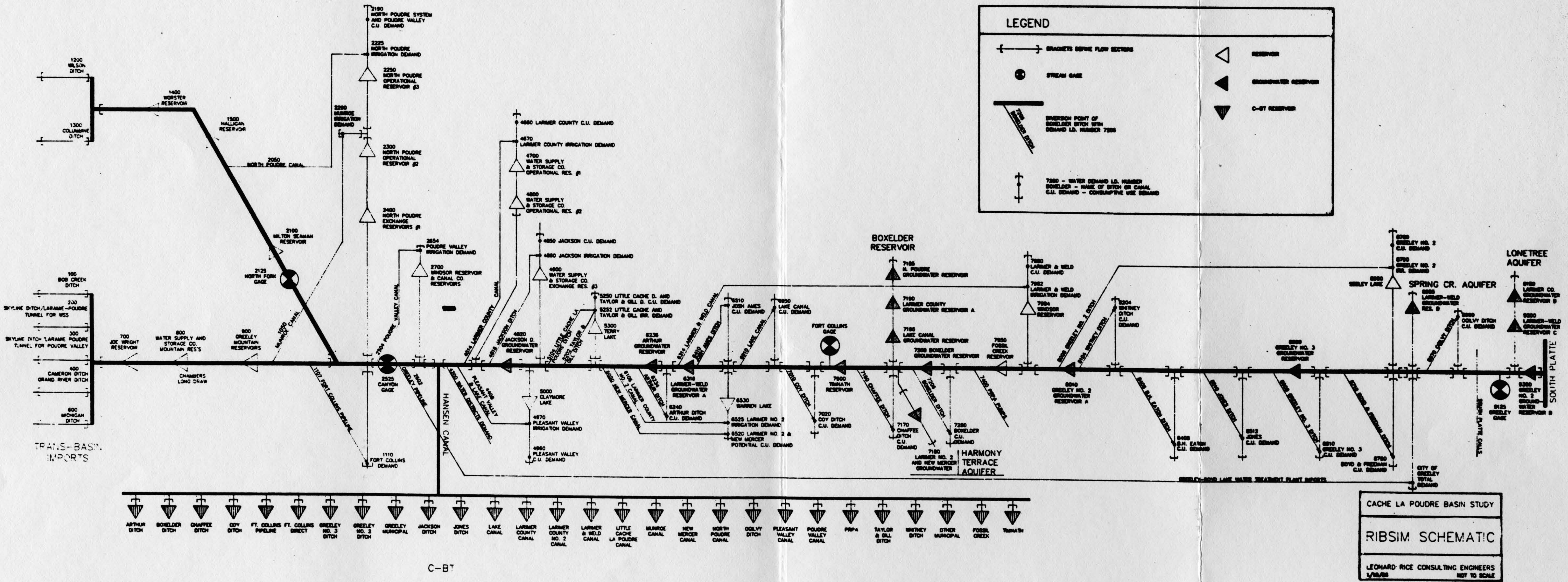
Basin consumptive use efficiency can be defined as the ratio of amount of water consumed to the amount of water diverted. For the Poudre Basin the amount of water consumed is defined as the amount of water diverted less the estimated return flows attributable to the amount of water diverted. The computation of historic basin consumptive use efficiency is given below based on averages for the 1951-80 period:

Water Diverted	364,000 af
Estimated Return Flow	81,000
Estimated Water Consumption	283,000 af
Basin Consumptive Use Efficiency[1]	78%

[1](Estimated water consumption divided by water diverted) X 100.

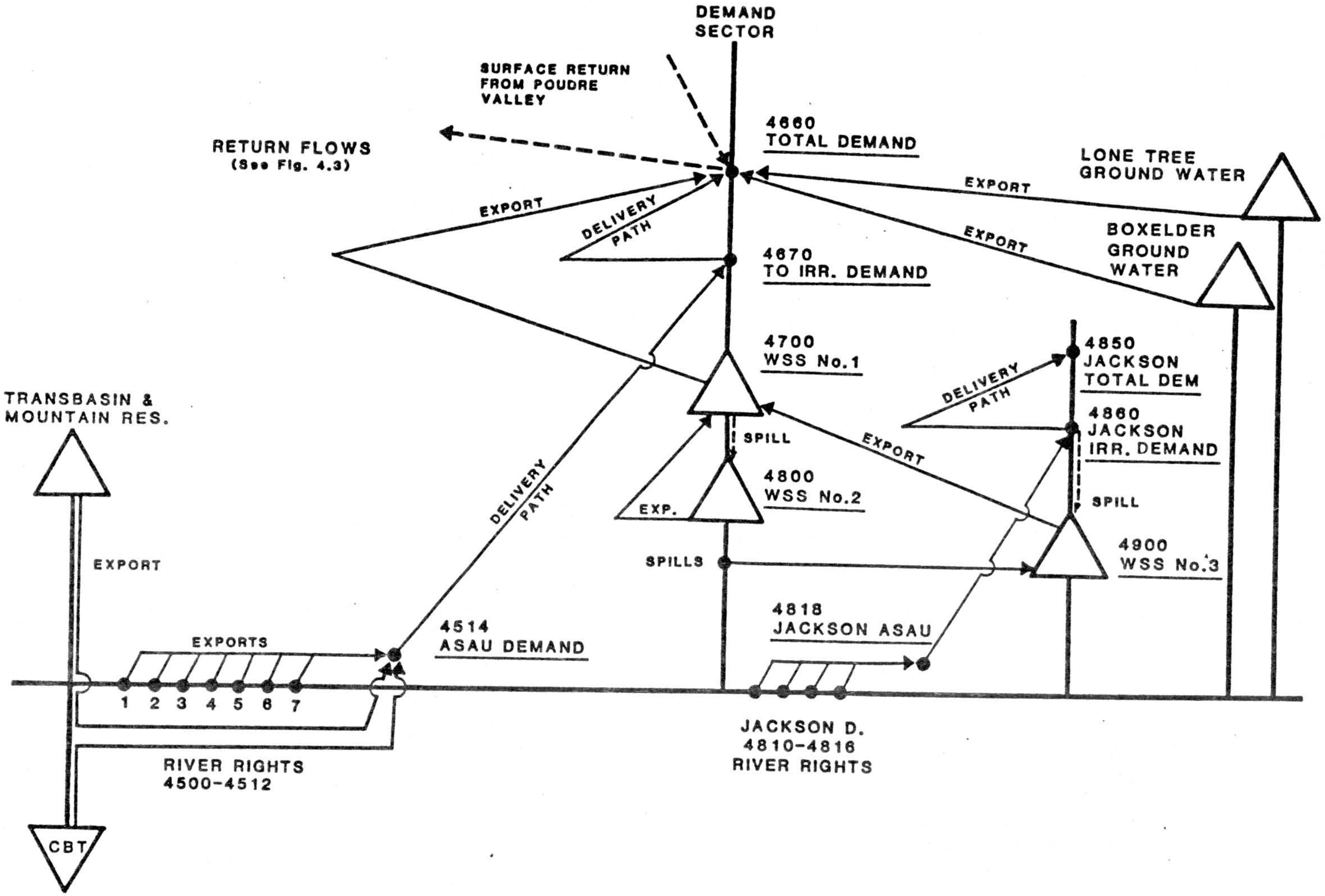
The historic overall basin efficiency (diversion efficiency X consumptive use efficiency) is estimated to be 70 percent (90 percent X 78 percent). Although each term of the efficiency estimate could be refined, the overall basin efficiency is considered to be a reasonable estimate based on historical conditions.

The overall basin efficiency of 70 percent in comparison to the weighted irrigation system efficiency of 55 percent demonstrates the effects of water reuse in the Basin.



LEGEND
BOXELDER RESERVOIR
LONETREE AQUIFER
SPRING CR. AQUIFER
HARMONY TERRACE AQUIFER
TRANS-BASIN IMPORTS
HANSEN CANAL
SOUTH PLATTE
C-BT
ARTHUR DITCH
BOXELDER DITCH
CHAFFEE DITCH
COY DITCH
FT. COLLINS PIPELINE
FT. COLLINS DIRECT
GREELEY NO. 3 DITCH
GREELEY NO. 2 DITCH
GREELEY MUNICIPAL
JACKSON DITCH
JONES DITCH
LAKE CANAL
LARIMER COUNTY CANAL
LARIMER COUNTY NO. 2 CANAL
LARIMER & WELD CANAL
LITTLE CACHE LA POUDRE CANAL
MUNROE CANAL
NEW MERCER CANAL
NORTH POUDRE CANAL
OGILVY DITCH
PLEASANT VALLEY CANAL
POUDRE VALLEY CANAL
PRPA
TAYLOR & GILL DITCH
WHITNEY DITCH
OTHER MUNICIPAL
FOSSIL CREEK
TIMNATH
CACHE LA POUDRE BASIN STUDY
RIBSIM SCHEMATIC
LEONARD RICE CONSULTING ENGINEERS
NOT TO SCALE

FIGURE 5.1



LARIMER COUNTY RIVER RIGHTS

NO.	RIBSIM PRIORITY	PRIORITY DATE
1	450	3-10-1862
2	560	9-15-1864
3	720	3-15-1868
4	970	3-20-1873
5	1170	4-01-1878
6	1230	4-25-1881
7	2145	9-28-1914

LEGEND

- △ RESERVOIR
- ● RIBSIM WATER RIGHT OR DEMAND
- 4514 RIBSIM DEMAND I.D. NUMBER
- ——→ PATH OF WATER DELIVERIES
- - - → PATH OF RETURN FLOWS

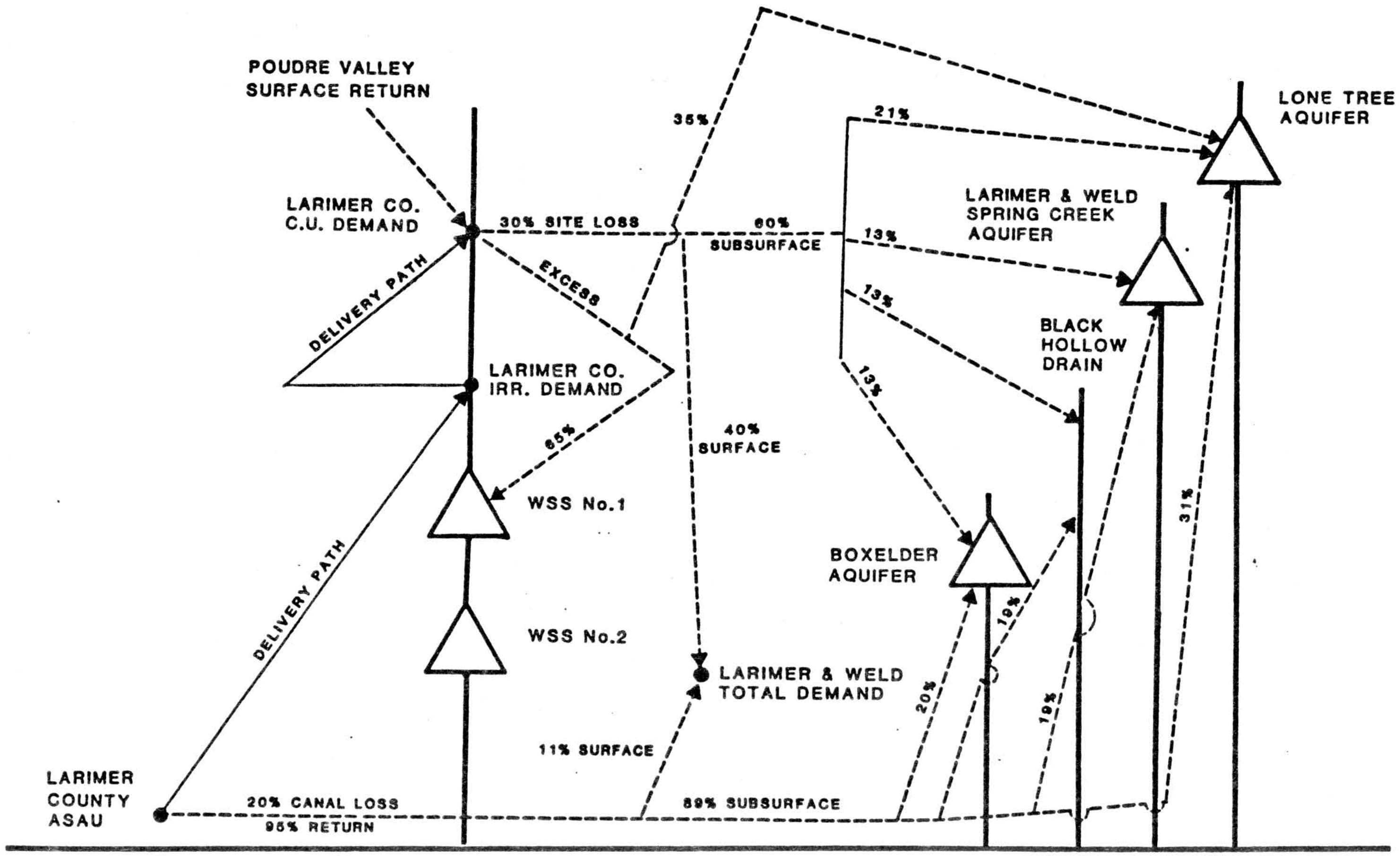
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY

DETAIL OF LARIMER COUNTY CANAL WATER SUPPLY (RIBSIM)

HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M. W. Bittinger
Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE: APR 1986

FIGURE 5.2



LARIMER COUNTY RIVER RIGHTS

NO.	RIBSIM PRIORITY	PRIORITY DATE
1	450	3-10-1862
2	560	9-15-1864
3	720	3-15-1868
4	870	3-20-1873
5	1170	4-01-1878
6	1230	4-25-1881
7	2145	9-26-1914

LEGEND

△ RESERVOIR

● RIBSIM WATER RIGHT OR DEMAND

4514 RIBSIM DEMAND I.D. NUMBER

——→ PATH OF WATER DELIVERIES

– – –→ PATH OF RETURN FLOWS

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

DETAIL OF LARIMER COUNTY RETURN FLOWS
(RIBSIM)

HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington - M. W. Bittinger
Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE: APR 1986

FIGURE 5.3

SOUTH PLATTE CALL ON WATER DISTRICT 3 PRIORITY

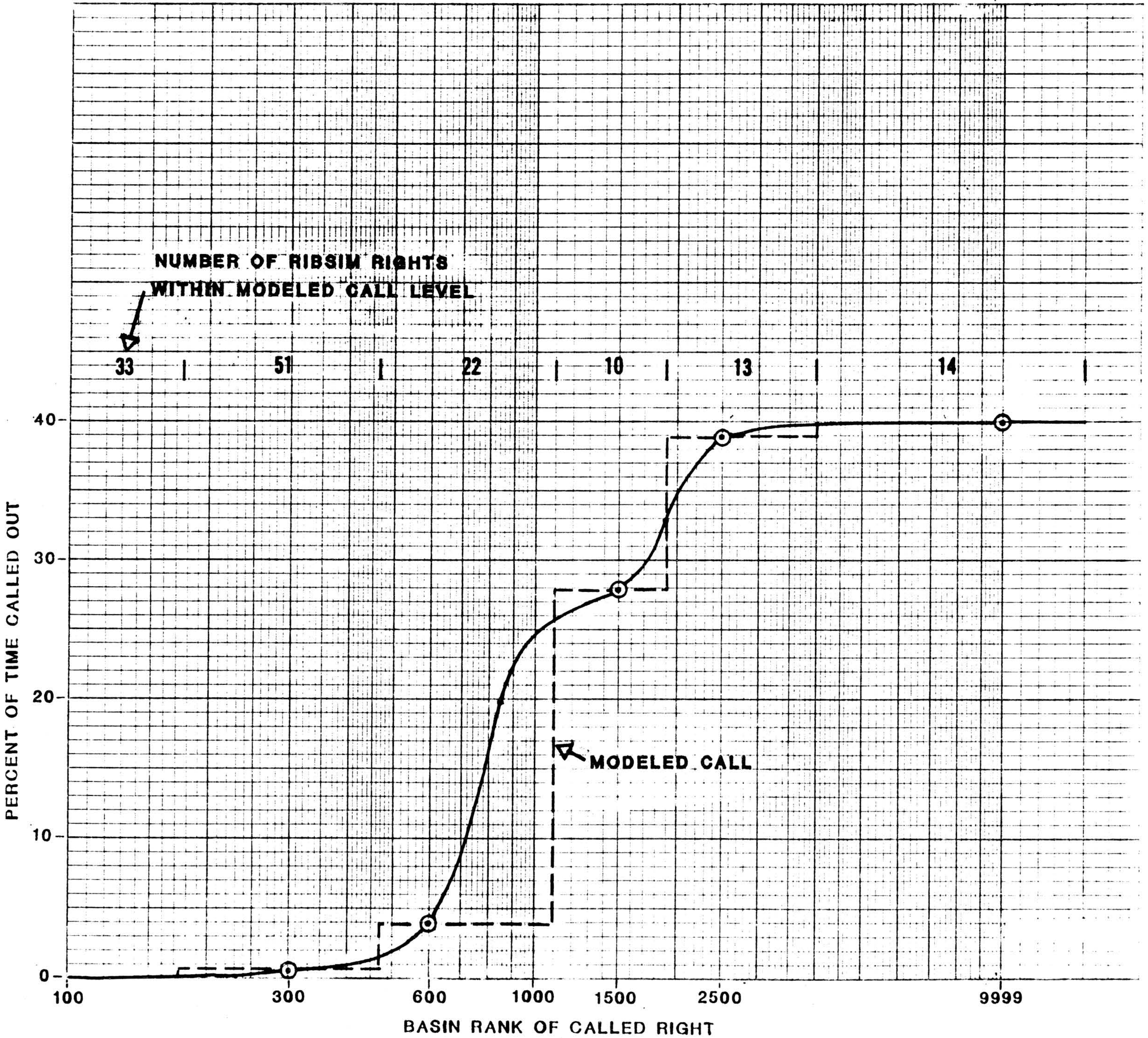


FIGURE 5.4

CACHE LA POUDRE RIVER AT CANYON MOUTH

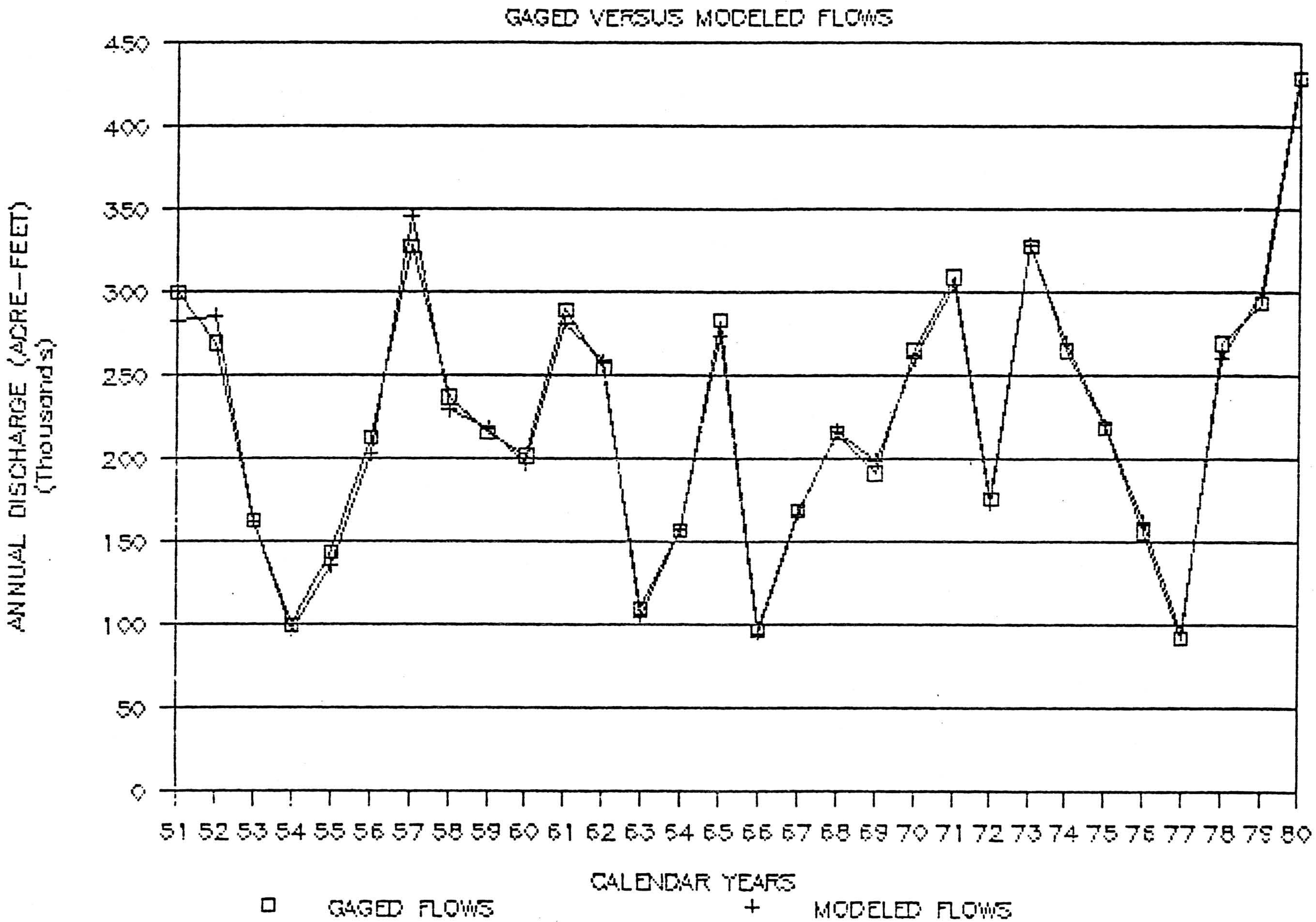


FIGURE 5.5

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY	CACHE LA POUDRE BASIN STUDY DATE: JAN 1986	HARZA ENGINEERING COMPANY Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates Leonard Rice Consulting Water Engineers, Inc.

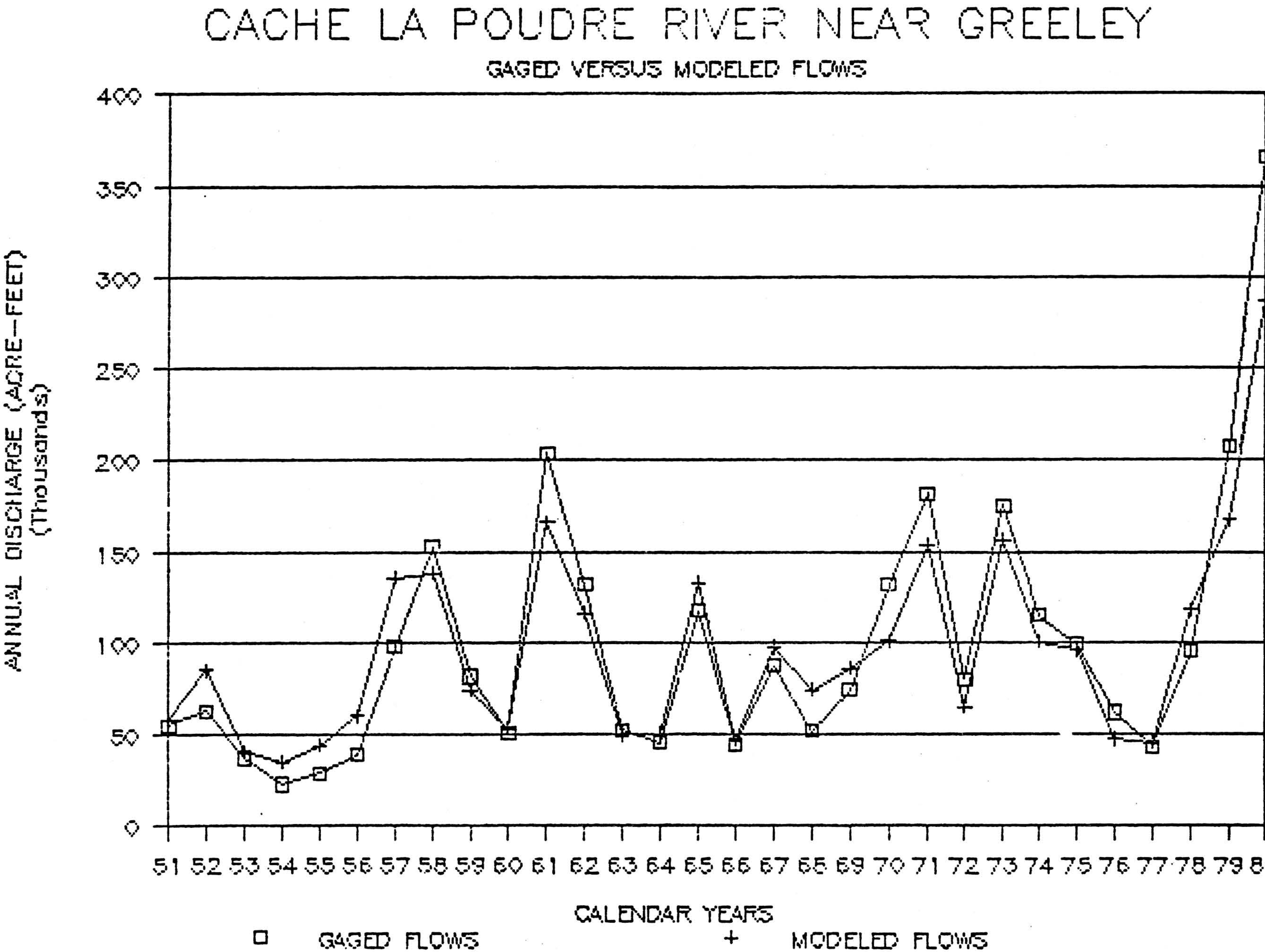


FIGURE 5.6

COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY	CACHE LA POUDRE BASIN STUDY DATE: JAN 1986	HARZA ENGINEERING COMPANY Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates Leonard Rice Consulting Water Engineers, Inc.

Chapter 6

Water Demand Forecasts

6.0 WATER DEMAND FORECASTS

6.1 GENERAL

The chapter presents forecasts of future water demands for the Basin. Water demand forecasts were based on extensive data collection within the Basin, which included interviews with major Basin water users. Forecasting techniques were selected to provide the flexibility needed to incorporate existing conservation programs and other measures as they may affect water demand in the future.

Several key points need to be emphasized with respect to the demand forecasts contained in this chapter.

1. Water demands have been defined without regard to source or availability. Therefore, forecasted demands were not constrained by the amount of water supply available for consumptive use.

2. Forecasts should be considered as baseline forecasts because they assume that policies and programs that are currently in-place will continue.

3. The price of water was assumed to remain constant in real terms. The effects of different pricing policies on water demand were considered in evaluating non-structural measures, as described in Chapter 10.

4. Water demand was defined as the initial demand by end users. In the M&I sector, this means water demands at the treatment plants plus raw water deliveries to urban-type end users. For the agricultural sector, water demand is the total consumptive use demand for irrigation water.

5. Other demands for water, particularly for instream flows, were not included.

The forecasting techniques assume a fundamental relationship between water demand and such factors as population growth, conversion of irrigated land to urbanized uses, personal income, the future of the feedlot industry, and other factors. These fundamental relationships could change radically in an unforeseen manner in the future. Consequently a single forecast is not appropriate.

Instead, three economic scenarios have been adopted to attempt to bracket the economic situation of the Basin during the next 50 years. They are designated Series 1, 2, and 3 and demand estimates for each are provided in this chapter.

- Series 1 assumes a relatively pessimistic outlook for the local economy and agriculture. Further declines will occur in the high tech and electronic industry. Unfavorable agricultural economic conditions will prevail indefinitely.

- Series 2 assumes gradual growth among the industries and major employers in the Basin. Agricultural prospects will stabilize at about present levels.

- Series 3 assumes a relatively optimistic long-term view. Urban areas and economies will soon resume the rapid growth patterns evident in the 1960s and early 1970s. Economic relationships in agriculture will turn favorable.

Water demands include some areas that are not in the Basin. There are irrigated lands outside the Basin which are supplied by systems originating in the Basin. There are also several towns outside of the Basin which are supplied by the City of Greeley. These situations have been taken into account in estimates of future water demands. However, other demands outside the Basin that might materialize during the next 50 years have not been included in the demand forecasts. For example, the possibility that Denver suburbs may turn to the Cache la Poudre Basin as a potential source of water supply has not been considered in making water demand forecasts.

6.2 DEMOGRAPHIC CHARACTERISTICS

The Basin encompasses portions of Larimer and Weld Counties in Northern Colorado. These two counties comprise the region for which a major portion of the demographic, economic, and related information covering the Basin is available.

6.2.1 Population

Larimer and Weld Counties (the region) have an estimated 1985 population of 332,000. The counties grew slowly in terms of population from 1930 to 1960. Since 1960, the population growth rate has exceeded that for Colorado and the U.S. Population in the region has more than doubled since 1960. Growth during 1980-85 was four percent per year for the region with the largest growth rate occurring in Larimer County, particularly Fort Collins.

Natural population growth (births less deaths) has increased steadily in the region since 1960. Positive net migration into the region indicates its comparative attractiveness in terms of job opportunities and amenities.

TABLE 6.1
Components of Population Growth
Larimer and Weld County Region, 1960-1985

Period	Net Natural Increase	Net Annual Migration	Total Annual Change
1960-65	1560	3080	4640
1965-70	1530	4590	6120
1970-75	1530	8170	9700
1975-80	2330	6490	8820
1980-85	3180	3730	6910

Source: State Demographer's Office

As shown in Table 6.1, annual population growth between 1980 and 1985 exceeded 6900 persons; however, this rate of growth is lower than the peak growth period of the early 1970's.

The annual change in Larimer County population, 4280 persons per year during the 1980-85 period, accounted for about 62 percent of the population growth in the region during that period.

The populace of the region is younger in comparison to Colorado and the U.S. Age distribution will become more weighted toward older individuals in the future, a factor that will affect future population growth. In part because of the presence of two major universities -- Colorado State University (CSU) at Fort Collins and the University of Northern Colorado (UNC) at Greeley -- the population of the region is more highly educated in comparison to the U.S. as a whole.

The population of the Cache la Poudre Basin is estimated to be 204,000 persons in 1985 or about 60 percent of the total population of Larimer and Weld Counties. Historic population growth within the Basin has been estimated by disaggregating regional population, based on U.S. Census figures for incorporated areas, and allocating rural census division data on a geographical basis. Basin population during the 1960-85 period is shown in Table 6.2.

6.2.2 Employment and Income

In July 1985, 150,000 residents of the two-county region were employed, out of an available labor force of 159,000. The relative strength of the local economy is demonstrated by the fact that unemployment rates are consistently lower than Colorado and U.S. rates. Annual employment growth averaged 3.4 percent per year from 1977 to 1985, with a 4.4 percent annual growth since 1982.

TABLE 6.2
Population of Incorporated Communities Within the
Cache la Poudre Basin, 1960-1985

Location	1960	1970	1980	1985
Larimer County Portion				
Fort Collins	25,030	43,340	65,090	82,800
Timnath	150	180	190	200
Wellington	530	690	1,210	1,450
Other Basin (Larimer)	10,490	15,990	28,000	34,400
Weld County Portion				
Greeley	26,310	38,900	53,010	57,000
Windsor	1,510	1,560	4,280	4,800
Ault	800	840	1,060	1,100
Eaton	1,270	1,390	1,930	2,020
Evans[(1)]	1,450	2,570	5,060	5,600
Garden City[(1)]	130	140	80	120
Rosedale[(1)]	70	70	40	30
Severance	70	60	100	110
Other Basin (Weld)	10,740	10,150	12,120	14,600
Total Cache la Poudre Basin	78,550	115,880	172,170	204,230
Total Larimer/ Weld Region	125,680	179,200	272,620	331,820

[(1)] Located outside the Basin but relying entirely on the City of Greeley for water supply.

The largest employment sectors in the region are government, manufacturing, trade, and services. In 1983 the government sector, including the two universities, accounted for nearly 25 percent of the regional employment in terms of wages and salaries (U.S. BEA, 1985). Wholesale and retail trade, manufacturing, and the services sector accounted for 22, 19, and 15 percent of the regional employment, respectively. The remaining 19 percent of total wage and salary employment occurred in agricultural activities, mining, construction, and finance related sectors. The Larimer-Weld region exhibits a well diversified economic base. The employers in Fort Collins and Greeley exhibit considerable diversity although there is more emphasis in Fort Collins on public sector employment. Major employers include:

Major Greeley Area Employers	Number of Employees
Monfort of Colorado	1,480
Univ. of Northern Colorado	1,100
Hewlett-Packard	900
Northern Colorado Medical Center	900
Weld County Government	850
Weld County School District No. 6	850

Major Fort Collins Area Employers	Number of Employees
Colorado State University	4,200
Kodak	2,800
Hewlett-Packard	2,320
Poudre Valley R-1 School District	1,800
Poudre Valley Hospital	1,100
Woodward Governer	900
Larimer County Government	770
City of Fort Collins	760
Teledyne Water Pik	700

About one-half of the employees in the region are considered "white collar". About one-third of the employees hold "blue collar" jobs. The remaining employees hold service positions or are involved in agriculture. The percentage of employment in agriculture in the region (over 5 percent) exceeds the averages for both Colorado and the U.S.

Total personal income in the region exceeded $3 billion in 1983, including work-related earnings (nearly $2 billion) and personal dividend income, personal interest income, rental income, and transfer payments. Work-related earnings more than doubled from 1976 to 1980. This is attributable to a combination of increased economic activity and inflation. Earnings growth was attributable entirely to nonfarm earnings. Farm earnings remained about steady in absolute dollars but their percentage of total earnings declined from 14 to 7 percent between 1976 and 1983.

Per capita income in both Larimer and Weld Counties remains below income levels for the rest of Colorado and the U.S. average. Per capita income for the region averaged $10,650 in 1983 and growth has averaged 9 percent per year in the 1976-83 period. Somewhat higher annual income growth (12.7 percent) has occurred in Larimer County in comparison to Weld County (8.4 percent).

Table 6.3 indicates employment trends by industry in the Larimer-Weld region from 1975 to 1983. The largest employment sectors, government, manufacturing, trade and services, also have been the fastest growing in recent years. The breadth and strength of these four economic sectors points to a healthy local economy with a well diversified economic base.

Government employment accounts for a high percentage of regional employment compared with the state or national economies, as shown in Table 6.4. Similarly, manufacturing represents a significantly higher proportion of employment in the region than in Colorado. These comparisons underscore the importance of these sectors in the local economy. Certain government and manufacturing establishments along with farming represent the economic foundation of the region in that they bring in money from outside the region which, in turn, generates retail and services employment. Conversely, services sector employment at 15 percent of the total, is relatively low compared with Colorado or the U.S. This suggests that potential for expansion of this sector might be evident in the future.

TABLE 6.3
Employment in the Larimer-Weld Region, 1975-1982[1]

Sector	1975	1976	1977	1978	1979	1980	1981	1982	1983
Farm	4,762	4,510	5,040	5,039	3,985	5,294	5,172	5,145	3,646
Agricultrual services, forestry and fishing	568	649	727	904	982	963	NA[2]	1,214	1,132
Mining	401	394	414	428	522	568	759	786	726
Construction	4,804	4,821	5,623	6,410	6,903	7,109	6,507	6,070	6,893
Manufacturing	13,651	15,763	16,587	18,073	20,238	19,043	18,430	19,197	19,719
Transportation and public utilities	2,657	2,886	3,007	3,241	3,412	3,514	3,526	3,629	3,444
Wholesale trade	2,643	2,923	3,025	3,079	3,224	3,306	NA[2]	3,753	3,545
Retail trade	12,927	13,997	15,112	16,339	17,476	17,929	18,366	18,181	18,472
Finance, insurance and real estate	3,007	3,273	3,587	3,838	4,177	4,331	4,358	4,272	4,347
Services	10,129	10,601	11,381	12,544	12,983	13,439	14,240	15,319	15,980
Government	21,045	21,947	22,118	23,369	23,995	24,084	24,891	26,667	25,531
Total wage and salary employment	76,594	81,764	86,621	93,264	97,897	99,580	100,953	104,233	103,933
Proprietors	13,648	13,925	15,152	15,876	16,901	17,025	17,238	17,589	--
Total Employment	90,242	95,689	101,773	109,140	114,798	116,605	118,191	121,822	--

(1) By place of work.

(2) Data not available due to disclosure problems.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information Systems, selected years.

TABLE 6.4
Distribution of Regional
Wage and Salary Employment, 1983
(Percent)

Sector	Larimer/ Weld Region	Colorado	U.S.
Farm, agricultural services, forestry and fisheries	4.6	1.8	2.0
Mining	0.7	2.6	1.2
Construction	6.6	5.8	4.1
Manufacturing	19.0	12.7	19.7
Transportation and public utilities	3.3	5.9	5.3
Wholesale and retail trade	21.7	22.9	21.3
Finance, insurance and real estate	4.2	6.4	5.8
Services	15.4	21.1	21.2
Government	24.6	20.9	19.4
Total Wage and Salary Employment	100.0	100.0	100.0

6.2.3 Education

The population of the region is highly educated compared with national educational levels. Over 43 percent of the region's population ages 25 and over in 1980 had at least some college education; only 32 percent of the corresponding age group in the U.S. had any college level education (U.S. Bureau of the Census, 1981). In part, this is attributable to the presence of two major universities in the region. In Fort Collins, 61 percent of this age group has completed some college. A highly educated populace is an important characteristic in attracting future industry to an area.

6.2.4 Households

Average household size in the region is slightly higher than elsewhere in Colorado but less than the U.S. average. The average household size in the region declined from 3.07 persons in 1970 to 2.70 persons in 1980, a rate of decline about equal to the national average.

Of the total estimated households in the Basin in 1985 (75,800), about 28,800 (38 percent) are in Fort Collins and 21,800 (29 percent) are in Greeley.

6.3 DEMOGRAPHIC FORECASTS

Forecasts of economic and demographic conditions in the future have been previously developed for the region by Federal, State, and local agencies. The methods of preparing these forecasts, their underlying assumptions, and their internal consistency were reviewed as part of the Study. In terms of population, the highest and lowest forecasts were used as the basis for Series 3 and Series 1, respectively. The Series 3 forecasts are from the Larimer and Weld Regional Council of Governments (LWRCOG) Transportation Plan and were developed in 1985. The Series 1 forecasts for the region are those by the U.S. Bureau of Economic Analysis (U.S. BEA) which were made in 1981. The 1985 forecasts by the Colorado Division of Local Government (CDLG) lie about in the middle of the other two forecasts and they were applied for Series 2. The underlying assumptions for these forecasts closely parallel those listed earlier for the three series.

The individual forecasts listed above needed two basic adjustments to provide population estimates for the Basin -- (1) extension to the year 2040 from the year 2010 or 2030 depending on the source of the forecast and (2) disaggregation from the two-county level to the Basin level.

Households in the Basin were estimated from the population forecasts and projected household sizes. Population in the Basin is expected to increase from about 204,000 persons in 1985 to nearly 294,000, 450,000, and 643,000 persons in the year 2040 under Series 1, 2 and 3 respectively as shown in Table 6.5. The corresponding increases in the number of households also is given in Table 6.5.

Household estimates are based upon Basin population forecasts and county-wide projections of household size. Narrowing of differences in average household size among communities is assumed. For example, average household size declines from 2.54 persons per household in Fort Collins in 1985 (not including persons in group quarters) to 2.22 persons in 2010. Greeley average household size declines from 2.48 to 2.22 persons per household over this period. No changes in household size were assumed beyond 2010.

6.4 MUNICIPAL AND INDUSTRIAL FORECASTS

Municipal water demands were forecast using projected demand patterns by dwelling unit and the number of units projected in the future. Future water demand factors were forecast by location, by location of use (indoor vs. outdoor), and type of unit, as shown in Table 6.6. Projections of demand factors from 1985 include adjustments to account for the effects of future household size, the status of current metering policies, continued conversion to low water-using plumbing fixtures, real income growth, and other factors. Projections of demand factors have been determined for the Fort Collins area, Greeley area, and the "other Basin" category. These demand factors are applied to household projections given in Table 6.5 to obtain water demand for the residential sector. Small commercial use is determined on a demand per employee basis. Gross demand at the water treatment plant is estimated by adding 5 percent to the net demand to cover "unaccounted for" water (losses, firefighting, public uses, etc.). Greeley demand factors reflect complete metering in that city's service area by the year 2010.

TABLE 6.5
Cache la Poudre Basin Population, 1985-2040

	1985	1990	2000	2010	2020	2030	2040
Fort Collins Area							
Series 1	92,200	92,200	100,600	114,800	126,600	134,400	134,400
Series 2	92,200	101,600	135,400	169,800	194,700	210,200	216,000
Series 3	92,200	114,400	158,800	203,200	247,300	291,400	335,500
Greeley Area							
Series 1	66,000	66,000	72,600	83,400	92,300	98,100	98,100
Series 2	66,000	69,500	90,400	112,400	128,900	140,110	145,900
Series 3	66,000	80,200	102,800	124,000	144,700	165,600	186,500
Other Basin							
Series 1	46,000	46,000	49,100	54,300	58,600	61,400	61,400
Series 2	46,000	48,700	60,000	71,700	80,300	85,800	88,200
Series 3	46,000	53,600	67,400	81,000	94,400	107,900	121,300
Total Basin							
Series 1	204,200	204,200	222,300	252,500	277,500	293,900	293,900
Series 2	204,200	219,900	285,900	353,900	403,900	436,100	450,100
Series 3	204,200	248,200	329,000	408,200	486,400	564,900	643,300

Cache la Poudre Basin Households, 1985-2040

	1985	1990	2000	2010	2020	2030	2040
Fort Collins Area							
Series 1	33,700	36,400	40,500	48,200	53,400	56,700	56,700
Series 2	33,700	40,200	55,000	72,100	82,800	89,500	92,000
Series 3	33,700	45,400	64,700	86,500	105,600	124,600	143,700
Greeley Area							
Series 1	25,400	27,100	30,400	36,100	40,000	42,600	42,600
Series 2	25,400	28,600	38,000	48,800	56,100	61,000	63,500
Series 3	25,400	33,000	43,300	53,900	63,000	72,200	81,300
Other Basin							
Series 1	17,100	19,200	20,800	23,800	25,700	27,000	27,000
Series 2	17,100	20,300	25,500	31,500	35,300	37,700	38,700
Series 3	17,100	22,300	28,600	35,600	41,500	47,500	53,400
Total Basin							
Series 1	76,200	82,700	91,700	108,100	119,100	126,300	126,300
Series 2	76,200	89,100	118,400	152,400	174,200	188,200	194,300
Series 3	76,200	100,800	136,600	176,000	210,100	224,300	278,400

TABLE 6.6
Fort Collins Water Demand Factors, 1985 and 2010
Average Gallons per Household per Day

Unit Type	1985 Indoor	1985 Outdoor	1985 Total	2010 Indoor	2010 Outdoor	2010 Total
Single Family/ Duplex-Unmetered						
Existing Units	210	330	540	155	347	502
New Units	162	330	492	155	347	502
Single Family/ Duplex-Metered						
Existing Units	210	130	340	155	137	292
New Units	162	200	362	155	210	365
Multifamily						
Existing Units	140	70	210	104	73	177
New Units	108	70	178	104	73	177
Commercial (per employee)	40	30	70	40	30	70

Greeley Area Water Demand Factors, 1985 and 2010
Average Gallons per Household per Day

Unit Type	1985 Indoor	1985 Outdoor	1985 Total	2010 Indoor	2010 Outdoor	2010 Total
Single Family/ Duplex-Unmetered						
Existing Units	250	500	750	--	--	--
New Units	--	--	--	--	--	--
Single Family/ Duplex-Metered						
Existing Units	240	320	560	185	336	521
New Units	199	320	519	185	336	521
Multifamily						
Existing Units	180	90	270	139	94	233
New Units	149	90	239	139	94	233
Commercial (per employee)	40	10	50	40	10	50

Other Basin Water Demand Factors, 1985 and 2010
Average Gallons per Household per Day

Unit Type	1985 Indoor	1985 Outdoor	1985 Total	2010 Indoor	2010 Outdoor	2010 Total
Existing Units	400	200	600	328	210	538
New Units	350	150	500	283	158	441

Demand projections for major users of water in the Basin were derived separately based on current demands and expected future use as determined by interviews with the major users and tied to the three series under consideration. The major users are light industry, food processing plants, the Platte River Power Authority, and the two universities. Under Series 3, total major user demand is forecast to grow from 8.6 to 37 million gallons per day (9,600 to 41,300 af per year) between 1985 and the year 2040.

6.5 LAND USE AND AGRICULTURE FORECASTS

6.5.1 General

Irrigated agriculture is the largest user of water in the Basin. Several of the existing agricultural water systems, supplied from the Cache la Poudre River, its tributaries, and from transbasin imports, extend outside the Basin. As population growth has occurred in the Basin, particularly in the Fort Collins and Greeley areas, existing irrigated land has been converted to urban uses. Significant changes in the irrigated agriculture of the Basin and in adjacent irrigated lands served from the Basin have occurred.

6.5.2 Land Use Changes

CSU performed an extensive land use inventory of the majority of the study area in 1970 (CSU, 1973). This study, plus estimates of agricultural lands converted to urbanized municipal, industrial, and rural subdivision use, provided the basis for estimating current land use in the Basin. As shown in Table 6.7, the dominant land use in the lower basin is agricultural. Of the total agricultural land use of about 692,000 acres in 1985, 219,000 acres are estimated to be irrigated. The decline of agricultural land from 1970 to 1985 is attributable to the expansion of urbanized municipal and industrial land use and rural subdivision land use. The water supply systems of the Basin were evaluated, as described in

TABLE 6.7
Land Use in the Basin, 1970 to 1985
(Acres)

Land Use Category	1970	1980	1985
Agricultural			
Irrigated Land (1)	260,100	227,100	219,000
Non-Irrigated and Idle	477,400	474,200	473,300
Sub total	737,500	701,300	692,300
Urbanized Municipal and Industrial	17,000	34,300	40,000
Rural Subdivision	7,900	26,800	30,100
Sub total (Lower Basin)	762,400	762,400	762,400
Upper Basin	421,600	421,600	421,600
Total Basin	1,184,000	1,184,000	1,184,000

(1) Includes lands served by existing irrigation systems extending outside the Basin.

Chapter 7, under present conditions (1985) using a total irrigated area of 197,600 acres. The remaining 21,400 acres are served by non-Basin supplies, primarily the Big Thompson River, or by small systems for which data are not available.

Land use in the upper basin is primarily Federally-owned wooded areas and grasslands, including the Roosevelt National Forest and several Wilderness Areas. Small population centers and limited irrigated agricultural areas in the upper basin are not expected to change during the 1985 to 2040 planning horizon.

6.5.3 Agricultural History of the Basin

Agriculture was the foundation for development of the Basin and the region. In the 1800s, homesteaders grew crops for domestic consumption and local trade. By the early 1900s, crops were being exported to other regions as rail transportation increased and irrigation systems were developed. Winter potatoes were an important crop at this time followed by sugarbeets. By the late 1920s, the cattle feedlot industry was established and growth in this industry has continued to the present time.

The availability of additional water because of the C-BT Project, plus the development of corn hybrids, changed once again the agricultural orientation of the region. Through C-BT, supplemental water was made available to existing irrigated lands, thereby enhancing production. The corn hybrids, which accommodated a shorter growing season, increased the acreages of corn grain and corn silage, rendering corn the dominant crop of the region.

The total value of agricultural production in the two-county region increased from $655 million in 1974 to $916 million in 1982. However, this increase was due primarily to inflation. Livestock products accounted for nearly 85 percent of all agricultural products sold in the region in 1982.

6.5.4 Present Crop Pattern

Crop mix information is available on a county-wide basis as published in 1985 by the Colorado Livestock Reporting Service (CLRS). Data are also available from the U.S. Census of Agriculture. Land use data for 1970 (CSU 1973) were used to adjust the CLRS and Census of Agriculture data to obtain 1970 planted acreage for each crop. Factors derived from adjusted estimates then were used to determine crop mixes for the period from 1970 through 1984. Results are summarized in Table 6.8.

Based on the information in Table 6.8, the basic crop mix has remained fairly stable. Corn (grain and silage), alfalfa, and pasture are the dominant crops. Remaining crops, particularly sorghums, barley, oats, and dry beans are usually referred to as replacement crops, or rotation crops. The dominance of corn grain, corn silage, and alfalfa is attributable to the feedlot industry. Pasture is an important use for two reasons -- an

TABLE 6.8
Crop Mix for the Cache la Poudre Basin Irrigated Lands 1970-84[1]

Crop	1970	1975	1980	1984
Corn Grain	41,000	45,500	63,100	60,700
Barley	14,200	10,200	10,500	6,800
Sugar Beets	25,500	28,000	17,600	6,400
Corn Silage	61,900	53,100	37,500	34,500
Alfalfa Hay	55,100	34,700	30,400	32,100
Other Hay	12,800	10,100	15,200	9,900
Pasture	20,500	26,100	23,900	27,400
Other[2]	30,100	35,900	28,900	33,800
Total	260,100	243,600	227,100	220,600

[1] Includes lands served from Basin water supplies but located outside the Basin.

[2] Includes winter wheat, sorghums, oats, spring wheat, dry beans, vegetables, other miscellaneous crops and idle land each being less than 5 percent of total land use and combined totalling less than 15 percent of total irrigated land use.

increasing population of horses and conversion of land to low-cost use prior to urbanization.

As late as 1983, there were four sugar beet processing plants in and near the Basin, with each plant requiring about 12,000 acres of beets. There are no plants currently operating in the Basin and the acreage planted to sugar beets has declined from 10 percent of the irrigated land in the early 1970s to around four percent in 1984.

The dominant influence on crop mix in the Basin is the feedlot industry. Feedlot capacity in 1985 exceeded 400,000 head of cattle, down about 13 percent from 1979. Over 960,000 head of cattle were expected to be marketed from the Larimer and Weld County region during 1985. The feedlots purchase a large portion of their feedstocks from farmers within the study area. In some years, the region is a net importer of corn grain.

6.5.5 Future Crop Pattern

The future crop mix of the irrigated lands will be influenced by a variety of factors which will be somewhat different under each of the three series. Generally, the Series 1 (declining agriculture scenario) will result in a decline in feed crops with corn grain remaining the dominant crop because of potentials to export from the Basin. Under Series 2, feed crops will increase slightly in importance and a stable crop mix will be evident. Under Series 3, the feed crop percentage of irrigated acreage will increase as feedlot activities increase. While traditional crops like corn grain, corn silage, and alfalfa will predominate under any series, the irrigated lands will continue to retain a mix of crops regardless of the demand for feed crops. Trends in various crops under the three series are indicated in Table 6.9. Some lands in the Basin are not served by Basin water sources and these lands need to be deducted in determining demands on Basin water sources as shown in Table 6.9.

6.5.6 New Lands

Water, not land, has been the resource limiting the development of irrigated agriculture in the Basin and the region as a whole. Based on available land-class mapping (SCS and CSU, 1979), there is a large area of land in the northeast section of the Basin, and lying outside the Basin as well, that is classified as potentially prime land if irrigation water could be made available in adequate amounts.

TABLE 6.9
Crop Mix Trends Under Series 1, 2 and 3 (in Year 2020)

Crop	1985	Series 1	Series 2	Series 3[1]
Corn Grain	73,070	55,000	80,000	90,000
Barley	8,970	14,000	4,800	5,000
Corn Silage	37,530	15,000	40,000	45,000
Alfalfa Hay	30,580	20,000	30,000	45,000
Other Hay	11,440	17,800	6,200	6,400
Pasture	24,820	38,700	13,400	30,000
Other	32,590	45,810	15,890	24,940
Total[2]	219,000	206,310	190,290	246,340
Lands Irrigated by Non-Basin Water	21,400	18,680	17,040	16,390
Net	197,600	187,630	173,250	229,950

[1] Includes 66,500 acres of new lands that could be brought under irrigation by extensions from existing irrigation systems if adequate water supply could be made available.

[2] Includes lands in the Basin supplied from non-Basin water sources and lands served by certain small systems for which no data are available.

Irrigation water could be supplied to these lands in several ways, each involving extending the North Poudre Irrigation Company (NPIC) system. The Larimer-Poudre Canal was constructed from the Cactus Hill Lateral to serve a large area in Weld County above the existing Pierce Lateral of the NPIC system. Although some water was run in the canal for a few years, the lack of a dependable water supply forced abandonment of the canal many years ago. The location of lands serviceable from the Larimer-Poudre Canal is shown on Figure 6.1. About 25,000 acres could be served by a 34-mile reconstruction of the Larimer-Poudre Canal. An additional 22,000 acres could be served with further extension of 29.5 miles.

The lands served by the upper part of the Larimer-Poudre Canal (first 34 miles) also could be served by canals located at higher elevations as shown on Figures 6.2, 6.3, and 6.4. The North Poudre Ditch could be extended from Indian Creek Reservoir with a gravity canal located at a higher elevation than the Larimer-Poudre Canal. This extension would be about 37 miles long and would serve 19,500 acres of prime land in addition to the 25,000 acres below the Larimer-Poudre Canal in its upper 34 miles (Figure 6.2). Two higher level canals also appear to be feasible from the standpoints of land suitability and topography. One possibility involves pumping water from Indian Creek Reservoir to a canal about 200 to 250 feet higher than the reservoir. As shown on Figure 6.3, this pump-lift canal would be about 25 miles long and would serve 70,000 acres of land. A canal from Park Creek Reservoir ("New" Park Creek Lateral), as shown on Figure 6.4, would command the largest area because it could serve an additional 14,400 acres of land located above the pump-lift canal from Indian Creek Reservoir.

As shown in Table 6.10, over 84,000 acres of prime land could be served by the highest elevation canal ("New" Park Creek Lateral). An additional 22,000 acres of prime land also exists along the downstream 29.5 miles of the potential Larimer-Poudre Canal.

For initial water demand forecasts, it was assumed that 66,500 acres of new land would be brought under irrigation in Series 3 because of favorable economic conditions. It was assumed that no new lands would be brought under irrigation in either Series 1 or 2. The 66,500 acres in Series 3 is the total area under the 63.5-mile long Larimer-Poudre Canal extension from the North Poudre Ditch system (47,000 acres) plus the area that could be served by a gravity system extension of the North Poudre Canal from Indian Creek Reservoir (19,500 acres).

TABLE 6.10
Summary of Potential New Irrigation Systems

System (Lowest to Highest)	Main Canal Length (miles)	Additional Land Served (acres)	Total Prime Irrigable Land[3] (acres)
Upper Portion of Larimer-Poudre Canal	34[1]	--	25,000[4]
Extension of North Poudre Canal (from Indian Creek Reservoir Outlet)	37	19,500	44,500
Pump-Lift Canal from Indian Creek Reservoir	25[2]	25,500	70,000
"New" Park Creek Lateral	64	14,400	84,400

(1) Length to serve Spring Creek/Lone Tree Creek Plain only.
(2) Plus pumping plant and 1-1/4 to 1-1/2 miles of pipeline.
(3) Assuming each Canal is the only one constructed.
(4) About 22,000 acres of land could be served by extending the Larimer-Poudre Canal an additional 29.5 miles.

6.5.7 Projected Irrigated Areas

Irrigated areas projected for the Basin for Series 1, 2, and 3 are presented in Table 6.11. Projections are based on the assumptions described in previous sections.

6.5.8 Irrigation Practices

Based on U.S. Census of Agriculture data (U.S. Bureau of the Census, 1969 with updates), about 61 percent of the irrigated lands supplied by water from the Basin are under ditch/furrow irrigation systems. About 9 percent of the lands are irrigated by sprinkler systems and 30 percent by flooding or sub-irrigation techniques.

A substantial amount of irrigation water reuse occurs in the Basin. This is attributable to capture by downstream ditch systems of return flows from upstream ditches and unplanned, but effective, conjunctive use of surface and ground water. The later situation is attributable to irrigation water which recharges shallow aquifers and is pumped under various augmentation plans.

TABLE 6.11
Projected Irrigated Areas[1] in
the Cache la Poudre Basin
(Acres)

	Year						
	1985	1990	2000	2010	2020	2030	2040
Series 1							
Existing Total	219,000	219,000	216,930	214,290	209,480	206,310	204,230
Acres Added	--	--	--	--	--	--	--
Acres Lost	--	2,070	2,640	4,810	3,170	2,080	--
Net Total	219,000	216,930	214,290	209,480	206,310	204,230	204,230
Series 2							
Existing Total	219,000	219,000	215,040	206,520	196,620	190,290	186,210
Acres Added	--	--	--	--	--	--	--
Acres Lost	--	3,960	8,520	9,900	6,330	4,080	1,770
Net Total	219,000	215,040	206,520	196,620	190,290	186,210	184,440
Series 3							
Existing Total	219,000	219,000	211,660	201,250	209,250	246,340	236,410
Acres Added	--	--	--	19,500	47,000	--	--
Acres Lost	--	7,340	10,410	11,500	9,910	9,930	9,930
Net Total	219,000	211,660	201,250	209,250	246,340	236,410	226,480

(1) Includes lands in the Basin supplied from non-Basin sources and lands served by small systems for which data are not available.

6.6 WATER DEMAND FORECASTS

6.6.1 General

Water demand forecasts have been developed using the inputs and assumptions outlined above.

6.6.2 Municipal and Industrial Water Demand

Future Basin water demands for the municipal and industrial sector under each series are provided for average year weather conditions in Table 6.12. The 1985 demand is an estimated figure based on population and demand factors and may differ from actual treated water production.

TABLE 6.12
Municipal and Industrial Water Demand Forecasts
by Service Area (Average Year Demand)

	(Acre-Feet)						
	1985	1990	2000	2010	2020	2030	2040
Series 1							
Ft. Collins	28,800	29,100	36,500	40,200	43,000	44,800	44,800
Greeley	20,300	20,200	20,900	22,700	24,500	25,800	25,800
Other Basin	11,400	11,700	12,300	13,500	14,700	15,300	15,300
Total M&I	60,500	61,000	69,700	76,400	82,200	85,900	85,900
Series 2							
Ft. Collins	28,800	36,800	47,900	57,700	63,900	67,500	69,000
Greeley	20,300	21,500	25,800	32,200	36,800	39,600	41,100
Other Basin	11,400	12,300	14,700	17,200	19,000	20,300	20,900
Total M&I	60,500	70,600	88,400	107,100	119,700	127,400	131,000
Series 3							
Ft. Collins	28,800	40,800	54,800	72,400	86,200	97,600	108,900
Greeley	20,300	30,100	38,700	46,300	52,800	58,900	65,400
Other Basin	11,400	13,200	16,300	19,300	22,400	25,500	28,200
Total M&I	60,500	84,100	109,800	138,000	161,400	182,000	202,500

Under each series, the residential water consumers will continue to be the primary water users. Water demand in the municipal and industrial sector is expected to be 9 to 10 percent higher during a dry year and 13 to 15 percent lower in a wet year.

The demand estimates shown in Table 6.12 are at the source of water supply (river diversion point). Typically, about two-thirds of M&I diversions are returned to the river after treatment. (This is based on estimates made by M. W. Bittinger for the City of Fort Collins.) These return flows are available for diversion by users located downstream from the M&I wastewater treatment plants. Consumptive use in the M&I sector is about one-third of the amount diverted. Consumptive use in the M&I sector for 1985 and year 2020 conditions is summarized in Table 6.13.

TABLE 6.13

Consumptive Use in the M&I Sector
(Average Weather Conditions)

Year/Series	Required for Diversion(1) (af/yr)	Consumptive Use(2) (af/yr)
1985	60,500	20,000
2020-Series 1	82,200	27,000
2020-Series 2	119,700	40,000
2020-Series 3	161,400	53,000

(1) See Table 6.12. About 7000 af/yr of the M&I demand is supplied from the Big Thompson River to the City of Greeley.

(2) Assuming about 67 percent of M&I diversion is treated and returned to the river (33 percent consumptive use)

6.6.3 Agricultural Water Demand

The total demand for water to irrigate crops in the Study Area is dependent on a variety of factors including irrigated area and types of crops, weather conditions, and irrigation system efficiencies.

Certain crops, such as alfalfa, require more water than others, such as corn and wheat. Weather has a significant effect on irrigation water demands. During periods of plentiful rainfall, little or no irrigation water is needed to satisfy the consumptive water use of crops. In dry periods virtually all of a crop's consumptive use needs will be supplied by irrigation applications. The amount of water that needs to be diverted at the river (or from the ground via wells) depends on the efficiency with which water is conveyed from the river to the farm and the efficiency of irrigation water use on the farm itself.

As described in Chapter 5, the overall irrigation system efficiency of the average ditch system in the Basin was estimated to be 55 percent based on the RIBSIM model calibration. For every 1.0 af of irrigation water needed by a crop, about 1.8 af is required to be diverted from some water source. Most of the 0.8 af diverted but not consumptively used by crops is available for reuse within downstream ditch systems.

Irrigation water demands were determined for 1985 and year 2020 conditions by month for each year of the 1951-80 modeling period. Cropped acreages were held constant and water demands were allowed to vary in response to weather conditions. Average year irrigation water demands are summarized in Table 6.14.

The irrigated areas shown in Table 6.14 exclude the irrigated lands in the Basin supplied by non-Basin water and irrigated lands located in the upper basin (see Table 6.9 for derivation of these acreages). During a dry year water demand could be 20 percent higher than the averages shown in Table 6.14.

TABLE 6.14
Present and Future Demands for
Irrigation Water
(Average for 1951-80)

Year/Series	Irrigated Area (acres)	Consumptive Use Demand[1] (af/yr)	Total Water Demand[2] (af/yr)
1985	197,600	320,000	580,000
2020-Series 1	187,630	300,000	550,000
2020-Series 2	173,250	280,000	510,000
2020-Series 3	229,950	380,000[3]	690,000
	(163,450)[4]	(260,000)[4]	(470,000[4]

(1) 30-year average for indicated year/series (1951-80)
(2) Consumptive use demand divided by average overall system efficiency of 55 percent.
(3) With 66,500 acres of new lands.
(4) 2020-Series 3, without new lands.

TABLE 6.15
Total Consumptive Use Demand
1985 and 2020
(Average Conditions)

Year/Series	Water Demand[1] in af/yr		
	M&I	Irrigated Agricultural	Total
1985	20,000	320,000	340,000
2020-Series 1	27,000	300,000	327,000
2020-Series 2	40,000	280,000	320,000
2020-Series 3	53,000	380,000[2]	433,000
	(53,000)	(260,000)[3]	(313,000)[3]

(1) Consumptive use demand, excluding conveyance and application losses.
(2) With 66,500 acres of new lands.
(3) Without new lands.

6.6.4 Total Water Demand

Average consumptive use demands in the M&I and agricultural sectors are summarized in Table 6.15 for 1985 and year 2020 conditions for the three economic series.

Water demand under Series 1 and 2 continues to decline beyond the year 2020. Under Series 3 conditions, the peak demand level was assumed to be reached in the year 2020 if new lands are brought under irrigation. Beyond 2020, demand is forecast to decline as urbanization continues to replace irrigated land.

Almost all of the trends in forecast water demand can be attributed to the offsetting key influences of population growth and urbanization of irrigated agricultural land as outlined below:

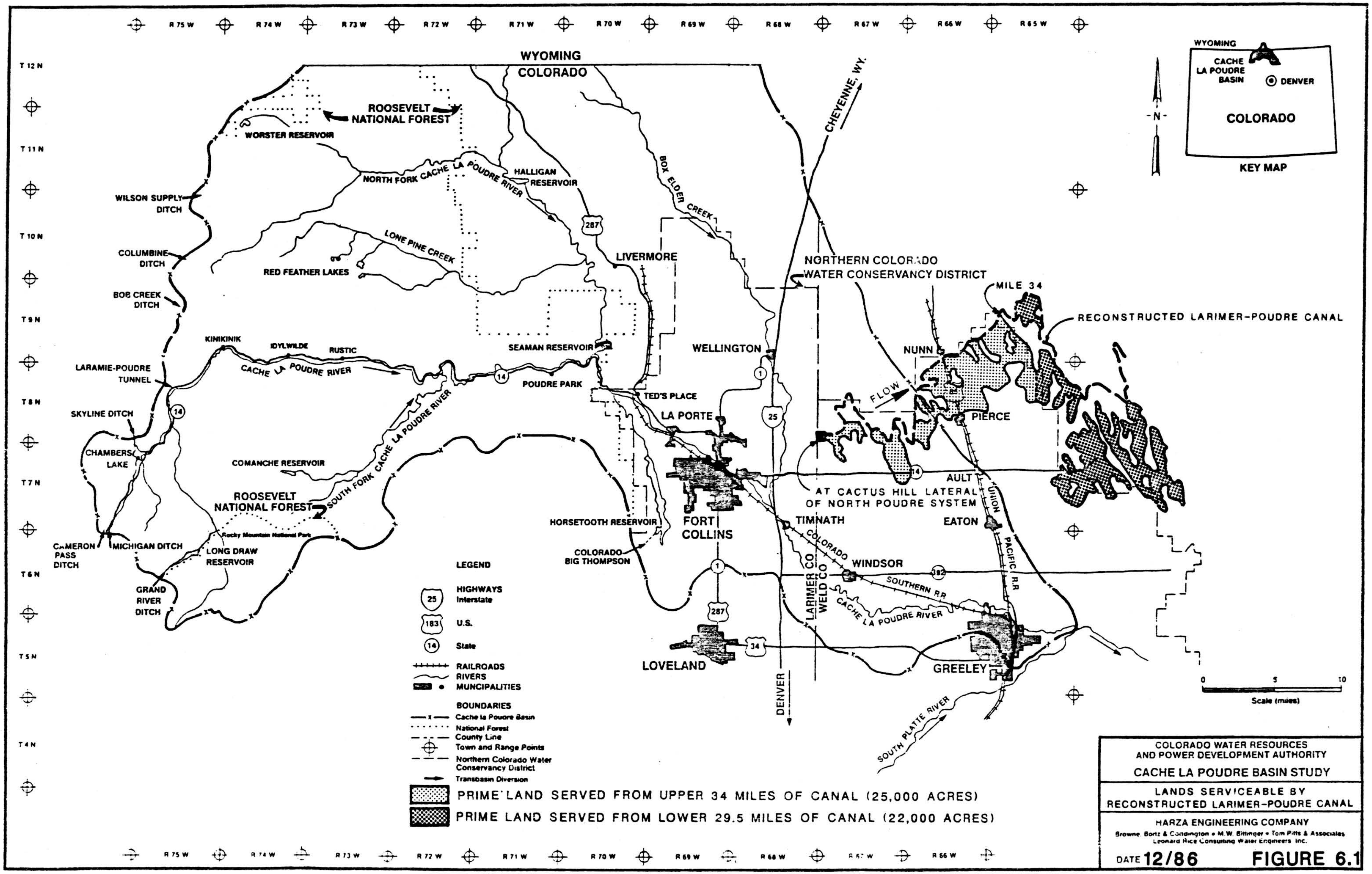
- In Series 1, a modest loss of agricultural lands, meaning a slight decrease in agricultural water demands, is nearly offset by demand associated with a modestly increasing population.
- Under Series 2, the greater urban water demands from increased population growth do not quite offset the loss of demand from the irrigated acres converted to urban uses.
- For Series 3, the additional irrigated acreage from newly irrigated lands more than offsets the urbanized losses, even under the high growth assumptions. Thus, with both agricultural and urban water demands expanding, a sharp increase in total demands is evident.

6.6.5 Sensitivity

The water demand forecasts are sensitive to a number of important assumptions. The three series approach incorporates a large degree of implied sensitivity to such factors as population growth and future cropped areas and crop mix. Sensitivity analysis, therefore, concentrates on particular factors which were not varied under the three series -- namely demand factors, future urban density, percent of irrigated area displaced by urbanization, conflicting economic series, and additional lands brought under irrigation. As shown below, the sensitivity of the demand forecasts to changes in these key factors is small except for the effect of adding more new irrigated lands.

Factor	Action/Condition	Effect on Total Basin Demand[1]
Demand Factors	Increase or Decrease by 20%	Increase or Decrease 3.6%
Future Urban Density	Density is 2.5, not 3.5 Density is 4.5, not 3.5	6.5% Decrease 3.7% Increase
Percent of Land Urbanized Which is Irrigated Land	70% vs. 90% 100% vs. 90%	3.8% Increase 1.9% Decrease
Different Series for Urban and Agricultural Economic Prospects	Series 2 Agricultural Scenario with Series 3 Urban Growth Scenario	2.4% Decrease
More New Lands Irrigated	Increase New Irrigated Land by 75,000 acres over present Series 3.	26.0% Increase

(1) Based on average conditions for the year 2040.



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

LANDS SERVICEABLE BY RECONSTRUCTED LARIMER-POUDRE CANAL

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers Inc.

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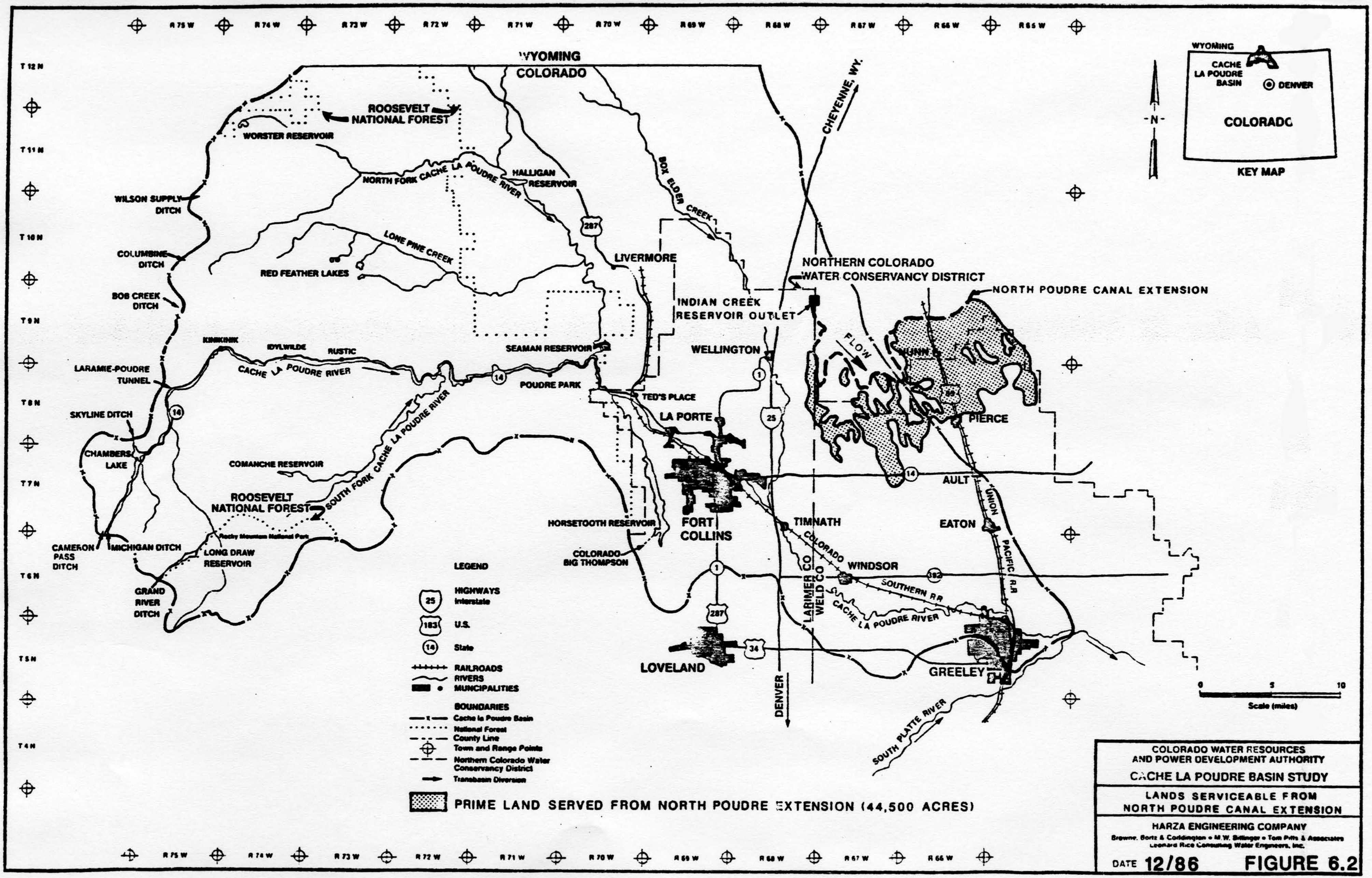
FIGURE 6.1



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

LANDS SERVICEABLE FROM NORTH POUDRE CANAL EXTENSION

HARZA ENGINEERING COMPANY

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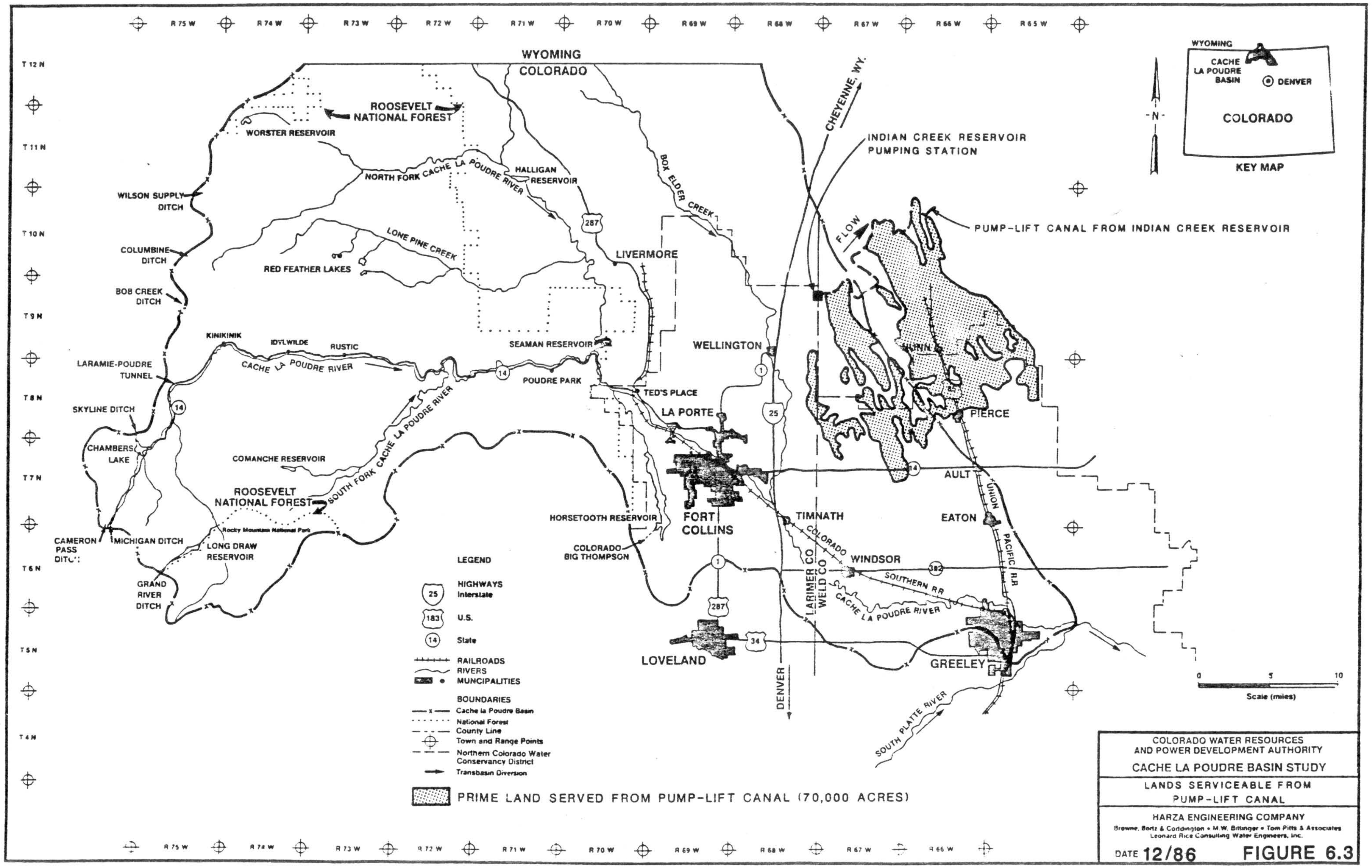
FIGURE 6.2



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

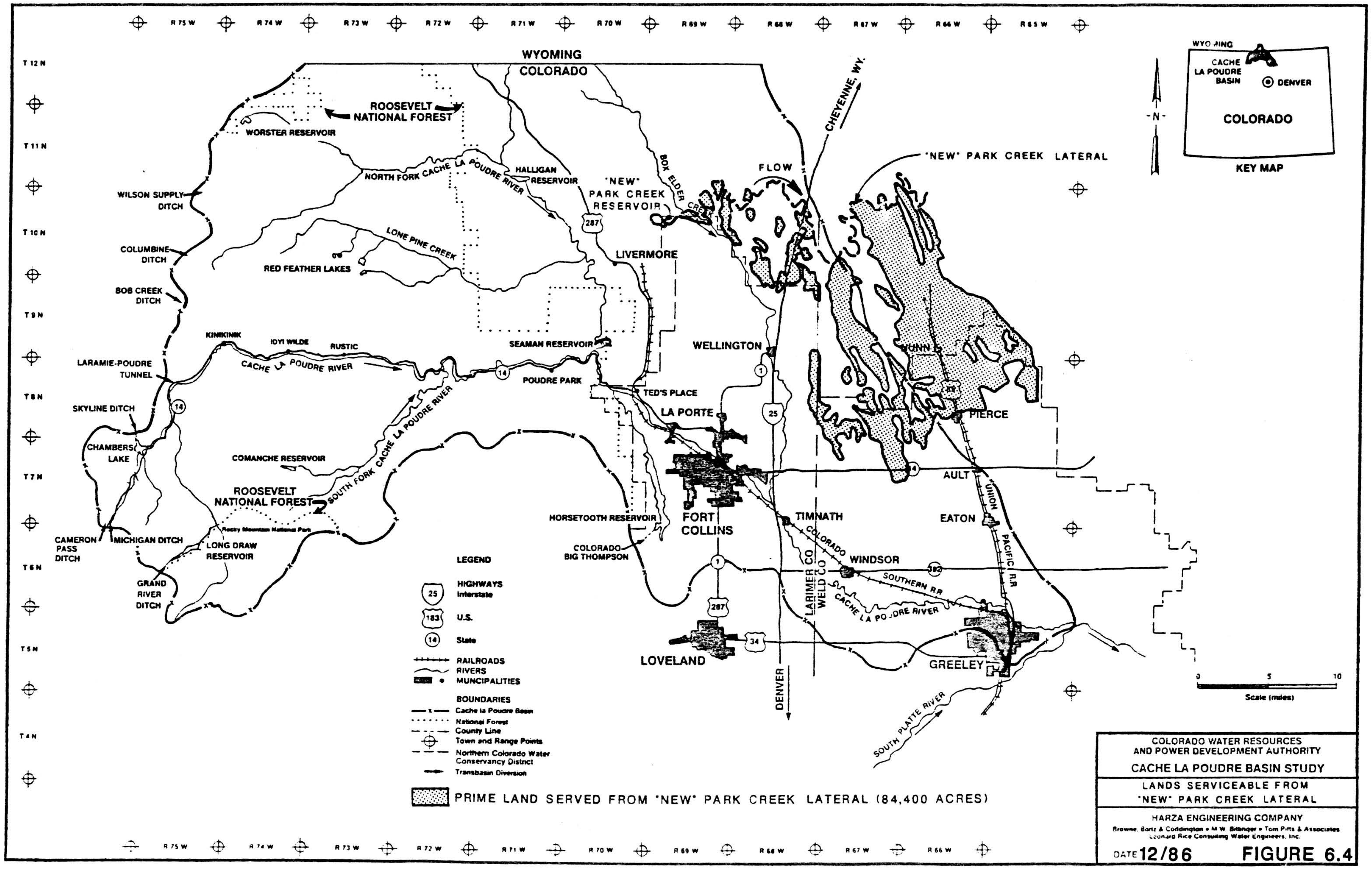
CACHE LA POUDRE BASIN STUDY

LANDS SERVICEABLE FROM PUMP-LIFT CANAL

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates Leonard Rice Consulting Water Engineers, Inc.

