# STATE OF COLORADO

## Colorado Water Conservation Board

**Department of Natural Resources**
1313 Sherman Street, Room 721
Denver, Colorado 80203
Phone: (303) 866-3441
Fax: (303) 866-4474
www.cwcb.state.co.us



TO: Colorado Water Conservation Board Members

FROM: Ted Kowalski, Chief, Interstate & Federal Section

DATE: January 12, 2011

SUBJECT: **Agenda Item 20, January 24-26, 2011 Board Meeting**
Interstate & Federal – National Register of Historic Places Multiple Property Documentation Form: "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960"

**Background**

On December 20, 2010, Director Gimbel received a copy of a letter from the Colorado Historical Society to the Colorado State Engineer, wherein this agency is requesting comments on the draft of the "Irrigation and Water Supply Ditches and Canals in Colorado, 1787-1960, a National Register of Historic Places multiple property documentation form." The agency requested comments on the form by January 10, 2011. Copies of the letters submitted by Director Gimbel, by the State Engineer, and by the Director of the Colorado Water Congress, are attached to this memo. Each of these letters requested additional time to submit comments, due to the fact that the form potentially listed over 25,000 structures within Colorado. Moreover, it is not yet clear what the effects will be of listing certain canals or ditches within this form. Over the next several weeks, the Staff of the CWCB will work with the State Engineer's Office, the Colorado Water Congress, and the owners of the ditches and canals listed within this documentation, to understand the full import of this form and the listing of a canal or ditch within this form. The letter from the Colorado Historical Society, and the form itself, are attached to this memo for the Board's consideration and information.

**Staff Recommendation**

The Staff seeks the Board's input on this matter.

# STATE OF COLORADO


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**Department of Natural Resources**
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Bill Ritter, Jr.
Governor

Mike King
DNR Executive Director

Jennifer L. Gimbel
CWCB Director


January 10, 2011

**Via Facsimile (303.866.4464) and U.S. Mail**

Edward C. Nichols
State Historic Preservation Officer and President,
Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

Steve W. Turner, A1A
Deputy State Historic Preservation Officer
Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

**Re: National Register of Historic Places Multiple Property Documentation Form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960"**

Dear Mr. Nichols, Mr. Turner;

I have received a copy of your request for comments on the Multiple Property Documentation Form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960." On behalf of the Colorado Water Conservation Board (CWCB), I am requesting that you extend your consideration of comments on this issue for at least 60 days.

The Colorado General Assembly established the CWCB to "assist in the protection and development of Colorado's water resources for the benefit of the present and future inhabitants of the state." To this end, I believe that the ditch owners and operators must have sufficient time to review the proposed listings because these listings may negatively affect water resource issues in Colorado. The Documentation Form includes over 25,000 potentially listed structures, and the public comment period fell over the holiday season. On behalf of the CWCB, I am requesting more time to insure the public participation and involvement of owners of these structures.

Thank you for your consideration. If you would like further information, or have any questions, feel free to contact our office.

Sincerely,

Jennifer Gimbel
CWCB Director

Bill Ritter, Jr.
Governor

Mike King
Executive Director

Dick Wolfe, P.E.
Director/State Engineer

January 6, 2011

Via Fax (303-866-4464) and U.S. Mail

Edward C. Nichols
State Historic Preservation Officer and President, Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

Steven W. Turner, AIA
Deputy State Historic Preservation Officer, Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

RE: National Register of Historic Places Multiple Property Documentation Form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960"

Dear Sirs:

Thank you for sending the Multiple Property Documentation Form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960" to the Division of Water Resources ("DWR"). The document presents an interesting review of the historical development of irrigation systems within Colorado.

DWR staff work with the owners and operators of the ditches and canals in Colorado on an almost daily basis. As a courtesy, I passed on the Multiple Property Documentation Form ("proposed listing") to a major water user representative group the Colorado Water Congress ("CWC"). This was done so that parties with an interest in the structures could be apprised of the proposed listing. Due to the scope of the proposed listing, the CWC has suggested that a delay in consideration of the proposed listing would be appropriate and that a representative of the State Office of Archeology and Historic Preservation make a presentation to water users at the CWC conference.

DWR would concur with the CWC that a delay in consideration of the proposal of at least 60 days would allow the owners or interested parties of the over 25,000 potentially listed structures to be informed of the proposed listing, allow them time to review, and comment, and allow the Colorado Historic Preservation Review Board ("Board") sufficient time to fully consider those comments. I would echo that the CWC conference is an excellent forum to meet and inform water users and owners of the proposed listing and would encourage the State Office of Archeology and Historic Preservation to take advantage of the offer the CWC has extended.

I would like to comment for DWR on the proposed listing. Working with DWR, one becomes familiar with the historical development of water use in Colorado. I personally found the historical context in the proposed listing interesting reading. However, it appears that the proposed listing is a general listing of all ditches and canals in Colorado and that DWR databases were used to generate much of the information. DWR databases were constructed for the purpose of tabulating and administering water rights. Proper understanding of the construction, intent, and constraints of those databases is important to utilizing the databases for other purposes. If not properly understood, one can arrive at erroneous conclusions from sorting the databases. My understanding is that the water right information and structure information from our databases were used to map and determine historical dates for the structures. There are several ways in which a sort of this type can lead to erroneous conclusions. As examples:

- Water rights in Colorado are transferrable property rights; thus water rights and structures are not permanently tied together. A water right can be, and many have been, transferred to another structure via a Water Court action. If a senior (older) water right is transferred into a 'new' structure, a sort of our database relying on a water right dates could indicate that the 'new' structure is much older than it actually is. The Rio Grande Canal was constructed and acquired several more senior water rights which it transferred into its newer main canal. Relying on these water rights dates would indicate the Rio Grande Canal is older than it actually is.
- Colorado law allows for 'conditional' water rights. In these cases, water rights receive a priority or 'place in line' with the promise that actual physical development will occur in the future. DWR tabulates these 'conditional' water rights in our databases. Examples of these would be large federal projects which list the date the project was first proposed as a priority date, despite the fact that the structures were not constructed until many years later. An extreme example of this would be the Animas-La Plata project which operates under a 1938 priority date however, the structures for diversion and storage (Lake Nighthorse) were just completed in 2009 and are still diverting for the first fill. It would seem inappropriate to list such new structures in this proposed listing.
- Further, the databases list 'conditional' water rights which are still not complete but which do specify 'proposed' locations. Since these are 'conditional' water rights the structures may not have ever existed and would probably be inappropriate to list.
- The water rights databases are dynamic databases. Approximately one thousand claims for water rights and changes of water rights are filed annually with the water courts. DWR continuously tabulates these new claims and changes of rights as the courts decree them. With a dynamic database, it may be difficult or impossible to recreate, at a future date, the same 'map' or list of structures proposed for listing. Without knowing which version and how the databases were manipulated to determine eligible structures, it is impossible to assure that inappropriate structures are not included in the proposed listing.

In light of need for the owners of the structures to have time to comment and the Board to properly consider such comments, DWR is of the opinion that a delay in consideration of this proposal by the Board would be appropriate. Further, to provide a useful tool to future historians and owners, it would seem appropriate that the proposed listing be amended to include a detailed list of the structures, their locations, and other pertinent information that help determine historical significance and listing eligibility.

If you have questions or would like further information please contact me.

Sincerely,

Michael J. Sullivan
Deputy Director/Deputy State Engineer
Colorado Division of Water Resources

cc: CWC

# Colorado Water Congress

1580 Logan Street, Suite 700 • Denver, Colorado 80203
www.cowatercongress.org

**Douglas Kemper**
Executive Director

tel 303.837.0812
cwc@cowatercongress.org


January 4, 2011

**Via facsimile (303.866.4464) and U.S. Mail**

Edward C. Nichols
State Historic Preservation Officer
and President,
Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

Steve W. Turner, AIA
Deputy State Historic Preservation Officer
Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

Re: National Register of Historic Places Multiple Property Documentation Form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960"

Dear Messrs. Nichols and Turner:

On behalf of its 350 organizational members, many of whom own, operate, or have property interests in irrigation and water supply ditches and canals in Colorado, the Colorado Water Congress (CWC) requests that the Colorado Historic Preservation Review Board (Review Board) defer its consideration of the multiple property documentation form entitled "Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960" for at least 60 days, until ditch owners have adequate time to understand the potential implications of the proposed form. This request includes both a request to extend the imminent January 10, 2011 comment deadline and to delay the Review Board's formal consideration of the proposed form at a meeting tentatively scheduled for February 2, 2011.

The CWC was founded in 1958 to assist in the conservation and stewardship of the water resources of the State of Colorado for the public benefit of present and future generations. Its membership includes large and small public and private water management organizations and users, including individual farmers and ranchers as well as the mutual ditch companies through which they frequently operate their ditches and canals. The CWC provides a forum where the water interests of the State strive to reach consensus on water issues. In addition, the CWC advocates positions on water policy; provides education and information on water issues affecting Colorado; and promotes a broad base of membership.

The CWC and other water users only became aware of the proposed form in the last several days. Irrigation and water supply facilities were and are important to the history and ongoing economic vitality of the State. And while it is possible that individual CWC members might, after carefully weighing the advantages and disadvantages, seek to have their ditches and canals placed on the National Register of Historic Places, meaningful public input into the Review Board's consideration of the proposed form simply cannot occur due 1) to the scope of the proposal (66 pages, covering the thousands of all pre-1960 ditches and canals in the entire State); 2) the timing of the release of the proposal for public comment over the holidays; and 3) the few days remaining prior to the comment deadline and public meeting.

Owner involvement and public participation are touchstones of the National Historic Preservation Act. 16 U.S.C. §§ 470a(a)(6); 470a(b)(1)(C). Accordingly, and to begin such involvement and participation, the CWC would like to invite an appropriate representative of the State Office of Archaeology and Historic Preservation to address the CWC concerning the proposed form at its annual convention, to be held January 26-28, 2010 at the Hyatt Regency Denver Tech Center. A thoughtful and thorough dialogue with ditch and canal owners will minimize any misunderstandings and controversy concerning this major proposal.

Thank you for your consideration. We look forward to hearing from you.

Sincerely,

Doug Kemper
Executive Director

Cc: Dick Wolfe
Jennifer Gimbel
Alex Davis

HISTORY Colorado

November 29, 2010

Dick Wolfe
Colorado Division of Water Resources
1313 Sherman St., Rm. 818
Denver, CO 80203

Re: *Irrigation and Water Supply Ditches and Canals in Colorado, 1787-1960* Multiple Property Documentation Form

Dear Mr. Wolfe:

We are pleased to inform you that *Irrigation and Water Supply Ditches and Canals in Colorado, 1787-1960*, a National Register of Historic Places multiple property documentation form, will be considered for acceptance by the Colorado Historic Preservation Review Board. The National Register is the federal government's official list of historic properties deserving preservation.

Your agency is invited to comment on the draft of this form by January 10, 2011. Additionally, you are invited to attend the February 2, 2011, State Review Board to be held at Trinity United Methodist Church, Basement Annex, 1820 Broadway, Denver. The National Register meeting will begin at 10:00 a.m. with public hearings at which comments concerning the eligibility of property nominations and multiple property documents are welcome. Please find enclosed a tentative agenda. A final agenda will be available the Monday before the meeting date. If you plan to attend the meeting, please contact our office at 303-866-3392 so we may note your attendance in the agenda.

Should you have questions before the Review Board meeting, please contact our office at 303-866-3392.

Sincerely,

Steve W. Turner, AIA
Deputy State Historic Preservation Officer

Enclosure
Tentative Agenda

CIVIC CENTER PLAZA 1560 BROADWAY SUITE 400 DENVER CO 80202 *www.historycolorado.org*

OFFICE *of*
ARCHAEOLOGY
*and* HISTORIC
PRESERVATION

# NOTICE OF PUBLIC MEETINGS

## COLORADO HISTORIC PRESERVATION REVIEW BOARD
And
## COLORADO STATE REGISTER REVIEW BOARD

**Wednesday, February 2, 2011**

Trinity Methodist Church, Basement Annex
1820 Broadway, Denver, Colorado

**TENTATIVE AGENDA***

10:00 COLORADO HISTORIC PRESERVATION REVIEW BOARD CALL TO ORDER
Edward C. Nichols, State Historic Preservation Officer

APPROVAL OF MINUTES
Approval of meeting minutes for October 1, 2010

10:15 NATIONAL REGISTER NOMINATION REVIEW
Explanation of program and procedures
Public review, discussion and Board eligibility recommendation

**Saint Philomena School (CLG)**
940 Fillmore Street, Denver (5DV.10941)

**Von Gohren-Thompson Homestead – Gerry Farm Rural Historic Landscape**
2781 AA Street, Greeley vicinity (5WL.1242)

**Peep O Day Park**
5445 Wild Lane, Loveland (5LR.830)

**Solandt Memorial Hospital**
150 Jackson St., Hayden (5RT.513)

**Lost Trail Station**
Creede vicinity, Hinsdale County (5HN.1149)

**Paonia First Christian Church**
235 Box Elder Ave., Paonia (5DT.1375)

**Canals and Irrigation Multiple Property Documentation Form**

**Historic Mining Resources of San Juan County, Colorado, Multiple Property Documentation Form**

**Historic Residential Subdivisions of Metropolitan Denver, 1940-1965 Multiple Property Documentation Form**

11:45 ADJOURNMENT OF COLORADO STATE HISTORIC PRESERVATION REVIEW BOARD

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11:50**

**STATE REGISTER REVIEW BOARD CALL TO ORDER**
Edward C. Nichols, President, Colorado Historical Society

**APPROVAL OF MINUTES**
Approval of meeting minutes for October 1, 2010

11:55

**STATE REGISTER NOMINATION REVIEW**
Explanation of nomination review procedures
Board nomination review and eligibility recommendation

**Saint Philomena School**
940 Fillmore Street, Denver (5DV.10941)

**Paonia First Christian Church**
235 Box Elder Ave., Paonia (5DT.1375)

**Arvada Jaycee Hall**
5640 Yukon St., Arvada (5JF.1355)

**Wilson Homestead**
11190 Old Pueblo Road, Fountain (5EP.6611)

**Los Angeles Railway Streetcar No. 3101**
Colorado Springs & Interurban Railway, Colorado Springs (5EP. 6739)

**Colorado Spring & Interurban Railway Streetcar No. 48**
Colorado Springs & Interurban Railway, Colorado Springs (5EP.6740)

**12:40****

**ADJOURNMENT OF STATE REVIEW BOARD**
**LUNCH FOR BOARD MEMBERS**

**Preliminary agendas are subject to change. The final meeting agenda will be available on the Monday before the meeting. For a copy, contact the National Register Staff at 303-866-4681 or by e-mail at astrid.liverman@chs.state.co.us

**Time shown is approximate and subject to change depending on the length of time required for board review of each nomination.