DATE 12/86 FIGURE 6.3



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

LANDS SERVICEABLE FROM "NEW" PARK CREEK LATERAL

HARZA ENGINEERING COMPANY

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Chapter 7

Supply and Demand Comparisons

7.0 COMPARISON OF WATER SUPPLY AND DEMAND

7.1 INTRODUCTION

Comparison of water supply and water demand was performed during Task 5 of the Study using the RIBSIM model described in Chapter 5 of this report. The comparison was made under current (1985) and year 2020 demand levels under Series 2 and 3. The economic conditions and water demands represented by Series 2 and 3 are described in Chapter 6.

Urbanization in the Poudre Basin will result in a reduction in existing irrigated agricultural lands and irrigation water demand at the same time that M&I demands are increasing. As a result, there is no growth in total water demand in the Basin from 1985 to 2040 under Series 1 and 2. In fact, there is a slight decline in water demand for these two series, as described in Chapter 6. Under Series 3, additional lands that could be brought under irrigation, if adequate water were available, cause a sharp increase in irrigation water demand between the years 2010 and 2020, with the peak demand occurring in the year 2020.

Supply and demand comparisons prepared for Task 5 were based on 1985 land use, population, and agricultural conditions in the Basin and on year 2020 conditions for Series 2 and 3. Series 1 was not investigated in Task 5 because the total water demand under this scenario is more than Series 2 but less than Series 3. The year 2020 was chosen because it exhibited the highest demand (under Series 3 with new lands) and because forecasts beyond that year are considered to be more subject to error. Under all three series, total water demands are forecast to decline between 2020 and 2040; however, that portion of the total water demand which is attributable to the M&I sector increases under all series. Based on current policies, it is expected that the municipalities in the Basin will continue to require that land developers secure adequate water rights before municipal water services can be provided. It is assumed that these water rights will continue to be purchased from agricultural water users.

The City of Greeley currently receives about 7000 af of water per year from the Big Thompson River. M&I demand estimates presented in Chapter 6.0 do not distinguish as to source of supply; therefore, the delivery of 7000 af/yr to Greeley was deducted from M&I demands for water on the Basin in estimating potential water shortages. It was assumed; however, that all future M&I supplies would be met from supplies within the Poudre Basin. This assumption probably is conservative because Greeley chose to obtain water from other sources such as the Big Thompson River Basin.

This chapter describes water shortage determinations made using the RIBSIM model for 1985 demand levels and for year 2020 demand levels under Series 2 and 3. The model simulation runs were made for the 1951-80 period with water supply varying according to hydrologic conditions but with irrigated acreage and M&I demands held constant at each of the three demand levels. Irrigation water requirements on the constant acreage were varied with climatological changes that occurred during the historical period. Supply and demand comparisons were made by water system for each demand level and for each month in the 30-year modeling period.

Task 5 of Phase I also included an assessment of the direct economic effects of water shortages on the Basin and on the regional economy. The regional economic effects include both the direct effects and indirect effects that economic losses in the agricultural sector can have on other sectors of the regional economy. Estimates of the economic effects of water shortages were used to place an economic value of additional water supply that may be provided by a new water management facility in the Basin.

7.2 SIMULATION OF PRESENT (1985) CONDITIONS IN THE BASIN

The calibrated RIBSIM model was used to simulate water system operations for the 1951-80 period under 1985 land use and water demand conditions in the Basin. Several modifications were made to the model to incorporate additional precipitation as a water source and to change various operational parameters and modes needed to reflect current conditions. These changes are presented in the Task 5 Summary Report (Harza, 1986).

7.2.1 Water Supply

The water supply for the Basin under 1985 land use, population, and agricultural conditions is defined in the same manner as described in Chapter 5 for historical conditions.

As shown in Table 7.1, the water supply of the Basin under 1985 conditions averages 385,000 af/yr for the 1951-80 modeling study period, excluding delivery of additional Windy Gap and C-BT water. Monthly inflow and outflow data are presented in Appendix D, Tables D.1 through D.7. The average monthly distribution of inflows to the lower basin and the water supply available for consumptive use are plotted on Figure 7.1.

TABLE 7.1
Average Water Supply Under 1985 Conditions
(Average for 1951-1980 Period)

	Average Annual Flow (af)
Modeled Inflows	
Canyon Gage	221,000
Diversions Above Gage	99,000
C-BT Imports	81,000
Big Thompson Imports	17,000
Additional Precipitation	131,000
Total Inflow	549,000
Modeled Outflows	
Greeley Gage	120,000
Ground Water Underflow	10,000
Out-of-Basin Returns	34,000
Total Outflow	164,000
Water Supply Available for Consumptive Use	385,000

During a dry year like 1954, the water supply can be substantially less. In 1954, the water supply, excluding any reservoir and aquifer storage, which would be available to overcome supply shortages, was estimated to be 257,000 af. In 1977, another dry year, the water supply was estimated to be 301,000 af.

Water from the Windy Gap Project was first delivered to the Basin, albeit in small quantities, in 1985. Ultimate deliveries of additional Windy Gap and additional C-BT imports water to the Basin will average at least 24,000 af/yr; however, additional storage will be needed in the Basin to attain this yield. Windy Gap supplies were not incorporated in the RIBSIM model for the 1985 and Year 2020 simulation runs because necessary data were not made available until after the model simulation runs were completed.

7.2.2 Water Demand

Demands for water in the Basin under 1985 conditions were determined for both the agricultural and M&I sectors using methods described in Chapter 6. The 1985 M&I demands for Fort Collins and the Water Districts were input directly to the RIBSIM model and were held constant during the entire 30-year simulation of supply. Of the total City of Greeley demand of 20,300 af, about 7000 af is obtained from the Big Thompson Basin with the remaining 13,300 af obtained from the Poudre Basin. M&I demands are summarized below:

	1985 Average Water Demand (af/yr)
Fort Collins	28,800
Greeley	20,300
Water Districts	11,400
Total	60,500

The irrigated land area used in the RIBSIM model was 197,600 acres (See Table D.8 in Appendix D for irrigated land by ditch system). The cropping pattern described in Chapter 6 essentially was duplicated for the modeling of 1985 conditions. About 80 percent of the irrigated area is devoted to feedcrops including corn, alfalfa, and pasture grass as indicated in Chapter 6. For modeling purposes, the same cropping pattern was used for each ditch system. Monthly irrigation water demands (at the farm headgate) and M&I demands at the water treatment plants are provided in Appendix D, Tables D.9 and D.10, respectively. Average net consumptive use demands for water by month for the 1951-80 period are shown on Figure 7.1 in comparison to the water supply available for meeting consumptive use. The net consumptive use of irrigation water is the water diverted less conveyance and application losses. The net consumptive use of M&I water is the amount of water diverted less return flows. Consumptive use in the M&I sector is about one-third of the diverted amount.

7.2.3 Water Shortages

Water shortages in the RIBSIM model were determined by comparing, for each month of the 1951-80 modeling period, computed water demand with modeled water diversions for each water user. The water users in the model are the City of Fort Collins, City of Greeley, the rural domestic Water Districts, and 19 irrigation systems that account for most of the irrigation water use. Results are summarized by year in Table 7.2.

Results from the month-by-month and system-by-system supply vs. demand comparisons under 1985 conditions in the Basin, are provided in Appendix D, Tables D.11 through D.14. The following conclusions have been drawn from that analysis and the summary given in Table 7.2:

- On an average annual basis over the 30-year period, there is about a 15,000 af shortage of irrigation water measured at the farm headgate. This corresponds to an average annual shortage of about 3 percent.

TABLE 7.2

Computed Annual Shortages in Meeting Consumptive Use Requirements for Irrigation Water
1985 Conditions

Year	Computed Shortage[1] (1000 af)	Computed Shortage (%)
1951	-	-
1952	1	-
1953	7	1
1954	178	32
1955	95	20
1956	77	16
1957	1	-
1958	2	-
1959	4	1
1960	8	1
1961	1	-
1962	2	-
1963	2	-
1964	10	2
1965	-	-
1966	16	3
1967	2	-
1968	3	1
1969	8	1
1970	1	-
1971	2	-
1972	1	-
1973	1	-
1974	1	-
1975	1	-
1976	1	-
1977	6	1
1978	1	-
1979	2	-
1980	2	-
Average	15	3

(1) At the farm headgate. Add 20% to obtain estimated shortage at the source of supply.

- In 27 years of the 30-year study period, the computed total irrigation water shortage was 3 percent or less. (This amount of shortage is negligible given the accuracy of modeling techniques employed).

- Significant irrigation water shortages occur during the 1950s drought (1953-56). In fact, 80 percent of the total computed irrigation shortage over the 30-year period occurs during these three years. The 1953-56 shortage at the farm headgate totals 357,000 af. The maximum shortage, 32 percent of the irrigation consumptive use requirement, occurred in 1954. In 1955 and 1956, the shortages were 20 and 16 percent, respectively. The four-year period 1953-56 is considered to be a 25-year drought in terms of native runoff.

- Shortages are not evident during the 1976-77 period which is considered to be a 10-year drought in terms of native runoff. This indicates that the combination of C-BT water and reservoir and aquifer storage in the Basin can provide protection against a 10-year drought under current demand conditions in the Basin. It should be noted that 1977 was the third driest year on record and that historical records indicate that the existing water systems were taxed to their limits in that year. Any prolonging of dry conditions in the late 1977 irrigation season and into 1978, would have resulted in serious irrigation water shortages.

- Certain of the small ditch systems (Little Cache, Lake, and Boyd and Freeman), which rely primarily on relatively junior direct flow rights, exhibit shortages on the order of 20 percent each year. The total area irrigated by these systems is 7970 acres (4 percent of the total area).

- No significant water shortages occur in the M&I sector based on model results for 1985 demand levels.

In general, it appears that under present demand levels, the Basin has an adequate supply of water to meet M&I demands for at least a 25-year drought and irrigation demands for at least a 10-year drought. The existing storage reservoirs and unplanned conjunctive use of surface water and ground water are essential in covering irrigation water shortages for 10-year drought events such as 1976-77.

By adjusting the inflow data for the model it was possible to simulate conditions expected in a 50-year drought having a duration of 6 years. The total farm headgate shortage was estimated to be 395,000 af for this event compared to a shortage of 357,000 af during a 25-year drought (see Table D.14 in Appendix D). No shortages occurred in the M&I sector for the 50-year drought in the modeling of 1985 conditions.

7.2.4 Storable Flows

Existing diversion and storage facilities in the Basin are not adequate to capture all runoff that could be stored. During the high flow periods, water escapes from the Basin without being put to beneficial use, primarily in May and June. The RIBSIM model provides a tool for analyzing the amount of water each month that could be stored under a junior priority storage right while meeting all downstream requirements, including historic senior direct flow rights on the South Platte. The average annual storable flow for the North Fork near Seaman Dam is estimated to be 16,000 af for the 30-year analysis under 1985 conditions. The storable flow on the mainstem at the Canyon Gage, excluding the North Fork, averages 17,000 af; therefore, the total storable flow in the canyon below the confluence is about 33,000 af on an average basis over the 30-year modeling study. The monthly distribution of storable flows for 1985 conditions is shown on Figure 7.2.

The storable flows in the Cache la Poudre Basin are sensitive to future water development in the South Platte Basin (such as the Narrows Project). To test the sensitivity, two simulations were performed -- one reflecting a 10 percent increase in the number of days affected by South Platte calls on the Poudre River and the other reflecting a 25 percent increase. A 10 percent increase would have little effect on storable flow; a 25 percent increase would reduce storable flows in the Basin by about 20 percent.

7.3 SIMULATION OF FUTURE CONDITIONS IN THE BASIN

The calibrated RIBSIM model was used to simulate water system operations for the 1951-80 period for two future scenarios; Year 2020 - Series 2, and Year 2020 - Series 3.

7.3.1 Water Supply

The average water supply in the Basin under year 2020 demand levels is estimated to be 381,000 af/yr for Series 2 and 412,000 af/yr for Series 3 conditions, as shown in Table 7.3.

TABLE 7.3
Average Water Supply Under 2020 Demands
Series 2 and Series 3 Conditions
(Average for 1951-1980 Period)

	Average Annual Flow (af)	
	Series 2	Series 3
Modeled Inflow		
Canyon Gage	221,000	221,000
Diversions Above Gage	94,000	94,000
C-BT Imports	85,000	97,000
Big Thompson Imports	17,000	17,000
Additional Precipitation	131,000	162,000
Total Inflow	548,000	591,000
Modeled Outflow		
Greeley Gage	129,000	136,000
Ground Water Underflow	10,000	10,000
Out-of-Basin Returns	28,000	33,000
Total Outflow	167,000	179,000
Estimated Water Available for Consumption	381,000	412,000

During dry years under Series 2, the available water supply declines to 230,000 af (1954) and 288,000 af (1977), excluding any reservoir and aquifer storage which would be available to overcome shortages. Under Series 3, water supply approximates 246,000 af and 308,000 af in 1954 and 1977, respectively.

The available water supply under Series 2 is about equal to that for the 1985 demand level given in Table 7.1. For Series 3, the water supply increases primarily because the additional precipitation component is higher due to the additional irrigated land under Series 3. Modeled monthly inflow and outflow data for Series 2 and 3 are given in Appendix D, Tables D.15 through D.26.

The average monthly distribution of inflows to the lower basin and water supply available for consumptive use are provided on Figures 7.3 and 7.4, for year 2020 Series 2 and year 2020 Series 3 demand levels, respectively.

7.3.2 Water Demand

Water demands for the year 2020 under Series 2 and 3 were determined in the same manner as described in Section 3.2. M&I demands were input to the model as indicated below:

	Average Annual Water Demand (af)	
	Series 2	Series 3
Fort Collins	63,900	86,200
Greeley	36,800	52,800
Water Districts	19,000	22,400
Total	119,700	161,400

The irrigation water demands were based on the following irrigated areas:

	Irrigated Areas (acres)	
	Series 2	Series 3
Land Irrigated in 1985	197,600	197,600
Lands Urbanized (-)	24,350	34,150
New Irrigated Lands (+)	-	66,500
Total	173,250	229,950

The cropping patterns under Series 2 and 3 consist of predominantly feedcrops (corn, alfalfa, and pasture grass) with 89 percent planted to feedcrops under Series 2 and 88 percent under Series 3. The irrigated areas by ditch system for Series 2 and 3 in the year 2020 are given in Appendix D, Table D.27. Consumptive use demands for irrigation water at the farm headgate and for M&I users at the water treatment plant are provided in Appendix D, Tables D.28, D.29, and D.30 for Series 2 and 3. Net consumptive use, including both irrigation and M&I use, is plotted for each series on Figures 7.3 and 7.4 for comparison with available water supply.

7.3.3 Water Shortages

Results from the RIBSIM comparison of water supply and water demand for the M&I sector and the 19 ditch systems in the agricultural sector generally follow the same pattern described under 1985 conditions in Section 7.2, except for shortages on the new irrigated lands under Series 3. Significant shortages in irrigation water supply occur during a 25-year drought (1950s) but not during a 10-year drought. Under Series 2, farm headgate shortages average 15,000 af per year, over the 30-year period, with a total shortage of 352,000 af in the 1953-56 period as shown in Table 7.4. Under Series 3, farm headgate shortages average 15,000 af per year, over the 30-year period, on the 163,450 acres of existing irrigated land that would receive water via existing irrigation systems. The total shortage on this land would be 359,000 af during the 1953-56 period, as shown in Table 7.5. Shortages on 66,500 acres of new land would average 122,000 af/yr during the 1951-80 modeling study period. Certain small ditch systems experience chronic shortages though these may be overcome by relatively minor redistributions of water.

TABLE 7.4

Computed Annual Shortages in Meeting Consumptive Use Requirements for Irrigation Water 2020 - Series 2[1]

Year	Computed Shortage[2] (1000 af)	Computed Shortage (%)
1951	-	-
1952	1	-
1953	8	2
1954	175	36
1955	94	23
1956	75	17
1957	-	-
1958	1	-
1959	2	-
1960	8	2
1961	-	-
1962	2	-
1963	1	-
1964	20	4
1965	-	-
1966	24	5
1967	1	-
1968	2	-
1969	8	2
1970	1	-
1971	1	-
1972	2	-
1973	1	-
1974	2	-
1975	1	-
1976	1	-
1977	6	1
1978	1	-
1979	1	-
1980	2	-
Average	15	4

(1) Urbanization reduces the 1985 irrigated area by 24,350 acres (from 197,600 to 173,250 acres).

(2) At the farm headgate. Add 20% to obtain estimated shortage at the source of supply.

TABLE 7.5

Computed Annual Shortages in Meeting Consumptive Use Requirements for Irrigation Water
2020 - Series 3

Year	"Existing Lands" (163,450 Acres)[1] Computed Shortage[2] (1000 af)	Computed Shortage (%)	"New Lands" (66,500 Acres) Computed Shortage[2] (1000 af)	Computed Shortage (%)
1951	-	-	75	68
1952	2	-	135	77
1953	9	2	139	83
1954	179	38	175	93
1955	97	24	139	87
1956	74	18	148	88
1957	-	-	95	65
1958	1	-	114	71
1959	3	1	133	79
1960	7	1	149	82
1961	-	-	38	36
1962	2	-	122	81
1963	1	-	145	85
1964	13	3	162	89
1965	1	-	86	69
1966	19	4	152	88
1967	2	-	82	65
1968	2	-	129	81
1969	7	2	127	82
1970	1	-	105	65
1971	3	1	116	73
1972	2	-	132	83
1973	1	-	137	80
1974	2	-	146	84
1975	1	-	100	68
1976	1	-	129	83
1977	5	1	148	86
1978	1	-	86	71
1979	1	-	84	59
1980	3	1	147	79
Average	15	4	122	77

(1) Urbanization reduces the 1985 irrigated area by 34,150 acres.

(2) At the farm headgate. Add 20% to obtain estimated shortage at the source of supply.

Shortages of water in the M&I sector occur in the model under both series. In Series 2 and 3, the Water Districts are shown to have shortages of 20 percent in some years. This is due to their almost total reliance on C-BT water in the model. In wet years, the low C-BT quota does not provide enough water to satisfy Water District demand. This shortage probably can be overcome by leasing water or by pumping from existing wells.

No shortages occur in Fort Collins or Greeley for 25-year drought conditions under Series 2. In Series 3, shortages (less than 10 percent) occur in some years in both Fort Collins and Greeley, despite the modeled transfer of ditch company water to the cities. These shortages occur in the October-December period even though in most years the cities have a modeled water surplus. Some mechanism, probably using existing irrigation storage reservoirs, is needed to carry over water from ditch company shares available in the irrigation season to the October-December period when modeled shortages occur.

Modeled water shortages under Series 2 and Series 3 demand levels in the Basin are identified in Appendix D, Tables D.31 through D.36 which summarize RIBSIM output.

7.3.4 Storable Flow

The storable flows estimated under Series 2 and Series 3 for the mainstem and North Fork are provided below:

	Storable Flow (af/yr)[1]	
	Series 2	Series 3
North Fork (nr. Seaman)	15,400	15,300
Mainstem (at Canyon)	21,700	21,700
Total (at Canyon)	37,100	37,000

(1) Average modeled storable flow (1951-80).

The monthly patterns of storable flow closely approximate that for 1985 conditions shown on Figure 7.2. Storable flows for Series 2 and 3 are given in Appendix D, Tables D.37 through D.40.

7.4 ECONOMIC EFFECTS OF WATER SHORTAGES

Evaluation of the economic effects of water shortages focused on the agricultural sector. As described previously, modeled water shortages in the M&I sector are relatively small and probably are avoidable through redistribution of existing water supplies. The annexation policies of Fort Collins and Greeley, which require land developers to have water rights (or cash to buy the rights), coupled with the large amount of agricultural water uses in comparison to M&I use and the comparative higher economic return on water uses in the M&I sector, also suggest that future water shortages will be faced predominantly by the agricultural sector of the Basin's economy. Procedures to estimate direct economic losses in the agricultural sector from irrigation water shortages were applied to evaluate economic effects. In addition, indirect or induced economic losses to the M&I sector have been identified to arrive at total regional economic loss.

Three methods were used to estimate direct economic loss in the agricultural sector:

- Economic losses were calculated based on a farm budget approach;
- Economic losses were estimated based on historical experience updated to present day conditions; and
- The rental prices of water during times of shortage were used to approximate the economic value of water.

The use of three independent methods provides a higher degree of confidence in the economic loss estimates than if a single method were used.

7.4.1 Calculated Economic Losses

Economic losses, likely to be experienced by irrigators during a drought will vary depending on the magnitude and duration of water shortage. Whether or not the farmer has prior knowledge of the drought and the ability to manage water effectively during a drought also will affect the economic losses. Minimum losses would be expected with forewarning about a water shortage. The farmer would adjust cultivation plans and water could even be shifted among users to minimize losses. Maximum losses would occur when, because of no forewarning, water supplies cannot be managed to minimize losses. Widespread losses might result under severe late season droughts.

Calculated economic loss measures the opportunity cost associated with the response scenarios to a given drought.[(1)] Opportunity cost is the difference between the drought response and normal conditions in terms of lost benefit. Under the minimum economic loss, opportunity cost would be gross farm revenues less the variable costs of production. Because he did not plant certain acreage, the farmer would lose the revenue the crop would have brought, but would save the variable costs related to cropping effort. Lowest value crops would be affected first, until the entire water deficit would be accounted for. Under the maximum loss scenario, gross revenues would represent the opportunity cost.

Calculated economic losses will vary depending on irrigated acreage, and cropping patterns, crop yields, and crop prices. Assumptions regarding these factors differ for 1985 and Series 2 and 3 conditions. Crop yields in the Basin were estimated from published data for the Larimer-Weld County region (CLRS, 1985). Crop price information also was obtained from published sources and was normalized to constant dollars (CLRS, selected years). For 1985 and Series 2 conditions, prices reflect average real prices found in the region for 1980-1984. Because of more favorable economic conditions under Series 3, average real prices found

(1) Only economic losses are being considered. Changes in financial condition would be determined by a cash flow analysis which is not in the scope of the present study.

in the region for 1970-79 were used. Series 3, crop prices are about 5 to 27 percent higher than for 1985 conditions, depending on crop type. Typical per-acre production costs for various crops in the region were derived from published sources with differentiation between variable costs (seed, fertilizer, water, etc.) and fixed costs (machine replacement, taxes, etc.). Cropping pattern and yield estimates, together with price and production cost data, were used to calculate economic losses for various crops.

The average economic loss was determined to be $100 per af of net consumptive use shortage for 1985 and Series 2 under minimum loss assumptions and $250 per af under maximum loss assumptions. For Series 3, the calculated losses are $170 and $300 per af under the minimum and maximum loss assumptions, respectively. As described in Section 3.3, the total farm headgate shortage during the 1953-56 drought (25-year event) under 1985 conditions was 357,000 af which corresponds to 246,000 af of irrigation water shortage at the crop. The total loss from this shortage would be about $60 million (246,000 af x $250 per af), under the maximum loss assumption.

7.4.2 Historical Experience

A review was made of the historical experience with drought in the Basin and the northeast Colorado region as a whole. Because of limited information and the need to account for factors other than water affecting crop yields, this approach is useful primarily for comparative purposes. Based on data from the 1930s updated to current price levels, losses for a 25-year drought event might be over $100 million under 1985 conditions in the Basin.

Economic benefits from the C-BT Project provide an indication of the losses that might have resulted under water shortage conditions. Direct benefits from C-BT are estimated to be $17 million per year attributable to alleviating a shortage of 25 percent of net consumptive use. This shortage level is typical of a 25-year event; therefore, a 25-year drought of 4-year duration would have an economic loss of $68 million, based on this approach.

7.4.3 Water Price

Rental prices give another indication of the economic value of water. Water rents for about $20 to $50 per af of net consumptive use based on updates of water prices in 1959 (Anderson, 1963). In dry years, rental prices have increased to $150 per af based on estimates from historical experience (Maass and Anderson, 1978). For 1985 conditions and a 25-year drought, the economic loss is estimated to be between $15 million and $37 million, using the rental price method for the 4-year duration of the drought.

7.4.4 Direct and Indirect Losses

Direct economic losses for various droughts were selected after reviewing results from the three estimating methods. Direct losses are shown in Table 7.6. The range of losses in Table 7.6 corresponds to a range of $80 to $250 per af of consumptive use shortage.

In developing this economic loss summary, more weight was given to the calculated economic loss method, compared with the historical experience or rental price methods. The latter techniques produce loss estimates which are on either side of the calculated loss ranges, thereby tending to corroborate the range derived from the calculated economic loss method. Also, the historical experience and the price methods have certain inherent shortcomings which must be represented in arriving at the final estimates.

The economic loss to irrigated agriculture could be significant under adverse circumstances, such as minimal prior knowledge or limited planning. The determination of significance should be tempered by an understanding of the drought frequency.

TABLE 7.6

Direct Economic Losses to Irrigated Agriculture from Water Shortages (Millions of 1985 Dollars)

Water Supply Conditions	1985	2020 Series 2	2020 - Series 3 Without New Lands	2020 - Series 3 With New Lands
10-Year Drought[(c)]				
Cumulative	(a)	(a)	(a)	30- 60
Worst Year	(a)	(a)	(a)	15- 30
25-Year Drought				
Cumulative	20-60	20-60	35-70	100-150
Worst Year	10-30	10-30	20-35	40- 70
50-Year Drought				
Cumulative	25-75	25-75	(b)	(b)
Worst Year	10-30	10-30	(b)	(b)

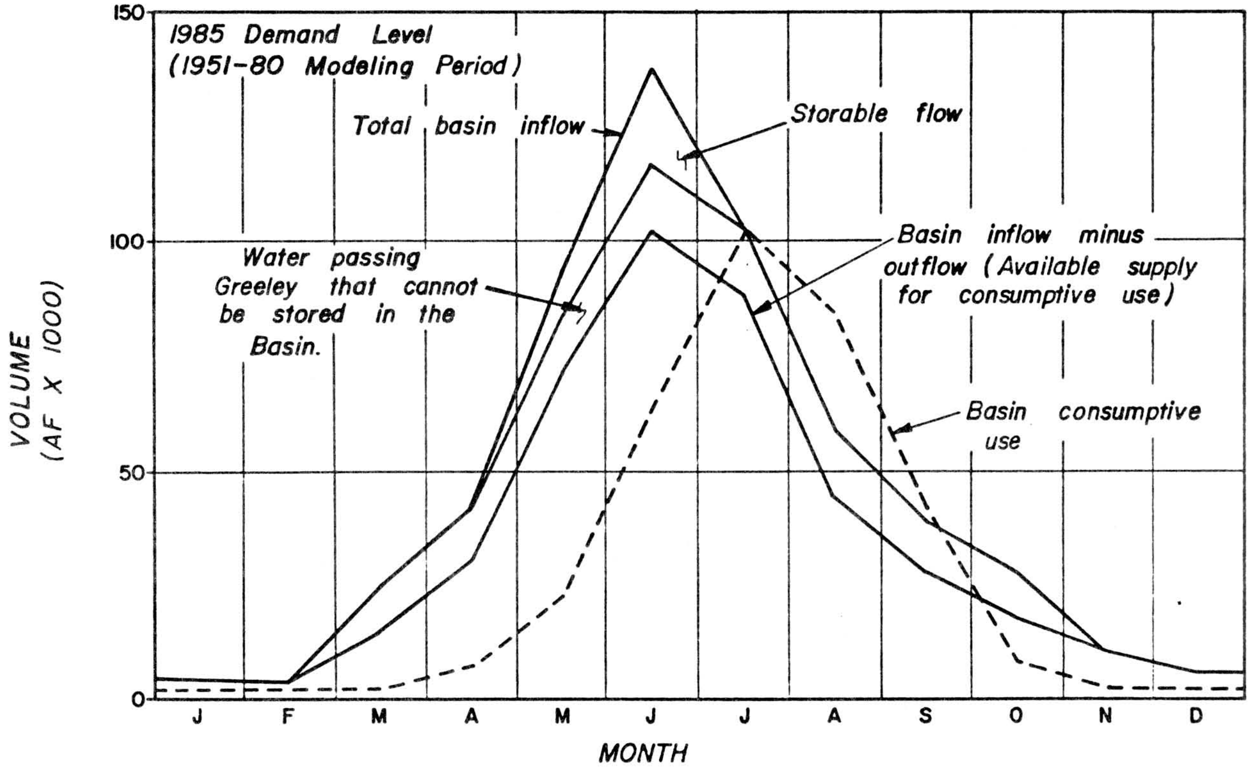
(a) Less than $1 million

(b) Not estimated. Based on 50-year drought shortage analysis described in Section 3.0, effects are expected to about the same as for a 25-year drought.

(c) Cumulative during the duration of the drought.

Regional economic losses attributable to water shortages also were determined. An economic input-output analysis was used to estimate indirect effects. Using this model, it was found by Gray and McKean (1976) that a $1 million change in irrigated agricultural output would translate into a $2.2 million change in total regional production (including agriculture). For the present Study it was assumed that direct economic losses to irrigated agriculture could be multiplied by a factor of 2.2 to estimate total economic losses in the region. For example, the cumulative regional economic loss for a 25-year drought under 1985 and 2020 - Series 2 would range from $40 to $130 million; under Series 3 the cumulative regional economic loss would be $75 to $180 million without new irrigated lands and $220 to $330 million with new lands.

The significance of potential regional economic losses can be evaluated in a broad perspective by comparing the losses with aggregate economic measures of the region. On a micro-level, individual towns, ditch companies, and farmers are exposed to the potential losses. The drought frequency must be considered in evaluating the significance of potential regional economic losses. A study of employment effects indicated that the economic effects of a 1-in-25 year drought might cause the regional unemployment rate to increase by 2 percent, a significant increase.



Note: 1. Basin inflow is from all sources, including additional precipitation. Pumping, which is a reuse of water, is not included.
2. Based on RIBSIM model results, Task 5.
3. Basin consumptive use is for M&I and agriculture only and excludes phreatophyte use and evaporation from reservoirs.

COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

AVERAGE MONTHLY SUPPLY AND
DEMAND RELATIONSHIP, 1985 DEMAND LEVEL

HARZA ENGINEERING COMPANY
Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

DATE 5/22/86 FIGURE 7.1

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	10489	0	0	0	537	0	0	11026
1952	0	0	0	0	11783	13724	0	0	0	0	0	0	25508
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	26985	0	0	0	0	0	0	26985
1958	0	0	0	0	33191	4549	0	0	0	0	0	0	37740
1959	0	0	0	0	0	5354	0	0	0	0	0	0	5354
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	6172	24987	0	0	0	497	0	1587	33243
1962	0	0	0	0	0	11034	0	0	0	0	0	0	11034
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	2504	1438	0	0	0	0	0	3942
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	4563	0	0	0	0	0	0	4563
1970	0	0	0	0	0	18373	0	0	0	0	0	0	18373
1971	0	0	0	0	20656	28462	0	0	0	0	0	0	49119
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	23332	22277	0	0	0	0	0	0	45610
1974	0	0	0	0	0	17308	0	0	0	0	0	0	17308
1975	0	0	0	0	0	9262	0	0	0	0	0	0	9262
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	25619	0	0	0	0	0	0	25619
1979	0	0	0	0	21110	22443	0	0	0	0	0	0	43553
1980	0	0	1323	19007	63861	25670	0	0	0	0	0	0	109862
AVERAGE	0	0	44	634	6004	9120	48	0	0	34	0	53	15937

NOTE: Measured at the stream gage on the North Fork near Livermore.

COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

MODELED STORABLE FLOWS AT NORTH FORK (1985 DEMANDS)

HARZA ENGINEERING COMPANY

Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

DATE DEC 1986 FIG 7.2 Sheet 1 of 2

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	16767	0	0	0	0	0	0	16767
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	3835	0	0	0	0	0	0	3835
1958	0	0	0	0	23270	8381	0	0	0	0	0	0	31651
1959	0	0	0	0	0	2260	0	0	0	0	0	0	2260
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	46249	0	0	0	7795	0	0	54044
1962	0	0	0	0	0	21906	0	0	0	0	0	0	21906
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	26649	1313	0	0	0	0	0	27961
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	12195	0	0	0	0	0	0	12195
1970	0	0	0	0	0	22923	0	0	0	0	0	0	22923
1971	0	0	0	0	16936	26994	0	0	0	0	0	0	43930
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	30447	0	0	0	0	0	0	30447
1974	0	0	0	0	0	13537	0	0	0	0	0	0	13537
1975	0	0	0	0	0	18884	0	0	0	0	0	0	18884
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	7782	0	0	0	0	0	0	7782
1979	0	0	0	0	4494	69131	0	0	0	0	0	0	73625
1980	0	0	0	0	91783	40779	0	0	0	0	0	0	132562
AVERAGE	0	0	0	0	4549	12291	44	0	0	260	0	0	17144

NOTE: Does not include North Fork Storable Flows.

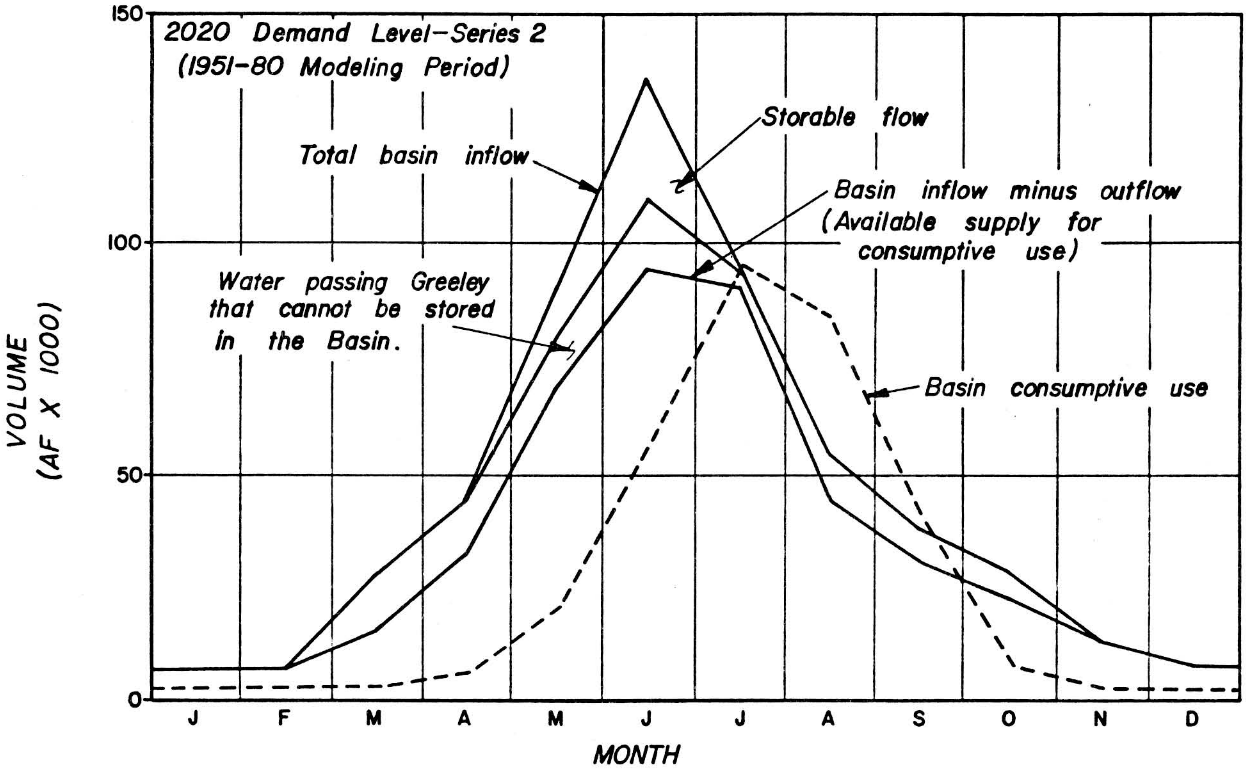
COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

MODELED STORABLE FLOWS AT
CANYON GAGE (1985 DEMANDS)

HARZA ENGINEERING COMPANY
Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

DATE DEC 1986 FIG 7.2 Sheet 2of2



Note: 1. Basin inflow is from all sources, including additional precipitation. Pumping, which is a reuse of water, is not included.
2. Based on RIBSIM model results, Task 5.
3. Basin consumptive use is for M&I and agriculture only and excludes phreatophyte use and evaporation from reservoirs.

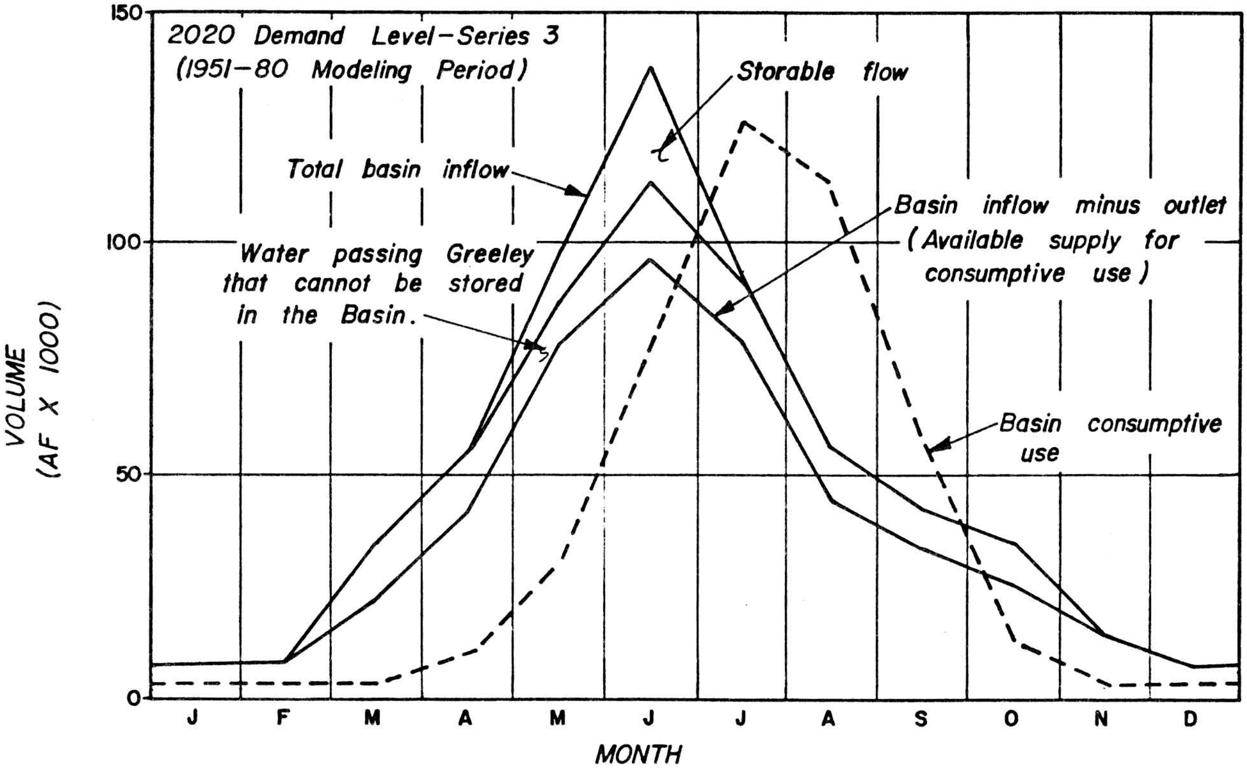
COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

AVERAGE MONTHLY SUPPLY AND DEMAND RELATIONSHIP

HARZA ENGINEERING COMPANY
Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

DATE 5/22/86 FIGURE 7.3



Note:
1. Basin inflow is from all sources, including additional precipitation. Pumping, which is a reuse of water, is not included.
2. Based on RIBSIM model results, Task 5.
3. Total inflow and consumptive use include effects of "new" irrigated lands under Series 3 (66,500 acres).
4. Basin consumptive use is for M&I and agriculture only and excludes phreatophyte use and evaporation from reservoirs.

COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

AVERAGE MONTHLY SUPPLY AND DEMAND RELATIONSHIP

HARZA ENGINEERING COMPANY
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Leonard Rice Consulting Water Engineers, Inc.

DATE 5/22/86

FIGURE 7.4

Chapter 8

Environmental Baseline

8.0 ENVIRONMENTAL BASELINE

8.1 INTRODUCTION

The objective of the environmental investigations conducted in Phase I of the Cache la Poudre Water and Hydropower Resources Management Study was to provide a preliminary assessment of environmental conditions within the Cache la Poudre Basin so that this information could be used to : (1) identify environmentally sensitive areas that might be subject to impacts of alternative water management measures; (2) assess the potential impacts of the various water management alternatives; and (3) identify the range of potential measures needed to mitigate environmental impacts. The environmental baseline was established at the prefeasibility level for the following categories: recreation, land use, aquatic life, terrestrial wildlife, vegetation, and water quality. Impacts on cultural resources are, by nature, site specific. These impacts were defined at a preliminary level of detail after specific alternatives were identified in Phase II. Environmental evaluations of alternative plans are presented in Chapter 12.

This chapter presents a summary of the environmental baseline data collected in Phase I of the Study and identifies environmentally sensitive areas that could be impacted by a water resources management project in the Basin.

8.2 RECREATION

The Cache la Poudre Basin provides a broad array of recreational opportunities in both its upper (mountainous) and lower (plains) areas.

8.2.1 Upper Basin

The Federal government is the principal landowner in the upper basin. Extensive portions of the upper basin are included in Roosevelt National Forest, and a small portion of the upper basin is included in Rocky Mountain

National Park. Three wilderness areas are wholly included in the upper Poudre basin, and a part of another wilderness area extends into the southwest portion of the upper basin. These publicly owned areas attract numerous recreationists in search of both primitive and developed recreational opportunities. Numerous hiking trails, campgrounds, and picnic areas are available for public use, and are used extensively. Private resorts offering supplies and both developed and primitive accommodations are concentrated in several areas along the Cache la Poudre River. Access to these facilities is primarily by Colorado Highway 14, which averaged more than 1400 vehicles per day in 1984.

The Poudre River offers recreational opportunities primarily in terms of scenic viewing, fishing, and whitewater boating. Whitewater boating is undertaken all along the Poudre River but use tends to be concentrated in three segments with the primary use being on the segment below the Fort Collins Filtration Plant to the takeout at ROTC rock. Several commercial rafting businesses operate during high-flow periods. The mainstem of the Cache la Poudre River upstream from Poudre Park and most of the South Fork are designated as Wild and Scenic River segments.

Three four-mile-long sections of the river have been designated as "wild trout stream" by the Colorado Division of Wildlife (CDOW). There are no fish stocked in these sections, and they may be fished only with artificial lures and flies. Other segments of the Cache la Poudre River are stocked, and the entire river is subject to heavy fishing pressure. Further discussion of mainstem fishery is provided in Section 8.4.

8.2.2 Lower Basin

Most of the land in the lower basin is under private ownership. It includes plains and irrigated lands. Opportunities exist for recreation on irrigation system reservoirs in the lower basin. Numerous reservoirs are leased by the CDOW and private associations for water skiing, sailing, hunting, fishing, camping, and other activities. Horsetooth Reservoir, which is part of the C-BT Project, is intensively managed for recreation by the Larimer County Parks Department. Lory State Park, which is adjacent to Horsetooth Reservoir, provides water-based recreation and hiking opportunities. The cities of Fort Collins and Greeley sponsor extensive recreational opportunities, some of which are associated with the Cache la Poudre River. The mainstem of the lower Cache la Poudre River is not a focal point of recreational activity. Public access is limited, and most recreational activities associated with water occur on irrigation reservoirs and the publicly owned Horsetooth Reservoir. The City of Fort Collins has a seven mile trail system along the Cache la Poudre River.

8.2.3 Sensitive Recreational Areas

Several recreational areas have been identified as being sensitive to water development activities particularly those involving structural measures such as storage dams and reservoirs. These include:

1. Stream segments proposed for designation under the National Wild and Scenic Rivers Act.

2. Developed public and private resorts and campgrounds.

3. Trailheads for hiking trails.

4. Colorado Highway 14 from the mouth of the canyon to the Continental Divide.

5. Primary and secondary whitewater boating areas.

6. Trailheads for hiking trails.

7. Mainstem of the Cache la Poudre River above the mouth of the canyon.

8. Wilderness areas.

9. Lower basin irrigation reservoirs.

10. State parks and recreation areas.

Table 8.1 lists these areas and provides descriptive comments, with references to the figures locating these areas.

TABLE 8.1

Sensitive Recreational Areas

1. Stream segments designated under the National Wild and Secenic Rivers Act.

   Comment: Several segments of the Poudre River were designated as Wild and Scenic, and these river segments are considered extremely sensitive to water development activities which would alter flow regimes, physical characteristics, and riverine or adjacent riparian conditions. (Figure 8.1).

2. Developed public and private resorts and campgrounds.

   Comment: There are a number of public and private camping and picnicking facilities and resort areas on the mainstem of the Cache la Poudre upstream of Poudre Park, and in the lower Cache la Poudre Basin. (Figure 8.2). Some of the larger facilities in the upper basin are high use areas, particularly during the summer tourist season. Lower basin reservoirs are also subject to very heavy use.

3. Trailheads for hiking trails.

   Comment: Numerous trailheads exist along Colorado Highway 14 which provide access to hiking trails in the upper Poudre basin. (See Figure 8.2).

4. State parks and recreation areas.

   Comment: These are Lory State Park near Horsetooth Reservoir and Boyd Lake State Recreation Area which provide recreational opportunities for numerous visitors (see Figure 8.2).

5. Colorado Highway 14 from the mouth of the canyon to the Continental Divide.

Comment: Highway 14 provides access to trailheads, camping, fishing, picnicking, and resort facilities throughout the upper Poudre basin, as well as recreational travel opportunities and opportunities for scenic viewing (see Figure 8.3).

6. Primary and secondary whitewater boating areas.

Comment: The primary area is between the Fort Collins water filtration plant and ROTC Rock. Secondary areas extend from Rustic to the confluence with the South Fork of the Cache la Poudre River, and for a few miles below the South Fork to a point a few miles below Poudre Park. (Figure 8.4).

7. Mainstem of the Cache la Poudre River above the mouth of the canyon.

Comment: The entire reach of the river is heavily fished. Loss of stream habitat would place additional pressure on other areas. Three sections of the river have been designated as "wild trout stream." (Figure 8.5).

8. Wilderness areas.

Comment: Three wilderness areas, Comanche Peak, Neota, and Cache la Poudre, are located within the upper basin, and part of the Rawah Wilderness area is in the upper basin (see Figure 8.6).

9. Lower basin irrigation reservoirs.

Comment: Numerous irrigation reservoirs are leased by the CDOW or private recreational associations for fishing, boating, hunting, and camping.

10. State Parks and recreation areas.

Comment: Existing state parks and recreation areas in the Study Area receive extensive use. Water development in the Basin is not expected to impact state-operated facilities.

8.3 LAND USE

The upper and lower portions of the Cache la Poudre Basin have distinctly different patterns of land use. Most of the upper basin is undeveloped and is Federally owned. Most of the lower basin is highly developed in terms of both urban and agricultural uses, and is primarily privately owned.

8.3.1 Upper Basin

Nearly all the lands (totalling about 760,000 acres) in the upper basin are part of Roosevelt National Forest. Various types of outdoor recreation are the primary use of the forest, because commercial timber harvesting, mining, and grazing are limited. Public, commercial, and residential developments are scattered along the Cache la Poudre River and around the Red Feather Lakes area. The Forest Service has the most influence over land use in the upper basin by virtue of ownership. The common management prescription north of the river provides for big game habitat, and land uses are generally limited to those compatible with the protection of cover and forage needed by big game species such as deer, elk, and bighorn sheep. The predominant Forest Service management prescription for the south side of the river is for rural and natural recreational opportunities, which includes driving for pleasure, fishing, picnicking, and other associated recreational activities. Some land uses are associated with special Federal designations, including the Wilderness Areas and the proposed Wild and Scenic River designations.

Approximately 100 acres of hay meadows along the river in the vicinity of Kinikinik are owned by the CDOW. These meadows provide important native forage for big game species during the winter. The CDOW also operates a trout rearing unit near Rustic.

There are fifteen developed Forest Service campgrounds, picnic grounds and trailheads concentrated along the river. The canyon is also a corridor for both transportation and public utilities. The City of Fort Collins operates a water filtration plant located between Poudre Park and the mouth of the canyon.

8.3.2 Lower Basin

The lower basin comprises an area of approximately 540,000 acres. It is relatively flat and unforested, with rich soils. Fort Collins and Greeley are the primary urbanized areas, and they have experienced a high rate of growth over the last several years. A number of smaller communities are also located in the lower basin. There are about 150,000 acres of irrigated land in the Cache la Poudre Basin within the topographic limits of the Basin. The agricultural production of Larimer and Weld counties has regional and statewide significance. Other land uses include mineral extraction (oil and gas wells and gravel pits), thermal power generation, water development for irrigation, fish and wildlife propagation, and flood control. Major transportation corridors include U.S. Highway 34, Highway 287, I-25, and the rail lines of Union Pacific and Burlington Northern.

The principal land use policies developed by Larimer County and Weld County include: (1) preservation and protection of existing prime agricultural lands; (2) channeling of residential and industrial growth within existing urban areas; and (3) the preservation and protection of natural resources, open space, and recreational opportunities.

8.3.3 Sensitive Land Uses

A number of land uses in the Cache la Poudre Basin are sensitive to potential structural and non-structural water development alternatives. These land uses include:

1. Wilderness areas.
2. Utility corridors.
3. Developed homesites and resort areas.
4. Transportation corridors.
5. Prime agricultural lands.
6. Aquifer recharge areas.
7. Private reservoirs in the lower basin.

These areas are listed in Table 8.2 with descriptive comments and references to figures showing the locations of these areas.

TABLE 8.2

Sensitive Land Use Areas

1. Wilderness Areas

Comment: Three wilderness areas (Figure 8.6) lie wholly within the Cache la Poudre basin, and part of one wilderness area extends into the upper Cache la Poudre Basin. These areas are extremely sensitive to water resource development. Development proposals affecting these areas would require Presidential authorization.

2. Utility Corridors

Comment: The Highway 14 right-of-way is used as the utility corridor for telephone and power lines. In addition, there are low diversion dams between Highway 287 and Poudre Park which provide municipal and agricultural water supply (Figure 8.7).

3. Developed Homesites and Resort Areas

Comment: There are a number of homesites and resort areas upstream from the mouth of the Poudre Canyon which would be sensitive to water resource development (Figure 8.8).

4. Transportation Corridors

Comment: Highway 14 provides access to the Poudre Canyon and points west. U.S. Highway 287 is a major transportation corridor between Fort Collins, Colorado and Laramie, Wyoming. I-25 is a major north-south interstate highway. Other localized transportation facilities could be affected by certain water developments.

5. Prime Agricultural Land

Comment: Much of the land in the Cache la Poudre Basin is prime agricultural land. Changes in water availability or available acreage resulting from water resource management activities may affect use of these lands.

6. Aquifer Recharge Areas

Comment: The lower Cache la Poudre River, and tributaries such as Boxelder Creek, are significant aquifer recharge areas. Ground water resources in the Basin are described in Chapter 3.

7. Private Reservoirs in the Lower Basin

Comment: Private reservoirs in the lower basin are used extensively to supply water to agricultural lands, and by homeowner associations, hunting clubs, and other organizations to provide hunting, fishing, boating, and camping opportunities. The number of reservoirs used for these purposes and the amount of usage is not known with any degree of accuracy.

8.4 AQUATIC LIFE

Aquatic habitats in the Basin are distinctly different in the upper and lower basins. The upper basin provides abundant cold water stream habitat, while the lower basin aquatic habitat consists primarily of man-made reservoirs.

8.4.1 Upper Basin

The Cache la Poudre River upstream of Fort Collins includes an extensive cold water fishery of dramatically varying quality from one section to another, due to wide variations in available habitat, regulations, and sportsfishing uses. In general, cold water habitat for salmonid species (trout) is fair to good when streamflows are sufficient. Natural winter streamflows are minimal, however, and overwintering habitat in the canyon is severely reduced. Many fish do not survive the winter period. Fishing pressure is extreme throughout the mainstem canyon. The primary salmonid species in the canyon is rainbow trout, with lesser populations of native Greenback cutthroats in the upper tributaries and German brown trout in the lower canyon areas and downstream of the canyon mouth.

In the upper basin, Greenback cutthroat trout exist at several locations. A population of pure stock occurs in the South Fork near Pingree Park, and this segment of the river is rated by federal and state standards as Class I, "unique" and "irreplaceable." This species is listed as "threatened" under the Federal Endangered Species Act and sportsfishing is presently prohibited. There are no species of fishes on the federal listings of endangered and threatened species that occur, or might be expected to occur, in the waters of the lower Cache la Poudre River. The State of Colorado has listed three warmwater species which do occur in the Poudre and its tributaries as species of special concern. These include the Iowa darter, common shiner, and river carpsucker. These three species are peripheral in Colorado but are widespread elsewhere.

On the mainstem above Poudre Park, the Colorado Division of Wildlife (CDOW) conducts an extensive game management program and stocks the river heavily with rainbow trout except for limited "Wild Trout" areas. The CDOW operates a hatchery and a rearing facility in support of this program at Watson Lake and Rustic. Wild Trout areas are not stocked, and fishing with artificial lures only is allowed.

The eight-mile stretch of the mainstem river from Poudre Park downstream to the canyon mouth includes 4.7 miles of stream designated as "Wild Trout" water. This is not, however, a high-quality cold water fishery by either federal or state standards. Under federal mitigation classifications and state classifications used to determine economic value (the latter measure is based on stream width, biological productivity, and fishing pressure), this section of the Poudre rates as a "fair" fishery (between a lower Class II and a higher Class III). CDOW electroshocking surveys of fish populations in this stretch show about 83 pounds of fish per surface acre of water (lbs per acre). When compared to a Class I fishery, such as the South Platte near Deckers, which yields from 600-700 lbs per acre, the productivity of this fishery is relatively poor.

Another measure of quality in the lower canyon section of the river is biological density, i.e., number of fish per surface acre. The density in this section of the Poudre is about 800 fish per acre. Serious flyfishermen claim these Wild Trout sections are dominated by little rainbows in the 5 to 7-inch class, possibly "stockers" who have moved down from the stocked areas upstream. Larger fish in this stretch are often taken by fishermen, since there are presently no fish release requirements. There are several factors which account for this low productivity, including low winter flows and consequent poor overwintering habitat, low sunlight and insect activity, lack of nutrients, and the lack of fish kill restrictions. The North Fork of the Poudre, in the vicinity of potential water developments, is closed to public fishing access by private owners and local water department regulations.

8.4.2 Lower Basin

Below the mouth of the canyon, CDOW surveys show that productivity is slightly higher, particularly through privately-owned sections. Trout species, notably German browns, have been noted as far downstream as Fort Collins, but in small numbers. In general, however, most of this stretch is rated Class IV, the poorest quality trout habitat, and like stretches of the river further downstream, the fish community is dominated by suckers and minnows. According to the CDOW biologists, however, this section of the stream could be greatly improved as a cold water fishery if adequate streamflows were available and habitat improvement activities were undertaken. The lower mainstem of the Cache la Poudre below the mouth of the canyon is not stocked by CDOW, and no attempts are presently being made to manage this segment of the river as a game fishery.

In the lower basin, fishery habitat is found in reservoirs developed to supply irrigation water. The Poudre River below the mouth of the Canyon provides a very limited aquatic life habitat. Between the mouth of the Canyon and the western edge of Fort Collins, there are numerous municipal and agricultural diversions, return flows, and reservoir releases which modify the flow of the river and, in some cases, dry it up at certain locations. The Colorado Water Quality Control Commission (CWQCC), recognizing the habitat limitations in this reach, classified it as Cold Water Aquatic Life Class 2, meaning that aquatic life in this segment is limited by habitat factors such as streambed and flow conditions. From Fort Collins to the mouth of the Cache la Poudre east of Greeley, aquatic life habitat is also limited by streamflow, benthic, and riparian conditions. Very few game fish are found in this reach due to habitat limitations. The CWQCC has classified this segment as Warm Water Aquatic Life Class 2, recognizing habitat limitations in the lower Cache la Poudre River.

The numerous irrigation reservoirs throughout the lower Basin support a warm water fishery dominated by yellow perch, black and white crappie, green sunfish, largemouth bass, and catfish. Many of these reservoirs are managed as fishery habitats through agreements between reservoir owners and the CDOW or private groups. Horsetooth Reservoir is an important recreational fishery resource with public access. The reservoir is stocked with a variety of fish species.

8.4.3 Sensitive Aquatic Life Areas

There are a number of sensitive aquatic life areas in the Poudre basin, including:

1. Greenback cutthroat habitat.
2. Fisheries management facilities.
3. Cache la Poudre River and tributaries upstream of the mouth of the canyon.
4. Wild trout waters.
5. Reservoirs in the lower Poudre basin.
6. Habitat for Colorado species of special concern.
7. Habitat for wood frog.

These sensitive areas are listed in Table 8.3 with descriptive comments and references to figures showing their locations.

TABLE 8.3

Sensitive Aquatic Life Areas

1. Greenback cutthroat trout habitat.

Comment: The Colorado Division of Wildlife has made a number of introductions of greenback cutthroat trout, an endangered species in Colorado, in the upper basin (Figure 8.9). A population of pure stock exists in the South Fork.

2. Fisheries management facilities.

Comment: CDOW maintains a trout rearing unit near Kinikinik, and a hatchery at Watson Lake (Figure 8.9). These facilities provide the base for stocking of the Cache la Poudre River.

3. Cache la Poudre River and tributaries upstream of the mouth of the Canyon.

Comment: The mainstem of the Cache la Poudre River and its tributaries provide excellent cold water trout habitat.

4. Wild trout waters.

Comment: Three four-mile long sections of the Cache la Poudre River have been designated as wild trout sections (Figure 8.5).

5. Reservoirs in the lower Poudre basin.

Comment: These reservoirs provide habitat for warm water fisheries.

6. Habitat for Colorado species of special concern.

Comment: The State of Colorado has listed four species which occur in the Poudre River and its tributaries as species of special concern. The species have been found previously in the lower Cache la Poudre River (Figure 8.9).

7. Habitat for wood frog.

Comment: The wood frog is found near Chambers Lake in the upper Cache la Poudre basin, and is considered endangered (Figure 8.9).

8.5 TERRESTRIAL WILDLIFE

Terrestrial wildlife communities in the Cache la Poudre Basin vary in response to differences of vegetation and other major habitat features. These differences are dramatically evident in comparing patterns of species occurrence and habitat use in the upper and lower portions of the Basin, and the relatively moist versus the relatively dry environment.

8.5.1 Upper Basin

The bighorn sheep is one of the species of greatest concern among mammals of the upper basin because of their sensitivity to increased levels of activity. Bighorn sheep occur along much of the main Poudre Canyon west of Greyrock Mountain, especially on the open south-facing slopes north of the river. There is a major wintering area north of the Red Feather Lakes Road. The area immediately north of the river also includes three identified lambing areas which coincide with and are adjacent to winter range areas.

Elk are widely distributed throughout the upper basin, and generally follow an east-west pattern of seasonal elevational migration. Much of the sub-alpine and upper montane habitat along both sides of the Poudre Canyon above the "Big Narrows" area is identified as calving habitat. The Basin also includes a large area of winter range and migration corridors between summer and winter range.

Mule deer are widespread in the upper basin, but tend to be of less concern than elk because they are generally more adaptable and tolerant of human activity. Mule deer habitat in the Basin includes winter range, which extends well up the Poudre Canyon on south-facing slopes adjacent to the valley floor. Winter concentration areas have been mapped in the vicinity of Seaman Reservoir and throughout the North Fork sub-basin.

The upper basin has been mapped as a hunting and nesting habitat for peregrine falcons. This species is listed as endangered. A nest site exists near Kinikinik.

Bald eagles winter in portions of the upper basin between Poudre Park and Big Narrows, and on the North Fork of the Cache la Poudre River northwest of Livermore, and around Horsetooth Reservoir. Golden eagles, which are also protected by the Bald Eagle Protection Act, nest along much of the mountain frontage, including a small area near Greyrock Mountain, a large area north of Seaman Reservoir, along Owl Canyon, and the Red Feather Lakes Road. Other golden eagle habitat undoubtedly exists but has not been identified.

Blue grouse occur throughout most of the mountainous portions of Larimer County, with concentration areas having been identified north of the river from Indian Meadows to Kinikinik, the South Fork of the Cache la Poudre, and in other areas. Wild turkey areas have ben identified south of the river from Big Narrows to Rustic, near Poudre Park and Grey Rock Mountain, among other locations.

The State wildlife areas (SWA) located in the upper basin include the Bliss SWA, above Kinikinik, the Poudre River SWA between the mouth of the Poudre Canyon and the Fort Collins diversion, and the Cherokee Park SWA on the North Fork of the Cache la Poudre River.

8.5.1 Lower Basin

Mule deer occur along drainages and upland habitats near water in the plains portion of the Cache la Poudre basin. Mule deer winter concentration areas have been located in the vicinity of Black Hollow Reservoir and Coalbank Creek. Several roads in the winter concentration areas southeast of Black Hollow Reservoir and east of Greeley are identified as major highway crossings.

White-tailed deer occur along drainages and upland habitat with access to water. Population densities in the lower basin are relatively low, and there are no winter concentration areas in the lower basin. Pronghorn antelope are relatively common in some native rangeland areas of the lower basin.

Black-tailed prairie dog towns have been identified at two locations in the lower basin, one three miles southeast of Windsor, and another in the southern part of Greeley. Black-footed ferrets have not been sighted in the lower basin.

There are three bald eagle winter concentration areas in the lower basin -- at Windsor Reservoir, Woods Lake area, and along the Cache la Poudre River. The Cache la Poudre River, Woods Lake, Windsor Reservoir, and Black Hollow Reservoir are concentration areas for golden eagles.

White pelicans, classified as a threatened species by the State, utilize Woods Lake, Seeley Lake, Windsor Reservoir, and Black Hollow Reservoir as feeding habitat. The Cache la Poudre River and most of the area reservoirs are habitat for great blue heron. A great blue heron rookery is located at Franklin, about three miles northeast of Windsor.

Most of the reservoirs in the study area and portions of the Cache la Poudre River provide production habitat and/or winter range for ducks and geese.

There is one state wildlife area within the lower basin, Frank State Wildlife Area, located near the Larimer-Weld County Line.

8.5.3 Sensitive Terrestrial Wildlife Areas

A number of sensitive terrestrial wildlife areas have been identified, including:

1. Bighorn sheep summer range, winter range, and lambing areas.

2. Elk migration corridors, critical winter range, winter range and calving areas.

3. Mule deer habitat.

4. White-tailed deer habitat.

5. Peregrine falcon habitat.

6. Bald eagle habitat.

7. Golden eagle habitat.

8. Blue grouse habitat.

9. Wild turkey habitat.

10. White pelican habitat.

11. Great blue heron habitat.

12. Duck and geese habitat.

13. State wildlife areas.

These habitats are listed in Table 8.4 with descriptive comments and references to figures locating these habitats.

TABLE 8.4

Sensitive Terrestrial Wildlife Areas

1. Big horn sheep summer range, winter range, and lambing areas.

Comment: Three significant lambing areas are located within two to three miles north of the Cache la Poudre River above Poudre Park, and in the Neota Wilderness Area (see Figure 8.10). These areas also coincide with winter range areas. Two significant summer range areas also lie north of the Cache la Poudre River, and a very significant winter range area is also found in the upper basin. Migration corridors between these areas are sensitive to disturbance.

2. Elk migration corridors, critical winter range, winter range, and calving areas.

Comment: The upper Poudre basin supports an extensive elk population which utilizes large portions of the upper Poudre basin (see Figure 8.11).

3. Mule deer habitat.

Comment: Mule deer are widespread in the lower and upper basin (Figure 8.12). Mule deer also occur in the plains areas along drainages and upland habitats near water.

4. White-tailed deer habitat.

Comment: There is a small population in the Poudre Basin which tends to be found most commonly in riparian areas, especially in the plains. Population densities are low, and there are no winter concentration areas in the study area.

5. Peregrine falcon habitat.

Comment: An active nest site exists near Kinikinik. The upper portion of the basin may provide both hunting habitat and nesting habitat for peregrine falcon. The lower Cache la Poudre is not identified as hunting or nesting habitat for the falcon. (Figure 8.13).

6. Bald eagle habitat.

Comment: The Basin is used as a winter residence by bald eagle (Figure 8.13). Wintering areas include Horsetooth Reservoir, mainstem of the Cache la Poudre River below the mouth of the canyon, an area on the North Fork of the Poudre, and a large area north of Fort Collins in the vicinity of numerous irrigation reservoirs. Winter concentration areas in the lower basin include Windsor Reservoir, Woods Lake, and the Cache la Poudre River.

7. Golden eagle habitat.

Comment: Golden eagle concentration areas and historic nesting areas are found in both the upper and lower Poudre basin (Figure 8.13). Golden eagles are protected by the Bald Eagle Protection Act. They are widespread and fairly common in the study area. Golden eagles nest along much of the mountain front and lower foothills, including a small area near Grey Rock Mountain, a large area north of Seaman Reservoir in the vicinity of Owl Canyon and the Red Feather Lakes Road. The Cache la Poudre River, Windsor Reservoir, Woods Lake, and Black Hollow Reservoir areas are concentration areas for golden eagles.

8. Blue grouse habitat.

Comment: Blue grouse are of concern because of the recreational value. Blue grouse (Figure 8.14) occur throughout most of the mountainous portions of the Larimer County, with concentration areas north of the river from Indian Meadows to Kinikinik and other portions of the basin.

9. Wild turkey habitat.

Comment: Wild turkey habitat has been defined south of the Cache la Poudre River from the Big Narrows to Rustic, and near Poudre Park and Grey Rock Mountain, among other locations. This includes both winter range and overall range (Figure 8.14).

10. White pelican habitat.

Comment: White pelican, a species considered by the State to be threatened, utilize Wood Lake, Seeley Lake, Windsor Reservoir, and Black Hollow Reservoir as feeding habitat.

11. Great blue heron habitat.

Comment: A great blue heron rookery of one to five nests, and growing, is located at Franklin Lake about three miles northeast of Windsor.

12. Duck and geese habitat.

Comment: Most of the reservoirs in the study area and portions of the Cache la Poudre River may represent production habitat and/or winter range for ducks and geese. Many of the plains reservoirs represent production habitat for geese.

13. State wildlife areas.

Comment: There are several State wildlife areas within the Poudre basin which are valuable for recreation and as habitat preserves. These include Bliss SWA, above Kinikinik, the State trout rearing unit and adjacent riparian habitat below Kinikinik, the Poudre River SWA between the mouth of the Poudre canyon and the Fort Collins Ditch diversion, the Cherokee Park SWA on the North Fork of the Poudre, and the Frank State Wildlife Area in the plains area on the Larimer-Weld County Line.

8.6 VEGETATION

The Cache la Poudre basin has four vegetative regions, including grassland, montane, sub-alpine, and alpine tundra regions.

8.6.1 Upper Basin

Shrub communities dominate the transition between grasslands in the plains and conifer woodland in the upper basin, and are particularly abundant on the hogback, and in other shallow-soil areas. The herbaceous floor of the shrub communities is diverse, since grasses from both the mountains and the prairie are common. Ponderosa pine forms extensive stands in the lower montane region and extends into the upper montane regions to elevations of about 8500 feet. Dense stands occur at higher elevations and on northern exposures. Understory shrub and herbaceous floor are similar to that of shrub and grassland communities. Douglas fir communities occur on very steep north-facing slopes in the foothills areas. Lodgepole pine stands are widespread in the upper montane and sub-alpine regions. Stands of quaking aspen also occur in the upper montane and sub-alpine regions.

Spruce-fir forests extend upward from the ponderosa pine-Douglas fir forests to the upper timberline. The dominant trees are Englemann spruce and sub-alpine fir. The undergrowth in dense tree spruce-fir stands is sparse.

8.6.2 Plains Area

The plains area of the Cache la Poudre basin is characterized by native grassland in the upland areas, and riparian communities along the Cache la Poudre River and other drainages.

The riparian vegetation common to plains river systems includes cottonwood stands, willow thickets, meadows, and marshes. All these are found within the Cache la Poudre riparian zone, and in the vicinity of irrigation reservoirs on the plains. Woody vegetation along the Poudre River occurs as isolated stands immediately along the channel or on the floodplain. Cottonwood communities are dominated by plains cottonwood, and usually have an abundance of peachleaf willow. The herbaceous understory vegetation is characterized by native grasses and weedy introduced forbes.

Meadow communities are dominated by the grasses and forbes common to the cottonwood stands. Species dominance depends on soil, moisture, and disturbance factors. In less alkaline areas, western wheatgrass frequently forms pure stands. In areas where ground water is near the surface, salt grass and alkali sacaton are generally abundant. Meadows, oxbow ponds, and slough communities are found along the Cache la Poudre River.

The grasslands of the plains extend into the low hills and mesas to elevations of about 6000 feet. The vegetation of these grasslands is mixed prairie, which needs an overstory of tall grasses. Taller grasses are more vigorous and abundant in swales, bottom lands, and drainages, while species such as blue gamma and buffalo grass dominate the upland sites.

8.6.3 Sensitive Areas

Five sensitive vegetation areas exist in both the upper and lower basin. These include:

1. Riparian vegetation;
2. Plants of high Federal interest;
3. Plants of State concern;
4. Plan associations of special concern; and
5. Owl Canyon Pinyon Grove Natural Area.

These areas are listed in Table 8.5, with descriptive comments and references to appropriate figures.

TABLE 8.5

Sensitive Vegetation Areas

1. Riparian Vegetation

Comment: Riparian vegetation in both the upper basin and lower basin provides wildlife habitat and is an integral component of the habitat for aquatic life in adjoining streams. Riparian vegetation sensitive to development is found along the mainstem of the Cache la Poudre, and in large and small tributary drainages.

2. Plants of High Federal Interest

Comment: Three plants under review for Federal protective status are present in the study area, including Larimer aletes, Colorado butterfly plant, and Bell's twinpod (Figure 8.15). Several populations of Larimer aletes occur within the study area in the vicinity of Greyrock Mountain, a few miles northeast of Poudre Park. The Colorado butterfly plant has been reported east of Poudre Park, and is potentially present in the study area in moist meadows along the Cache la Poudre and tributaries. Eight populations of Bell's twinpod occur in the study area. Three are known along the eastern shore of Horsetooth Reservoir, near North Poudre Reservoir No. 15, one-half mile south of Curtis Lake, and about two miles west of Curtis Lake.

3. Plants of State Concern.

Comment: Plants of State concern include three species which potentially occur in the study area, including white upland aster, purple cliffbrake, and feverfew. White upland aster is a prairie relic which has been found near Horsetooth Mountain and at the Owl Canyon area (Figure 8.15). It may potentially be present in the plains area. Purple cliffbrake has been reported in Larimer County but is relatively rare. Feverfew has been collected in Weld County, outside of the study area. However, the Basin does represent potential habitat for this plant.

4. Plant Associations of Special Concern.

Comment: Ten different plant associations considered to be rare or extremely rare in Colorado occur within the study area:

1. Big Bluestem/Sideoats Grama/Blue Brama/Little Bluestem Xeric.
2. Bitterbrush/Mountain Muhly
3. Bitterbrush/Needle-and-thread
4. Rocky Mountain Juniper/True Mountain Mahogany
5. Rocky Mountain Juniper/Bitterbrush
6. Ponderosa Pine (Douglas fir)/Spike Fescue
7. True Mountain Mahogany/Needle-and-thread
8. Parry Oatgrass Montane Grassland
9. Mountain Muhly/Needle-and-thread Montane Grassland
10. Wyoming Big Sagebrush/Colorado Wildrye

Plant associations of special concern are primarily located in the area of the Poudre Basin west of Fort Collins.

5. Owl Canyon Pinyon Grove Natural Area

Comment: This is the only natural area administered by the Colorado Division of Parks and Outdoor Recreation. It is located one mile east of Livermore. It adjoins 317 acres of land owned by the CDOW, and was established to preserve a disjunct population of pinyon pine. The site also serves as a botanical research area.

8.7 WATER QUALITY

Water quality, and water uses, vary considerably between the upper and lower basins. The upper basin is primarily regarded as a water supply source for municipal and agricultural uses in the plains. Water quality concerns in the upper basin are primarily related to protecting water supply sources and cold water aquatic life uses. In the mainstem of the Cache la Poudre River and its tributaries in the lower basin, aquatic habitat is limited by diversions of water from the river for water supply to municipal, industrial, and agricultural users.

8.7.1 Upper Basin

The Cache la Poudre River, and practically all the tributaries to the Cache la Poudre River upstream of the mouth of the canyon, are classified by the CWQCC as Cold Water Aquatic Life Class 1, Recreation Class 1, Water supply, and Agriculture. These classifications reflect uses in the upper basin, and the need to protect water supplies for downstream uses. The only exceptions to these classifications are on the North Fork, from the inlet of Halligan Reservoir to its confluence with the Cache la Poudre River, and the tributaries to that segment of the North Fork classified as Recreation Class 2, Cold Water Aquatic Life Class 2, and Agriculture. The quality of water in the North Fork is lower than the mainstem and South Fork because of higher sediment loadings.

Water quality in the upper basin is excellent, as indicated by the fact that these waters support an outstanding cold water trout fishery. No significant impairments to water quality in the upper basin have been identified, although there is a concern about increased recreational use and its impact on water quality in the future. There is also concern over the impact on water quality of continued development of mountain subdivisions.

8.7.2 Lower Basin

The mainstem of the Cache la Poudre River is restricted in terms of aquatic life habitat because of the withdrawal of water from the numerous diversions which exist from the mouth of the canyon to the City of Greeley. In recognition of this, the CWQCC classified the mainstem of the Cache la Poudre from Munroe Canal diversion structure near the mouth of the canyon to Shields Street immediately west of Fort Collins, as Cold Water Aquatic Life Class 2, Recreation Class 1, Water Supply and Agriculture.

The mainstem of the Cache la Poudre River from Shields Street to the confluence with the South Platte River is classified as Recreation Class 2, Cold Water Aquatic Life Class 2, and Agriculture, as are most of the tributaries to the Cache la Poudre River. The Class 2 Aquatic Life classification recognizes streambed and flow limitations to maintenance of aquatic life.

Water uses in the lower basin are not impaired by adverse water quality conditions. Water quality standards applied by the CWQCC for numerous chemical constituents are rarely exceeded, and aquatic life in the lower Cache la Poudre River is not limited by water quality conditions.

8.7.3 Sensitive Areas

Sensitive water quality areas in the Poudre basin include:

1. Diversion headgates;
2. Classified high quality segments; and
3. Water quality in mountainous areas.

Table 8.6 lists these areas and provides descriptive comments concerning these sensitive water quality areas.

TABLE 8.6

Sensitive Water Quality Areas

1. Diversion Headgates

   Comment: There are numerous diversion headgates between the point a few miles above the mouth of the Poudre Canyon and the City of Greeley, where water is diverted for municipal, industrial, and agricultural water supply, and to supply a fish hatchery at Bellvue. These locations would be sensitive to changes in water quality that might affect the uses of water withdrawn at these diversion structures.

2. Classified High Quality Segments

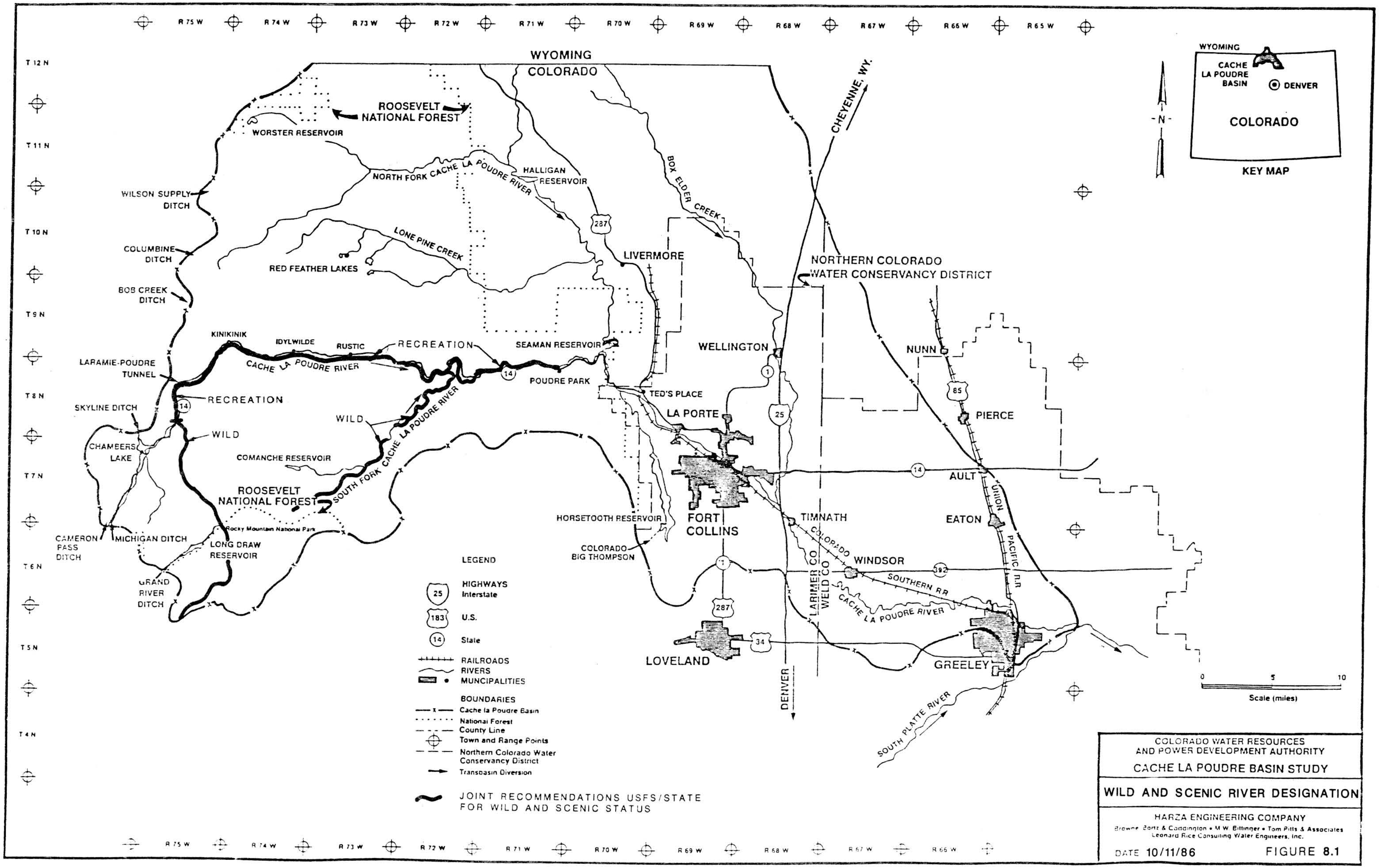
   Comment: The Colorado Water Quality Control Commission has classified stream segments within Rocky Mountain National Park as high quality, indicating no degradation may occur (Figure 8.16).

3. Water Quality in Mountainous Areas

   Comment: The mountainous areas in western Larimer municipalities and industries in the Cache la Poudre basin. Degradation of water quality resulting from increased recreational use and land development is a concern. Water management alternatives that would increase recreational use or opportunities for land development within the upper basin should consider the consequences to water quality. Furthermore, because of the extensive cold water fishery existing in mountainous areas, changes in water quality in terms of chemistry, temperature, or sediment load, must be considered.

8.8 ARCHAEOLOGICAL AND CULTURAL RESOURCES

Archaeological and cultural resources that could be impacted by reservoir construction were identified. A description of the site specific survey which was based on previously published information, is contained in the Task 7 Summary Report (Harza, 1986). The numbers of archaeological and cultural resource sites that could be impacted under various water management alternatives are identified in Chapter 12.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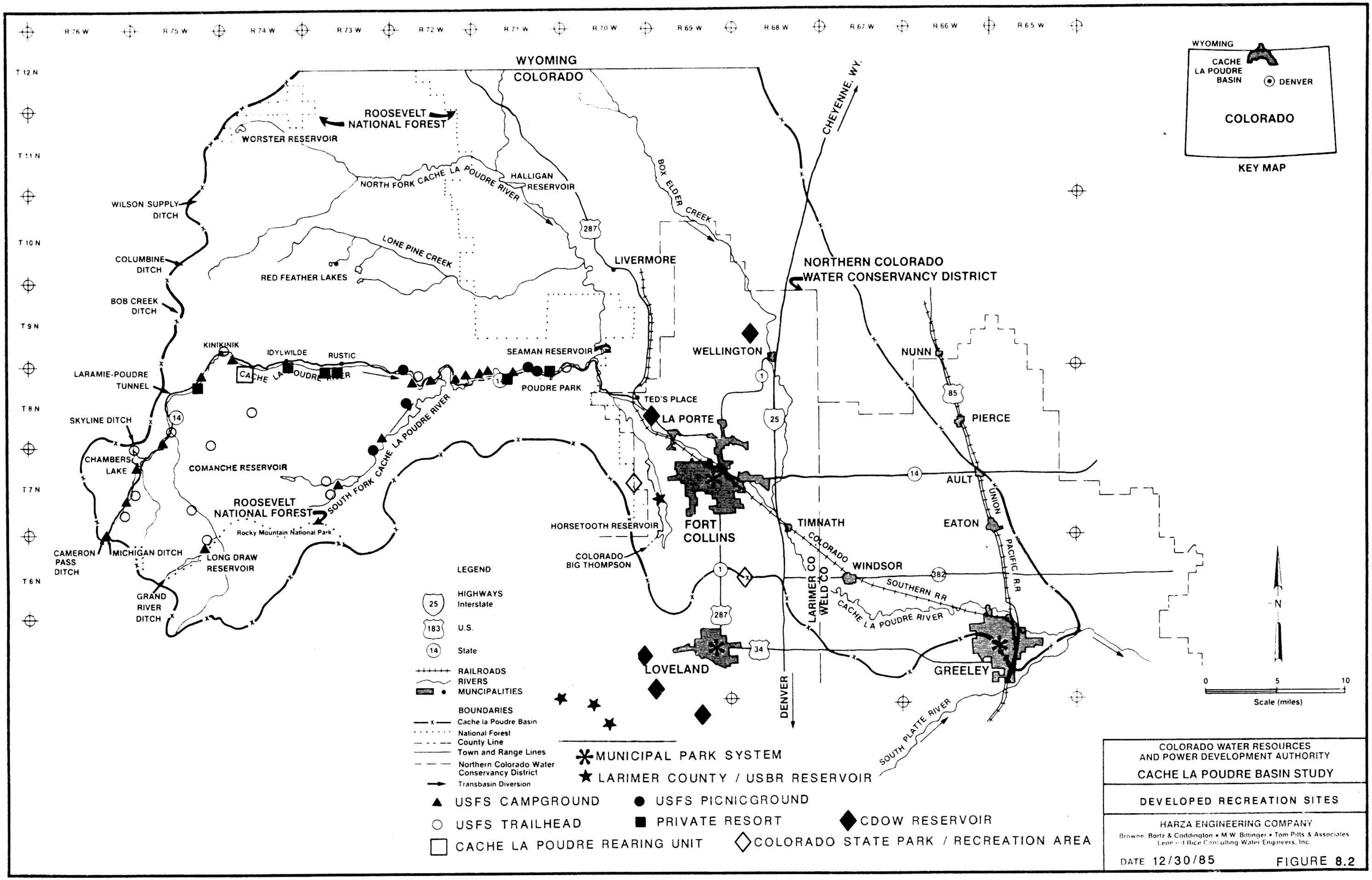
Northern Colorado Water Conservancy District
Transbasin Diversion
JOINT RECOMMENDATIONS USFS/STATE FOR WILD AND SCENIC STATUS
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
WILD AND SCENIC RIVER DESIGNATION
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 10/11/86
FIGURE 8.1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USFS PICNICGROUND
USFS TRAILHEAD
PRIVATE RESORT
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CACHE LA POUDRE REARING UNIT
COLORADO STATE PARK / RECREATION AREA
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CACHE LA POUDRE BASIN STUDY
DEVELOPED RECREATION SITES
HARZA ENGINEERING COMPANY
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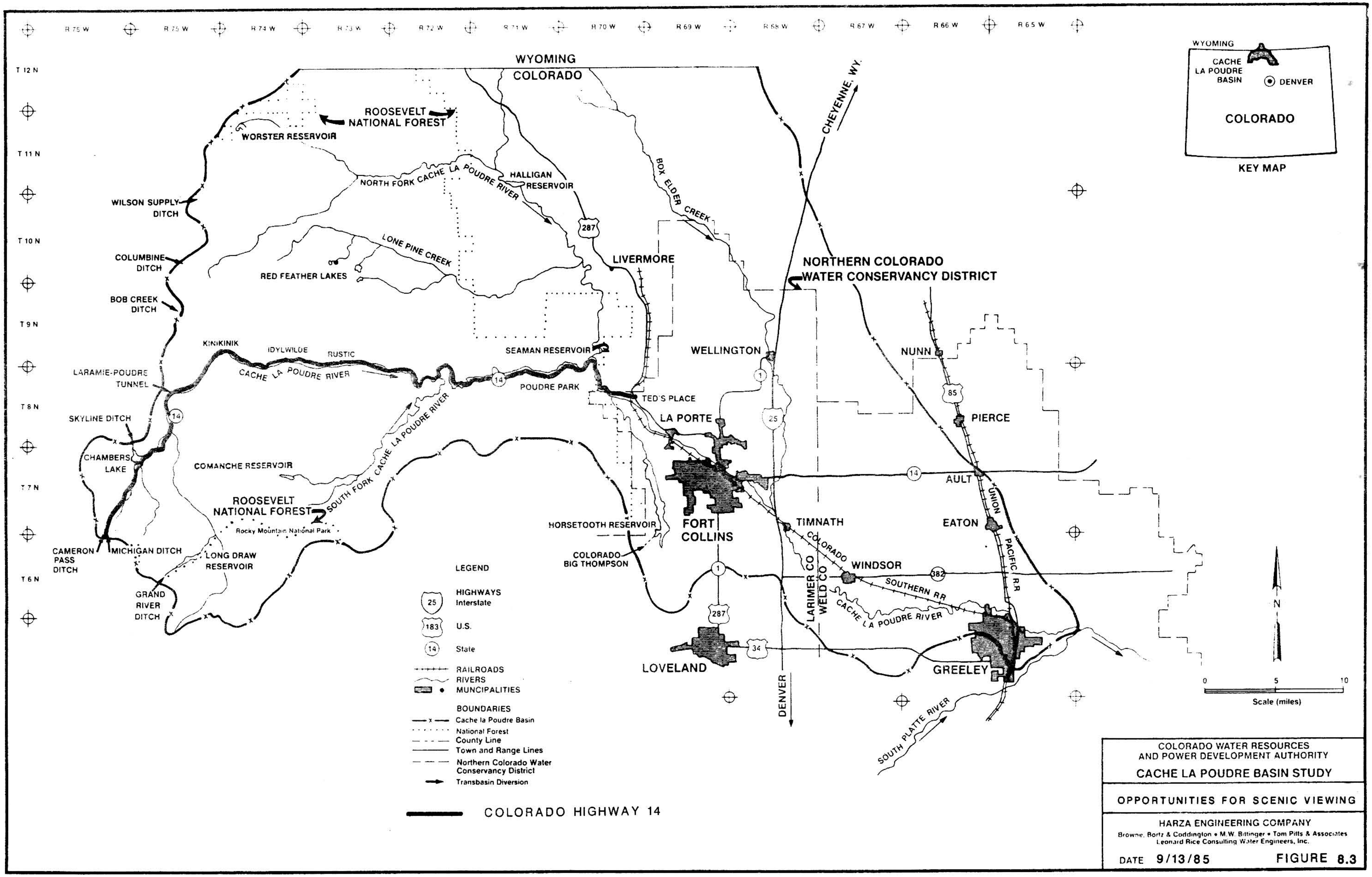
DATE 12/30/85
FIGURE 8.2



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

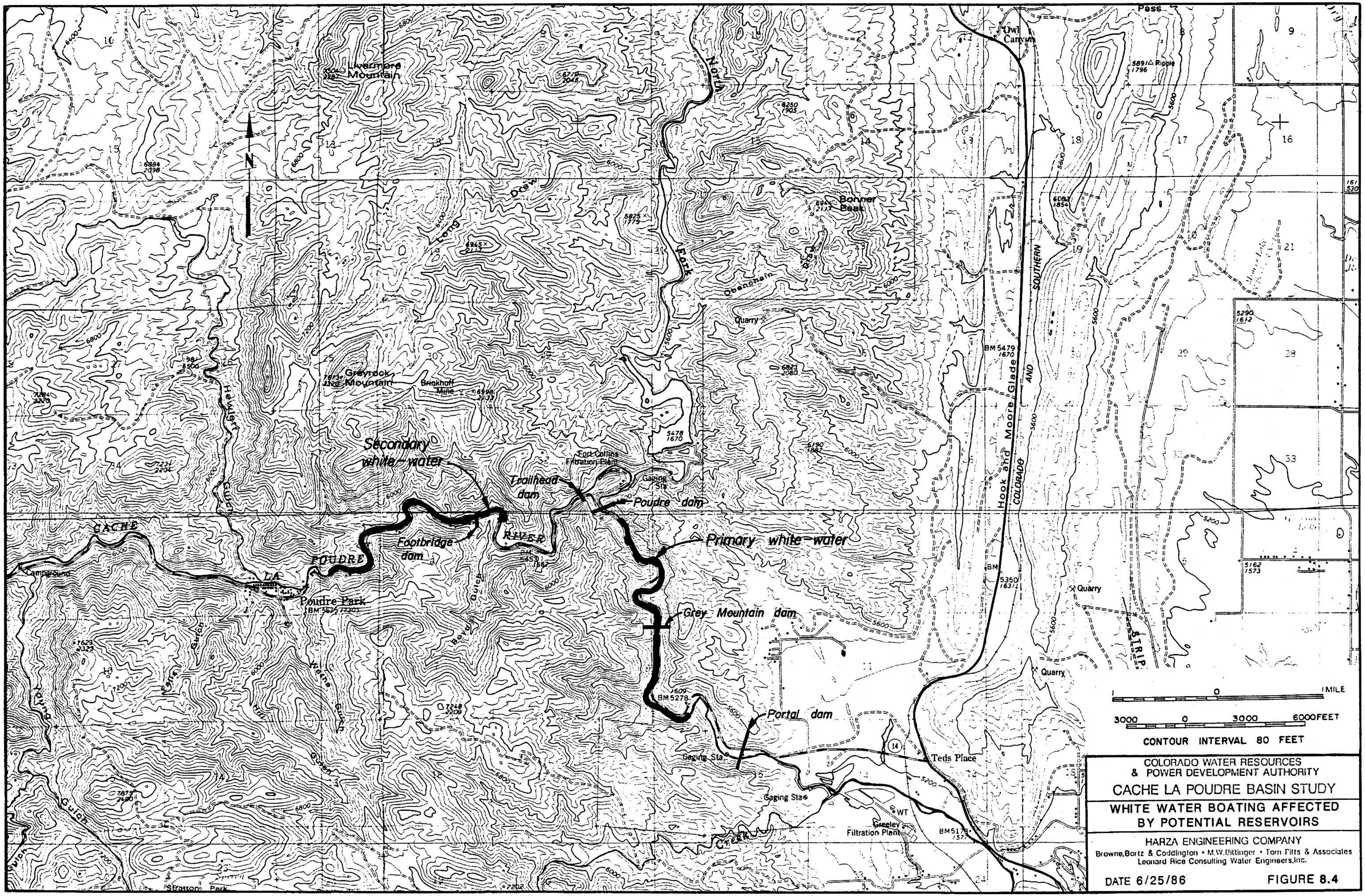
CACHE LA POUDRE BASIN STUDY

OPPORTUNITIES FOR SCENIC VIEWING

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE 9/13/85 FIGURE 8.3



COLORADO WATER RESOURCES
& POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

WHITE WATER BOATING AFFECTED
BY POTENTIAL RESERVOIRS

HARZA ENGINEERING COMPANY
Browne,Bortz & Coddington • M.W.Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers,Inc.

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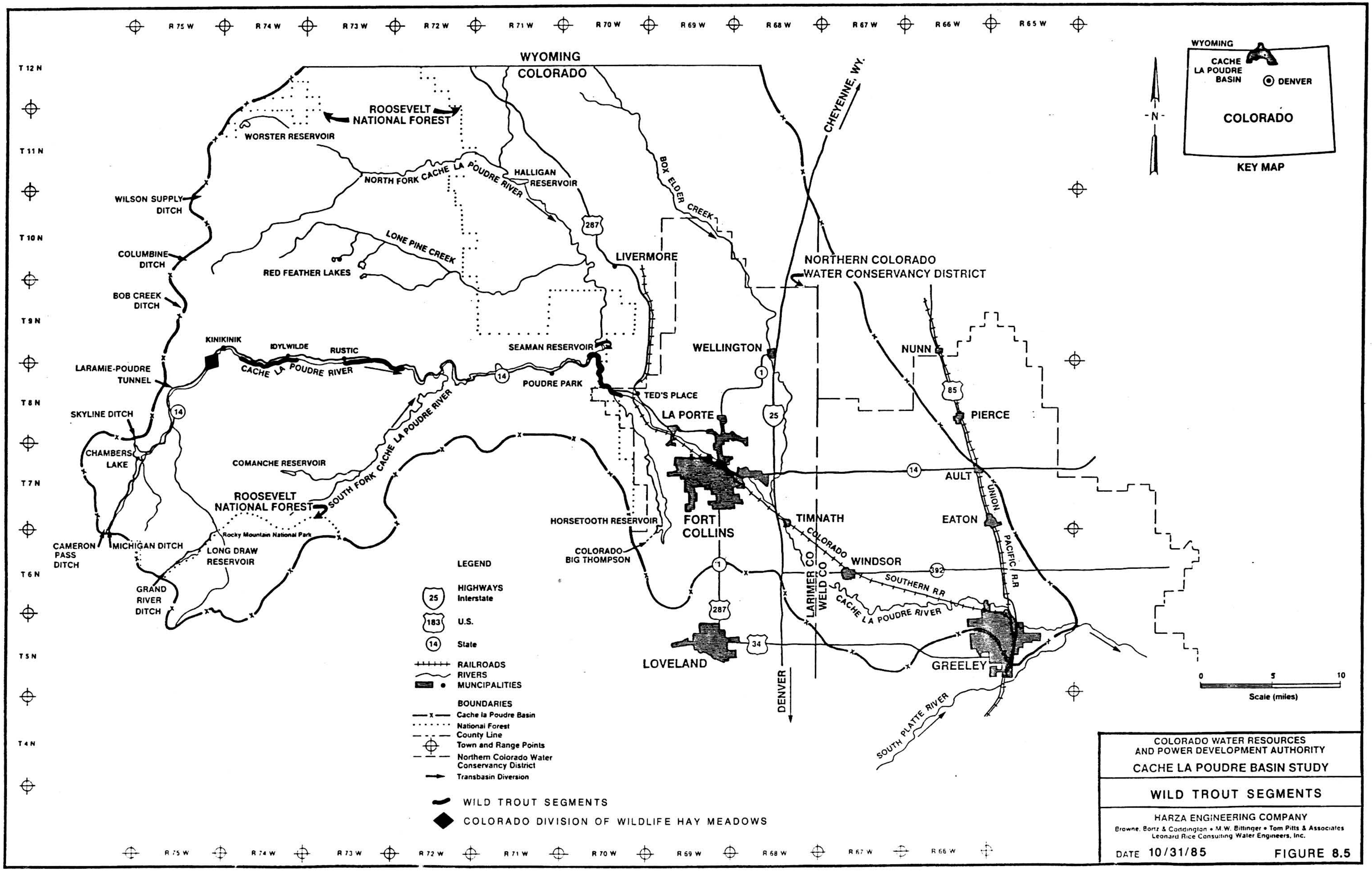
FIGURE 8.4



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

WILD TROUT SEGMENTS

HARZA ENGINEERING COMPANY

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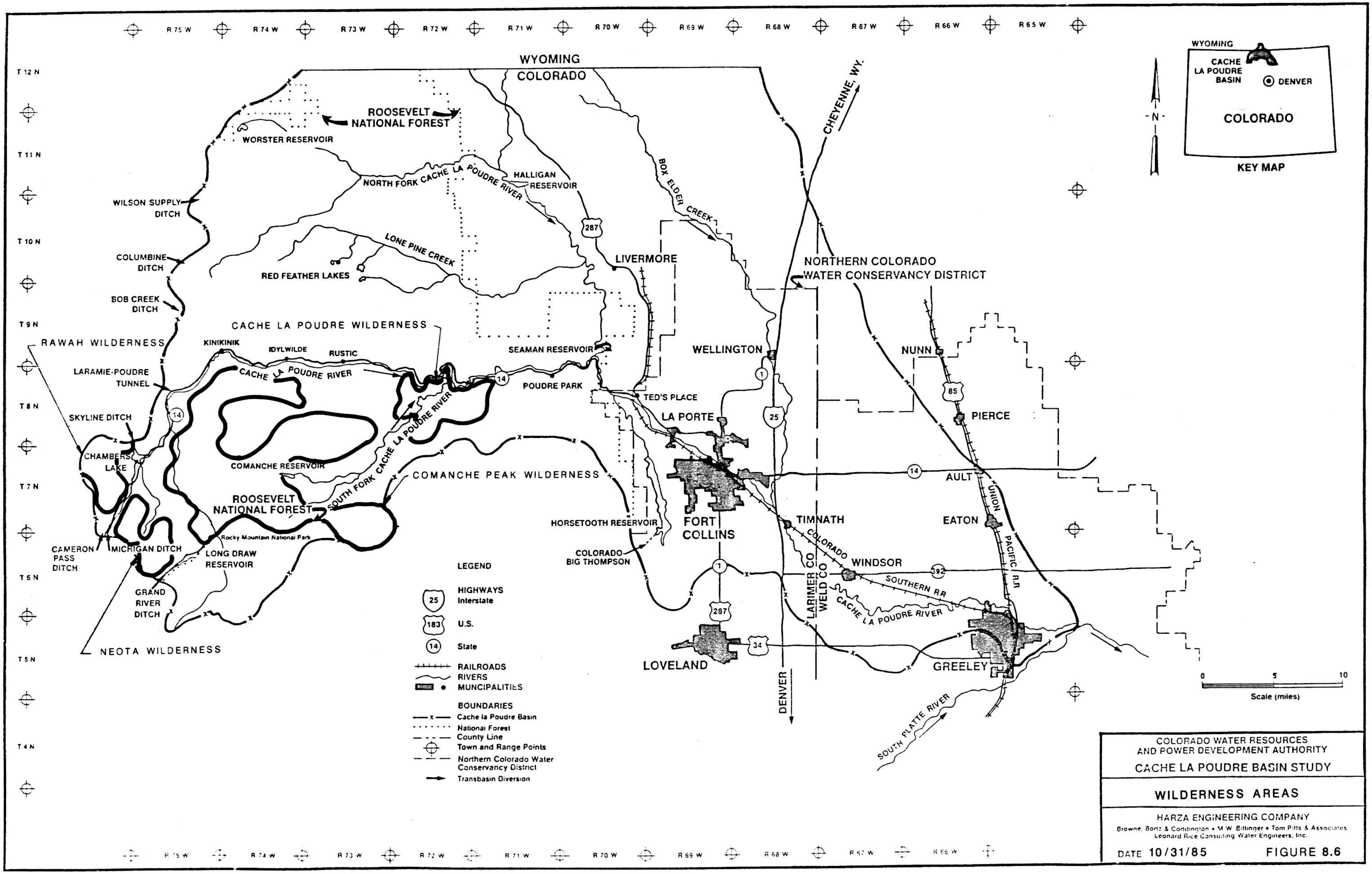
Leonard Rice Consulting Water Engineers, Inc.

DATE 10/31/85

FIGURE 8.5



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

WILDERNESS AREAS

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
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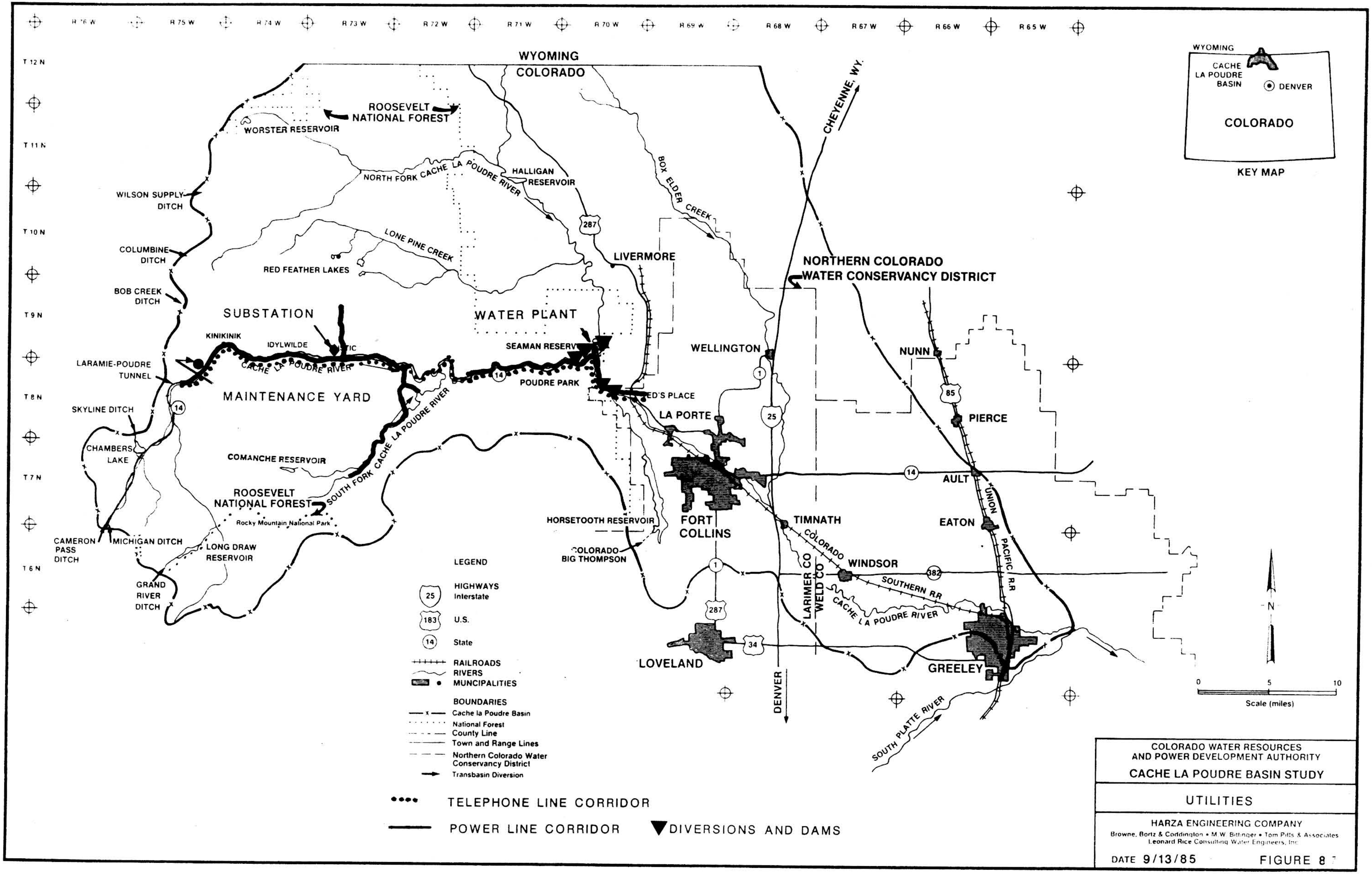
FIGURE 8.6



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

UTILITIES

HARZA ENGINEERING COMPANY

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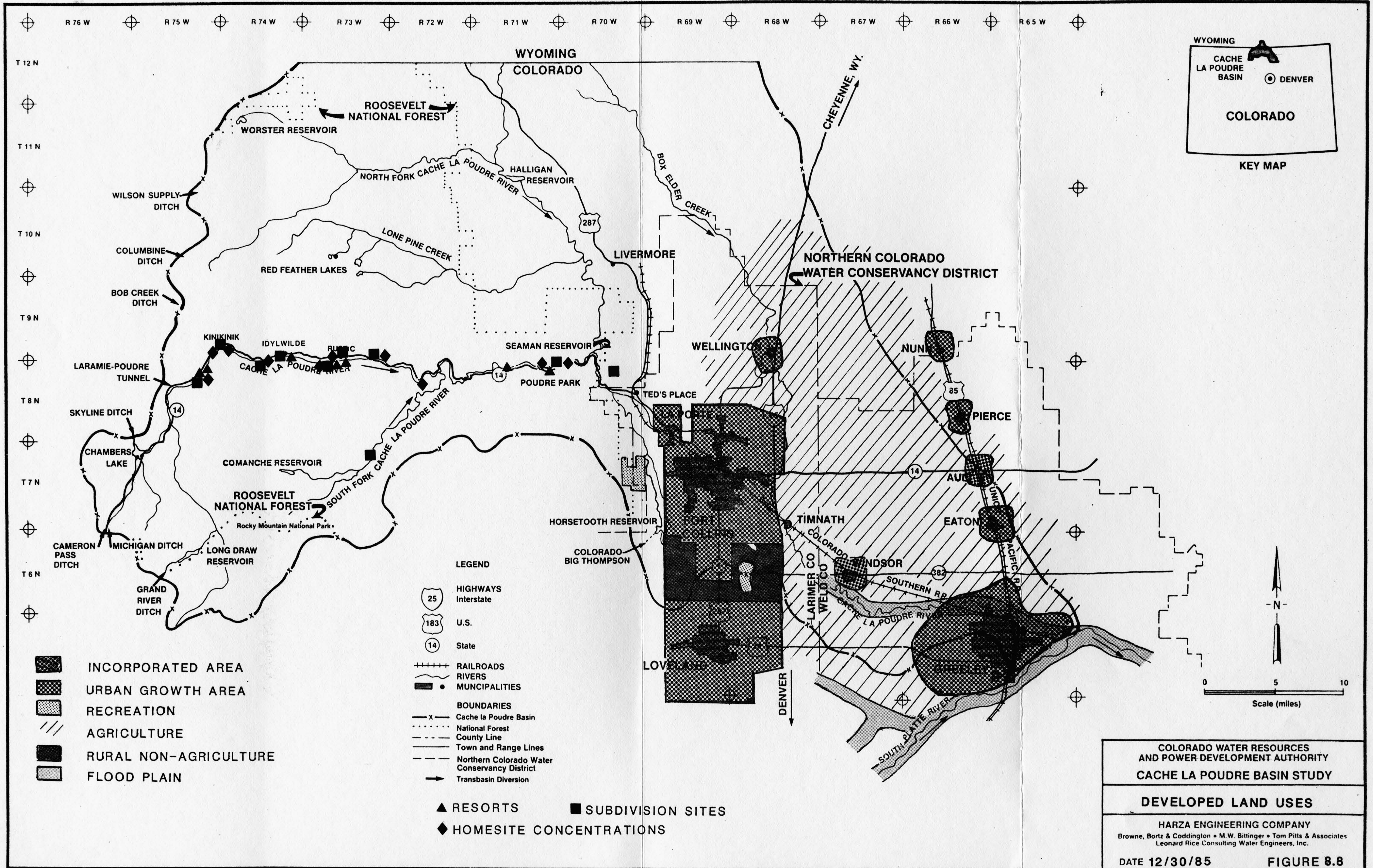

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COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
DEVELOPED LAND USES
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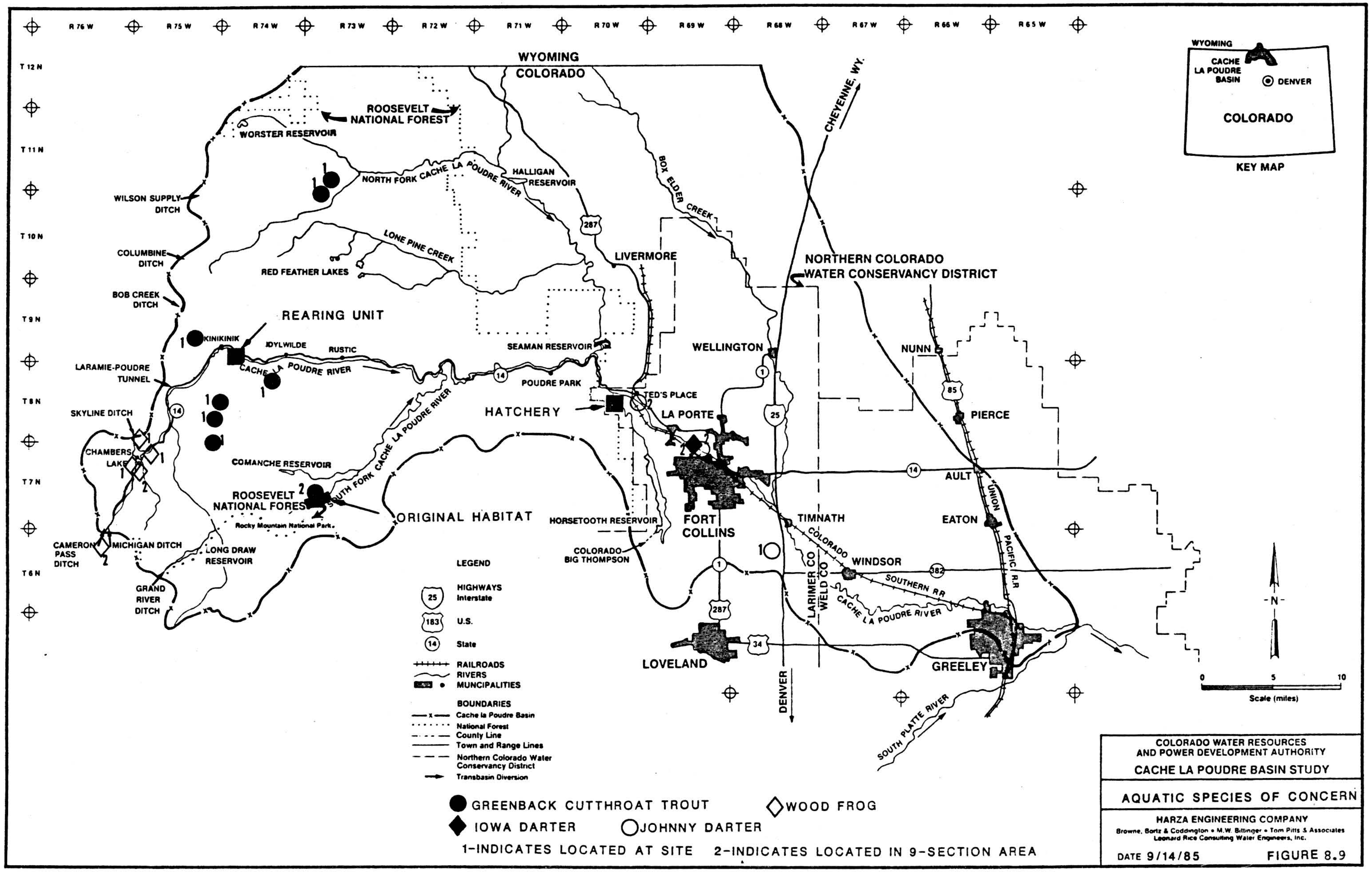
DATE 12/30/85
FIGURE 8.8



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WOOD FROG
IOWA DARTER
JOHNNY DARTER
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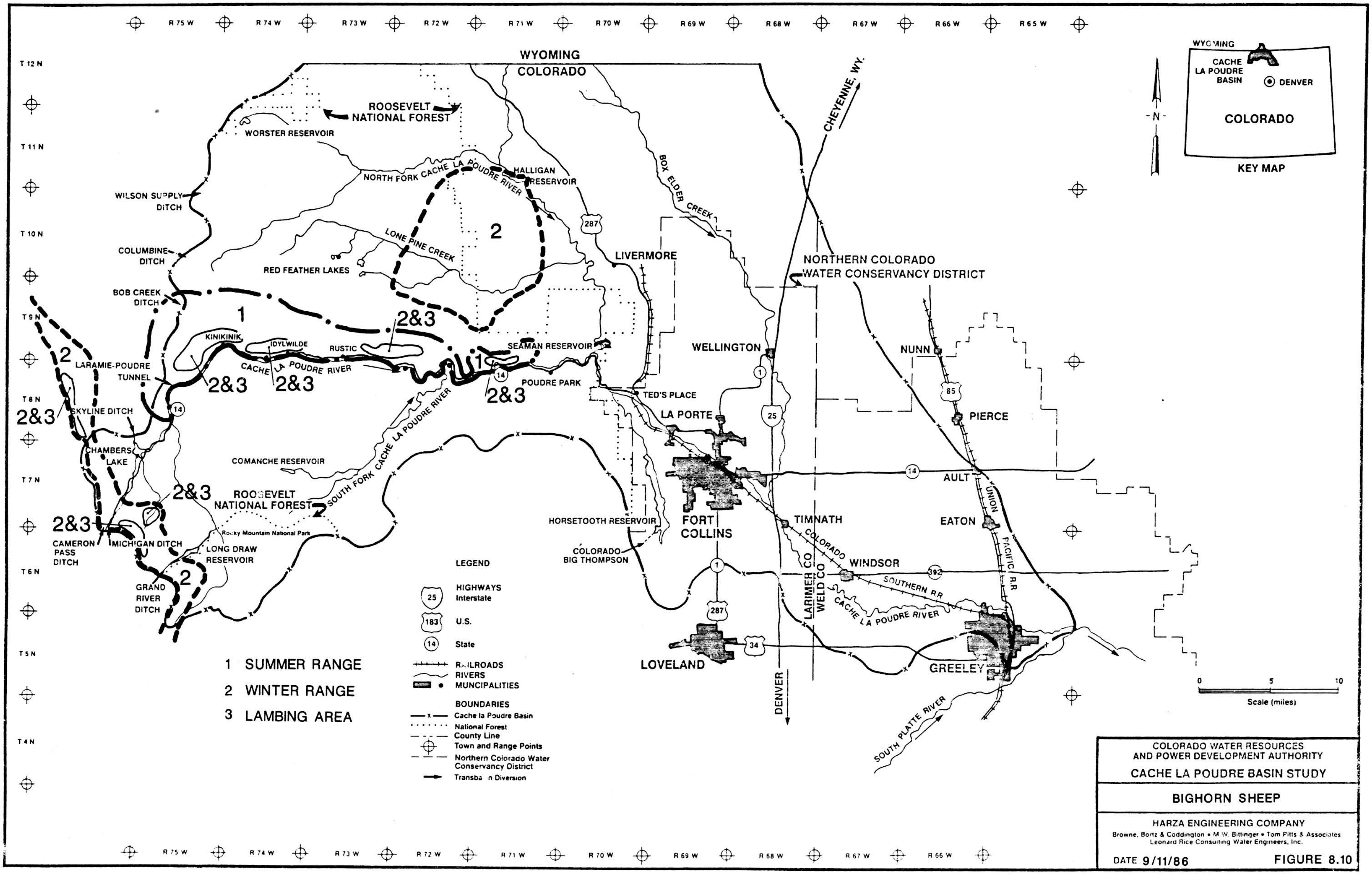
2-INDICATES LOCATED IN 9-SECTION AREA
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
AQUATIC SPECIES OF CONCERN
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 9/14/85
FIGURE 8.9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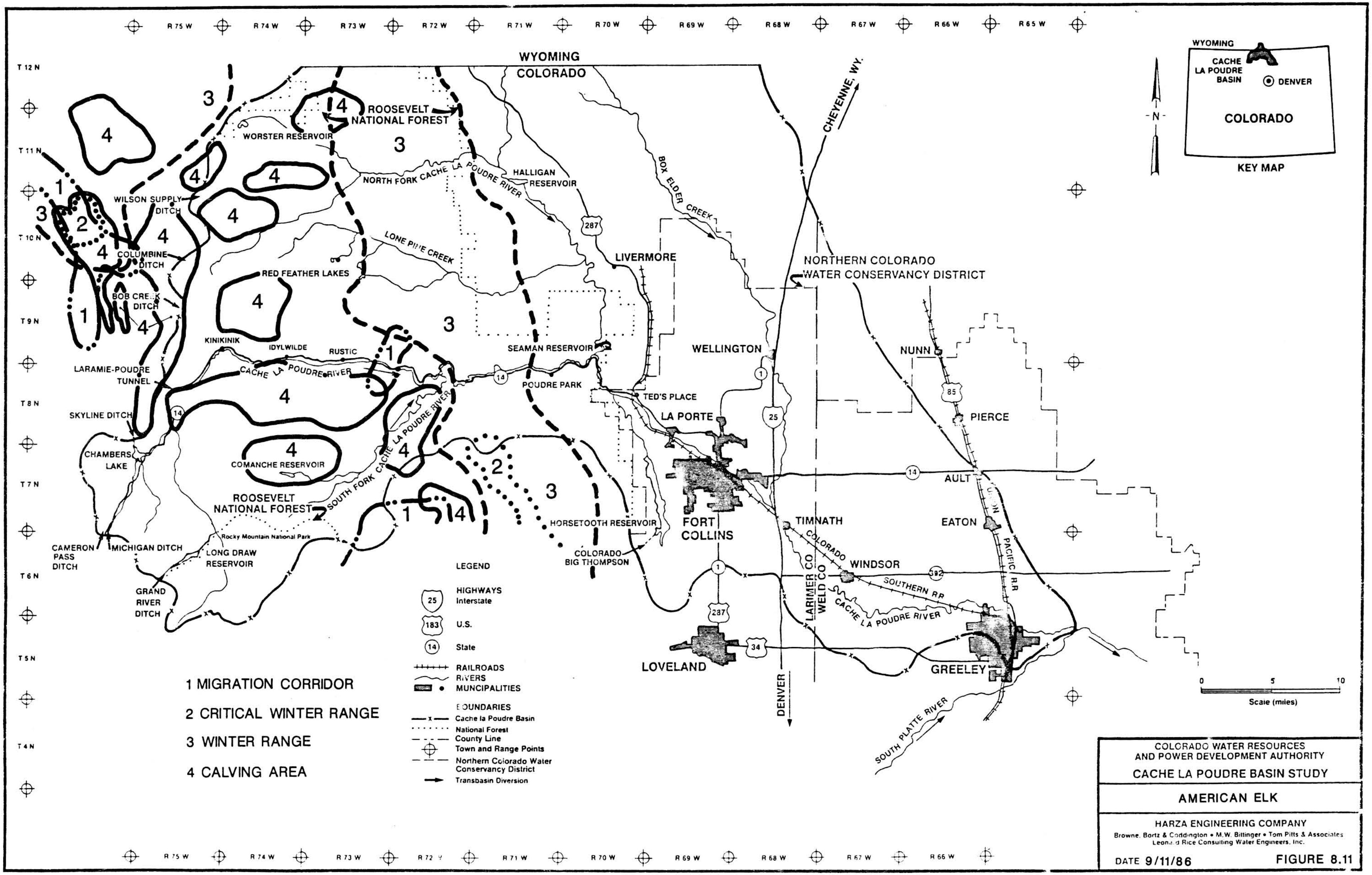
CHEYENNE, WY.
WILSON SUPPLY DITCH
LONE PINE CREEK
RED FEATHER LAKES
COLUMBINE DITCH
BOB CREEK DITCH
LIVERMORE
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
KINIKINIK
IDYLWILDE
RUSTIC
SEAMAN RESERVOIR
WELLINGTON
NUNN
LARAMIE-POUDRE TUNNEL
CACHE LA POUDRE RIVER
POUDRE PARK
TED'S PLACE
SKYLINE DITCH
LA PORTE
PIERCE
CHAMBERS LAKE
COMANCHE RESERVOIR
SOUTH FORK CACHE LA POUDRE RIVER
AULT
ROOSEVELT NATIONAL FOREST
Rocky Mountain National Park
HORSETOOTH RESERVOIR
FORT COLLINS
TIMNATH
EATON
CAMERON PASS DITCH
MICHIGAN DITCH
LONG DRAW RESERVOIR
COLORADO BIG THOMPSON
COLORADO SOUTHERN RR
WINDSOR
UNION PACIFIC R.R.
GRAND RIVER DITCH
LARIMER CO
WELD CO
CACHE LA POUDRE RIVER
LOVELAND
GREELEY
DENVER
SOUTH PLATTE RIVER
1 SUMMER RANGE
2 WINTER RANGE
3 LAMBING AREA
LEGEND
HIGHWAYS
Interstate
U.S.
State
RAILROADS
RIVERS
MUNCIPALITIES
BOUNDARIES
Cache la Poudre Basin
National Forest
County Line
Town and Range Points
Northern Colorado Water Conservancy District
Transbasin Diversion
KEY MAP
CACHE LA POUDRE BASIN
DENVER
COLORADO
Scale (miles)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
BIGHORN SHEEP
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 9/11/86
FIGURE 8.10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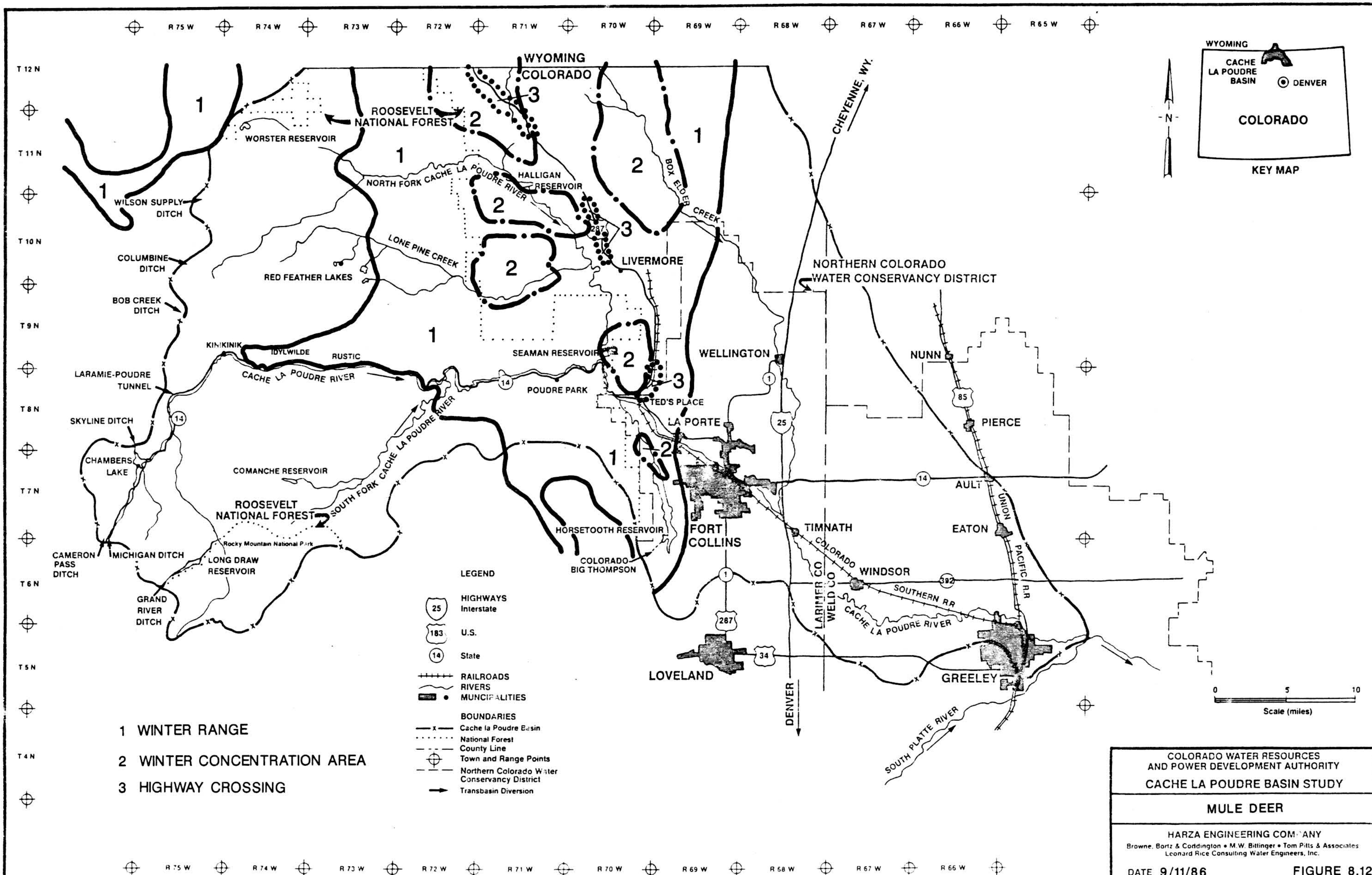
COLORADO
ROOSEVELT NATIONAL FOREST
WORSTER RESERVOIR
NORTH FORK CACHE LA POUDRE RIVER
HALLIGAN RESERVOIR
BOX ELDER CREEK
CHEYENNE, WY.
WILSON SUPPLY DITCH
COLUMBINE DITCH
BOB CREEK DITCH
LONE PINE CREEK
RED FEATHER LAKES
LIVERMORE
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
KINIKINIK
IDYLWILDE
RUSTIC
SEAMAN RESERVOIR
WELLINGTON
NUNN
LARAMIE-POUDRE TUNNEL
CACHE LA POUDRE RIVER
POUDRE PARK
TED'S PLACE
LA PORTE
PIERCE
SKYLINE DITCH
CHAMBERS LAKE
COMANCHE RESERVOIR
SOUTH FORK CACHE LA POUDRE RIVER
AULT
ROOSEVELT NATIONAL FOREST
FORT COLLINS
TIMNATH
EATON
Rocky Mountain National Park
HORSETOOTH RESERVOIR
CAMERON PASS DITCH
MICHIGAN DITCH
LONG DRAW RESERVOIR
COLORADO BIG THOMPSON
WINDSOR
COLORADO SOUTHERN RR
UNION PACIFIC R.R.
GRAND RIVER DITCH
LARIMER CO
WELD CO
LOVELAND
GREELEY
DENVER
SOUTH PLATTE RIVER
1 MIGRATION CORRIDOR
2 CRITICAL WINTER RANGE
3 WINTER RANGE
4 CALVING AREA
LEGEND
HIGHWAYS
Interstate
U.S.
State
RAILROADS
RIVERS
MUNCIPALITIES
BOUNDARIES
Cache la Poudre Basin
National Forest
County Line
Town and Range Points
Northern Colorado Water Conservancy District
Transbasin Diversion
WYOMING
CACHE LA POUDRE BASIN
DENVER
COLORADO
KEY MAP
Scale (miles)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
AMERICAN ELK
HARZA ENGINEERING COMPANY
DATE 9/11/86
FIGURE 8.11



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

MULE DEER

HARZA ENGINEERING COMPANY

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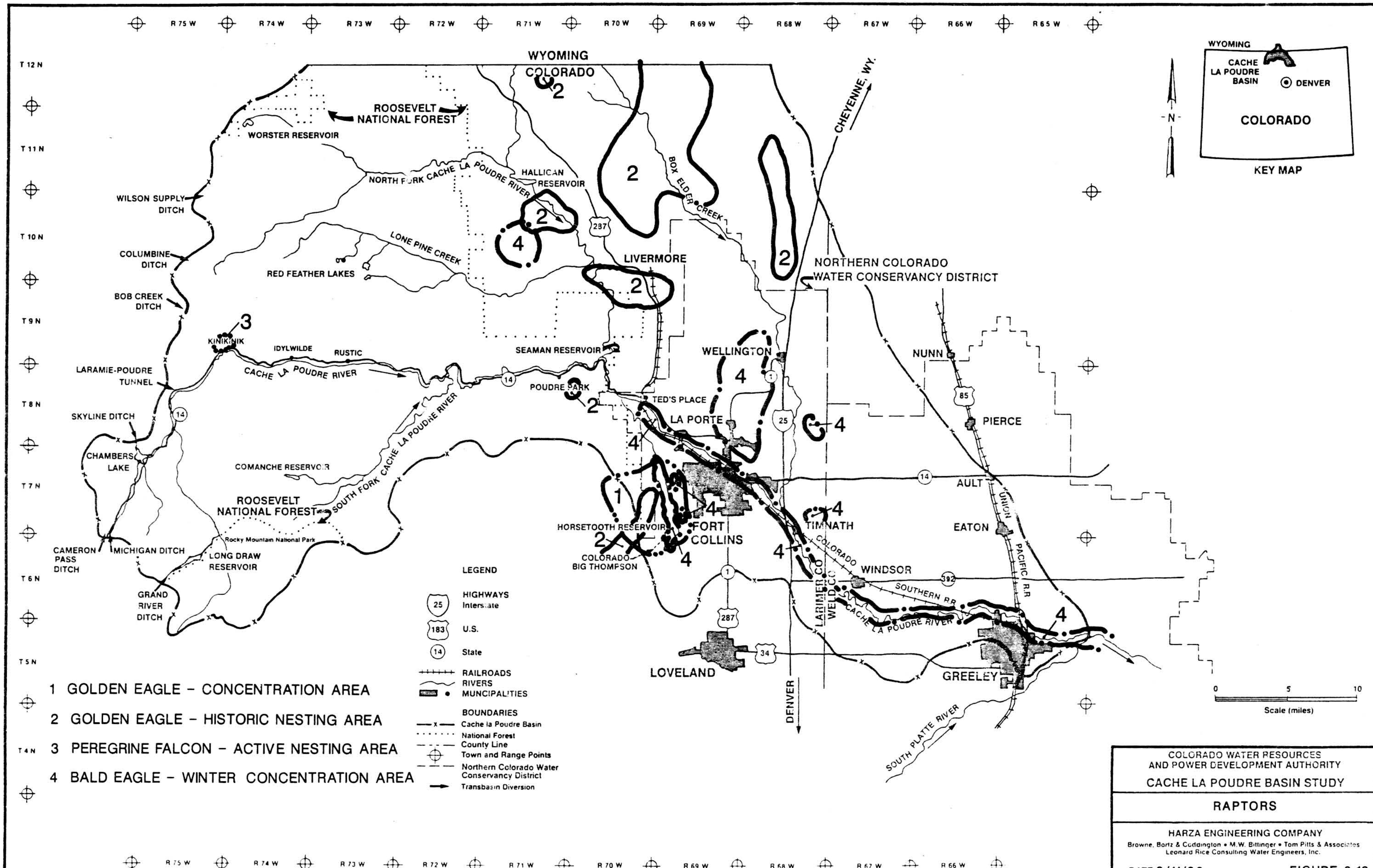
Leonard Rice Consulting Water Engineers, Inc.

DATE 9/11/86 FIGURE 8.12



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

CACHE LA POUDRE BASIN STUDY

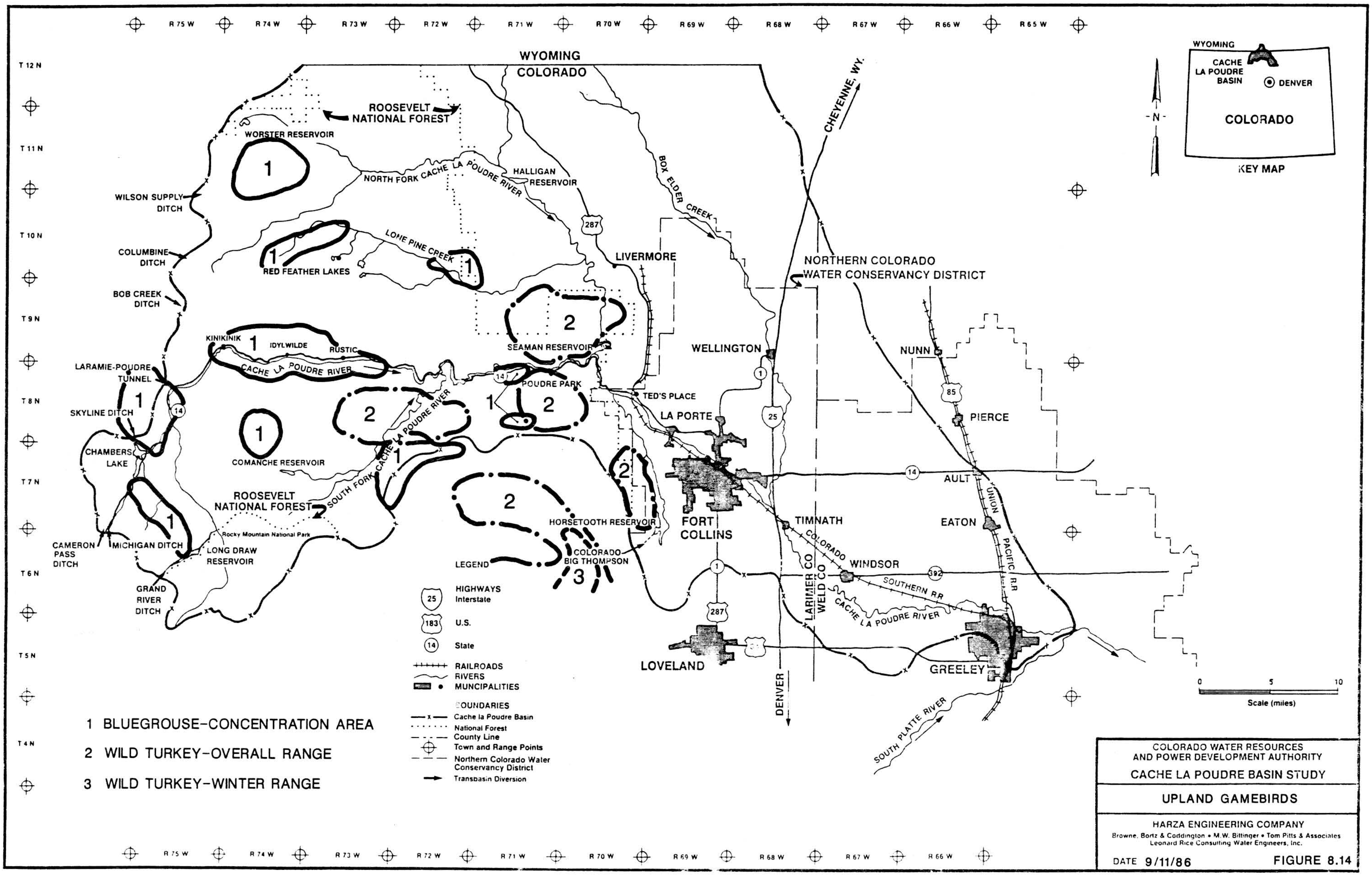
RAPTORS

HARZA ENGINEERING COMPANY

Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE 9/11/86

FIGURE 8.13



COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY

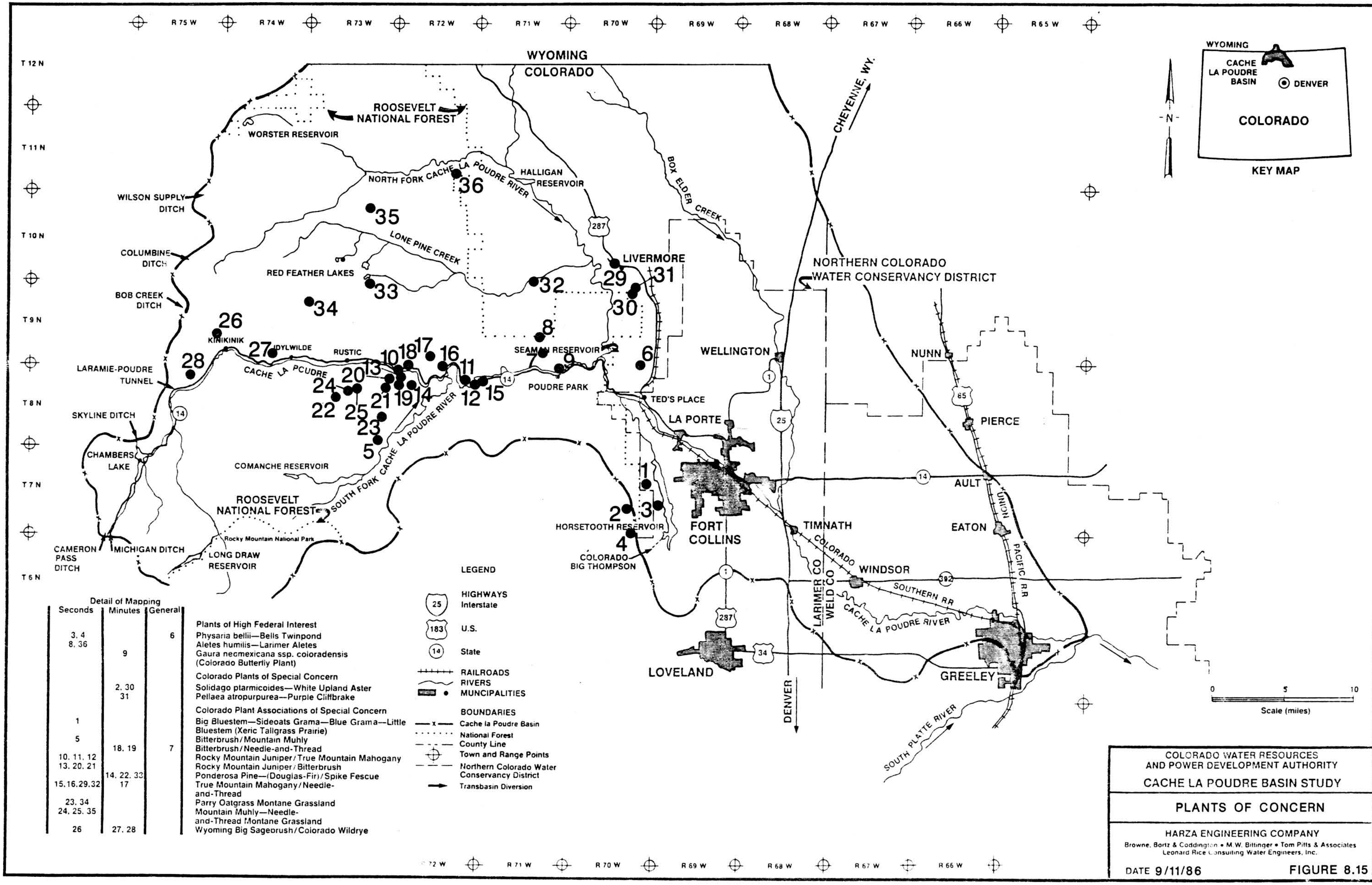
CACHE LA POUDRE BASIN STUDY

UPLAND GAMEBIRDS

HARZA ENGINEERING COMPANY

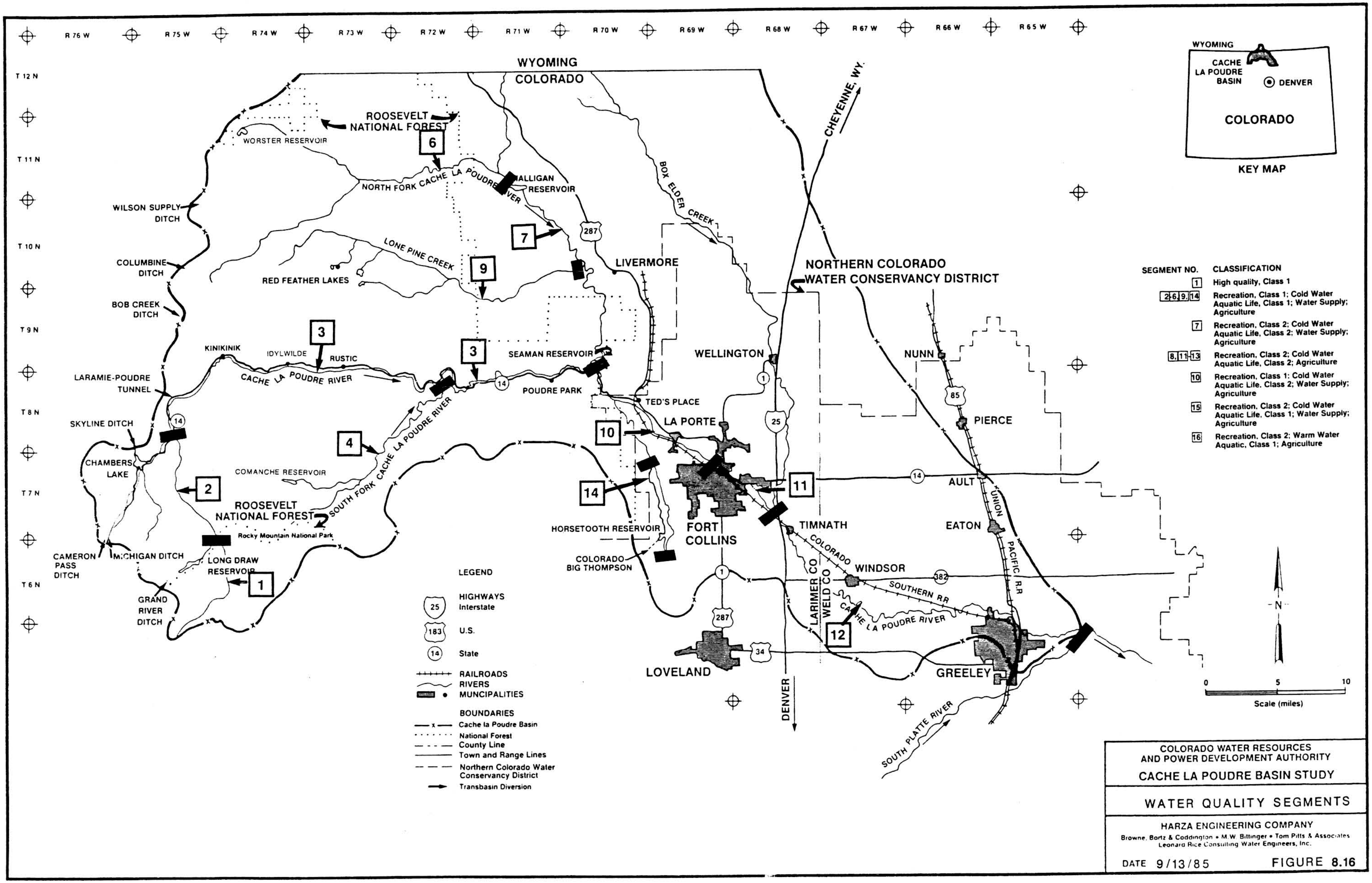
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.

DATE 9/11/86 FIGURE 8.14



PLANTS OF CONCERN

FIGURE 8.15


WYOMING
COLORADO
ROOSEVELT NATIONAL FOREST
WORSTER RESERVOIR
NORTH FORK CACHE LA POUDRE RIVER
HALLIGAN RESERVOIR
BOX ELDER CREEK
CHEYENNE, WY.
WILSON SUPPLY DITCH
COLUMBINE DITCH
BOB CREEK DITCH
LONE PINE CREEK
RED FEATHER LAKES
LIVERMORE
NORTHERN COLORADO WATER CONSERVANCY DISTRICT
KINIKINIK
IDYLWILDE
RUSTIC
CACHE LA POUDRE RIVER
SEAMAN RESERVOIR
POUDRE PARK
WELLINGTON
NUNN
LARAMIE-POUDRE TUNNEL
TED'S PLACE
LA PORTE
PIERCE
SKYLINE DITCH
SOUTH FORK CACHE LA POUDRE RIVER
CHAMBERS LAKE
COMANCHE RESERVOIR
AULT
ROOSEVELT NATIONAL FOREST
Rocky Mountain National Park
HORSETOOTH RESERVOIR
FORT COLLINS
TIMNATH
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UNION PACIFIC R.R.
CAMERON PASS DITCH
MICHIGAN DITCH
LONG DRAW RESERVOIR
COLORADO BIG THOMPSON
COLORADO SOUTHERN RR
WINDSOR
GRAND RIVER DITCH
LARIMER CO
WELD CO
LOVELAND
GREELEY
DENVER
SOUTH PLATTE RIVER
R 76 W
R 75 W
R 74 W
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R 72 W
R 71 W
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R 69 W
R 68 W
R 67 W
R 66 W
R 65 W
T 12 N
T 11 N
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KEY MAP
WYOMING
CACHE LA POUDRE BASIN
DENVER
COLORADO
SEGMENT NO. CLASSIFICATION
1 High quality, Class 1
2-6, 9, 14 Recreation, Class 1; Cold Water Aquatic Life, Class 1; Water Supply; Agriculture
7 Recreation, Class 2; Cold Water Aquatic Life, Class 2; Water Supply; Agriculture
8, 11-13 Recreation, Class 2; Cold Water Aquatic Life, Class 2; Agriculture
10 Recreation, Class 1; Cold Water Aquatic Life, Class 2; Water Supply; Agriculture
15 Recreation, Class 2; Cold Water Aquatic Life, Class 1; Water Supply; Agriculture
16 Recreation, Class 2; Warm Water Aquatic, Class 1; Agriculture
LEGEND
HIGHWAYS
25 Interstate
183 U.S.
14 State
RAILROADS
RIVERS
MUNCIPALITIES
BOUNDARIES
Cache la Poudre Basin
National Forest
County Line
Town and Range Lines
Northern Colorado Water Conservancy District
Transbasin Diversion
N
0 5 10
Scale (miles)
COLORADO WATER RESOURCES AND POWER DEVELOPMENT AUTHORITY
CACHE LA POUDRE BASIN STUDY
WATER QUALITY SEGMENTS
HARZA ENGINEERING COMPANY
Browne, Bortz & Coddington • M.W. Bittinger • Tom Pitts & Associates
Leonard Rice Consulting Water Engineers, Inc.
DATE 9/13/85
FIGURE 8.16

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GLOSSARY AND ABBREVIATIONS

A

absolute water right - A water right that has been perfected and placed to beneficial use.

abutment - The support at the end of a dam, arch or bridge.

acre - A measure of area; equivalent to 43,560 square feet.

acre-foot (af) - The volume of water, equal to the quantity required to cover an acre of land to a depth of 1 foot, equivalent to 43,560 cubic feet or about 326,000 gallons. An acre-foot of water can supply the water needs of a typical family of four for about one year.

acre-feet per year (af/yr) - The flow rate of water equal to 0.00138 cubic feet per second for one year.

adjudication - A judicial proceeding in which a priority is assigned to an appropriation and a decree issued defining the water right.

afterbay - A channel, short stretch of stream, or small reservoir conducting water away from a water turbine or into which a hydropower plant discharges.

alluvium - Clay, silt, sand, gravel, or detritus material deposited by running water.

amphibolite - Metamorphic rock formed by metamorphism of basalt and rocks of similar composition.

appropriation - The volume or flow of water that is legally allocated to an individual, municipality, corporation, or government entity for an identified beneficial use.

aquifer - A geologic formation that contains sufficient saturated permeable material to yield water to wells and springs.

arable land - Fit for or cultivated by farming. Land which, when properly prepared for agriculture, will have a sufficient yield to justify its development.

artificial recharge - The addition of water to the ground water reservoir by activities of man, such as irrigation or induced infiltration from streams, wells, or spreading basins.

augmentation - Enlarging or increasing the quantity of an item such as increasing the flow of a stream or river.

augmentation plan - A requirement of the 1969 Water Right Determination and Administration Act covering tributary ground water. An augmentation plan allows each well owner to provide replacement (augmentation) water to the stream at times when a senior right would be "calling out" his well.

average flow - The arithmetic mean of flow rates over a period of time, usually one year.

B

basalt - A dark, fine-grained extrusive rock composed primarily of feldspar and pyroxene.

base load capacity - A constant load over a period in time.

basement - The rock complex generally consisting of igneous and metamorphic rocks. Where not exposed, overlain unconformably by sedimentary strata. The crystalline crest of the earth.

basin - The drainage or catchment area of a stream or lake.

basin rank - A number used in Colorado by the State Engineer in the tabulation of decreed water rights to indicate the relative standing of a decreed right with respect to all other decreed rights within a water division.

bedrock - Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

beneficial use - The use of that amount of water that is reasonable and appropriate under reasonable efficient practices to accomplish, without waste, the purpose for which the diversion is lawfully made and without limiting the generality of the foregoing, shall include impoundment of water for recreational purposes, including fishery or wildlife.

benefits (economic) - The increase in economic value produced by the addition of a project, typically represented as a time stream of value produced by the generation of consumable resources.

biotite - A complex silicate of potassium, iron, aluminum and magnesium.

brecciated - Highly angular and coarse rock components.