**Copies of the nominations to be reviewed may be examined at:**
Office of Archaeology and Historic Preservation, National Register and State Register Offices,
Civic Center Plaza, 1560 Broadway, Suite 400, Denver, CO 80202 Monday – Friday 8am to 5 pm

## NOMINATION SUBMISSION DATES AND REVIEW BOARD MEETING DATES

Board meetings will typically be held in Denver

| SUBMISSION DEADLINES° | BOARD MEETINGS | SUBMISSION DEADLINES° | BOARD MEETINGS |
|---|---|---|---|
| February 25, 2011 | June 10, 2011°° | October 28, 2011 | February 3, 2012°° |
| July 1, 2011 | October 7, 2011°° | February 26, 2012 | June 8, 2012 |

°Official nomination submissions must include all required materials including the nomination form, maps and photographs. Only complete and adequately documented nominations will be forwarded to the Review Board. Draft nominations may be submitted at any time. °°Location subject to change

*A Preservation Program of*

HISTORY Colorado

United States Department of the Interior
National Park Service

# National Register of Historic Places Multiple Property Documentation Form

This form is used for documenting property groups relating to one or several historic contexts. See instructions in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items

X New Submission ___ Amended Submission

## A. Name of Multiple Property Listing

Irrigation and Water Supply Ditches and Canals in Colorado, 1787 to 1960

## B. Associated Historic Contexts

Anasazi Settlement and Irrigation (1075-1300)
Hispano Settlement and *Acequias* (1787-1866)
Early American Period Ditches (1858-1912)
Irrigation through Government Systems and the Modern Period (1875-present)

## C. Form Prepared by

name/title Michael Holleran, Association Dean of Research, College of Architecture and Planning
organization University of Colorado at Denver and Health Sciences Center date October 10, 2005
street & number telephone
city or town Denver state CO zip code 80217
e-mail

## D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.
( ___ See continuation sheet for additional comments.)

DRAFT

Signature and title of certifying official | Date

State or Federal Agency or Tribal government

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper | Date of Action

## Table of Contents for Written Narrative

Provide the following information on continuation sheets. Cite the letter and title before each section of the narrative. Assign page numbers according to the instructions for continuation sheets in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Fill in page numbers for each section in the space below.

## STATEMENT OF HISTORIC CONTEXT

### Introduction

Most of Colorado is semi-arid, with average precipitation of ten to twelve inches on the eastern plains, and as little as five inches in the San Luis Valley, but up to fifty inches in the mountains. Precipitation in the mountains falls mainly as snow in the spring, and melts throughout the summer, providing water to the surrounding plains and valleys during the growing season. Going back to the Anasazi Period (1075-1300), people came to the Colorado region and created permanent settlements in large part by diverting this water through irrigation, bringing mountain runoff to fields in the sunny lowlands by means of ditches and canals.[1] Some of Colorado's settlers came north from New Mexico and brought a centuries-old irrigation culture, with roots going back still further in the Old World. When American settlers came to the area, those that came from the humid East found a very unfamiliar climate, but they were able to learn from the Americans who had experienced irrigation in California, Utah, New Mexico or Texas.

Many of these settlers came in the Gold Rush of 1859 and first built water works for mining rather than agriculture. Over the years other ditches and canals supplied water for towns, for water-powered mills, for industrial process water and for hydroelectric generation. Many systems were built for multiple purposes, or were adapted to new purposes as things changed around them.

In 1860, in the early stages of both Hispano and American settlement in Colorado, about 35,000 acres were irrigated through a few dozen mutual ditches and probably a greater number of individual farm ditches that have gone unrecorded. By 1890 the total was over a million acres, and more than 4,000 ditch owners had filed for adjudication of water rights.[2] Ten years later Colorado surpassed California as the state irrigating the greatest land area.

By 1950 the total irrigated acreage tripled to 3.2 million, served by 9,258 "irrigation enterprises" (this number includes some reservoir companies that were distinct from ditch companies) running about 17,000 miles of canal.[3] In 2000, the Colorado Water Resources Department database listed 22,800 ditches and canals.[4] Of these, 17,500 have appropriation dates before 1950. That total includes a handful of great canals that shaped the development of the state. The Rio Grande Canal in the San Luis Valley was the largest in the United States when completed in 1884. Extensive canal systems run for more than a hundred miles along the Arkansas and South Platte Rivers. The biggest system of all is Bureau of Reclamation's Colorado-Big Thompson. The total also includes thousands of mutual ditches that bring water to their shareholders, including the oldest surviving ditch system: the 1852 San Luis People's Ditch. In addition, it includes thousands of individual ranch ditches that may carry water a

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[1] There is no clear definition distinguishing "canals" from "ditches," yet the two terms are not quite interchangeable. "Ditch" is the more inclusive term, and is sometimes used to refer to all water conveyance channels no matter what size. "Canal" generally refers to a larger channel, but that may mean anything from 10 to 150 feet in width.

[2] Royce J. Tipton, "More Efficient Use of Water Resulting from Consolidation of Ditches and Regulation of Water Supplies," in Colorado Water Conservation Board, and Colorado State University, *A Hundred Years of Irrigation in Colorado; 100 Years Organized and Continuous Irrigation, 1852-1952* (Fort Collins: Colorado Water Conservation Board and Colorado Agricultural and Mechanical College, 1952),42; Colorado State Engineer, *Fifth Biennial Report, 1889-90* (Denver, 1890),533.

[3] Tipton, *Hundred Years of Irrigation in Colorado*, 4.

[4] This number is inflated by perhaps a few hundred, because canals are listed more than once if they cross water district boundaries.

hundred yards to a stock pond. The physical legacy of water diversion systems in Colorado also includes the remains of probably thousands of localized ditches that watered a homestead, town site, or mining claim that did not survive long enough to enter the state's water adjudication system.

**Anasazi Settlement and Irrigation (1075-1300)**

Prehistoric inhabitants of the American Southwest constructed water distribution systems, some of them extensive, but most of Colorado is outside the region of these cultures. One exception was the water system at Mesa Verde dating from the Great Pueblo Period of Anasazi settlement, which included check dams, small diversion ditches and reservoirs.[5] There is some evidence of prehistoric dams in the northwest area of the state, but no irrigation systems. Prehistory water conveyance for community or agricultural purposes seems to be localized in the southwest region of Colorado. prehistoric water-related resources are treated in Colorado Historical Society archaeological context reports.[6]

**Hispano Settlement and *Acequias* (1787-1866)**

The earliest Colorado irrigation ditches in historical times were short-lived features of aborted settlements in the Spanish and Mexican periods, or served American trading posts during the same period. The first were at the San Carlo de Jupes settlement next to the Arkansas River about eight miles east of present-day Pueblo, begun in 1787 but abandoned just a few months later. In the Arkansas Valley at Bent's Old Fort, the Bent brothers irrigated 40 acres beginning in 1832.[7] A ditch at the early settlement of Pueblo operated from 1841 until a massacre by the Utes in 1854. John Hatcher, a Bent brothers' foreman, established a supply station in 1846 on the Purgatoire River twenty miles downstream from Trinidad and dug a ditch to irrigate about 60 acres. He abandoned it about a year later after conflict with the Indians. J. W. Lewelling revived the ditch in 1865. This may be the oldest operating (though not continuously operating) ditch in Colorado.[8]

Hispanos moving north from New Mexico established the first permanent non-Native American settlements in present-day Colorado after the U.S. acquired southern Colorado from Mexico in 1848 and signed a treaty with the Utes in 1849. The settlers were operating under a Spanish legal and cultural system as these lands were originally Spanish land grants to individuals in the Taos region. The grantees were to parcel out their land to settlers who were willing to work the land and establish settlements. What made that arrangement different from later American patterns was "a system of

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[5] Kenneth R. Wright, *Water for the Anasazi: How the Ancients of Mesa Verde Engineered Public Works* (Boise: Public Works Historical Society, Essays in Public Works History no. 22, 2003).

[6] Frank W. Eddy, Allen S. Kane, and Paul R. Nickens, *Southwest Colorado Prehistoric Context: Archaeological Background and Research Directions* (Denver: Colorado Historical Society, 1984); Alan D. Reed, *West Central Colorado Prehistoric Context: Regional Research Design* (Denver: Colorado Historical Society, 1984); Mark R. Guthrie et al., *Colorado Mountains Prehistoric Context* (Denver: Colorado Historical Society, 1984); Jeffrey L. Eighmy, *Colorado Plains Prehistoric Context;* James Grady, *Northwest Colorado Prehistoric Context* (Denver: Colorado Historical Society, 1984).

[7] A. W. McHendrie, "The Early History of Irrigation in Colorado and the Doctrine of Appropriation," in *A Hundred Years of Irrigation in Colorado*, 14-15; Carroll Joe Carter and Steven F. Mehls, *Southern Frontier Historical Context* (Denver: Colorado Historical Society, 1984), 11-2.

[8] A. W. McHendrie, "The Hatcher Ditch (1846-1928): The Oldest Colorado Irrigation Ditch Now in Use," *Colorado Magazine* 5:3 (June 1928): 81-91; Carter and Mehls, *Southern Frontier*, 11-46.

water allocation that depend[ed] on common maintenance of a network of earthen ditches and on common commitment to the principle that water is to be shared in times of scarcity."[9] When the land became part of Mexico, the Mexican government continued to recognize the original Spanish land grants and supported that system of settlement patterns. By the early 1850s, settlers from New Mexico established the towns of San Luis and San Pedro in the San Luis Valley. Colorado initially recognized the land and water rights as practiced in the Spanish tradition by this area, thus encouraging further settlement. By the middle of the decade settlers had established Guadalupe (now Conejos), Servilleta, Mogote, San Pablo, San Acacio, and San Francisco.[10] These settlements all relied upon small communal ditches. The San Luis People's Ditch is the oldest continuously operating ditch in Colorado, and its water right when Colorado moved to integrate Hispano water-rights tradition into a prior appropriation system, is priority number one in the state with a date of April 10, 1852.[11] The U.S. Army's Fort Garland, established 1858 in the San Luis Valley, also included irrigated agriculture in the town that grew up around it.[12]

Hispano ditches are called *Acequias* (ah.SA Y 'kee'uhs). In New Mexico and Texas, the history of *acequia* irrigation goes back to the seventeenth and eighteenth centuries, and shows an integration of both Puebloan irrigation systems predating Spanish settlement in the area, and systems with European roots that in turn come from the Middle East via the Moorish period in Spain. New Mexico in particular has generated a rich *acequia* history and culture and an extensive literature describing them.[13]

The *acequia* is best understood as both a physical and a cultural system. The word *acequia* refers both to the ditch and to the ditch company, which in the *acequia* tradition is the smallest unit of civil government. This tradition is one of community control of generally small-scale systems. Water resources and shortages are shared, as is the work of maintenance and decisions about the system.

> The defining features of the *acequia* landscape are the networks of diversion works, typically consisting of earthen ditches and of head gates and check dams built from locally available materials, and the parceling out and physical arrangement of private land holdings so that all settlers owned arable lands served by the ditch system.[14]

Irrigation historian Karl Wittfogel refers to this as the "local subsistence mode" of irrigation; American irrigation historian Donald Worster describes it as "characterized by a general dependence on local

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[9] Gregory A. Hicks, Devon G. Peña, "Community *Acequias* in Colorado's Rio Culebra Watershed: A Customary Commons in the Domain of Prior Appropriation," *University of Colorado Law Review* 72, 2 (2003): 389.
[10] Carter and Mehls, *Southern Frontier*, 11-17-18.
[11] Hinderlider (in *A Hundred Years of Irrigation in Colorado*, 25) suggests that work may have begun as early as 1849. Cultural resource inventory form 5CF47.13 (San Luis Peoples Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society.
[12] Carter and Mehls, *Southern Frontier*, 11-35.
[13] Neal W. Ackerly, *A Review of the Historic Significance and Management Recommendations for Preserving New Mexico's Acequia Systems* (Silver City, New Mexico: Dos Rios Consultants, for New Mexico Historic Preservation Division, 19%); Stanley Crawford, *Mayordomo: Chronicle of an Acequia in Northern New Mexico* (Albuquerque: University of New Mexico Press, 1988); Jose A. Rivera, *Acequia Culture: Water, Land and Community in the Southwest* (Albuquerque: University of New Mexico Press, 1998); Michael C. Meyer, *Water in the Hispanic Southwest: A Social and Legal History, 1550-1850* (Tucson: University of Arizona Press, 1984, 1996).
[14] Hicks and Peña, 392.

skills and means."[15] The Colorado Territorial Legislature recognized Hispano practice in 1866 by providing for annual elections, in Costilla and Conejos counties (at that time all of the San Luis Valley and southwestern Colorado), of *acequia* superintendents (*mayordomos*).[16]

Agriculture in Hispano areas of southern Colorado began shifting from a subsistence to a market economy with the opening of gold fields after 1859. *Acequias* maintained cultural continuity with their Hispano origins, even while becoming absorbed into Colorado's system of water administration after statehood. More than a century of further irrigation development — of large investor canals and federal reclamation projects — have added new layers in the Arkansas and San Luis Valleys, but have not erased the initial layer of *acequia* heritage.[17] When the cultural traditions kept the *acequia* system viable, places such as the Culebra watershed were able to support approximately 700 farm families.[18] This system came under threat in the 1960s with the landmark Taylor Ranch legal battle that resulted in numerous lawsuits over the next fifty years. The Taylor Ranch area had been the common area for nearby settlements as established in the Spanish land grants, but in 1960 the courts of Colorado decided not to recognize communal rights to grazing and water.[19] Finally in 2002, the Colorado Supreme Court reversed previous decisions and recognized the cultural legacy of communal water and grazing rights in the San Luis Valley.[20] However, during the half century where communities were denied access to those resources, the *Acequias* tradition began to disappear. Where the Culebra watershed had previously supported 700 farm families, it only supported 270 families in 2003.

**Early American Period Ditches (1858-1912)**

As American explorers and prospectors moved into the Colorado area, they brought certain traditions with them that ultimately shaped the way that American settlements developed in relation to their surroundings. As those early pioneers shifted their focus from quickly harvesting resources before moving on to establishing more permanent settlements, the types of irrigation systems evolved from the very simple ditch to more complex irrigation systems. The four distinct periods in this early American era are mining diversions, pioneer ditches, colony ditches, and commercial canals. Each of these systems are typified by their function.