C

calibration - Usually a trial and error procedure of adjusting simulation model coefficients such that results from the model provide a reflection of the actual system.

call - The placing of a request by a senior priority to the Water Commissioner to shut down junior priorities so that the senior is able to divert its full entitlement. In such cases, junior priorities are curtailed or "called out."

capability - The potential to produce resources, supply goods and services, and allow resource uses under a given level of management intensity and assumed set of management practices.

capacity - The power output or load that a turbine-generator, station, or system is capable of producing.

capacity value - That part of the market value of electric power that is assigned to dependable capacity.

compact - A contract between states of the Union, entered into with the consent of the National Government, and in water, defining the relative rights of two or more states on an interstate stream to use the waters of that stream.

conditional decree - A decree of the court awarding a priority date of appropriation to use water even though actual taking and use of the water is delayed until a future time, usually until a project is constructed.

conditional water right - A right to perfect a water right with a certain priority upon the completion with reasonable diligence of the appropriation upon which such water right is based.

conduit - A channel for conveying water or fluid.

conglomerate - A cemented elastic rock containing gravel- or pebble-sized rounded fragments.

conservation storage - Storage of water for later release for useful purposes such as municipal water supply, power, or irrigation in contrast with storage capacity used for flood control.

consumptive use - The amount of water consumed during use of the water and no longer available to the stream system. For irrigation, consumptive use is water used by crops in transpiration and building of plant tissue.

conveyance - The act of transporting (e.g., water is conveyed in a pipeline, canal, or tunnel).

conveyance loss - The loss of water from a conduit or open channel due to leakage, seepage, evaporation or evapotranspiration.

correlation - The process of establishing a relation between a variable and one or more related variables. Correlation is simple if there is only one independent variable; multiple, if there is more than one independent variable. For gaging station records, the usual variables are the short-term gaging station record and one or more long-term gaging station records.

costs (economic) - The stream of value required to produce the desired product. In water resources projects this is often the construction cost required to develop the resource, and the engineering and administration, and operation, maintenance and replacement costs required to continue the project in service.

cost effective - The least cost method of achieving a specified output or objective.

Creager's C - A coefficient characteristic, such as the determined value of an enveloping curve, used in flood study analysis that will give an estimate of the maximum flood from a given drainage basin.

crest - The top line or peak of a dam or hill.

Cretaceous Period - The third and latest of the periods included in the Mesozoic Era. Approximately from 65 to 135 million years ago.

crop irrigation requirement - The amount of water required at the farm field level to supplement natural precipitation in satisfying the crops consumptive use.

cubic feet per second (cfs) - A measure of a moving volume of water at the flow rate of water equal to 724 acre-feet per year or 449 gallons per minute.

cultural resource - A building, site, district, structure, or object significant in history, architecture, archaeology, culture or science.

crystalline - Of or pertaining to the nature of a crystal, having regular molecular structure.

D

dead storage - The volume in a reservoir below the lowest controlable level. Not susceptible to gravity release.

decree - An official document issued by the Court defining the priority, amount, use, and location of a water right or plan of augmentation. When issued, the decree serves as a mandate to the State Engineer to administer the water rights involved.

deep percolation - The drainage of soil water by gravity below the maximum effective depth of the root zone.

delivery efficiency - The volume of water delivered to the farm divided by the volume diverted from the source. Both conveyance losses and storage losses are subtracted from the source waters in deriving the farm deliveries.

depletion - Net rate or quantity of water taken from a stream or ground water aquifer and consumed by beneficial and non-beneficial uses. For irrigation or municipal uses, the depletion is the headgate or well-head diversion less return flow to the same stream or ground water aquifer.

developed recreation site - A land allocation designation for environments that have been substantially modified for campgrounds, ski areas, etc.

developed water - Water so situated that it would not, but for man's actions, contribute materially to either a natural stream or to a non-tributary ground water, but is placed under control of man by some such artificial works as a mine or a tunnel.

direct diversion - the diversion of water from a natural flowing stream.

direct flow right - A right defined in terms of discharge and which must be put to use more or less promptly following diversion from the source.

discharge, or rate of flow - The volume of water passing a particular point in a unit of time. Units of discharge commonly used include cubic feet per second (cfs) and gallons per minute (gpm).

discounting - The process of finding the present value of a series of future cash flows, opposite of compounding.

ditch (or canal) - A trench cut into the surface of the ground to transport water from a stream to a point of use away from the stream.

diversion - (1) The act of taking of water from a stream or other body of water into a canal, pipe or other conduit. (2) A man-made structure for taking water from a stream or other body of water.

diversion dam - A barrier across a stream built to turn all or some of the water into a diversion channel or conduit.

diversion records - Record of the daily flow in cubic feet per second for a ditch or other diversion structure. Compiled by the District Water Commissioner, ditch rider or other water official, diversion records are generally on file and available for review at the State Engineer's Office.

divert - To remove water from its natural course or location, or to control water in its natural course or location, by means of a ditch, canal, flume, reservoir, bypass, pipeline, conduit, well, pump, or other structure or device.

drainage area - The drainage area of a stream at a specified location is that area, measured in a horizontal plane, which is enclosed by a drainage divide. It is expressed in acres, square miles or other units of area.

drainage basin - A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

drawdown - The decrease in elevation of a lake, reservoir, or aquifer due to a release or discharge from the lake or reservoir or by pumping from the aquifer.

drought - There is no universally accepted quantitative definition of drought; generally, each investigator establishes his own definition. For the Cache la Poudre Basin Study, drought was defined as a year or series of consecutive years with below average runoff.

dryland farming - Growing of crops without the aid of additional water through irrigation.

E

Eastern Slope - That portion of Colorado lying east of the Continental Divide.

effective precipitation - The amount of rain that falls during the growing season and is available for growth of crops. Effective precipitation is a portion of the total precipitation that falls during the growing season and is a function of the type of soil, the time period in which each rain falls, and its intensity. Thus, effective precipitation usually is less than precipitation measured at a given point.

electric system - The physically connected generation, transmission, distribution, and other facilities operated as an integral unit under a control, management, or operating supervision.

endangered species - Life forms found on the U.S. Department of the Interior's list and published in the Federal Register. Their presence on the list implies their continued existence as a species is questionable.

energy - The capacity for performing work. The electrical energy term generally used is kilowatt-hours and represents power (kilowatts) operating for some time period (hours).

energy costs - The variable costs associated with production of electrical energy, representing the cost of fuel and most operation, maintenance, and replacement expenses.

enlargement - A subsequent right awarded to a ditch or structure enlarging the amount granted originally. More than one enlargement may be awarded to a ditch or structure and each enlargement will have a priority related to the date it was appropriated and applied to beneficial use. Enlargements may be absolute or conditional.

environment - All the conditions, circumstances, and influences surrounding and affecting the development of an organism or group of organisms.

environmental analysis - An analysis of alternative actions and their predictable short- and long-term environmental effects.

erosion - The group of processes whereby earth or rock material is loosened or dissolved and removed from any part of the earth's surface.

evaporation - The physical process by which a liquid or solid is transformed to the gaseous state which in irrigation usually is restricted to the change of water from liquid to gas.

evapotranspiration - The combined processes by which water is transferred from the earth surface to the atmosphere; evaporation of liquid or solid water plus transpiration from plants (see consumptive use).

exchange - A formal or informal agreement between owners of water rights to allow flexibility in the use of water. An example would be releasing reservoir storage water to a calling ditch, rather than decreasing the upstream diversion. There are many methods which have been devised by water users to exchange water rights.

existing reservoir - A reservoir that was created by the construction of an embankment.

F

farm headgate irrigation efficiency - The volume of water consumed by crops divided by the volume of water delivered to the farm.

fault - a fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

feasibility study - An investigation performed to formulate a project and definitively assess its desirability for implementation.

Federal Energy Regulatory Commission (FERC) - an agency in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy.

firm water supply (or yield) - An assured minimum supply of water (or yield) under the most adverse water year supply conditions.

firm energy - The energy generation ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified for a particular system load.

flood - (1) An overflow or inundation that comes from a river or other body of water and causes or threatens damage. (2) Any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. (3) A relatively high flow as measured by either gage height or discharge quantity.

forebay - The upper water impoundment or reservoir from which water is discharged to a hydroelectric generating plant.

freeboard - Represents the vertical distance between the maximum elevation reached in routing of the spillway design flood and the top of the dam.

G

gage - (1) An instrument used to measure magnitude or position; gages may be used to measure the elevation of a water surface, the velocity of flowing water, the pressure of water, the amount of intensity of precipitation, the depth of snowfall, etc. (2) The act or operation of registering or measuring magnitude or position. (3) The operation, including both field and office work, of measuring the discharge of a stream of water in a waterway.

gage height - The height of the water surface above the gage datum. Gage height is often used interchangeably with the more general term, "stage," although gage height is more appropriate when used with a gage reading.

gaging station - A particular site on a stream, canal, lake or reservoir where systematic observations of gage height or discharge are made.

generator - A machine that converts mechanical energy into electrical energy.

geographical - Pertaining to the surface of the earth, including its form, development, and the phenomena that take place thereon.

geological - Of, or pertaining to the science which deals with the earth, the rocks of which it is composed, and the changes which it has undergone.

geomorphology - The branch of both physiography and geology which deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of landforms.

gigawatt-hours (GWh) - One million kilowatt-hours.

glaciation - Alteration of the earth's solid surface through erosion and deposition by glacial ice.

gneiss - A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.

graben - A block, generally long compared to its width, that has been downthrown along faults relative to the rocks on either side.

granite - Quartz-bearing igneous rock characterized by granular texture and having feldspar as the chief mineral.

granodiorite - Close relative of granite.

gross head - The gross difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric power plant, under specified conditions.

ground water - For administrative purposes, ground water is usually defined as any water not visible on the surface of the ground under natural conditions.

ground water outflow - The part of the discharge from a drainage basin that occurs through the ground water. The term "under-flow" is often used to describe the ground-water outflow that takes place in valley alluvium (instead of the surface channel) and thus is not measured at a gaging station.

ground water recharge - Inflow to a ground water reservoir.

ground water reservoir - An aquifer or aquifer system in which ground water is stored. The water may be placed in the aquifer by either artificial or natural means.

H

headgate - A physical structure on a stream through which water is diverted into a ditch.

head losses - Reductions to the gross difference in elevation between water surfaces upstream and downstream from a hydroelectric power plant due to friction of the flow of water through a penstock or conduit and changes in direction or velocity of the flow.

headwaters - Source of water in a stream.

headworks - Structure at the head of a channel or conduit for diverting water into the channel.

historic use - The documented diversion and use of water by a water right holder over a period of years.

hogback - A ridge produced by highly tilted strata.

horst - A block of the earth's crust, generally long compared to its width, that has been uplifted along faults relative to the rocks on either side.

hydroelectric plant or hydropower plant - An electric power plant in which the turbine-generators are driven by falling water.

hydrology - The science dealing with water on the land, its properties, laws, and geographic distribution.

hydrologic study period - A period of time specified for the selection of data for analysis. The base period should be sufficiently long to contain data representative of the averages and deviations of the averages that must be expected in other periods of similar and greater length. As an example, the U.S. Weather Bureau computes values of average, heavy, and light monthly precipitation from data observed during the base period 1931-1960. For ground-water studies, the base period should begin and also end at the conclusion of a dry trend so that the difference between the amount of water in transit in the soil at the ends of the base period is minimal.

I

igneous - rocks formed by solidification from a molten or partially molten state.

impervious - An adjective describing a material through which water either cannot pass or through which it passes with great difficulty.

infiltration - Water moving into the ground from a surface supply such as precipitation or irrigation.

installed capacity - The total of the capacities shown on the nameplates of the generating units in a power plant.

instream flows - A prescribed level(s) of streamflow, usually expressed as a stipulation in a permit authorizing a dam or water diversion, which can be met with bypass flows.

intrusion - A body of plastic solid or magmatic igneous rock that is emplaced within older rock.

inundate - To flood or cover with water.

irrigable land - Arable land for which a water supply is available.

irrigation - The application of water to crops, lawns, and gardens by artificial means to supplement natural precipitation. Water can be applied by spreading over the ground, by sprinkling, or dripping.

irrigation system efficiency - The ratio of the volume of water consumed by crops divided by the volume of water diverted from the source.

irrigation return flow - Applied water which is not consumptively used and returns to a surface water or ground water supply. In water right litigation, the definition may be restricted to measurable water returning to the stream from which it was derived.

irrigation water requirement - The quantity of water, exclusive of effective precipitation, that is required for various beneficial uses.

isohyet - A line on the surface of the earth, as represented on a map, connecting all points of equal precipitation. Also called "isohyetal line" and "isopluvial line."

J

joint - Fracture in rock, generally vertical or transverse to bedding, along which no appreciable movement has occurred.

joint use storage (or capacity) - That storage (or capacity) which is shared by more than one use on a time (or some other priority) basis.

K

kilowatt (kW) - one thousand watts.

kilowatt-hour (kWh) - The amount of electric energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

L

lateral - A minor ditch headgating off the main ditch used to direct water onto the land. A ditch may have many laterals, depending on the amount of acreage irrigated, the slope of the land, and the rate of seepage losses.

load - The amount of power needed to be delivered at a given point in an electric system.

load factor - The ratio of the average load during a designated period to the peak or maximum load occurring in that period.

loss - The difference between the amount of water that is actually placed on the land and the amount of water that was physically diverted to the headgate. Losses usually are from seepage and evaporation.

M

market value - The value of power at the load center as measured by the cost of producing and delivering equivalent alternative power to the market.

mean annual flow - The average or yearly flow of a stream.

megawatt (MW) - One thousand kilowatts.

megawatt-hour (MWh) - One thousand kilowatt-hours.

metamorphic rock - Includes all those rocks which have formed in the solid state in response to pronounced changes of temperature, pressure, and chemical environment.

mitigate - To lessen the severity.

N

natural flow - The rate of water movement past a specified point on a natural stream from a drainage area for which there have been no effects caused by stream diversion, storage, import, export, return flow or change in consumptive use caused by man-controlled modifications to land use. Natural flow rarely occurs in a developed country.

net benefits - The result of subtracting total costs from total benefits.

net head - The adjusted gross head on a power plant, accounting for reductions due to head losses.

non-consumptive use - A use of water that does not reduce the supply, such as for hunting, fishing, boating, water-skiing, and swimming.

non-tributary ground water - Water that is not part of a natural stream as established through geologic and hydrologic facts. The factual determination of "non-tributary" usually involves the length of time the impact of withdrawal would take to reach the stream and the amount of impact relative to the total volume of surface flow impacted.

O

observation well - A non-pumping well used for observing the elevation of the water table or the piezometric surface.

out-of-priority storage option - The ability to store water before one has the right according to his court decree to do so.

overburden - Material of any nature, consolidated or unconsolidated, that overlies a rock unit of interest.

P

Paleozoic - One of the eras of geologic time. Approximately from 225 to 570 million years ago.

pan evaporation - The depth of water evaporation for a pan of standard dimensions over a specified time period, normally expressed as inches per unit of time.

pasture - Land that is currently improved for grazing by irrigation or other means.

peaking capacity - That part of a system's generating capacity which is operating during the hours of highest power demand within the system.

peak load - The maximum load in a stated period of time.

pediments - Areas along the face of the uplifted mountain ranges, which are generally relatively gently sloping and which have been formed by several factors including sheet erosion and deposition, stream braiding, etc. The general slope of these areas is governed by the slope and erodability of the underlying bedrock formations.

Pennsylvanian - The sixth of seven periods in the Paleozoic Era. Approximately from 280 to 320 million years ago.

permeability - A term used to describe the ability of water or other liquid to move through a porous formation under the action of a gradient. The facility with which a fluid will move through a formation is greater for some than for others. For a given bed, the permeability is expressed by a constant K representing the flow through unit area, in unit time under the influence of a unit gradient.

permeable material - That which allows water to pass through easily.

Permian - The last of seven periods in the Paleozoic Era. Approximately from 225 to 280 million years ago.

phreatophyte - A water-loving plant which consumes a substantial amount of water without corresponding benefits to mankind, such as cottonwood trees or salt cedars.

physiography - The study of the genesis and evolution of land forms.

piedmont - Lying or formed at the base of mountains.

plant factor - Ratio of the average load to the installed capacity of the plant, usually expressed as an annual percentage.

plateau - A relatively elevated area of comparatively flat land which is commonly limited on at least one side by an abrupt descent to lower land.

Pleistocene - The earlier of the two epochs in the Quarternary Period. Approximately from 0.1 to 2 million years ago.

power (electric) - The rate of generation or use of electric energy, usually measured in kilowatts.

Precambrian - All rocks formed before the Cambrian Period. Approximately from 570 million years ago to the formation of the earth.

precipitation - The discharge of water, in liquid or solid state, out of the atmosphere.

prefeasibility study - An investigation performed to evaluate available resources and to define alternative resource development options so that the best plan of development can be identified.

present worth - The value today of a future dollar or stream of dollars, discounted at the appropriate rate.

priority - The relative seniority of a water right as determined by its adjudication date and appropriation date. In some cases, other factors are also involved in determining priority. The priority of a water right determines its ability to divert in relation to other rights in periods of limited supply.

probable maximum flood (PMF) - The estimated flood that would result if all factors that contribute to a flood were to reach the most critical combination of values that could occur simultaneously.

R

rate of return(on investment) - The interest rate at which the present worth of annual benefits equals the present worth of annual costs.

recreation visitor days - Twelve visitor hours, which may be aggregated continuously, intermittently or simultaneously by one or more persons.

reliability council - One of nine regions in which power suppliers coordinate their output to prevent electrical power shortage.

reservoir - A pond, lake, or basin, either natural or artificial, used for the storage, regulation, and control of water.

return flow - Unconsumed water which returns to its source or some other water body after its diversion as surface water or its extraction from the ground.

return period - In statistical analysis of hydrologic data, assuming that observations are equally spaced in time, and, choosing the interval between two successive observations as unit of time, return period is the reciprocal of 1 minus the probability of a value equal to or less than a certain value. Where the interval between observations is a year, a return period of 100 years for example means that, on the average, in the long run, not more often than once in 100 years is an event of this magnitude, or greater, expected to occur.

reuse - Subsequent use of imported water, by the importer, for the same purpose as the original use. An example would be the treatment of sewage water to result in potable water to be recycled into the raw water system.

revenue bond - Project funding, repayment for which is strictly dependent on the income from the project to meet the interest and principal payments.

Richter scale - The range of numerical values of earthquake magnitude.

roller compacted concrete (RCC) dam - A dam consisting essentially of an inner or enclosed low cement content concrete mixture which is compacted within a pre-formed higher cement content concrete shell.

run-of-the-river (plant/hydroelectric generation) - A power plant that uses natural flows or flows released for other purposes to generate power.

S

sandstone - A cemented or otherwise compacted detrital sediment composed predominantly of sand-sized quartz grains.

saturated thickness - The thickness of an aquifer in which the void space is filled with water.

schist - A medium or coarse-grained metamorphic rock with subparallel orientation of the micaceous minerals which dominate its composition.

sediment - Solid material, both mineral and organic, that in suspension has been transported from its site of origin by air, water, or ice.

sedimentary rocks - Rocks formed by the accumulation and compaction of sediment in water or from air.

sedimentation - The process of subsidence and deposition of suspended matter carried by water, sewage or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material.

sediment storage - The volume of a reservoir set aside to store incoming sediments that are deposited in the reservoir over the useful life of the project.

seepage - (1) The slow movement of water through small cracks, pores, interstices, etc., of a material into or out of a body of surface or subsurface water. (2) The loss of water by infiltration into the soil from a canal, reservoir, or other body of water, or from a field. Seepage is generally expressed as flow volume per unit time.

seismic - Pertaining to an earthquake or earth vibration.

seismicity - The phenomenon of earth movements or seismic activity.

shale - A laminated sediment in which the constituent particles are predominantly of the clay grade.

shear zone - A zone in which shearing has occurred on a large scale so that the rock is crushed and brecciated.

siltstone - Shale comprised of silt-sized grains.

spillway - Overflow channel of a dam.

stochastic procedure - A procedure involving chance or probability: probabilistic.

storable flow - The portion of river inflow to a reservoir legally available for storage in the reservoir after considering all senior water rights and diversions both upstream and downstream.

storage decree - A decree of the court allowing the storage of water, usually in a reservoir.

storage right - A right defined in terms of the volume of the water which may be diverted from the flow of the stream and stored in a reservoir or lake to be released and used at a later time either within the same year or a subsequent year.

stream - A general term for a body of flowing water. In hydrology the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term streamgaging, it is applied to the water flowing in any channel, natural or artificial.

Relation to Time

- Ephemeral - One that flows only in direct response to precipitation, and whose channel is at all times above the water table.
- Intermittent or Seasonal - One which flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in the mountainous areas.
- Perennial - One which flows continuously.

Relation to Ground Water

- Gaining - A stream or reach of a stream that receives water from the zone of saturation.
- Insulated - A stream or reach of a stream that neither contributes water to the zone of saturation nor receives water from it. It is separated from the zones of saturation by an impermeable bed.
- Perched - A perched stream is either a losing stream or an insulated stream that is separated from the underlying ground water by a zone of aeration.

strike (geology) - A line formed by the intersection of a horizontal plane and a geologic stratum.

strike slip - The component of the movement parallel with the fault strike.

supplemental irrigation water - Additional water applied to irrigate crops over and above that historically or normally used, which could be beneficially used to increase the crop yield or to support growing higher value crops.

surcharge - Reservoir storage designed to accommodate a sudden increase in the flow of water into a reservoir.

switchyard - An area, usually fenced, containing equipment for routing the flow of electrical power.

T

tailrace - A channel for conveying discharged water from a hydroelectric power plant.

tailwater level - Water level in the channel below or downstream from a powerhouse or water control structure.

terrace - A relatively flat, horizontal, or gently inclined surface, sometimes long and narrow, which is bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.

Tertiary - The earlier of two geologic periods within the Cenozoic Era. Approximately from 2 to 65 million years ago.

thermal plant - A generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, or use nuclear energy to produce thermal energy.

topographic - Of, relating to, or concerned with the configuration of the earth's surface including its relief and the position of its natural and man-made features.

topography - The physical features of a district or region, especially the relief and contour of the land.

total consumptive use - The amount of water, regardless of its source, used by the crops during the growing season. It is the amount of water that is physically removed from the stream's system and is not available for other users on the stream.

trans-basin diversion - The removal of the water of a natural stream from its natural basin into the natural basin of another stream.

transfer - The process of moving a water right originally decreed to one ditch, to another ditch, by court decree. A transferred water right generally retains its priority in the stream system and may or may not retain its right to divert its entire decreed amount.

transmission - The act or process of transporting electric energy in bulk.

transmission line - A facility for transmitting electrical energy at high voltage from one point ot another point. Transmission line voltages are normally 115 kV or larger.

transmountain - The crossing or extending over or through a mountain.

tributary - Any stream which contributes water to another stream.

tributary ground water - Seepage, underflow, and percolating water that will eventually become part of the natural stream. A natural stream's waters include water in the unconsolidated alluvial aquifer of sand, gravel and other sedimentary materials, and all other waters hydraulically connected thereto, which can influence the rate or direction of movement of the water in that alluvial aquifer or natural stream. In Colorado, all ground water is presumed to be tributary unless proved otherwise.

tundra - A level or undulating treeless plain characteristic of the arctic regions.

turbine - The part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

V

virgin flow (or native flow) - The flow of a river that would occur in the absence of human activities.

visit - A significant amount of time spent by one individual at a particular recreation facility during a 24-hour period.

visitor-day - Consists of 12 visitor hours which may be aggregated continuously, intermittently, or simultaneously by one or more persons at a recreation facility.

W

water development - The process of building diversion, storage, pumping and/or conveyance facilities to apply water to beneficial use.

water right - A right to use, in accordance with its priority, a certain portion of the waters of the State by reason of the appropriation of the same.

water level - The height of water in a reservoir, well, or aquifer.

watershed - The whole region or area contributing to the water supply of a river or lake.

water supply, basin - For the Cache la Poudre Basin Study, basin water supply is defined as that quantity of surface and ground water which could be made available for all users in the basin. This quantity would include transbasin diversions, natural flow, ground water, and the reuse of these waters.

water table - The upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

water year - The 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1959, is the "1959 water year."

water yield (or yield) - The quantity of water expressed either as a continuous rate of flow (i.e., cubic feet per second) or as a volume per unit of time (i.e., acre-feet per year), which can be collected for a given use or uses from surface or ground water sources in a watershed. The yield may vary with the use proposed, with the plan of development, and also with economic considerations. (2) Total runoff. (3) The streamflow in a given interval of time derived from a unit area of watershed. It is determined by dividing the observed streamflow at a given location by the drainage area above that location and is usually expressed in cubic feet per second per square mile.

watt - The rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.

weathering - The group of processes, such as the chemical action of air and rain water and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

Western Slope - That portion of Colorado lying west of the Continental Divide.

wheeling - Transportation of electricity by a utility over its lines for another utility; also includes the receipt from and delivery to another system of like amount but not necessarily the same energy.

wilderness - Under the 1964 Wilderness Act, wilderness is undeveloped Federal land retaining its primeval character and influence without permanent improvements or human habitation. It is protected and managed so as to preserve its natural conditions which: 1) generally appear to have been affected primarily by the forces of nature with the imprint of man's activity substantially unnoticeable, 2) has outstanding opportunities for solitude or a primitive and confirmed type of recreation, 3) has at least 5,000 acres or is of sufficient size to make practical its preservation, enjoyment, and use in an unimpaired condition, and 4) may contain features of scientific, educational, scenic, or historical value as well as ecologic and geologic interest.

ABBREVIATIONS AND ACRONYMS

af - acre-feet
ASAU - All sources/all uses (demand)
Authority - Colorado Water Resources and Power Development Authority
BLM - Bureau of Land Management
C-BT - Colorado-Big Thompson Project
CCWCD - Central Colorado Water Conservancy District
CDLG - Colorado Division of Local Government
CDOW - Colorado Division of Wildlife
CDPOR - Colorado Division of Parks and Outdoor Recreation
cfs - cubic feet per second
CLRS - Colorado Livestock Reporting Service
CLPWUA - Cache la Poudre Water Users Association
COE - U.S. Army Corps of Engineers
CSU - Colorado State University
CWCB - Colorado Water Conservation Board
CWQCC - Colorado Water Quality Control Commission
ELCO - East Larimer County Water District
Elevation - El.
Feet - ft
FERC - Federal Energy Regulatory Commission
GASP - Ground Water Appropriators of the South Platte River Basin, Inc.
gpd - gallons per day
gpm - gallons per minute
GWh - gigawatt hours, equivalent to 1,000 MWh
kV - kilovolt
kW - kilowatts, equivalent to 1000 watts
kWh - kilowatt-hour
LWRCOG - Larimer and Weld Regional Council of Governments
M&I - Municipal and Industrial
mgd - million gallons per day
MSL - mean sea level
MW - megawatts, equivalent to 1,000,000 watts (capacity term)
MWh - megawatt hours (energy term)
NCWCD - Northern Colorado Water Conservancy District (also the Northern District)
NCWA - Northern Colorado Water Users Association
NPIC - North Poudre Irrigation Company
NEPA - National Environmental Policy Act
NOAA - National Oceanic and Atmospheric Administration
OM&R - Operation, Maintenance, and Replacement
PMF - Probable Maximum Flood
PMP - Probable Maximum Precipitation
POS - Plan of Study
PRPA - Platte River Power Authority
RIBSIM - River Basin Simulation Model
sq. mi. - square miles
SWA - State Wildlife Area
UNC - University of Northern Colorado

U.S. BEA - U.S. Bureau of Economic Analysis
USBR - United States Bureau of Reclamation
USGS - United States Geological Survey
WSS - Water Supply and Storage Company
yr - year

Appendix A

Streamflow and Transbasin Diversion Data

APPENDIX A

STREAMFLOW AND TRANSBASIN DIVERSION DATA

This appendix contains records of gaged flows at streamgaging stations within the Basin and at points of transbasin diversions into the Basin. It also contains tabulations of estimated native flows of the Cache la Poudre River at the mouth of the Canyon and the North Fork near Livermore and pumpage estimates from aquifers of the lower basin. The records are provided in the form of the tables organized as follows:

Table No.	Title
Streamflow Records by Month for the Following Stations:	
A.1	North Fork Near Livermore
A.2	South Fork Near Rustic
A.3	Cache la Poudre Near Rustic
A.4	Fall Creek Near Rustic
A.5	Little Beaver Creek Near Idylwilde
A.6	Little Beaver Creek Near Rustic
A.7	Cache la Poudre at Canyon Mouth
A.8	Cache la Poudre at Fort Collins
A.9	Cache la Poudre Near Greeley
Native Flow Estimates by Month For:	
A.10	Cache la Poudre River at Mouth of Canyon
A.11	North Fork Near Livermore
Transbasin Imports by Month For:	
A.12	Cameron Pass Ditch
A.13	Michigan Ditch
A.14	Wilson Supply Ditch
A.15	Columbine Ditch and Bob Creek Ditch
A.16	Laramie-Poudre Tunnel

Table No.	Title
A.17	Skyline Ditch
A.18	Grand River Ditch
A.19	Colorado-Big Thompson Project

Pumping Estimates:

A.20	Estimate of Annual Pumping of Ground Water Tributary to Cache la Poudre River Above Greeley
A.21	Estimate of Annual Pumping of Ground Water Tributary to Cache la Poudre or South Platte River Below Greeley Gage

TABLE A.1

NORTH FORK CACHE LA POUDRE RIVER NEAR LIVERMORE, CO

USGS GAGE 6751500 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	296	383	887	4160	14000	9070	708	4580	830	775	669	673	37031
1952	586	489	472	3890	12390	7220	512	380	354	787	757	394	28231
1953	432	397	503	717	1430	1130	559	410	209	964	976	639	8366
1954	661	569	589	493	172	72	44	300	1300	507	273	187	5167
1955	150	196	328	245	34	197	81	220	17	110	418	316	2312
1956	239	239	368	459	5440	1810	416	356	256	444	376	271	10674
1957	196	207	271	3680	26390	26120	2400	785	466	1590	569	471	63145
1958	280	293	550	7880	32130	5100	837	437	375	1020	690	570	50162
1959	487	1290	1960	9730	25660	7480	619	388	359	854	1220	718	50765
1960	423	559	1500	2580	10990	4740	424	166	477	1210	387	278	23734
1961	670	369	1210	4580	42630	27810	3060	2110	2930	6380	629	1610	93988
1962	3090	3730	2240	7890	15690	10390	947	599	580	2360	527	585	48628
1963	345	1040	80	3240	694	516	162	202	711	1080	339	223	8632
1964	188	196	481	455	2680	4580	367	1480	486	8	279	289	11489
1965	240	38	272	253	2510	30890	4100	286	352	-1	-1	-1	38941
MINIMUM	150	38	80	245	34	72	44	166	17	8	273	187	2312
MAXIMUM	3090	3730	2240	9730	42630	30890	4100	4580	2930	6380	1220	1610	93988
AVERAGE	552	666	781	3350	12856	9142	1016	847	647	1292	579	516	32084

(-1) GAGE DISCONTINUED

TABLE A.2

SOUTH FORK CACHE LA POUDRE RIVER NEAR RUSTIC, CO

USGS GAGE 6748600 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1956	--	--	--	--	--	--	--	3590	1760	1120	875	651	7996
1957	605	613	756	1060	6340	27630	20990	6830	3310	1690	1060	801	71685
1958	680	680	766	1120	14910	18840	5810	4510	1580	928	859	553	51236
1959	430	389	536	934	4010	17630	6380	4190	1260	1210	920	492	38381
1960	369	288	476	938	5000	15920	7360	3530	1340	736	655	615	37227
1961	615	444	492	748	7610	23580	8260	5060	3990	2980	1180	1080	56039
1962	912	744	698	1940	8700	14960	9900	2860	1380	1170	893	738	44895
1963	430	417	461	821	5690	9080	4510	5350	2300	1290	829	439	31617
1964	354	346	493	889	6380	10760	7160	2940	1070	619	499	553	32063
1965	430	282	300	822	6040	28550	14760	6260	2410	1760	1190	833	63637
1966	522	298	423	863	4200	8340	4390	2450	1320	1150	652	443	25051
1967	302	310	469	831	3730	11570	8770	4290	2060	1650	1280	677	35939
1968	566	469	543	752	2540	14890	9910	3500	1470	922	604	547	36713
1969	618	439	480	895	9460	16270	9360	3640	3000	1500	1260	859	47781
1970	754	515	469	946	9750	24670	14090	6080	2410	1350	831	656	62521
1971	516	467	530	960	7290	23470	12100	6220	2820	1290	1080	762	57505
1972	611	466	611	1000	4400	15220	8380	3360	1840	1050	772	609	38319
1973	561	500	544	841	11180	21600	13870	7980	2360	1260	877	668	62241
1974	609	502	728	1930	10680	20040	9810	6820	1660	1370	1110	668	55927
1975	659	562	728	803	2730	15560	14770	7620	1600	916	610	522	47080
1976	512	457	559	1190	4960	9680	6630	4870	3060	1160	563	466	34107
1977	219	166	220	785	3270	5030	5050	3650	1250	978	750	661	22029
1978	479	399	474	968	5120	20710	11000	4090	3540	902	594	446	48772
1979	375	305	498	1660	6590	20020	12340	6510	4080	-1	-1	-1	52378
MINIMUM	219	166	220	748	2540	5030	4390	2450	1070	619	499	439	7996
MAXIMUM	912	744	766	1940	14910	28550	20990	7980	4080	2980	1280	1080	71685
AVERAGE	505	419	511	987	6274	16418	9400	4842	2203	1261	867	641	44214

(--) GAGE NOT IN OPERATION

(-1) GAGE DISCONTINUED

THIS STATION WAS DISCONTINUED IN SEPT. OF 1979.

TABLE A.3

CACHE LA POUDRE RIVER / NEAR RUSTIC ,COLORADO.

USGS GAGE 6747500 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1956	--	--	--	--	--	--	--	--	5640	1620	1120	1060	9440
1957	1060	869	823	1240	13940	100300	94840	27320	19170	2310	1510	1140	264522
1958	976	958	1050	1540	44970	78230	23040	13440	8390	3450	1040	944	178028
1959	865	712	887	1280	18730	87870	32410	17340	10430	2900	2080	1560	177064
1960	1170	988	1270	5430	34980	88100	33870	13970	9550	1900	1200	1130	193558
1961	1110	833	799	984	22460	70140	27200	18290	14150	7140	3630	3470	170206
1962	2210	1680	1590	9070	50390	66810	44880	19590	11160	2110	809	605	210904
1963	532	568	675	1810	30550	40250	19480	16080	9720	1830	1290	930	123715
1964	849	599	827	1130	34940	59080	35540	14690	6200	1930	867	849	157501
1965	837	700	833	1740	27770	81780	60430	24970	9600	4180	2350	1900	217090
1966	1290	859	1070	2020	33640	36200	17080	13030	10850	2310	932	841	120122
1967	754	668	742	1290	21560	70630	33830	13520	13330	6910	2550	1440	167224
1968	1010	916	1050	1230	13890	84630	40990	20890	7350	-1	-1	-1	171956
MINIMUM	532	568	675	984	13890	36200	17080	13030	5640	1620	809	605	9440
MAXIMUM	2210	1680	1590	9070	50390	100300	94840	27320	19170	7140	3630	3470	264522
AVERAGE	974	796	894	2213	26755	66463	35661	16395	10426	3216	1615	1322	166256

(--) GAGE NOT IN OPERATION
(-1) GAGE DISCONTINUED

NOTE: DATA COLLECTION ON THIS STATION WAS DISCONTINUED SEPTEMBER 1968.

TABLE A.4

FALL CREEK, RUSTIC COLORADO.

USGS GAGE 6748200 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1961	47	27	24	34	484	1730	910	680	468	347	156	89	4996
1962	58	41	35	141	566	1320	1190	519	200	101	48	29	4248
1963	16	21	23	35	708	1310	691	588	291	144	88	25	3940
1964	23	18	18	35	613	1150	1030	523	222	124	60	32	3848
1965	32	23	21	48	427	2450	1790	672	348	223	108	67	6209
1966	36	20	28	58	497	827	676	392	221	170	79	34	3038
1967	17	21	27	41	406	1510	1200	443	283	219	101	51	4319
1968	35	23	25	29	220	1770	978	553	200	106	60	45	4044
1969	38	25	26	44	856	1480	1040	525	277	173	89	48	4621
1970	24	21	22	21	628	2040	1610	798	361	201	95	66	5887
1971	47	33	26	52	316	2350	1360	622	407	180	83	27	5503
1972	13	7	16	42	558	1900	779	451	311	149	85	50	4361
1973	34	24	20	23	441	1740	1330	546	250	-1	-1	-1	4408
MINIMUM	13	7	16	21	220	827	676	392	200	101	48	25	3038
MAXIMUM	58	41	35	141	856	2450	1790	798	468	347	156	89	6209
AVERAGE	32	23	24	46	517	1660	1122	562	295	178	88	47	4571

(-1) GAGE DISCONTINUED

TABLE A.5

LITTLE BEAVER CREEK NEAR IDYLWIDE COLO.

USGS GAGE 6748500 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1961	5	3	2	1	21	450	171	59	35	41	37	23	848
1962	15	8	7	7	88	377	237	42	22	16	11	8	838
1963	5	3	3	3	122	213	72	41	28	22	16	11	539
1964	7	5	4	3	81	296	144	44	23	16	11	8	642
1965	5	4	4	4	16	485	303	65	32	35	31	25	1009
1966	17	12	9	7	99	219	78	31	19	16	11	7	525
1967	5	4	4	4	36	367	173	47	25	21	16	12	714
1968	9	7	7	5	8	430	164	52	27	20	14	11	754
1969	8	6	4	3	146	355	153	44	26	20	13	10	788
1970	7	6	5	5	68	587	310	53	26	22	16	14	1119
1971	12	9	8	10	23	563	283	58	30	22	16	13	1047
1972	5	3	2	2	29	221	47	17	11	16	11	9	373
1973	7	6	4	5	25	466	329	62	25	11	8	7	955
MINIMUM	5	3	2	1	8	213	47	17	11	11	8	7	373
MAXIMUM	17	12	9	10	146	587	329	65	35	41	37	25	1119
AVERAGE	8	6	5	5	59	387	190	47	25	21	16	12	781

THIS STATION WAS DISCONTINUED IN DEC.1973.

TABLE A.6

LITTLE BEAVER CREEK NEAR RUSTIC COLORADO.

USGS GAGE 674853 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1961	76	67	69	111	1080	3360	952	347	257	276	231	196	7022
1962	147	109	122	300	1300	1960	928	248	152	123	105	104	5598
1963	78	60	82	117	580	919	341	327	226	163	136	104	3133
1964	81	61	63	111	790	1410	560	217	126	125	83	101	3728
1965	84	64	64	134	771	4090	1550	431	251	248	168	130	7985
1966	108	87	104	120	538	856	370	213	141	132	116	94	2879
1967	74	72	74	102	467	1960	816	249	180	171	128	100	4393
1968	94	86	97	96	409	2710	764	302	161	165	123	119	5126
1969	111	72	80	142	1830	2180	881	245	159	133	142	116	6091
1970	102	71	74	124	1480	3230	1440	356	187	164	140	127	7495
1971	124	100	104	165	1040	4010	1570	372	245	219	159	115	8223
1972	96	85	95	143	871	2360	578	241	154	139	118	93	4973
1973	91	85	72	116	1600	3970	1630	357	156	219	159	115	8570
MINIMUM	74	60	63	96	409	856	341	213	126	123	83	93	2879
MAXIMUM	147	109	122	300	1830	4090	1630	431	257	276	231	196	8570
AVERAGE	97	78	85	137	981	2540	952	300	184	175	139	116	5786

TABLE A.7

CACHE LA POUDRE RIVER AT MOUTH OF CANYON , NEAR FORT COLLINS CO

USGS GAGE 6752000 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	1730	1780	2380	6950	62490	100800	69410	26930	16780	5410	3100	2620	300380
1952	2650	1640	2160	5960	48460	122500	39080	24580	15340	3680	2150	1670	269870
1953	2180	2250	2050	2890	20450	72440	27080	18150	7810	3420	1960	2030	162710
1954	1960	1570	1560	2950	25660	34470	15040	3760	5750	5020	1650	1060	100450
1955	1220	920	1240	1980	22080	60930	28190	15640	4360	3080	2310	2460	144410
1956	1710	1410	1930	3490	72790	87350	24540	11670	3230	2040	1220	1600	212980
1957	1290	1360	1440	7060	35530	136300	104600	20330	9720	5050	2720	2640	328040
1958	2110	2080	2690	10930	92800	96130	16260	4070	3260	3180	1880	2020	237410
1959	1650	2000	3070	12120	44150	103800	24810	10820	4070	4530	3750	1150	215920
1960	1070	770	3030	5550	50190	96750	27910	6540	4230	3000	1700	1550	202290
1961	2250	1650	2800	7880	70220	116800	31970	18770	11690	16210	6740	3220	290200
1962	3600	5710	5420	19160	68930	84900	45970	11310	2220	3780	2100	1760	254860
1963	1100	1040	760	4000	27300	37800	12230	11700	7380	3710	2120	980	110120
1964	830	850	1550	2300	35820	65840	31460	10820	4450	1850	1030	780	157580
1965	830	860	860	2530	32330	129700	77210	25500	7570	4010	1050	1310	283760
1966	1170	1220	1670	2820	29830	33360	9720	6240	5870	2850	1440	799	96989
1967	738	567	1090	1860	26300	75860	43390	7150	4180	1680	3280	2830	168925
1968	2210	2530	1940	2990	28840	102800	40920	20290	6720	2570	2160	1680	215650
1969	1170	1040	1640	6290	50520	74280	35650	6900	7480	4190	1880	891	191931
1970	872	617	1440	5570	59140	108800	55920	17230	6260	4770	4210	1870	266699
1971	1850	1350	1960	11640	62340	141700	56500	13340	9560	2480	4510	2180	309410
1972	1630	1820	2180	3970	36000	86010	25380	5180	6240	3890	2630	1590	176520
1973	1460	1450	2050	3470	89410	123400	65520	22890	3750	5210	6520	3090	328220
1974	2400	2940	5700	7270	78840	108100	39960	6570	4690	4740	2740	1380	265330
1975	810	740	1150	2100	18790	86830	78920	17250	5950	3240	1700	1670	219150
1976	1540	1410	1520	2300	27730	65040	27330	18980	3530	4590	1600	1010	156580
1977	916	849	1350	2970	12550	39170	10500	14160	3740	2460	2230	1630	92525
1978	1420	1280	1620	3910	36160	127800	66100	19680	5850	2860	1790	1300	269770
1979	1150	932	1460	5020	51250	123100	59420	34610	8780	3320	1810	2650	293502
1980	5560	4380	9140	32760	158700	142300	41410	16840	6210	5130	4290	3090	429810
MINIMUM	738	567	760	1860	12550	33360	9720	3760	2220	1680	1030	780	92525
MAXIMUM	5560	5710	9140	32760	158700	142300	104600	34610	16780	16210	6740	3220	429810
AVERAGE	1703	1634	2295	6356	49187	92835	41080	14930	6556	4065	2609	1817	225066

TABLE A.8

CACHE LA POUDRE RIVER AT FORT COLLINS

USGS GAGE 6752260 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1975	--	--	--	--	2340	41870	16080	2160	565	445	266	251	63977
1976	213	202	179	420	917	9920	10290	9810	1960	362	156	128	34557
1977	151	147	188	271	7150	12770	5380	2510	1040	151	106	118	29982
1978	141	125	212	188	6220	55360	11040	3020	1080	198	208	207	77999
1979	171	197	306	302	39260	82280	10380	2530	2060	912	2430	1110	141938
1980	5260	4740	8350	34560	167200	67360	6320	1270	638	2290	414	264	298666
MINIMUM	141	125	179	188	917	9920	5380	1270	565	151	106	118	29982
MAXIMUM	5260	4740	8350	34560	167200	82280	16080	9810	2060	2290	2430	1110	298666
AVERAGE	989	902	1539	5957	37181	44927	9915	3550	1224	726	597	346	107853

(--) GAGE NOT IN OPERATION

TABLE A.9

CACHE LA POUDRE RIVER NEAR GREELEY CO

USGS GAGE 6752500 STREAMFLOW RECORDS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	3010	2870	3260	2960	2530	6090	1530	11710	1750	5580	7770	6130	55190
1952	6950	6390	6270	6490	5700	10000	1990	1410	1290	4950	5890	5360	62690
1953	4380	3850	4020	4190	1000	2350	1250	1300	1240	2950	5240	4780	36550
1954	4190	3410	3120	1200	590	560	800	980	590	1370	2460	3510	22780
1955	3240	2980	3430	2210	760	1530	1250	2270	940	2390	3850	4070	28920
1956	3510	2990	3410	2170	5590	6720	980	1250	940	2220	4570	4320	38670
1957	3600	3140	3120	3740	6270	39250	9540	1640	1990	5770	9480	10220	97760
1958	7110	7850	7180	14650	67790	25340	2770	1320	1290	4130	6820	6450	152700
1959	5700	5340	7380	14150	12310	8110	1960	1500	2710	8040	7520	6850	81570
1960	6640	5770	6740	4250	2300	3490	2320	1160	1980	5000	6060	5510	51220
1961	5090	4580	5380	4290	34520	78120	4670	3900	8260	20720	21900	12760	204190
1962	10910	14130	14930	12560	4710	23100	18610	3760	3710	8530	7800	9060	131810
1963	8370	7690	6460	3460	1060	3710	840	3150	3320	3440	5920	5250	52670
1964	4870	3960	4660	6420	3200	3500	930	2350	1680	4160	4910	4640	45280
1965	3970	3890	4010	2870	2500	70530	4970	1510	3430	6830	5850	7150	117510
1966	8570	6590	5690	2870	620	2020	2150	1380	3170	2970	3870	4660	44560
1967	3860	3160	3790	2740	2010	35970	13500	1900	2700	5320	6060	5870	86880
1968	4810	4980	4150	3350	1690	10260	1880	2040	2010	5400	5820	5360	51750
1969	4810	4020	4430	3070	1880	23090	2180	1160	2220	9350	10520	7600	74330
1970	7460	8190	7980	7970	3630	51190	6210	3960	4910	8140	12180	10200	132020
1971	7820	6630	7020	12280	57360	35620	10400	4100	8220	9420	12990	10050	181910
1972	9030	9060	6710	6270	1200	20000	2130	3830	5410	5380	6190	4890	80100
1973	7730	7400	6690	6230	60280	29240	9600	5690	7140	11560	13350	10380	175290
1974	9420	9060	7360	7810	5590	32980	5060	4830	5380	9320	8880	8860	114550
1975	8440	6520	6360	5970	5190	31650	8560	2610	3680	6960	7220	6040	99200
1976	5710	5610	5860	4720	3630	3250	1720	6720	3920	6150	6050	8770	62110
1977	5120	4670	4600	2680	1690	563	6310	1730	1270	4400	5170	5000	43203
1978	5380	4920	5470	4590	8160	41490	2300	1950	3190	6440	6100	4910	94900
1979	4500	4850	6790	6630	44250	86790	5930	12710	6100	9760	10440	8810	207560
1980	9430	14360	21100	43530	187300	59170	3890	2430	4770	7180	7120	5590	365870
MINIMUM	3010	2870	3120	1200	590	560	800	980	590	1370	2460	3510	22780
MAXIMUM	10910	14360	21100	43530	187300	86790	18610	12710	8260	20720	21900	12760	365870
AVERAGE	6121	5962	6246	6877	17844	24856	4541	3208	3307	6461	7600	6768	99791

TABLE A.10

ESTIMATED NATIVE (ADJUSTED) FLOWS
CACHE LA POUDRE RIVER AT MOUTH OF CANYON
COMPARISON OF RECORDED AND ADJUSTED FLOWS

(ACRE-FEET)

RECORDED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1730	1780	2380	6950	62490	100800	69410	26930	16780	5410	3100	2620	300380
1952	2650	1640	2160	5960	48460	122500	39080	24580	15340	3680	2150	1670	269870
1953	2180	2250	2050	2890	20450	72440	27080	18150	7810	3420	1960	2030	162710
1954	1960	1570	1560	2950	25660	34470	15040	3760	5750	5020	1650	1060	100450
1955	1220	920	1240	1980	22080	60930	28190	15640	4360	3080	2310	2460	144410
1956	1710	1410	1930	3490	72790	87350	24540	11670	3230	2040	1220	1600	212980
1957	1290	1360	1440	7060	35530	136300	104600	20330	9720	5050	2720	2640	328040
1958	2110	2080	2690	10930	92800	96130	16260	4070	3260	3180	1880	2020	237410
1959	1650	2000	3070	12120	44150	103800	24810	10820	4070	4530	3750	1150	215920
1960	1070	770	3030	5550	50190	96750	27910	6540	4230	3000	1700	1550	202290
1961	2250	1650	2800	7880	70220	116800	31970	18770	11690	16210	6740	3220	290200
1962	3600	5710	5420	19160	68930	84900	45970	11310	2220	3760	2100	1760	254860
1963	1100	1040	760	4000	27300	37800	12230	11700	7380	3710	2120	980	110120
1964	830	850	1550	2300	35820	65840	31460	10820	4450	1850	1030	780	157580
1965	830	860	860	2530	32330	129700	77210	25500	7570	4010	1050	1310	283760
1966	1170	1220	1670	2820	29830	33360	9720	6240	5870	2850	1440	799	96989
1967	738	567	1090	1860	26300	75860	43390	7150	4180	1680	3280	2830	168925
1968	2210	2530	1940	2990	28840	102800	40920	20290	6720	2570	2160	1680	215650
1969	1170	1040	1640	6290	50520	74280	35650	6900	7480	4190	1880	891	191931
1970	872	617	1440	5570	59140	108800	55920	17230	6260	4770	4210	1870	266699
1971	1850	1350	1960	11640	62340	141700	56500	13340	9560	2480	4510	2180	309410
1972	1630	1820	2180	3970	36000	86010	25380	5180	6240	3890	2630	1590	176520
1973	1460	1450	2050	3470	89410	123400	65520	22890	3750	5210	6520	3090	328220
1974	2400	2940	5700	7270	78840	108100	39960	6570	4690	4740	2740	1380	265330
1975	810	740	1150	2100	18790	86830	78920	17250	5950	3240	1700	1670	219150
1976	1540	1410	1520	2300	27730	65040	27330	18980	3530	4590	1600	1010	156580
1977	916	849	1350	2970	12550	39170	10500	14160	3740	2460	2230	1630	92525
1978	1420	1280	1620	3910	36160	127800	66100	19680	5850	2860	1790	1300	269770
1979	1150	932	1460	5020	51250	123100	59420	34610	8780	3320	1810	2650	293502
1980	5560	4380	9140	32760	158700	142300	41410	16840	6210	5130	4290	3090	429810
AVG	1703	1634	2295	6356	49187	92835	41080	14930	6556	4065	2609	1817	225066

ADJUSTED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1978	2204	2832	8270	67797	119691	68281	26993	7919	8514	5060	3996	323535
1952	4098	2270	3228	15054	78446	143517	30379	13776	8635	4412	3190	2894	309899
1953	3490	3344	4428	5582	26827	91347	26905	16286	5970	4244	3300	2858	194581
1954	2882	2690	2842	7176	35686	30929	14728	6321	4008	6014	2978	2632	118886
1955	2192	2056	2712	5596	31729	60039	23702	16658	5560	3042	3786	3904	160976
1956	2832	2642	4292	5384	81627	94350	20645	11356	4423	2628	2620	3194	235993
1957	2286	2940	3344	12606	64500	200030	106139	25162	11525	8158	5086	4068	445844
1958	3956	3802	3704	11020	111524	99860	22068	9822	5739	4184	4286	4398	284363
1959	3692	3208	3804	14968	54613	113451	29313	12682	6486	8022	7442	3634	261315
1960	1568	2260	5840	11458	53920	104392	29382	8588	5225	4708	4032	3258	234631
1961	3894	3310	4390	10906	102714	141540	33483	17950	17248	18112	11996	5340	370883
1962	4524	5594	5950	21050	82014	100024	50015	11892	5673	5630	4000	3802	300168
1963	2654	2844	3410	6966	39742	45710	15606	15586	10122	13362	3638	2482	162122
1964	1944	2432	3160	7230	46515	72920	28357	10896	5297	3392	2520	2090	186753
1965	2180	2850	2576	6124	40316	169427	68974	21733	13766	11330	5228	4348	348852
1966	2318	3522	3464	6348	37619	38516	15222	7056	5070	5394	2136	2477	129142
1967	1836	2501	3462	5696	37595	107086	49500	10774	11858	10484	5636	4683	251111
1968	3246	3429	2809	6176	31952	130233	39307	16065	12473	4988	3920	3284	257882
1969	3261	3073	3590	8402	78844	88845	37092	9669	6241	6112	4700	2963	252792
1970	2933	2489	2202	8796	79181	141028	53687	15341	9210	5648	6117	3190	329822
1971	4396	3666	4638	18760	74770	165866	53416	15414	13048	7550	7434	4060	373018
1972	4601	2307	6174	7125	50794	101178	25068	9761	8668	6749	5558	2925	230908
1973	4449	3192	4361	9394	99620	147363	64599	18914	9156	9865	8323	6174	385410
1974	5741	4181	7174	14953	94532	119502	44403	12139	7790	7924	5463	3223	327025
1975	2650	3161	4185	6765	29886	116406	70000	16111	6460	6026	3777	3721	269148
1976	3623	3444	6623	5604	39207	73013	30588	24836	6989	6279	3631	2503	206340
1977	1141	1490	2370	8534	33068	43422	14156	9570	5502	5013	4133	3230	131629
1978	2623	3366	5389	5606	66888	157545	57540	12510	5614	5779	4289	3527	330676
1979	3190	2664	5458	16671	85042	151265	59358	24975	10615	4990	6316	6019	376563
1980	7109	7231	11290	32042	167885	163272	42626	12585	9286	7950	9932	6766	477974
AVG	3243	3139	4323	10342	64162	111059	40818	14714	8186	6883	5018	3721	275608

TABLE A.11

NORTH FORK CACHE LA POUDRE RIVER
ESTIMATED NATIVE FLOWS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	300	380	890	4160	19460	18400	6850	7370	1620	2280	1770	1570	65050
1952	1590	490	470	9840	24620	18990	3330	1780	870	790	1060	1190	65020
1953	1330	1100	1500	2650	8680	10320	3260	3000	830	960	1480	1140	36250
1954	1060	1070	1190	2990	4670	2360	860	890	260	610	770	890	17620
1955	650	800	1130	1950	3480	4930	1730	1490	830	510	1120	1220	19840
1956	840	940	1470	1420	14010	9680	2090	1260	370	440	1080	1170	34770
1957	700	1110	1370	8520	38130	48020	11870	3850	1800	2450	2370	1670	121860
1958	1380	1490	950	6670	37810	13970	4080	2160	1560	1480	1890	2270	75710
1959	1890	1790	2160	11130	28500	18540	3640	2050	1510	1860	3320	2320	78710
1960	420	1460	3400	3880	14550	12280	2460	850	710	1410	1190	1280	43890
1961	1470	1170	1910	7080	48780	32640	7110	4640	4280	4880	3330	2910	120200
1962	2890	2130	3240	10850	22000	17450	5480	1660	1150	2260	1430	1780	72320
1963	1250	1940	2080	4840	5760	4800	1240	2180	2200	1380	1040	920	29630
1964	790	800	1280	4730	10100	10590	2730	690	900	910	880	890	35290
1965	840	1040	1070	2520	10030	37180	7910	2580	4060	6070	1820	2060	77180
1966	770	1400	1400	3160	9190	3776	1790	1446	630	2130	890	900	27482
1967	470	990	1700	2730	9140	17670	5590	1410	3680	2720	1940	2270	50310
1968	1350	1370	960	3050	6700	23870	5194	2660	2520	1100	1430	1400	51604
1969	1360	1220	1490	4520	27010	12790	4220	1120	920	1300	1700	1264	58914
1970	1150	990	560	4780	27150	26760	6060	2480	1680	1220	2090	1340	76260
1971	2060	1460	2190	11370	25240	33410	6030	2530	2680	1680	2490	1880	93020
1972	2190	920	3220	3670	14860	16090	2870	1237	1600	1400	1920	1180	51157
1973	2100	1270	2010	5180	36010	28460	7270	3400	1670	1940	2750	3200	95260
1974	2900	1670	3890	8850	35800	21270	5130	1760	1310	1810	1890	1360	87640
1975	980	1260	1890	3440	5800	20170	7870	2710	970	2820	1380	1670	50960
1976	1580	1370	3989	2670	9840	8550	3500	4840	1140	2440	1340	910	42169
1977	51	590	1045	4610	7180	2768	2212	1080	720	1110	1490	1370	24226
1978	960	1340	2700	2670	21830	31190	6490	1820	750	1850	1540	1550	74690
1979	1310	1060	3665	9990	29690	29500	6690	4840	2070	1100	3548	3110	96573
1980	3750	2900	6660	20160	65570	32720	4830	1810	1745	2550	4567	3685	150947
AVERAGE	1346	1251	2049	5803	20720	18971	4680	2386	1568	1849	1851	1679	64152
51-65 AVG	1160	1181	1607	5549	19372	17343	4309	2430	1530	1886	1637	1552	59556
66-80 AVG	1532	1321	2491	6057	22067	20600	5050	2343	1606	1811	2064	1806	68747

NOTES: 1. Recorded flows 1951 through 1965.
2. Generated flows 1966 through 1980.
3. Additional adjustment for actual diverted amount, where necessary.

TABLE A.12

CAMERON PASS DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	131	180	0	0	0	0	0	311
1952	0	0	0	0	0	68	48	0	0	0	0	0	116
1953	0	0	0	0	0	125	0	0	0	0	0	0	125
1954	0	0	0	0	10	119	4	0	0	0	0	0	133
1955	0	0	0	0	0	145	41	0	0	0	0	0	186
1956	0	0	0	0	3	261	0	0	0	0	0	0	264
1957	0	0	0	0	0	0	63	0	0	0	0	0	63
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	119	7	0	0	0	0	0	126
1960	0	0	0	0	0	152	4	0	0	0	0	0	156
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	53	50	0	0	0	0	0	103
1969	0	0	0	0	0	0	1	0	0	0	0	0	1
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	103	8	0	0	0	0	0	111
1973	0	0	0	0	0	137	258	12	0	0	0	0	407
1974	0	0	0	0	40	208	48	0	0	0	0	0	296
1975	0	0	0	0	0	60	216	0	0	0	0	0	276
1976	0	0	0	0	0	141	79	0	0	0	0	0	220
1977	0	0	0	0	42	173	0	0	0	0	0	0	215
1978	0	0	0	0	0	68	133	0	0	0	0	0	201
1979	0	0	0	0	0	119	114	0	0	0	0	0	233
1980	0	0	0	0	0	112	42	0	0	0	0	0	154
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	42	261	258	12	0	0	0	0	407
AVERAGE	0	0	0	0	3	76	43	0	0	0	0	0	123

TABLE A.13

MICHIGAN DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	127	1800	2080	301	0	0	0	0	4308
1952	0	0	0	0	0	1080	916	82	0	0	0	0	2078
1953	0	0	0	0	0	1450	0	0	0	0	0	0	1450
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	249	1610	0	0	0	0	0	0	1859
1957	0	0	0	0	0	0	1010	165	0	0	0	0	1175
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	1080	462	0	0	0	0	0	1542
1960	0	0	0	0	0	1440	26	0	0	0	0	0	1466
1961	0	0	0	0	0	127	0	0	0	0	0	0	127
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	484	0	0	0	0	0	0	0	0	484
1965	0	0	0	0	0	63	1010	89	0	0	0	0	1162
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	749	689	0	0	0	0	0	1438
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	400	1280	83	0	0	0	0	0	1763
1973	0	0	0	0	0	571	2110	0	0	0	0	0	2681
1974	0	0	0	0	40	208	48	0	0	0	0	0	296
1975	0	0	0	0	104	360	1160	90	0	0	0	0	1714
1976	0	0	0	0	225	1320	76	149	0	0	0	0	1770
1977	0	0	0	0	0	345	61	60	0	0	0	0	466
1978	0	0	0	0	0	70	191	0	0	0	0	0	261
1979	0	0	0	0	0	0	394	307	25	0	0	0	726
1980	0	0	0	0	0	486	479	139	11	0	0	0	1115
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	484	400	1800	2110	307	25	0	0	0	4308
AVERAGE	0	0	0	16	38	468	360	46	1	0	0	0	929

TABLE A.14

WILSON SUPPLY DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	2380	2760	116	0	0	0	0	0	5256
1952	0	0	0	0	2000	625	127	0	0	0	0	0	2752
1953	0	0	0	0	738	1250	38	0	0	0	0	0	2026
1954	0	0	0	0	721	317	0	0	0	0	0	0	1038
1955	0	0	0	0	881	581	136	0	0	0	0	0	1598
1956	0	0	0	0	2370	1010	15	0	0	0	0	0	3395
1957	0	0	0	0	642	256	384	0	0	0	0	0	1282
1958	0	0	0	0	1480	377	0	0	0	0	0	0	1857
1959	0	0	0	0	877	1180	50	0	0	0	0	0	2107
1960	0	0	0	22	1790	1310	69	0	0	0	0	0	3191
1961	0	0	0	0	902	80	169	0	0	0	0	0	1151
1962	0	0	0	0	3180	1600	147	0	0	0	0	0	4927
1963	0	0	0	0	868	154	42	0	0	0	0	0	1064
1964	0	0	0	0	1750	692	21	0	0	0	0	0	2463
1965	0	0	0	0	1000	1980	114	0	0	0	0	0	3094
1966	0	0	0	0	697	234	0	0	0	0	0	0	931
1967	0	0	0	0	986	1410	0	0	0	0	0	0	2396
1968	0	0	0	0	332	3840	157	0	0	0	0	0	4329
1969	0	0	0	0	887	656	73	0	0	0	0	0	1616
1970	0	0	0	0	2170	592	151	0	0	0	0	0	2913
1971	0	0	0	0	501	66	286	0	0	0	0	0	853
1972	0	0	0	0	805	1530	38	0	0	0	0	0	2373
1973	0	0	0	0	0	1140	243	0	0	0	0	0	1383
1974	0	0	0	0	2520	1810	12	0	0	0	0	0	4342
1975	0	0	0	0	374	1420	159	0	0	0	0	0	1953
1976	0	0	0	0	649	1150	96	0	0	0	0	0	1895
1977	0	0	0	26	396	137	0	0	0	0	0	0	559
1978	0	0	0	0	556	1230	127	0	0	0	0	0	1913
1979	0	0	0	0	248	118	0	0	0	0	0	0	366
1980	0	0	0	0	0	213	74	0	0	0	0	0	287
MINIMUM	0	0	0	0	0	66	0	0	0	0	0	0	287
MAXIMUM	0	0	0	26	3180	3840	384	0	0	0	0	0	5256
AVERAGE	0	0	0	2	1090	991	95	0	0	0	0	0	2177

TABLE A.15

COLUMBINE DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	105	30	0	0	0	0	0	135
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	46	26	0	0	0	0	0	0	72
1955	0	0	0	0	51	99	15	0	0	0	0	0	165
1956	0	0	0	0	86	169	0	0	0	0	0	0	255
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	86	169	30	0	0	0	0	0	255
AVERAGE	0	0	0	0	31	67	8	0	0	0	0	0	105

BOB CREEK DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	363	21	0	0	0	0	0	384
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	169	55	0	0	0	0	0	0	224
1955	0	0	0	0	307	230	22	0	0	0	0	0	559
1956	0	0	0	0	475	230	0	0	0	0	0	0	705
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	475	363	22	0	0	0	0	0	705
AVERAGE	0	0	0	0	159	146	7	0	0	0	0	0	312

TABLE A.16

LARAMIE-POUDRE TUNNEL

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	1060	2510	9470	1540	0	0	0	0	14580
1952	0	0	0	0	2400	3490	4290	4040	845	0	0	0	15065
1953	0	0	0	0	1330	9090	3680	0	350	0	0	0	14450
1954	0	0	0	0	4130	4150	4130	1310	292	0	0	0	14012
1955	0	0	0	0	3850	7990	2980	0	0	0	0	0	14820
1956	0	0	0	0	5450	6670	2880	0	0	0	0	0	15000
1957	0	0	0	0	0	0	8180	6000	875	0	0	0	15055
1958	0	0	0	0	0	6890	4480	1960	391	0	0	0	13721
1959	0	0	0	0	0	8160	7490	2270	0	0	0	0	17920
1960	0	0	0	0	4710	7000	4170	0	0	0	0	0	15880
1961	0	0	0	0	198	1320	5610	2860	411	0	0	0	10399
1962	0	0	0	0	4610	2390	3390	3400	163	0	0	0	13953
1963	0	0	0	0	4500	7920	3480	772	0	0	0	0	16672
1964	0	0	0	0	4020	7440	4060	0	0	0	0	0	15520
1965	0	0	0	0	2530	3540	9550	2680	0	0	0	0	18300
1966	0	0	0	0	4800	8500	3730	1630	466	0	0	0	19126
1967	0	0	0	0	2520	2540	1710	2760	1210	0	0	0	10740
1968	0	0	0	0	1330	6880	6610	2290	0	0	0	0	17110
1969	0	0	0	0	3970	3990	5970	1070	0	0	0	0	15000
1970	0	0	0	0	1650	1320	7380	3630	1000	0	0	0	14980
1971	0	0	0	0	0	555	8500	3960	1100	0	0	0	14115
1972	0	0	0	0	4470	5800	5670	244	0	0	0	0	16184
1973	0	0	0	0	216	5020	6980	4340	139	0	0	0	16695
1974	0	0	0	0	2290	5500	7600	2480	0	0	0	0	17870
1975	0	0	0	0	2750	1490	9930	2960	0	0	0	0	17130
1976	0	0	0	0	3800	9790	5180	0	0	0	0	0	18770
1977	0	0	0	196	2970	6950	2560	2020	814	0	0	0	15510
1978	0	0	0	180	289	3790	11920	2880	0	0	0	0	19059
1979	0	0	0	0	0	313	9040	4770	914	0	0	0	15037
1980	0	0	0	0	0	4650	7330	2570	1320	0	0	0	15870
MINIMUM	0	0	0	0	0	0	1710	0	0	0	0	0	10399
MAXIMUM	0	0	0	196	5450	9790	11920	6000	1320	0	0	0	19126
AVERAGE	0	0	0	13	2328	4855	5932	2148	343	0	0	0	15618

TABLE A.17

SKYLINE DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	3640	0	0	0	0	0	0	3640
1952	0	0	0	0	0	0	1770	0	0	0	0	0	1770
1953	0	0	0	0	0	4180	611	0	0	0	0	0	4791
1954	0	0	0	0	1090	3640	194	0	0	0	0	0	4924
1955	0	0	0	0	0	3430	250	0	0	0	0	0	3680
1956	0	0	0	0	0	2270	0	0	0	0	0	0	2270
1957	0	0	0	0	0	0	3130	367	0	0	0	0	3497
1958	0	0	0	0	0	587	0	0	0	0	0	0	587
1959	0	0	0	0	0	1210	210	0	0	0	0	0	1420
1960	0	0	0	0	0	2260	301	0	0	0	0	0	2561
1961	0	0	0	0	0	353	952	0	0	0	0	0	1305
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	538	2050	0	0	0	0	0	0	2588
1964	0	0	0	0	0	2370	1050	0	0	0	0	0	3420
1965	0	0	0	0	0	0	772	0	0	0	0	0	772
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	530	968	0	0	0	0	0	0	1498
1968	0	0	0	0	0	301	1840	0	0	0	0	0	2141
1969	0	0	0	0	520	1910	1290	0	0	0	0	0	3720
1970	0	0	0	0	0	202	1350	0	0	0	0	0	1552
1971	0	0	0	0	0	161	1650	0	0	0	0	0	1811
1972	0	0	0	0	30	2320	0	0	0	0	0	0	2350
1973	0	0	0	0	0	571	2110	0	0	0	0	0	2681
1974	0	0	0	0	0	466	184	0	0	0	0	0	650
1975	0	0	0	0	0	266	1410	0	0	0	0	0	1676
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	528	1470	0	0	0	0	0	0	1998
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	426	0	0	0	0	0	426
1980	0	0	0	0	0	0	205	0	0	0	0	0	205
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	1090	4180	3130	367	0	0	0	0	4924
AVERAGE	0	0	0	0	108	1154	657	12	0	0	0	0	1931

TABLE A.18

GRAND RIVER DITCH

TRANSBASIN DIVERSIONS IN ACRE-FEET

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	192	9200	11630	3630	315	0	0	0	24967
1952	0	0	0	0	532	11980	6300	2570	0	0	0	0	21382
1953	0	0	0	0	707	11970	5360	1710	0	0	0	0	19747
1954	0	0	0	0	3570	5690	2690	781	8	0	0	0	12739
1955	0	0	0	0	1940	7500	5260	1380	72	0	0	0	16152
1956	0	0	0	0	3340	12510	3330	1280	11	0	0	0	20471
1957	0	0	0	0	0	0	11590	4120	352	0	0	0	16062
1958	0	0	0	0	0	9430	3260	996	88	0	0	0	13774
1959	0	0	0	0	0	11790	5230	1550	0	0	0	0	18570
1960	0	0	0	0	1430	13440	6520	1560	57	0	0	0	23007
1961	0	0	0	0	194	3390	4760	1420	115	0	0	0	9879
1962	0	0	0	0	734	8880	10620	3180	596	0	0	0	24010
1963	0	0	0	0	2790	7560	2680	1990	578	0	0	0	15598
1964	0	0	0	0	123	7680	6900	1540	503	0	0	0	16746
1965	0	0	0	0	0	2860	10710	2460	342	0	0	0	16372
1966	0	0	0	0	2410	7020	3450	1090	70	0	0	0	14040
1967	0	0	0	0	33	4220	2860	1420	404	0	0	0	8937
1968	0	0	0	0	0	6730	6910	2370	246	0	0	0	16256
1969	0	0	0	44	3590	6070	6840	1740	60	0	0	0	18344
1970	0	0	0	0	0	2910	7440	2020	471	0	0	0	12841
1971	0	0	0	0	0	3940	7990	2260	766	0	0	0	14956
1972	0	0	0	0	1570	10870	3890	1310	873	0	0	0	18513
1973	0	0	0	0	0	2930	9320	2510	0	0	0	0	14760
1974	0	0	0	0	1190	8380	5400	678	0	0	0	0	15648
1975	0	0	0	0	248	7140	11900	2310	235	0	0	0	21833
1976	0	0	0	0	1390	7910	6540	2070	435	0	0	0	18345
1977	0	0	0	214	1870	8040	1640	641	357	33	0	0	12795
1978	0	0	0	56	454	10300	11040	2680	670	0	0	0	25200
1979	0	0	0	0	0	4980	8850	3350	751	0	0	0	17931
1980	0	0	0	0	0	5530	6360	1150	286	0	0	0	13326
MINIMUM	0	0	0	0	0	0	1640	641	0	0	0	0	8937
MAXIMUM	0	0	0	214	3590	13440	11900	4120	873	33	0	0	25200
AVERAGE	0	0	0	10	944	7362	6576	1926	289	1	0	0	17107

TABLE A.19

TOTAL DELIVERED C-BT WATER
CACHE LA POUDRE BASIN

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	2596	8762	8562	30	0	0	19950
1953	0	0	0	0	5862	18278	31556	26604	19288	146	0	0	101734
1954	0	0	0	3250	29854	24010	32758	35812	12612	1298	0	0	139594
1955	0	0	0	120	24398	6354	23470	27978	15338	3708	0	0	101366
1956	0	0	0	192	7478	4312	23634	25184	17164	414	0	0	78378
1957	0	0	0	0	0	0	7668	26310	22620	13064	0	0	69662
1958	0	0	0	0	140	8788	36536	48850	31838	2284	0	0	128436
1959	0	0	0	0	56	7412	27490	43330	19542	6150	0	0	103980
1960	0	0	0	0	0	2296	26386	45330	20624	1138	0	0	95774
1961	0	0	0	0	162	94	14716	26880	13024	0	0	0	54876
1962	0	0	0	96	6566	8968	26418	36666	22574	4684	0	0	105972
1963	0	0	0	5552	28050	12752	33465	34781	16225	3468	27	27	134347
1964	27	27	27	27	27598	10150	29350	39079	15739	1842	78	78	124022
1965	78	78	78	230	18612	2856	3994	22949	14678	35105	109	109	98876
1966	109	109	109	109	11708	16433	38714	42272	12325	5931	123	123	128065
1967	144	163	146	169	3096	718	5626	44991	28013	6138	212	142	89558
1968	218	216	191	212	5380	3941	21280	22063	13099	2018	210	147	68976
1969	204	212	227	419	684	4089	28916	35010	9980	345	452	320	80860
1970	180	195	200	184	777	1267	14565	33186	11783	248	232	267	63084
1971	237	262	309	257	1230	3602	37538	35900	9480	7876	281	275	97246
1972	267	288	232	398	7854	5038	24007	33122	4304	5445	463	208	81627
1973	232	221	264	462	2105	2903	18765	31905	10314	430	306	300	68207
1974	293	284	274	346	5432	2930	37743	40519	10200	12675	259	259	111214
1975	259	268	266	274	8888	3448	15913	34111	10695	16724	297	301	91445
1976	310	307	305	304	2313	13583	39106	36347	9727	13727	464	352	116847
1977	302	376	542	568	11640	20270	31578	27508	13749	1782	285	44	108643
1978	304	285	377	803	593	1555	21709	26497	7462	6354	0	0	65940
1979	0	0	0	394	669	1281	23708	18033	6195	1992	333	365	52971
1980	368	367	380	458	1466	3921	29046	26007	8336	11101	419	424	82292
AVERAGE	118	122	131	494	7087	6375	23608	31200	13850	5537	152	125	88798
MINIMUM	0	0	0	0	0	0	2596	8762	4304	0	0	0	19950
MAXIMUM	368	376	542	5552	29854	24010	39106	48850	31838	35105	464	424	139594

NOTES: 1. Based on Water Commissioner's recorded diversions.

TABLE A.20

ESTIMATE OF ANNUAL PUMPING OF GROUNDWATER [1]
TRIBUTARY TO CACHE LA POUDRE RIVER ABOVE GREELEY

(Acre-feet)

YEAR	Larimer County	Greeley No. 2	Larimer & Weld	N. Poudre System	Lake Canal	Greeley No. 3	Lar. Co. 2/ New Mercer	Jackson	Arthur	Boxelder	TOTAL
1951	5746	4468	6244	7785	717	494	262	195	185	99	26194
1952	6129	4766	6660	8304	765	527	280	208	197	106	27940
1953	6256	4865	6799	8477	781	538	286	213	201	108	28522
1954	6384	4965	6938	8650	797	549	292	217	205	110	29104
1955	6512	5064	7076	8823	812	559	297	221	209	112	29686
1956	7533	5858	8186	10207	940	647	344	256	242	130	34343
1957	7916	6156	8603	10726	988	680	361	269	254	136	36089
1958	8172	6355	8880	11072	1020	702	373	278	262	141	37253
1959	6512	5064	7076	8823	812	559	297	221	209	112	29686
1960	8427	6553	9158	11418	1051	724	385	286	271	145	38417
1961	4852	3773	5273	6574	605	417	222	165	156	84	22119
1962	6639	5163	7215	8996	828	570	303	226	213	114	30268
1963	10980	8539	11933	14878	1370	943	501	373	353	189	50059
1964	11236	8738	12210	15224	1402	965	513	382	361	194	51223
1965	7405	5759	8048	10034	924	636	338	252	238	128	33761
1966	12257	9532	13320	16608	1529	1053	560	417	394	211	55880
1967	6256	4865	6799	8477	781	538	286	213	201	108	28522
1968	9704	7546	10545	13148	1211	834	443	330	312	167	44238
1969	9321	7248	10129	12629	1163	801	426	317	299	161	42492
1970	8044	6255	8741	10899	1004	691	367	273	258	139	36671
1971	8682	6752	9435	11764	1083	746	396	295	279	150	39581
1972	10597	8241	11516	14359	1322	911	484	360	340	183	48313
1973	10087	7844	10961	13667	1258	867	461	343	324	174	45984
1974	10725	8340	11655	14532	1338	921	490	365	344	185	48895
1975	11236	8738	12210	15224	1402	965	513	382	361	194	51223
1976	11747	9135	12765	15916	1466	1009	536	399	377	202	53551
1977	12513	9730	13598	16954	1561	1075	571	425	402	216	57044
1978	12640	9830	13736	17127	1577	1086	577	430	406	218	57626
1979	9065	7050	9851	12283	1131	779	414	308	291	156	41328
1980	12768	9929	13875	17300	1593	1097	583	434	410	220	58208
AVERAGE	8878	6904	9648	12029	1108	763	405	302	285	153	40474

1 Based an annual pumping estimates for 1980 and estimates for other years as a percentage of 1980 pumping. Data provided by Morton W. Bittinger.

TABLE A.21

ESTIMATE OF ANNUAL PUMPING OF GROUNDWATER TRIBUTARY TO CACHE LA POUDRE OR SOUTH PLATTE RIVER BELOW GREELEY GAGE

(Acre-feet)

YEAR	Larimer County	Greeley No. 2	Larimer & Weld	TOTAL
1951	7460	8627	5806	21893
1952	7957	9202	6193	23352
1953	8123	9394	6322	23839
1954	8289	9586	6452	24326
1955	8454	9777	6581	24812
1956	9780	11311	7613	28704
1957	10278	11886	8000	30164
1958	10609	12269	8258	31137
1959	8454	9777	6581	24812
1960	10941	12653	8516	32110
1961	6299	7285	4903	18487
1962	8620	9969	6710	25299
1963	14256	16487	11097	41840
1964	14588	16870	11355	42813
1965	9615	11119	7484	28218
1966	15914	18404	12387	46705
1967	8123	9394	6322	23839
1968	12599	14570	9806	36975
1969	12101	13995	9419	35515
1970	10444	12078	8129	30650
1971	11272	13036	8774	33083
1972	13759	15912	10709	40380
1973	13096	15145	10193	38434
1974	13925	16104	10839	40867
1975	14588	16870	11355	42813
1976	15251	17637	11871	44759
1977	16245	18788	12645	47678
1978	16411	18979	12774	48164
1979	11770	13611	9161	34542
1980	16577	19171	12903	48651
AVERAGE	11527	13330	8972	33829

1 Based on annual pumping estimates for 1980 and estimates for other years as a percentage of 1980.
Data provided by Morton W. Bittinger.

Appendix B

Data on Water Supply Systems of the Basin

APPENDIX B

DATA ON WATER SUPPLY SYSTEMS OF THE BASIN

This appendix contains information on direct flow and storage water rights, municipal and industrial treated water production and wastewater flows, and ditch diversion data for the 1951-80 period. Where space permitted in the main text, small tabulations of information on water rights are included therein. Information contained in this appendix is organized as follows:

Table No.	Title
M & I Water Systems	
B.1	Fort Collins Water Rights and Ditch Company Shares
B.2	City of Fort Collins Monthly Water Production
B.3	Flows at Fort Collins Wastewater Treatment Plant No. 1
B.4	Flows at Fort Collins Wastewater Treatment Plant No. 2
B.5	City of Greeley Water Rights and Wells
B.6	City of Greeley Bellvue Filtration Plant Finished Water Production
B.7	City of Greeley Boyd Lake Plants 1 and 2 Treated Water
B.8	City of Greeley 1st Avenue Wastewater Treatment Plant Monthly Discharges
B.9	City of Greeley Lonetree Lagoon Wastewater Treatment Facility Total Monthly Volume to Lone Tree Creek
Agricultural Water Systems	
B.10	North Poudre Irrigation Company Direct Flow Rights and Storage Rights
B.11	North Poudre Ditch Diversions
B.12	Munroe Gravity Canal Diversions

Table No.	Title
B.13	New Cache la Poudre Irrigation Company - Direct Flow Rights in Greeley No. 2 Canal and Cache la Poudre Reservoir Company - Storage Decrees in Timnath Reservoir
B.14	Greeley No. 2 Canal Diversions
B.15	Water Supply and Storage Company - Direct Flow Rights in Larimer County Canal, Jackson Ditch Company - Direct Flow Rights in Jackson Ditch, Water Supply and Storage Company - Transbasin Diversions, and Water Supply and Storage Company - Storage Rights
B.16	Larimer County Canal Diversions
B.17	Jackson Ditch Diversions
B.18	Larimer and Weld Irrigation Company - Direct Flow Rights in Larimer and Weld Canal, Larimer and Weld Irrigation Company - Storage Decrees, Divide Canal and Reservoir Company - Storage Decrees, Windsor Reservoir and Canal Company - Direct Flow Rights in Poudre Valley Canal, and Windsor Reservoir and Canal Company - Storage Decrees
B.19	Larimer and Weld Canal Diversions
B.20	Poudre Valley Canal Diversions
B.21	Greeley Canal No. 3 Diversions
B.22	Lake Canal Company Water Rights
B.23	Lake Canal Diversions
B.24	New Mercer Ditch Diversions
B.25	Boxelder Ditch Diversions
B.26	Arthur Ditch Diversions
B.27	B. H. Eaton Ditch Diversions
B.28	Boyd and Freeman Ditch Diversions
B.29	Chaffee Ditch Diversions
B.30	Coy Ditch Diversions
B.31	Jones Ditch Diversions
B.32	Josh Ames Ditch Diversions
B.33	Little Cache la Poudre Ditch Diversions

Table No.	Title
B.34	Ogilvy Ditch Diversions
B.35	Pleasant Valley and Lake Canal Diversions
B.36	Whitney Ditch Diversions

TABLE B.1

Fort Collins Water Rights and Ditch Company Shares

Fort Collins Municipal Direct Flow Rights

Amount (cfs)	Appropriation Date	Adjudication Date
3.5	6/01/1860	4/11/1882
2.5	3/01/1862	4/11/1882
7.0	3/15/1862	4/11/1882
2.78	9/15/1864	4/11/1882
4.5	5/01/1865	4/11/1882

Fort Collins Storage Rights

Reservoir	Amount (cfs)	Appropriation Date	Adjudication Date
Joe Wright Res.	797	9/20/1904	4/22/1922
	797	12/31/1921	9/10/1953
	7202	2/18/1971	12/31/1971

Fort Collins Ownership of Ditch Company Shares

Company	No. of Shares
North Poudre Irrigation Co.	958.25
Water Supply and Storage Co.	17.917
Pleasant Valley and Lake Canal	142.02
Arthur Irrigation Company	218.00
Chaffee Ditch	Not Available
Dixon Lateral Ditch Company	4.80
Emigh Lateral Ditch Company	23.00
Harmony Lateral Ditch Company	1.75
Lake Canal Company	6.00
Larimer County Canal No. 2	45.34
Louden Irrigating Canal & Res. Co.	3.75
New Mercer Ditch Company	25.73
North Louden Ditch & Reservoir Co.	3.75
Portner Reservoir	Not Available
Taylor & Gill Ditch Company	.06
Warren Lake Reservoir Company	46.38

TABLE B.2

CITY OF FORT COLLINS
MONTHLY WATER PRODUCTION
(ACRE FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	381	344	387	442	560	531	764	536	503	397	316	338	5498
1952	322	324	381	417	565	706	724	740	638	473	333	335	5957
1953	345	316	412	345	589	677	836	801	660	503	367	336	6188
1954	325	322	381	646	686	816	784	664	609	480	420	379	6514
1955	377	344	414	614	681	644	847	597	549	436	371	285	6161
1956	333	339	367	443	536	922	819	600	684	494	348	350	6236
1957	333	318	393	394	379	687	875	578	545	420	344	310	5576
1958	338	301	325	339	466	741	743	884	677	506	322	347	5989
1959	285	267	276	364	494	921	1048	977	718	400	316	304	6371
1960	333	311	347	569	789	1117	1266	1358	1036	675	417	373	8591
1961	408	351	394	497	560	835	1066	956	555	393	333	368	6718
1962	411	376	420	634	803	1002	1188	1337	999	677	491	419	8756
1963	428	393	465	796	1139	1122	1233	856	756	671	476	464	8799
1964	463	439	459	582	1120	1122	1474	1183	1002	740	548	450	9580
1965	496	414	494	628	916	715	1125	1266	758	623	532	480	8447
1966	503	460	652	784	1366	890	1594	1274	982	858	617	511	10491
1967	519	474	595	778	770	580	977	1397	829	694	537	537	8686
1968	589	539	546	729	957	1396	1403	1123	1103	767	543	511	10207
1969	537	483	566	896	1055	922	1518	1465	1118	544	568	552	10226
1970	598	625	628	618	1325	1473	1561	1595	1065	638	589	543	11258
1971	585	522	643	737	758	1814	1833	2017	1018	783	709	631	12049
1972	684	701	649	1025	1557	1774	1974	1704	1083	938	881	697	13667
1973	733	680	763	759	1381	2217	1921	2208	1290	1030	723	654	14359
1974	677	618	709	971	2084	2327	2638	2438	1563	1166	826	796	16812
1975	819	763	769	875	1504	1534	2373	2061	1708	1255	819	705	15186
1976	698	697	784	1181	1283	2165	2542	1832	1363	992	817	806	15161
1977	727	754	873	988	1615	2348	1907	1490	1859	1251	1086	975	15871
1978	729	667	851	1382	1224	1987	2488	2160	1701	1426	771	721	16107
1979	768	748	798	924	1016	1616	2396	1520	2047	1330	691	652	14505
1980	657	665	706	945	1122	3008	2698	2549	1744	1383	790	749	17017
AVERAGE	513	485	548	710	977	1287	1487	1339	1039	765	563	519	10233

TABLE B.3

FLOWS AT FORT COLLINS WASTEWATER
TREATMENT PLANT NO. 1 (IN ACRE FEET)
(FROM CITY RECORDS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	178	161	166	163	202	255	308	391	336	316	256	233	2965
1952	217	190	196	208	251	317	295	322	276	277	226	198	2973
1953	187	164	177	183	218	294	319	294	282	278	211	184	2791
1954	180	160	171	173	222	274	292	276	252	238	191	228	2657
1955	228	203	227	217	272	332	373	375	325	307	280	260	3399
1956	259	244	250	247	309	365	432	420	386	379	319	296	3906
1957	284	234	251	248	341	369	480	452	372	393	343	308	4075
1958	303	252	181	286	316	333	356	364	224	38	235	306	3194
1959	298	243	273	147	206	295	605	565	522	500	439	393	4486
1960	356	328	362	371	470	574	703	626	537	545	439	414	5725
1961	396	350	365	414	528	399	387	580	546	528	467	439	5399
1962	416	397	431	424	546	532	682	624	563	543	460	417	6033
1963	435	402	428	434	541	540	586	520	551	551	479	457	5924
1964	464	416	450	456	531	594	693	668	577	613	536	491	6489
1965	495	444	473	462	548	629	690	719	657	670	592	525	6904
1966	527	449	498	529	663	755	791	725	680	678	614	561	7470
1967	551	488	529	572	596	666	703	726	705	668	580	529	7314
1968	554	474	352	356	389	259	393	361	417	330	228	220	4334
1969	210	195	210	39	-1	-1	-1	439	392	439	383	334	2641
1970	320	280	296	327	385	473	525	492	446	416	368	338	4667
1971	339	322	34	372	424	444	597	574	553	491	402	317	4869
1972	302	354	354	374	427	543	598	584	505	496	420	408	5364
1973	412	367	381	380	479	578	749	636	552	492	451	387	5864
1974	404	362	368	400	484	727	794	738	576	555	459	366	6234
1975	347	336	359	384	454	619	682	685	589	478	419	393	5745
1976	379	359	368	366	429	534	644	690	573	567	524	506	5939
1977	500	444	460	409	513	568	626	600	504	459	408	392	5883
1978	396	395	414	414	521	630	714	704	619	571	503	476	6359
1979	452	439	502	542	629	695	721	690	619	563	537	525	6914
1980	527	565	665	612	630	460	494	658	617	509	455	425	6616
AVERAGE	364	334	340	350	417	468	541	550	492	463	407	377	5104

(-1) INDICATES PLANT NOT OPERATING

TABLE B.4
FLOWS AT FORT COLLINS WASTEWATER
TREATMENT PLANT NO.2 IN ACRE FEET
(FROM CITY RECORDS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1971	0.0	0.0	0.0	0.0	0.0	410.9	454.8	494.1	493.8	448.7	392.2	352.3
1972	315.5	326.8	347.7	352.9	402.3	500.2	532.8	526.3	474.8	0.0	398.7	0.0
1973	360.3	314.9	377.8	388.8	455.1	502.1	617.5	583.1	529.4	514.0	464.6	417.1
1974	428.1	384.2	404.2	416.4	556.1	699.7	786.3	733.5	668.4	619.0	574.2	504.5
1975	529.1	355.4	364.9	400.2	422.3	448.4	629.4	648.2	554.6	473.8	413.1	381.5
1976	364.0	369.2	381.8	378.1	412.2	522.6	595.7	698.5	663.8	486.1	376.9	435.8
1977	405.4	365.2	369.8	352.0	404.5	370.1	768.5	596.9	436.4	435.2	390.1	328.1
1978	285.1	293.7	366.7	315.2	577.6	469.5	687.4	667.2	506.4	495.3	414.6	391.0
1979	378.7	356.3	398.3	413.1	612.6	579.7	794.8	796.7	614.7	577.3	544.7	542.9
1980	527.9	544.7	619.3	879.9	927.1	1012.4	1198.4	836.9	688.4	600.6	501.8	455.4
AVERAGE	399.3	367.8	403.4	433.0	530.0	551.6	706.6	658.1	563.1	465.0	447.1	380.9

TABLE B.5

Greeley Water Rights and Wells

Greeley Direct Flow Rights

Amount (cfs)	Appropriation Date	Adjudication Date
5.0	3/15/1862	4/11/1882
7.5	8/01/1862	9/30/1907*

*Priority assigned as if decreed April 11, 1882.

Greeley Storage Rights

Name	Amount (af)	Appropriation Date	Adjudication Date
Big Beaver (Hourglass) Reservoir	1,529.5	8/09/1898	9/23/1905
	59.14	8/08/1901	9/23/1905
Twin Lake	460	10/17/1904	4/22/1922
Barnes Meadow Reservoir	1,697.2	7/17/1921	12/18/1945
	651.8	8/26/1968	12/31/1975
Peterson Lake	915.4	7/22/1921	12/18/1945
	336.9	8/26/1960	12/31/1975
Comanche Reservoir	1,661.4	6/13/1923	12/10/1945
	967.6	6/18/1925	12/10/1945
Milton Seaman Reservoir	4,328	11/20/1939	9/10/1953

Greeley Ownership of Ditch Company Shares

Company	No. of Shares
Greeley No. 3 Ditch	3/8 of Direct Flow
Pleasant Valley & Lake Canal	90 inches
Greeley Irrigation Company	21
Sand Creek Lateral Irrigation Co.	8
Delta Irrigation Company	3
New Cache la Poudre Irrigation Co.	4
Cache la Poudre Reservoir Company	8
Greeley-Loveland Irrigation Co.*	292.583
Lake Loveland*	20.75
Seven Lakes*	58.5

*In Big Thompson River Basin

TABLE B.5 (Continued)

City of Greeley Transbasin Diversions
(from the Laramie River Basin)

Ditch	Amount (af)	Appropriation Date	Adjudication Date
Bob Creek	60	9/24/1897	9/11/1944
Columbine	Not Decreed		

City of Greeley Wells

Name	Amount (cfs)	Appropriation Date	Adjudication Date
Well 7-7109**	2.22	12/31/1972	11/12/1948
Well 8**	0.11	12/31/1974	5/01/1950
Well 6-4738**	1.33	12/31/1972	9/24/1963
Island Grove Well #1	1.32	9/10/1953	5/31/1950
Well 1-4503**	1.32	12/31/1972	9/24/1963
Well 2-4504**	1.78	12/31/1972	5/31/1950
Linn Grove Cemetery #1	2.78	9/10/1953	4/30/1941
Linn Grove Cemetery #2	1.00	9/10/1953	4/30/1932
Linn Grove Cemetery #3	1.33	9/10/1953	5/31/1937
Well 3-4505**	2.44	12/31/1972	4/30/1935
Well 4-4506**	0.55	12/31/1972	6/30/1955
Well 5-4507**	1.20	12/31/1972	10/31/1941
Well 9-29743**	0.022	12/31/1972	5/15/1967
Well 68594	0.033	12/31/1974	5/31/1953

**Wells noted by ** are also adjudicated as alternate points of diversion to the Canal #3 Decree, and if used as an alternate point of diversion for Canal #3, these wells would have a basin rank of 253. See Case W-7767.

TABLE B.6

CITY OF GREELEY BELLVUE FILTRATION PLANT
FINISHED WATER PRODUCTION (IN ACRE FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1961	610	447	514	641	857	1077	1235	1148	749	744	726	741	9490
1962	616	505	545	893	1120	1107	1325	1401	1003	859	676	645	10694
1963	575	464	532	1025	1475	1388	1629	1008	902	934	696	651	11280
1964	668	535	546	678	1426	1254	1831	1505	1170	994	717	739	12062
1965	705	539	581	899	1193	1024	1427	1468	945	738	707	681	10907
1966	625	521	649	895	1502	1349	1768	1382	964	837	696	692	11880
1967	587	525	622	1001	1002	683	1469	1518	1116	902	583	593	10603
1968	592	547	644	832	1259	1600	1784	1446	1347	881	658	596	12186
1969	604	544	597	983	1240	1252	1588	1690	1183	700	611	569	11558
1970	562	547	627	703	1317	1274	1518	1552	1202	752	579	600	11233
1971	602	539	642	928	1015	1456	1647	1708	1039	946	680	716	11918
1972	704	633	910	1172	1315	1406	1669	1587	1191	1186	734	817	13323
1973	830	663	701	801	1230	1662	1541	1691	1231	1108	765	727	12949
1974	717	636	735	973	1601	1556	1712	1601	1282	1110	843	775	13540
1975	803	651	875	985	1391	1384	1661	1677	1567	1415	937	886	14232
1976	915	772	955	1103	1278	1356	1592	1595	1144	1159	945	873	13686
1977	824	759	899	1083	1082	1468	1492	1443	1555	1608	1091	902	14207
1978	918	786	1078	1316	1062	1340	1566	1530	1482	1411	869	904	14263
1979	853	796	922	881	906	1133	1639	1514	1422	1384	863	895	13208
1980	895	893	911	1017	1074	1599	1712	1584	1274	1160	958	949	14026
AVERAGE	710	615	724	940	1217	1318	1590	1502	1188	1041	767	747	12362

TABLE B.7

CITY OF GREELEY
BOYD LAKE PLANTS 1 & 2
TREATED WATER (ACRE FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1969	0	0	0	0	0	104	308	272	51	11	11	11	769
1970	3	3	28	28	205	357	539	520	126	16	2	3	1831
1971	3	10	28	8	74	498	511	549	124	50	22	24	1901
1972	19	20	22	76	342	477	735	124	0	0	0	0	1815
1973	0	0	0	1	19	759	567	630	83	38	0	0	2282
1974	0	0	24	34	586	627	841	513	15	17	8	0	2665
1975	1	35	29	152	314	453	764	851	378	17	4	2	3001
1976	0	22	38	120	442	906	1188	836	381	63	103	43	4143
1977	105	134	137	120	721	928	808	458	536	4	2	0	3993
1978	0	0	104	163	538	1101	1402	1125	889	273	150	22	5883
1979	119	88	68	439	524	1122	1546	632	680	362	32	21	5633
1980	10	3	0	181	332	1424	1594	1284	893	511	91	0	6325
AVERAGE	22	26	40	110	342	730	900	649	346	114	35	11	3353

TABLE B.8
CITY OF GREELEY
1ST AVENUE WASTEWATER TREATMENT PLANT
MONTHLY DISCHARGES IN ACRE FEET

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1971	-1	-1	-1	-1	-1	663	704	799	764	761	608	609
1972	628	543	561	534	580	635	637	685	755	714	727	733
1973	714	610	656	644	733	691	723	704	654	590	580	561
1974	590	490	533	644	790	810	675	742	681	761	700	714
1975	723	644	609	626	666	709	685	599	516	618	644	647
1976	637	552	580	617	618	552	609	685	654	714	663	790
1977	723	490	571	626	685	506	542	552	635	723	718	799
1978	685	610	685	700	733	718	733	752	709	761	718	694
1979	704	619	618	608	818	819	780	790	727	761	718	733
1980	694	667	704	718	961	801	780	856	746	799	737	694
AVERAGE	678	581	613	635	731	691	687	716	684	720	681	697

TABLE B.9

CITY OF GREELEY
EFFLUENT FROM LONE TREE LAGOON WASTEWATER TREATENT FACILITY
TOTAL MONTHLY VOLUME-ACRE FEET DISCHARGED TO LONE TREE CREEK

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1974	-1	-1	143	120	95	129	48	-1	46	57	-1	79	704
1975	97	75	90	79	60	41	43	40	46	105	111	105	892
1976	114	109	114	46	43	85	79	77	88	121	122	130	1128
1977	122	113	124	107	110	119	116	138	121	127	122	159	1478
1978	125	131	118	104	120	109	114	106	87	99	95	106	1312
1979	111	108	114	96	120	114	106	114	91	102	26	13	1115
1980	48	99	71	18	11	0	0	0	0	3	12	13	277
AVERAGE	103	106	110	81	80	85	72	79	68	88	81	86	986

TABLE B.10

North Poudre Irrigation Company
Direct Flow Rights and Storage Rights

Direct Flow Rights

Name	Amount (cfs)	Appropriation Date	Adjudication Date
North Poudre Canal	0.72	6/01/1861	4/11/1882
	1.73	6/01/1861	4/11/1882
	4.75	4/15/1866	4/11/1882
	2.165	7/01/1866	4/11/1882
	2.165	6/01/1866	4/11/1882
	4.0	5/01/1871	4/11/1882
	15.0	7/20/1872	4/11/1882
	7.2	7/01/1873	4/11/1882
	9.38	7/15/1873	4/11/1882
	3.32	8/15/1873	4/11/1882
	11.0	9/10/1873	4/11/1882
	3.32	5/15/1874	4/11/1882
	6.72	5/01/1875	4/11/1882
	6.72	6/01/1876	4/11/1882
	6.72	6/01/1876	4/11/1882
	2.85	6/01/1877	4/11/1882
	397.0	2/01/1880	4/11/1882
North Poudre Supply Canal (Munroe Gravity Canal)	203.0	1/12/1943	9/10/1953
	250.0	1/12/1943	9/10/1953
	48.0	1/12/1943	9/10/1953

Storage Rights

Name	Amount (af)	Appropriation Date	Adjudication Date
Halligan Reservoir (North Poudre No. 16)	3,719	4/30/1900	12/09/1904
	6,420	8/16/1906	4/22/1922
	4,591	12/31/1921	9/10/1953
	1,817	12/31/1921	9/10/1953
Park Creek Reservoir	92	10/01/1884	12/09/1904
	45.6	10/01/1888	12/09/1904
	56	10/01/1888	12/09/1904
	109	11/02/1904	4/22/1922
	110	5/20/1905	4/22/1922
	244	5/10/1906	4/22/1922
	7,320	11/15/1958	12/31/1970

TABLE B.10 (Continued)
Storage Rights

Name	Amount (af)	Appropriation Date	Adjudication Date
North Poudre Res. No. 15	1,377	5/01/1894	12/09/1904
	4,086	4/30/1900	12/09/1904
	5,464	4/09/1909	4/22/1922
	4,591	12/31/1924	9/10/1953
	872	12/31/1924	9/10/1953
Boxelder Reservoir No. 1	570	7/01/1884	12/09/1904
Boxelder Reservoir No. 2	195	7/01/1883	12/09/1904
Boxelder Reservoir No. 3	792	10/01/1888	12/09/1904
Mountain Supply No. 7 (Bubbles Lake)	215	4/20/1905	4/22/1922
North Poudre Res. No. 1 (Miners Lake)	436	3/01/1883	12/09/1904
	238	10/01/1888	12/09/1904
Refill	459	12/31/1921	9/10/1953
Refill	215	12/31/1921	9/10/1953
Spitzer Reservoir (Mountain Supply No. 19)	138	5/20/1905	4/22/1922
	306	5/10/1906	4/22/1922
Demmel Lake (North Poudre Reservoir No. 2)	3,328	2/20/1890	12/09/1904
	551	8/01/1901	12/09/1904
Refill	1,337	12/31/1921	9/10/1953
Refill	2,504	12/31/1921	9/10/1953
Mountain Supply Reservoir No. 8	482	2/10/1905	4/22/1922
Mountain Supply Reservoir No. 9	413	2/20/1905	4/22/1902
Mountain Supply Reservoir No. 10	344	5/15/1905	4/22/1902
Bee Lake (North Poudre Reservoir No. 3)	4,362	2/01/1903	12/09/1904
	1,995	3/01/1903	12/09/1904
	5,051	10/14/1910	4/22/1922
North Poudre Reservoir No. 6	2,410	4/30/1900	12/09/1904
	4,132	10/14/1910	4/22/1922
Mountain Supply No. 22 (Wasson Lake)	269	10/15/1906	4/22/1922

TABLE B.10 (Continued)
Storage Rights

Name	Amount (af)	Appropriation Date	Adjudication Date
North Poudre Reservoir No. 3	2,525	10/01/1884	12/09/1904
	1,076	11/01/1889	12/09/1904
	344	5/05/1892	12/09/1904
	744	11/01/1904	4/22/1922
	2,846	12/31/1921	9/10/1953
North Poudre Reservoir No. 4	707	5/15/1903	4/22/1922
	918	12/31/1921	9/10/1953
	863	12/31/1921	9/10/1953
Clarks Lake (North Poudre Nos. 12 & 13)	2,296	10/01/1901	12/09/1904
	1,800	10/01/1901	12/09/1904
	4,095	9/10/1953	12/31/1921
Indian Creek Res. (Mtn. Supply Res. No. 16)	895	3/04/1904	4/22/1922
	1,011	11/07/1946	9/10/1953
	895	12/31/1921	9/10/1953
Mtn. Supply Res. No. 18 (Hinkley Lake)	918	2/15/1904	4/22/1922
	459	12/31/1921	9/10/1953
	459	12/31/1921	9/10/1953
North Poudre Res. No. 11 (Stutchell Reservoir)	70	10/01/1888	12/09/1904
	137	11/02/1904	4/22/1922
	27	11/02/1904	4/22/1922
Fossil Creek Reservoir	12,052	3/05/1901	4/22/1922
	1,545	3/05/1901	9/10/1953
	12,052	6/01/1904	9/10/1953
	1,545	6/01/1904	9/10/1953
Portner Reservoir (North Poudre No. 17)	610	6/18/1906	4/22/1922
	322	1/14/1908	4/22/1922

TABLE B.11

NORTH POUDRE DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	5240	9896	4890	6986	2890	0	0	0	29902
1952	0	0	0	5454	7634	13396	5146	4502	2912	0	0	0	39044
1953	0	0	0	336	7086	8136	4734	4190	5518	0	0	0	30000
1954	0	0	0	0	3662	3330	3214	1890	2258	0	0	0	14354
1955	0	0	0	0	3382	4414	4302	3366	2416	0	0	0	17880
1956	0	0	0	1480	9328	7044	3488	2408	2412	0	0	0	26160
1957	0	0	0	5544	7782	21258	11552	5068	4630	2162	0	0	57996
1958	0	0	0	386	2756	9748	5244	4218	3384	2362	0	0	28098
1959	0	0	0	0	2112	11638	6168	4566	2454	308	0	0	27246
1960	0	0	0	1322	3748	9154	5006	4082	2136	0	0	0	25448
1961	0	0	0	0	5648	5014	5624	4934	4548	0	0	0	25768
1962	0	0	0	864	6892	7960	6280	5666	3266	0	0	0	30928
1963	0	0	0	1204	5832	4238	4516	2774	4288	0	0	0	22852
1964	0	0	0	1672	7372	7298	5388	3712	2110	0	0	0	27552
1965	0	0	0	66	6418	5766	5828	6222	6910	434	0	0	31644
1966	0	0	0	2270	4330	3710	4788	3646	2054	0	0	0	20798
1967	0	0	0	304	7006	6640	4106	5070	5468	2184	0	0	30778
1968	0	0	0	102	4856	9622	5862	5154	5448	0	0	0	31044
1969	0	0	0	1068	7038	6158	5058	4980	2864	0	0	0	27166
1970	0	0	0	0	3778	7148	7632	7742	2104	0	0	0	28404
1971	774	0	0	1468	5074	4958	5362	6431	5930	2171	0	0	32168
1972	0	0	1636	4216	5429	6870	5623	5849	3104	0	0	0	32727
1973	0	0	67	2699	2443	7279	5950	7187	7368	677	0	0	33670
1974	0	0	0	4297	1261	5457	5730	5239	4368	0	0	0	26352
1975	0	0	0	1174	5192	6366	5384	4421	5471	0	0	0	28007
1976	0	248	3960	0	4415	7156	3774	3530	5572	640	1031	0	30326
1977	0	0	0	44	6427	3410	2299	2602	3683	0	36	0	18500
1978	0	0	0	4942	6081	6780	5009	5683	4221	218	0	0	32933
1979	0	0	1445	6934	2938	7130	8307	5801	4267	950	0	0	37773
1980	0	0	0	83	1697	7207	7237	3748	2063	172	5049	2376	29633
AVERAGE	26	8	237	1598	5095	7473	5450	4722	3871	409	204	79	29172
MINIMUM	0	0	0	0	1261	3330	2299	1890	2054	0	0	0	14354
MAXIMUM	774	248	3960	6934	9328	21258	11552	7742	7368	2362	5049	2376	57996

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March

TABLE B.12

MUNROE GRAVITY CANAL
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	11040	6208	3980	4502	0	0	0	25730
1954	0	0	0	650	10830	6748	5006	4586	2488	0	0	0	30308
1955	0	0	0	120	11140	2580	4812	3488	1464	0	0	0	23604
1956	0	0	0	0	3078	4228	6382	2372	4172	0	0	0	20232
1957	0	0	0	0	0	7874	10772	10640	11934	772	0	0	41992
1958	0	0	0	0	644	7108	11890	11988	6324	1450	0	0	39404
1959	0	0	0	0	0	7798	13430	10696	7902	0	0	0	39826
1960	0	0	0	0	1454	9632	11388	9136	5474	0	0	0	37084
1961	0	0	0	0	3350	6200	7494	6392	7002	0	0	0	30438
1962	0	0	0	0	7430	5064	11906	11252	10398	1302	0	0	47352
1963	0	0	0	72	8926	9050	10660	9002	4770	7660	0	0	50140
1964	0	0	0	0	6350	7998	8122	6938	2450	0	0	0	31858
1965	0	0	0	0	5002	8454	8546	9026	3264	120	0	0	34412
1966	0	0	0	0	7136	10902	10808	7524	5336	0	0	0	41706
1967	0	0	0	0	436	2536	660	11850	11114	2170	0	0	28766
1968	0	0	0	0	770	4972	11098	6436	2456	0	0	0	25732
1969	0	0	0	0	2362	9922	11300	12526	5226	0	0	0	41336
1970	0	0	0	0	4648	11338	10460	10682	6062	0	0	0	43190
1971	0	0	0	0	1137	9616	14581	13157	6121	0	0	0	44612
1972	0	0	0	0	4346	10959	11582	8319	3793	0	0	0	38999
1973	0	0	0	0	4009	12977	11767	7079	5964	0	0	0	41796
1974	0	0	0	0	10874	12553	13094	12389	7088	0	0	0	55998
1975	0	0	0	0	4699	5710	10363	12345	7536	0	0	0	40653
1976	0	0	0	0	2810	12977	13549	8175	8332	0	279	0	46122
1977	0	0	0	0	8932	11013	8312	3863	4091	0	0	0	36210
1978	0	0	0	0	3946	10229	11704	6989	2239	0	0	0	35108
1979	0	0	0	0	1140	7577	12260	3067	5259	0	0	0	29304
1980	0	0	0	0	0	10999	12529	9435	1786	0	0	0	34749
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	650	11140	12977	14581	13157	11934	7660	279	0	55998
AVERAGE	0	0	0	28	3848	7935	9356	7778	5152	449	9	0	34555

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March for 1951-1970.

TABLE B.13

New Cache la Poudre Irrigation Company
Direct Flow Rights in Greeley No. 2 Canal

Amount (cfs)	Appropriation Date	Adjudication Date
110	10/25/1870	4/11/1882
170	9/15/1871	4/11/1882
184	11/10/1874	4/11/1882
121	9/15/1877	4/11/1882

Cache la Poudre Reservoir Company
Storage Decrees in Timnath Reservoir

Amount (af)	Appropriation Date	Adjudication Date
8,380	3/17/1892	12/09/1904
1,740	12/02/1902	4/22/1922
5,948 (Refill)	12/31/1923	9/10/1953
4,171 (Refill)	12/31/1923	9/10/1953

TABLE B.14

GREELEY NO. 2 CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	11140	22680	23030	15392	3678	0	0	0	75920
1952	0	0	0	0	13150	25780	16486	4950	2392	0	0	0	62758
1953	0	0	0	150	5468	26920	8114	6920	1190	0	0	0	48762
1954	0	0	0	0	11820	14430	7026	3956	2632	0	0	0	39864
1955	0	0	0	180	9664	16614	10012	6314	2190	100	0	0	45074
1956	0	0	0	1988	18620	21348	7222	5074	864	0	0	0	55116
1957	0	0	0	448	0	17640	30540	13116	4198	0	0	0	65942
1958	0	0	0	0	7044	22140	10310	3956	2756	0	0	0	46206
1959	0	0	0	0	10656	23790	13530	7166	2448	0	0	0	57590
1960	0	0	0	622	13920	21150	17230	5904	2052	0	0	0	60878
1961	0	0	0	1200	3134	11970	14786	9184	2682	0	0	0	42956
1962	0	0	0	4620	21000	18500	15418	9776	2214	0	0	0	71528
1963	0	0	0	306	12950	11840	6220	6410	2450	0	0	0	40176
1964	0	0	0	0	11990	15760	11894	4278	1216	0	0	0	45138
1965	0	0	0	304	7502	8604	20870	9100	2684	0	0	0	49064
1966	0	0	0	288	11536	8730	5628	2904	1796	0	0	0	30882
1967	0	0	0	392	4774	6012	14154	4750	2682	0	0	0	32764
1968	0	0	0	0	5634	22320	14576	8170	1856	0	0	0	52556
1969	0	0	0	0	8582	13450	12540	4378	1350	0	0	0	40300
1970	0	0	0	0	13056	10800	19010	5020	1718	0	0	0	49604
1971	0	0	0	0	2565	19526	16650	5633	1189	0	0	0	45563
1972	0	0	357	121	9497	16024	7974	2603	238	0	0	0	36814
1973	0	0	0	0	7538	15923	14072	5053	641	0	0	0	43227
1974	0	0	727	0	14642	17877	12618	5854	1821	0	0	0	53539
1975	0	0	0	169	9185	8781	20513	6134	2182	0	0	0	46964
1976	0	0	0	0	7681	16545	10280	9669	2377	0	0	0	46552
1977	0	0	0	915	5370	11801	5211	6363	1650	0	0	0	31310
1978	0	0	0	0	3356	16236	16339	5810	928	0	0	0	42669
1979	0	0	0	0	1273	8583	15224	7437	1576	0	0	0	34093
1980	0	0	0	1051	1018	20849	12138	4342	2172	0	0	0	41570
AVERAGE	0	0	36	425	8792	16421	13654	6521	1994	3	0	0	47846
MINIMUM	0	0	0	0	0	6012	5211	2603	238	0	0	0	30882
MAXIMUM	0	0	727	4620	21000	26920	30540	15392	4198	100	0	0	75920

1) Includes direct flow, exchanges, reservoir water and CBT water for irrigation.

TABLE B.15

Water Supply and Storage Company
Direct Flow Rights in Larimer County Canal

Amount (cfs)	Appropriation Date	Adjudication Date
10.77	3/01/1862	4/11/1882
13.89	9/15/1964	4/11/1882
4.66	3/15/1868	4/11/1882
4.0	3/20/1873	4/11/1882
7.23	4/01/1878	4/11/1882
463.0	4/25/1881	10/20/1885
326.0	9/28/1914	9/28/1914

Jackson Ditch Company
Direct Flow Rights in Jackson Ditch

Amount (cfs)	Appropriation Date	Adjudication Date
11.67	6/10/1861	4/11/1882
14.42	10/21/1870	4/11/1882
12.13	9/15/1873	4/11/1882
12.70	7/15/1879	4/11/1882

Water Supply and Storage Company
Transbasin Diversions

Name	Amount (cfs)	Source	Appropriation Date	Adjudication Date
Cameron Pass Ditch	10.0	Michigan River	7/30/1882	4/23/1902
	18.0	(North Platte)	7/07/1898	4/23/1902
Skyline Ditch*	400.0	Laramie River	8/07/1891	10/30/1896
Laramie-Poudre Tunnel*	300.0	Laramie River	8/25/1902	2/20/1914
Grand River Ditch	524.6	Colorado River	9/01/1890	8/03/1906

*Seasonal allotment limited to 19,850 af from Laramie River.

TABLE B.16

LARIMER COUNTY CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	12658	25456	22552	15198	10792	380	0	0	87036
1952	0	0	0	4786	18542	26820	14142	13290	11592	0	0	0	89172
1953	0	0	0	816	9968	20436	20298	16146	17900	0	0	0	85564
1954	0	0	0	2672	14244	15484	16300	15116	9112	0	0	0	72928
1955	0	0	0	0	14914	13284	17634	14918	9410	0	0	0	70160
1956	0	0	0	0	18390	19242	15218	14884	11302	0	0	0	79036
1957	0	0	0	560	16910	25926	29824	14526	13634	4274	0	0	105654
1958	0	0	0	0	4784	27120	18620	21076	13670	2080	0	0	87350
1959	0	0	0	1414	6376	29794	18248	20814	8718	5310	0	0	90674
1960	0	0	0	574	9384	24964	16540	17656	9174	60	0	0	78352
1961	0	0	0	5656	15778	15518	16266	13978	11202	0	0	0	78398
1962	0	0	0	2072	15352	14556	19518	17408	13134	3066	0	0	85106
1963	0	0	0	2954	10666	12418	14444	13652	7854	300	0	0	62288
1964	0	0	0	1058	14232	21212	18668	18558	8560	1312	0	0	83600
1965	0	0	0	1058	13240	19182	23468	14314	9072	0	0	0	80334
1966	0	0	0	620	9356	12386	14734	17314	10388	0	0	0	64798
1967	0	0	0	0	7072	12054	5166	17894	13194	100	0	0	55480
1968	0	0	0	54	9356	21596	17106	11018	9676	0	0	0	68806
1969	0	0	0	360	14232	13760	20954	13376	5786	34	0	0	68502
1970	0	0	0	332	16554	15624	21016	17234	7090	0	0	0	77850
1971	0	0	0	0	2837	25341	23833	15906	8563	1918	0	0	78398
1972	0	0	405	718	9209	15551	16521	12118	3780	865	0	0	59167
1973	0	0	236	1513	7756	18530	20960	18753	3424	0	362	0	71533
1974	0	0	319	2109	20608	18970	23138	16386	4394	3798	0	0	89721
1975	0	0	0	0	9989	9617	23140	19507	8835	5394	0	0	76482
1976	0	0	0	0	11561	18121	20998	19541	7718	6497	0	0	84436
1977	0	0	0	0	5879	18772	15642	12341	9217	0	0	0	61851
1978	0	0	0	1087	10668	22148	24744	18771	5145	2067	0	0	84630
1979	0	0	0	1756	4544	13601	21709	19183	5053	1196	0	0	67041
1980	0	0	0	0	0	22596	21864	17818	6930	1707	851	0	71765
AVERAGE	0	0	32	1072	11169	19003	19109	16290	9144	1345	40	0	77204
MINIMUM	0	0	0	0	0	9617	5166	11018	3424	0	0	0	55480
MAXIMUM	0	0	405	5656	20608	29794	29824	21076	17900	6497	851	0	105654

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March for 1951-1970.

TABLE B.17

JACKSON DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	1910	2606	2262	820	506	12	0	0	8116
1952	0	0	0	0	154	1016	1626	952	748	700	0	0	5196
1953	0	0	0	0	1226	2036	1432	1062	696	716	0	0	7168
1954	0	0	0	356	1484	1554	1180	842	790	1030	0	0	7236
1955	0	0	0	0	1372	1594	1464	1272	732	750	0	0	7184
1956	0	0	0	0	1238	1724	1272	864	716	632	0	0	6446
1957	0	0	0	0	0	1422	2136	1394	754	452	0	0	6158
1958	0	0	0	0	0	1606	1384	924	800	688	0	0	5402
1959	0	0	0	0	90	1500	1452	1186	688	34	0	0	4950
1960	0	0	0	0	1210	2108	1284	876	742	636	0	0	6856
1961	0	0	0	0	848	708	1586	1418	1336	0	0	0	5896
1962	0	0	0	104	2116	2252	2360	1336	760	28	0	0	8956
1963	0	0	0	168	1452	1546	1238	1456	690	98	0	0	6648
1964	0	0	0	0	1328	1974	1588	1024	848	320	0	0	7082
1965	0	0	0	0	1304	2036	1722	946	764	78	0	0	6850
1966	0	0	0	0	1228	1752	960	820	786	562	0	0	6108
1967	0	0	0	0	1036	1110	818	778	788	384	0	0	4914
1968	0	0	0	0	1266	2194	1492	864	708	40	0	0	6564
1969	0	0	0	230	1144	1632	1450	796	958	96	0	0	6306
1970	0	0	0	0	1072	1196	1762	1188	726	0	0	0	5944
1971	0	0	0	0	385	1310	2138	1027	454	0	0	0	5314
1972	0	0	0	424	1974	2257	1331	843	524	0	0	0	7353
1973	0	0	0	0	1099	2222	1944	1164	404	69	0	0	6902
1974	0	0	0	0	2170	1934	1632	988	376	0	0	0	7100
1975	0	0	0	0	1162	796	2024	1107	822	550	0	0	6461
1976	0	0	174	174	1849	2158	1632	1069	887	111	675	0	8730
1977	0	0	0	297	1784	1804	857	840	758	636	137	0	7112
1978	0	0	0	127	998	1469	1990	923	709	723	0	0	6938
1979	0	0	0	0	0	499	2471	731	109	0	0	0	3810
1980	0	0	0	0	0	1675	1701	867	794	556	0	0	5594
MINIMUM	0	0	0	0	0	499	818	731	109	0	0	0	3810
MAXIMUM	0	0	174	424	2170	2606	2471	1456	1336	1030	675	0	8956
AVERAGE	0	0	6	63	1097	1656	1606	1013	712	330	27	0	6510

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March for 1951-1970.

TABLE B.18

Larimer and Weld Irrigation Company
Direct Flow Rights in Larimer and Weld Canal

Amount (cfs)	Appropriation Date	Adjudication Date
3.0	6/01/1964	4/11/1882
1.47	4/01/1866	4/11/1882
16.67	4/01/1867	4/11/1882
75.0	9/20/1871	4/11/1882
54.33	1/15/1875	4/11/1882
571.0	9/--/1878	4/11/1882
326.0	4/01/1893	12/18/1945

Larimer and Weld Irrigation Company
Storage Decrees

Name	Amount (af)	Appropriation Date	Adjudication Date
Terry Lake	5153.0	6/30/1890	12/09/1904
	2296.0	4/01/1895	12/09/1904
	2296.0	9/02/1905	4/22/1922
	633.0	4/22/1937	9/10/1953
Lee Lake	(Not found in State Engineer's Water Rights Tabulation.)		

Divide Canal and Reservoir Company
Storage Decrees

Name	Amount (af)	Appropriation Date	Adjudication Date
Worster Reservoir	1515.0	7/14/1907	4/22/1922
	1525.0	11/28/1908	4/22/1922
	707.0	8/03/1910	4/22/1922

Windsor Reservoir and Canal Company
Direct Flow Decrees in Poudre Valley Canal

Amount (cfs)	Appropriation Date	Adjudication Date
2.35	3/15/1868	4/11/1882
28.51	3/20/1873	4/11/1882

Note: The Larimer and Weld Irrigation, Divide Canal and Reservoir, and Windsor Reservoir and Canal companies were not willing to provide information for the Study. Information shown in the report is from secondary sources.

TABLE B.18 (Continued)

Windsor Reservoir and Canal Company
Storage Decrees

Name		Amount (af)	Appropriation Date	Adjudication Date
Douglas Reservoir		10,560	9/15/1901	12/09/1904
Windsor Reservoir No. 8		15,381	6/23/1903	
No. 8 Annex		(Not found in State Engineer's Water Rights Tabulation.)		
Elder Reservoir		1,500	7/10/1904	6/15/1906
Cobb Lake		9,113	7/15/1919	5/30/1930
		7,462	12/31/1938	9/10/1953
		3,858	12/31/1938	9/10/1953
	(Refill)	3,858	12/31/1938	12/31/1977
Windsor Reservoir		11,732	7/08/1890	12/09/1904
		5,937	9/09/1901	12/09/1904
	(Refill)	15,620	9/15/1911	9/10/1953
Thompson Lake		(Not found in State Engineer's Water Rights Tabulation.)		

TABLE B.19

LARIMER & WELD CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	3442	13862	25256	16720	4880	1492	0	0	0	65652
1952	0	0	0	0	7288	31990	12204	10048	5460	0	0	0	66990
1953	0	0	0	1160	2602	23520	16302	13590	4356	0	0	0	61530
1954	0	0	0	336	12192	12920	15444	15704	4044	836	0	0	61476
1955	0	0	0	16	6366	12252	10110	9944	3880	0	0	0	42568
1956	0	0	0	0	16310	22070	12450	10574	4236	162	0	0	65802
1957	0	0	0	6822	5222	30670	29840	18190	10818	5350	0	0	106912
1958	0	0	0	0	11038	21698	18872	20498	8478	0	0	0	80584
1959	0	0	0	3282	10906	23696	16630	20884	9070	6748	0	0	91216
1960	0	0	0	974	10900	30142	15220	20932	9646	386	0	0	88200
1961	0	0	0	842	13512	13036	11434	20004	5968	0	0	0	64796
1962	0	0	0	4874	19960	14876	12322	20166	5840	752	0	0	78790
1963	0	0	0	2712	14988	10952	14528	16856	6534	902	0	0	67472
1964	0	0	0	816	17414	20290	21616	18742	6118	0	0	0	84996
1965	0	0	0	462	11148	22732	23740	17390	6800	11370	0	0	93642
1966	0	0	0	612	8708	12944	17860	21744	3338	0	0	0	65206
1967	0	0	0	924	5644	12898	13010	20144	6338	610	0	0	59568
1968	0	0	0	0	8708	24838	23012	20978	3818	1442	0	0	82796
1969	0	0	0	0	16366	14590	18910	17866	6616	0	0	0	74348
1970	0	0	0	0	18066	14278	23592	19756	4724	0	0	0	80416
1971	0	0	0	0	1025	35254	32663	21820	2898	0	0	0	93660
1972	0	0	290	26	8125	21886	16110	14459	85	6899	1508	0	69388
1973	0	0	604	1196	11440	28354	28659	25037	5869	0	0	0	101158
1974	0	0	0	2200	18937	27100	24736	17357	4095	4045	0	0	98469
1975	0	501	614	899	4782	21313	28386	19283	2400	935	895	1350	81356
1976	982	1148	796	297	4800	23116	18656	17321	1828	893	535	414	70785
1977	430	610	430	703	2336	9744	12811	18677	1897	568	430	758	49393
1978	1457	1144	960	933	9033	25061	25342	13779	2503	679	1816	1588	84294
1979	1518	760	843	986	511	13805	24902	25352	2998	27	174	475	72352
1980	0	0	0	0	0	28021	21214	14818	2627	0	2222	2485	71387
MINIMUM	0	0	0	0	0	9744	10110	4880	85	0	0	0	42568
MAXIMUM	1518	1148	960	6822	19960	35254	32663	25352	10818	11370	2222	2485	106912
AVERAGE	146	139	151	1150	9740	20977	19243	17560	4826	1420	253	236	75840

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March

TABLE B.20

POUDRE VALLEY CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	644	16024	15302	6164	152	8	0	0	38294
1952	0	0	0	2800	18318	13600	1482	256	2530	172	0	0	39158
1953	0	0	0	0	80	13386	438	226	240	334	0	0	14704
1954	0	0	0	0	398	600	244	140	94	648	0	0	2124
1955	0	0	0	0	160	4746	126	66	26	3286	0	0	8410
1956	0	0	0	0	2620	10110	460	174	0	164	0	0	13528
1957	0	0	0	0	13790	22814	3940	3026	136	7750	0	0	51456
1958	0	0	0	0	3802	1716	454	498	5620	368	0	0	12458
1959	0	0	0	460	5478	1984	590	446	164	2526	0	0	11648
1960	0	0	0	2580	2406	7846	456	240	314	434	0	0	14276
1961	0	0	0	0	15576	12054	516	0	2152	1660	0	0	31958
1962	0	0	0	114	3828	5028	1124	112	400	334	0	0	10940
1963	0	0	0	196	148	4702	230	164	2892	1894	0	0	10226
1964	0	0	0	0	386	1022	318	60	114	0	0	0	1900
1965	0	0	0	40	400	16390	2930	184	972	23588	0	0	44504
1966	0	0	0	10	544	810	208	144	90	6174	0	0	7980
1967	0	0	0	0	176	20454	8308	282	6744	11274	0	0	47238
1968	0	0	0	198	428	16642	208	84	0	266	0	0	17826
1969	0	0	0	0	12408	7830	236	204	206	68	0	0	20952
1970	0	0	0	1928	2738	9772	664	186	94	0	0	0	15382
1971	0	0	0	0	0	5117	300	266	328	3058	0	0	9069
1972	0	0	0	0	597	11629	200	0	230	0	0	0	12656
1973	0	0	0	1022	2123	2812	1238	404	1646	61	0	0	9306
1974	0	0	0	0	1515	2362	416	396	316	3487	0	0	8491
1975	0	0	0	0	1998	4219	634	467	4	9013	0	0	16334
1976	0	0	0	0	1188	1026	333	135	154	8851	0	0	11687
1977	0	0	0	0	376	545	135	75	0	0	0	0	1131
1978	0	0	374	0	12238	11146	538	283	0	3564	0	0	28143
1979	0	0	0	6102	14260	10464	798	214	306	142	0	0	32286
1980	0	0	0	0	0	998	28	515	279	5588	0	0	7408
AVERAGE	0	0	12	515	3954	7928	1428	514	873	3157	0	0	18382
MINIMUM	0	0	0	0	0	545	28	0	0	0	0	0	1131
MAXIMUM	0	0	374	6102	18318	22814	15302	6164	6744	23588	0	0	51456

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March

TABLE B.21

GREELEY NO. 3 CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	26	2781	4056	5153	4638	3739	1137	0	0	21530
1952	0	0	0	0	2290	5336	4564	4188	3118	2990	0	0	22486
1953	0	0	0	0	2284	4826	4304	4116	3232	2400	0	0	21162
1954	0	0	0	544	4036	3452	3100	3094	2492	2686	0	0	19404
1955	0	0	0	0	3558	3204	3438	3544	2886	2286	0	0	18916
1956	0	0	0	584	4956	5542	3896	3586	2540	1864	0	0	22968
1957	0	0	0	0	2570	5048	6466	4538	3658	2282	0	0	24562
1958	0	0	0	0	2080	5678	4484	4240	3810	2394	0	0	22686
1959	0	0	0	0	3168	5132	4808	3998	3470	0	0	0	20576
1960	0	0	0	810	3194	4250	4514	3582	3552	1960	0	0	21862
1961	0	0	0	62	3436	3892	4970	4462	4618	0	0	0	21440
1962	0	0	0	994	4040	2384	4476	4648	4198	170	0	0	20910
1963	0	0	0	300	4046	3192	3412	3498	1976	934	0	0	17358
1964	0	0	0	0	4214	4006	4532	3566	3440	1984	0	0	21742
1965	0	0	0	508	3310	1736	5038	4810	2552	0	0	0	17954
1966	0	0	0	1022	3362	2082	3572	3752	1208	442	0	0	15440
1967	0	0	0	300	2562	798	4128	4160	2080	880	0	0	14908
1968	0	0	0	170	3136	4420	4710	4194	3754	960	0	0	21344
1969	0	0	0	370	2424	2332	4018	3864	2000	108	0	0	15116
1970	0	0	0	0	2802	1572	4902	4410	1872	0	0	0	15558
1971	0	0	0	1116	4084	4702	4990	3667	2108	0	0	0	20667
1972	0	0	0	1950	2846	4009	3949	3917	3045	2358	0	0	22074
1973	0	0	0	0	2392	3772	4269	4182	3873	1376	0	0	19863
1974	0	0	0	69	3338	4241	4962	3986	2715	1707	0	0	21018
1975	0	0	0	0	3604	3812	5269	4863	4629	671	0	0	22847
1976	0	0	0	0	3390	3530	3905	3804	3503	1766	0	0	19897
1977	0	0	0	1944	2348	3083	3851	3406	2481	2742	224	0	20079
1978	0	0	0	849	3734	4956	4940	3837	3346	3823	0	0	25487
1979	0	0	0	0	2228	4807	5229	5188	4277	5853	1590	0	29171
1980	0	0	0	0	1255	5366	4766	4505	4520	4823	1849	0	27084
MINIMUM	0	0	0	0	1255	798	3100	3094	1208	0	0	0	14908
MAXIMUM	0	0	0	1950	4956	5678	6466	5188	4629	5853	1849	0	29171
AVERAGE	0	0	0	387	3116	3841	4487	4075	3156	1687	122	0	20870

1) Includes direct flow, reservoir water, and CBT water irrigation.

TABLE B.22

Lake Canal Company Water Rights

Name	Amount		Appropriation Date	Adjudication Date
Lake Canal	2.16	cfs	3/01/1862	4/11/1882
Lake Canal	2.78	cfs	9/15/1864	4/11/1882
Lake Canal	158.35	cfs	11/01/1872	4/11/1882
Lake Canal Collection	10.0	cfs	11/01/1872	12/18/1945
Lake Canal Drain Tile 1	.485	cfs	12/31/1957	12/31/1971
Lake Canal Drain Tile 2	.415	cfs	12/31/1957	12/31/1971
Lake Canal Drain Tile 3	.155	cfs	12/31/1957	12/31/1971
Lake Canal Drain Tile 4	.340	cfs	12/31/1957	12/31/1971
Lake Canal Reservoir #1	803	af	10/15/1898	12/09/1904
North Gray Reservoir	135	af	4/01/1882	12/09/1904
North Gray Res. Enlg.	140	af	11/01/1902	12/09/1904
North Gray Res. 2nd Enlg.	57	af	11/15/1904	4/22/1922
South Gray Reservoir	275	af	4/01/1882	12/09/1904
South Gray Res. Enlg.	236	af	11/01/1902	12/09/1904
South Gray Res. 2nd Enlg.	222	af	11/16/1904	4/22/1922
Gray Reservoir No. 3	111	af	11/14/1904	4/22/1922

TABLE B.23

LAKE CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	3598	5932	5682	230	300	54	0	0	15796
1952	0	0	0	0	2540	7234	690	946	564	80	0	0	12054
1953	0	0	0	0	1684	7852	900	1382	748	128	0	0	12694
1954	0	0	0	0	3454	1912	1584	1404	318	708	0	0	9380
1955	0	0	0	50	1622	6898	954	1690	1026	0	0	0	12240
1956	0	0	0	0	4658	6800	988	764	456	0	0	0	13666
1957	0	0	0	0	296	5816	6768	1522	1066	0	0	0	15468
1958	0	0	0	0	0	5062	922	1748	902	30	0	0	8664
1959	0	0	0	0	1918	7094	1974	1504	620	0	0	0	13110
1960	0	0	0	0	5070	4264	980	1902	444	0	0	0	12660
1961	0	0	0	0	1240	3424	2160	1034	306	0	0	0	8164
1962	0	0	0	408	5068	4184	4424	1562	516	0	0	0	16162
1963	0	0	0	0	2568	1470	1750	1102	582	0	0	0	7472
1964	0	0	0	0	3636	5522	1812	1322	686	0	0	0	12978
1965	0	0	0	0	2974	2360	4808	1552	358	0	0	0	12052
1966	0	0	0	0	932	3420	1964	1986	146	0	0	0	8448
1967	0	0	0	0	1792	2232	2524	2074	762	184	0	0	9568
1968	0	0	0	0	1470	6436	2832	560	0	0	0	0	11298
1969	0	0	0	0	3484	2726	2328	1466	684	0	0	0	10688
1970	0	0	0	0	3128	2812	4002	1100	608	0	0	0	11650
1971	0	0	0	0	960	5365	4629	1238	292	0	0	0	12484
1972	0	0	0	0	2563	3271	1184	1511	389	0	0	0	8918
1973	0	0	0	0	2321	5170	4657	1436	434	0	0	0	14017
1974	0	0	0	0	4457	4805	3067	1422	826	0	0	0	14577
1975	0	0	0	0	2271	3198	6147	1895	711	0	0	0	14221
1976	0	0	0	0	2047	5544	1753	2162	1017	0	0	0	12522
1977	0	0	0	0	958	3872	1073	1497	713	0	0	0	8113
1978	0	0	0	0	1245	5485	4572	1586	411	0	0	0	13299
1979	0	0	0	0	319	2891	5486	1722	742	0	0	0	11160
1980	0	0	0	0	0	5199	4502	2108	1213	0	0	0	13023
AVERAGE	0	0	0	15	2276	4608	2904	1448	595	39	0	0	11885
MINIMUM	0	0	0	0	0	1470	690	230	0	0	0	0	7472
MAXIMUM	0	0	0	408	5070	7852	6768	2162	1213	708	0	0	16162

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March

TABLE B.24

NEW MERCER DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	2572	2342	2104	470	508	0	0	0	7996
1952	0	0	0	0	334	2944	1246	1010	436	26	0	0	5996
1953	0	0	0	0	874	3118	1318	1170	600	84	0	0	7164
1954	0	0	0	0	1346	1276	1208	506	128	116	0	0	4580
1955	0	0	0	0	1056	2324	1294	1446	536	56	0	0	6712
1956	0	0	0	0	1888	2568	1100	1038	476	0	0	0	7070
1957	0	0	0	0	0	3124	3500	744	1016	160	0	0	8544
1958	0	0	0	0	0	2018	1388	1138	650	0	0	0	5194
1959	0	0	0	0	78	3476	1388	1262	660	12	0	0	6876
1960	0	0	0	0	760	2288	1308	1566	408	0	0	0	6330
1961	0	0	0	0	0	1074	1570	1194	428	0	0	0	4266
1962	0	0	0	0	1754	1658	2258	1402	446	0	0	0	7518
1963	0	0	0	24	1818	1716	1762	1034	520	0	0	0	6874
1964	0	0	0	0	1268	1698	2192	1230	0	90	0	0	6478
1965	0	0	0	0	1188	1428	1768	1380	360	0	0	0	6124
1966	0	0	0	0	1628	2186	1708	966	222	0	0	0	6710
1967	0	0	0	0	466	1040	1384	1924	1070	0	0	0	5884
1968	0	0	0	0	464	2628	1990	938	730	190	0	0	6940
1969	0	0	0	0	636	1610	2178	1220	508	0	0	0	6152
1970	0	0	0	0	1072	1832	2370	1412	550	0	0	0	7236
1971	0	0	0	0	0	3342	2442	1357	268	0	0	0	7409
1972	0	0	0	0	1087	2985	1458	817	123	0	0	0	6470
1973	0	0	0	0	729	2653	2253	1210	438	0	0	0	7283
1974	0	0	0	0	2532	1820	1622	1059	220	0	0	0	7253
1975	0	0	0	0	857	2018	2532	1236	303	0	0	0	6946
1976	0	0	0	0	764	2926	1850	1113	330	0	0	0	6983
1977	0	0	0	0	812	2244	976	366	238	24	0	0	4660
1978	0	0	0	0	956	2489	2600	1317	232	0	0	0	7594
1979	0	0	0	0	0	477	2873	1557	810	107	0	0	5824
1980	0	0	0	0	0	3093	2523	1023	602	368	0	0	7609
AVERAGE	0	0	0	1	898	2213	1872	1137	461	41	0	0	6622
MINIMUM	0	0	0	0	0	477	976	366	0	0	0	0	4266
MAXIMUM	0	0	0	24	2572	3476	3500	1924	1070	368	0	0	8544

1) Includes direct flow, exchanges, reservoir water and CBT water
for irrigation and storage.

TABLE B.25

BOXELDER DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	1292	1806	2166	670	1050	0	0	0	6984
1952	0	0	0	0	792	2448	1576	1998	1558	0	0	0	8372
1953	0	0	0	0	1530	2284	2388	1870	856	0	0	0	8928
1954	0	0	0	188	2578	2238	2214	524	470	254	0	0	8466
1955	0	0	0	100	2112	870	2150	1312	558	0	0	0	7102
1956	0	0	0	0	750	1794	2276	1080	380	1034	0	0	7314
1957	0	0	0	0	0	1082	2352	1364	838	0	0	0	5636
1958	0	0	0	0	0	1162	2048	1658	646	46	0	0	5560
1959	0	0	0	0	394	2352	2334	2072	494	0	0	0	7646
1960	0	0	0	228	1060	1712	2300	1572	670	74	0	0	7616
1961	0	0	0	0	174	780	1912	1452	494	0	0	0	4812
1962	0	0	0	336	1706	1244	2022	1830	668	0	0	0	7806
1963	0	0	0	320	2530	988	2290	632	562	0	0	0	7322
1964	0	0	0	0	1970	1190	2712	1282	600	720	0	0	8474
1965	0	0	0	0	1464	246	1368	1636	672	0	0	0	5386
1966	0	0	0	168	1584	1122	2312	470	228	198	0	0	6082
1967	0	0	0	0	496	72	1040	1660	560	410	0	0	4238
1968	0	0	0	0	1072	1246	2478	1338	896	456	0	0	7486
1969	0	0	0	8	794	674	2268	1438	342	0	0	0	5524
1970	0	0	0	0	692	652	1676	1756	374	0	0	0	5150
1971	0	0	0	0	165	1989	2176	1609	373	0	0	0	6312
1972	0	0	0	91	1339	1049	2128	1275	159	210	0	0	6251
1973	0	0	0	0	271	1756	2129	1758	782	65	0	0	6762
1974	0	0	0	0	1744	1378	2265	1719	659	121	0	0	7886
1975	0	0	0	0	909	741	2499	1663	568	214	0	0	6593
1976	0	0	0	0	737	2055	2699	2123	715	34	0	0	8362
1977	0	0	0	0	1533	2528	1186	1190	750	412	0	0	7599
1978	0	0	0	77	255	1162	2485	2172	838	0	0	0	6989
1979	0	0	0	0	0	18	2256	1115	53	0	0	0	3442
1980	0	0	0	0	0	1443	1691	1477	535	0	0	0	5146
MINIMUM	0	0	0	0	0	18	1040	470	53	0	0	0	3442
MAXIMUM	0	0	0	336	2578	2528	2712	2172	1558	1034	0	0	8928
AVERAGE	0	0	0	51	998	1336	2113	1457	612	142	0	0	6708

1) Includes direct flow and CBT water for irrigation.

TABLE B.26

ARTHUR DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	1602	1432	2102	368	546	18	0	0	6068
1952	0	0	0	0	1128	3016	1856	696	414	294	0	0	7404
1953	0	0	0	0	1202	2504	1402	1024	644	348	0	0	7124
1954	0	0	0	0	1872	2298	514	514	282	616	0	0	6096
1955	0	0	0	234	2076	2060	1438	990	686	518	0	0	8002
1956	0	0	0	0	2248	2340	1122	936	522	48	0	0	7216
1957	0	0	0	0	0	1714	3068	1278	566	224	0	0	6850
1958	0	0	0	0	32	3010	1660	828	664	878	0	0	7072
1959	0	0	0	0	266	3048	1646	1086	698	0	0	0	6744
1960	0	0	0	324	1798	2230	1760	902	794	564	0	0	8372
1961	0	0	0	0	182	2264	1932	1040	402	0	0	0	5820
1962	0	0	0	360	2186	1738	1964	966	530	0	0	0	7744
1963	0	0	0	42	2340	1882	798	1074	382	0	0	0	6518
1964	0	0	0	0	1946	1738	1730	924	380	0	0	0	6718
1965	0	0	0	0	1578	640	1844	1190	258	0	0	0	5510
1966	0	0	0	250	1822	1800	918	632	400	358	0	0	6180
1967	0	0	0	0	640	446	1038	934	336	4	0	0	3398
1968	0	0	0	0	876	1942	1826	576	456	84	0	0	5760
1969	0	0	0	0	520	1330	1846	506	326	50	0	0	4578
1970	0	0	0	0	908	1248	2008	910	98	0	0	0	5172
1971	0	0	0	0	0	2380	2400	671	264	0	0	0	5715
1972	0	0	0	0	1277	1230	1006	414	54	0	0	0	3981
1973	0	0	0	0	762	1976	1424	933	176	0	0	0	5271
1974	0	0	0	0	1340	1287	1881	729	83	0	0	0	5320
1975	0	0	0	0	687	788	1727	737	218	0	0	0	4156
1976	0	0	0	0	875	2081	1414	350	192	0	0	0	4912
1977	0	0	0	0	964	1418	671	55	354	0	0	0	3463
1978	0	0	0	0	99	1186	1905	362	0	0	0	0	3552
1979	0	0	0	0	145	871	1362	206	46	0	0	0	2629
1980	0	0	0	0	0	1125	1109	370	149	0	0	0	2752
AVERAGE	0	0	0	40	1046	1767	1579	740	364	133	0	0	5670
MINIMUM	0	0	0	0	0	446	514	55	0	0	0	0	2629
MAXIMUM	0	0	0	360	2340	3048	3068	1278	794	878	0	0	8372

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation.

TABLE B.27

B.H. EATON DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	792	706	908	772	712	0	0	0	3890
1952	0	0	0	0	390	1170	1542	1344	552	154	0	0	5152
1953	0	0	0	0	484	916	1192	868	736	64	0	0	4260
1954	0	0	0	650	524	582	1028	518	522	46	0	0	3870
1955	0	0	0	102	1002	440	792	386	270	10	0	0	3002
1956	0	0	0	80	524	752	840	494	240	0	0	0	2930
1957	0	0	0	0	0	592	1278	1050	462	0	0	0	3382
1958	0	0	0	0	0	838	1196	1252	906	0	0	0	4192
1959	0	0	0	0	392	1178	1500	1376	852	0	0	0	5298
1960	0	0	0	250	644	1262	1616	1434	868	0	0	0	6074
1961	0	0	0	0	314	448	1390	1466	718	0	0	0	4336
1962	0	0	0	0	1172	712	1602	1584	912	0	0	0	5982
1963	0	0	0	418	1500	1086	1506	932	438	0	0	0	5880
1964	0	0	0	0	1320	692	1664	1542	970	10	0	0	6198
1965	0	0	0	204	1128	218	1020	1318	408	0	0	0	4296
1966	0	0	0	14	1264	606	1606	1150	308	0	0	0	4948
1967	0	0	0	38	500	70	652	1454	472	0	0	0	3186
1968	0	0	0	0	1044	946	1572	1390	694	0	0	0	5646
1969	0	0	0	110	806	656	1530	1626	862	0	0	0	5590
1970	0	0	0	0	832	312	1250	1502	748	0	0	0	4644
1971	0	0	0	0	0	460	1726	1676	825	0	0	0	4687
1972	0	0	0	674	722	426	1698	1636	42	0	0	0	5198
1973	0	0	0	0	285	1632	1638	1505	681	0	0	0	5740
1974	0	0	0	0	665	685	1820	1467	426	0	0	0	5063
1975	0	0	0	0	946	564	1764	1535	1071	16	0	0	5896
1976	0	0	0	0	554	935	1879	1493	784	0	0	0	5645
1977	0	0	0	0	939	1538	849	636	634	160	0	0	4756
1978	0	0	0	548	83	814	1792	1406	1083	115	0	0	5841
1979	0	0	0	0	0	47	1414	473	489	0	0	0	2423
1980	0	0	0	0	0	774	1612	1717	1016	152	0	0	5271
AVERAGE	0	0	0	103	628	735	1396	1233	657	24	0	0	4776
MINIMUM	0	0	0	0	0	47	652	386	42	0	0	0	2423
MAXIMUM	0	0	0	674	1500	1632	1879	1717	1083	160	0	0	6198

1) Includes direct flow water for irrigation.

TABLE B.28

BOYD & FREEMAN DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	156	232	218	100	6	0	0	712
1952	0	0	0	0	52	490	382	376	160	66	0	0	1526
1953	0	0	0	0	66	178	248	320	202	152	0	0	1166
1954	0	0	0	70	286	158	192	208	156	202	0	0	1272
1955	0	0	0	0	188	284	152	280	190	110	0	0	1204
1956	0	0	0	20	296	340	198	224	120	120	0	0	1318
1957	0	0	0	0	2	62	456	302	56	26	0	0	904
1958	0	0	0	0	0	344	214	316	314	160	0	0	1348
1959	0	0	0	0	212	390	260	312	160	0	0	0	1334
1960	0	0	0	76	114	102	106	78	20	0	0	0	496
1961	0	0	0	0	46	40	116	152	24	0	0	0	378
1962	0	0	0	46	70	120	312	262	120	0	0	0	930
1963	0	0	0	122	274	242	274	162	24	0	0	0	1098
1964	0	0	0	0	232	200	274	218	144	46	0	0	1114
1965	0	0	0	0	182	110	390	338	258	0	0	0	1278
1966	0	0	0	0	348	210	304	240	40	4	0	0	1146
1967	0	0	0	0	220	12	196	332	302	0	0	0	1062
1968	0	0	0	0	232	278	294	236	188	118	0	0	1346
1969	0	0	0	0	264	272	438	330	78	0	0	0	1382
1970	0	0	0	0	152	128	178	214	68	0	0	0	740
1971	0	0	0	0	149	339	405	250	61	0	0	0	1204
1972	0	0	0	157	256	335	325	198	0	0	0	0	1271
1973	0	0	0	0	131	404	477	345	204	83	0	0	1643
1974	0	0	0	0	251	319	467	481	0	0	0	0	1519
1975	0	0	0	0	180	164	311	289	246	24	0	0	1214
1976	0	0	0	0	178	184	341	291	244	77	0	0	1315
1977	0	0	0	166	152	150	154	69	36	0	0	0	729
1978	0	0	0	26	30	149	301	182	24	0	0	0	711
1979	0	0	0	0	0	0	190	180	18	0	0	0	388
1980	0	0	0	0	0	200	315	147	0	0	0	0	661
AVERAGE	0	0	0	23	152	212	283	252	119	40	0	0	1080
MINIMUM	0	0	0	0	0	0	106	69	0	0	0	0	378
MAXIMUM	0	0	0	166	348	490	477	481	314	202	0	0	1643

1) Includes direct flow water for irrigation.

TABLE B.29

CHAFFEE DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	180	284	300	0	0	0	0	0	764
1952	0	0	0	0	12	472	48	22	0	0	0	0	554
1953	0	0	0	0	82	364	32	46	0	0	0	0	524
1954	0	0	0	0	302	92	0	0	0	0	0	0	394
1955	0	0	0	0	250	96	0	0	0	18	0	0	364
1956	0	0	0	0	246	410	40	0	0	0	0	0	696
1957	0	0	0	0	0	176	456	40	0	0	0	0	672
1958	0	0	0	0	0	236	0	0	0	0	0	0	236
1959	0	0	0	0	0	350	64	42	10	0	0	0	466
1960	0	0	0	0	194	230	70	24	0	18	0	0	536
1961	0	0	0	0	0	202	54	50	18	0	0	0	324
1962	0	0	0	0	266	162	226	62	0	0	0	0	716
1963	0	0	0	0	342	66	46	34	0	0	0	0	488
1964	0	0	0	0	298	252	48	38	60	0	0	0	696
1965	0	0	0	0	196	28	270	36	6	0	0	0	536
1966	0	0	0	0	238	70	82	24	0	0	0	0	414
1967	0	0	0	0	86	12	30	62	0	0	0	0	190
1968	0	0	0	0	0	422	142	60	0	0	0	0	624
1969	0	0	0	0	92	52	162	64	0	0	0	0	370
1970	0	0	0	0	112	144	166	90	0	0	0	0	512
1971	0	0	0	0	0	335	266	108	0	0	0	0	709
1972	0	0	0	0	206	242	58	34	0	0	0	0	540
1973	0	0	0	0	182	325	121	75	0	0	0	0	703
1974	0	0	0	0	105	141	125	117	0	0	0	0	487
1975	0	0	0	0	0	0	305	0	0	0	0	0	305
1976	0	0	0	0	0	190	12	20	0	0	0	0	222
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	4	48	30	0	0	0	0	0	81
1979	0	0	0	0	0	50	79	0	0	0	0	0	129
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
AVERAGE	0	0	0	0	113	182	108	35	3	1	0	0	442
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	342	472	456	117	60	18	0	0	764

1) Includes direct flow and CBT water for irrigation.

TABLE B.30

COY DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	76	868	948	162	282	36	0	0	2372
1952	0	0	0	0	212	506	346	324	232	38	0	0	1658
1953	0	0	0	0	284	350	374	412	190	130	0	0	1740
1954	0	0	0	210	408	396	310	88	18	0	0	0	1430
1955	0	0	0	82	220	164	498	498	46	86	0	0	1594
1956	0	0	0	0	152	326	380	230	14	120	0	0	1222
1957	0	0	0	0	0	196	478	336	166	34	0	0	1210
1958	0	0	0	0	0	166	304	456	154	0	0	0	1080
1959	0	0	0	0	88	220	472	306	34	0	0	0	1120
1960	0	0	0	36	110	328	682	574	20	0	0	0	1750
1961	0	0	0	0	0	16	152	142	106	0	0	0	416
1962	0	0	0	0	102	118	198	264	94	0	0	0	776
1963	0	0	0	40	230	136	294	174	6	0	0	0	880
1964	0	0	0	0	152	168	294	214	50	22	0	0	900
1965	0	0	0	0	130	142	254	334	72	0	0	0	932
1966	0	0	0	42	144	228	312	160	160	6	0	0	1052
1967	0	0	0	0	80	14	156	142	0	0	0	0	392
1968	0	0	0	0	80	178	320	154	78	0	0	0	810
1969	0	0	0	0	22	142	406	354	0	0	0	0	924
1970	0	0	0	0	58	120	342	222	174	4	0	0	920
1971	0	0	0	2	34	182	282	301	228	109	0	0	1138
1972	0	0	8	20	93	254	339	347	268	161	0	0	1490
1973	0	0	0	0	141	271	347	333	121	57	0	0	1269
1974	0	0	0	14	286	306	380	300	250	46	20	22	1624
1975	0	0	0	14	218	176	320	268	272	126	0	0	1394
1976	0	0	0	10	186	208	208	234	198	100	20	22	1186
1977	20	18	20	20	126	286	232	214	202	132	20	20	1310
1978	22	0	22	176	138	190	210	240	168	136	20	0	1322
1979	0	0	20	20	186	180	116	210	132	130	68	18	1080
1980	0	0	0	0	22	330	248	208	138	96	0	0	1042
AVERAGE	1	1	2	23	133	239	340	273	129	52	5	3	1201
MINIMUM	0	0	0	0	0	14	116	88	0	0	0	0	392
MAXIMUM	22	18	22	210	408	868	948	574	282	161	68	22	2372

1) Includes direct flow and CBT water for irrigation.