*Mining Diversions (1858-1910)*

Prospectors and miners constructed the first wave of water diversions in the early American era. The first miners needed water to wash sand and gravel from heavier gold in placer mining, using rocker boxes, long toms, or sluices. A number of Colorado gold seekers in 1858 had been to California as Forty-niners. They brought familiarity with the technology and culture of mining, including water diversions. They dug small temporary ditches or built temporary flumes. Few if any of these survive and few were recorded. As the summer progressed and stream flows diminished, operations halted and miners often turned to building ditches from more reliable water supplies that might be some distance away. Ditches permitted working "dry diggings," alluvial deposits not along a watercourse.

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[15] Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985), 64.
[16] McHendrie, *A Hundred Years of Irrigation in Colorado*, 17.
[17] Carter and Mehls, *Southern Frontier*, 11-46-47.
[18] Hicks and Peña, 395.
[19] Taylor v. Jaquez, 1965; Sanchez v. Taylor, 1967; Rael v. Taylor, 1986. 1991, 1994.
[20] Lobato v. Taylor, 2000, 2002.

In later years, the industry brought much greater water needs for hydraulic mining, for dredge mining, and as a power source for hard-rock mills. Hydraulic mining involved spraying water under pressure to excavate sand and gravel deposits. The pressure came from water supply ditches and flumes elevated above the diggings. Dredges worked deposits in the bed of a stream, whose flow might be controlled through dams and ponds and augmented by ditches.

Some mining ditches also served agricultural users, or were later adapted as part of agricultural supply systems.[21] For instance, the Davidson Ditch outside Golden, dug for placer mining in 1859, was bought in 1862 for agricultural use.[22] Mining ditches primarily fall into two periods of significance, with the first covering the initial boom of placer mining from 1858-1865. Some of these systems might have been impacted by a second wave of placer mining from 1929-1941 when poor economic conditions caused miners to return to the practice. The second period of significance would cover hydraulic mining from 1880-1910. While dredge mining resulted from the deposits left behind by placer and especially hydraulic mining, the development of dredge mining varied greatly across the state with the peak of dredge mining being 1910. For additional information on how mining operations used water conveyance systems, how to identify those features, and how to determine their significance and integrity, consult the *Mining Industry in Colorado* MPDF.[23]

*Pioneer Ditches (1858-ca. 1900)*

Pioneer ditches refer not to a specific period of Colorado's history, but rather to the first generation of ditches in any particular locality. Pioneer ditches typically watered bottomlands, the floodplain and flat lands not much elevated above the stream itself. A ditch for such purposes could be brought off the stream close to its users, and it required little elaborate engineering and minimal capital. The dates of the pioneer ditch period vary from valley to valley, depending when settlement began, from the 1850s and 1860s to the early twentieth century. Some places skipped the pioneer ditch period altogether when early settlement was controlled by a colony or commercial enterprise building a larger coordinated system.

If the ditch served a single user it was a farm or ranch ditch, if it served and was owned by multiple users it was a mutual ditch. Ditches that are not individually owned are generally operated by a ditch company, a term used whether or not it is operated for profit. A ditch rider tends the ditch, making sure both the main headgate to the ditch and the lateral gates from it are opened and closed at the proper times, and watching for debris, leaks and other problems.

Settlers, usually individual farmers or a group of farmers, created the small and simply constructed pioneer ditches. The paramount goal in the first year was to get the water running. Learning by trial and error, most of these early earthen ditches were reworked over time. Some pioneer ditches were well-sited and later extended to serve additional land, a few becoming the stems of large canal systems. Others were absorbed as branches of these larger systems. Where topography or other factors

[21] This transition was common in California. JRP Historical Consulting Services and the California Department of Transportation, *Water Conveyance Systems in California: Historical Context Development and Evaluation Procedures* (Sacramento: California Department of Transportation, 2000), 53.
[22] Gregory M. Silkensen, *The Farmers' High Line Canal and Reservoir Company: A Century of Change on Clear Creek* (Denver: North Suburban Printing, 2000), 9.
[23] James E. Fell and Eric Twitty, *Mining Industry in Colorado*, National Register of Historic Places Multiple Property Documentation Form, Colorado Historical Society, Denver, CO, 2006.

prevented incorporation into a larger, re-engineered system, the pioneer ditch may remain in substantially its original form.

Mining technology, from California and Colorado, informed agricultural ditch development. So did mining economics. Some Forty-niners had observed in California that supplying food and fodder to prospectors could tap mineral wealth more reliably than prospecting itself. David K. Wall, after living in California from 1850 to 1854, came to Golden in 1859, skipped gold prospecting and went straight to digging a ditch and growing crops. He made the princely sum of $2,000 that year.[24] That same year two of Boulder's first residents, Marinus Smith and William Pell, sold a single load of hay to miners in Black Hawk for $400. Smith and Pell dug Boulder's first ditch.[25]

Many early ditches sustained the local production of hay for animal feed. In an economy where animals were the power source for most transportation and industry, hay was the functional equivalent of petroleum fuels today. Irrigators also grew produce and grains for local consumption. As transportation improved, they grew more grain for distant markets, and as population increased they grew more produce for towns and cities. After the drought of the 1880s and the disastrous winter of 1885-86, when cattle by the thousands froze to death, irrigated hay again increased in importance as ranchers combined rangeland grazing with supplementary feeding.[26]

Smith's Ditch (later City Ditch) in Denver marked a transition from the pioneer ditch period to the commercial ditch period. It was begun in 1860 by the Capital Hydraulic Company, but was laid out without sufficient drop, and work stopped in 1861. Denver businessman John W. Smith revived the project, working with surveyor Richard S. Little (for whom Littleton is named). They relocated its headgate and enlarged its channel. When they finished it in 1867, it was more than twenty miles long and irrigated thousands of acres of benchland, an early demonstration that Colorado agriculture could extend beyond the river bottoms.[27]

In order to water benchlands above a river valley, a canal needed to leave the stream above the land to be irrigated, often many miles upstream. Such canals were beyond the reach of a few farmers acting together as they created their pioneer ditches; these systems required capital and a large workforce. One solution, which quickly became common, was outside investment. Another solution, communitarian or colony organization, initially had conspicuous success and remained for years one strain of Colorado irrigation development.

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[24] Silkensen, *Farmers' High Line*, 7. Several of the Boulder Valley's early ditch builders came to Colorado after spending time in California. Michael Holleran, *Boulder Valley Ditches Historical Survey Report: Anderson Ditch (5BL.3935), Farmers Ditch (5BL.6632), Silver Lake Ditch (5BL.38!3)* (Denver: University of Colorado College of Architecture and Planning, 2000).

[25] Amos Bixoy, *History o/Clear Creek and Boulder Valleys* (Chicago, 1880),389; Phyllis Smith, A *Look at Boulder: From Settlement to City* (Boulder: Pruett, 1981), 20.

[26] R. Laurie Simmons and Thomas H. Simmons. *Historic Ranching Resources of South Park, Colorado*, National Register of Historic Places Multiple Property Documentation Form, Colorado Historical Society, Denver, CO, 1999, p 12-13, 15.

[27] Cultural resource inventory forms 5DV.181 and 5AH.254 (City Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society; Earl A. Mosley, 'History of the Denver Water System: 1858 to 1919, Unpublished MS, Denver Water Department (1966), 28, 53.

*Colony Ditch Systems (1869-1909)*

Agricultural colonies were established by settlers who organized themselves elsewhere and then came to Colorado as a group to build a community together. The first significant one, and the best known, was the Union Colony that built Greeley. It was led by Nathan Meeker, the agricultural editor for Horace Greeley's New York Tribune. Meeker had lived for a time in a utopian settlement in the East, and had traveled to see Mormon irrigation in Utah. He launched the Union Colony with an organizational meeting at the Cooper Institute in New York City on December 23, 1869, explaining to his audience the great promise of irrigated agriculture in the West and the usefulness of cooperative action in achieving it. Prospective colonists paid $155 for a Union Colony membership, which entitled them to an irrigated farm and a lot in town. By the following year Meeker had bought 12,000 acres on the Cache La Poudre River, and five hundred families arrived on the site that summer.[28]

Among their first tasks was building ditches. Meeker, with General Robert A. Cameron, another Union Colony member, laid out a comprehensive system that was extraordinarily ambitious. Four main ditches of up to thirty-five miles in length would water both the valley floor and the bluffs above on both sides of the Cache La Poudre. Work started first on Greeley No.3 Ditch, which watered the townsite. It was intended to irrigate 5,000 acres, but in its first year did not carry enough for 200 acres.

At the Cooper Institute meeting Meeker had reassured his audience that "the cost of irrigation is perhaps equal to fencing."[29] It proved a little more costly than that. The colonists budgeted $20,000 for the whole system of four canals. Greeley No.3 needed to be enlarged in each of the next three years, and ended up costing $27,000. Greeley No.2 was the biggest ditch, watering the benchlands on the north side of the Poudre across from town. It too was begun in 1870, but not completed until 1877, in part by hiring Benjamin Eaton (who would go on to build even bigger canals and later to be elected governor).[30]

By the time the system was complete, it cost by various reckonings from $200,000 to more than $400,000, soaking up the capital that colonists intended for other shared enterprises. A year after completing Greeley No.2, the Union Colony sold it to its users, now organized as the Cache La Poudre Irrigation Company.

Some of the cost overrun came from gross underestimation of the magnitude of the project. However, much of it came from errors in design and construction. Grades were too shallow and the water would not flow, or too steep and the ditch washed out. Everything had to be done over.[31] "When they began digging," writes Donald Worster, "what they knew about the rise and fall of a Rocky Mountain stream or how much water it took to irrigate a crop could have been put in a tin cup."[32]

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[28] David Boyd, *Irrigation Near Greeley, Colorado* (Washington: U.S. Government Printing Office, 1897),28; Worster, *Rivers of Empire*. 83-88; Christine Whitacre and R. Laurie Simmons, *Historic Farms and Ranches of Weld County Multiple Property Listing* (Denver: Front Range Research Associates, 1990), 7; Jane E. Norris, *Written in Water: the life of Benjamin Harrison Eaton* (Athens, Ohio: Swallow Press/Ohio University Press, 1990)
[29] Quoted in McKinnon, *A Hundred Years of Irrigation in Colorado*. 33.
[30] Boyd, *Irrigation near Greeley;* McKinnon, *A Hundred Years of Irrigation in Colorado*. 33-34; Norris, *Written in Water*. 93-94.
[31] Boyd, *Irrigation near Greeley*, 29; Norris, *Written in Water*, 198.
[32] Worster, *Rivers of Empire*. 87.

The Union Colony's irrigation experiment was not easy, but it succeeded. While the cost was daunting, the system irrigated tens of thousands of acres; by one calculation it came to a very reasonable $350 per 80 acres irrigated. The colonists, and particularly their engineer, Edwin S. Nettleton, learned from their mistakes so that they would do it right the next time — for example, incorporating check structures where a channel needed to run down a slope.[33] The novelty of the effort and the coverage of the *New York Tribune* ensured that the eyes of the nation were upon Greeley. The colony movement was born, with imitators within the year.[34]

The Chicago-Colorado Company founded Longmont in 1870-71. The St. Louis- Western Colony was established at Evans in 1871. Fort Collins Agricultural Colony, including some Union Colony members, began in 1872. Other colony towns included Montrose, Green City, and Platteville.[35] Colony settlement and irrigated agriculture were not inherently linked, but they were a good fit with one another. Irrigation required disciplined cooperative effort and rewarded it well, and the colony philosophy sought just such opportunities. Colonies varied in their level of communalism. Some were little more than attempts to market townsites by invoking the success of Greeley.[36]

One notable set of colonies drew from a group of settlers with well-established traditions of communal enterprise and irrigation — the Mormons. The Latter-Day Saints established colonies, particularly in the San Luis Valley, where they settled Manassa in 1879 and Richfield in 1881. Other Mormon colonies settled in the valley during this time included Sanford, Morgan, and Uracca. Ephraim was settled in 1881 but abandoned in 1888; Eastdale was settled in 1890 and lasted until 1909. All colonies built ditches first. The Richfield site was made possible by Mormon skills in surveying, which demonstrated that a new ditch could in fact reach the site.[37]

The San Luis Valley attracted other colony settlements, encouraged by the Denver and Rio Grande Railroad. The Mosca Land and Farm Company established Mosca in 1891. The Costilla Estate Development Company built a reservoir in 1909 and set up the towns of San Acacio, Mesita, and Jarosa, where Seventh-day Adventists set up a colony and cooperative farm. Farther west, the Colorado Cooperative Company, incorporated in 1894, established Piñon and Nucla. At Piñon the colonists in 1903 built the Cottonwood Trestle, the longest and highest irrigation flume in the world. In the Arkansas Valley, east of Lamar, the Salvation Army in April 1898 established the town of Amity. Intensive irrigation rendered the soil there alkaline, and the colonists abandoned Amity in 1908.[38]

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33 McKinnon, *A Hundred Years of Irrigation in Colorado*, 34; Boyd, *Irrigation near Greeley*.

34 For more on the history of utopian communities in Colorado and their irrigation systems, see William J. Convery, "Tabeguache Utopia," *Colorado Heritage* (March/April 2009): 4-5.

35 Alvin T. Steinel, *History of Agriculture in Colorado* (Fort Collins: State Agricultural College, 1926), 390-95; Whitacre and Simmons, *Historic Farms and Ranches of Weld County*, E4-5; Norris, *Written in Water*, 113-15; Worster, *Rivers of Empire*, 85. Green City was also known as the "Tennessee Colony."

36 Kathleen A. Brosnan, *Uniting Mountain & Plain: Cities, Law, and Environmental Change along the Front Range* (Albuquerque: University of New Mexico, 2002), 76-77; Steven F. Mehls, *Colorado Plains Historic Context* (Denver: Colorado Historical Society, 1984), 55-62.

37 Steinel, *History of Agriculture in Colorado*, 401-05; Carter and Mehls, *Southern Frontier*, 11-109; Andrew Jenson, "The Founding of Mormon Settlements in the San Luis Valley, Colorado," *Colorado Magazine* 17 (1940): 179.

38 Michael B. Husband, *Colorado Plateau Country Historic Context* (Denver: Colorado Historical Society, (1984J), 100; Carter and Mehls, *Southern Frontier*, 11-110.

Greeley's influence extended beyond the example that it set for large-scale irrigation and cooperative effort. Greeley produced many of the irrigation advocates and innovators who would advance the field for the rest of the century. E. S. Nettleton (who became the first State Engineer), Benjamin Eaton (who became governor), William E. Pabor, J. Max Clark, Abner S. Baker, and David Boyd were Greeley men who designed and developed many of the major canal systems throughout Colorado, in particular the rest of the South Platte Valley east of Greeley. Some were active in new colony settlements, but they also brought their experience to a new generation of canals built by private enterprise for profit.