TABLE B.31

JONES DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	436	886	1026	760	608	0	0	0	3716
1952	0	0	0	0	678	854	898	912	816	162	0	0	4320
1953	0	0	0	0	570	950	842	930	830	120	0	0	4242
1954	0	0	0	648	686	856	826	822	734	184	0	0	4756
1955	0	0	0	180	752	526	794	666	878	22	0	0	3818
1956	0	0	0	142	546	896	904	856	636	174	0	0	4154
1957	0	0	0	0	0	410	690	864	666	0	0	0	2630
1958	0	0	0	0	60	586	770	872	716	0	0	0	3004
1959	0	0	0	0	360	872	884	830	658	0	0	0	3604
1960	0	0	0	274	776	890	844	926	812	12	0	0	4534
1961	0	0	0	0	328	180	846	914	580	0	0	0	2848
1962	0	0	0	272	780	404	808	928	874	0	0	0	4066
1963	0	0	0	424	932	738	976	718	274	0	0	0	4062
1964	0	0	0	0	826	694	938	950	796	8	0	0	4212
1965	0	0	0	150	792	328	674	850	292	0	0	0	3086
1966	0	0	0	0	796	754	876	858	118	76	0	0	3478
1967	0	0	0	102	626	208	720	864	306	0	0	0	2826
1968	0	0	0	0	684	844	900	898	654	236	0	0	4216
1969	0	0	0	14	622	608	902	788	206	56	0	0	3196
1970	0	0	0	0	556	538	866	872	404	16	0	0	3252
1971	0	0	0	0	0	573	893	871	347	0	0	0	2684
1972	0	0	0	397	791	635	885	789	282	44	0	0	3823
1973	0	0	0	0	153	764	883	915	537	55	0	0	3307
1974	0	0	0	0	410	677	919	766	392	48	0	0	3212
1975	0	0	0	0	440	299	863	816	552	20	0	0	2990
1976	0	0	0	0	261	647	911	786	596	0	0	0	3202
1977	0	0	0	20	545	828	562	739	618	141	0	0	3451
1978	0	0	0	224	255	408	950	941	665	0	0	0	3443
1979	0	0	0	0	0	109	871	537	467	32	0	0	2016
1980	0	0	0	0	0	343	744	853	546	28	0	0	2515
AVERAGE	0	0	0	95	489	610	849	836	562	48	0	0	3489
MINIMUM	0	0	0	0	0	109	562	537	118	0	0	0	2016
MAXIMUM	0	0	0	648	932	950	1026	950	878	236	0	0	4756

1) Includes direct flow and CBT water for irrigation.

TABLE B.32

JOSH AMES DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	504	732	1038	108	142	38	0	0	2562
1952	0	0	0	0	0	596	482	362	108	24	0	0	1572
1953	0	0	0	0	188	920	818	592	138	48	0	0	2704
1954	0	0	0	0	646	854	504	178	80	0	0	0	2262
1955	0	0	0	0	690	388	794	378	102	0	0	0	2352
1956	0	0	0	0	136	794	708	178	34	24	0	0	1874
1957	0	0	0	0	0	292	868	626	310	0	0	0	2096
1958	0	0	0	0	0	420	700	324	26	72	0	0	1542
1959	0	0	0	0	0	426	762	546	52	0	0	0	1786
1960	0	0	0	0	110	450	642	426	94	0	0	0	1722
1961	0	0	0	0	0	90	526	294	30	0	0	0	940
1962	0	0	0	0	210	208	520	284	24	0	0	0	1246
1963	0	0	0	0	498	248	400	268	46	0	0	0	1460
1964	0	0	0	0	284	132	502	176	8	0	0	0	1102
1965	0	0	0	0	242	248	400	300	104	0	0	0	1294
1966	0	0	0	0	332	354	350	140	36	0	0	0	1212
1967	0	0	0	0	0	0	106	240	32	0	0	0	378
1968	0	0	0	0	30	442	574	190	130	8	0	0	1374
1969	0	0	0	0	36	196	422	94	110	8	0	0	866
1970	0	0	0	0	44	122	354	258	30	0	0	0	808
1971	0	0	0	0	0	244	137	75	6	0	0	0	462
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
MINIMUM	0	0	0	0	0	0	106	75	6	0	0	0	378
MAXIMUM	0	0	0	0	690	920	1038	626	310	72	0	0	2704
51-71 AVG	0	0	0	0	188	388	553	287	78	11	0	0	1505

1) Includes direct flow and CBT water for irrigation.
2) After 1971, diverted at Munroe Canal.

51-80 avg	0	0	0	0	132	272	387	201	55	7	0	0	1054

TABLE B.33

LITTLE CACHE LA POUDRE DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	518	4338	1630	304	100	0	0	0	6890
1952	0	0	0	1284	552	2490	1300	490	180	722	0	0	7018
1953	0	0	0	0	454	2880	1840	690	44	392	0	0	6300
1954	0	0	0	0	1270	1590	644	304	0	544	0	0	4352
1955	0	0	0	1180	1716	1420	1940	1170	40	446	0	0	7912
1956	0	0	0	1630	1572	2294	2298	1528	0	0	0	0	9322
1957	0	0	0	0	2876	1658	3176	3714	1876	480	0	0	13780
1958	0	0	0	0	2390	2296	3596	798	256	538	0	0	9874
1959	0	0	0	704	1040	3564	3618	1620	266	918	0	0	11730
1960	0	0	0	486	2162	4634	3780	842	196	1994	0	0	14094
1961	0	0	0	714	1426	978	3786	3782	2186	0	0	0	12872
1962	0	0	0	276	2952	3066	3326	1664	214	5102	0	0	16600
1963	0	0	0	88	2990	3260	954	1180	10	2414	0	0	10896
1964	0	0	0	0	1578	3680	3680	1192	30	0	0	0	10160
1965	0	0	0	314	946	4064	3826	3268	292	2126	0	0	14836
1966	0	0	0	0	3010	3724	1852	616	64	1138	0	0	10404
1967	0	0	0	0	936	2742	1572	684	80	1024	0	0	7038
1968	0	0	0	0	2056	2396	5612	1232	0	0	0	0	11296
1969	0	0	0	0	4232	2672	3666	804	0	0	0	0	11374
1970	0	0	132	5686	1124	4360	3878	2914	626	0	0	0	18720
1971	0	0	0	778	0	1948	3116	2821	202	4295	0	0	13160
1972	0	0	210	87	3584	3455	2979	653	990	188	1166	360	13672
1973	0	0	537	0	337	4507	2966	1081	0	0	0	1071	10499
1974	0	0	590	719	3619	3289	3859	1184	545	3079	0	0	16884
1975	0	0	0	0	2228	1574	2680	2356	147	1749	497	0	11231
1976	0	0	89	654	1812	4742	4412	1825	440	2907	160	75	17116
1977	0	0	0	321	3342	3754	1974	2198	275	645	1244	778	14532
1978	0	46	0	0	2192	3528	4475	2095	2071	1776	0	0	16183
1979	0	554	638	2229	1635	451	3625	2760	67	0	0	0	11961
1980	0	0	0	0	374	3273	4002	2020	491	2877	1067	0	14103
AVERAGE	0	20	73	572	1831	2954	3002	1593	390	1178	138	76	11827
MINIMUM	0	0	0	0	0	451	644	304	0	0	0	0	4352
MAXIMUM	0	554	638	5686	4232	4742	5612	3782	2186	5102	1244	1071	18720

1) Includes direct flow, exchanges and CBT water for irrigation and storage.

2) "To Storage" diversions not available for November through March for 1951-1970.

TABLE B.34

OGILVY DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	756	3228	3524	3242	2932	566	0	0	14248
1952	0	0	0	0	2124	3360	2810	2952	2720	1028	0	0	14994
1953	0	0	0	0	2044	3068	2578	2596	2480	1916	0	0	14682
1954	0	0	0	736	1976	1754	1716	1666	1630	1836	0	0	11314
1955	0	0	0	0	1532	2222	786	1534	1770	838	0	0	8682
1956	0	0	0	420	1780	2792	1712	2096	1662	676	0	0	11138
1957	0	0	0	0	0	3120	3608	3118	2722	1120	0	0	13688
1958	0	0	0	0	1188	2720	2848	2814	2864	958	0	0	13392
1959	0	0	0	0	1018	2548	2638	2590	2422	224	0	0	11440
1960	0	0	0	82	1828	2352	2840	2462	3478	1122	0	0	14164
1961	0	0	0	0	2456	2568	3278	3504	2902	0	0	0	14708
1962	0	0	0	600	3100	2846	2350	3306	3070	158	0	0	15430
1963	0	0	0	840	2040	2514	2756	3164	2154	1232	0	0	14700
1964	0	0	0	0	1650	2020	2760	1432	2574	930	0	0	11366
1965	0	0	0	386	2036	812	3156	3634	2424	0	0	0	12448
1966	0	0	0	374	2062	2260	1656	2234	1828	1140	0	0	11554
1967	0	0	0	252	998	130	2204	3040	2418	0	0	0	9042
1968	0	0	0	232	2330	2762	2810	2828	2346	896	0	0	14204
1969	0	0	0	0	2088	1482	2926	3240	2780	432	0	0	12948
1970	0	0	0	0	1896	2374	3202	3616	2502	0	0	0	13590
1971	0	0	0	0	87	2961	3390	3442	2073	0	0	0	11953
1972	0	0	0	1470	2930	3237	3598	3682	783	0	0	0	15700
1973	0	0	0	0	1269	3320	3443	3743	2344	0	0	0	14119
1974	0	0	0	285	3366	3190	3792	3831	1556	0	0	0	16020
1975	0	0	0	1689	3124	2926	3909	4126	2738	0	0	0	18512
1976	0	0	0	444	2728	3195	3681	4079	2412	0	0	0	16539
1977	0	0	0	1572	2689	3045	3831	3859	3059	26	0	0	18081
1978	0	0	0	610	1994	3182	4065	4794	3388	1778	0	0	19811
1979	0	0	0	0	1548	3821	4328	877	2841	1455	0	0	14870
1980	0	0	0	0	1398	4592	5003	4809	3714	1671	0	0	21187
AVERAGE	0	0	0	333	1868	2680	3040	3077	2486	667	0	0	14151
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	1689	3366	4592	5003	4809	3714	1916	0	0	21187

1) Includes direct flow, reservoir water, and CBT water for irrigation.

TABLE B.35

PLEASANT VALLEY & LAKE CANAL DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	392	3616	3816	3646	1010	2340	200	0	0	15020
1952	0	0	0	0	1520	4746	3178	3124	2064	750	0	0	15382
1953	0	0	0	0	1964	4230	3200	2690	2460	1360	0	0	15904
1954	0	0	0	1138	3038	3572	3242	2110	1494	2046	0	0	16640
1955	0	0	0	380	2916	3818	3474	3030	2152	1970	0	0	17740
1956	0	0	0	276	3912	4484	3222	2708	1578	1410	0	0	17590
1957	0	0	0	0	214	4712	4784	2704	1860	1644	0	0	15918
1958	0	0	0	0	60	4430	3356	3164	2662	1944	0	0	15616
1959	0	0	0	0	910	5194	3542	3278	1928	786	0	0	15638
1960	0	0	0	348	3374	5044	3580	3326	1714	1784	0	0	19170
1961	0	0	0	0	734	2220	3472	3166	1942	0	0	0	11534
1962	0	0	0	120	4156	4922	5070	3364	3028	26	0	0	20686
1963	0	0	0	614	3216	3430	3328	3082	1972	1950	0	0	17592
1964	0	0	0	60	3020	4584	3538	3076	1822	2346	0	0	18446
1965	0	0	0	104	2348	3616	3894	2980	2386	258	0	0	15586
1966	0	0	0	204	2536	3418	2950	1646	2324	2000	0	0	15078
1967	0	0	0	144	1972	288	1456	3096	2138	670	0	0	9764
1968	0	0	0	80	1968	5252	3268	2884	2336	686	0	0	16474
1969	0	0	0	0	2276	3100	3124	2870	1974	180	0	0	13524
1970	0	0	0	216	3062	2386	3708	3078	2156	258	0	0	14864
1971	0	0	0	188	0	4406	4703	3091	1984	56	0	0	14428
1972	0	0	0	0	3235	4804	2957	3059	2085	1367	0	0	17507
1973	0	0	0	125	2645	5958	3748	2891	2678	456	0	0	18501
1974	0	0	0	0	4536	4619	3356	3053	2540	818	0	0	18922
1975	0	0	0	426	1746	3716	4912	3019	2128	963	0	0	16911
1976	0	0	0	0	2156	4399	3317	2865	1995	895	0	0	15628
1977	0	0	0	455	2635	3259	2634	2497	2688	1155	0	0	15324
1978	0	0	145	303	1497	3370	3514	3188	2675	1634	0	0	16326
1979	0	0	0	0	782	3008	3393	2558	1655	1168	0	0	12565
1980	0	0	0	0	55	4471	3030	3239	2459	962	0	0	14216
AVERAGE	0	0	5	186	2203	3976	3487	2862	2174	1058	0	0	15950
MINIMUM	0	0	0	0	0	288	1456	1010	1494	0	0	0	9764
MAXIMUM	0	0	145	1138	4536	5958	5070	3364	3028	2346	0	0	20686

1) Includes direct flow, exchanges, reservoir water, CBT water and transbasin imports for irrigation and storage.

2) "To Storage" diversions not available for November through March for 1951-1970.

TABLE B.36

WHITNEY DITCH DIVERSIONS
ALL SOURCES FOR ALL USES

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	1352	2194	3026	2362	1832	0	0	0	10766
1952	0	0	0	0	1544	2870	3024	2742	1596	0	0	0	11776
1953	0	0	0	0	1440	2432	2786	2350	2046	0	0	0	11054
1954	0	0	0	1860	1744	2436	2344	2190	1904	0	0	0	12478
1955	0	0	0	466	2206	1296	2394	2280	1874	0	0	0	10516
1956	0	0	0	132	1588	2586	2572	2186	2030	0	0	0	11094
1957	0	0	0	0	38	1348	2764	2616	1598	0	0	0	8364
1958	0	0	0	0	360	1838	2468	2670	1900	0	0	0	9236
1959	0	0	0	0	1080	2530	2922	2706	2256	0	0	0	11494
1960	0	0	0	722	1872	2374	2220	2972	1870	0	0	0	12030
1961	0	0	0	0	1044	854	2604	2568	1568	0	0	0	8638
1962	0	0	0	870	2210	1746	2488	3052	1506	0	0	0	11872
1963	0	0	0	1328	2638	1712	2710	2462	1160	0	0	0	12010
1964	0	0	0	0	2196	1454	3270	2748	2392	18	0	0	12078
1965	0	0	0	624	2386	492	2380	2856	1722	0	0	0	10460
1966	0	0	0	416	2586	1390	2972	2692	1374	0	0	0	11430
1967	0	0	0	100	1708	610	1686	3072	1862	0	0	0	9038
1968	0	0	0	0	1892	2064	2848	2938	2024	0	0	0	11766
1969	0	0	0	184	1500	1142	3316	3262	1570	0	0	0	10974
1970	0	0	0	0	1798	1440	2940	2924	1740	0	0	0	10842
1971	0	0	0	262	242	2180	3130	3160	1218	0	0	0	10192
1972	0	0	0	879	2602	1472	3140	2739	603	266	0	0	11701
1973	0	0	0	0	1059	2034	3233	3665	1267	0	0	0	11258
1974	0	0	0	0	1770	1988	3837	2889	1097	0	0	0	11581
1975	0	0	0	0	1635	725	3877	3495	1645	129	0	0	11506
1976	0	0	0	119	600	2006	3956	3813	1938	0	0	0	12432
1977	0	0	0	414	1307	2823	2188	2166	1323	255	0	0	10476
1978	0	0	0	845	156	1362	3926	3253	1863	190	0	0	11597
1979	0	0	0	291	95	469	3677	1378	1804	115	0	0	7829
1980	0	0	0	0	0	2024	3291	3540	2099	265	0	0	11219
AVERAGE	0	0	0	317	1422	1730	2933	2792	1689	41	0	0	10924
MINIMUM	0	0	0	0	0	469	1686	1378	603	0	0	0	7829
MAXIMUM	0	0	0	1860	2638	2870	3956	3813	2392	266	0	0	12478

1) Includes direct flow, reservoir water and CBT water for irrigation.

Appendix C

Data on RIBSIM Model Development and Calibration

APPENDIX C

DATA ON RIBSIM MODEL DEVELOPMENT AND CALIBRATION

This appendix contains information relating to the input data for and output data from the RIBSIM model, including results from the model calibration for historical conditions in the Basin. The tables contained in this appendix support the discussions contained in Chapter 5.0 of the Main Report. Information contained in this appendix is organized as follows:

Table No.	Title
C. 1	Diversion Structures to be Modeled
C. 2	Reservoirs to be Modeled
C. 3	Modeled Exchanges
C. 4	North Fork Cache la Poudre River near Livermore, Colorado Comparison of Recorded and Adjusted Flows
C. 5	Cache la Poudre River at Mouth of Canyon Comparison of Recorded and Adjusted Flows
C. 6	Correlation of North Fork Gage with Canyon Gage, Monthly Equations
C. 7	North Fork Cache la Poudre River, Recorded and Generated Flows
C. 8	Average Recorded Transbasin Diversions into the Cache la Poudre Basin
C. 9	Return Flows from Big Thompson River Irrigation Ditches to the Poudre Basin
C.10	City of Greeley, Treated Water from Big Thompson River through Boyd Lake Plants 1 & 2
C.11	Monthly Reservoir Evaporation Rates
C.12	Total Delivered C-BT Water, Cache la Poudre Basin
C.13	Estimated Future C-BT shares under Each Ditch System
C.14	C-BT Project Declared Quotas
C.15	Irrigation Return Flow Locations

Table No.	Title
C.16	Table of Multipliers for Annual Ground Water Pumping as a Fraction of 1980 Pumping
C.17	Estimate of Annual Pumping of Ground Water Tributary to the Cache la Poudre River above Greeley
C.18	Estimate of Annual Pumping of Ground Water Tributary to Cache la Poudre or South Platte River below Greeley Gage
C.19	Modeled South Platte Call on Water District 3 Priorities
C.20	Modeled Call, 1984 State Engineer's Basin Rank 300
C.21	Modeled Call, 1984 State Engineer's Basin Rank 600
C.22	Modeled Call, 1984 State Engineer's Basin Rank 1466
C.23	Modeled Call, 1984 State Engineer's Basin Rank 2500
C.24	Modeled Call, 1984 State Engineer's Basin Rank 9999
C.25	Cache la Poudre Basin Study Irrigated Area by Ditch System (1970)
C.26	Cache la Poudre River at Mouth of Canyon, Comparison of Recorded and Modeled Flows
C.27	Cache la Poudre River near Greeley, Comparison of Recorded and Modeled Flows
C.28	Modeled Average Diversions for All Sources All Uses Demands
C.29	Average Modeled Transbasin Diversions into the Cache la Poudre Basin
C.30	Modeled Average C-BT Diversions
C.31	Modeled Average Ground Water Use
C.32	Summary of Modeled Return Flows between Canyon Gage and Larimer & Weld Canal
C.33	Summary of Modeled Return Flows between Larimer and Weld Canal and Greeley No. 2 Canal
C.34	Summary of Modeled Return Flows between Greeley No. 2 Canal and Greeley No. 3 Canal
C.35	Summary of Modeled Return Flows between Greeley No. 3 Canal and Greeley Gage
C.36	Modeled Out-of-Basin Return Flows
C.37	Average Monthly Modeled Flows from Wastewater Treatment Plants

Table No.	Title
C.38	Comparison of Modeled and Reported Wastewater Treatment Plant Flows
C.39	Modeled Potential Storable Flows at the Canyon Gage

TABLE C.1

Cache la Poudre Basin Study

Diversion Structures to be Modeled

DITCHES

North Poudre Canal
Poudre Valley Canal
Larimer County Canal
Little Cache la Poudre Ditch
New Mercer Canal
Josh Ames Ditch
Lake Canal
Chaffee Ditch
Greeley No. 2 Ditch (New Cache)
Whitney Ditch
Jones Ditch
Greeley No. 3 Ditch
Munroe Gravity Canal
Pleasant Valley & Lake Canal
Jackson Ditch
Larimer & Weld Canal
Larimer County No. 2 Canal
Arthur Ditch
Coy Ditch
Boxelder Ditch
B. H. Eaton Ditch
Boyd & Freeman Ditch
Ogilvy Ditch

MUNICIPAL DIVERSIONS

Fort Collins Pipeline
Greeley Pipeline
Other Municipal (Water Districts and Small Municipalities)

RESERVOIR INLETS

Timnath Reservoir Inlet (Cache la Poudre Reservoir)
Fossil Creek Reservoir Inlet

OTHER

Platte River Power Authority Diversion for Rawhide Reservoir

TABLE C.2

Cache la Poudre Basin Study

Reservoirs to be Modeled

JOE WRIGHT RESERVOIR

WATER SUPPLY & STORAGE MOUNTAIN RES.[1]
Chambers Lake
Long Draw

GREELEY MOUNTAIN RESERVOIRS
Barnes Meadow
Comanche
Peterson
Big Beaver (Hourglass)
Twin Lake

WORSTER RESERVOIR (EATON)

HALLIGAN RESERVOIR

NORTH POUDRE NO. 1
(Filled by Munroe Canal and North Poudre Ditch, used for exchange)
Mtn. Supply No. 8 (N.P. No. 8)
Mtn. Supply No. 10
N.P. No. 6
Mtn. Supply No. 9
Bee Lake (N.P. No. 5)

NORTH POUDRE NO. 2
(Filled by Munroe Canal, used for operation)
Demmel Lake (N.P. No. 2)
Caverly Reservoir
Wasson Lake (Mtn. Supply No. 22)
Indian Creek Res. (Mtn. Supp. 16)
N.P. No. 3
Boxelder No. 3
Miners Lake (N.P. No. 1)
Spitzer Reservoir
Clarks Lake (N.P. No.12&13)
Hinkley Lake (Mtn. Supp. 18)
N.P. No. 4

NORTH POUDRE NO. 3
(Filled by North Poudre Ditch, used for operation)
Park Creek Reservoir
Boxelder No. 1
Bubbles Lake (Mtn. Supply No. 7)
N.P. No. 15
Boxelder No. 2

MILTON SEAMAN RESERVOIR

WINDSOR RES. & CANAL NO. 1
(Filled by Poudre Valley Canal, used for exchange)
Douglas Reservoir
No. 8 Annex
Cobb Lake
Windsor Res. No. 8
Elder Reservoir

CLAYMORE LAKE

TABLE C.3 **(Continued)**

7. Plains reservoirs of Water Supply and Storage Company release through Long Pond to Larimer & Weld. In return, Douglas Reservoir water is released to the Larimer County Canal.	Water Supply and Storage Company reservoirs export water directly to the Larimer & Weld Canal. Water Supply and Storage No. 2 and No. 3 protect Larimer County out-of-priority diversions.
8. Lindenmeir Lake water released to River for diversion by New Cache, which in turn supplies C-BT or other water to Larimer County Canal.	Water Supply and Storage Reservoir No. 3 (Lindenmeir Lake and Long Pond) are used to protect Larimer County Canal diversions. Thus, when New Cache is calling for C-BT water, Larimer County Canal can divert it and release water from Water Supply and Storage No. 3 in exchange.
9. Fort Collins releases water from Joe Wright Reservoir for diversion by the Munroe Canal. NPIC then releases C-BT water to Fort Collins.	Fort Collins Water Treatment Plant diverted its historic amount of C-BT water directly from Horsetooth without regard to who originally owned the C-BT water. Munroe Canal was not tied to Joe Wright Reservoir after Fort Collins purchased it from NPIC.
10. Water belonging to Water Supply and Storage is diverted by other ditches. In return, C-BT is assigned to WSS.	This exchange was not modeled. The other ditches (Fort Collins, Greeley, Arthur, New Mercer and Larimer County No. 2) diverted their C-BT water directly.
11. Larimer County Canal diverts water belonging to Larimer & Weld. Water is released to Larimer & Weld from Long Pond.	WSS Reservoir No. 3 (Lindenmeir & Long Pond) protects Larimer County Canal out-of-priority diversions.
12. Water belonging to Little Cache la Poudre Ditch is diverted by Larimer & Weld. Water is replaced to Little Cache la Poudre from Terry Lake.	Little Cache la Poudre Ditch diverted the water it was entitled to, and Terry Lake exported water directly to Larimer & Weld Canal.

TABLE C.3

Cache la Poudre Basin Study
Modeled Exchanges

Actual[1]	Modeled[2]
1. Worster Reservoir to Halligan for use in North Poudre Canal. North Poudre Irrigation Company (NPIC) C-BT water released to Poudre Valley Canal or Larimer & Weld Canal.	Worster Reservoir to Larimer & Weld Canal and North Poudre Canal. When Worster Reservoir releases water to Larimer & Weld, North Poudre Canal diverts the water and releases C-BT water in exchange. Worster was also tied to North Poudre Canal as an additional source of supply.
2. River water diverted by Munroe and North Poudre Canals. C-BT water released to river to protect out-of-priority diversions when the call is the Hansen Feeder Canal.	North Poudre System C-BT Reservoir protects North Poudre and Munroe Canal out-of-priority diversions.
3. Greeley Mountain Reservoirs release water for diversion by Munroe Canal. C-BT water released to Greeley.	Releases from Greeley Mountain Reservoir to the Greeley Pipeline can be diverted by Munroe Canal in exchange for releases from the North Poudre System C-BT Reservoir to the Greeley Pipeline. Greeley Mountain Reservoirs are also tied to Munroe Canal as an additional source of supply.
4. Fossil Creek Reservoir water released to others who assign C-BT water to NPIC. Reduces transit losses from Horsetooth Reservoir.	This exchange was not modeled because C-BT releases are equivalent to what the ditches historically diverted, not what was released from Horsetooth and thus already include the transit losses.
5. Larimer & Weld diverts water belonging to the senior New Cache la Poudre right. Water provided to New Cache from Windsor Reservoir.	Windsor Reservoir protects out-of-priority diversions made by the Larimer & Weld Canal.
6. Water in Fossil Creek or Windsor Reservoir is taken by New Cache, which assigns C-BT water to Larimer & Weld or NPIC.	This exchange was not modeled because of the lack of data on the amounts exchanged.

TABLE C.3 **(Continued)**

7. Plains reservoirs of Water Supply and Storage Company release through Long Pond to Larimer & Weld. In return, Douglas Reservoir water is released to the Larimer County Canal.	Water Supply and Storage Company reservoirs export water directly to the Larimer & Weld Canal. Water Supply and Storage No. 2 and No. 3 protect Larimer County out-of-priority diversions.
8. Lindenmeir Lake water released to River for diversion by New Cache, which in turn supplies C-BT or other water to Larimer County Canal.	Water Supply and Storage Reservoir No. 3 (Lindenmeir Lake and Long Pond) are used to protect Larimer County Canal diversions. Thus, when New Cache is calling for C-BT water, Larimer County Canal can divert it and release water from Water Supply and Storage No. 3 in exchange.
9. Fort Collins releases water from Joe Wright Reservoir for diversion by the Munroe Canal. NPIC then releases C-BT water to Fort Collins.	Fort Collins Water Treatment Plant diverted its historic amount of C-BT water directly from Horsetooth without regard to who originally owned the C-BT water. Munroe Canal was not tied to Joe Wright Reservoir after Fort Collins purchased it from NPIC.
10. Water belonging to Water Supply and Storage is diverted by other ditches. In return, C-BT is assigned to WSS.	This exchange was not modeled. The other ditches (Fort Collins, Greeley, Arthur, New Mercer and Larimer County No. 2) diverted their C-BT water directly.
11. Larimer County Canal diverts water belonging to Larimer & Weld. Water is released to Larimer & Weld from Long Pond.	WSS Reservoir No. 3 (Lindenmeir & Long Pond) protects Larimer County Canal out-of-priority diversions.
12. Water belonging to Little Cache la Poudre Ditch is diverted by Larimer & Weld. Water is replaced to Little Cache la Poudre from Terry Lake.	Little Cache la Poudre Ditch diverted the water it was entitled to, and Terry Lake exported water directly to Larimer & Weld Canal.

TABLE C.3 **(Continued)**

13. More than decree amount is diverted into Larimer County Canal. Releases made from Lindenmeir Lake to replace river flow.	Any diversions greater than the decreed amount consisted of water types other than river water. Lindenmeir lake only replaced out-of-priority diversions up to the decreed Larimer County direct flow amount.
14. Direct flow belonging to New Cache la Poudre Ditch is diverted to Poudre Valley Canal to fill Douglas Reservoir and other reservoirs. Water is replaced to New Cache from Windsor Reservoir.	Windsor Reservoir protects Poudre Valley Canal out-of-priority diversions.

Notes:

1. Refer to Figure 2.4 in Task 2 Summary Report for diagrams.

2. The exchanges are modeled to simulate the net effect on the river system, not necessarily the actual operation of the exchanges.

TABLE C.4

NORTH FORK CACHE LA POUDRE RIVER NEAR LIVERMORE, COLORADO
COMPARISON OF RECORDED AND ADJUSTED FLOWS

(ACRE-FEET)

RECORDED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	296	383	887	4160	14000	9070	708	4580	830	775	669	673	37031
1952	586	489	472	3890	12390	7220	512	380	354	787	757	394	28231
1953	432	397	503	717	1430	1130	559	410	209	964	976	639	8366
1954	661	569	589	493	172	72	44	300	1300	507	273	187	5167
1955	150	196	328	245	34	197	81	220	17	110	418	316	2312
1956	239	239	368	459	5440	1810	416	356	256	444	376	271	10674
1957	196	207	271	3680	26390	26120	2400	785	466	1590	569	471	63145
1958	280	293	550	7880	32130	5100	837	437	375	1020	690	570	50162
1959	487	1290	1960	9730	25660	7480	619	388	359	854	1220	718	50765
1960	423	559	1500	2580	10990	4740	424	166	477	1210	387	278	23734
1961	670	369	1210	4580	42630	27810	3060	2110	2930	6380	629	1610	93988
1962	3090	3730	2240	7890	15690	10390	947	599	580	2360	527	585	48628
1963	345	1040	80	3240	694	516	162	202	711	1080	339	223	8632
1964	188	196	481	455	2680	4580	367	1480	486	8	279	289	11489
1965	240	38	272	253	2510	30890	4100	2860	352	-1	-1	-1	41512
AVERAG	552	666	781	3350	12856	9142	1016	1018	647	1292	579	516	32256

ADJUSTED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	296	383	887	4160	19460	18401	6852	7366	1620	2275	1769	1573	65042
1952	1586	489	472	9844	24624	18991	3331	1782	866	787	1057	1194	65023
1953	1332	1097	1503	2653	8678	10316	3255	3000	827	964	1476	1139	36240
1954	1061	1069	1189	2993	4667	2359	858	890	258	607	773	887	17611
1955	650	796	1128	1945	3484	4931	1732	1486	833	510	1118	1216	19829
1956	839	939	1468	1425	14012	9675	2089	1264	368	444	1076	1171	34770
1957	696	1107	1371	8524	38130	48022	11868	3853	1796	2452	2369	1671	121859
1958	1380	1493	950	6666	37806	13971	4081	2155	1559	1482	1890	2270	75703
1959	1887	1790	2160	11130	28495	18538	3637	2054	1513	1862	3320	2318	78704
1960	423	1459	3400	3880	14548	12284	2461	848	713	1410	1187	1278	43891
1961	1470	1169	1910	7080	48776	32644	7115	4644	4278	4880	3329	2910	120205
1962	2890	2130	3240	10854	22002	17450	5480	1665	1146	2260	1427	1785	72329
1963	1245	1940	2080	4844	5758	4800	1236	2176	2199	1380	1039	923	29620
1964	788	796	1281	4727	10102	10586	2734	912	896	908	879	889	35498
1965	840	1038	1072	2519	10028	37176	7914	2582	4062	3233	2299	1999	74762
AVERAGE	1159	1180	1607	5550	19371	17343	4310	2445	1529	1697	1667	1548	59406

NOTE: -1 DENOTES GAGE DISCONTINUED.

TABLE C.5

CACHE LA POUDRE RIVER AT MOUTH OF CANYON
COMPARISON OF RECORDED AND ADJUSTED FLOWS

(ACRE-FEET)

RECORDED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1730	1780	2380	6950	62490	100800	69410	26930	16780	5410	3100	2620	300380
1952	2650	1640	2160	5960	48460	122500	39080	24580	15340	3680	2150	1670	269870
1953	2180	2250	2050	2890	20450	72440	27080	18150	7810	3420	1960	2030	162710
1954	1960	1570	1560	2950	25660	34470	15040	3760	5750	5020	1650	1060	100450
1955	1220	920	1240	1980	22080	60930	28190	15640	4360	3080	2310	2460	144410
1956	1710	1410	1930	3490	72790	87350	24540	11670	3230	2040	1220	1600	212980
1957	1290	1360	1440	7060	35530	136300	104600	20330	9720	5050	2720	2640	328040
1958	2110	2080	2690	10930	92800	96130	16260	4070	3260	3180	1880	2020	237410
1959	1650	2000	3070	12120	44150	103800	24810	10820	4070	4530	3750	1150	215920
1960	1070	770	3030	5550	50190	96750	27910	6540	4230	3000	1700	1550	202290
1961	2250	1650	2800	7880	70220	116800	31970	18770	11690	16210	6740	3220	290200
1962	3600	5710	5420	19160	68930	84900	45970	11310	2220	3780	2100	1760	254860
1963	1100	1040	760	4000	27300	37800	12230	11700	7380	3710	2120	980	110120
1964	830	850	1550	2300	35820	65840	31460	10820	4450	1850	1030	780	157580
1965	830	860	860	2530	32330	129700	77210	25500	7570	4010	1050	1310	283760
1966	1170	1220	1670	2820	29830	33360	9720	6240	5870	2850	1440	799	96989
1967	738	567	1090	1860	26300	75860	43390	7150	4180	1680	3280	2830	168925
1968	2210	2530	1940	2990	28840	102800	40920	20290	6720	2570	2160	1680	215650
1969	1170	1040	1640	6290	50520	74280	35650	6900	7480	4190	1880	891	191931
1970	872	617	1440	5570	59140	108800	55920	17230	6260	4770	4210	1870	266699
1971	1850	1350	1960	11640	62340	141700	56500	13340	9560	2480	4510	2180	309410
1972	1630	1820	2180	3970	36000	86010	25380	5180	6240	3890	2630	1590	176520
1973	1460	1450	2050	3470	89410	123400	65520	22890	3750	5210	6520	3090	328220
1974	2400	2940	5700	7270	78840	108100	39960	6570	4690	4740	2740	1380	265330
1975	810	740	1150	2100	18790	86830	78920	17250	5950	3240	1700	1670	219150
1976	1540	1410	1520	2300	27730	65040	27330	18980	3530	4590	1600	1010	156580
1977	916	849	1350	2970	12550	39170	10500	14160	3740	2460	2230	1630	92525
1978	1420	1280	1620	3910	36160	127800	66100	19680	5850	2860	1790	1300	269770
1979	1150	932	1460	5020	51250	123100	59420	34610	8780	3320	1810	2650	293502
1980	5560	4380	9140	32760	158700	142300	41410	16840	6210	5130	4290	3090	429810
AVG	1703	1634	2295	6356	49187	92835	41080	14930	6556	4065	2609	1817	225066

ADJUSTED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1978	2204	2832	8270	67797	119691	68281	26993	7919	8514	5060	3996	323535
1952	4098	2270	3228	15054	78446	143517	30379	13776	8635	4412	3190	2894	309899
1953	3490	3344	4428	5582	26827	91347	26905	16286	5970	4244	3300	2858	194581
1954	2882	2690	2842	7176	35686	30929	14728	6321	4008	6014	2978	2632	118886
1955	2192	2056	2712	5596	31729	60039	23702	16658	5560	3042	3786	3904	160976
1956	2832	2642	4292	5384	81627	94350	20645	11356	4423	2628	2620	3194	235993
1957	2286	2940	3344	12606	64500	200030	106139	25162	11525	8158	5086	4068	445844
1958	3956	3802	3704	11020	111524	99860	22068	9822	5739	4184	4286	4398	284363
1959	3692	3208	3804	14968	54613	113451	29313	12682	6486	8022	7442	3634	261315
1960	1568	2260	5840	11458	53920	104392	29382	8588	5225	4708	4032	3258	234631
1961	3894	3310	4390	10906	102714	141540	33483	17950	17248	18112	11996	5340	370883
1962	4524	5594	5950	21050	82014	100024	50015	11892	5673	5630	4000	3802	300168
1963	2654	2844	3410	6966	39742	45710	15606	15586	10122	13362	3638	2482	162122
1964	1944	2432	3160	7230	46515	72920	28357	10896	5297	3392	2520	2090	186753
1965	2180	2850	2576	6124	40316	169427	68974	21733	13766	11330	5228	4348	348852
1966	2318	3522	3464	6348	37619	38516	15222	7056	5070	5394	2136	2477	129142
1967	1836	2501	3462	5696	37595	107086	49500	10774	11858	10484	5636	4683	251111
1968	3246	3429	2809	6176	31952	130233	39307	16065	12473	4988	3920	3284	257882
1969	3261	3073	3590	8402	78844	88845	37092	9669	6241	6112	4700	2963	252792
1970	2933	2489	2202	8796	79181	141028	53687	15341	9210	5648	6117	3190	329822
1971	4396	3666	4638	18760	74770	165866	53416	15414	13048	7550	7434	4060	373018
1972	4601	2307	6174	7125	50794	101178	25068	9761	8668	6749	5558	2925	230908
1973	4449	3192	4361	9394	99620	147363	64599	18914	9156	9865	8323	6174	385410
1974	5741	4181	7174	14953	94532	119502	44403	12139	7790	7924	5463	3223	327025
1975	2650	3161	4185	6765	29886	116406	70000	16111	6460	6026	3777	3721	269148
1976	3623	3444	6623	5604	39207	73013	30588	24836	6989	6279	3631	2503	206340
1977	1141	1490	2370	8534	33068	43422	14156	9570	5502	5013	4133	3230	131629
1978	2623	3366	5389	5606	66888	157545	57540	12510	5614	5779	4289	3527	330676
1979	3190	2664	5458	16671	85042	151265	59358	24975	10615	4990	6316	6019	376563
1980	7109	7231	11290	32042	167885	163272	42626	12585	9286	7950	9932	6766	477974
AVG	3243	3139	4323	10342	64162	111059	40818	14714	8186	6883	5018	3721	275608

TABLE C.6

CORRELATION OF NORTH FORK GAGE WITH CANYON GAGE
MONTHLY EQUATIONS

GENERAL EQUATION: Y = (B * X) - C

MONTH	B	C	R SQUARED
January	0.62297	0.67557	0.78367
February	0.40242	0.01272	0.49480
March	0.67121	0.92136	0.72073
April	0.66179	1.04136	0.83463
May	0.43313	7.14081	0.65813
June	0.26780	11.00544	0.89155
July	0.11123	-0.09404	0.86488
August	0.24535	1.28287	0.68585
September	0.25879	0.70521	0.76358
October	0.17106	-0.25002	0.55553
November	0.30102	-0.24739	0.79090
December	0.62294	0.64426	0.76938

TABLE C.7

NORTH FORK CACHE LA POUDRE RIVER
RECORDED AND GENERATED FLOWS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	300	380	890	4160	19460	18400	6850	7370	1620	2280	1770	1570	65050
1952	1590	490	470	9840	24620	18990	3330	1780	870	790	1060	1190	65020
1953	1330	1100	1500	2650	8680	10320	3260	3000	830	960	1480	1140	36250
1954	1060	1070	1190	2990	4670	2360	860	890	260	610	770	890	17620
1955	650	800	1130	1950	3480	4930	1730	1490	830	510	1120	1220	19840
1956	840	940	1470	1420	14010	9680	2090	1260	370	440	1080	1170	34770
1957	700	1110	1370	8520	38130	48020	11870	3850	1800	2450	2370	1670	121860
1958	1380	1490	950	6670	37810	13970	4080	2160	1560	1480	1890	2270	75710
1959	1890	1790	2160	11130	28500	18540	3640	2050	1510	1860	3320	2320	78710
1960	420	1460	3400	3880	14550	12280	2460	850	710	1410	1190	1280	43890
1961	1470	1170	1910	7080	48780	32640	7110	4640	4280	4880	3330	2910	120200
1962	2890	2130	3240	10850	22000	17450	5480	1660	1150	2260	1430	1780	72320
1963	1250	1940	2080	4840	5760	4800	1240	2180	2200	1380	1040	920	29630
1964	790	800	1280	4730	10100	10590	2730	690	900	910	880	890	35290
1965	840	1040	1070	2520	10030	37180	7910	2580	4060	6070	1820	2060	77180
1966	770	1400	1400	3160	9190	3776	1790	1446	630	2130	890	900	27482
1967	470	990	1700	2730	9140	17670	5590	1410	3680	2720	1940	2270	50310
1968	1350	1370	960	3050	6700	23870	5194	2660	2520	1100	1430	1400	51604
1969	1360	1220	1490	4520	27010	12790	4220	1120	920	1300	1700	1264	58914
1970	1150	990	560	4780	27150	26760	6060	2480	1680	1220	2090	1340	76260
1971	2060	1460	2190	11370	25240	33410	6030	2530	2680	1680	2490	1880	93020
1972	2190	920	3220	3670	14860	16090	2870	1237	1600	1400	1920	1180	51157
1973	2100	1270	2010	5180	36010	28460	7270	3400	1670	1940	2750	3200	95260
1974	2900	1670	3890	8850	35800	21270	5130	1760	1310	1810	1890	1360	87640
1975	980	1260	1890	3440	5800	20170	7870	2710	970	2820	1380	1670	50960
1976	1580	1370	3989	2670	9840	8550	3500	4840	1140	2440	1340	910	42169
1977	51	590	1045	4610	7180	2768	2212	1080	720	1110	1490	1370	24226
1978	960	1340	2700	2670	21830	31190	6490	1820	750	1850	1540	1550	74690
1979	1310	1060	3665	9990	29690	29500	6690	4840	2070	1100	3548	3110	96573
1980	3750	2900	6660	20160	65570	32720	4830	1810	1745	2550	4567	3685	150947
AVERAGE	1346	1251	2049	5803	20720	18971	4680	2386	1568	1849	1851	1679	64152
51-65 AVG	1160	1181	1607	5549	19372	17343	4309	2430	1530	1886	1637	1552	59556
66-80 AVG	1532	1321	2491	6057	22067	20600	5050	2343	1606	1811	2064	1806	68747

NOTES: 1. Recorded flows 1951 through 1965.
2. Generated flows 1966 through 1980.
3. Additional adjustment for actual diverted amount, where necessary.

TABLE C.8

Average Recorded Transbasin Diversions into
the Cache la Poudre Basin
(Acre-feet)

IMPORTING DITCH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
BOB CREEK DITCH	0	0	0	0	159	146	7	0	0	0	0	0	312
CAMERON PASS DITCH	0	0	0	0	3	76	43	0	0	0	0	0	123
COLUMBINE DITCH	0	0	0	0	31	67	8	0	0	0	0	0	105
GRAND RIVER DITCH	0	0	0	10	944	7362	6576	1926	289	1	0	0	17107
LARAMIE-POUDRE TUNNEL	0	0	0	13	2328	4855	5932	2148	343	0	0	0	15618
MICHIGAN DITCH	0	0	0	16	38	468	360	46	1	0	0	0	929
SKYLINE DITCH	0	0	0	0	108	1154	657	12	0	0	0	0	1931
WILSON SUPPLY DITCH	0	0	0	2	1090	991	95	0	0	0	0	0	2177
TOTAL	0	0	0	41	4701	15119	13678	4132	633	1	0	0	38302

NOTES: 1. Averages based on 1951-1980 except Columbine and Bob Creek Ditches, which are for 1951-1956 only.

TABLE C.9

RETURN FLOWS FROM BIG THOMPSON RIVER
IRRIGATION DITCHES TO THE POUDRE BASIN

(ACRE-FEET)

AVERAGE DIVERSIONS (1)

DITCH		MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
LOVELAND-GREELEY CANAL	(2)	700	4796	6758	3246	800	0	16300
TO IRRIGATION	(3)	236	1711	2478	1180	295	0	5900
BOOMERANG-GRAPEVINE	(4)	157	1141	1652	787	197	0	3933
OKLAHOMA LAKE		79	570	826	393	98	0	1967
LOUDEN DITCH	(5)	1777	3017	4146	2799	1409	212	13360
TOTAL DIVERTED TO POUDRE	(6)	2013	4728	6624	3979	1704	212	19260

AVERAGE RETURN FLOWS (7)

DITCH	MAY	JUNE	JULY	AUGUST	SEPT	OCT	TOTAL
BOOMERANG-GRAPEVINE RETURNS	79	570	826	393	98	0	1967
OKLAHOMA LAKE RETURNS	39	285	413	197	49	0	983
LOUDEN RETURNS	889	1509	2073	1400	705	106	6680
TOTAL	1007	2364	3312	1990	852	106	9630

NOTES:
1. 1970 through 1973 and 1980 through 1983 average diversions.
2. Total diversions by the canal.
3. To irrigation in the Poudre basin, based on 4500 af diverted by the City of Greeley during 1970-1973 and 1980-1984,and 50 percent of the irrigated land located in the Poudre basin.
4. Based on aerial photography, about 2/3 of the irrigated land in the basin is located under the Boomerang and Grapevine laterals and 1/3 under Oklahoma Lake.
5. Based on aerial photographs, 100 percent of the irrigated land is in the Poudre basin.
6. Total of Boomerang-Grapevine, Oklahoma Lake and Louden.
7. Assumed return flows are 50 percent of water application.

TABLE C.10

CITY OF GREELEY
TREATED WATER FROM BIG THOMPSON RIVER THROUGH
BOYD LAKE PLANTS 1 & 2

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1969	0	0	0	0	0	104	308	272	51	11	11	11	769
1970	3	3	28	28	205	357	539	520	126	16	2	3	1831
1971	3	10	28	8	74	498	511	549	124	50	22	24	1901
1972	19	20	22	76	342	477	735	124	0	0	0	0	1815
1973	0	0	0	1	19	759	567	630	83	38	0	0	2282
1974	0	0	24	34	586	627	841	513	15	17	8	0	2665
1975	1	35	29	152	314	453	764	851	378	17	4	2	3001
1976	0	22	38	120	442	906	1188	836	381	63	103	43	4143
1977	105	134	137	120	721	928	808	458	536	4	2	0	3993
1978	0	0	104	163	538	1101	1402	1125	889	273	150	22	5883
1979	119	88	68	439	524	1122	1546	632	680	362	32	21	5633
1980	10	3	0	181	332	1424	1594	1284	893	511	91	0	6325
1981	71	31	21	518	364	1146	1370	1129	934	623	141	0	6350
1982	0	0	0	617	685	879	1381	1300	691	611	41	0	6206
1983	0	0	0	66	340	556	1542	1794	1201	534	26	0	6058
1984	0	0	0	0	915	1124	2296	1516	1140	111	0	0	7103
AVERAGE	21	22	31	158	400	779	1087	846	508	203	40	8	4122
70-73 & 80-84 avg	12	8	11	166	364	802	1170	983	577	277	36	3	4430

NOTES: 1. Plant began operation in 1969.
2. 1970-1973 and 1980-1984 corresponds to availability of diversion records for Big Thompson River irrigation ditches.

TABLE C.11

Cache la Poudre Basin Study

Monthly Reservoir Evaporation Rates[1]
(Feet per Acre)

Plains Reservoirs[2]

Apr.	May	June	July	Aug.	Sept.	Oct.	Total
0.10	0.14	0.29	0.29	0.26	0.21	0.13	1.42

Mountain Reservoirs[3]

May	June	July	Aug.	Sept.	Total
0.17	0.27	0.23	0.19	0.20	1.06

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1. Derived from pan evaporation data and precipitation records maintained by U.S. Department of Commmerce, National Weather Service.

2. Based on pan evaporation and precipitation data at Fort Collins, Colorado, 1971-1980.

3. Based on 1956-1971 average pan evaporation and long-term average precipitation data at Estes Park, Colorado.

TABLE C.12

TOTAL DELIVERED C-BT WATER
CACHE LA POUDRE BASIN

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	2596	8762	8562	30	0	0	19950
1953	0	0	0	0	5862	18278	31556	26604	19288	146	0	0	101734
1954	0	0	0	3250	29854	24010	32758	35812	12612	1298	0	0	139594
1955	0	0	0	120	24398	6354	23470	27978	15338	3708	0	0	101366
1956	0	0	0	192	7478	4312	23634	25184	17164	414	0	0	78378
1957	0	0	0	0	0	0	7668	26310	22620	13064	0	0	69662
1958	0	0	0	0	140	8788	36536	48850	31838	2284	0	0	128436
1959	0	0	0	0	56	7412	27490	43330	19542	6150	0	0	103980
1960	0	0	0	0	0	2296	26386	45330	20624	1138	0	0	95774
1961	0	0	0	0	162	94	14716	26880	13024	0	0	0	54876
1962	0	0	0	96	6566	8968	26418	36666	22574	4684	0	0	105972
1963	0	0	0	5552	28050	12752	33465	34781	16225	3468	27	27	134347
1964	27	27	27	27	27598	10150	29350	39079	15739	1842	78	78	124022
1965	78	78	78	230	18612	2856	3994	22949	14678	35105	109	109	98876
1966	109	109	109	109	11708	16433	38714	42272	12325	5931	123	123	128065
1967	144	163	146	169	3096	718	5626	44991	28013	6138	212	142	89558
1968	218	216	191	212	5380	3941	21280	22063	13099	2018	210	147	68976
1969	204	212	227	419	684	4089	28916	35010	9980	345	452	320	80860
1970	180	195	200	184	777	1267	14565	33186	11783	248	232	267	63084
1971	237	262	309	257	1230	3602	37538	35900	9480	7876	281	275	97246
1972	267	288	232	398	7854	5038	24007	33122	4304	5445	463	208	81627
1973	232	221	264	462	2105	2903	18765	31905	10314	430	306	300	68207
1974	293	284	274	346	5432	2930	37743	40519	10200	12675	259	259	111214
1975	259	268	266	274	8888	3448	15913	34111	10695	16724	297	301	91445
1976	310	307	305	304	2313	13583	39106	36347	9727	13727	464	352	116847
1977	302	376	542	568	11640	20270	31578	27508	13749	1782	285	44	108643
1978	304	285	377	803	593	1555	21709	26497	7462	6354	0	0	65940
1979	0	0	0	394	669	1281	23708	18033	6195	1992	333	365	52971
1980	368	367	380	458	1466	3921	29046	26007	8336	11101	419	424	82292
AVERAGE	118	122	131	494	7087	6375	23608	31200	13850	5537	152	125	88798
MINIMUM	0	0	0	0	0	0	2596	8762	4304	0	0	0	19950
MAXIMUM	368	376	542	5552	29854	24010	39106	48850	31838	35105	464	424	139594

NOTES: 1. Based on Water Commissioner's recorded diversions.

TABLE C.13

ESTIMATED FUTURE C-BT SHARES UNDER EACH DITCH SYSTEM

DITCH	NUMBER OF SHARES
ARTHUR	320
BOXELDER	55
CITY OF FT. COLLINS	11237 *
CITY OF GREELEY	18687 *
GREELEY NO. 2	11357
JACKSON	32
LAKE CANAL	3188
LARIMER AND WELD	27797
LARIMER CO. CANAL	6577
LARIMER CO. NO. 2	541
LITTLE CACHE LA POUDRE	168
NEW MERCER	1632
NORTH POUDRE SYSTEM	40000 *
PLEASANT VALLEY & LAKE	680
WHITNEY	640

NOTES: 1. Estimated from 1982 records provided by NCWCD.

2. '*' denotes 1985 values from interviews.

3. Number of shares is the total owned by the ditch company plus those owned or leased by individuals under the ditch system.

TABLE C.14

C-BT PROJECT DECLARED QUOTAS

WATER YEAR	DECLARED QUOTA
1951 e	0.60
1952 e	0.60
1953 e	0.70
1954 e	1.00
1955 e	1.00
1956 e	0.70
1957	0.60
1958	1.00
1959	0.80
1960	0.70
1961	0.60
1962	0.75
1963	1.00
1964	0.90
1965	0.60
1966	1.00
1967	0.70
1968	0.60
1969	0.70
1970	0.60
1971	0.60
1972	0.80
1973	0.70
1974	1.00
1975	0.80
1976	1.00
1977	1.00
1978	0.60
1979	0.60
1980	0.70

NOTE: The declared quota for years marked with an 'e' has been estimated by the NCWCD for a similar study in the St. Vrain basin.

TABLE C.15

CACHE LA POUDRE BASIN STUDY
IRRIGATION RETURN FLOW LOCATIONS

	CANAL LOSSES (1)				ONSITE LOSSES					
	SURFACE RETURNS		GROUND WATER RETURNS (2)		SURFACE RETURNS		GROUND WATER RETURNS (2)		SPILLS (3)	
CANAL OR DITCH	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION
Munroe Canal	11	Larimer County Canal	89	Boxelder Aquifer						
N.Poudre Canal	11	Larimer County Canal	89	Boxelder Aquifer						
Poudre Valley Cnl.	11	Jackson Ditch	89	Boxelder Aquifer						
N.Poudre System					45	Larimer County Canal	55	Boxelder Aquifer	100	North Poudre Res. No. 3
Pleasant Valley	2	River abv. Larimer County Canal	89	Harmony Terrace Aquifer	2	River above Little Cache la Poudre Ditch	89	Harmony Terrace Aquifer	100	Claymore Reservoir
	9	Larimer County Canal No.2 and New Mercer Canal			9	River above the New Cache Canal				
Larimer County Canal	11	Larimer & Weld Canal	20	Boxelder Aquifer	40	Larimer & Weld Canal	13	Boxelder Aquifer	65	Water Supply and Storage Res. No.1
			19	River via Black Hollow			13	River via Black Hollow	35	Lonetree Aquifer
			19	Spring Creek Aquifer			13	Spring Creek Aquifer		
			31	Lonetree Aquifer			21	Lonetree Aquifer		
Jackson Ditch	11	Little Cache,Taylor & Gill	89	River above Boxelder Ditch	10	Little Cache,Taylor & Gill	90	River above Boxelder Ditch	100	Water Supply and Storage Res. No.3
Little Cache la Poudre Ditch	100	River above Larimer & Weld								
Taylor and Gill	100	River above Larimer & Weld								
Little Cache, Taylor & Gill					100	River above Larimer & Weld			100	Terry Lake
New Mercer Canal	11	Arthur Ditch	89	Harmony Terrace Aquifer						
Larimer County Canal No.2	11	Arthur Ditch	89	Harmony Terrace Aquifer						
New Mercer and Larimer County Canal No.2					10	River above Larimer & Weld	90	Harmony Terrace Aquifer	100	Warren Lake

IRRIGATION RETURN FLOW LOCATIONS

CANAL OR DITCH	CANAL LOSSES (1)				ONSITE LOSSES					
	SURFACE RETURNS		GROUND WATER RETURNS (2)		SURFACE RETURNS		GROUND WATER RETURNS (2)		SPILLS (3)	
	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION	PERCENT	LOCATION
Arthur Ditch	100	River above Larimer & Weld			100	River above Larimer & Weld				
Larimer and Weld	9	New Cache la Poudre Canal	9	Boxelder Aquifer	24	New Cache la Poudre Canal	7	Boxelder Aquifer	52	Windsor Reservoir
	2	Lake Canal	23	River via Black Hollow	6	Lake Canal	19	River via Black Hollow	48	Lonetree Aquifer
			14	Spring Creek Aquifer			10	Spring Creek Aquifer		
			43	Lonetree Aquifer			34	Lonetree Aquifer		
Josh Ames Ditch	100	River above Coy Ditch			100	River above Coy Ditch			100	River above Coy Ditch
Lake Canal	100	River above New Cache			100	River above New Cache			100	River above New Cache
Coy Ditch	100	River above Chaffee Ditch			100	River above Chaffee Ditch			100	River above Chaffee Ditch
Chaffee Ditch	50	River above Boxelder Ditch			50	River above Boxelder Ditch			50	River above Boxelder Ditch
	50	River above New Cache			50	River above New Cache			50	River above New Cache
Boxelder Ditch	100	River above New Cache			100	River above New Cache			100	River above New Cache
New Cache la Poudre Ditch	5	River via Black Hollow	31	River via Black Hollow	5	River via Black Hollow	31	River via Black Hollow	65	Seeley Lake
	6	River above Ogilvy Ditch	31	River above Ogilvy Ditch	6	River above Ogilvy Ditch	31	River above Ogilvy Ditch	35	Poudre River below Gage
			27	Poudre River below Gage			27	Poudre River below Gage		
Whitney Ditch	100	River above Jones Ditch			100	River above Jones Ditch			100	River above Jones Ditch
B.H. Eaton Ditch	100	River above Jones Ditch			100	River above Jones Ditch			100	River above Jones Ditch
Jones Ditch	100	River above Greeley No.3			100	River above Greeley No.3			100	River above Greeley No.3

IRRIGATION RETURN FLOW LOCATIONS

CANAL OR DITCH	CANAL LOSSES (1) SURFACE RETURNS PERCENT	LOCATION	CANAL LOSSES (1) GROUND WATER RETURNS (2) PERCENT	LOCATION	ONSITE LOSSES SURFACE RETURNS PERCENT	LOCATION	ONSITE LOSSES GROUND WATER RETURNS (2) PERCENT	LOCATION	ONSITE LOSSES SPILLS (3) PERCENT	LOCATION
Greeley No.3 Canal	10	Boyd and Freeman Ditch			10	Boyd and Freeman Ditch			10	Boyd and Freeman Ditch
	90	River above Ogilvy Ditch			90	River above Ogilvy Ditch			90	River above Ogilvy Ditch
Boyd and Freeman Ditch	100	River above Ogilvy Ditch			100	River above Ogilvy Ditch			100	River above Ogilvy Ditch
Ogilvy Ditch	6	River above Greeley Gage	94	River below Greeley gage	6	River above Greeley Gage	94	River below Greeley gage	100	River below Greeley Gage

NOTES (1) Canal losses were assumed at 20 percent for all ditches with 95 percent returning. Five percent was consumed to account for phreatophytes and evaporation.
(2) Ground water returns were delayed up to a year with a constant percent return each month.
(3) Spills are defined as the excess water applied to meet potential consumptive use. It was assumed that excess water was stored if storage was available.

TABLE C.16

Cache la Poudre Basin Study

Table of Multipliers for Annual Ground-Water Pumping as a Fraction of 1980 Pumping*

Year	Multiplier
1951	0.45
1952	0.48
1953	0.49
1954	0.50
1955	0.51
1956	0.59
1957	0.62
1958	0.64
1959	0.51
1960	0.66
1961	0.38
1962	0.52
1963	0.86
1964	0.88
1965	0.58
1966	0.96
1967	0.49
1968	0.76
1969	0.73
1970	0.63
1971	0.68
1972	0.83
1973	0.79
1974	0.84
1975	0.88
1976	0.92
1977	0.98
1978	0.99
1979	0.71
1980	1.00

*From information compiled by Morton W. Bittinger, 1959 through 1980 from power records, 1951 through 1958 from number of wells.

TABLE C.17

ESTIMATE OF ANNUAL PUMPING OF GROUNDWATER [1]
TRIBUTARY TO CACHE LA POUDRE RIVER ABOVE GREELEY

(Acre-feet)

YEAR	Larimer County	Greeley No. 2	Larimer & Weld	N. Poudre System	Lake Canal	Greeley No. 3	Lar. Co. 2/ New Mercer	Jackson	Arthur	Boxelder	TOTAL
1951	5746	4468	6244	7785	717	494	262	195	185	99	26194
1952	6129	4766	6660	8304	765	527	280	208	197	106	27940
1953	6256	4865	6799	8477	781	538	286	213	201	108	28522
1954	6384	4965	6938	8650	797	549	292	217	205	110	29104
1955	6512	5064	7076	8823	812	559	297	221	209	112	29686
1956	7533	5858	8186	10207	940	647	344	256	242	130	34343
1957	7916	6156	8603	10726	988	680	361	269	254	136	36089
1958	8172	6355	8880	11072	1020	702	373	278	262	141	37253
1959	6512	5064	7076	8823	812	559	297	221	209	112	29686
1960	8427	6553	9158	11418	1051	724	385	286	271	145	38417
1961	4852	3773	5273	6574	605	417	222	165	156	84	22119
1962	6639	5163	7215	8996	828	570	303	226	213	114	30268
1963	10980	8539	11933	14878	1370	943	501	373	353	189	50059
1964	11236	8738	12210	15224	1402	965	513	382	361	194	51223
1965	7405	5759	8048	10034	924	636	338	252	238	128	33761
1966	12257	9532	13320	16608	1529	1053	560	417	394	211	55880
1967	6256	4865	6799	8477	781	538	286	213	201	108	28522
1968	9704	7546	10545	13148	1211	834	443	330	312	167	44238
1969	9321	7248	10129	12629	1163	801	426	317	299	161	42492
1970	8044	6255	8741	10899	1004	691	367	273	258	139	36671
1971	8682	6752	9435	11764	1083	746	396	295	279	150	39581
1972	10597	8241	11516	14359	1322	911	484	360	340	183	48313
1973	10087	7844	10961	13667	1258	867	461	343	324	174	45984
1974	10725	8340	11655	14532	1338	921	490	365	344	185	48895
1975	11236	8738	12210	15224	1402	965	513	382	361	194	51223
1976	11747	9135	12765	15916	1466	1009	536	399	377	202	53551
1977	12513	9730	13598	16954	1561	1075	571	425	402	216	57044
1978	12640	9830	13736	17127	1577	1086	577	430	406	218	57626
1979	9065	7050	9851	12283	1131	779	414	308	291	156	41328
1980	12768	9929	13875	17300	1593	1097	583	434	410	220	58208
AVERAGE	8878	6904	9648	12029	1108	763	405	302	285	153	40474

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1 Based an annual pumping estimates for 1980 and estimates for other years as a percentage of 1980 pumping. Data provided by Morton W. Bittinger.

TABLE C.18

ESTIMATE OF ANNUAL PUMPING OF GROUNDWATER TRIBUTARY TO CACHE LA POUDRE OR SOUTH PLATTE RIVER BELOW GREELEY GAGE

(Acre-feet)

YEAR	Larimer County	Greeley No. 2	Larimer & Weld	TOTAL
1951	7460	8627	5806	21893
1952	7957	9202	6193	23352
1953	8123	9394	6322	23839
1954	8289	9586	6452	24326
1955	8454	9777	6581	24812
1956	9780	11311	7613	28704
1957	10278	11886	8000	30164
1958	10609	12269	8258	31137
1959	8454	9777	6581	24812
1960	10941	12653	8516	32110
1961	6299	7285	4903	18487
1962	8620	9969	6710	25299
1963	14256	16487	11097	41840
1964	14588	16870	11355	42813
1965	9615	11119	7484	28218
1966	15914	18404	12387	46705
1967	8123	9394	6322	23839
1968	12599	14570	9806	36975
1969	12101	13995	9419	35515
1970	10444	12078	8129	30650
1971	11272	13036	8774	33083
1972	13759	15912	10709	40380
1973	13096	15145	10193	38434
1974	13925	16104	10839	40867
1975	14588	16870	11355	42813
1976	15251	17637	11871	44759
1977	16245	18788	12645	47678
1978	16411	18979	12774	48164
1979	11770	13611	9161	34542
1980	16577	19171	12903	48651
AVERAGE	11527	13330	8972	33829

1 Based on annual pumping estimates for 1980 and estimates for other years as a percentage of 1980. Data provided by Morton W. Bittinger.

TABLE C.19

Cache la Poudre Basin Study

Modeled South Platte Call on Water District 3 Priorities

1984 State Engineer Basin Rank of Call	Range of Affected Basin Rank	Number of Actual RIBSIM Rights in Range	Percent of Time Called Out
-	0-174	33	0
300	175-470	51	0.6
600	471-1099	22	4
1466	1100-1900	10	27
2500	1900-3800	13	39
9999	> 3800	14	40

TABLE C.20

MODELED CALL
1984 STATE ENGINEERS BASIN RANK 300
CACHE LA POUDRE RIVER NEAR GREELEY, CO

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	1300	0	0	0	0	1300
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	1530	0	0	0	0	0	0	1530
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	0	0	0	0	0	1530	0	1300	0	0	0	0	1530
AVERAGE	0	0	0	0	0	51	0	43	0	0	0	0	94

NOTE: This call was modeled as affecting water rights with 1984 State Engineer basin rank of 175 through 470.

TABLE C.21

MODELED CALL
1984 STATE ENGINEERS BASIN RANK 600
CACHE LA POUDRE RIVER NEAR GREELEY, CO

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	1300	0	0	0	0	1300
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	1530	0	0	0	0	0	0	1530
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	2350	0	0	0	0	2350
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	2150	1380	0	0	0	0	3530
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	1160	2220	9350	10520	7600	30850
1970	7460	8190	7980	7970	2240	0	0	0	0	0	0	0	33840
1971	0	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	2130	0	0	0	0	0	2130
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	4052	4830	1071	0	0	0	9953
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	0
MAXIMUM	7460	8190	7980	7970	2240	1530	4052	4830	2220	9350	10520	7600	33840
AVERAGE	249	273	266	266	75	51	278	367	110	312	351	253	2849

NOTE: This call was modeled as affecting water rights with 1984 State Engineer basin rank of 471 through 1100.

TABLE C.22

MODELED CALL
1984 STATE ENGINEER BASIN RANK 1466
CACHE LA POUDRE RIVER NEAR GREELEY, CO

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	2200	2450	1530	10575	1750	0	0	0	18505
1952	0	0	0	0	0	2239	0	0	1290	2950	0	0	6479
1953	0	0	0	0	1000	2350	1250	1300	1240	1279	0	0	8419
1954	0	0	0	1200	590	560	800	980	590	1370	0	0	6090
1955	0	0	0	2210	760	1530	1250	2270	940	2390	0	0	11350
1956	0	0	0	2170	5590	6010	0	1250	940	2220	4570	4320	27070
1957	3600	3140	3120	3330	6270	39250	8080	1640	1990	0	0	0	70420
1958	0	0	0	0	0	0	1509	1320	1290	4130	0	0	8249
1959	0	0	0	0	0	1750	0	0	0	0	0	0	1750
1960	0	0	0	0	0	1320	2320	0	1980	925	0	0	6545
1961	0	0	0	0	1750	0	4670	3000	0	0	0	0	9420
1962	0	0	0	545	1422	0	0	0	0	0	0	0	1967
1963	0	0	0	380	1060	1067	840	3150	3320	902	0	0	10719
1964	0	0	0	2265	3200	0	930	2350	1680	4160	0	0	14585
1965	0	0	0	859	2500	62190	0	1510	0	0	0	0	67059
1966	0	0	0	0	0	0	2150	1380	3063	159	0	0	6752
1967	0	0	0	2438	2010	0	0	0	0	0	0	0	4448
1968	0	0	0	0	0	1960	0	0	0	0	0	0	1960
1969	0	0	0	416	175	0	2180	1160	2220	9350	10520	7600	33621
1970	7460	8190	7980	7970	2240	0	0	0	0	0	0	0	33840
1971	0	0	0	0	0	0	10400	4100	1570	0	0	0	16070
1972	0	0	0	5120	1200	13380	2130	0	0	0	0	0	21830
1973	0	0	0	0	0	0	3642	0	0	0	0	0	3642
1974	0	0	0	0	1240	4146	4052	4830	1071	0	0	0	15339
1975	0	0	0	1924	2602	0	5304	2610	486	0	0	0	12926
1976	0	0	0	0	790	2396	1720	2622	1974	0	0	0	9502
1977	0	0	0	655	565	0	2521	1730	1270	1131	0	0	7872
1978	0	0	0	3836	4483	3759	2300	1950	3190	6440	0	0	25958
1979	0	0	0	0	0	0	3848	3788	0	0	0	0	7636
1980	0	0	0	0	0	0	1948	2430	0	0	0	0	4378
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	1750
MAXIMUM	7460	8190	7980	7970	6270	62190	10400	10575	3320	9350	10520	7600	70420
AVERAGE	369	378	370	1177	1388	4879	2179	1865	1062	1247	503	397	15813

NOTE: This call was modeled as affecting water rights with 1984 State Engineer basin rank of 1100 through 1900.

TABLE C.23

MODELED CALL
1984 STATE ENGINEER BASIN RANK 2500
CACHE LA POUDRE RIVER NEAR GREELEY, CO

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	2200	6090	1530	10575	1750	0	0	0	22145
1952	0	0	0	0	0	3073	0	0	1290	4950	0	0	9313
1953	0	0	0	0	1000	2350	1250	1300	1240	1279	0	0	8419
1954	0	0	0	1200	590	560	800	980	590	1370	2460	3510	12060
1955	3240	925	0	2210	760	1530	1250	2270	940	2390	1300	0	16815
1956	0	0	0	2170	5590	6010	0	1250	940	2220	4570	4320	27070
1957	3600	3140	3120	3740	6270	39250	8680	1640	1990	0	0	0	71430
1958	0	0	0	0	0	0	1509	1320	1290	4130	0	0	8249
1959	0	0	0	0	0	1750	0	0	0	0	0	0	1750
1960	0	0	0	0	0	3490	2320	0	1980	2656	0	0	10446
1961	0	0	2698	0	1436	0	4670	3000	3009	0	0	0	14813
1962	0	0	0	545	1422	0	18610	3760	3710	6149	0	0	34196
1963	0	0	0	3460	1060	1067	840	3150	3320	3440	0	0	16337
1964	0	3960	4660	6420	3200	3500	930	2350	1680	4160	2360	0	33220
1965	3150	3890	4010	1894	2500	70530	1656	1510	0	0	0	0	89140
1966	0	0	0	0	0	0	2150	1380	3063	2378	3489	4660	17120
1967	3860	3160	3790	2740	2010	0	0	0	0	0	0	0	15560
1968	0	0	0	0	0	4685	0	0	0	2291	0	0	6976
1969	0	0	0	416	175	0	2180	1160	2220	9350	10520	7600	33621
1970	7460	8190	7980	7970	2240	0	4854	3960	2628	0	0	0	45282
1971	0	0	0	0	0	0	10400	4100	4671	0	0	0	19171
1972	0	0	0	5120	1200	4814	2130	0	4953	0	0	0	18217
1973	0	0	0	0	0	0	5482	2428	7140	11560	13350	10380	50340
1974	9420	9060	7360	7810	5590	4146	4052	4830	1279	0	0	0	53547
1975	0	0	0	1924	3074	0	5304	2610	1398	0	0	0	14310
1976	0	0	0	0	790	2396	1720	2622	3920	6150	0	0	17598
1977	0	0	2350	1160	920	0	4336	1730	1270	4400	5170	5000	26336
1978	5380	4920	0	3836	6547	35852	2300	1950	3190	6440	0	3049	73464
1979	0	0	6790	5038	0	0	3847	4096	0	0	0	0	19771
1980	0	0	0	0	0	0	1948	2430	3949	0	0	0	8327
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	1750
MAXIMUM	9420	9060	7980	7970	6547	70530	18610	10575	7140	11560	13350	10380	89140
AVERAGE	1204	1242	1425	1922	1619	6370	3158	2213	2114	2510	1441	1284	26501

NOTE: This call was modeled as affecting water rights with 1984 State Engineer basin rank of 1901 through 3800.

TABLE C.24

MODELED CALL
1984 STATE ENGINEER BASIN RANK 9999
CACHE LA POUDRE RIVER NEAR GREELEY,CO

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	2200	6090	1530	10575	1750	0	0	0	22145
1952	0	0	0	0	0	3073	0	0	1290	4950	0	0	9313
1953	0	0	0	0	1000	2350	1250	1300	1240	1279	0	0	8419
1954	0	0	0	1200	590	560	800	980	590	1370	2460	3510	12060
1955	3240	925	0	2210	760	1530	1250	2270	940	2390	1300	0	16815
1956	0	0	0	2170	5590	6010	0	1250	940	2220	4570	4320	27070
1957	3600	3140	3120	3740	6270	39250	8680	1640	1990	0	0	0	71430
1958	0	0	0	0	0	0	1509	1320	1290	4130	0	0	8249
1959	0	0	0	0	0	1750	0	0	0	0	0	0	1750
1960	0	0	0	0	0	3490	2320	0	1980	2656	0	0	10446
1961	0	0	2698	0	1436	0	4670	3000	3009	0	0	0	14813
1962	0	0	0	545	1422	0	18610	3760	3710	6149	0	0	34196
1963	0	0	0	3460	1060	1067	840	3150	3320	3440	0	0	16337
1964	0	3960	4660	6420	3200	3500	930	2350	1680	4160	2360	0	33220
1965	3150	3890	4010	1894	2500	70530	1656	1510	0	0	0	0	89140
1966	0	0	0	0	0	0	2150	1380	3063	2378	3489	4660	17120
1967	3860	3160	3790	2740	2010	0	0	0	0	0	0	0	15560
1968	0	0	0	0	0	4685	0	0	0	2291	0	0	6976
1969	0	0	0	416	175	0	2180	1160	2220	9350	10520	7600	33621
1970	7460	8190	7980	7970	2240	0	4854	3960	2628	0	0	0	45282
1971	0	0	0	0	0	0	10400	4100	4671	0	0	0	19171
1972	0	0	0	5120	1200	4814	2130	0	4953	0	0	0	18217
1973	0	0	0	0	0	0	5482	2428	7140	11560	13350	10380	50340
1974	9420	9060	7360	7810	5590	4146	4052	4830	1279	0	0	0	53547
1975	0	0	0	1924	3074	0	5304	2610	1398	0	0	0	14310
1976	0	0	0	920	790	2396	1720	2622	3920	6150	0	0	18518
1977	0	0	2350	1160	1690	0	4939	1730	1270	4400	5170	5000	27709
1978	5380	4920	0	3836	8160	35852	2300	1950	3190	6440	0	3049	75077
1979	0	0	6790	5038	0	0	3847	4096	0	0	0	0	19771
1980	0	0	0	0	0	0	1948	2430	3949	0	0	0	8327
MINIMUM	0	0	0	0	0	0	0	0	0	0	0	0	1750
MAXIMUM	9420	9060	7980	7970	8160	70530	18610	10575	7140	11560	13350	10380	89140
AVERAGE	1204	1242	1425	1952	1699	6370	3178	2213	2114	2510	1441	1284	26632

NOTE: This call was modeled as affecting water rights with 1984 State Engineer basin rank greater than 3800.

TABLE C.25

CACHE LA POUDRE BASIN STUDY
Irrigated Acreage by Ditch System

Ditch System	Irrigated Acreage (Acres)
Arthur	1,785
B. H. Eaton	1,024
Boxelder	1,879
Boyd and Freeman	562
Chaffee	634
Coy	117
Greeley No. 2	42,546
Greeley No. 3	4,114
Jackson	2,531
Jones	355
Josh Ames	136
Lake	8,605
Larimer County	50,826
Larimer & Weld	67,891
Little Cache, Taylor and Gill	1,412
New Mercer and Larimer Co. No. 2	9,860
North Poudre System, and Poudre Valley	33,727
Ogilvy	2,649
Pleasant Valley and Lake	5,768
Whitney	2,254
Total	238,675

TABLE C.26

CACHE LA POUDRE RIVER AT MOUTH OF CANYON
COMPARISON OF RECORDED AND MODELED FLOWS

(ACRE-FEET)

RECORDED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1730	1780	2380	6950	62490	100800	69410	26930	16780	5410	3100	2620	300380
1952	2650	1640	2160	5960	48460	122500	39080	24580	15340	3680	2150	1670	269870
1953	2180	2250	2050	2890	20450	72440	27080	18150	7810	3420	1960	2030	162710
1954	1960	1570	1560	2950	25660	34470	15040	3760	5750	5020	1650	1060	100450
1955	1220	920	1240	1980	22080	60930	28190	15640	4360	3080	2310	2460	144410
1956	1710	1410	1930	3490	72790	87350	24540	11670	3230	2040	1220	1600	212980
1957	1290	1360	1440	7060	35530	136300	104600	20330	9720	5050	2720	2640	328040
1958	2110	2080	2690	10930	92800	96130	16260	4070	3260	3180	1880	2020	237410
1959	1650	2000	3070	12120	44150	103800	24810	10820	4070	4530	3750	1150	215920
1960	1070	770	3030	5550	50190	96750	27910	6540	4230	3000	1700	1550	202290
1961	2250	1650	2800	7880	70220	116800	31970	18770	11690	16210	6740	3220	290200
1962	3600	5710	5420	19160	68930	84900	45970	11310	2220	3780	2100	1760	254860
1963	1100	1040	760	4000	27300	37800	12230	11700	7380	3710	2120	980	110120
1964	830	850	1550	2300	35820	65840	31460	10820	4450	1850	1030	780	157580
1965	830	860	860	2530	32330	129700	77210	25500	7570	4010	1050	1310	283760
1966	1170	1220	1670	2820	29830	33360	9720	6240	5870	2850	1440	799	96989
1967	738	567	1090	1860	26300	75860	43390	7150	4180	1680	3280	2830	168925
1968	2210	2530	1940	2990	28840	102800	40920	20290	6720	2570	2160	1680	215650
1969	1170	1040	1640	6290	50520	74280	35650	6900	7480	4190	1880	891	191931
1970	872	617	1440	5570	59140	108800	55920	17230	6260	4770	4210	1870	266699
1971	1850	1350	1960	11640	62340	141700	56500	13340	9560	2480	4510	2180	309410
1972	1630	1820	2180	3970	36000	86010	25380	5180	6240	3890	2630	1590	176520
1973	1460	1450	2050	3470	89410	123400	65520	22890	3750	5210	6520	3090	328220
1974	2400	2940	5700	7270	78840	108100	39960	6570	4690	4740	2740	1380	265330
1975	810	740	1150	2100	18790	86830	78920	17250	5950	3240	1700	1670	219150
1976	1540	1410	1520	2300	27730	65040	27330	18980	3530	4590	1600	1010	156580
1977	916	849	1350	2970	12550	39170	10500	14160	3740	2460	2230	1630	92525
1978	1420	1280	1620	3910	36160	127800	66100	19680	5850	2860	1790	1300	269770
1979	1150	932	1460	5020	51250	123100	59420	34610	8780	3320	1810	2650	293502
1980	5560	4380	9140	32760	158700	142300	41410	16840	6210	5130	4290	3090	429810
51-80 AV	1703	1634	2295	6356	49187	92835	41080	14930	6556	4065	2609	1817	225066
74-80 AV	1971	1790	3134	8047	54860	98906	46234	18299	5536	3763	2309	1819	246667

MODELED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% OF ACTUAL
1951	368	1393	1589	5162	46373	108590	70736	21410	15637	5322	2742	3080	282402	94
1952	1616	1517	1697	5901	53909	133044	40364	23014	17879	3287	1857	2070	286155	106
1953	468	1820	2467	4413	17320	77656	27147	15717	7866	3796	2060	2130	162860	100
1954	0	1081	1243	2595	21404	36600	16112	4332	4396	5327	1974	1760	96824	96
1955	460	1475	1703	2621	17339	61063	26573	12862	3635	3156	2415	2471	135773	94
1956	496	2097	2369	2766	68079	92933	17705	8494	1451	3052	1736	2137	203315	95
1957	512	2071	2040	7993	34746	156241	106411	18178	7019	7876	1975	1867	346929	106
1958	740	1619	1531	417	104526	97965	13178	1963	1992	1218	2085	2394	229628	97
1959	696	1727	2085	7437	44424	114676	28189	3551	1213	8498	3352	2869	218717	101
1960	726	1691	1891	4717	44571	101623	30596	2037	1513	3890	2091	1861	197207	97
1961	584	1859	3000	9677	65108	122804	32918	12770	11104	8689	8971	4472	281956	97
1962	2848	2138	4153	19494	71584	93735	50309	5913	1312	3506	2053	1869	258914	102
1963	1356	1523	1753	2444	27373	44372	9275	6321	3778	3206	2220	1626	105247	96
1964	1530	2050	1765	3569	28410	73570	30128	6405	3085	3460	1692	1718	157382	100
1965	1488	1597	1556	3289	25775	135357	75753	16260	4208	5015	2089	1903	274290	97
1966	1408	1589	1865	2629	27580	35396	9664	4254	3110	4050	1758	1764	95067	98
1967	1480	1647	1881	2160	17681	84456	40586	5985	4201	1111	3067	2771	167026	99
1968	2284	2523	1720	1051	20192	115234	42535	13884	10905	2584	2089	1873	216874	101
1969	1446	2253	2104	3482	53196	76819	41470	3508	4554	5500	3420	2067	199819	104
1970	2351	1895	1700	6293	62381	97809	58819	13294	9027	3474	2032	1888	260963	98
1971	1441	1648	1998	5458	59575	149705	57275	10458	10804	3007	2423	1943	305735	99
1972	1504	1662	2909	2584	34264	85969	25240	3942	4416	6292	2835	1792	173409	98
1973	2101	1740	2207	4986	74627	133173	66944	17212	5846	8526	6676	5068	329106	100
1974	2900	3036	5135	6557	77305	109429	43044	4227	7485	4896	3952	2150	270116	102
1975	1816	1932	2312	2580	15224	92627	78324	8105	7820	5046	2385	2574	220745	101
1976	1799	1911	2679	2315	27628	71163	25319	18801	4521	3003	2646	1233	163018	104
1977	820	1018	1078	2578	14848	48365	8002	9767	2177	3820	2279	1756	96508	104
1978	1894	1775	2178	3443	29365	130215	65764	10504	3954	6150	2689	2483	260414	97
1979	1809	1871	3118	2063	48127	130685	63850	35364	5084	3420	2305	2304	300000	102
1980	1540	3126	2368	19841	165221	154224	47864	15458	7985	6940	5651	2928	433146	101
51-80 AV	1349	1843	2203	5017	46605	98850	41670	11133	5933	4571	2851	2294	224318	
% OF ACT	79	113	96	79	95	106	101	75	90	112	109	126	100	
74-80 AV	1797	2096	2695	5625	53960	105244	47452	14604	5575	4754	3130	2204	249135	
% OF ACT	91	117	86	70	98	106	103	80	101	126	136	121	101	

TABLE C.27

CACHE LA POUDRE RIVER NEAR GREELEY
COMPARISON OF RECORDED AND MODELED FLOWS

(ACRE-FEET)

RECORDED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	3010	2870	3260	2960	2530	6090	1530	11710	1750	5580	7770	6130	55190
1952	6950	6390	6270	6490	5700	10000	1990	1410	1290	4950	5890	5360	62690
1953	4380	3850	4020	4190	1000	2350	1250	1300	1240	2950	5240	4780	36550
1954	4190	3410	3120	1200	590	560	800	980	590	1370	2460	3510	22780
1955	3240	2980	3430	2210	760	1530	1250	2270	940	2390	3850	4070	28920
1956	3510	2990	3410	2170	5590	6720	980	1250	940	2220	4570	4320	38670
1957	3600	3140	3120	3740	6270	39250	9540	1640	1990	5770	9480	10220	97760
1958	7110	7850	7180	14650	67790	25340	2770	1320	1290	4130	6820	6450	152700
1959	5700	5340	7380	14150	12310	8110	1960	1500	2710	8040	7520	6850	81570
1960	6640	5770	6740	4250	2300	3490	2320	1160	1980	5000	6060	5510	51220
1961	5090	4580	5380	4290	34520	78120	4670	3900	8260	20720	21900	12760	204190
1962	10910	14130	14930	12560	4710	23100	18610	3760	3710	8530	7800	9060	131810
1963	8370	7690	6460	3460	1060	3710	840	3150	3320	3440	5920	5250	52670
1964	4870	3960	4660	6420	3200	3500	930	2350	1680	4160	4910	4640	45280
1965	3970	3890	4010	2870	2500	70530	4970	1510	3430	6830	5850	7150	117510
1966	8570	6590	5690	2870	620	2020	2150	1380	3170	2970	3870	4660	44560
1967	3860	3160	3790	2740	2010	35970	13500	1900	2700	5320	6060	5870	86880
1968	4810	4980	4150	3350	1690	10260	1880	2040	2010	5400	5820	5360	51750
1969	4810	4020	4430	3070	1880	23090	2180	1160	2220	9350	10520	7600	74330
1970	7460	8190	7980	7970	3630	51190	6210	3960	4910	8140	12180	10200	132020
1971	7820	6630	7020	12280	57360	35620	10400	4100	8220	9420	12990	10050	181910
1972	9030	9060	6710	6270	1200	20000	2130	3830	5410	5380	6190	4890	80100
1973	7730	7400	6690	6230	60280	29240	9600	5690	7140	11560	13350	10380	175290
1974	9420	9060	7360	7810	5590	32980	5060	4830	5380	9320	8880	8860	114550
1975	8440	6520	6360	5970	5190	31650	8560	2610	3680	6960	7220	6040	99200
1976	5710	5610	5860	4720	3630	3250	1720	6720	3920	6150	6050	8770	62110
1977	5120	4670	4600	2680	1690	563	6310	1730	1270	4400	5170	5000	43203
1978	5380	4920	5470	4590	8160	41490	2300	1950	3190	6440	6100	4910	94900
1979	4500	4850	6790	6630	44250	86790	5930	12710	6100	9760	10440	8810	207560
1980	9430	14360	21100	43530	187300	59170	3890	2430	4770	7180	7120	5590	365870
51-80 AV	6121	5962	6246	6877	17844	24856	4541	3208	3307	6461	7600	6768	99791
74-80 AV	6857	7141	8220	10847	36544	36556	4824	4711	4044	7173	7283	6854	141056

MODELED FLOWS

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% OF ACTUAL
1951	15	0	305	2465	5238	20642	2788	8765	2141	2856	5762	6882	57859	105
1952	3399	5525	6216	6371	17922	28106	2943	1749	1411	4950	3219	3116	84927	135
1953	3051	4040	5857	5375	2968	7930	1933	1890	1328	1279	2442	2367	40460	111
1954	2340	4261	5242	4513	3581	2386	2521	1534	1139	1472	2547	3510	35046	154
1955	3240	2273	4859	4840	4847	4172	3045	2298	1391	2390	4745	5906	44006	152
1956	3083	3083	4831	2540	17256	11860	2911	2279	1531	2273	4570	4320	60537	157
1957	3725	3680	6065	10717	15120	70263	8680	2312	2101	2621	3855	6524	135663	139
1958	3832	5172	6390	6157	84928	15672	2536	1723	1404	4130	3146	3173	138263	91
1959	3219	5419	5592	6311	21009	16247	2494	1823	2745	2946	3318	3347	74470	91
1960	3253	5426	6031	5168	7795	8837	2722	2881	1980	2656	3450	3362	53561	105
1961	3295	5126	6061	4661	35108	72806	4670	3000	3009	7724	12378	8117	165955	81
1962	5341	5742	7759	10657	11857	42737	11346	3760	3710	5930	3401	3395	115635	88
1963	4059	4199	6977	4688	3853	2427	2065	3150	2801	3440	6337	6445	50441	96
1964	3505	3960	4824	6420	7261	3500	2856	3568	2735	4160	3264	4391	50444	111
1965	3203	3890	4339	4843	4904	81919	2395	1705	2485	9326	6873	6955	132837	113
1966	3849	3782	6218	5711	5053	2104	3355	3047	3380	2378	3489	4660	47026	106
1967	3860	3160	4614	5560	6176	53407	6592	1793	695	1972	3307	6231	97367	112
1968	6251	5977	6156	4812	5272	27699	3545	3156	2040	2296	3377	3299	73880	143
1969	3277	5888	6306	5999	6769	27018	3197	2539	2298	9091	7398	6252	86032	116
1970	6970	6141	6869	6651	4375	40915	4854	3960	2628	5602	6180	5956	101101	77
1971	3141	3107	3098	4619	56362	52528	6396	4100	4671	3903	6187	6125	154237	85
1972	3235	4010	3750	5120	3160	14806	2569	2263	4285	8507	6712	6713	65130	81
1973	3733	3656	3576	4215	46965	51506	5482	2861	4324	11159	9496	9398	156371	89
1974	7602	7058	7360	7810	5590	32492	4274	4830	2416	5547	7592	7639	100210	87
1975	4540	4456	4476	3695	7189	43318	5407	3004	2695	3715	6559	6420	95474	96
1976	3579	4208	4230	4788	2633	2396	3785	3893	3920	5117	3600	5448	47597	77
1977	2779	2835	5032	3192	1633	2472	4337	4056	4674	3932	5170	5000	45112	104
1978	5380	4920	3291	3836	9297	61211	5852	3042	4526	5916	4086	6335	117692	124
1979	3497	3375	6216	5038	38186	88309	3848	5116	2951	3856	2889	4158	167439	81
1980	2639	2790	5008	22890	168008	63253	2131	4016	4627	4009	3355	4678	287404	79
51-80 AV	3763	4239	5252	5989	20344	31765	4051	3137	2735	4505	4957	5337	96073	
% OF ACT	61	71	84	87	114	128	89	98	83	70	65	79	96	
74-80 AV	4288	4235	5088	7321	33219	41922	4233	3994	3687	4585	4750	5668	122990	
% OF ACT	63	59	62	67	91	115	88	85	91	64	65	83	87	

TABLE C.28

MODELED AVERAGE DIVERSIONS
FOR ALL SOURCES ALL USES DEMANDS
1951-1980

(ACRE-FEET)

DITCH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MUNROE CANAL	0	0	0	28	3848	7935	9356	7778	5152	449	9	0	34555
NORTH POUDRE DITCH	26	8	996	1490	5095	7473	5450	4704	3621	409	1000	500	30772
POUDRE VALLEY CANAL	0	0	12	515	3824	7335	1428	477	870	3102	0	0	17563
PLEASANT VALLEY	0	0	5	186	2203	3976	3422	2752	1776	1034	0	0	15354
LARIMER COUNTY CANAL	0	0	32	1072	11169	19003	19109	16290	9117	1345	40	0	77177
JACKSON DITCH	0	0	6	63	1097	1656	1605	955	678	330	27	0	6417
LITTLE CACHE	0	94	260	546	1831	2954	2964	1266	196	981	387	206	11685
TAYLOR & GILL	0	0	0	28	525	694	689	574	260	76	0	0	2846
NEW MERCER	0	0	0	1	898	2213	1778	1071	377	38	0	0	6376
LARIMER CO. NO. 2	10	0	0	75	1770	3960	1660	1034	473	24	0	0	9006
ARTHUR DITCH	0	0	0	40	1046	1767	1579	618	284	97	0	0	5431
LARIMER & WELD	1000	1000	1000	1150	9740	20977	19170	17516	4823	1343	1000	1000	79719
JOSH AMES	0	0	0	0	132	272	387	179	43	7	0	0	1020
LAKE CANAL	0	0	0	15	2276	4608	2730	1330	525	36	0	0	11520
COY DITCH	1	1	2	23	133	239	340	270	81	47	5	3	1145
CHAFFEE DITCH	0	0	0	0	113	182	106	29	1	1	0	0	432
BOXELDER DITCH	0	0	0	51	998	1336	2113	1378	384	142	0	0	6402
GREELEY NO. 2	0	0	36	425	8792	16421	13654	5928	1132	3	0	0	46391
WHITNEY DITCH	0	0	0	317	1422	1730	2933	2792	1605	41	0	0	10840
B.H. EATON	0	0	0	103	628	735	1396	1233	510	24	0	0	4629
JONES DITCH	0	0	0	95	489	609	846	836	537	48	0	0	3460
GREELEY NO. 3	0	0	0	387	3116	3841	4487	3995	2788	1643	122	0	20379
BOYD & FREEMAN	0	0	0	23	152	212	283	252	117	40	0	0	1079
OGILVY DITCH	0	0	0	302	1868	2680	2634	2506	1722	592	0	0	12304
TOTAL IRRIGATION	1037	1103	2349	6935	63165	112808	100119	75763	37072	11852	2590	1709	416502
FT. COLLINS PIPELINE	509	469	524	650	789	938	1069	987	716	714	527	521	8413
GREELEY PIPELINE	615	528	602	816	1084	1217	1437	1288	1016	955	700	658	10916
TOTAL MUNICIPAL	1124	997	1126	1466	1873	2155	2506	2275	1732	1669	1227	1179	19329
TOTAL FROM RIVER	2161	2100	3475	8401	65038	114963	102625	78038	38804	13521	3817	2888	435831
GREELEY-BOYD LAKE	4	10	16	44	137	292	360	260	138	46	14	4	1341
FT. COL.- DIRECT CBT	11	15	26	47	154	334	369	284	174	52	30	12	1508
WATER DISTRICTS	106	106	111	128	188	244	271	241	193	153	109	107	1957
TOTAL NON-RIVER	121	131	153	219	479	870	1000	785	505	251	153	123	4806
TOTAL DIVERSIONS	2282	2231	3628	8620	65517	115833	103625	78823	39309	13772	3970	3011	440637

TABLE C.29

AVERAGE MODELED TRANSBASIN DIVERSIONS INTO
THE CACHE LA POUDRE BASIN

(ACRE-FEET)

IMPORTING DITCH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
BOB CREEK DITCH	0	0	0	0	159	146	7	0	0	0	0	0	312
COLUMBINE DITCH	0	0	0	0	31	67	8	0	0	0	0	0	105
CAMERON PASS/GRAND RI	0	0	0	3	831	6736	6604	1926	289	0	0	0	16389
L-P TUNNEL/SKYLINE D.	0	0	0	5	2358	5918	6125	1983	330	0	0	0	16719
MICHIGAN DITCH	0	0	0	0	34	372	236	33	1	0	0	0	676
WILSON SUPPLY DITCH	0	0	0	2	612	140	23	0	0	0	0	0	777
TOTAL	0	0	0	10	4024	13378	13002	3943	620	0	0	0	34978

NOTES: 1. Averages based on 1951-1980 except Columbine and Bob Creek Ditches, which are for 1951-1956 only.

TABLE C.30

MODELED AVERAGE CBT DIVERSIONS
1951-1980

(ACRE-FEET)

DITCH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ARTHUR DITCH	0	0	0	0	3	2	101	258	180	15	0	0	559
BOXELDER DITCH	0	0	0	0	0	0	0	8	21	0	0	0	30
CHAFFEE DITCH	0	0	0	0	0	0	13	28	1	0	0	0	41
COY DITCH	0	0	0	0	0	0	0	1	1	0	0	0	2
FT. COLLINS PIPELINE	0	0	0	0	0	0	2	0	6	0	0	0	8
FT. COLLINS DIRECT	11	15	26	47	154	334	369	284	174	52	30	12	1508
FOSSIL CR. RESERVOIR	0	0	0	0	0	0	9	58	3	20	10	0	99
GREELEY NO. 3 CANAL	0	0	0	0	0	0	12	0	0	0	0	0	12
GREELEY NO. 2 CANAL	0	0	0	0	0	491	275	279	22	0	0	0	1067
GREELEY PIPELINE	0	0	0	19	311	422	245	138	133	72	0	0	1339
JACKSON DITCH	0	0	0	0	0	1	37	46	25	13	0	0	122
JONES DITCH	0	0	0	0	0	0	1	0	0	0	0	0	2
JOSH AMES DITCH	0	0	0	0	0	0	0	19	19	2	0	0	40
LAKE CANAL	0	0	0	0	29	96	802	1328	513	26	0	0	2796
LARIMER COUNTY CANAL	0	0	0	170	1795	218	3345	8199	6231	1086	0	0	21043
LARIMER CO. NO. 2	0	0	0	0	20	68	458	850	413	20	0	0	1830
LARIMER & WELD CANAL	0	0	0	86	1229	806	9352	14426	3818	711	0	0	30428
LITTLE CACHE DITCH	0	0	0	0	0	54	4	67	20	464	0	0	609
NORTH POUDRE SYSTEM	0	0	0	42	3249	3503	7436	3888	985	136	0	0	19238
NEW MERCER DITCH	0	0	0	0	54	78	515	704	275	5	0	0	1632
OGILVY DITCH	0	0	0	0	0	0	0	5	0	0	0	0	5
PLEASANT VALLEY	0	0	0	0	17	28	204	172	124	192	0	0	737
POUDRE VALLEY CANAL	0	0	0	0	9	23	83	104	590	2462	0	0	3271
TAYLOR & GILL DITCH	0	0	0	0	0	0	0	0	8	0	0	0	8
TIMNATH RESERVOIR	0	0	0	0	0	0	23	68	62	103	0	0	256
WHITNEY DITCH	0	0	0	0	0	2	6	8	1	0	0	0	18
WATER DISTRICTS	106	106	111	128	188	244	271	241	193	153	109	107	1957
TOTAL	117	121	137	492	7058	6370	23563	31179	13818	5532	149	119	88657

TABLE C.31

MODELED GROUND WATER USE
1951-1980

(ACRE-FEET)

DITCH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
FROM AQUIFERS ABOVE GREELEY GAGE													
N. POUDRE/POUDRE VALL	0	0	0	0	1444	1925	3489	3849	1323	0	0	0	12029
JACKSON DITCH	0	0	0	0	36	48	88	97	33	0	0	0	302
ARTHUR DITCH	0	0	0	0	34	46	83	91	31	0	0	0	285
LARIMER 2/NEW MERCER	0	0	0	0	49	65	118	130	45	0	0	0	405
LAKE CANAL	0	0	0	0	133	177	321	355	122	0	0	0	1108
BOXELDER DITCH	0	0	0	0	18	24	44	49	17	0	0	0	153
LARIMER & WELD	0	0	0	0	1158	1544	2798	3087	1061	0	0	0	9648
GREELEY NO. 3	0	0	0	0	92	122	221	244	84	0	0	0	763
GREELEY NO. 2	0	0	0	0	829	1105	2002	2209	759	0	0	0	6904
LARIMER COUNTY CANAL	0	0	0	0	1065	1420	2575	2841	977	0	0	0	8878
TOTAL ABOVE GAGE	0	0	0	0	4858	6476	11739	12952	4452	0	0	0	40475
FROM AQUIFERS BELOW GEELEY GAGE													
LARIMER & WELD	0	0	0	0	1077	1410	2443	2599	977	0	0	0	8506
GREELEY NO. 2	0	0	0	0	1599	2133	3866	4266	1466	0	0	0	13330
LARIMER COUNTY CANAL	0	0	0	0	1383	1844	3313	3314	1164	0	0	0	11019
TOTAL BELOW GAGE	0	0	0	0	4059	5387	9622	10179	3607	0	0	0	32855
TOTAL MODELED PUMPING	0	0	0	0	8917	11863	21361	23131	8059	0	0	0	73330

TABLE C.32

SUMMARY OF MODELED RETURN FLOWS
BETWEEN CANYON GAGE AND LARIMER & WELD

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	19	57	1	636	1554	1302	535	199	27	0	0	4330
1952	0	19	57	245	547	1347	1111	636	256	440	0	0	4658
1953	0	19	57	0	572	1927	1383	770	38	250	0	0	5016
1954	0	19	57	30	1090	1248	712	236	27	663	65	57	4204
1955	0	19	57	228	1302	1166	1437	1035	58	37	95	57	5491
1956	0	19	57	372	1249	1623	1599	1117	29	25	52	57	6199
1957	0	19	57	0	614	1296	2096	2333	1301	280	95	57	8148
1958	0	19	57	0	630	1512	2275	429	56	301	95	57	5431
1959	0	19	57	134	427	1804	2267	1211	254	181	95	57	6506
1960	0	19	57	220	1533	2827	2373	115	37	408	95	57	7741
1961	0	19	57	136	676	839	2373	2373	861	1	95	57	7487
1962	0	19	57	213	1681	1622	2180	1205	459	729	95	57	8317
1963	0	19	57	100	1924	1780	871	1009	397	506	95	0	6758
1964	0	19	57	0	1117	2334	2328	291	42	26	0	0	6214
1965	0	19	1	60	873	1465	2410	2098	377	414	95	57	7869
1966	0	19	57	2	1902	2340	1348	156	49	83	0	0	5956
1967	0	19	57	1	383	845	1206	589	56	210	95	57	3518
1968	0	19	2	0	1379	1407	2606	959	262	11	95	57	6797
1969	0	19	57	5	1390	1495	2314	404	28	4	95	57	5868
1970	0	19	0	934	854	1796	2427	1893	312	3	95	57	8390
1971	0	19	57	149	4	1190	2061	1865	301	943	95	57	6741
1972	0	2	57	25	2227	1534	1956	691	264	49	95	0	6900
1973	0	19	57	1	486	1959	1595	977	286	3	95	57	5535
1974	0	19	57	137	1265	1441	1338	493	360	594	95	32	5831
1975	0	19	57	2	823	864	1292	930	18	912	95	57	5069
1976	0	19	61	195	843	1646	1387	763	42	328	6	0	5290
1977	0	0	0	102	1309	1322	720	38	203	167	98	0	3959
1978	0	19	58	103	565	1242	1545	675	18	359	95	57	4736
1979	0	19	57	426	686	566	1235	924	358	12	95	57	4435
1980	0	19	57	0	334	1331	1303	358	32	567	95	57	4153
AVERAGE	0	18	50	127	977	1511	1702	904	233	284	74	39	5918
AVG CFS	0	0	1	2	16	25	28	15	4	5	1	1	8

TABLE C.33

SUMMARY OF MODELED RETURN FLOWS
BETWEEN LARIMER & WELD AND GREELEY NO. 2

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	2499	2258	2501	2424	9550	11723	11518	3952	3990	3010	2823	2915	59163
1952	2897	2681	2939	2744	6768	12778	5729	5671	4615	3164	2734	2796	55516
1953	2779	2542	2839	2592	7090	14124	7221	6327	3840	3314	2703	2763	58134
1954	2853	2630	2904	3148	10225	8353	6161	4578	3346	3993	2872	2899	53962
1955	2895	2637	2887	3043	8413	11291	6884	5988	4100	3172	2832	2817	56959
1956	2850	2638	2882	2705	9900	10630	6933	4925	3461	3818	2737	2802	56281
1957	2800	2564	2802	2611	3036	9469	12327	6329	4829	3037	2714	2745	55263
1958	2759	2514	2722	2610	2848	9685	6984	6181	3907	3233	2604	2745	48792
1959	2706	2451	2692	2557	4722	12009	7087	6684	4202	2744	2669	2730	53253
1960	2741	2515	2749	3119	9869	9205	7769	5939	3798	3360	2863	2894	56821
1961	2925	2648	2901	2688	4313	7259	7327	5794	4041	2816	2760	2864	48336
1962	2900	2647	2905	3475	11228	8453	9341	6670	4255	3122	2991	2995	60982
1963	3000	2747	3017	3257	9379	6427	6844	5301	3979	3086	2876	2933	52846
1964	2941	2691	2932	2756	10317	8541	7553	5775	3553	3773	2971	2970	56773
1965	3005	2727	2960	2813	8489	5471	8941	6607	4256	3076	3006	3046	54397
1966	3052	2786	3182	3305	7022	7743	7181	5285	2981	3620	2992	3053	52202
1967	3088	2822	3145	2922	5477	4429	6025	6755	4130	3451	2998	3078	48320
1968	3124	2853	3065	2859	5882	10297	9219	5449	4387	3607	3071	3120	56933
1969	3141	2869	3155	3036	6876	6430	8379	6168	3795	3061	3073	3139	53122
1970	3179	2987	3192	2831	6258	6423	8927	6212	4160	3097	3040	2825	53131
1971	2868	2689	2860	2637	3199	9632	9454	5717	3504	2878	2966	2912	51316
1972	2967	2868	2868	2872	6739	7000	6706	5466	3267	3161	3141	2986	50041
1973	3023	2855	2985	2643	5438	9057	8723	5885	3972	3138	3087	3046	53852
1974	3070	2894	3030	2882	8293	8354	8396	6005	4063	3216	3147	3150	56500
1975	3154	2981	3033	2767	7038	5786	10287	5862	3185	3351	3084	2999	53527
1976	2992	2872	3010	2901	5514	9714	7307	6044	3482	3024	3140	3160	53160
1977	3063	2984	3157	2847	5454	8177	5273	4234	3100	3541	3157	3083	48070
1978	2986	2768	3053	3204	4646	9360	9954	6436	3091	3500	2969	2913	54880
1979	2958	2816	2939	2802	3210	5268	8959	4888	3807	3317	2953	2920	46837
1980	2913	2808	2899	2730	2786	8462	8243	5686	3679	3401	3131	3048	49786
AVG.	2938	2725	2940	2859	6666	8718	8055	5760	3826	3269	2937	2945	53639
AVG CFS	48	49	48	48	109	147	131	94	64	53	49	48	74

TABLE C.34

SUMMARY OF MODELED RETURN FLOWS
BETWEEN GREELEY NO. 2 AND GREELEY NO. 3

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	4	8	13	27	3998	6917	9029	7857	5773	2490	2307	2256	40679
1952	2237	2237	2237	2241	5902	8751	9585	7874	5104	2600	2170	2127	53065
1953	2107	2107	2107	2102	5337	8036	8575	6806	5467	2316	2019	1967	48946
1954	1945	1945	1945	4794	5747	7124	7830	6185	4744	2035	1694	1653	47641
1955	1638	1638	1638	2171	6165	5839	7494	5944	4951	1763	1592	1553	42386
1956	1537	1537	1537	1866	5418	7433	8383	6895	5037	2369	2065	2023	46100
1957	2006	2006	2006	2026	2732	5932	9152	8064	5686	2867	2646	2580	47703
1958	2549	2545	2545	2516	4063	7555	8818	7600	5808	2353	2182	2121	50655
1959	2097	2096	2096	2114	5014	8219	9212	7638	6391	2405	2232	2178	51692
1960	2158	2154	2154	3263	6374	8184	9097	8193	5801	2500	2320	2261	54459
1961	2240	2241	2241	2265	4845	5345	9269	7933	5492	2011	1846	1788	47516
1962	1766	1766	1766	2931	7281	7103	9339	8607	5768	2444	2276	2221	53268
1963	2201	2200	2200	4086	7428	7160	8586	7162	4045	2041	1882	1832	50823
1964	1813	1812	1812	1776	7009	6555	9564	8125	5766	2411	2219	2165	51027
1965	2147	2147	2146	2960	7098	5192	8564	7853	5304	2339	2149	2093	49992
1966	2072	2067	2066	2435	7210	6460	8715	7432	3303	2156	1931	1869	47716
1967	1852	1852	1850	2010	5424	4679	7193	7816	4324	1767	1612	1557	41936
1968	1532	1532	1531	1523	6123	7415	9721	8558	5572	2632	2243	2184	50566
1969	2166	2165	2163	2326	5955	6304	9744	8397	4919	2248	2017	1963	50367
1970	1945	1945	1943	1938	5894	6150	9262	8008	5392	2348	2157	2103	49085
1971	2155	2147	2148	2381	3061	6881	10032	8508	5379	2429	2242	2200	49563
1972	2181	2174	2193	3904	6999	6526	9749	8242	3470	2297	1954	1921	51610
1973	1908	1893	1883	1881	4181	7708	10160	8727	5191	2505	2294	2239	50570
1974	2219	2211	2223	2219	5601	7608	11028	8470	4748	2713	2512	2461	54013
1975	2448	2431	2432	2414	6406	5550	10913	9081	4978	2613	2326	2268	53860
1976	2254	2237	2241	2293	4399	7438	10914	9407	6034	2468	2314	2178	54177
1977	2141	2144	2148	2551	5288	7962	7738	6218	2691	2263	1667	1631	44442
1978	1646	1636	1648	3161	3234	6477	11311	9059	4914	2827	2375	2309	50597
1979	2301	2282	2278	2507	3343	4944	9893	5749	4745	2243	1947	1871	44103
1980	1850	1865	1861	1869	2922	6851	9557	8968	5818	2598	2169	2103	48431
AVERAGE	1971	1967	1968	2418	5348	6810	9281	7846	5087	2368	2112	2056	49233
AVG CFS	32	35	32	41	87	115	151	128	86	39	36	33	68

TABLE C.35

SUMMARY OF MODELED RETURN FLOWS
BETWEEN GREELEY NO. 3 AND GREELEY GAGE

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	856	752	799	862	3693	5179	5929	6397	5025	3095	2078	2028	36693
1952	2017	1876	1898	1975	4382	6686	5028	4705	3804	4645	1867	1834	40717
1953	1789	1679	1759	1653	3895	6018	4373	4251	3718	3812	1253	1254	35454
1954	1251	1199	1251	2099	5644	3888	3562	3457	3119	4161	1680	1549	32860
1955	1519	1406	1469	1484	4799	4397	3757	3811	3882	3676	1596	1751	33547
1956	1603	1520	1497	2036	6879	5975	4245	4595	3198	3387	1746	1883	38564
1957	1775	1648	1719	1633	4092	5788	7255	5515	4832	4212	1962	2048	42479
1958	2127	1894	1970	1852	3865	7158	5067	4523	4851	3967	1781	1896	40951
1959	1836	1638	1652	1616	5069	6027	4884	4325	4769	1781	1903	2014	37514
1960	1940	1781	1801	2336	4931	5009	4966	4195	4457	3746	1950	1946	39058
1961	1900	1738	1768	1792	5271	4486	5842	5147	6146	1626	1741	1800	39257
1962	1679	1528	1562	2454	6074	3974	5151	5267	4967	2025	1944	1980	38605
1963	1903	1747	1807	2224	5455	4397	3969	4320	2858	2236	1708	1728	34352
1964	1731	1560	1563	1539	6095	4764	4871	4137	4432	3441	1849	1929	37911
1965	1885	1678	1705	2068	5065	2976	6112	5380	4438	2260	1831	1863	37261
1966	1798	1654	1740	2585	5049	3407	4138	4231	1744	1913	1745	1815	31819
1967	1723	1566	1615	1894	4270	1875	4814	4777	3071	2098	1592	1643	30938
1968	1643	1557	1607	1654	4994	5549	5593	5245	4739	2619	1919	1925	39044
1969	1922	1798	1836	2145	4457	3707	4786	4559	3214	1816	1762	1794	33796
1970	1819	1690	1773	1682	4518	3169	5518	4842	3228	1797	1804	1875	33715
1971	1788	1679	1752	2745	5398	5591	5693	4373	3805	1831	1800	1862	38317
1972	1843	1745	1909	3591	4721	5461	4645	4962	3881	3895	1743	1854	40250
1973	1819	1677	1690	1617	3952	4790	5496	4774	5093	2826	1827	1847	37408
1974	1763	1652	1744	1793	4950	5955	5809	5099	3982	3434	2057	2075	40313
1975	2072	1924	2027	2087	6164	4889	6410	6070	4389	2392	1970	2001	42395
1976	2014	1863	1964	1966	5403	4768	4791	5125	5118	3487	2030	1526	40055
1977	1411	1380	1458	3646	3813	4076	4469	2213	1442	3899	1768	1593	31168
1978	1620	1510	1618	2200	5709	6570	6375	5255	2585	5789	1964	1961	43156
1979	2003	1823	1848	1899	3941	6017	5881	6355	4962	6159	3288	1589	45765
1980	1555	1604	1650	1685	2686	6466	5453	5254	3097	6527	3752	1921	41650
AVERAGE	1753	1626	1682	2027	4841	4967	5163	4772	3962	3285	1930	1826	37834
AVG CFS	29	29	27	34	79	84	84	78	67	54	32	30	52

TABLE C.36

CACHE LA POUDRE BASIN STUDY
MODELED OUT-OF-BASIN RETURN FLOWS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1204	1085	1198	1169	3037	5804	6716	5233	5207	2668	2105	2112	37538
1952	2106	1983	2094	2066	5187	6216	6059	6023	4570	2903	1937	1958	43102
1953	1951	1831	1949	1902	4720	5997	5524	5719	4142	3560	1771	1793	40859
1954	1792	1679	1793	2393	4665	4196	5044	5117	3479	3381	1715	1727	36979
1955	1720	1600	1718	1683	4046	4971	4638	5165	3828	2526	1749	1790	35436
1956	1770	1653	1759	2145	4853	5405	5638	6082	3748	2462	1886	1924	39325
1957	1910	1789	1905	1854	2839	5943	6024	7199	5195	3122	2039	2063	41880
1958	2066	1933	2050	1998	4429	6037	6639	6521	4967	2678	1813	1850	42982
1959	1842	1712	1822	1783	3895	5206	5860	5846	4612	2130	1886	1923	38516
1960	1912	1787	1898	1929	4981	5390	6720	6614	5353	3000	1957	1978	43518
1961	1971	1846	1957	1930	4891	4746	5789	5389	5031	1804	1759	1788	38901
1962	1770	1646	1758	2376	6135	5928	5272	5876	3113	2031	1974	2003	39882
1963	1992	1867	1982	2643	5171	5963	7087	7341	3211	2793	1755	1781	43586
1964	1779	1652	1761	1719	5037	5414	7445	7007	4849	2671	1859	1891	43084
1965	1883	1753	1864	2144	4819	3808	6816	7072	4979	1960	1846	1871	40815
1966	1858	1735	1853	2135	5472	5978	7029	7626	3540	2781	1725	1757	43491
1967	1745	1620	1733	1903	3523	2969	5393	6008	4103	1724	1661	1691	34075
1968	1686	1570	1686	1860	5306	6082	7252	7501	4653	2686	1923	1941	44145
1969	1939	1818	1930	1909	5254	4779	6900	7345	5218	1986	1795	1821	42692
1970	1821	1700	1816	1771	4810	5271	6165	5830	4304	1913	1853	1884	39137
1971	1873	1752	1869	1835	3110	5849	5448	6128	4791	1912	1847	1876	38290
1972	1871	1753	1884	2258	6120	6673	7862	8504	3598	1862	1795	1831	46011
1973	1824	1701	1810	1766	4402	6324	7891	7899	3409	1907	1841	1865	42640
1974	1853	1734	1860	2024	6424	6774	8203	7070	4121	1997	1940	1965	45965
1975	1963	1839	1957	3485	6633	6333	8839	9184	3818	1978	1902	1925	49856
1976	1924	1800	1920	2258	6126	6789	8381	8714	4418	1210	1913	1875	47327
1977	1857	1746	1862	3312	5920	6058	4749	3184	1802	537	1604	1570	34201
1978	1536	1528	1540	2067	5284	6997	9550	9582	2674	1101	1878	1897	45634
1979	1899	1772	1882	1851	4553	6898	7407	4489	2794	2280	1735	1742	39302
1980	1734	1632	1746	1727	4768	7916	7850	4935	2154	2329	1835	1858	40486
AVERAGE	1835	1717	1828	2063	4880	5757	6673	6540	4056	2263	1843	1865	41322

NOTES: 1. Includes irrigation return flows from Larimer County, Larimer & Weld, Greeley No. 2 and Ogilvy ditches and municipal returns from the City of Greeley.

TABLE C.37

AVERAGE MONTHLY MODELED FLOWS
FROM WASTEWATER TREATMENT PLANTS
(ACRE-FEET)

WWTP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVG MGD
FORT COLLINS WWTP NO. 1														
CITY	354	333	371	288	267	397	552	484	411	422	379	357	4614	
WATER DIST	18	18	16	15	18	16	15	16	17	17	17	18	202	
TOTAL WWTP NO. 1	364	343	381	296	277	406	560	493	421	432	389	368	4729	4.22
FORT COLLINS WWTP NO. 2														
CITY	315	303	329	248	235	396	521	448	389	381	348	322	4235	3.78
SOUTH FORT COLLINS WWTP														
WATER DIST	57	56	52	48	58	51	49	51	55	55	55	59	644	0.58
BOXELDER SANITATION DISTRICT														
WATER DIST	26	26	27	27	27	27	28	28	28	28	29	29	330	0.29
WINDSOR AND SEVERANCE WWTP'S														
WATER DIST	18	18	17	16	19	17	16	16	18	18	18	19	209	0.19
KODAK WWTP	75	68	72	77	94	91	90	86	83	90	86	81	994	0.89
EATON WWTP														
WATER DIST	14	14	13	12	14	12	12	12	13	13	13	14	157	0.14
CITY OF GREELEY WWTP														
CITY	502	426	431	483	559	464	472	480	485	531	531	547	5912	5.28
GROUND WATER FROM SEPTIC SYSTEMS														
WATER DIST	17	17	16	14	17	15	14	15	16	16	16	18	191	0.17

NOTES: 1. Averages are for period of operation of each plant.
Fort Collins and Greeley are for the 1951-1980 study period.
The water districts' contribution began in 1963.

TABLE C.38

COMPARISON OF MODELED AND REPORTED
WASTEWATER TREATMENT PLANT FLOWS

WWTP	MODELED 1951-1980 AVG. MGD	MODELED 1980 AVG. MGD	REPORTED RECENT AVG. MGD
FORT COLLINS WWTP NO. 1	4.2	5.5	5.0
FORT COLLINS WWTP NO. 2	3.8	4.6	8.9
SOUTH FORT COLLINS WWTP	0.6	1.2	0.8
BOXELDER SANITATION DIST	0.3	0.6	0.8
WINDSOR & SEVERANCE WWTP	0.2	0.4	0.8
KODAK WWTP	0.9	1.0	1.1
EATON WWTP	0.1	0.3	0.3
CITY OF GREELEY WWTP	5.3	6.7	6.5

NOTES:

1. Averages are for period of operation of each plant. Fort Collins and Greeley are for the 1951-1980 study period. The water districts' contribution began in 1963.

2. Reported values are from interviews or the 1985 update of the Areawide Water Quality Management Plan by the Larimer and Weld Regional Council of Governments.

TABLE C.39

MODELED POTENTIAL STORABLE FLOWS
AT THE CANYON GAGE

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	13865	0	0	0	0	0	542	14407
1952	0	0	0	0	11289	23094	0	0	0	0	0	0	34383
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	7373	5850	0	0	0	0	0	0	13223
1957	0	0	0	0	2734	31013	0	0	0	0	0	0	33747
1958	0	0	0	0	80369	9986	0	0	0	0	0	0	90355
1959	0	0	0	0	14373	12404	0	0	0	0	0	0	26777
1960	0	0	0	0	0	4952	0	0	0	0	0	0	4952
1961	0	0	0	0	27099	71709	0	0	0	5091	6856	2517	113272
1962	1454	569	2377	8009	2287	36672	0	0	0	0	0	0	51368
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	11389	0	0	0	0	0	0	11389
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	46679	4831	0	0	0	0	0	51510
1968	0	0	0	0	0	23014	0	0	0	0	0	0	23014
1969	0	0	0	0	1422	23282	0	0	0	0	0	0	24704
1970	0	0	0	0	0	38621	0	0	0	0	0	0	38621
1971	0	0	0	1430	51899	50720	0	0	0	0	0	0	104049
1972	0	0	0	0	0	1426	0	0	0	0	0	0	1426
1973	0	0	0	0	43351	49702	0	0	0	0	0	0	93053
1974	0	0	0	0	0	28346	0	0	0	0	0	0	28346
1975	0	0	0	0	0	42176	0	2	0	0	0	0	42178
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	25359	0	0	0	0	0	0	25359
1979	0	0	0	0	36060	86759	0	0	0	0	0	0	122819
1980	0	0	0	18479	163487	62013	0	0	0	0	0	0	243979
AVERAGE	48	19	79	931	14725	23301	161	0	0	170	229	102	39764

Appendix D

Data Supporting Water Supply and Demand Analysis

APPENDIX D

DATA SUPPORTING WATER SUPPLY AND DEMAND ANALYSIS

This appendix contains data relating to the use of the RIBSIM model for water supply and demand comparisons for 1985, Series 2 - 2020, and Series 3 - 2020 conditions in the Basin. The tables contained in this appendix support the discussions contained in Chapter 7.0 of the Main Report. Information contained in this appendix is organized as follows:

Table No.	Title
D. 1	Average Modeled Transbasin Imports (1985 Demands)
D. 2	Modeled Flows at the Canyon Gage (1985 Demands)
D. 3	Modeled Diversions Above the Canyon Gage (1985 Demands)
D. 4	Modeled Monthly Total Diversions of C-BT Water (1985 Demands)
D. 5	Modeled Total Additional Precipitation for Cache la Poudre Basin (1985 Demands)
D. 6	Modeled Flows at the Greeley Gage (1985 Demands)
D. 7	Modeled Out-of-Basin Return Flows (1985 Demands)
D. 8	Irrigated Acres by Ditch in Cache la Poudre Basin (1985 Demand Level)
D. 9	Average Monthly Total Demand for Irrigation Systems 1985 Demand Level
D.10	Cache la Poudre Basin Study - Estimated Monthly Municipal and Industrial Demands, 1985
D.11	Modeled Total Demand Shortages for All Irrigation Systems (1985 Demands)
D.12	Modeled Total Demand Shortages for Municipal and Industrial Systems (1985 Demands)
D.13	Modeled Annual Total Demand Shortages (1985 Demands)
D.14	Cumulative total Demand Shortages for Various Droughts - Cache la Poudre Basin Study - 1985 Demand Levels

APPENDIX D (Continued)

Table No.	Title
D.15	Modeled Flows at the Canyon Gage (2020 Series 2 Demands)
D.16	Modeled Diversions Above the Canyon Gage (2020 Series 2 Demands)
D.17	Modeled Monthly Total Diversions of C-BT water (2020 Series 2 Demands)
D.18	Modeled Additional Precipitation for Cache la Poudre Basin (2020 Series 2 Demands)
D.19	Modeled Flows at the Greeley Gage (2020 Series 2 Demands)
D.20	Modeled Out-of-Basin Return Flows (2020 Series 2 Demands)
D.21	Modeled Flows at the Canyon Gage (2020 Series 3 Demands)
D.22	Modeled Diversions Above the Canyon Gage (2020 Series 3 Demands)
D.23	Modeled Monthly Total Diversions of C-BT Water (2020 Series 3 Demands)
D.24	Modeled Additional Precipitation for the Cache la Poudre Basin (2020 Series 3 Demands)
D.25	Modeled Flows at the Greeley Gage (2020 Series 3 Demands)
D.26	Modeled Out-of-Basin Return Flows (2020 Series 3 Demands)
D.27	Cache la Poudre Basin Study Irrigated Acres by Ditch (Estimates for the Year 2020)
D.28	Average Monthly Total Demand for Irrigation Systems - 2020 Series 2 Demands
D.29	Average Monthly Total Demand for Irrigation Systems - 2020 Series 3 Demands
D.30	Cache la Poudre Basin Study - Monthly Municipal and Industrial Demands - Year 2020, Series 2 and 3
D.31	Modeled Total Demand Shortages for All Irrigation Systems (Year 2020 Demands)
D.32	Modeled Total Demand Shortages for Municipal and Industrial Systems (Year 2020 Demands)
D.33	Modeled Annual Total Demand Shortages (2020 Series 2 Demands)

APPENDIX D (Continued)

Table No.	Title
D.34	Modeled Annual Total Demand Shortages (2020 Series 3 Demands)
D.35	Modeled Total Demand Shortages for Additional Lands
D.36	Cache la Poudre Basin Study - Cumulative Total Demand Shortages for Droughts
D.37	Modeled Storable Flows at the North Fork (2020 Series 2 Demands)
D.38	Modeled Storable Flows at the Canyon Gage (2020 Series 2 Demands)
D.39	Modeled Storable Flows at the North Fork (2020 Series 3 Demands)
D.40	Modeled Storable Flows at the Canyon Gage (2020 Series 3 Demands)

TABLE D.1

AVERAGE MODELED TRANSBASIN IMPORTS
(1985 DEMANDS)

(ACRE-FEET)

IMPORTING DITCH	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
TUNNEL/SKYLINE	0	0	0	5	2367	5936	6187	2048	338	0	0	0	16881
CAMERON/GRAND	0	0	0	3	947	6897	6619	1926	289	0	0	0	16671
MICHIGAN DITCH	0	0	0	16	38	468	360	46	1	0	0	0	929
WILSON SUPPLY	0	0	0	2	833	290	24	0	0	0	0	0	1148
TOTAL	0	0	0	26	4185	13581	13190	4020	628	0	0	0	35629

NOTE: Average over the 1951-1980 modeling study period.

TABLE D.2

MODELED FLOWS AT THE CANYON GAGE
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	1515	1656	1674	4232	42945	94326	62808	21418	12322	2460	3765	2710	251831
1952	1761	1656	916	6338	51679	130982	36221	16970	13457	2781	1895	1809	266465
1953	1761	1657	1612	3648	20462	78708	39780	17194	2446	3405	1972	1809	174454
1954	1763	1656	1416	5259	37750	35750	14101	2871	1825	4466	1655	1310	109822
1955	966	949	1286	2375	30585	46511	30492	14381	1825	2762	2491	2390.	137013
1956	1763	1632	1678	2428	59491	76437	24141	11191	3583	2949	1835	1908	189036
1957	1763	1657	1712	7770	24069	143068	101971	26630	18454	7223	3791	1812	339920
1958	1763	1657	1007	1070	79594	97245	25360	11163	1824	4195	2991	2818	230687
1959	1890	1765	1462	5898	23530	100829	30109	21276	6241	6794	6147	1812	207753
1960	1719	1656	1675	4132	38521	87769	30150	13044	5742	3758	2703	1972	192841
1961	1763	1657	1710	9222	40472	118925	34491	22488	16726	9603	10701	3639	271397
1962	2737	1657	1518	10592	63227	90687	50326	14520	7615	3830	2592	1812	251113
1963	1763	1657	1631	4663	34562	41253	11607	6576	3160	5566	2019	1156	115613
1964	790	1325	1325	2179	43350	64919	32535	3976	2020	2614	1157	790	156980
1965	954	1657	1229	2542	34265	113833	71595	22487	16625	8362	3674	1812	279235
1966	1763	1657	1746	1951	30734	39146	11853	2511	2191	3865	1155	1151	99723
1967	610	1394	1510	963	18349	65908	39810	14806	12590	4512	4341	2696	167489
1968	1763	1657	1286	1204	23388	83016	42073	16285	17873	3879	2625	1998	197047
1969	1763	1657	1656	2919	44436	66729	43897	12560	6507	1620	3405	1809	188958
1970	1763	1656	800	5787	53556	93667	61193	17505	9171	3510	4822	1812	255242
1971	1763	1657	1506	1258	44892	149568	65220	13664	14328	5960	6139	1812	307767
1972	1763	1656	2220	2212	33895	72715	26641	10698	7215	5906	4263	1809	170993
1973	2100	1657	1856	3803	53589	132277	68008	25163	6586	7911	7008	4125	314083
1974	2898	1670	2643	8534	64611	107886	50853	13106	1938	6937	4135	1830	267041
1975	1763	1657	1603	1496	22972	78613	78014	20297	6254	5512	2482	2200	222863
1976	1763	1657	2100	1996	26803	63048	35611	19590	4761	5081	2512	1717	166639
1977	186	590	950	1685	14231	48706	14481	5987	1654	3820	2746	1904	96940
1978	1397	1657	2270	2334	25671	131038	66273	20363	8666	5487	2994	2241	270391
1979	1763	1656	1645	3722	36123	130308	62182	37208	6321	3358	5021	2287	291594
1980	2042	1829	2454	20077	157502	153342	47124	19326	10277	6602	8637	2554	431766
AVERAGE	1659	1587	1603	4410	42508	91240	43631	15842	7680	4824	3722	2050	220757

TABLE D.3

MODELED DIVERSIONS ABOVE THE CANYON GAGE
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1226	1107	2116	2260	8931	28957	29265	18135	8848	2452	2348	1742	107387
1952	1228	1161	2311	5783	24826	29463	17490	13777	10137	2709	2348	1742	112975
1953	1228	1161	2311	2358	6740	25927	11230	9136	6544	1915	2187	1726	72462
1954	1226	1107	2226	2169	7238	11563	10990	8512	3741	1932	1957	1726	54396
1955	1226	1107	2226	2330	7921	18108	11622	8832	5755	1432	2187	1726	64471
1956	1226	1107	2226	2559	12741	26854	16717	14306	8959	1735	1770	1726	91926
1957	1226	1107	2226	6731	23595	46317	29822	21847	19185	3294	2187	1726	159262
1958	1226	1107	2226	2085	9539	21425	20536	19463	8463	3015	2187	1726	92997
1959	1226	1107	2226	1647	9927	24499	23598	18656	6635	2104	2187	1726	95537
1960	1148	800	2226	4345	9631	29711	19824	15630	3359	1660	2187	1726	92246
1961	1226	1107	2226	1187	26173	26248	16582	14274	15504	2886	2187	1726	111325
1962	1226	1107	2226	2677	20487	20905	22258	19978	15122	2673	2187	1726	112571
1963	1226	904	2226	2659	13583	19974	16632	13166	8502	10780	2187	1726	93564
1964	1154	1107	2226	3343	15334	18302	15054	11881	4990	778	2074	1700	77944
1965	1226	1107	1829	1293	13046	31964	20862	18469	12721	3678	2187	1726	110108
1966	1226	1107	2226	3467	13236	16609	17030	11034	5263	1912	1770	1726	76606
1967	1226	1107	2226	1491	9641	26852	16022	20150	19286	11046	2187	1726	112960
1968	1226	1107	2226	1487	8077	33010	20726	14622	8270	1991	2187	1726	96655
1969	1226	1107	2226	2255	23831	26763	19542	20604	7550	1294	2187	1726	110310
1970	1226	1107	2226	3115	13187	31111	21704	21558	10253	1226	2187	1726	110625
1971	2000	1107	2226	3167	8548	22544	23191	22802	13135	1974	2187	1726	104606
1972	1226	1107	2226	5403	12709	32537	20436	16943	6021	1226	2187	1726	103747
1973	1226	1107	2226	4908	10912	26147	22513	17618	15976	2568	2348	1742	109291
1974	1228	1161	2311	5996	15987	23433	22236	20972	11511	1371	2187	1726	110117
1975	1226	1107	2226	2361	14016	19374	19939	20271	14766	1606	2187	1726	100804
1976	1226	1355	2226	1187	10661	23666	18958	13215	10146	2012	2049	1726	88428
1977	956	900	1830	1231	17758	16500	12033	7826	6500	1226	2187	1726	70672
1978	1226	1107	2600	3857	24288	31078	20390	15903	7902	1444	2187	1726	113707
1979	1226	1107	2226	14735	20675	28024	24707	12285	11423	2318	2187	1726	122639
1980	1226	1161	2311	1782	4034	22283	23221	16784	5605	1731	2187	1726	84050
AVERAGE	1238	1099	2220	3329	13909	25338	19504	15955	9736	2600	2159	1727	98813

NOTE: Water diverted by North Poudre Ditch, Munroe Canal, Poudre Valley Canal and Fort Collins Pipeline is considered part of the basin water supply.

TABLE D.4

MODELED MONTHLY TOTAL DIVERSIONS OF CBT WATER
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1101	1104	1216	1762	1626	1418	4452	13205	16273	1729	17254	970	62110
1952	1101	1050	1131	1475	1330	1556	27525	14063	6232	1229	5387	970	63049
1953	1101	1050	1131	1529	2384	1681	42504	10694	7209	1910	6318	1181	78692
1954	1101	1104	1216	7844	2725	42131	15778	10385	7281	1890	13438	1680	106623
1955	1864	1760	1216	7524	2435	3049	55114	9884	7356	2914	12009	1181	106306
1956	1101	1127	1216	2892	1443	18214	29692	10228	4141	1510	1299	1181	74044
1957	1101	1104	1216	1756	1830	2031	15922	27593	8334	1498	1400	986	64771
1958	1101	1104	1216	2198	1595	6144	59364	13772	7195	2657	1299	1181	98826
1959	1101	1104	1216	1872	1430	10449	47414	10570	1531	1561	1299	1181	80728
1960	1179	1411	1216	4431	1726	6175	41324	11290	3435	1813	1301	1131	76482
1961	1101	1104	1216	2737	1500	9412	19854	19526	4701	2001	1837	986	65975
1962	1101	1104	1216	1067	1418	5749	29097	25045	8273	1898	1441	1181	78590
1963	1101	1307	1216	8459	14871	20227	32525	12858	8189	1991	1504	1834	106082
1964	1936	1435	1216	3078	2489	15541	45833	11833	7004	2396	5286	2016	100063
1965	1864	1104	1371	5130	2507	2011	13073	29786	6189	2092	1467	986	67580
1966	1101	1104	1216	3127	15244	24783	35986	12297	7104	1825	1812	1839	107438
1967	1864	1366	1216	6221	1750	2176	23189	27568	6235	1945	1299	1181	76010
1968	1101	1104	1216	2243	1750	6429	35678	9753	1990	1387	1299	986	64936
1969	1101	1104	1216	8196	1796	8021	34788	12058	1888	1892	1299	1181	74540
1970	1101	1104	1216	3929	1768	10885	22937	14810	4397	1968	1400	986	66501
1971	1101	1104	1216	1747	10978	3299	21317	17386	3806	1884	1346	986	66170
1972	1101	1104	1210	7290	9101	7112	35373	12116	3861	1684	1321	1181	82454
1973	1101	1104	1216	1799	1406	11877	16301	26377	7321	1426	1158	1165	72251
1974	1099	1050	1131	1978	5661	2519	52192	17843	7798	1776	2363	1163	96573
1975	1101	1104	1216	2777	1536	2280	23585	34421	7739	1497	2339	1181	80776
1976	1101	1104	1216	3823	4416	12674	53063	15046	5968	1781	1283	1274	102749
1977	2134	1953	1831	5315	28931	24340	14389	8220	8393	1707	8567	1205	106985
1978	1660	1104	1198	1776	1704	1965	4552	35928	10832	1704	3708	986	67117
1979	1101	1104	1200	1730	3913	4871	29891	8277	7972	2081	2334	972	65346
1980	1101	1050	1131	2227	9680	9664	30914	10971	2369	1736	1033	1181	73057
AVERAGE	1261	1185	1229	3598	4695	9289	30454	16460	6367	1846	3505	1205	81094

TABLE D.5

MODELED TOTAL ADDITIONAL PRECIPITATION
FOR CACHE LA POUDRE BASIN
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	7844	25616	36923	12012	6925	31732	8642	39236	0	0	168929
1952	0	0	24957	31751	39594	6917	1652	3871	2107	5332	0	0	116182
1953	0	0	22207	35174	27850	9700	2893	2143	2083	2004	0	0	104054
1954	0	0	12428	4469	9700	3074	1238	4309	9540	5691	0	0	50449
1955	0	0	18947	3024	15529	15584	1436	6107	16842	5027	0	0	82496
1956	0	0	11918	22042	20283	1852	4959	16814	1324	509	0	0	79701
1957	0	0	6519	65549	86414	6578	1449	7940	7948	33700	0	0	216097
1958	0	0	29847	31974	46447	8410	4820	3707	6763	9830	0	0	141797
1959	0	0	29745	39563	35260	2900	1401	2141	18461	49016	0	0	178487
1960	0	0	12326	21028	21323	2895	2482	1367	6153	36293	0	0	103867
1961	0	0	61425	10512	75714	9319	17785	15892	40120	15220	0	0	245989
1962	0	0	7232	9759	18070	17407	4782	4941	5174	20459	0	0	87824
1963	0	0	19253	8634	3072	17163	1834	16239	27471	6596	0	0	100261
1964	0	0	14465	30100	19303	3371	1239	2303	5582	1732	0	0	78094
1965	0	0	10798	18453	26757	31719	9860	2261	32889	8258	0	0	140995
1966	0	0	1324	24382	3771	10843	1197	4122	25448	9072	0	0	80160
1967	0	0	10565	44096	56137	22778	11452	6301	5215	9283	0	0	166327
1968	0	0	15993	33216	31469	3354	4657	6265	2052	12435	0	0	109440
1969	0	0	11103	25375	27700	13295	3465	5283	17184	91679	0	0	195085
1970	0	0	46247	19589	10177	14786	4646	2976	17822	23003	0	0	139246
1971	0	0	10085	68883	22935	2333	1705	2417	45489	17194	0	0	171040
1972	0	0	7427	17477	8276	10842	2262	13034	11191	10897	0	0	81407
1973	0	0	20984	51737	18044	2121	7111	2013	17709	5095	0	0	124814
1974	0	0	21727	30273	1121	15533	2683	5047	13030	25868	0	0	115282
1975	0	0	23633	31665	68452	10278	5305	7695	4281	10787	0	0	162096
1976	0	0	11511	28918	25075	3708	2601	6426	19501	5775	0	0	103514
1977	0	0	5806	39084	9745	1714	16936	7564	2666	13001	0	0	96517
1978	0	0	12122	18827	67058	14573	3199	3885	4004	28784	0	0	152453
1979	0	0	53889	25240	54583	20033	2024	20522	7248	15319	0	0	198857
1980	0	0	41765	47822	35385	2404	1702	2615	5049	8913	0	0	145654
AVERAGE	0	0	19470	28808	30739	9916	4523	7281	12966	17534	0	0	131237

NOTE: Based on 6.45 inches of additional precipitation on an average annual basis and 244,478 acres of irrigated and urban land. See section 3.1.1.5

TABLE D.6

MODELED FLOWS AT THE GREELEY GAGE
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	704	945	4496	4648	9015	23787	6126	10575	4929	7259	7838	7707	88028
1952	3534	6529	8051	8251	25280	39192	8619	7152	5522	4950	7511	8343	132936
1953	5698	7566	8570	8368	7201	14366	7544	7134	5757	7862	8145	8145	96356
1954	3789	6792	8295	7587	7709	7011	6085	3746	3483	3241	4943	7297	69978
1955	3240	5695	7672	6952	5701	7799	9346	4214	4245	4623	7449	7488	74425
1956	3175	6135	7649	5897	15791	6457	9755	5107	4634	6753	7579	7565	86497
1957	3600	5962	7545	9375	14255	70070	8680	5666	5793	6248	8245	8013	153454
1958	4031	6635	8823	9435	64724	21127	8529	8099	6334	7558	7698	7664	160655
1959	3665	6009	8306	8233	11283	13988	8747	9746	7731	8338	8139	8067	102253
1960	3971	6564	8221	7419	11954	5952	8876	9564	7108	8227	8448	8375	94679
1961	4145	6979	9995	6905	15768	76257	6921	6262	5631	14346	6814	8232	168256
1962	3030	5989	6702	4984	16682	42484	10971	6330	7288	6149	4886	8075	125570
1963	3856	6661	8688	6930	5018	6093	8937	7064	6303	5552	7771	7652	80524
1964	3540	5464	7839	7883	9060	5052	8610	7796	6608	5654	8152	8048	83707
1965	3844	4068	8118	7228	7069	70530	6017	6315	6843	7632	7549	7249	142461
1966	3408	3847	6852	6925	5285	5405	10122	6744	5449	5726	7490	7407	74662
1967	3860	3821	7501	7545	7655	34716	8194	7949	5196	7192	6935	7657	108223
1968	3848	5790	7851	8008	7118	6885	7692	7618	6479	7082	7944	7772	84288
1969	3755	6387	7968	8134	7128	22175	9288	7859	5849	9649	9123	7453	104767
1970	7295	6997	7980	7970	7428	46394	6959	8121	4850	5332	7951	7733	125000
1971	3768	6346	7929	9218	44198	60019	10400	7288	5614	4151	7358	7618	173908
1972	3700	6213	7428	7469	5743	13380	7618	6625	7646	6998	7550	7528	88097
1973	3413	6018	7886	8386	28111	58086	6514	7232	7140	11560	8237	10380	162963
1974	9093	7653	7360	7810	5590	37609	8620	8393	5047	7323	9301	8244	121043
1975	4022	6869	8733	8295	12650	32249	6727	6371	6357	4343	7688	7596	111899
1976	3547	5825	7682	7933	5771	5406	7998	6865	6569	6150	3638	7601	74986
1977	3515	6109	7556	6577	4791	7063	6508	4805	5042	4400	5170	5000	66535
1978	5380	4920	6074	6693	8160	69252	6355	6175	6454	6440	5266	7015	133184
1979	3229	5434	8533	7308	33420	96519	5617	6631	5841	6803	4607	7082	191025
1980	3304	5572	9538	27134	164080	72210	7880	7113	7126	5587	7749	7975	325267
AVERAGE	3965	5860	7861	8183	19121	32584	8015	7085	5969	6771	7206	7733	120354

NOTE: Surface flows only. Does not include ground water underflows.

TABLE D.7

MODELED OUT-OF-BASIN RETURN FLOWS
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1261	1134	1248	1232	1641	2471	3029	2833	2909	2133	1943	1968	23802
1952	1951	1824	1938	1932	2552	3231	3993	5282	3636	2347	2067	2090	32843
1953	2071	1944	2058	2029	2538	3065	4390	5245	3530	2459	1994	2012	33337
1954	1993	1864	1978	2169	2704	3240	4833	4721	3050	2210	1791	1826	32379
1955	1814	1687	1802	1808	2296	2477	4722	4798	3147	2089	1848	1879	30368
1956	1866	1739	1853	1937	2520	3232	5254	5384	3244	2080	1894	1924	32928
1957	1916	1790	1904	1869	1805	2650	3329	3956	3631	2314	2020	2038	29223
1958	2021	1894	2008	1992	2421	3113	3151	5905	3739	2215	1951	1974	32334
1959	1958	1830	1944	1923	2326	3029	5320	5442	3487	2141	2021	2041	33462
1960	2026	1900	2014	2049	2661	3015	5057	6116	4057	2382	2093	2113	35482
1961	2095	1968	2082	2085	2532	2751	3357	4041	2448	1840	1765	1790	28754
1962	1779	1652	1766	1961	2821	2812	3366	5522	3607	2158	2029	2049	31522
1963	2035	1907	2021	2180	2749	3500	6693	6845	3859	2275	1925	1951	37941
1964	1936	1807	1922	1895	2410	2723	6791	6769	4095	2268	1983	2007	36605
1965	1992	1863	1977	2068	2509	2194	3042	5771	2576	1939	1853	1870	29655
1966	1858	1730	1844	1891	2598	3231	6865	7144	3918	2193	1882	1910	37063
1967	1897	1769	1896	1935	2104	1917	3287	4950	3264	1903	1790	1816	28529
1968	1797	1668	1778	1795	2352	2943	5036	6455	3905	2257	1974	1999	33959
1969	1981	1852	1966	1992	2606	2552	6115	6366	3736	2014	1871	1897	34951
1970	1883	1757	1871	1849	2556	2660	5525	6040	3606	2045	1963	1984	33739
1971	1970	1843	1957	1935	2027	3599	5658	6260	3140	2008	1926	1947	34272
1972	1937	1810	1951	2243	2808	2960	6540	6690	3499	1951	1863	1893	36145
1973	1878	1750	1857	1817	2235	3142	4542	6864	3813	2074	1964	1983	33919
1974	1970	1841	1971	2015	3094	3042	4650	7070	3816	2104	2012	2036	35622
1975	2024	1895	2005	2300	2610	2672	3810	7140	4050	2004	1897	1924	34331
1976	1906	1778	1892	1967	2614	3022	6706	7399	3988	1978	1891	1917	37058
1977	1902	1775	1890	2195	2662	5299	7059	7461	4194	1925	1849	1877	40089
1978	1862	1734	1852	1941	2214	2598	3084	4849	3679	2192	1787	1815	29608
1979	1799	1672	1787	1793	2168	2713	6007	4435	3727	2191	1815	1844	31949
1980	1826	1697	1811	1802	2171	4149	7675	7960	4540	2387	1970	1994	39980
AVERAGE	1907	1779	1895	1953	2443	3000	4963	5857	3596	2136	1921	1946	33397

NOTE: Return flows which are not measured at the Greeley gage are due to irrigation on lands outside the basin by Larimer County, Larimer and Weld, Greeley No. 2 and Ogilvy Systems and to municipal wastewater effluent from Greeley's Lone Tree wastewater treatment plant.

TABLE D.8

IRRIGATED ACRES BY DITCH IN CACHE LA POUDRE BASIN
1985 Demand Level

Ditch	Irrigated Acres
Arthur	1,000
Boxelder	1,880
Boyd & Freeman	560
Chaffee	360
Coy	---
B.H. Eaton	860
Greeley #2	36,000
Greeley #3	380
Jackson	2,000
Jones	360
Josh Ames	---
Lake	6,000
Larimer County	46,800
Larimer County #2	4,500
Larimer/Weld	55,110
Little Cache	1,410
North Poudre	26,150
Ogilvy	2,650
Pleasant Valley	2,000
Poudre Valley	7,580
Whitney	2,000
TOTAL	197,600

Miscellaneous Ditches (Not Modeled)[1]	
Louden[2]	4,300
Boomerang[2]	3,650
Grapevine[2]	3,430
Oklahoma[2]	2,990
Miscellaneous	5,660
Charles Hansen[3]	920
Dixon[3]	450
TOTAL	21,400

Notes:
1. Ditches whose source is other than the Poudre River, but with irrigated land in the Poudre Basin
2. Big Thompson River Ditches
3. C-BT Ditches

Source: Agricultural Engineering Department, Colorado State University, Agricultural Land Use in the Poudre Valley, by Evans, Walker and Skogerboe, October, 1973; interviews and analysis conducted by Raymond Anderson, Ph.D., Colorado State University; and input provided by Mr. Ross Bethel, Leonard Rice Consulting Water Engineers, Inc.

TABLE D.9

AVERAGE MONTHLY TOTAL DEMAND
FOR IRRIGATION SYSTEMS
1985 DEMAND LEVEL

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	3064	16490	58455	128127	63367	53667	4201	0	0	327372
1952	0	0	0	6457	17705	112717	159336	129371	80658	8525	0	0	514768
1953	0	0	0	1193	17095	82672	144315	144168	90548	16067	199	0	496256
1954	0	0	0	19812	43544	115263	174790	127058	63898	11163	278	0	555806
1955	0	0	0	13746	38777	60596	175139	123875	51875	10441	0	0	474450
1956	0	0	0	5642	32823	143999	140330	87837	74407	14178	0	0	499216
1957	0	0	0	557	2170	78566	162966	122454	61088	4535	0	0	432336
1958	0	0	0	3986	18009	99606	132098	137507	65870	10431	0	0	467507
1959	0	0	0	3093	17585	115228	170627	147087	44738	1764	0	0	500121
1960	0	0	0	10391	32261	113402	150893	151577	72527	6501	201	0	537754
1961	0	0	0	7037	6619	81405	94598	97154	17330	5229	0	0	309373
1962	0	0	0	14497	35397	66302	140321	126164	46375	12012	676	0	441745
1963	0	0	0	15482	70192	80691	180382	92083	46193	20247	1389	0	506659
1964	0	0	0	5401	31339	103000	183160	135737	64437	15827	0	0	538901
1965	0	0	0	10784	25637	39229	119908	136018	21285	9787	1552	0	364219
1966	0	0	0	5894	58987	82021	188863	124915	44647	8664	0	0	513992
1967	0	0	3148	8214	12935	36273	100480	112937	75623	18822	0	0	368431
1968	0	0	0	2268	19002	101718	135877	112451	82111	16080	0	0	469506
1969	0	0	0	14264	32989	73056	154398	130491	46884	0	0	0	452082
1970	0	0	0	5835	48580	79742	152349	142266	46625	5279	0	0	480675
1971	0	0	0	3200	27077	119487	149697	146853	23366	5609	0	0	475288
1972	0	0	5422	14730	48288	86627	145760	99194	56480	10189	0	0	466691
1973	0	0	0	1885	30529	118696	126462	161032	45652	17339	119	0	501714
1974	0	0	1332	9242	80972	84679	160765	119839	41322	9401	199	0	507749
1975	0	0	0	4439	7599	73772	139585	122106	70160	13294	0	0	430956
1976	0	0	0	7894	28791	102384	151779	116086	45039	8701	0	0	460675
1977	0	0	436	8186	57354	151097	108954	108075	62517	8578	0	0	505195
1978	0	0	931	6032	3809	55909	113818	108295	66460	4628	0	0	359882
1979	0	0	199	10712	14188	57187	157198	83703	81534	15956	0	0	420677
1980	0	0	0	4222	20556	123260	169470	136969	79184	14040	0	0	547700
AVERAGE	0	0	382	7605	29911	89901	147082	121556	57417	10250	154	0	464257

TABLE D.10
CACHE LA POUDRE BASIN STUDY
ESTIMATED MONTHLY MUNICIPAL AND INDUSTRIAL DEMANDS
1985
(All values in acre-feet)

City	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Fort Collins	1445	1365	1543	1999	2749	3622	4186	3768	2923	2152	1586	1461	28800
Greeley	1064	920	1059	1440	1968	2433	2939	2577	1951	1658	1172	1120	20300
Other Areas	617	618	648	743	1088	1418	1574	1402	1120	887	634	649	11400
TOTAL	3126	2903	3250	4182	5805	7473	8699	7747	5994	4697	3392	3230	60500

TABLE D.11
MODELED TOTAL DEMAND SHORTAGES
FOR ALL IRRIGATION SYSTEMS
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	114	53	91	0	0	0	258
1952	0	0	0	0	0	0	569	259	422	5	0	0	1255
1953	0	0	0	0	0	4	550	2461	3336	1000	7	0	7358
1954	0	0	0	30	0	4671	59875	74594	36248	2500	83	0	178001
1955	0	0	0	234	0	10	19182	54946	17112	3515	0	0	94999
1956	0	0	0	0	0	178	5582	8750	50798	11700	0	0	77008
1957	0	0	0	0	0	93	22	242	167	0	0	0	524
1958	0	0	0	0	0	0	411	715	573	19	0	0	1718
1959	0	0	0	0	0	0	1023	2575	721	0	0	0	4319
1960	0	0	0	0	0	233	561	4716	2609	0	5	0	8124
1961	0	0	0	0	0	148	179	186	0	0	0	0	513
1962	0	0	0	38	0	28	1455	337	83	0	17	0	1958
1963	0	0	0	11	0	72	1150	182	53	283	38	0	1789
1964	0	0	0	0	0	84	1191	5626	2160	668	0	0	9729
1965	0	0	0	0	0	0	9	309	0	95	43	0	456
1966	0	0	0	0	0	113	2158	12421	1851	6	0	0	16549
1967	0	0	0	0	0	277	212	168	612	306	0	0	1575
1968	0	0	0	0	0	6	249	242	2602	96	0	0	3195
1969	0	0	0	0	0	77	234	2389	5598	0	0	0	8288
1970	0	0	0	0	0	184	405	403	69	0	0	0	1061
1971	0	0	0	0	157	227	1279	399	0	0	0	0	2062
1972	0	0	3	0	0	44	370	196	501	43	0	0	1157
1973	0	0	0	0	0	0	148	416	51	558	3	0	1176
1974	0	0	0	0	81	24	259	218	736	0	5	0	1323
1975	0	0	0	0	0	132	112	278	499	96	0	0	1117
1976	0	0	0	0	0	152	425	255	83	102	0	0	1017
1977	0	0	0	0	95	603	293	2930	2302	0	0	0	6223
1978	0	0	0	0	0	42	221	328	612	0	0	0	1203
1979	0	0	0	0	0	238	498	479	296	16	0	0	1527
1980	0	0	0	0	0	370	535	662	863	7	0	0	2437
AVERAGE	0	0	0	10	11	267	3309	5925	4368	701	7	0	14597

NOTE: Total Demand Shortage is determined by comparing input Total Demands with modeled diversions.

TABLE D.12
MODELED TOTAL DEMAND SHORTAGES
FOR MUNICIPAL AND INDUSTRIAL SYSTEMS
(1985 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	0	195	195
1952	0	0	0	0	0	0	0	0	0	0	0	195	195
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0	0	0	0	195	195
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	0	0	195	195
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	195	195
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	195	195
1969	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	195	195
1971	0	0	0	0	0	0	0	0	0	0	0	195	195
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	195	195
1979	0	0	0	0	0	0	0	0	0	0	0	195	195
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
AVERAGES	0	0	0	0	0	0	0	0	0	0	0	65	65

NOTE: Total Demand Shortage is determined by comparing input Total Demands with modeled diversions.