*Commercial Canals (1881-1912)*
J. C. McKinnon in 1952 explained the origins of Colorado's commercial canals:

> The success of the Greeley colony gave Colorado tremendous publicity. The whole world seemed to be watching the experiment. When the success of irrigation farming on the uplands seemed assured, there was a rush to build big ditches throughout the state... Most of the big ditches that followed the Greeley success were not built by colonists, but by corporations using British capital, however... An option would be taken on railroad lands. Without water these lands would bring from $2.50 to $4.00 per acre. With water available, the value would skyrocket to $100 or more... After the land was sold it was confidently expected that the sale of water would give very liberal returns as a permanent investment.[39]

After the example of Greeley itself, a second spur to large-scale canal construction was the 1881 Colorado Irrigation Act, born of the Greeley experience, which established the Office of the State Engineer and with the mandate to establish clear water rights, efficiently administered. The early 1880s brought nationwide economic expansion after the depression of the 1870s. The 1880s saw years of above-average rainfall (ending in the drought of 1888). The Ute Removal Act of 1880 relocated the tribes to Utah and southwest Colorado and opened northwestern Colorado for Euro-American settlement. An early example of an investor-financed project was the Larimer and Weld Canal. Benjamin Eaton proposed it in 1878 as an extension of Larimer County Ditch No. 10, which watered the north side of the Poudre Valley at Fort Collins. Ditch No.10 was begun in 1864, and had been enlarged three times, most recently by Eaton himself in 1875. Eaton then went on to complete the Greeley No.2 Canal, and he saw that if Larimer No. 10 could be extended at its elevation for 50 miles all the way from Fort Collins to Greeley, it would water up to 50,000 acres of benchlands above Greeley No. 2. Much of this was land of the Denver Pacific Railway, which had been granted from the public domain as a subsidy for building the line. Eaton approached the railroad as a partner, and they secured financing from the Colorado Mortgage and Investment Company. Known locally as "The English Company," this was an outlet for British investment capital, with James Duff as its Denver representative. E. S. Nettleton surveyed and engineered the canal. It was so much bigger than anything yet constructed that its promoters seriously considered using it for navigation as well as irrigation. Up to 100 men worked on its construction, moving along in a camp with their animals and equipment, completing its full length by 1881.[40]

The High Line Canal near Denver was built as another English Company project. It had been proposed in 1876 as a means of developing Kansas Pacific Railroad lands, but that effort failed through undercapitalization. By 1879 the Kansas Pacific was in merger talks with Jay Gould's Union Pacific.

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[39] McKinnon, A Hundred Years of Irrigation in Colorado, 34.
[40] Norris, *Written in Water,* 119-29; Cultural resource inventory forms 5WL842 and 5LR863 (Eaton Ditch/ Larimer and Weld Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

Gould sought out James Duff, who agreed to buy 120,000 acres of Kansas Pacific's land, and incorporated the Northern Colorado Irrigation Company to build a canal serving it. Duff engaged Nettleton as engineer, and construction — some of it by Eaton — began as soon as the railroad merger was completed in 1880. The High Line reached forty-four miles to Cherry Creek by 1882 and was completed in 1883 to its full length of more than seventy miles, then the longest canal in Colorado. It cost $652,000, including an expensive tunnel and flumes to take its water high enough in Platte Canyon for all the land it was meant to serve.[41]

Like the Larimer and Weld, many investor canals were physical extensions of existing mutual ditches. For example, the Farmers High Line in Jefferson County began in 1886 by acquiring the Golden Canal, which dated at least to 1862 and perhaps 1859.

The Havemeyer-Willcox Canal west of Rifle was developed beginning in 1902 as an extension of the 1893 Henry Hallett Canal. Commercial canals included not just new construction but also consolidation and reconfiguration of earlier ditches as more efficient systems.[42] In this, canal investments paralleled those in railroads and public utilities.

Investor canals were considerably more expensive than pioneer ditches, even on a per-acre basis. Settlers had already brought water to the lands that were easy to irrigate. The commercial canal business model could anticipate revenues from three sources: annual fees for water carriage to cover operating expenses; payments from each irrigator upon connection to the system (opponents called these "royalties"), covering the company's capital investment; and profits from land sales where the promoters owned or had optioned lands under the canal. Royalties and fees were the equivalents of capital and operating costs for mutual ditches, but irrigators found them more distasteful when imposed by profit- seeking investors. A populist backlash was reinforced when the investors were out-of- state or foreign. The English Company was the most conspicuous example, but not the only one. The Earl of Airlie and his son, Lord Ogilvie, with Abner S. Baker constructed Ogilvie Ditch near Greeley and developed other projects in the San Luis Valley. The Grass Valley Land and Water Corporation, near Silt, was also English- financed.[43] Carriage fees were regulated (under an 1861 territorial act) by county commissioners, who often allowed only the barest costs without much room for profits or even maintenance. The Colorado legislature outlawed royalties in 1887, and the state Supreme Court upheld the act the following year. In addition, land sales, even when successful, were a onetime source of profits.[44]

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[41] FRASERdesign, "High Line: Historic American Engineering Record Documentation of the High Line Canal," (HAER CO-43); Pabor, *Colorado as an Agricultural State*. 15; Steinel. *History of Agriculture in Colorado*, 204; Norris, *Written in Water*. 140.

[42] Silkensen, *Farmers' High Line*, 7-9; Cultural resource inventory form 5GF654 (Havemeyer- Willcox Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Don Davidson, "The Grand River Ditch: A Short History of Pioneering Irrigation in Colorado's Grand Valley." *Journal of the Western Slope* 1:4 (Winter 1986): 1-30; State Engineer, *Biennial Report, 1889-90*, 47.

[43] J. M. Dille, *Irrigation in Morgan County* (Fort Morgan: [Farmers State Bank], 1960), 17; Toni Rae Linenberger, *The Silt Project: Participating Project, Colorado River Storage Project* (Denver: Bureau of Reclamation History Program, 1997).

[44] *Wheeler v. The Northern Colorado Irrigation Company* (10 Colo. 582); Roger Clements, "British-controlled Enterprise in the West Between 1870 and 1900, and Some Agrarian Reactions," *Agricultural History* 27 (1953): 132-41.

Land sales and outside investment succeeded in getting many canals built, but they quickly foundered on a scarcity of water and an abundance of maintenance costs. Colorado's system of water rights protected the vested interests of those who came first; most commercial canals, especially on the Eastern Slope, were relative latecomers with junior appropriations. Pioneer ditches had fully appropriated the normal stream flow. Commercial canals might attempt to overcome this problem by absorbing earlier ditches into their systems, or buying some of their senior water rights. Sometimes this made water available through increased efficiency, but it also led to squabbles among users and a continuing drain of resources into legal costs.

Investors also hoped that the exaggerated quantities of early appropriations could be reduced through more accurate measurement and accounting. However, earlier ditch companies proved unexpectedly adept at defending their water rights.[45]

These new systems required reservoir storage, a fact that some canal developers understood and many apparently did not. Few recognized the magnitude of the task. Even Ferdinand V. Hayden, who between 1873 and 1876 surveyed reservoir sites for the federal government, thought that the necessity for using reservoirs was "far in the future."[46] Systems initiated before 1888 discovered the problem in the drought of that year. The Northern Colorado Irrigation Company had sold 31,000 acres of land with High Line Canal water rights (and 30,000 without), but at best delivered enough for 25,000 acres, and in 1889 delivered only enough for 7500 acres. Water users successfully sued both the High Line and the Larimer and Weld for supplies inadequate to their obligations. Both eventually developed reservoirs. In the 1890s Eaton built Windsor Lake, and other irrigators built Terry Lake and Timnath Reservoir. On the High Line, a number of competing efforts to develop reservoir storage began in the 1880s, and finally produced Antero Reservoir, constructed from 1907 to 1909 near the South Platte's headwaters in South Park. The Antero Company then purchased the High Line Canal the following year.[47]

After water supply, the second biggest financial consideration was maintenance. Commercial canals generally were better engineered, and better constructed, than the early pioneer canals. This did not mean, however, that they worked flawlessly, and ongoing problems could overwhelm their finances. The High Line, despite Nettleton's growing expertise, suffered from erosion due to excessive grade and sharp curves. Its wooden flumes and siphons quickly deteriorated under the pounding from fast-moving sediment-laden water. Its physical capacity was less than half its 1184 cubic feet per second (cfs) appropriation, and by 1907 its water right was reduced to 570 cfs. Because commercial canals were based in the cash economy, they could be vulnerable to a drying up of investment capital. For example,

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45 "The High Line, or English, Ditch May Go Dry Shortly," *Denver Times*. 26 May 1902, quoted in HAER CO-43:20 n. 62: "A profound mistake was made in not first ascertaining that the water of the Platte River was all appropriated. In order to help the ditch after construction, the legislature passed a law requiring that old ditch owners affirmatively prove their original appropriation quantities when making claims to an indefinite amount of water. It was expected by the friends of the ditch company, and by the owners of the land under the ditch, that these old ditch owners would fail to prove the appropriation of three-quarters of the water they claimed, thus leaving enough water unappropriated to adequately supply the English ditch. However, contrary to expectations the old-timers proved that the entire river was theirs. Logically, not a drop of water was left for the ditch." See also Silkensen, *Farmers' High Line*; Mead, *Irrigation Institutions*.

46 Quoted in Steinel, *History of Agriculture in Colorado*, 196.

47 "Highline Extension Canal (Doherty Ditch)" HAER CO-67: 5; HAER CO-43:11-14; James E. Sherow, "Watering the Plains: An Early History of Denver's Highline Canal," *Colorado Heritage* 1988 (4): 2-13; Noms, *Written in Water*, 197-202

by the time the Havemeyer-Willcox Canal system opened in May 1912, it cost $425,000. When Colorado River floods damaged its head gate one month later, its New York backers decided not to repair it but to write off the whole investment.[48]

Because of flaws in the business model and problems with water supplies and maintenance, few if any canals made money for their investors. Canal promoters and investors accomplished a great deal for Colorado, if not for themselves. Construction of these great canal and reservoir systems was itself a significant industry and a significant part of the economy. Most systems were eventually taken over by their users — some through mutual ditch companies, and after 1901, through irrigation districts (see below). Most remain in use, often with supplemental storage through reservoirs constructed later or through additional resources from Bureau of Reclamation projects.

Commercial canal and reservoir systems enabled the establishment and growth of the sugar beet industry in Colorado. When wheat prices plummeted in the 1890s, Colorado farmers shifted to producing beets. The systems were sometimes built or expanded in conjunction with sugar enterprises. The legislature, the Colorado Agricultural College (now CSU), and others beginning in territorial days had pushed for development of a sugar beet industry. The first sugar beet plant in Colorado, developed by Charles Boettcher and John Campion, opened in 1899 in Grand Junction. They and others quickly followed with plants in the Arkansas, South Platte, and San Luis Valleys, making Colorado the leading beet-sugar state in the U.S. fifteen years later. Sugar beets required late-season irrigation that became possible through development of reservoirs in the 1890s. The expanding beet industry in turn led to more reservoir construction. The sugar industry sometimes backed reservoirs and canal improvements that served their plants. The Havemeyer-Willcox Canal, for example, expanded a ditch developed for fruit orchards with financing from the Havemeyer Sugar Company of New York.[49] Sugar beet plants also needed water for industrial processing — nineteen gallons per pound of refined sugar — that became another water delivery purpose for canals.[50]

The next few pages will examine major commercial canals and canal systems around Colorado by region. One individual–Theodore C. Henry–whose activities encompassed most regions of the state, ultimately earned the moniker "Irrigation King of Colorado." T. C. Henry arrived in Colorado from Kansas, where he was known as the "Wheat King" for his role in introducing winter wheat there. In 1883 he set up the Colorado Load and Investment Company, with backing from the Travelers Insurance Company of Hartford, Connecticut. He invested in the Uncompahgre Canal Company near Montrose, the Grand River Ditch Company near Grand Junction (now the Grand Valley Canal), and the Del Norte Ditch (now the Rio Grande Canal) and Citizens Canal in the San Luis Valley. Each of these four systems was then under construction. They quickly ran over budget and required additional capital from Travelers. The insurance company's board sent more money but also sent representatives who

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[48] HAER CO-43: 8; Cultural resource inventory form 5GF654 (Havemeyer- Willcox Canal).

[49] Joseph E. King, *Colorado Engineering Context* (Denver: Colorado Historical Society, 1984), 172-77; Steinel, *History of Agriculture in Colorado*, 281-308; Dena S. Markoff, "The Sugar Industry in the Arkansas River Valley: National Beet Sugar Company," *Colorado Magazine* 55: 1 (1978),69-92; Whitacre and Simmons, *Historic Farms and Ranches of Weld County*, 10-12; Mehls, *Colorado Plains Historic Context*, 97-103; Carter and Mehls, *Southern Frontier*, 11-123-24; James E. Sherow, *Watering the Valley: Development Along the High Plains Arkansas River Valley, 1870-1950* (Lawrence: University Press of Kansas, 1990), 14-17; Cultural resource inventory form 5GF654 (Havemeyer- Willcox Canal).

[50] Markoff, "The Sugar Industry in the Arkansas River Valley," 78.

tried to push Henry out of the projects. By 1885 they were in court, and they stayed there for years. Travelers finally sold its Colorado canals in 1892.[51]

Meanwhile, Henry found Colorado and Kansas backers for a new venture in the Arkansas Valley. The Arkansas River Land, Town, and Canal Company Ditch had been built beginning in 1883, diverting water on the north side of the Arkansas just west of La Junta and running about 20 miles by 1886. Henry incorporated the Fort Lyon Canal Company to extend it all the way to the Kansas line, which would make it the longest irrigation canal in the country. By 1890 it was completed to 113 miles in length, meant to irrigate over 40,000 acres. But the flow of the Arkansas, and the junior appropriations that made up most of the Fort Lyon water rights, were not adequate to supply such extensive acreage. Henry's investors, as well as the Fort Lyon water users, fought him in court until the users finally achieved control of the system in 1903. Henry envisioned solving the water shortage with reservoirs to catch the flood waters of the Arkansas, and "highline" canals watering up to a million acres on each side of the river. He began the Bob Creek Canal, above Fort Lyon, in 1889 (it was later called Twin Lakes Canal, and is now known as the Colorado Canal). Even as the Fort Lyon Canal was spinning out of his control, Henry optioned thousands of acres of state lands and sold water rights far to the east, with a promise of delivery in time for spring planting. After the turn of the century he proposed equally ambitious plans for the South Platte Valley, to take water through a tunnel from the Western Slope, but by this time investors had downgraded his schemes from highly speculative bonds to swindles.[52]

Henry died in 1914, largely discredited and financially ruined. His few remaining funds were all invested in canal company bonds — he was a true believer. Almost all of Henry's canals remain in operation today, mostly through the efforts of successors who completed the storage and other corrections to make the systems work.

**Government Systems and the Modern Period (1875-present)**

"Almost everything that could be done to rivers with limited funds, on local capital, had been done by the last decade of the [nineteenth] century," writes Donald Worster. "What was required next, if the state was to escape from its plateau of water development, was to find the money to buy more advanced engineering."[53] Between the 1880s and the twentieth century, in Karl Wittfogel's (noted cultural theorist) terminology, irrigation in Colorado moved from the "local subsistence mode" to the "capitalist state mode," in which government and the private sector together accomplished hydraulic control on an unprecedented scale. This new phase was well underway by the time of investor-financed canals in the 1880s. The financial failure or difficulties of every such enterprise showed the limits of private capital in further developing Colorado's water resources, and led to demands for government action.

Federal aid for irrigation development was on the agenda of Colorado's boosters at least since 1864, when William N. Byers' *Rocky Mountain News* called on Congress to encourage canal building, as it did

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[51] James E. Sherow, 'Marketplace Agricultural Reform: T. C. Henry and the Irrigation Crusade in Colorado, 1883-1914.' *Journal of the West* (October 1992), 51-58.

[52] Sherow, *"Marketplace Agricultural Reform"*; Sherow, *Watering the Valley*, 17-20; Joseph O. Van Hook, "Development of Irrigation in the Arkansas Valley," *Colorado Magazine* 10 (1933): 10-11; Cultural resource inventory form 5CW.51 (Lake Meredith), Office of Archaeology and Historic Preservation, Colorado Historical Society.

[53] Worster, *Rivers of Empire*, 110.

railroad building, through grants of public land. In 1873, President Ulysses S. Grant endorsed the booster fantasy of a canal from Denver to the Missouri River, and proposed federal land grants to get it built (the High Line Canal descended from this scheme, watering railroad land grants rather than any newly created land grants).[54]

The Desert Land Act of 1877 was an effort at encouraging private irrigation efforts, authorizing the sale of up to 640 acres of arid lands to individuals provided that the land be irrigated within three years. The original legislation did not apply to Colorado. It was in any case ill-suited to the realities of irrigation — far too much land to work as an irrigated farm, not enough land to build a ditch system. After years in which the Act was used more by cattlemen and speculators than by irrigators, Congress in 1891 reduced the acreage to 320, but allowed farmers in groups to make larger claims together, and at this time extended it to Colorado. The results were still disappointing.[55] Around the West, advocates of government-sponsored irrigation turned their attention from the federal level to the states, including Colorado.

*State Irrigation Projects (1889-1901)*

Colorado Governor Alva Adams convened a "Reservoir Convention" in 1888 that recommended that the federal government build reservoirs and canals. When Congress took no action, the state legislature in 1889 appropriated funds for several reservoir and canal projects. State Engineer J. P. Maxwell found feasible only one of them, which proceeded as State Canal No.1, to be constructed near Cañon City by local convict labor, diverting water from the Arkansas River after it left the Royal Gorge. Maxwell laid out a canal 30 miles long, designed to irrigate 27,000 acres of state land, and work began in 1890. The 1891 legislature authorized several reservoirs around the state, as well as a State Canal No.2, to take water from the Colorado and irrigate the Grand Valley from a high elevation. State Canal No.1 continued slowly and costs mounted to $200,000 with no end in sight. By 1895 a few small reservoirs had been built but the canals had not.[56]

Agitation for federal action grew in the 1890s. A drought depopulated some of the Great Plains. The Populist reaction against perceived exploitation by commercial canal-builders won significant victories in the late 1880s, but that together with the national depression of 1893 drove investors away from irrigation.[57] Colorado's experiments with state-financed irrigation were not encouraging. The state was financially no more capable than private capital. Colorado and other western states needed a new model of irrigation development, and increasingly looked to the national government. Congress in 1894 passed the Carey Act, which provided for grants of federal lands to states for state or private irrigation projects. The experiment was not taken up as widely as expected, and despite being successful in both Idaho and Wyoming, it was little used in Colorado. By the time the U.S. Reclamation Service was founded in 1902, no lands had yet been patented under the Carey Act in Colorado. By 1917, Colorado had patented 11,511 acres, the smallest total of any of the six participating states.[58]

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[54] Steinel, *History of Agriculture in Colorado,* 190-91.

[55] Brookings Institution, *The U. S. Reclamation Service: Its History. Activities and Organization* (New York, 1919): 4; Worster, *Rivers of Empire,* 156-57.

[56] State Engineer, *Biennial Report, 1889-90,* 613-14; Donald A. MacKendrick, "Before the Newlands Act: State-sponsored Reclamation Projects in Colorado, 1888-1903," *Colorado Magazine* 52: I (1975): 1-21.

[57] Worster, Rivers of Empire, 131. Steinel, History of Agriculture in Colorado. 208-09.

[58] Brookings Institution, *The U. S. Reclamation Service,* 6.

Colorado tried one more irrigation venture, the Uncompahgre valley project that was to take its water through a tunnel from the Gunnison River canyon. State Canal No.3 began in 1901 with a $25,000 appropriation, and was meant to be otherwise self-financing. By the end of the year a route was surveyed for a 3-mile tunnel feeding a 12-mile ditch to the Uncompahgre River, and construction began with an estimate of $1.5 million to complete. The project was abandoned within a year, after building 900 feet of tunnel. Private funding had dried up, partly because of early indications that the new U.S. Reclamation Service might take over the project, and ultimately they did take over and complete the project.[59]

*Irrigation Districts (1901-present)*
Irrigation districts were a financing and management mechanism pioneered by Utah in 1865 and adopted in California in 1887. In 1901, the Colorado General Assembly passed a District Irrigation Law. Irrigation districts could be organized by a majority of landowners within their boundaries, with acquisitions and construction financed through bonds paid off by assessments on all irrigated lands in the district.[60] Within a decade, one or more irrigation districts had been organized in most regions of Colorado. They were a means of organizing user takeover of canal systems at a scale commensurate with large commercial operations, and of financing their completion through bonds. In some places districts were organized to build reservoirs independently of ongoing commercial operations that had failed to provide them. Irrigation districts became a vehicle for developers of new commercial systems to finance portions of their works through public-private partnerships.

Some of the first irrigation districts were in the South Platte Valley, including the Fort Morgan (1903), Hillrose (1903), Riverside (1904), and Bijou (1905) districts. D. A. Camfield was an active organizer, and sold district bonds to eastern investors. The Hillrose district included 11,000 acres under the Lower Platte and Beaver Ditch in Morgan and Washington counties, organized to finance the purchase of shares in Jackson Lake Reservoir. The Bijou district took over the partially-constructed Bijou Canal and brought the project to completion. The Riverside district constructed the Riverside Canal in 1907-08. The district found itself in financial difficulties because its ambitious storage and distribution system suffered heavy losses to seepage and evaporation, and it was unable to serve the whole area except in years when water was plentiful enough to allow a late spring refill of the reservoir.[61] The Hillrose, Bijou, and Riverside districts continue in operation.

Farther up the South Platte, High Line Canal irrigators between 1903 and 1907 made an unsuccessful effort to organize an irrigation district to build reservoirs. The Henrylyn Irrigation District was incorporated in 1907 by Clarence M. Ireland to irrigate 100,000 acres of South Platte lands downstream from the High Line by diverting water from the Western Slope — the plan later adopted by the Denver Water Department as the Jones Pass Tunnel. The Henrylyn district succeeded in constructing a canal and reservoir system within the South Platte Valley, part of which it operates today jointly with the Farmers Reservoir and Irrigation Company. On the Western Slope, Arthur and Raymond Havemeyer

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59 MacKendrick, "Before the Newlands Act," 18-20.
60 Radosevich et al, *Evolution and Administration of Colorado Water Law*, 162-63; Gordon M. Bakken, "The Development of Law in Colorado, 1861-1912," *Colorado Magazine* 53:1 (1976): 63-78; Mead, *Irrigation Institutions*; Worster, *Rivers of Empire*, 108, 139, 215. Dille, *Irrigation in Morgan County*, 25.
61 Dille, *Irrigation in Morgan County*, 15, 26, 33-39; Cultural resource inventory form 5MR.563 (Riverside Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

established the Grand Valley Irrigation District in 1909 to develop the Willcox-Havemeyer canal system.[62]

The Greeley-Poudre Irrigation District contributed to the evolution of western water law, but not in the way its promoters might have hoped. The district was formed in 1911 to irrigate 125,000 acres north of Greeley by diverting water to the Poudre River through a tunnel from the headwaters of the Laramie River. The plan could only work by ignoring the rights of irrigators downstream in Wyoming. The U.S. Supreme Court in 1922 decided in *Wyoming v. Colorado* that those rights could not be ignored, establishing that prior appropriation applied across state lines. Most of the new towns and farms in the Greeley-Poudre district were eventually abandoned; some areas continue in use with water from the later Colorado-Big Thompson project.[63] In 1921, Colorado's irrigation district law was amended to require that new irrigation districts submit a plan, the feasibility of which would be evaluated by the state engineer. As of 2003, sixteen irrigation districts continue operating in Colorado.[64]

*Bureau of Reclamation (1902-1976)*

The National Reclamation Act of 1902, known as the Newlands Act for its sponsor, U.S. Representative Francis Newlands of Nevada, began a new era for western irrigation. Historian Donald Worster has called it "the most important single piece of legislation in the history of the West, overshadowing even the Homestead Act in the consequences it has had for the region's life."[65] The Reclamation Service (renamed the Bureau of Reclamation in 1923) built reservoirs, hydroelectric plants, and canal systems throughout the western states. They were financed by the federal government, with their costs to be repaid by users interest-free, and to then be turned over to user-organized irrigation districts.

<u>Uncompahgre Project</u>

One of the first five projects selected in the country was the Uncompahgre project (the Reclamation Service originally called it the Gunnison Project), already begun but unable to be completed by the State of Colorado.[66] Construction, suspended by the state in 1902, was authorized by the Reclamation Service in 1903 and resumed in 1905 with a $2.5 million budget. The original tunnel alignment proved impractical and a new location was selected for a six-mile-long tunnel. By 1906, its west portal was a temporary town with a population of 800. President William Howard Taft opened the Gunnison Tunnel,

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[62] HAER *CO-43:* 13; HAER *CO-67:* 7-8; Cultural resource inventory forms 5AM.517 (Denver Hudson Canal) and 5GF654 (Havemeyer- Willcox Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Everett Kissler, "Whiskey's Fer Drinkin', Water's For Fightin'" Colorado Water Conservation Board: *Educational Resource Guide* (2000), compact disc.

[63] Steven L. Scott, "Abandonment in the Greeley-Poudre Irrigation District," 24-29.

[64] Radosevich et al, *Evolution and Administration of Colorado Water Law,* 162-63; Data from the Colorado Department of Local Affairs: Bijou Irrigation District (Morgan and Weld counties), Henrylyn Irrigation District (Weld), Hillrose Irrigation District (Morgan, Washington), Iliff Irrigation District (Logan), Julesburg Irrigation District (Sedgwick), Logan Irrigation District (Logan), Maybell Irrigation District (Moffat), Mesa County Irrigation District (Mesa), North Sterling Irrigation District (Logan), Orchard City Irrigation District (Delta), Orchard Mesa Irrigation District (Mesa), Palisade Irrigation District (Mesa), Pine River Irrigation District (Archuleta, La Plata), Pioneer Irrigation District (Yuma), Riverside Irrigation District (Morgan, Weld), San Luis Valley Irrigation District (Alamosa, Rio Grande, Saguache)

[65] Worster, *Rivers of Empire,* 130-31.

[66] David Clark and William Joe Simonds, "The Uncompahgre Project," Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, 1994); MacKendrick, "Before the Newlands Act," 18-20.

the longest irrigation tunnel in the world, in 1909. Before the project began, the Uncompahgre Valley contained 110 ditches, totaling 405 miles. The Reclamation Service set out to buy them in order to unify the system. The Montrose and Delta Canal, purchased in 1908 for $110,000, became the first canal operated by the Reclamation Service. The Gunnison Diversion Dam was completed in 1912. By 1925, the whole system-including coordination and improvement of the valley's ditch distribution system — was largely completed, at cost of $6.8 million.[67] The project was transferred from the federal government to the Uncompahgre Valley Water Users Association in 1932.

Grand Valley Project

The Grand Valley project was the second Colorado project among the first six selected by the Reclamation Service. It was originally proposed and surveyed in 1897 as a commercial initiative. The Reclamation project was put on hold while private investors considered reviving it, but when this avenue proved unlikely, the Reclamation Service approved the project in 1907. Construction began in 1912, with the first deliveries of water in 1915 and the project completed in 1917. It included a low (14-foot) diversion dam in the Colorado River upstream from Palisade, and a new Government High Line Canal, fifty-five miles long, above the 1880s canals on the north side of the Grand Valley. The project also delivers water through a siphon under the Colorado River to Orchard Mesa Canals numbers 1 and 2 on the south side of the river. This phase, completed in 1924, accommodated a competing project being pursued by the Orchard Mesa Irrigation District.[68]

Colorado-Big Thompson

The Colorado-Big Thompson project, authorized in 1935, was among the biggest, most complex Reclamation projects anywhere. It does not include any single great dam, but gathers water through an extensive collection system in the upper Colorado River Valley, brings it under Rocky Mountain National Park to the Eastern Slope, and distributes it through an extensive system of canals and sixty reservoirs from Boulder nearly to Wyoming, from the Front Range foothills all the way to the Nebraska state line. The project serves 720,000 acres and 400,000 people and spans 250 miles west to east and 65 miles north to south. Drilling began in 1940 on the thirteen-mile Alva Adams tunnel; it was completed in 1947. The whole project was finished by 1959.[69]

Other Reclamation Projects

The Bureau of Reclamation began work on several other projects in the 1930s: Pine River, authorized 1936 and constructed 1937-41; Fruitgrowers Dam, authorized and constructed on an emergency basis by the Works Progress Administration (WPA) in 1938 to replace a dam that failed in 1937; Mancos, authorized in 1939 and constructed first by the Civilian Conservation Corps (CCC) and WPA, then as a Conscientious Objector camp during the Second World War, and finally completed by contractors between 1947 and 1949. Adding onto the *acequia* and colony systems already in place, the San Luis

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[67] "Historic Canals on the Bureau of Reclamation's Uncompahgre Project," Official Determination of Eligibility (1983); MacKendrick, "Before the Newlands Act."