TABLE D.13

MODELED ANNUAL TOTAL DEMAND SHORTAGES
(1985 DEMANDS)

(AS PERCENT OF TOTAL DEMAND)

	M&I			IRRIGATION SYSTEMS																			
YEAR	FTCO	GREL	WDIS	NPDR	LARC	JACK	PLVA	LILC	ARTH	LAR2	LAKE	COY	CHAF	BOX	LARW	WHIT	BHEA	JONES	GRE3	BOYD	GRE2	JGIL
1951	0	0	2	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	10	0	0
1952	0	0	2	0	0	0	0	5	0	0	0	0	65	0	0	0	0	0	0	11	0	2
1953	0	0	0	0	0	0	0	14	0	0	28	0	71	0	0	0	1	0	0	21	0	3
1954	0	0	0	44	19	19	0	36	0	0	52	0	80	0	42	0	12	0	0	37	32	26
1955	0	0	0	32	22	10	0	3	0	0	28	0	71	0	18	0	23	0	0	31	15	39
1956	0	0	0	15	15	6	0	16	0	0	27	0	55	0	19	0	14	0	0	22	16	9
1957	0	0	2	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	15	0	0
1958	0	0	0	0	0	0	0	21	0	0	0	0	68	0	0	0	0	1	0	16	0	0
1959	0	0	0	0	0	0	0	12	0	0	12	0	62	0	0	0	0	0	0	23	0	8
1960	0	0	0	0	0	0	0	35	0	0	24	0	65	0	0	0	0	0	0	55	0	4
1961	0	0	2	0	0	0	0	0	0	0	0	0	36	0	0	0	1	2	0	26	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	2	0	0	15	0	19
1963	0	0	0	0	0	0	0	0	0	0	1	0	57	0	0	0	3	3	0	24	0	7
1964	0	0	0	0	0	0	0	29	0	0	30	0	66	0	0	0	2	2	0	31	0	18
1965	0	0	2	0	0	0	0	0	0	0	0	0	34	0	0	0	1	1	0	7	0	2
1966	0	0	0	0	0	0	0	22	0	0	20	0	63	0	7	0	0	0	0	27	0	21
1967	0	0	0	0	0	0	0	16	0	0	0	0	64	0	0	0	5	3	0	10	0	7
1968	0	0	2	0	0	0	0	5	0	0	14	0	51	0	0	0	1	0	0	13	0	0
1969	0	0	0	0	0	0	0	17	0	0	12	0	55	0	4	0	0	0	0	8	0	0
1970	0	0	2	0	0	0	0	0	0	0	0	0	46	0	0	0	4	0	0	33	0	0
1971	0	0	2	0	0	0	0	0	0	0	0	0	31	0	0	0	11	2	0	16	0	17
1972	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	11	0	0	17	0	2
1973	0	0	0	0	0	0	0	0	0	0	2	0	47	0	0	0	3	0	0	9	0	3
1974	0	0	0	0	0	0	0	0	0	0	4	0	50	0	0	0	0	0	0	5	0	0
1975	0	0	0	0	0	0	0	10	0	0	0	0	59	0	0	0	0	0	0	9	0	1
1976	0	0	0	0	0	0	0	1	0	0	0	0	64	0	0	0	1	1	0	18	0	1
1977	0	0	0	0	0	0	0	17	0	0	22	0	87	0	0	0	0	0	0	44	0	0
1978	0	0	2	0	0	0	0	13	0	0	0	0	79	0	0	0	0	0	0	21	0	0
1979	0	0	2	0	0	0	0	0	0	0	0	0	64	0	0	0	9	0	0	31	0	6
1980	0	0	0	0	0	0	0	16	0	0	0	0	91	0	0	0	0	0	0	38	0	0

TABLE D.14

CUMULATIVE TOTAL DEMAND SHORTAGES FOR VARIOUS DROUGHTS[1]
CACHE LA POUDRE BASIN STUDY
1985 Demand Levels
(All values in acre-feet)

System	1-in-10	1-in-25	1-in-50
Fort Collins	0	0	0
Greeley	0	0	0
Other Municipal	0	0	195
North Poudre	0	77880	61996
Larimer County	0	66714	94044
Jackson	0	2134	3137
Pleasant Valley	0	0	
Little Cache	757	2914	4584
Arthur	0	0	0
Larimer County No. 2/ New Mercer	0	0	0
Lake	3864	24158	27623
Chaffee	1530	2926	4258
Boxelder	0	0	0
Larimer & Weld	0	112006	133461
Whitney	0	0	0
B.H. Eaton	19	1257	330
Jones	9	1	108
Greeley No. 3	0	0	0
Boyd & Freeman	991	1855	2363
Greeley No. 2	0	59567	57169
Ogilvy	70	5954	5560
TOTAL	7240	357366	394633

Notes:

1 Cumulative shortage for duration of drought. Duration years are 1976-1977 for 1-in-10 year drought, 1953-1956 for 1-in-25 and 1963-1969 for 1-in-50.

TABLE D.15

MODELED FLOWS AT THE CANYON GAGE
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	2036	2110	2183	5274	39965	97725	65016	23467	14961	3149	4031	2670	262587
1952	1769	1163	954	6997	41815	133282	37048	18656	14478	2381	1803	1568	261914
1953	1769	1695	1630	3409	21178	74287	41406	19015	3102	2473	1892	1532	173388
1954	1656	1583	1416	5008	37249	35521	13155	1404	558	4227	1563	1306	104646
1955	966	949	1286	2376	30601	45552	31216	15599	1401	1608	2399	2350	136303
1956	1606	1535	1696	2839	55606	78367	25738	17740	5825	2089	1316	1868	196225
1957	1060	1695	1730	7497	26160	143570	104282	27174	17765	8133	3699	1772	344537
1958	1769	1695	1209	1813	73479	98745	26954	10519	3067	3358	2899	2778	228285
1959	1890	1790	1852	6824	27054	99208	31284	21320	6174	6472	6055	1772	211695
1960	956	1460	1693	4128	36787	83204	31432	17833	4424	3338	2606	1932	189793
1961	1769	1695	1710	8929	39984	120041	37185	24039	18498	10254	10328	3614	278046
1962	1769	1695	2051	10228	58715	90860	49302	15568	8323	3174	2542	1772	245999
1963	1428	1695	1649	4411	31321	39865	14363	5776	2662	5793	2221	1156	112340
1964	790	1325	1680	2609	40806	58586	35198	9512	2227	2614	1253	790	157390
1965	954	1695	1547	2529	31436	115622	70481	23822	17620	9957	4351	2355	282369
1966	1821	1695	1751	2015	28928	36642	13906	945	355	4023	859	1151	94091
1967	610	1394	1709	1096	19036	69505	42077	15745	10436	5046	4249	2656	173559
1968	1769	1695	1423	953	25087	81035	40120	20816	19860	4360	2533	1958	201609
1969	1769	1695	1701	2644	40323	68256	41855	17088	6976	2830	3313	1637	190087
1970	1707	1382	769	5644	48434	97928	58076	19049	13842	4422	4729	1772	257754
1971	1769	1695	1532	2001	40843	150903	66460	14736	13688	5591	6047	1772	307037
1972	1769	1200	2358	2955	31178	67895	28232	13133	9887	5522	4170	1599	169898
1973	2100	1695	1874	4261	51987	134384	65575	26461	7596	6048	6924	2656	311561
1974	1852	1695	3329	5148	63141	115998	55721	10936	770	6553	4055	1790	270988
1975	1424	1695	1621	1244	23423	77752	75739	21838	8590	5333	2390	2160	223209
1976	1769	1695	2117	1918	26792	60520	36527	20442	1283	4412	2189	1177	160841
1977	186	590	1296	1910	15026	42309	17555	9133	1596	3820	2746	1904	98071
1978	1396	1695	2328	3153	26538	132150	64726	21782	9888	5420	2902	2201	274179
1979	1769	1557	1932	4720	34688	131639	60728	39064	6681	2672	4929	2247	292626
1980	1941	2283	1295	18127	161163	155444	47110	20699	9624	6405	8545	2514	435150
AVERAGE	1528	1581	1711	4422	40958	91227	44282	17444	8072	4716	3651	1948	221539

TABLE D.16

MODELED DIVERSIONS ABOVE THE CANYON GAGE
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1226	1107	2116	2260	8134	28865	29013	16459	7636	1840	2187	1726	102576
1952	1226	1107	2226	5271	23715	28651	16074	12055	8845	2105	2187	1726	105188
1953	1226	1107	2226	2137	6740	25485	10879	9135	6544	1770	2187	1726	71163
1954	1226	1107	2226	2169	7239	11108	10990	8384	3751	1787	1957	1726	53669
1955	1226	1107	2226	2330	7921	17311	11622	8832	5067	1435	2187	1726	62989
1956	1226	1107	2226	2559	11944	26572	14995	12443	4618	626	1770	1726	81812
1957	1226	1107	2226	6731	22798	44651	28500	19888	17887	4305	2187	1726	153231
1958	1226	1107	2226	1573	8428	19759	18814	17708	8102	1096	2187	1726	83952
1959	1226	1107	2226	1647	8816	23687	21876	16934	4901	1679	2187	1726	87912
1960	1148	800	2226	5089	8834	29259	18102	14180	4894	1374	2187	1726	89818
1961	1226	1107	2226	1187	25062	24582	14360	12552	14637	2885	2187	1726	104238
1962	1226	1107	2226	2165	19376	19239	20536	18256	14455	2673	2187	1726	105171
1963	1226	904	2226	2659	16132	19177	16632	13166	8616	10780	2187	1726	95431
1964	1154	1107	2226	3343	15334	17505	15054	11878	4785	778	2187	1700	77050
1965	1226	1107	2226	1293	13046	30298	19540	16747	12333	3678	2187	1726	105406
1966	1226	1107	2226	3467	13236	16609	17030	11032	6677	1371	2187	1726	77893
1967	1226	1107	2226	1491	8844	25186	14300	18428	18077	11246	2187	1726	106045
1968	1226	1107	2226	1487	7290	31867	19083	12900	7012	1371	2187	1726	89471
1969	1226	1107	2226	2255	23034	25097	17820	18891	4836	1294	2187	1726	101699
1970	1226	1107	2226	3115	12390	29445	19982	19836	8379	1226	2187	1726	102845
1971	2000	1107	2226	2655	7437	20878	21469	21080	12761	1974	2187	1726	97499
1972	1226	1107	2226	5403	11998	31925	18714	15394	5578	1226	2187	1726	98710
1973	1226	1107	2226	4908	9801	24826	22291	15896	14684	1964	2187	1726	102842
1974	1226	1107	2226	5484	14916	21767	20514	19250	10351	1371	2187	1726	102134
1975	1226	1107	2226	2361	13219	17842	18767	18549	13773	1226	2187	1726	94209
1976	1226	1355	2226	1187	9854	23665	18958	13215	11861	1867	2466	1726	89617
1977	956	900	2226	1231	16961	16500	12033	7553	7131	1226	2187	1726	70629
1978	1226	1107	2600	3857	23491	29412	18668	14181	6692	1444	2187	1726	106591
1979	1226	1107	2226	14223	19564	26358	22985	10615	11006	2318	2187	1726	115540
1980	1226	1107	2226	1270	2923	20877	21499	15057	4824	1543	2187	1726	76464
AVERAGE	1235	1092	2235	3226	13287	24280	18387	14683	9021	2383	2174	1725	93726

NOTE: Water diverted by North Poudre Ditch, Munroe Canal, Poudre Valley Canal and Fort Collins Pipeline is considered part of the basin water supply.

TABLE D.17

MODELED MONTHLY TOTAL DIVERSIONS OF CBT WATER
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	3758	3197	3585	3759	1456	1291	2719	14253	9953	2916	16734	2700	66321
1952	3856	4144	4094	3765	1071	929	20123	13919	6343	2959	4157	3187	68547
1953	3856	3612	4094	5438	1456	2944	29596	7399	8332	5323	9091	4124	85265
1954	3969	3724	4094	7412	1315	30103	13332	13092	10110	3866	16820	4531	112368
1955	4777	4321	4094	8855	1305	2072	40733	7797	9472	6411	15013	4068	108918
1956	4019	3772	4094	5795	1385	13417	24891	8709	5304	4103	3738	3687	82914
1957	4565	3612	4094	4085	1805	1684	14791	18324	8948	216	1799	1265	65188
1958	3617	3612	3935	4829	1798	5071	47752	11696	6716	3467	4097	4068	100658
1959	3856	3612	4094	3797	1634	8981	35732	9797	2966	3717	2755	4039	84980
1960	4715	4154	4094	5182	1242	3415	34376	9197	4229	2036	3102	4068	79810
1961	3856	3612	4094	5228	1305	7496	15938	15303	5236	3047	1799	1265	68179
1962	2718	3612	3495	1589	1023	5105	22369	19732	6325	5150	3617	4068	78803
1963	4197	3816	4094	7833	13086	16376	19503	13130	10728	4759	4320	4681	106523
1964	5104	3982	4094	5890	1010	14444	31043	10061	9681	6025	9279	4920	105533
1965	4987	3612	4094	7315	950	2461	14703	18518	6121	1928	1134	631	66504
1966	3163	3612	4094	4941	11141	19134	23364	14465	12514	5215	7720	4686	114049
1967	5081	3929	4094	7586	1315	2082	20701	20726	4881	2703	2990	2986	79074
1968	3856	3612	4094	6040	1182	6229	27305	7747	1318	2814	2625	2986	69808
1969	3856	3612	4094	10069	1388	8361	24641	10423	3226	5273	3100	4218	92261
1970	4268	4247	4444	6720	1251	5252	19821	16450	1991	5328	1927	2986	74685
1971	3856	3612	4094	3787	9719	5090	13718	15056	3060	5454	3784	2986	74216
1972	3856	4107	3976	7053	6742	5329	29370	10362	3994	1532	3070	4238	83629
1973	3856	3612	4066	4498	1314	11591	16245	13440	7687	4069	3089	2697	76164
1974	4126	3934	3769	3705	5285	2176	35021	12899	9384	2475	9178	4051	96003
1975	4201	3612	4094	6030	1309	2015	20824	24741	8079	3327	4136	3765	86133
1976	3856	3612	4058	6800	3088	13006	34847	5737	10412	5505	9355	4661	104937
1977	5117	4616	4380	5154	20457	20171	11332	9768	12395	3732	10690	4402	112214
1978	4633	3612	3961	4418	2082	1650	4551	26889	10055	1734	5047	2986	71618
1979	3856	3750	4078	3818	1941	3004	22296	7562	7856	1259	5622	2972	68014
1980	3856	2400	3585	3855	8464	9342	23234	10646	3328	3829	3354	4068	80161
AVERAGE	4110	3742	4034	5508	3617	7674	23162	13268	7021	3672	5771	3535	85116

TABLE D.18

MODELED TOTAL ADDITIONAL PRECIPITATION
FOR CACHE LA POUDRE BASIN
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	7766	25914	37277	11689	6918	29862	8632	39643	0	0	167702
1952	0	0	24709	32742	40358	7330	1644	3218	2048	5342	0	0	117391
1953	0	0	21986	35079	28728	10097	3057	2039	1785	1995	0	0	104768
1954	0	0	12304	4587	9527	3240	1175	3538	8806	5825	0	0	49001
1955	0	0	18758	3044	15076	15853	1371	5181	15586	5073	0	0	79949
1956	0	0	11800	22436	20358	1902	4889	14638	1311	504	0	0	77838
1957	0	0	6454	65297	88311	6751	1516	7466	7474	34361	0	0	217630
1958	0	0	29549	32408	47436	8919	4733	2831	6342	10075	0	0	142294
1959	0	0	29449	39993	35935	3086	1411	1953	16271	49530	0	0	177629
1960	0	0	12203	21945	21416	3041	2452	1321	5516	36993	0	0	104888
1961	0	0	60813	10743	77031	9680	17744	14203	36992	15510	0	0	242767
1962	0	0	7160	10098	17523	17774	4655	4161	5276	21076	0	0	87724
1963	0	0	19061	9000	3023	17880	1725	13815	26188	6754	0	0	97446
1964	0	0	14321	30801	19101	3536	1236	1986	5267	1714	0	0	77961
1965	0	0	10690	19097	26630	32272	9698	1991	32124	8554	0	0	141057
1966	0	0	1311	24978	3744	11309	1182	3403	23556	9322	0	0	78806
1967	0	0	10547	46467	58253	22565	11303	5934	4481	9454	0	0	169003
1968	0	0	15834	33378	32328	3540	4831	5807	2008	12787	0	0	110514
1969	0	0	10993	26258	27157	13017	3119	4423	17393	91461	0	0	193821
1970	0	0	45786	19906	10150	15485	4607	2252	16697	23319	0	0	138203
1971	0	0	9984	70746	23305	2422	1675	2040	44157	17678	0	0	172007
1972	0	0	7509	18567	8142	11123	2146	11056	10426	11051	0	0	80022
1973	0	0	20775	52207	18167	2191	7170	1934	15853	5177	0	0	123475
1974	0	0	21728	31909	1109	16129	2489	4146	12893	26513	0	0	116918
1975	0	0	23397	32336	70448	10550	5375	7069	3946	11079	0	0	164201
1976	0	0	11396	30211	25105	3662	2537	5536	17768	5843	0	0	102058
1977	0	0	5749	40787	9632	1803	16182	6073	2666	12995	0	0	95886
1978	0	0	12001	19408	68611	15164	3071	3592	4003	29014	0	0	154866
1979	0	0	53390	26754	56285	20667	2039	18340	5885	15605	0	0	198965
1980	0	0	41349	49014	36192	2543	1738	2236	4253	9138	0	0	146464
AVERAGE	0	0	19292	29537	31214	10181	4455	6402	12187	17780	0	0	131048

NOTE: Based on 6.5 inches of additional precipitation on an average annual basis and 242,043 acres of irrigated and urban land.

TABLE D.19

MODELED FLOWS AT THE GREELEY GAGE
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	1502	5373	7198	6937	9829	32926	10250	10575	4702	9218	9413	9253	117176
1952	8712	9203	10474	10173	15811	55544	10075	5136	4184	4950	7035	9132	150427
1953	9678	9087	10264	9531	5786	16000	6872	4866	3828	2499	8745	8573	95728
1954	8482	8000	8767	6179	6346	5445	2568	1462	1750	1934	7175	8324	66433
1955	6417	7624	8585	6984	4297	8543	7356	4424	2122	2528	8708	8644	76232
1956	6677	7941	8695	6447	16782	18388	7178	6293	3331	6637	8997	8673	106038
1957	7115	8247	8841	9390	10832	74838	20013	7108	5110	5771	9075	8877	175216
1958	9412	8938	10242	10444	58643	32192	9236	5521	4918	4130	6426	8669	168771
1959	8448	7969	9254	8798	9641	24094	8209	6015	3757	5060	8137	9056	108438
1960	8844	8368	9141	7052	11489	10665	8963	5309	3045	3446	9217	9160	94699
1961	8942	8463	10693	7174	14345	81726	8367	6471	6077	13680	7966	9413	183337
1962	8361	7880	8502	5293	17300	44696	12766	6299	5175	6149	4125	8048	134594
1963	9231	8748	9731	7026	5053	6485	2935	3379	3914	3440	8025	8565	76533
1964	3374	7781	8685	8641	8578	7031	6679	5759	4018	4160	6678	8837	80222
1965	3593	7170	8861	7254	4377	70530	9592	6470	6111	9133	8510	8267	149867
1966	6635	8325	8769	7350	5609	5566	3827	4742	4613	4584	8269	8202	76491
1967	3860	5747	8188	7845	6504	37662	11671	6395	3403	3600	8085	7336	110296
1968	7879	7395	8268	8531	5375	13103	8887	5815	5592	2919	8826	8318	90909
1969	8859	8376	9106	8405	6398	27360	7373	6576	3255	9350	10520	8944	114522
1970	8810	8302	10132	8494	7157	54890	8876	6126	3730	4360	6543	8281	135700
1971	8824	8343	9042	9341	39498	75947	10400	4100	4671	4193	5656	8276	188291
1972	8821	8338	8611	7357	5582	13500	6166	5487	5494	4329	8791	8765	91242
1973	8545	8063	9071	9188	27703	71012	7986	5081	7140	11560	9666	10380	185395
1974	9420	8850	9177	9014	8052	54569	8755	4955	3631	3405	6737	9516	136082
1975	9220	8811	9914	8889	11426	36635	9457	6962	6219	4750	9066	8987	130335
1976	8566	8275	9019	8692	5821	7203	6916	4832	4203	6150	3808	7566	81353
1977	8574	8282	8854	6320	4350	5822	4336	4035	4727	4400	5170	5000	69870
1978	5380	7330	8295	6479	8160	74688	8370	6257	4915	6440	4833	8029	149175
1979	6171	8090	10099	8371	31277	99289	6944	7768	5081	4413	2077	6386	195965
1980	7704	7790	9437	25150	166659	86876	6794	5427	4736	4189	3918	8824	337504
AVERAGE	7535	8037	9131	8558	17956	38441	8261	5655	4448	5379	7341	8487	129228

NOTE: Surface flows only. Does not include ground water underflows.

TABLE D.20

MODELED OUT-OF-BASIN RETURN FLOWS
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1336	1198	1314	1298	1703	2497	3034	2740	3177	2144	1966	1995	24405
1952	1975	1838	1953	1944	2566	3183	3900	4914	3267	2133	1880	1919	31485
1953	1904	1766	1882	1859	2366	2856	4555	4766	3057	2164	1748	1784	30690
1954	1770	1633	1749	1922	2457	3122	4406	4529	2927	2122	1729	1768	30119
1955	1753	1616	1731	1731	2222	2395	4459	4653	2991	1981	1765	1802	29118
1956	1786	1649	1764	1853	2431	3034	4920	5180	3132	1987	1812	1850	31403
1957	1836	1698	1814	1786	1736	2543	3278	5355	3613	2241	1960	1987	29865
1958	1970	1833	1948	1932	2358	2999	4152	5511	3425	2018	1785	1824	31772
1959	1810	1672	1788	1768	2173	2820	5018	4951	3204	1760	1853	1890	30692
1960	1874	1738	1853	1882	2489	2802	5508	4072	2540	1330	1882	1919	29889
1961	1905	1767	1883	1883	2349	2525	3096	2983	1462	1775	1726	1702	25059
1962	1671	1630	1660	1873	2740	2758	3676	3914	2296	1364	1941	1973	27497
1963	1959	1821	1937	2086	2646	3371	5701	4716	2448	889	1559	1547	30678
1964	1528	1501	1505	1521	1983	2260	5663	4460	2614	828	1736	1704	27303
1965	1686	1653	1683	1798	2215	1892	2709	5037	1534	1860	1790	1822	25664
1966	1806	1668	1783	1832	2524	2762	6136	4713	2388	781	1342	1332	29069
1967	1313	1286	1294	1381	1536	1277	2661	3962	1841	742	1387	1358	20052
1968	1328	1306	1311	1370	1677	2489	4293	4475	2455	1026	1847	1848	25614
1969	1802	1730	1831	1842	2443	2410	5426	4219	2360	716	1599	1568	27944
1970	1547	1527	1535	1555	2205	2379	5179	4061	2251	1039	1828	1856	26974
1971	1794	1713	1829	1808	1863	3132	5278	4244	1879	1047	1821	1859	28264
1972	1844	1706	1840	2125	2684	2818	5979	4600	2073	652	1520	1501	29345
1973	1486	1465	1466	1469	1841	2706	5087	5864	2427	932	1791	1829	28364
1974	1815	1677	1806	1845	2899	2837	5109	6701	2545	916	1914	1951	32012
1975	1937	1799	1911	2207	2537	2558	3954	6348	2670	695	1794	1767	30177
1976	1720	1678	1725	1820	2433	2874	6115	5204	2396	712	1676	1638	29992
1977	1614	1586	1590	1938	2360	4551	4437	3369	1786	548	1127	1124	26029
1978	1107	1089	1102	1233	1491	1901	2426	4883	2845	968	1744	1739	22526
1979	1681	1626	1700	1709	2065	2579	5411	2926	2315	980	1667	1620	26262
1980	1581	1559	1566	1601	1922	3887	6695	5491	2981	998	1675	1639	31573
AVERAGE	1705	1614	1692	1762	2237	2741	4609	4626	2563	1311	1729	1737	28328

NOTE: Return flows which are not measured at the Greeley gage are due to irrigation on lands outside the basin by Larimer County, Larimer and Weld, Greeley No. 2 and Ogilvy Systems and to municipal wastewater effluent from Greeley's Lone Tree wastewater treatment plant.

TABLE D.21

MODELED FLOWS AT THE CANYON GAGE
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	2036	2110	2183	5284	40356	96609	65012	23773	14927	3393	3948	2670	262301
1952	1769	1163	954	7024	41109	133283	37433	17776	12723	2306	1802	1568	258910
1953	1769	1695	1630	3356	21193	74369	41423	18923	3555	2656	1883	1532	173984
1954	1060	1583	1416	5286	37566	35797	13155	1405	558	4227	1564	1306	104923
1955	786	949	1286	2376	30770	45890	31446	15179	1401	1608	2399	2350	136440
1956	1606	1535	1696	2339	55720	77288	25737	17736	5797	2092	1317	1868	195231
1957	1060	1695	1730	7473	26308	143508	104301	26180	18487	7961	3698	1772	344172
1958	1380	1695	1559	1813	72563	99094	26955	10513	3186	3336	2899	2778	227770
1959	1890	1790	1852	6847	28076	99208	31396	21206	6161	6377	6055	1772	212630
1960	956	1460	1693	4061	37542	81593	32547	17669	4345	3337	2600	1932	189735
1961	1769	1695	1710	8938	39974	120040	36082	24041	21668	10364	8906	3545	278732
1962	1769	1695	2051	9620	59052	89640	49301	15761	6983	3174	2512	1772	243330
1963	786	1695	1649	4644	31313	40436	12565	5777	2747	5807	2028	1156	110603
1964	790	1325	1680	2644	41344	58315	34930	9018	1509	2605	1157	790	156107
1965	954	1695	1226	2547	32383	117033	70065	23835	17388	9389	4281	2355	283151
1966	1301	1909	1764	2070	29161	38208	9769	938	569	4023	859	1151	91722
1967	610	1394	1588	1287	20463	66527	41798	16563	10222	4463	4249	2656	171820
1968	1769	1695	1423	953	25479	80089	41101	19502	19908	3655	2533	1958	200065
1969	1769	1695	1701	2675	40497	68253	42160	16660	6962	1316	3313	1637	188638
1970	1707	1382	769	5650	48524	98231	57121	19048	14089	3982	4730	1772	257005
1971	1769	1695	1541	2001	41775	150903	65739	14736	14296	5576	6047	1772	307850
1972	1769	1200	2252	2954	32080	65849	28240	13132	9874	5523	4171	1599	168643
1973	2100	1695	1874	4186	51997	134281	65575	26460	7192	4640	6917	1772	308688
1974	786	1695	3339	5189	65951	115991	54376	12283	530	6552	4045	1790	272527
1975	1424	1695	1621	1245	24034	76671	75743	21840	8590	5325	2390	2160	222738
1976	1580	1695	2117	2107	27160	59701	36530	20292	847	4409	2189	1177	159304
1977	51	591	1279	1978	15384	42394	17216	8435	1632	3820	2746	1904	97430
1978	1376	1695	2293	2913	27186	132150	64769	21898	9768	5388	2902	2201	274559
1979	1769	1557	1932	4288	34654	131639	60470	38140	6942	2672	4927	2247	291238
1980	1941	2283	1299	18123	161085	155446	46681	21220	10250	6405	8545	2514	435791
AVERAGE	1404	1589	1704	4413	41356	90948	43988	17331	8104	4546	3587	1916	220884

TABLE D.22

MODELED DIVERSIONS ABOVE THE CANYON GAGE
2020 SERIES 3 DEMANDS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1226	1107	2116	2260	8134	28865	29013	16459	7504	1848	2187	1726	102445
1952	1226	1107	2226	5271	23715	28650	16074	12055	8843	2106	2187	1726	105186
1953	1226	1107	2226	2137	6740	25485	10879	9148	6533	1770	2187	1726	71163
1954	1226	1107	2226	2169	7238	10832	10990	8384	3758	1787	1957	1726	53400
1955	1226	1107	2226	2330	7921	17311	11622	8832	5067	1435	2187	1726	62990
1956	1226	1107	2226	2559	11944	26572	14995	12445	4648	627	1770	1726	81845
1957	1226	1107	2226	6731	22795	44650	28500	19888	17687	3724	2187	1726	152650
1958	1226	1107	2226	1573	8428	19758	18814	17728	7922	857	2187	1726	83552
1959	1226	1107	2226	1647	8816	23687	21876	16934	4823	1679	2187	1726	87933
1960	1148	800	2226	4345	8834	29259	18102	14179	4060	1371	2187	1726	88236
1961	1226	1107	2226	1187	25062	24581	14860	12552	14640	2886	2187	1727	104241
1962	1226	1107	2226	2165	19376	19238	20536	18256	14511	2673	2187	1726	105227
1963	1226	904	2226	2610	16132	19177	16632	13166	8994	10780	2187	1726	95760
1964	1154	1107	2226	3343	15334	17505	15054	11888	4949	786	2067	1700	77113
1965	1226	1107	1829	1293	13046	30298	19540	16747	12333	3678	2187	1726	105009
1966	1226	1107	2226	3467	13236	16609	17030	11042	6853	1371	2187	1726	78079
1967	1226	1107	2226	1491	6844	25186	14300	18428	18091	9054	2187	1726	103866
1968	1226	1107	2226	1487	7280	31867	19083	12900	7831	1371	2187	1726	90291
1969	1226	1107	2226	2255	23034	25096	17820	18886	4980	1294	2187	1726	101837
1970	1226	1107	2226	3115	12390	29444	19982	19636	8406	1226	2187	1726	102873
1971	2000	1107	2226	2655	7437	20877	21469	21080	12761	1974	2187	1726	97499
1972	1226	1107	2226	5403	11998	31925	18714	15394	5578	1226	2187	1726	98709
1973	1226	1107	2226	4908	9801	24825	22291	15896	14679	1964	2187	1726	102837
1974	1226	1107	2226	5484	14916	21766	20514	19222	10394	1375	2187	1726	102143
1975	1226	1107	2226	2361	13219	17842	18767	18549	13777	1264	2187	1726	94251
1976	1226	1355	2226	1187	9864	23656	19958	13215	11873	1866	2466	1726	89647
1977	1090	900	2226	1231	16961	16500	12033	7826	7021	1226	2187	1726	70926
1978	1226	1107	2600	3857	23491	29411	18668	14191	6717	1444	2187	1726	106615
1979	1226	1107	2226	14223	19564	26357	22985	10515	11006	2318	2187	1726	115540
1980	1226	1107	2226	1269	2923	20876	21499	15063	4972	1543	2187	1726	76618
AVERAGE	1242	1092	2222	3200	13283	24271	18387	14693	9047	2284	2170	1725	93516

NOTE: Water diverted by North Poudre Ditch, Munroe Canal, Poudre Valley Canal and Fort Collins Pipeline is considered part of the basin water supply.

TABLE D.23

MODELED MONTHLY TOTAL DIVERSIONS OF CBT WATER
2020 SERIES 3 DEMANDS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	5886	5145	5789	6583	1305	941	1164	14681	9288	6093	19748	3069	75692
1952	5978	6092	6298	6512	853	341	17721	12389	6705	6306	7495	3753	80443
1953	5978	5560	6298	8277	1274	3676	25007	8164	9105	7939	8138	3643	93058
1954	5978	5672	6298	10457	1721	28133	11926	16454	12757	6277	15364	3869	124906
1955	5978	6270	6298	12417	953	3025	34954	9504	11227	9306	17135	6258	123325
1956	6141	5720	6298	8795	1151	12813	21246	9389	7180	7320	4713	3383	94149
1957	6687	5560	6298	6798	3251	1641	13837	16659	6623	1924	4100	3858	77236
1958	5978	5560	5789	7905	2815	4998	43188	12259	8499	8390	6743	6258	118382
1959	5978	5560	6298	6569	1574	8889	31280	8937	4906	6288	5473	6258	98010
1960	6838	6102	6298	8630	1220	4439	27902	9975	7114	5250	5474	3759	93001
1961	5978	5560	6298	8117	1263	8052	15694	12900	2420	6374	3305	3938	79899
1962	5978	5560	5699	2811	570	5120	21692	15915	7574	8332	5597	6258	91106
1963	5978	5764	6298	11573	13720	15479	15178	14840	13293	7849	6770	6871	123613
1964	7231	5930	6298	9184	562	14902	26051	12608	12730	8907	9260	3279	116942
1965	7111	5560	6483	10802	435	2711	14743	13895	5260	5011	4258	3436	79705
1966	5463	5346	6298	8283	13548	17720	19300	17501	15564	8017	5943	4024	127007
1967	7212	5861	6298	10963	708	2290	19902	16848	6604	6502	6743	4349	94280
1968	5978	5560	6298	9180	871	6439	22960	7195	1554	6211	5452	3069	80767
1969	5978	5560	6299	13787	1185	8690	20469	9505	5897	8518	5422	2662	93971
1970	6390	6195	6648	9830	971	2077	20105	15042	4105	7935	2231	0	81529
1971	5978	5560	6298	6465	12704	6609	8069	14087	4818	7560	2735	444	81527
1972	5978	6055	6152	9853	6413	8357	21244	10911	6630	4446	6530	6425	98997
1973	5978	5560	6259	7414	1254	12204	13141	11188	8386	7182	5361	6347	90274
1974	6328	5882	4793	7756	2987	2486	33930	12679	12330	5148	9509	6241	110068
1975	6323	5560	6298	9078	1059	3190	20711	18969	8820	6346	6826	6258	99438
1976	5978	5560	6262	9834	4088	13771	28629	5132	12306	8636	10575	6851	117622
1977	6849	6574	6602	8505	23229	13581	13178	12478	13748	6692	9831	3406	124673
1978	6686	5560	6165	7197	2172	1593	5699	21898	11431	3608	7108	2245	81362
1979	5978	5698	6282	6827	6312	5369	15337	7643	8900	2875	5617	2130	78968
1980	5978	4348	5789	6820	12427	13391	16122	8327	4145	5593	3422	3406	89768
AVERAGE	6226	5683	6193	8574	4093	7764	20013	12599	8331	6561	7229	4192	97457

TABLE D.24

MODELED TOTAL ADDITIONAL PRECIPITATION
FOR CACHE LA POUDRE BASIN
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	9868	32644	45328	14579	8760	37549	10188	48678	0	0	207593
1952	0	0	31397	40359	48808	8948	2055	3976	2512	6731	0	0	144787
1953	0	0	27937	44431	35066	12422	3816	2584	2213	2525	0	0	130994
1954	0	0	15634	5705	11600	3982	1492	4379	10494	7187	0	0	60473
1955	0	0	23836	3839	18458	19827	1746	6396	18704	6361	0	0	99167
1956	0	0	14994	28054	24832	2389	6220	18311	1666	641	0	0	97106
1957	0	0	8202	82646	107833	8304	1883	9478	9095	42018	0	0	269458
1958	0	0	37548	40684	58009	11048	6049	3526	7554	12178	0	0	176596
1959	0	0	37420	50186	43613	3759	1732	2457	20012	61837	0	0	221067
1960	0	0	15506	27050	26012	3739	3089	1665	6658	43908	0	0	127627
1961	0	0	77275	13479	94113	11973	22429	17765	45781	19308	0	0	302122
1962	0	0	9099	12532	21697	22306	5928	5136	6244	25160	0	0	108101
1963	0	0	24221	11119	3750	22242	2201	17148	31146	8061	0	0	119887
1964	0	0	18197	38289	23350	4379	1552	2471	6301	2179	0	0	96719
1965	0	0	13584	23240	32267	40040	12184	2483	39699	10527	0	0	174024
1966	0	0	1666	31256	4620	14100	1504	4255	28495	11537	0	0	97434
1967	0	0	13355	56832	70368	27979	13948	7278	5562	11538	0	0	206859
1968	0	0	20120	42123	39307	4327	6014	7357	2528	15528	0	0	137303
1969	0	0	13968	32321	33729	16402	4026	5395	20287	115010	0	0	241138
1970	0	0	58181	24990	12315	19242	5890	2794	20004	28930	0	0	172345
1971	0	0	12687	87415	28004	2992	2089	2514	54400	21869	0	0	211969
1972	0	0	9457	22589	9950	13661	2677	13644	12500	13364	0	0	97843
1973	0	0	26399	65403	21935	2718	9022	2473	19374	6329	0	0	153652
1974	0	0	27501	38972	1410	20064	3136	5134	15152	31613	0	0	142981
1975	0	0	29731	40308	85369	12993	6690	8893	4790	13483	0	0	202258
1976	0	0	14481	36814	30517	4745	3143	6857	21544	7311	0	0	125411
1977	0	0	7305	49433	11879	2226	20508	7482	3316	16294	0	0	118492
1978	0	0	15250	24139	84472	18178	3778	4469	4912	35688	0	0	190886
1979	0	0	67824	32859	68385	25587	2513	22765	7275	18758	0	0	245993
1980	0	0	52542	60885	43652	3100	2115	2768	5235	11147	0	0	181443
AVG	0	0	24506	36688	38021	12608	5608	7981	14788	21857	0	0	162058

NOTE: Based on 6.32 inches of additional precipitation on an average annual basis and 307,563 acres of irrigated and urban land.

TABLE D.25

MODELED FLOWS AT THE GREELEY GAGE
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	2343	8178	9122	8724	8400	30513	9074	10575	3753	11987	11840	9492	124002
1952	10795	10960	12517	11992	13474	54478	8372	3340	2434	5839	11912	9776	155888
1953	11580	10833	12279	11229	3590	14097	5286	4489	2836	5480	7572	7870	97140
1954	10399	9759	10733	7169	4579	4245	1643	1971	2304	6486	7182	7488	73957
1955	7870	9380	10589	8495	3551	6407	4973	3278	1942	8024	10706	10621	85836
1956	8318	9686	10642	7811	15287	16736	5795	6469	3934	8310	8604	8091	109685
1957	8636	10004	10765	11439	11527	73717	19495	5998	5770	7546	10940	9788	185626
1958	11279	10642	12265	12189	56581	32161	7609	6322	2184	6426	10703	10649	179008
1959	10353	9716	11320	10662	8250	24013	6779	4461	3375	6171	11097	11001	117198
1960	10716	10083	11060	8480	9985	8749	7295	3771	3069	6792	11227	8832	100058
1961	10847	10211	12965	8856	13157	80623	6979	6237	5137	18311	9861	10547	193730
1962	10239	9600	10394	3645	15785	41832	11363	4975	4111	6149	7584	11397	137073
1963	11097	10457	11689	8117	4365	5320	1708	3298	3320	7341	10688	10542	87942
1964	5427	9602	10649	10130	7348	6054	4994	5694	2873	5082	9851	7200	84905
1965	5144	9897	10815	8759	3276	70530	8031	5024	5734	11432	10815	9343	158801
1966	9081	10078	10657	8948	4254	4607	3247	5643	3377	7891	7088	7367	82242
1967	6778	9260	10125	9678	5170	33417	10681	5722	1906	6942	10184	8663	118525
1968	9729	9138	10240	10344	4245	11535	6899	5527	4067	6255	11125	8460	97563
1969	10684	10095	11021	10079	5078	26055	5448	5471	2882	11783	11083	7548	117228
1970	10671	10058	12313	10235	5202	53550	7634	4690	3363	5959	8288	5612	137576
1971	10749	10110	10999	11067	40686	75928	10400	4100	4671	4853	5952	5922	195436
1972	10705	10064	10506	8059	4758	13380	3839	5211	4953	7842	10773	10717	100808
1973	10423	9784	11050	11089	26292	70206	5733	4945	7140	12295	11673	11472	192100
1974	11221	10550	10840	10890	10623	53922	6353	4830	2880	5944	11573	11476	151102
1975	11104	10538	11919	10673	9634	34297	8204	7185	5523	6979	11056	10946	138059
1976	10451	10003	10947	10406	4703	5494	4850	3933	3955	6150	7195	10981	89068
1977	10489	10039	10772	7999	3402	4044	4337	2859	3608	4400	5170	5055	72174
1978	9994	9267	10233	7887	8160	73145	6911	5660	3503	6440	6791	7156	155147
1979	10149	9863	12344	10058	31739	97993	5548	6374	3218	3603	4906	6727	202520
1980	10140	9383	11064	26596	167270	86179	5218	5614	3949	3404	4584	7530	340929
AVERAGE	9580	9908	11094	10057	17012	37108	6823	5122	3726	7404	9267	8942	136044

NOTE: Surface flows only. Does not include ground water underflows.

TABLE D.26

MODELED OUT-OF-BASIN RETURN FLOWS
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	1409	1261	1377	1370	1793	2571	3093	2646	3239	2216	2037	2070	25082
1952	2045	1897	2013	2015	2648	3251	3948	4978	3335	2207	1954	1821	32112
1953	1976	1828	1944	1926	2450	2927	4720	4830	3140	2240	1826	1865	31673
1954	1846	1698	1815	2006	2548	3443	4469	4597	2993	2195	1800	1844	31254
1955	1823	1674	1791	1804	2305	2466	4517	4720	3061	2057	1840	1882	29939
1956	1860	1712	1828	1924	2518	3501	4977	5244	3198	2059	1883	1923	32627
1957	1906	1758	1875	1851	1807	2615	3335	4963	3674	2308	2028	1959	30078
1958	2036	1888	2004	1998	2441	3059	4324	5564	3502	2086	1854	1898	32654
1959	1876	1728	1845	1833	2251	2885	5057	5023	3266	2033	1921	1963	31683
1960	1943	1795	1911	1953	2572	2864	5819	5724	3738	2221	1954	1917	34409
1961	1976	1828	1944	1953	2426	2591	3300	3982	2691	1878	1818	1787	28174
1962	1835	1687	1803	2002	2870	2820	3585	5352	3481	2098	2002	2039	31574
1963	2018	1870	1987	2151	2718	3425	6207	6652	3666	2124	1831	1867	36516
1964	1846	1697	1814	1798	2329	2579	6479	6419	3864	2066	1836	1799	34526
1965	1859	1711	1828	1926	2382	2041	3211	5505	2764	1929	1863	1813	28830
1966	1876	1728	1844	1900	2607	3219	6396	6827	3854	2019	1749	1793	35811
1967	1773	1625	1743	1797	1985	1776	3698	4727	3035	1800	1725	1710	27393
1968	1747	1598	1714	1742	2314	2831	5617	6271	3656	2148	1912	1767	33316
1969	1930	1782	1898	1931	2552	2463	5918	6037	3576	1964	1824	1747	33619
1970	1847	1699	1815	1803	2515	2567	5718	5714	3454	1986	1815	1759	32692
1971	1928	1779	1896	1884	1987	3493	5393	5924	3082	1962	1887	1778	32992
1972	1908	1760	1898	2195	2762	3120	6419	6558	3343	1883	1824	1869	35538
1973	1849	1701	1812	1785	2217	3249	5366	6464	3451	1921	1861	1903	33579
1974	1883	1735	1867	1918	2979	2898	5825	6849	3695	2044	1978	2018	35688
1975	1998	1849	1962	2266	2605	2617	4368	6976	3876	1929	1860	1902	34206
1976	1880	1731	1848	1932	2588	2936	6819	7258	3914	1954	1895	1932	36688
1977	1910	1762	1880	2194	2656	5019	6842	7406	4004	1785	1736	1778	38972
1978	1758	1610	1728	1827	2125	2538	3052	5787	4248	2208	1815	1855	30551
1979	1834	1686	1803	1815	2203	2701	6021	4366	3510	2100	1772	1912	31624
1980	1791	1643	1760	1761	2143	4042	7429	7622	4112	2222	1845	1886	38255
AVERAGE	1872	1724	1842	1909	2410	2950	5064	5699	3481	2055	1865	1865	32735

NOTE: Return flows which are not measured at the Greeley gage are due to irrigation on lands outside the basin by Larimer County, Larimer and Weld, Greeley No. 2 and Ogilvy Systems and to municipal wastewater effluent from Greeley's Lone Tree wastewater treatment plant.

TABLE D.27

CACHE LA POUDRE BASIN STUDY
IRRIGATED ACRES BY DITCH
(Estimates for the Year 2020)

Ditch	Year 2020 Irrigated Acreages Series 2	Year 2020 Irrigated Acreages Series 3
Arthur	1000	1000
B.H. Eaton	860	860
Boxelder	900	-
Boyd & Freeman	560	560
Chaffee	-	-
Coy	-	-
Greeley No. 2	33000	32000
Greeley No. 3	380	380
Jackson	2000	2000
Jones	360	360
Lake	5000	4000
Larimer County	43400	40000
Larimer County No. 2	2000	2000
Larimer and Weld	45000	42500
Little Cache	1410	1410
North Poudre	26150	26150
Ogilvy	2650	2650
Pleasant Valley	-	-
Poudre Valley	7580	7580
Whitney	1000	-
TOTAL	173250	163450
PLUS:		
North Poudre Ext.	-	19500
Larimer-Poudre Canal	-	47000
	173250	229950
Miscellaneous Ditches (Not Modeled)[1]		
Boomerang[2]	3650	3650
Grapevine[2]	2500	2000
Louden[2]	4300	4300
Oklahoma[2]	2990	2990
Charles Hansen[3]	920	920
Dixon[3]	450	450
Miscellaneous	2230	2080
	17040	16390

Notes:

2. Big Thompson River Ditches
3. C-BT Ditches
1. Ditches whose source is other than the Poudre River, but with irrigated land in the Poudre Basin

TABLE D.28

AVERAGE MONTHLY TOTAL DEMAND FOR IRRIGATION SYSTEMS
2020 SERIES 2 DEMANDS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	1708	12001	47831	111430	58660	48497	3173	0	0	283300
1952	0	0	0	3997	12867	90748	138511	120678	76794	5551	0	0	449145
1953	0	0	0	648	12424	65516	122111	131340	87139	11997	108	0	431283
1954	0	0	0	13300	34396	94937	153599	118164	60152	7712	151	0	482411
1955	0	0	0	8728	30281	49048	153692	115117	48651	6859	0	0	412375
1956	0	0	0	3480	25309	117632	122667	83264	69889	10033	0	0	432273
1957	0	0	0	302	1506	63238	139022	112047	57396	3221	0	0	376732
1958	0	0	0	2476	13357	80183	115703	129835	61693	6973	0	0	410220
1959	0	0	0	1798	13090	93181	146988	136098	42913	1210	0	0	435278
1960	0	0	0	6713	24541	92599	131814	140600	69131	4913	198	0	470508
1961	0	0	0	4104	4798	65391	81705	90948	16681	2988	0	0	266614
1962	0	0	0	9573	27287	53953	123939	117533	40694	8708	367	0	382055
1963	0	0	0	10167	57149	64879	159599	87209	42762	15172	858	0	437795
1964	0	0	0	3334	24036	84117	160023	126653	60633	11359	0	0	470156
1965	0	0	0	7119	19086	30398	104905	125586	19880	5314	843	0	313131
1966	0	0	0	3602	47813	65720	164941	116975	42151	5389	0	0	446591
1967	0	0	1709	5203	9104	27792	87518	103579	71741	15892	0	0	322539
1968	0	0	0	1231	14139	81810	115536	103717	79061	13252	0	0	408747
1969	0	0	0	9929	25523	61776	138158	121521	41026	0	0	0	397932
1970	0	0	0	3555	38674	63479	133209	133498	43751	3654	0	0	419819
1971	0	0	0	1886	20324	97289	130555	136119	22148	3046	0	0	411367
1972	0	0	2944	9500	37626	71296	130327	93111	53314	7703	0	0	405822
1973	0	0	0	1083	23549	96862	109232	148936	43602	12939	65	0	436267
1974	0	0	723	6065	65484	68772	144437	113671	37278	7067	108	0	443605
1975	0	0	0	2544	5464	58907	120019	112936	66370	9647	0	0	375887
1976	0	0	0	5045	21898	84041	133218	108175	42642	5795	0	0	400813
1977	0	0	237	5559	45403	126109	98424	102625	56250	5832	0	0	440438
1978	0	0	505	3781	2455	44070	97926	97412	60972	3524	0	0	310644
1979	0	0	108	6545	10108	43880	136254	78077	78269	13313	0	0	366555
1980	0	0	0	2471	14998	99611	146426	127174	76048	10813	0	0	477541
AVERAGE	0	0	208	4848	23156	72835	128396	113042	53918	7435	90	0	403928

TABLE D.29

AVERAGE MONTHLY TOTAL DEMANDS FOR IRRIGATION SYSTEMS
2020 SERIES 3 DEMANDS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	3185	19818	66349	146941	77392	68160	5680	0	0	387526
1952	0	0	0	7165	20639	125503	184012	159889	104135	10152	0	0	611494
1953	0	0	0	1225	20188	91906	162648	172989	116113	18600	204	0	583873
1954	0	0	0	22224	50157	129298	202588	156282	83146	14164	286	0	658145
1955	0	0	0	14876	45037	67423	202495	152527	67213	12530	0	0	562099
1956	0	0	0	6191	38406	159659	161656	110313	96347	18128	0	0	590700
1957	0	0	0	572	2582	88715	184931	147816	77682	5819	0	0	508117
1958	0	0	0	4441	21692	108981	151950	172013	85405	12768	0	0	557251
1959	0	0	0	3324	20986	128477	195113	180037	57770	2192	0	0	587899
1960	0	0	0	11632	36997	126459	174245	186093	93931	8948	303	0	638607
1961	0	0	0	7345	7935	90410	108315	120383	22483	5596	0	0	362468
1962	0	0	0	16125	40669	73354	162719	155829	61224	15891	694	0	526504
1963	0	0	0	17218	81042	88444	210161	115596	60414	26776	1538	0	601189
1964	0	0	0	6007	36900	114666	211104	167801	83447	20073	0	0	639998
1965	0	0	20	12377	30202	44067	139326	166312	27053	10047	1593	0	430998
1966	0	0	0	6442	68844	89456	216658	154784	57917	9937	0	0	604039
1967	0	0	3084	8959	13987	41151	118632	137172	95690	23880	0	0	442555
1968	0	0	0	2335	22457	113384	153709	136825	105518	20371	0	0	554598
1969	0	0	0	16695	37414	82709	181372	161684	60424	7	0	0	540305
1970	0	0	0	6331	56988	86961	175165	176825	60503	6621	0	0	569394
1971	0	0	0	3446	31220	134359	173762	180385	29917	5759	0	0	558848
1972	0	0	5289	15729	54378	98551	173239	123232	73345	13393	0	0	557157
1973	0	0	0	1999	36240	132970	144714	197019	59051	22480	123	0	594597
1974	0	0	1359	10348	92031	93537	190771	151041	54218	12312	204	0	605821
1975	0	0	0	4709	9103	82640	159960	149527	89942	16963	0	0	512844
1976	0	0	0	8933	33439	115506	176803	143328	58399	10092	0	0	546500
1977	0	0	430	9520	65345	169886	130003	136392	81985	10078	0	0	603640
1978	0	0	912	6523	4060	63400	132897	129372	83640	6368	0	0	427172
1979	0	0	204	11569	15849	62452	181655	103072	104702	20996	0	0	500499
1980	0	0	0	4527	23835	137424	194934	168468	102071	17988	0	0	649246
AVERAGE	0	0	377	8399	34615	100270	170083	149680	74062	12820	165	0	550469

NOTE: Includes new irrigated lands.

TABLE D.30

CACHE LA POUDRE BASIN STUDY
MONTHLY MUNICIPAL AND INDUSTRIAL DEMANDS
Year 2020, Series 2 and 3
(All Values in Acre-Feet)

Series 2

City	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Fort Collins	3201	3025	3418	4427	6090	8025	9272	8348	6476	4768	3513	3237	63800
Greeley	1929	1667	1920	2610	3568	4411	5328	4671	3536	3006	2124	2030	36800
Other Areas	1029	1030	1080	1238	1813	2364	2624	2337	1867	1478	1057	1082	19000
TOTAL	6159	5722	6418	8275	11471	14800	17224	15356	11879	9252	6694	6349	119600

Series 3

City	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Fort Collins	4325	4087	4618	5982	8228	10842	12528	11279	8750	6442	4746	4374	86200
Greeley	2767	2392	2754	3745	5120	6329	7644	6702	5073	4313	3048	2913	52800
Other Areas	1213	1215	1274	1459	2138	2787	3094	2755	2201	1743	1246	1276	22400
TOTAL	8305	7694	8646	11186	15486	19958	23266	20736	16024	12498	9040	8563	161400

TABLE D.31

MODELED TOTAL DEMAND SHORTAGES
FOR ALL IRRIGATION SYSTEMS
(YEAR 2020 DEMANDS)

SERIES 2:

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	102	0	4	0	0	0	106
1952	0	0	0	0	0	0	266	90	996	0	0	0	1352
1953	0	0	0	0	0	0	200	2132	4185	1522	4	0	8043
1954	0	0	0	0	0	602	57340	78894	36751	912	30	0	174529
1955	0	0	0	144	0	0	16145	57323	19421	1006	0	0	94039
1956	0	0	0	0	0	200	5225	8712	51815	8553	0	0	74505
1957	0	0	0	0	0	66	9	59	76	0	0	0	210
1958	0	0	0	0	0	0	150	663	504	2	0	0	1319
1959	0	0	0	0	0	0	680	1359	129	0	0	0	2168
1960	0	0	0	0	0	164	312	3956	3090	0	5	0	7527
1961	0	0	0	0	0	138	67	88	0	0	0	0	293
1962	0	0	0	12	0	12	1388	118	0	0	10	0	1540
1963	0	0	0	0	0	0	863	86	36	105	25	0	1115
1964	0	0	0	0	0	59	854	3610	12880	2826	0	0	20229
1965	0	0	0	0	0	0	0	333	0	0	25	0	358
1966	0	0	0	0	0	4	2473	20046	1861	0	0	0	24384
1967	0	0	0	0	0	174	67	15	798	269	0	0	1323
1968	0	0	0	0	0	0	81	270	1950	68	0	0	2369
1969	0	0	0	0	0	0	113	3646	3985	0	0	0	7744
1970	0	0	0	0	0	147	234	222	29	0	0	0	632
1971	0	0	0	0	61	235	657	242	0	0	0	0	1195
1972	0	0	0	0	0	74	130	829	820	13	0	0	1866
1973	0	0	0	0	0	0	0	391	128	296	2	0	817
1974	0	0	0	0	0	0	164	1166	987	0	3	0	2320
1975	0	0	0	0	0	0	72	68	423	47	0	0	610
1976	0	0	0	0	0	79	128	238	50	63	0	0	558
1977	0	0	0	0	0	272	374	2457	2648	0	0	0	5751
1978	0	0	0	0	0	0	11	125	561	0	0	0	697
1979	0	0	0	0	0	151	235	515	318	34	0	0	1253
1980	0	0	0	0	0	127	182	764	1170	0	0	0	2243
AVERAGE	0	0	0	5	2	83	2951	6281	4854	524	3	0	14703

SERIES 3: Does not include additional lands

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	102	0	17	0	0	0	119
1952	0	0	0	0	0	0	289	263	1121	0	0	0	1673
1953	0	0	0	0	0	0	226	1409	4759	2546	6	0	8946
1954	0	0	0	0	0	8295	58903	71328	37117	3253	53	0	178949
1955	0	0	0	200	0	0	17541	55899	20014	3094	0	0	96748
1956	0	0	0	0	0	232	6123	7447	49205	11426	0	0	74433
1957	0	0	0	0	0	82	15	60	81	0	0	0	238
1958	0	0	0	0	0	0	148	633	597	24	0	0	1402
1959	0	0	0	0	0	0	901	2262	274	0	0	0	3437
1960	0	0	0	0	0	177	319	3833	2761	0	7	0	7097
1961	0	0	0	0	0	174	68	90	0	0	0	0	332
1962	0	0	0	29	0	18	1377	120	5	0	15	0	1564
1963	0	0	0	0	0	0	859	90	52	169	34	0	1204
1964	0	0	0	0	0	85	856	3636	4469	3694	0	0	12740
1965	0	0	0	0	0	0	0	426	0	66	35	0	527
1966	0	0	0	0	0	11	3078	15112	1134	5	0	0	19340
1967	0	0	0	0	0	276	93	18	837	339	0	0	1563
1968	0	0	0	0	0	0	85	317	1241	142	0	0	1785
1969	0	0	0	0	0	0	139	3362	3611	0	0	0	7112
1970	0	0	0	0	0	172	232	224	39	0	0	0	667
1971	0	0	0	0	168	263	1662	642	0	0	0	0	2735
1972	0	0	0	0	0	94	134	941	954	98	0	0	2221
1973	0	0	0	0	0	0	0	437	151	457	4	0	1049
1974	0	0	0	0	0	0	214	1189	509	0	5	0	1917
1975	0	0	0	0	0	0	77	69	446	155	0	0	747
1976	0	0	0	0	0	93	131	492	12	127	0	0	855
1977	0	0	0	0	0	282	493	1628	2326	0	0	0	4729
1978	0	0	0	0	0	0	22	128	562	0	0	0	712
1979	0	0	0	0	0	187	241	523	342	84	0	0	1377
1980	0	0	0	0	0	171	187	1483	1361	0	0	0	3202
AVERAGE	0	0	0	8	6	354	3151	5802	4467	856	5	0	14647

TABLE D.32

MODELED TOTAL DEMAND SHORTAGES FOR
MUNICIPAL AND INDUSTRIAL SYSTEMS
(YEAR 2020 DEMANDS)

SERIES 2:

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	121	1057	1082	2260
1952	0	0	0	0	0	0	0	0	0	0	564	1082	1646
1953	0	0	0	0	0	0	0	0	0	0	0	181	181
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	382	382
1957	0	0	0	0	0	0	0	0	0	1262	1057	1082	3401
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0	0	1017	1057	1082	3156
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	206	1057	1082	2345
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0	0	0	139	1082	1221
1968	0	0	0	0	0	0	0	0	0	0	505	1082	1587
1969	0	0	0	0	0	0	0	0	0	0	0	46	46
1970	0	0	0	0	0	0	0	0	0	0	1047	1082	2129
1971	0	0	0	0	0	0	0	0	0	276	1057	1082	2415
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	857	1082	1939
1979	0	0	0	0	0	0	0	0	198	1426	1057	1082	3763
1980	0	0	0	0	0	0	0	0	0	0	0	0	0
AVERAGE	0	0	0	0	0	0	0	0	7	144	315	417	892

SERIES 3: Does not include additional lands

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1951	0	0	0	0	0	0	0	0	0	0	427	2903	3330
1952	0	0	0	0	0	0	0	0	0	0	0	2706	2706
1953	0	0	0	0	0	0	0	0	0	49	3263	2852	6164
1954	0	0	0	0	0	0	0	0	0	409	3263	2852	6524
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	2457	2875	5332
1957	0	0	0	0	0	0	0	0	0	1168	1246	2400	4814
1958	0	0	0	0	0	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0	0	0	0	2499	2499
1961	0	0	0	0	0	0	0	0	0	827	1246	2059	4132
1962	0	0	0	0	0	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	1129	3836	4965
1965	0	0	0	0	0	0	0	0	0	0	620	2239	2859
1966	0	0	0	0	0	0	0	0	0	77	3263	2852	6192
1967	0	0	0	0	0	0	0	0	0	0	0	1910	1910
1968	0	0	0	0	0	0	0	0	0	0	0	3190	3190
1969	0	0	0	0	0	0	0	0	0	0	0	3792	3792
1970	0	0	0	0	0	0	0	0	0	0	3328	6258	9586
1971	0	0	0	0	0	0	0	0	0	1324	4047	5815	11186
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	1796	2836	4632
1978	0	0	0	0	0	0	0	0	0	0	165	4013	4178
1979	0	0	0	0	0	0	0	0	96	1651	2281	4114	8142
1980	0	0	0	0	0	0	0	0	0	0	1831	2852	4683
AVERAGE	0	0	0	0	0	0	0	0	3	184	1012	2162	3361

TABLE D.33

MODELED ANNUAL TOTAL DEMAND SHORTAGES
(2020 SERIES 2 DEMANDS)
AS PERCENT OF TOTAL DEMANDS

	M&I			IRRIGATION SYSTEMS															
YEAR	FTCO	GREL	WDIS	NPDR	LARC	JACK	LILC	ARTH	LAR2	LAKE	BOX	LARW	WHIT	BHEA	JONES	GRE3	BOYD	GRE2	OGIL
1951	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
1952	0	0	9	0	0	8	9	0	0	0	0	0	0	2	0	0	14	0	2
1953	0	0	1	0	0	23	17	0	0	29	0	0	0	7	0	0	24	1	3
1954	0	0	0	42	7	39	39	0	0	50	0	43	0	23	0	0	39	39	26
1955	0	0	0	31	5	23	4	0	0	29	0	18	0	32	0	0	33	20	40
1956	0	0	2	18	5	25	19	0	0	28	0	17	0	26	0	0	23	21	10
1957	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0
1958	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	18	0	0
1959	0	0	0	0	0	16	3	0	0	0	0	0	0	0	0	0	24	0	10
1960	0	0	0	0	0	23	38	0	0	19	0	0	0	0	0	0	57	0	6
1961	0	0	17	0	0	0	0	0	0	0	0	0	0	2	0	0	27	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	16	0	19
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	27	0	8
1964	0	0	0	0	0	16	33	0	0	17	0	11	0	2	2	0	32	0	20
1965	0	0	12	0	0	6	0	0	0	0	0	0	0	0	0	0	8	0	0
1966	0	0	0	0	0	31	26	0	0	22	0	14	0	0	0	0	29	0	23
1967	0	0	6	0	0	5	17	0	0	0	0	0	0	8	3	0	9	0	5
1968	0	0	8	0	0	14	7	0	0	8	0	0	0	1	0	0	16	0	0
1969	0	0	0	0	0	20	20	0	0	17	0	4	0	0	0	0	11	0	1
1970	0	0	11	0	0	0	0	0	0	0	0	0	0	4	0	0	35	0	0
1971	0	0	13	0	0	0	0	0	0	0	0	0	0	11	1	0	17	0	9
1972	0	0	0	0	0	10	13	0	0	0	0	0	0	13	0	0	21	0	3
1973	0	0	0	0	0	7	0	0	0	0	0	0	0	2	0	0	11	0	2
1974	0	0	0	0	0	19	12	0	0	4	0	0	0	0	0	0	6	0	0
1975	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	10	0	1
1976	0	0	0	0	0	3	2	0	0	0	0	0	0	0	1	0	19	0	1
1977	0	0	0	0	0	21	27	0	0	14	0	0	0	5	0	0	45	0	5
1978	0	0	10	0	0	0	15	0	0	0	0	0	0	0	0	0	23	0	0
1979	0	0	20	0	0	0	2	0	0	0	0	0	0	14	0	0	31	0	7
1980	0	0	0	0	0	16	11	0	0	0	0	0	0	1	0	0	40	0	0

TABLE D.34

MODELED ANNUAL TOTAL DEMAND SHORTAGES
(2020 SERIES 3 DEMANDS)
AS PERCENT OF TOTAL DEMANDS

	M&I			IRRIGATION SYSTEMS														
YEAR	FTCO	GREL	WDIS	NPDR	LARC	JACK	LILC	ARTH	LAR2	LAKE	LARW	BHEA	JONES	GRE3	BOYD	GRE2	OGIL
1951	2	0	8	0	0	0	0	0	0	0	0	0	0	0	11	0	0
1952	0	4	3	0	0	12	10	0	0	0	0	3	0	0	15	0	2
1953	7	0	0	0	0	23	17	0	0	23	0	7	0	0	23	4	4
1954	8	0	0	50	23	39	39	0	0	55	45	23	0	0	39	39	26
1955	0	0	0	33	25	24	5	0	0	30	20	33	0	0	32	20	40
1956	6	0	0	20	14	27	20	0	0	29	17	27	0	0	24	22	9
1957	0	2	16	0	0	0	0	0	0	0	0	0	0	0	17	0	0
1958	0	0	0	0	0	2	25	0	0	0	0	1	1	0	18	0	0
1959	0	0	0	0	0	25	19	0	0	0	0	0	0	0	24	0	10
1960	2	2	0	0	0	25	37	0	0	18	0	0	0	0	56	0	6
1961	0	1	15	0	0	0	0	0	0	0	0	3	1	0	27	0	0
1962	0	0	0	0	0	0	0	0	0	0	0	1	0	0	16	0	18
1963	0	0	0	0	0	0	0	0	0	0	0	4	4	0	28	0	7
1964	5	2	0	0	0	22	28	0	0	18	5	3	2	0	33	0	19
1965	0	2	8	0	0	8	0	0	0	0	0	1	1	0	8	0	1
1966	7	0	0	0	0	27	25	0	0	26	10	0	0	0	29	0	22
1967	0	1	6	0	0	6	16	0	0	0	0	11	4	0	12	0	7
1968	1	4	3	0	0	15	8	0	0	3	0	2	0	0	15	0	0
1969	3	3	0	0	0	20	29	0	0	17	1	0	0	0	12	3	1
1970	6	6	7	0	0	0	0	0	0	0	0	4	0	0	35	0	0
1971	9	3	9	0	0	8	0	0	0	0	0	13	2	0	17	0	23
1972	0	0	0	0	0	12	14	0	0	0	0	15	0	0	21	0	4
1973	0	0	0	0	0	9	0	0	0	0	0	3	0	0	11	0	3
1974	0	0	0	0	0	20	13	0	0	0	0	0	0	0	7	0	0
1975	0	0	0	0	0	0	13	0	0	0	0	1	0	0	10	0	2
1976	0	0	0	0	0	8	1	0	0	0	0	1	1	0	19	0	1
1977	5	0	0	0	0	24	24	0	0	11	0	5	0	0	47	0	0
1978	3	0	5	0	0	0	14	0	0	0	0	0	0	0	24	0	0
1979	4	0	19	0	0	0	3	0	0	0	0	16	0	0	32	0	7
1980	5	0	0	0	0	19	26	0	0	0	0	2	0	0	40	0	0

TABLE D.35

MODELED TOTAL DEMAND SHORTAGES
FOR ADDITIONAL LANDS
SERIES 3 DEMANDS

(ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	%
1951	0	0	0	0	0	3423	40154	14027	17301	0	0	0	74905	68
1952	0	0	0	0	0	6766	52211	44893	29256	1450	0	0	134776	77
1953	0	0	0	0	0	6512	45717	48942	32748	4776	58	0	138753	83
1954	0	0	0	1746	11844	36138	57648	43774	21524	2499	82	0	175255	93
1955	0	0	0	0	7169	15006	57567	42263	15189	2210	0	0	139404	87
1956	0	0	0	0	0	43254	44913	27607	27210	5048	0	0	148032	88
1957	0	0	0	0	0	0	34049	40249	20262	0	0	0	94560	65
1958	0	0	0	0	0	0	41569	48460	22806	1021	0	0	113856	71
1959	0	0	0	0	0	14535	55447	50987	12204	0	0	0	133173	79
1960	0	0	0	0	0	21724	49193	52891	25439	0	0	0	149247	82
1961	0	0	0	0	0	0	6982	30607	0	0	0	0	37589	36
1962	0	0	0	0	844	16168	45280	43481	16169	0	0	0	121942	81
1963	0	0	0	0	18971	20499	59662	29370	10554	5919	440	0	145415	85
1964	0	0	0	0	0	26880	60072	47483	22517	5273	0	0	162225	99
1965	0	0	0	0	0	1205	37235	47054	0	0	213	0	85707	69
1966	0	0	0	0	13427	22549	61672	43372	10412	348	0	0	151780	88
1967	0	0	0	0	0	0	13717	37678	26179	4338	0	0	81912	65
1968	0	0	0	0	0	16647	42684	37562	29647	2472	0	0	129012	81
1969	0	0	0	0	0	18303	51030	45099	12905	0	0	0	127337	82
1970	0	0	0	0	0	0	42182	49995	12988	0	0	0	105165	65
1971	0	0	0	0	0	15661	49270	51074	0	0	0	0	116005	73
1972	0	0	0	0	6213	25247	48994	32313	18285	942	0	0	131994	83
1973	0	0	0	0	0	23812	39459	55843	12709	5065	35	0	136923	80
1974	0	0	0	0	15008	22428	53912	42111	12239	0	0	0	145698	84
1975	0	0	0	0	0	0	32263	40865	24701	1939	0	0	99768	68
1976	0	0	0	0	0	26462	49913	39531	12053	1307	0	0	129266	83
1977	0	0	0	0	6700	48132	32767	37411	22743	0	0	0	147753	86
1978	0	0	0	0	0	0	27295	36054	22872	0	0	0	86221	71
1979	0	0	0	0	0	0	29230	24567	28388	1952	0	0	84137	59
1980	0	0	0	0	0	12808	55324	47610	28076	2737	0	0	146555	79
AVERAGE	0	0	0	58	2673	14812	43914	41106	18246	1643	28	0	122479	

TABLE D.36

CACHE LA POUDRE BASIN STUDY
CUMULATIVE TOTAL DEMAND SHORTAGES FOR DROUGHTS

Year 2020 Demand Levels
(All Values in Acre-Feet)

System	Series 2 1-in-10 Drought	Series 2 1-in-25 Drought	Series 3 1-in-10 Drought	Series 3 1-in-25 Drought
Fort Collins	0	0	4632	17997
Greeley	0	0	0	23
Other Municipal	0	563	0	0
TOTAL MUNICIPAL	0	563	4632	18020
North Poudre	0	78405	0	92022
Larimer County	0	73346	0	64591
Jackson	1408	6469	1871	6847
Little Cache	1182	3367	1059	3561
Arthu	0	0	0	0
Larimer 2/New Mercer	0	0	0	0
Lake	2105	19945	1329	16761
Boxelder	0	0	-	-
Larimer & Weld	0	90767	0	92806
Whitney	0	0	-	-
B.H. Eaton	141	2192	157	2328
Jones	5	0	9	1
Greeley No. 3	0	0	0	0
Boyd & Freeman	1033	1944	1088	2010
Greeley No. 2	0	68556	0	71881
Ogilvy	435	6125	71	6265
TOTAL IRRIGATION	6309	351116	5584	359073
TOTAL	6309	351679	10216	377093

TABLE D.37

MODELED STORABLE FLOWS AT THE NORTH FORK
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	11973	0	0	0	376	0	0	12349
1952	0	0	0	0	2985	13741	0	0	0	0	0	0	16726
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	1	0	0	0	0	0	0	0	0	1
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	2130	0	0	0	0	0	0	2130
1957	0	0	0	0	0	26997	640	0	0	0	0	0	27636
1958	0	0	0	0	30575	4563	0	0	0	0	0	0	35137
1959	0	0	0	0	0	5369	0	0	0	0	0	0	5369
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	6368	24999	0	0	0	0	0	1602	32970
1962	0	0	0	0	0	11051	0	0	0	0	0	0	11051
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	4174	1434	0	0	0	0	0	5608
1968	0	0	0	0	0	4137	0	0	0	0	0	0	4137
1969	0	0	0	0	0	4580	0	0	0	0	0	0	4580
1970	0	0	0	0	0	15833	0	0	0	0	0	0	15833
1971	0	0	0	0	16319	28479	0	0	0	0	0	0	44798
1972	0	0	0	0	0	120	0	0	0	0	0	0	120
1973	0	0	0	0	21545	22293	0	0	0	0	0	0	43838
1974	0	0	0	0	2186	17315	0	0	0	0	0	0	19502
1975	0	0	0	0	0	6435	0	0	0	0	0	0	6435
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	25619	0	0	0	0	0	0	25619
1979	0	0	0	0	19490	22455	0	0	0	0	0	0	41945
1980	0	0	0	16314	63873	25687	0	0	0	0	0	0	105874
AVERAGE	0	0	0	544	5445	9265	69	0	0	13	0	53	15389

NOTE: Measured at the stream gage on the North Fork near Livermore.

TABLE D.38

MODELED STORABLE FLOWS AT THE CANYON GAGE
(2020 SERIES 2 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	6188	0	0	0	0	0	0	6188
1952	0	0	0	0	0	30275	0	0	0	0	0	0	30275
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	6142	0	0	0	0	0	0	6142
1957	0	0	0	0	0	8592	6794	0	0	0	0	0	15386
1958	0	0	0	0	19482	16994	0	0	0	0	0	0	36476
1959	0	0	0	0	0	8769	0	0	0	0	0	0	8769
1960	0	0	0	0	0	2013	0	0	0	0	0	0	2013
1961	0	0	0	0	0	49953	0	0	0	8203	0	0	58155
1962	0	0	0	0	0	23092	0	0	0	0	0	0	23092
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	6	0	0	0	0	0	0	6
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	27534	2360	0	0	0	0	0	29894
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	15721	0	0	0	0	0	0	15721
1970	0	0	0	0	0	32893	0	0	0	0	0	0	32893
1971	0	0	0	0	16382	39454	0	0	0	0	0	0	55836
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	1562	41850	0	0	0	0	0	0	43412
1974	0	0	0	0	0	29413	0	0	0	0	0	0	29413
1975	0	0	0	0	0	24450	0	0	0	0	0	0	24450
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	13217	0	0	0	0	0	0	13217
1979	0	0	0	0	3065	70176	0	0	0	0	0	0	73241
1980	0	0	0	0	94438	52622	0	0	0	0	0	0	147060
AVERAGE	0	0	0	0	4498	16645	305	0	0	273	0	0	21721

NOTE: Does not include North Fork Storable Flows.

TABLE D.39

MODELED STORABLE FLOWS AT THE NORTH FORK
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	11914	0	0	0	620	0	0	12534
1952	0	0	0	0	2380	13741	0	0	0	0	0	0	16121
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	1050	0	0	0	0	0	0	1050
1957	0	0	0	0	0	26997	640	0	0	0	0	0	27636
1958	0	0	0	0	29233	4565	0	0	0	0	0	0	33797
1959	0	0	0	0	0	5369	0	0	0	0	0	0	5369
1960	0	0	0	0	0	0	0	0	0	0	0	0	0
1961	0	0	0	0	5287	25000	0	0	0	0	0	1533	31820
1962	0	0	0	0	0	11051	0	0	0	0	0	0	11051
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	2908	1437	0	0	0	0	0	4345
1968	0	0	0	0	0	3530	0	0	0	0	0	0	3530
1969	0	0	0	0	0	4580	0	0	0	0	0	0	4580
1970	0	0	0	0	0	15833	0	0	0	0	0	0	15833
1971	0	0	0	0	16608	28479	0	0	0	0	0	0	45087
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	21545	22293	0	0	0	0	0	0	43838
1974	0	0	0	0	5033	17314	0	0	0	0	0	0	22347
1975	0	0	0	0	0	6238	0	0	0	0	0	0	6238
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	25619	0	0	0	0	0	0	25619
1979	0	0	0	0	19490	22456	0	0	0	0	0	0	41945
1980	0	0	0	16310	63873	25687	0	0	0	0	0	0	105870
AVERAGE	0	0	0	544	5448	9154	69	0	0	21	0	51	15287

NOTE: Measured at the stream gage on the North Fork near Livermore.

TABLE D.40

MODELED STORABLE FLOWS AT THE CANYON GAGE
(2020 SERIES 3 DEMANDS)

(ACRE-FEET)

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1951	0	0	0	0	0	5366	0	0	0	0	0	0	5366
1952	0	0	0	0	0	30899	0	0	0	0	0	0	30899
1953	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	6443	0	0	0	0	0	0	6443
1957	0	0	0	0	0	7469	7879	0	0	0	0	0	15348
1958	0	0	0	0	21140	17984	0	0	0	0	0	0	39124
1959	0	0	0	0	0	9464	0	0	0	0	0	0	9464
1960	0	0	0	0	0	1175	0	0	0	0	0	0	1175
1961	0	0	0	0	0	49906	0	0	0	8203	0	0	58109
1962	0	0	0	0	0	21716	0	0	0	0	0	0	21716
1963	0	0	0	0	0	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	24283	2765	0	0	0	0	0	27048
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	15624	0	0	0	0	0	0	15624
1970	0	0	0	0	0	33107	0	0	0	0	0	0	33107
1971	0	0	0	0	17010	40341	0	0	0	0	0	0	57351
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	993	42440	0	0	0	735	0	0	44167
1974	0	0	0	0	0	29686	0	0	0	0	0	0	29686
1975	0	0	0	0	0	23428	0	0	0	0	0	0	23428
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	11674	0	0	0	0	0	0	11674
1979	0	0	0	0	2963	70037	0	0	0	0	0	0	73000
1980	0	0	0	0	94360	52896	0	0	0	0	0	0	147256
AVERAGE	0	0	0	0	4549	16465	355	0	0	298	0	0	21666

NOTE: Does not include North Fork Storable Flows.