[68] William Joe Simonds, "The Grand Valley Project," Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, 1994).

[69] Robert Autobee, "Colorado-Big Thompson Project," Bureau of Reclamation History Program Research on Historic Reclamation Projects (Denver, CO: U.S. Bureau of Reclamation, 1996); Tyler, *The Last Water Hole in the West;* Rocky Mountain National Park Multiple Properties Nomination (1988), 36-37.

Valley project was authorized in 1939, but construction of Platoro Dam began in 1949 and was completed in 1952.[70]

Also during the 1930s, Reclamation carried out investigations into a number of potential projects in Colorado, some of which were realized decades later. The first were the Paonia project (authorized in 1947 and its first phase completed in 1953), and Collbran (Vega Reservoir), authorized in 1952, and constructed from1957 to1961. In 1956, Congress authorized the mammoth Colorado River Storage Project (CRSP), which bundled together reservoirs throughout the upper Colorado River basin so that hydroelectric generation at some of the large dams could help subsidize construction of storage elsewhere. In Colorado it included the Wayne N. Aspinall Storage Unit on the Gunnison River, consisting of the Blue Mesa Dam (constructed 1962-66), Morrow Point Dam (constructed 1963-68), and Crystal Dam (constructed 1973-76). Among the other participating projects were Aorida (constructed 1959-62), Smith Fork (constructed 1960-62), Silt (constructed 1964-68), Bostwick Park (constructed 1966- 72), and an enlargement of the Paonia project (constructed 1959-62). Congress enlarged the CRSP in 1962 to include the San Juan-Chama project in Colorado and New Mexico, and in 1968 to include the Dolores, Dallas Creek, and Animas-La Plata projects.[71]

The most important of the new projects outside the CRSP is the Fryingpan-Arkansas ("Fry-Ark"), supplementing both agricultural and urban supplies in the Arkansas River Valley. This too resulted from Reclamation studies carried out in the 1930s, but was not authorized until 1962.[72] Reclamation projects often served to correct the water supply deficiencies of earlier canal systems. Most dramatically, the Fruitgrowers Dam project northeast of Delta in 1938 rebuilt a dam originally constructed in 1898 by the Fruit Growers Ditch and Reservoir Company and then enlarged several times before failing in 1937. For a more typical example, the Riverside Irrigation District north of Fort Morgan early sought Colorado-Big Thompson water to remedy its shortages from leakage and evaporation.[73]

Other federal programs affected ditches and canals, particularly during the New Deal era in the 1930s. The Public Works Administration (PWA) financed Denver's completion of the Moffat Tunnel, built some reservoirs, and surveyed sites for others.[74] The PWA's successor, the Works Progress Administration, rebuilt parts of ditch systems, covered ditches in some urban settings (particularly City Ditch in Denver), and built many bridges. The Federal Relief Administration, through the San Luis Valley Project, built drainage ditches in low-lying parts of the valley and rebuilt irrigation laterals there. The Soil Conservation Service assisted ditch companies and individual farmers with designs for improving

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[70] William Joe Simonds, "The Pine River Project" (1994); Simonds, "The Fruitgrowers Dam Project" (1994); Eric A. Stene, "The Mancos Project" (1994); William Joe Simonds, "San Luis Valley Project" (1994). All in the series: Bureau of Reclamation (Denver) History Program Research on Historic Reclamation Projects.

[71] Thomas Latousek "The Paonia Project" (1995); Toni Rae Linenberger, "The Coli bran Project" (1997); Robert Autobee, "The Florida Project" (1995); Thomas Latousek, "The Smith Fork Project" (1995); Toni Rae Linenberger, "The Silt Project" (1997); Linenberger, "Bostwick Park Project" (1999); William Joe Simonds, "Dallas Creek Project" (1999). All in the series: Bureau of Reclamation (Denver) History Program Research on Historic Reclamation Projects. See also Bureau of Reclamation (Denver), "Animas-La Plata Project Chronology of Events" (2002).

[72] Carter and Mehls. *Southern Frontier*, 11-117.

[73] Tyler, *The Last Water Hole in the West;* Dille, *Irrigation in Morgan County,* 33-39.

[74] Paul William Turelli, "Denver's Water Supply: From City Ditch to Two Forks" (Denver: University of Colorado History masters thesis, 1991), 17; Husband, *Plateau Country Historic Context,* 104; Autobee, "Florida Project."

irrigation structures. The Rural Electrification Administration provided a new power source for farm irrigation from wells rather than ditches.[75]

*Municipal Systems (1875-present)*
Ditches also delivered water for a variety of non-agricultural purposes, and many Coloradans experienced ditches as part of the urban landscape. Denver had at one time 1100 miles of street laterals carrying water for a variety of urban purposes in addition to urban agriculture such as vegetable gardens and livestock. Most Colorado cities and towns had similar systems. Just as on the farm, the ditch was often the first urban infrastructure to be completed. Eaton, Colorado, at its beginnings had "newly plowed ditches marking both sides of cactus- covered streets."[76]

William E. Pabor described Greeley in 1883:

> The waters flow through the streets of Greeley, furnishing the inhabitants with water for house hold purposes as well as for the irrigation of trees that line each street, and the flowers that bloom so profusely about the houses. Greeley has been termed the Garden Town of Colorado because of the multitude of gardens within its limits, and the Forest City on account of the trees that abound in it.[77]

This was the place that Union colonists had encountered just thirteen years earlier as a treeless and barren plain. One of the most important roles of urban ditches was the creation of a cultural landscape that fit the expectations of migrants from the humid, green East. Benjamin Eaton transplanted cottonwoods to streets in Eaton, Colorado, in 1881 even before houses went up.[78] Street laterals also served as dust control, very important for unpaved streets, and as a source of water for firefighting.

Ditches provided domestic water supply in town as on the farm. The Pacific Slope Ditch was Grand Junction's first source of domestic water, delivered through street laterals running east and west from a main lateral flowing south down Seventh Street. Households might use a well for human consumption, especially where the purity of ditch water was in doubt, but the depth of the well and the weight of the bucket made ditches attractive sources of water for other household uses.[79] Even as cities and towns installed municipal systems of treated water, street laterals remained as a secondary distribution system for untreated water. The arrangement continues today in many places, mainly for urban irrigation.

Industrial power and water processing are a relatively small but sometimes important use of ditch water. Grist mills were essential to the viability of early settlement. The successor to mechanized waterpower is hydroelectric generation, which relies on the same inputs–the volume of water, the ability to control it, and the height (or "head") of its fall–but can transmit its output over great distances to be used where convenient. This makes the power more valuable. Littleton's Rough and Ready Mill took the unused section of City Ditch as its power canal. Boulder's Yount Mill ran from a flume off Farmers

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[75] "San Luis Valley Resettlement Project" *San Luis Historian* 21: 2 (1989); Dille, *Irrigation in Morgan County*, 50.
[76] Norris, *Written in Water*, 150.
[77] Pabor, *Colorado as an Agricultural State*, 77.
[78] Norris, *Written in Water*, 112; Pauline Allison, "The Founding and Early Years of Eaton, Colorado," *Colorado Magazine* (1941), 57.
[79] Davidson, "Grand River Ditch," 3; District 6 Water Adjudication case no. 4842, Evidence and Abstract Book 2 (1904), in Boulder Carnegie Library.

Ditch. Drops on ditches could be planned for water power potential rather than as protective features only. An example was the Pioneer Extension Ditch in Grand Junction, designed as a major industrial power source, though its big water-powered mills were never developed.[80] The Bureau of Reclamation early learned that it could finance the irrigation, flood control, and recreation branches of its mission with "cash-register" hydroelectric dams.

Urban interactions with ditches went beyond the use of water to include problems and opportunities as it was conveyed through the city. Hazards of drowning and flooding led to periodic campaigns to fence or pipe ditches in towns. These efforts did not accomplish much statewide, because of the extraordinary expense, but they had effects in particular localities, most notably in getting the majority of Denver's City Ditch put underground. Irrigators were often sympathetic with these goals, because of what they saw as the urban issues of water quality and service disruptions from town residents dumping trash in or otherwise interfering with the ditch. However, irrigators and town residents typically did not agree who should pay for the fences and pipes.

While some townspeople saw ditches as hazards, others saw amenities. At the largest scale, they could become an element of urban design, as in Denver where City Ditch was incorporated as a median canal in the Marion Street Parkway. Frederick Law Olmsted, Jr., in 1910 proposed a "Beasley Ditch Parkway" in Boulder.[81] Ditches provided the opportunity for ornamental bridges in Rocky Ford and many other towns. Photographer "Rocky Mountain Joe" Sturtevant used a ditch lateral to create the "Boulder Cascade" as a backdrop for his portraits.

Nor were ditches as amenities a merely urban phenomenon. At McGraw Ranch, now part of Rocky Mountain National Park, the owners rebuilt the ranch ditch to serve as a "babbling brook" for dude ranch cabins.[82] Many ditches in every part of the state have elicited expressions of folk art — footbridges, benches and adornments, ornamental water wheels and other flights of whimsy. This folk art is a rich vein of expressive material culture.

Municipal water systems are the most important non-agricultural use of water in Colorado. They figure in the history of Colorado's ditches in three main ways. First, most municipal systems began by cities buying into or taking over existing ditches. In several cases cities and ditch companies have co-developed reservoir or distribution systems, as the companies had reservoir sites and the cities had money. Second, cities built their own systems, some of them moving water through canals. Finally, municipalities have come to hold the fate of historic ditches in their hands, by dewatering them through water transfers, but also sometimes by preserving them through open space programs.

The earliest, biggest, most important municipal system belongs to Denver. The city bought Smith's Ditch — thereafter called City Ditch — in 1875. The growing city continued to develop its water supply through a succession of competing private companies, consolidated in 1892 as the Denver Union Water Company, with Walter Cheesman as president. The company built Cheesman Reservoir on the South Platte from 1900-1905. After Cheesman died in 1907, Mayor Robert Speer sought city purchase of the company, finally accomplished in 1918 with the creation of the Denver Water Department. The

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[80] Steinel, *History of Agriculture in Colorado;* Davidson, "Grand River Ditch," 3, 10.
[81] Frederick Law Olmsted, Jr. The Improvement of Boulder. Colorado. Report to the City Improvement Association (1910).
[82] Cultural resource inventory form 5LR.1131.26 (McGraw Ranch Ditch System), Office of Archaeology and Historic Preservation, Colorado Historical Society.

city contracted to buy the High Line and High Line Extension Canals, and the new Antero Reservoir, in 1915. After extensive litigation, Denver took possession of the High Line in 1924.[83] The Denver Water Department went on to construct an extensive network of trans-divide diversions, starting with the Moffat Tunnel, which first delivered water in 1936.

A number of other Colorado cities went through some of the same stages as Denver: early private water companies; municipalization of water supply and acquisition of local ditches (or shares in them) followed by more extensive development of new facilities later as the cities grew. Loveland, for example, bought the 1903 Eureka Ditch, a trans-divide diversion in what is now Rocky Mountain National Park, in 1914. The Big Dam west of Loveland, built in 1880 and rebuilt in 1895 for the Home Supply Ditch Company, now also supplies the Loveland Water Treatment Plant.[84]

Municipalities have contracted for water supply from Reclamation projects. In recent decades, cities have become major competitors with agricultural users for water, buying water rights and transferring them from ditches to municipal pipelines. Colorado Springs began buying water rights in South Park in the 1950s as the city's postwar growth spurt began. In the same decade the Denver Water Department faced legal difficulties over its plans to build Dillon Reservoir and the Roberts Tunnel, and for several years stopped extending water lines into suburban areas beyond a "Blue Line." This forced outer suburban communities to look for their own supplies, mainly through purchases of agricultural land or water fights that they could transfer out of the ditches. By the middle of the twentieth century, almost all of Colorado's irrigation ditches and canals had been constructed. The system continued to evolve with new Reclamation and municipal water supply projects. Ditch companies and individual irrigators refined and improved their facilities.

Many parts of the historic system have been shrinking. Irrigated agricultural lands along the Front Range, in the Grand Valley, and elsewhere are the scene of Colorado's fastest urban growth, consuming farms and their laterals, putting ditches underground and eventually doing away with them altogether. Urban water demands lead to water transfers out of irrigation ditches into municipal pipelines. Where land continues in agricultural use, some farmers have shifted to groundwater irrigation, and some who still use ditch water have replaced surface systems with pipe laterals or drip irrigation.

If parts of the water system are changing out of existence, it is also remarkable how much remains stable. Ditches that date from the first years of settlement continue to flow, sometimes through much-changed surroundings, sometimes delivering water for much different uses, but still serving vital purposes.

**Evolution of Colorado Water Law**

The early evolution of irrigation in the Greeley colony had a great impact on water law in Colorado, and much of the rest of the West. Water development requires some system of assuring who will have the right to use the water. This is important even in an ordinary year, but critically important in a drought. Colorado developed its own distinctive system of water law, which became a prototype for most of the

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[83] Turelli, "Denver's Water Supply"; HAER CO-67: 9-10.

[84] Rocky Mountain National Park Multiple Resource Nomination, 30-31; Cultural resource inventory form 5LR.509 (The Big Dam), Office of Archaeology and Historic Preservation, Colorado Historical Society.

other western states. The "Colorado Doctrine" refers, in short, to prior appropriation rights together with a system of government administration.[85]

Prior appropriation is the basis of water rights in Colorado and most of the West, and is often referred to by the catchphrase: "First in time, first in right." The person who first takes water from a stream and puts it to use gains the right to continue doing so. Later arrivals may appropriate only from what remains in the stream. When the ordinary flow of a stream is fully appropriated, then newcomers must either acquire an existing right to water, or take water during high flows and build reservoirs to store it.

A water right is a property right that may be sold or inherited, and includes four dimensions:

1. A fixed quantity (in cubic feet per second);
2. A priority date, referring to the beginning of work to divert and deliver water, diligently carried to completion;
3. A "beneficial use": water must be applied, not wasted. Beneficial use must continue; non-use for a period of years will constitute abandonment, and the water will revert to the state. ("Abandonment" is a legal term, referring to relinquishment of water rights. When describing a particular unused ditch or part of a ditch system, it is best to limit description to physical conditions, avoiding any version of the word "abandoned" unless there is documentary evidence of legal abandonment.)
4. A diversion point: a water right allows water to be taken from a particular stream at a particular place. Once taken from the stream it may be delivered anywhere within a ditch system. However, the point of diversion may only be changed (in the Colorado system as it has evolved) through a court proceeding meant to ensure that other water rights are not hurt.

The first territorial legislature, in November 1861, recognized the right to build ditches to serve lands not on a stream. Prior appropriation was recognized by the territorial legislature in 1864 and the U.S. Congress in 1866.[86] These measures acknowledged what was already practice throughout the territory, and an established practice in other parts of the country such as California and Utah. However, prior appropriation departed from water rights as practiced in the East under the Riparian Doctrine in that water rights were not tied to land on the stream, or to any land at all. Prior appropriation was brought from California by Forty-niners who came to Colorado a decade later. It is a system of resource allocation that made sense to miners, by analogy from their mining claims. Like a mining claim, a water right vests in the person who takes it first. "Beneficial use" of water is analogous to the requirement that

[85] Donald J. Pisani, "Water, Land, and Law," in *West: the Limits of Public Policy, 1850-1920* (Lawrence: University Press of Kansas, 1992); Pisani, *To Reclaim a Divided West: Water, Law, and Public Policy, 1848-1902* (Albuquerque: University of New Mexico Press, 1996); Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985); Elwood Mead, *Irrigation Institutions: A Discussion of the Economic and Legal Questions Created by the Growth of Irrigated Agriculture in the West* (New York: MacMillan, 1903; reprinted New York: Amo, 1972); Robert G. Dunbar, "The Significance of the Colorado Agricultural Frontier," *Agricultural History* 34, 3 (1960): 119-25; Dunbar, "The Origins of the Colorado System of Water Right Control," *Colorado Magazine* 27 (October 1944): 241-62; Dunbar, "Water Conflicts and Controls in Colorado," *Agricultural History* 22 (July 1948): 180-86; G. E. Radosevich, K. C. Nobe, D. Allardice, and C. Kirkwood, *Evolution and Administration of Colorado Water Law: 1876-1976* (Fort Collins: Water Resources Publications, 1976).

[86] McHendrie, *A Hundred Years of Irrigation in Colorado,* 17; Colorado Territory, Laws, 1864, p. 49, cited in John T. Ganoe, "The Beginnings of Irrigation in the United States," *Mississippi Valley Historical Review* 25: I (June 1938),69; Steinel, History of Agriculture in Colorado, 221.

a mining claim be actively worked. In 1876 the new state constitution adopted the doctrine as the fundamental law of the land: "The right to divert unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose."[87]

The second basic part of the Colorado Doctrine, just as important as prior appropriation, is the state's administration of the system through a state engineer and water commissioners. The problem is that water rights, if enforceable only at the pace and through the expense of lawsuits in the courts, are not usable rights at all. This is where Greeley made its contribution. In the drought year of 1874, Greeley irrigators found that no water was reaching them because the newer Fort Collins colony ditches upstream were taking it all. Under prior appropriation the Fort Collins ditches should have been the dry ones. However, the only remedy, a lawsuit, would bring results only after crops had failed. Another approach, often advocated and occasionally put into practice, was violence. Representatives of the two communities reached a tenuous agreement to share the limited supply of water; conflict was averted by the coming of rain.[88]

Nathan Meeker in an 1874 *Greeley Tribune* editorial expressed clearly the Greeley solution: a comprehensive system of water administration to "consolidate the interests of every ditch owner and to make the river an irrigation canal, subject to such superintendence as is established on our Number Two; for by this means everyone would have his rights, the supply of water would be constant, and all would know what to depend on."[89] A second Irrigation Congress in Denver in December 1878 led to major irrigation legislation by the Colorado legislature the following year, amended and refined in 1881. It specified procedures for filing and adjudicating water rights. It created ten water districts, each with a water commissioner to administer priorities, and established the office of the state engineer to oversee the system.[90]

Subsequent development of the water rights-system refined the basic components of prior appropriation and state administration. The legislature regularized the process for appropriating water and strengthened the role of water commissioners and state engineer. An 1897 state law provided for the exchange of water between reservoirs, ditches and streams, formally recognizing and regulating a practice that had begun at least by the early 1890s. Courts and the legislature grappled with the distinction between direct flow rights and storage appropriations, eventually incorporating them into a single system. Rights to water within the state were balanced with rights in downstream states through U. S. Supreme Court decisions (starting with Kansas v. Colorado in 1907 and Wyoming v. Colorado in 1922) and interstate compacts (most importantly the Colorado River Compact of 1926).[91] More recently, Colorado has broadened the concept of beneficial use to include uses of water remaining in the stream for wildlife and for recreation. Water law remains in a contentious and lively state of evolution.

*Water Measurement*

Prior appropriation commodified water in fixed quantities and thus assumed a measurement system. It would need to include physical instruments to gauge diversions into canals and division of waters

[87] Article XVI, section 6.

[88] Norris, *Written in Water*. 116-18. Worster, *Rivers of Empire*, 93-95.

[89] Quoted in McKinnon, *A Hundred Years of Irrigation in Colorado*. 35.

[90] Worster, *Rivers of Empire*, 94-95.

[91] *Kansas v. Colorado* (185 U.S. 125); *Wyoming v. Colorado* (259 U.S. 419); Steven L. Scott, "Abandonment in the Greeley-Poudre Irrigation District," *Heritage of the Great Plains* 22:3 (1989): 24-29.

distributed by the canal, and administrative systems for gathering, recording, and taking action based upon these measurements. When the Colorado system was being formulated, such a system did not yet exist.

The state of measurement in early years was described in 1883 by William E. Pabor in *Colorado as an Agricultural State*:

> There are few farmers who, using the inch measure under pressure, know how much water they get or use, though they know how much they pay for. The grade, the size of the orifice through which the water flows, the depth and breadth of the channel, all affect the result, more or less. There is no one rule that governs all the canals in Colorado.[92]

The uncertainties of water measurement undermined Colorado's system of water rights. As Donald Worster described it, appropriators "with no accurate sense of flow dynamics or crop requirements, with only a primitive means of measurement, made immense claims, Amazonian claims, calling for more water than any ten streams could carry, enough water to sail a clipper ship across the plains."[93] Elwood Mead tallied appropriations relative to actual streamflows on South Platte tributaries in 1891: on the Poudre, 4,693 second-feet appropriated, out of a mean June streamflow of 2,900, and an August flow of 265. On Boulder Creek, 4,741 second-feet appropriated, out of a mean flow of just under 1,000 in June, and 123 in August. Comparing the decrees with measurements of ditch capacities, he found that they were frequently two to three times what could fit in the channel. Examining appropriations relative to land irrigated produced the most dramatic discrepancies; some pioneer ditches held rights between 20 and 100 times the water that could realistically be used. "Ditches," wrote Mead, "cannot divert more water than the stream carries, nor can the irrigators use more water than the ditches divert."[94] The numbers simply were not accurate. In the pioneer period the question was of limited practical import — irrigators used the water they needed and the rest remained in the stream. Few appropriations had been quantified and these quantities remained abstractions. However, in the commercial period the numbers mattered. Appropriations in excess of real use were bought and sold, becoming the subject of water speculation. Eventually the appropriations were taken out of the stream, and long-time irrigators could find themselves dry while new ditches carried supposedly senior water.[95]

These problems persisted for decades, gradually improving on two fronts. First, available measurement technology came into use, district by district and headgate by headgate. An 1889 state law required the installation of headgates and measurement devices and gave water commissioners the right to install them at the expense of irrigators. Actual implementation lagged, in some places for decades. Droughts and water conflicts were frequently the catalyst for installation of better measurement devices. Another part of this larger system (beyond the scope of the present report) was measurement of stream flows. An 1897 Colorado state law required that irrigators using the public stream to exchange waters between reservoirs and canals install measuring devices in the streams so that water commissioners could regulate their exchanges.

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[92] William E. Pabor, *Colorado as an Agricultural State: Its Farms, Fields, and Garden Lands* (New York: Orange Judd, 1883), 47.
[93] Worster, *Rivers of Empire*, 95.
[94] Mead, *Irrigation Institutions*, 150-151 (quote on ISO).
[95] Mead, *Irrigation Institutions*.

A second approach to improved water measurement was the development of better technology. This was a national and international effort, in which Colorado played a leading role. For several decades it was pursued through specialized instrumentation brought to a channel to measure flows, so that trained experts could calibrate the devices installed on a particular ditch. During the early twentieth century, Professor Ralph Parshall of Colorado State University solved the problem in a more permanent way with a measuring device, the Venturi flume or Parshall flume, whose design eliminated the variables that required field calibration.

**Regional Development**

*South Platte Valley*
The South Platte Valley and its tributaries upstream from the Poudre River to Denver were fairly thoroughly served by ditches from the pioneer and colony periods. Commercial canal development supplemented and rationalized this network of early ditches. The Larimer and Weld and High Line Canals are described above. Other English Company ditches included the Loveland and Greeley Canal from the Big Thompson River and the Platte Valley Canal which waters the east side of the valley from Fort Lupton toward Greeley. The Farmers Highline Company in 1885 began seeking a ditch on Clear Creek that could be extended to water Jefferson and Adams counties between Golden and what is now Thornton.[96] One later system is particularly worth mentioning: the Farmers Reservoir and Irrigation Company (FRICo), incorporated in 1902 by Joseph Standley, Milton Smith, and Thomas B. Croke. They consolidated early ditches while building new reservoirs and canals, first on the west side of the South Platte in Jefferson and Adams counties, and then on the east side as well, extending to Weld county. They began construction in 1909 on an enlargement of the Burlington Ditch into the O'Brian Canal (named after its engineer, Peter O'Brian) and an enlargement of Barr Lake. By 1910, FRICo was in financial trouble — the company owed its Kansas City contractor $900,000 — and it reorganized. FRICo has since grown into the largest private ditch company operating today in Colorado, and one of the largest in the country, largely through astute partnerships with urban municipalities, tapping their financial reserves to develop reservoir sites that the company already controlled.[97]

The real growth along the South Platte in the commercial canal period was in the downstream end of the valley from Fort Collins and Greeley to the east. The Weldon Valley Ditch, Platte and Beaver Ditches (Upper and Lower), Fort Morgan Canal and Bijou Ditch were all incorporated in the early 1880s. Weldon Valley and the Platte and Beaver system were each delivering water by 1884, both constructed by Abner S. Baker of Greeley, and his brothers. The Baker brothers began the Fort Morgan Canal in 1882, but ran into financial difficulties that led to its takeover by T. C. Henry and the Travelers Insurance Company. Travelers ran the canal from 1886 to 1894, when it turned the system over to its users, organized as the Ft. Morgan Reservoir and Irrigation Company. The Bijou system began with incorporation of the Kiowa and Bijou Irrigation and Land Company (another Baker brothers' project) in 1884. The effort did not progress far; its bondholders foreclosed and it was reorganized by D. A.

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[96] HAER CO-43-A:7; Silkensen, *Fanners' High Line.*
[97] "O'Brian Canal," HAER CO-46; Cultural resource inventory forms 5AM.457 (Bull Canal), 5AM.516 (Neres Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society. The Neres Canal was built in 1889 as the West Hudson Lateral by the Hudson Ditch and Reservoir Company. FRICo enlarged it in 1909 to fifty-five miles at a cost of $175,000 as part of the Standley Lake system.

Camfield in 1889 as the Bijou Canal. Water finally flowed in 1904, and the system was only completed after Camfield organized the Bijou Irrigation District in 1905.[98]

The major canals east of Greeley have junior appropriations relative to ditches in the Denver area and those along South Platte tributaries closer to the Front Range; the river was fully appropriated by the 1870s. Irrigation development in this enormous area from the 1880s through about 1910 was made possible, first, by the return flows that grew over time as upstream irrigators saturated riparian aquifers. This slow replenishment of stream flows — it could take a decade or more — may help explain the persistent optimism of ditch builders.[99] Next, South Platte irrigation developers built reservoirs — only a few of the oldest ditches attempted to operate as run-of-river ditches, and they were not very successful. Jackson Lake, Riverside Reservoir and Empire Reservoir were all built in the first decade of the twentieth century.[100]

After rural electrification began in the 1930s, many farmers in the eastern South Platte Valley installed supplementary wells using electric pumps, sometimes abandoning ditches altogether. Finally, as the Bureau of Reclamation began operating the Colorado-Big Thompson system in 1947, the remaining large canal and reservoir companies used this supplemental water to make up deficiencies in their operations.[101]

*Arkansas Valley*
Like the South Platte, the upper Arkansas Valley was developed early and thoroughly with pioneer ditches. Larger canals began with the Rocky Ford Ditch, built by George Swink and others with a priority date of May 15, 1874, diverting water upstream of the town of Rocky Ford and originally extending about ten miles. In 1887-88 they extended it to sixteen miles, watering almost 8,000 acres. The fifty-mile-long Rocky Ford High Line Canal was built in the early 1880s to water 30,000 acres. The Arkansas River Land, Town, and Canal Company Ditch on the north side of the river was begun in 1883, and then extended by T. C. Henry as the Fort Lyon Canal beginning in 1886. Henry also developed the Bob Creek Canal, later called the Twin Lakes Canal and now the Colorado Canal, and the Otero Canal on the south side of the river. The forty-mile-long Catlin Consolidated Canal (Catlin was the former name of Manzanola) was constructed in 1884-87 at a cost of $60,000, to irrigate 20,000 acres. The Bessemer Ditch extends thirty-five miles, some of it through the city of Pueblo, and was completed in 1890 at a cost of $450,000 to irrigate 20,000 acres.[102]

A second wave of commercial canals, after the depression of 1893, coincided with the advent of the sugar beet industry. The Great Plains Water Storage Company of Denver, beginning in 1896, built a system of large reservoirs on the plains — Neesopah, Neegronda, Neenoshe, Neeskah, and King. The

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[98] Cultural resource inventory forms 5MR.480 (Fort Morgan Canal) and 5WL.2429.1 (Bijou Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society; Dille, *Irrigation in Morgan County*. 24-26.
[99] Steinel, *History of Agriculture in Colorado*, 225-27; Mark Fiege. *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: U. Washington Press, 1999).
[100] Dille, *Irrigation in Morgan County*.
[101] Dille, *Irrigation in Morgan County;* Daniel Tyler, *The Last Water Hole in the West: The Colorado - Big Thompson Project and the Northern Colorado Water Conservancy District* (Niwot, Colorado: University Press of Colorado, 1992).
[102] Van Hook, "Development of Irrigation in the Arkansas Valley," 10-11; Sherow, *Watering the Valley*, 12-14; Cultural resource inventory forms 5CW.28.1 and 5PE.1667.1 (Colorado Canal) and 5OT.120 (Catlin Consolidated Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

reservoirs took their supply through T. C. Henry's Fort Lyon Canal, and then distributed water farther east through the Comanche and Pawnee Canals to the Amity Canal. The system was completed by 1902 at a cost of over $2 million. Soon afterward it was acquired by the Arkansas Sugar Beet and Irrigated Land Company, and then by the Amity Mutual Irrigation Company. The Twin Lakes Reservoir Company was established by some of T. C. Henry's Bob Creek Canal backers to supply the water needed by that project by building a reservoir near Leadville. The same investors then incorporated the National Beet Sugar Company to create a profitable market for their water.[103]

*San Luis Valley*

The first *Acequias* were in the southern part of the valley. Pioneer ditches soon appeared in the north as well. The San Luis Valley began as Colorado's most subsistence agricultural region. The expense of irrigation works led to more intensive market agriculture. The Denver and Rio Grande Railroad promoted potato, onion, and carrot cultivation.[104]

T. C. Henry expanded the Rio Grande Canal — originally the Del Norte Canal — as one of his first projects with Travelers Insurance Company. Henry also built the Empire, Citizens, and San Luis canals. The advent of large irrigation canals in the flat valley led to water-logging and alkali flats in low-lying lands, some of which were abandoned or became less productive. In the 1930s the Federal Relief Administration built drainage ditches to address these problems.[105]

*Western Slope*

Most of northwestern Colorado was part of the Ute Reservation until 1881, and opened for settlement with the relocation of the Utes in that year. The major low-altitude valleys — the Grand Valley in Mesa County and the Uncompahgre in Montrose and Delta counties — quickly proved to be ideal sites for fruit-growing, which demanded intensive and reliable irrigation. These areas largely skipped the pioneer stage of small bottomland ditches. Their initial development came during the period *of* investor-built canals.[106]

The Grand River Ditch (now the Grand Valley Canal) was begun in 1881, and reorganized in 1883 by Matt Arch and W. E. Pabor with $200,000 in stock. The first part opened that year, but the company ran out *of* money. T. C. Henry bought them out and finished the 49-mile canal in 1884. He in turn sold out to his backers, the Travelers Insurance Co., the following year. By 1888, the Grand River Ditch was insolvent and Travelers sold it at auction. In 1894, at a second auction, the water users bought the ditch.[107] In the Uncompahgre River Valley, large canals were begun quickly in the 1880s, and by 1903, settlers had claimed 100,000 acres and irrigated 30,000 acres through canals up to 40 miles long. As in much of the eastern half of the state, this ambitious development outstripped available water supply. In the drought of 1888, the Uncompahgre carried only enough water for 10,000 acres. A few miles to the east, the Gunnison River carried more water with less irrigable land in its valley. F. C. Lanzon in 1890

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[103] Markoff, "The Sugar Industry in the Arkansas River Valley," 76-79; Carter and Mehls, *Southern Frontier*, 11-47, 123; Cultural resource inventory form 5KW.63.1 (Lone Wolf Canal), Office of Archaeology and Historic Preservation, Colorado Historical Society.

[104] Carter and Mehls, *Southern Frontier*. 11-47.

[105] Cultural resource inventory forms 5RN.63 and 5SH.1033 (Rio Grande Canal) and 5RN.510.1 (Empire Canal). Office of Archaeology and Historic Preservation. Colorado Historical Society; Clements, "British-controlled Enterprise" 138 n. 46; "San Luis Valley Resettlement Project," *San Luis Historian* 21: 2 (1989).

[106] Husband, *Colorado Plateau Historic Context*, 78-88.

[107] Davidson, "Grand River Ditch."

proposed to divert water from the Gunnison through a tunnel to the Uncompahgre Valley. In 1894 he ran level lines proving that the elevations were feasible. A survey team led by William W. Torrance, "Father of the Gunnison Tunnel," entered the Black Canyon in 1900, but gave up after four weeks.[108] The project would be revived by the state and then by the federal government (see below).

108 "Historic Canals on the Bureau of Reclamation's Uncompahgre Project, Montrose and Delta Counties, Colorado (South [5MN,185l], East, and Montrose and Delta Canals [5MN.1855])," Official Determination of Eligibility (1983), at Office of Archaeology and Historic Preservation, Colorado Historical Society.

## ASSOCIATED PROPERTY TYPES

This section focuses on property types that occur mainly as components of ditch or canal systems (e.g., head gates, laterals). It also includes others that exist in other contexts but may be associated with ditch and canal systems (e.g., dams, bridges). It is organized by groupings of functions within the water delivery system:

- **Diversion structures**
  (headgates and headworks; diversion dams);
- **Water conduits**
  (main canals and ditches; flumes; tunnels and rock cuts; pipes and culverts; siphons; laterals; pumps and sprinkler systems);
- **Protective and cleaning features**
  (sand traps; debris grates; waste and overflow gates; drop structures; overchutes);
- **Water storage**
  (reservoirs);
- **Control and measurement features**
  (turnouts or lateral headgates; weirs and checks; non-structural field control devices; water measuring and recording devices);
- **Associated properties**
  (camps and buildings; borrow pits and quarries; power stations and mills; bridges, retaining walls; access roads; communication lines; drains; vegetation; ditching machinery ).

### Diversion Structures

<u>Subtype: Headgates and Headworks</u>
A *headgate* is a single structure controlling water flow into a ditch. *Headworks* are a complex including a headgate and additional components (the word "headgate" is often used for a lateral turnout, especially to a large lateral. Lateral headgates typically have few if any additional headworks components). The modern ditch headworks, common by the early twentieth century, may include an outside headgate structure (primarily intended to keep excess water and debris out of the ditch); a spillway back to the stream and inside gates, which are the mechanism for fine control of water flow; usually a sand trap, frequently combined with the spillway; a measuring flume and recording apparatus. Most headworks include at least a low dam in the stream to channel water toward the ditch. Where there is no dam there may be some manipulation of the streambed for the same purpose, especially during periods of low flow. A roadway provides vehicular access to the headgate, even if the ditch right-of- way itself has no such access.

The earliest ditches, especially small ditches on small streams, might get by without headworks or head gates at all. "The river ran bank full," wrote William E. Pabor in 1883, "and filled these ditches without the requirement of dams."[109] Headgates function not only to keep out excess water and debris, but also to shut off the ditch when it has no right to run water; thus the impetus for installing headgates has not always come from the ditch users. The 1889 "Act To Provide for Erecting Head-Gates, Waste-Gates, Locks, Fastenings, and Paying the Expenses Thereof" required every ditch to erect and maintain a head gate, upon order by the district water commissioner. Long after the South Platte was

[109] Pabor, *Colorado as an Agricultural State.* 76.

fully appropriated by ditches in the Denver area and farther north, ditches at the headwaters in South Park had no headgates and therefore took water throughout the season regardless of their junior appropriations.[110]

Ditch headgates were initially made of wood. Some, especially on large canals, used supplementary steel. In the 1880s, on the privately-built canals in Montrose and Delta counties that later became part of the Bureau of Reclamation's Uncompahgre Project, "the headgates were made entirely of wood with a few steel straps (to hold the gate leafs together) and perhaps a threaded steel shaft with a wheel on top to run the wooden gate up and down through wooden slots." One of those heagates, on the East Canal, survived in operation at least until 1980.[111]

The cost of concrete came down in the 1880s and 1890s, and it began to come into common use on ditches in the 1890s. Headworks were most likely to be the first component rebuilt in concrete and steel, usually after damage by a flood. The Grand Valley Ditch was built with a wooden headgate in 1883. When a flood destroyed it in 1898, it was rebuilt with steel gates set in stone masonry (completed 1901, and still in service in 1986). Large ditches and canals began using radial steel gates around the turn of the twentieth century.[112]

Subtype: Diversion Dams

Dams that impound water to create reservoirs are considered separately below. *Diversion dams* do not store an appreciable amount of water, but rather regulate the water level in the stream to supply the headgate reliably. The earliest diversion dams were brush or cobble, rearranged each year as needed. Even large canals might adopt this system, so long as stream levels were adequate. On the pre-Uncompahgre-project canals in the 1880s, "a diversion weir or dam was not built across the river, but rocks were simply piled in the stream to force the water to a high enough elevation so that it would flow through the head gates into the ditch."[113] The Grand River Ditch in Grand Junction had no diversion dam, but in the drought of 1888, the managers built wooden cribbing into the river to direct water toward the headgate.[114]

On the Weldon Valley Ditch in Morgan County, built in 1881, "[i]n the early days the diversion dam was built of brush, rock and piled up river sand. Many car loads of rock were shipped in on the new railroad to maintain and rebuild this structure and protect the headgate after every flood in the river."[115] The railroad permitted an industrialized version of the ancient pre-industrial system of temporary diversion works.

By the early twentieth century, concrete dams were common as ditch headgates were built or rebuilt for major ditches. They ranged from low weirs in small streams to the Reclamation Service's Grand Valley

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110 State Engineer, *Biennial Report, 1889-90*, 13; *Colorado Agricultural Experiment Station* Bulletin 67 (1901): 9; Silkensen, *Farmers' High Line*.
111 "Historic Canals on the Bureau of Reclamation's Uncompahgre Project," Official Determination of Eligibility (1983).
112 Farmers High Line first began replacing wooden structures with concrete and steel c. 1910. Silkensen, *Farmers' High Line*, 79 n. 6; Davidson, "Grand River Ditch," 13,27.
113 "Historic Canals on the Bureau of Reclamation's Uncompahgre Project," Official Determination of Eligibility (1983).
114 Davidson, "Grand River Ditch," 21.
115 Dille, *Irrigation in Morgan County*, 10.

diversion dam in the Colorado River, the largest roller-crest dam in the world when it was completed in 1914 (it is National Register-listed, NRIS 91001485, and visible from Interstate 70).[116]

### Water Conduits

Subtype: Canals and Ditches

There is no clear definition distinguishing "canals" from "ditches," yet the two terms are not quite interchangeable. *Ditch* is the more inclusive term, and is sometimes used to refer to all water conveyance channels no matter what size. *Canal* generally refers to a larger channel, but that may mean anything from 10 to 150 feet in width.

*Earthen (and clay-lined) Channels*

Almost all early ditches, and most Colorado ditches to the present, are earthen channels. Their section is typically trapezoidal, with side slopes depending on the stability of the ground, and generally in the range from 1:1 to 1:2, vertical to horizontal.

Ditches typically drop 1 to 5 feet per mile. Large canals will be at the lower end of the range because the water flowing in them is subject to less hydraulic friction from the channel. Any drop greater than the norm increases erosion, creating maintenance concerns both where the erosion occurs, and where the sediment is deposited. Ditch builders sought shallow grades in order to water as much land as possible from a given diversion point, but too little slope would not allow the ditch to flow. Setting the grade of the ditch was not at first an exact science. A pan filled with water might serve as a level. Surveying instruments were sometimes available, but not always in skilled hands. Smith's Ditch (later City Ditch) in Denver needed to be rebuilt when it would not flow. Twenty years later in 1881-82, the original survey for Grand Valley Ditch ran the channel uphill. Less dramatic grading errors needed to be corrected in the early Greeley canals, and probably many others.[117]

Ditching techniques varied with terrain and available labor and technology. Mining ditches were constructed by miners, conveniently since they often needed to cut through rocks (see *Tunnels and Rock Cuts*, below). On the plains, the first step was breaking sod, sometimes with great ten-oxen teams. Then horse-drawn *fresnoes* (scrapers) could excavate the earth. Observers described a rhythm of pulling along the bottom of the ditch, up the bank to dump, then back down, over and over.[118] On sloping ground the earth was dumped mainly on the downhill side to build up an embankment. Over the years, spoil from ditch clean-out would be placed on the same side to maintain the embankment.

Large canals drew upon the techniques of railroad construction. This most often meant the organization and deployment of large numbers of men and animals, rather than the application of mechanized power. The construction of reservoirs in the 1880s and 1890s began to employ steam shovels for the massive excavations required to build earthen dams, and steam shovels sometimes worked on the big canals that were parts of the same systems. One very large canal, the Grand River Canal, was enlarged in 1888 using a steam-powered dredge floating in the canal itself.[119] For smaller ditches, patented ditchers aimed for greater efficiency through continuous rotary action.

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[116] Silkensen, *Farmers' High Line*, 83-84; Simonds, "The Grand Valley Project."
[117] Silkensen, *Farmers' High Line*, 28; Worster, *Rivers of Empire*, 76; Davidson, "Grand River Ditch," 4, 6.
[118] Norris, *Written in Water*.
[119] Davidson, "Grand River Ditch," 21.

Ditches from the period of mechanized excavation sometimes include deep cuts through high ground, similar to railroad or highway construction. Such cuts were rare on earlier hand-dug ditches. When Americans returned from the First World War in 1918, many brought back experience with treaded vehicles, some of which were available as Army surplus. By the 1930s mechanized excavation became the norm. Over the succeeding decades, troublesome sections of ditch previously tolerated were sometimes reconstructed or realigned.[120] Trouble free sections were not likely to be changed.
New ditches could be thirsty, losing much of their water to seepage. This problem usually became less severe over time, partly through rising water tables fed by the ditches, partly as fine silt from the leaking water permeated the soil and began to seal the ditch. In porous ground or leaky sections of ditch, ditch builders "puddled" the ditch by soaking it and working in imported silt to seal it. Even porous rock, such as Grand Junction's blue shale, could require puddling, which might cost as much per mile as the excavation itself.[121] Such clay lining remains an important tool of seepage control.

*Lined*
Lining is intended to keep water in the ditch, to reduce annual maintenance, and to reduce hydraulic friction and thus increase the capacity of a given channel size. Lining includes the whole surface below the water line — the bottom as well as both sides of the channel. Retaining walls, by contrast, are meant to support the ground behind them, and may be installed on one or both sides of the ditch. They do not necessarily include a bottom though they may be installed with a bottom lining.

Lining is usually of concrete or applied cementitious coatings.[122] The South Canal, constructed 1904-09 on the Bureau of Reclamation Uncompahgre Project, included sections lined with 10-inch thick concrete. The Havemeyer-Willcox canal system was concrete-lined when it was built in 1911. The expense of concrete lining made it rare as a treatment for whole ditches, and more common for particular sections subject to leaks, erosion, or other problems. By 1915, *Irrigation Age* featured the "cement gun" as an economical means of applying a lining (now called "Gunite" or "shotcrete") without formwork.[123] Later solutions, which relied on mechanization of the jobsite, included movable, re-usable formwork, and pre-cast concrete linings, mostly for smaller ditches and laterals.

In the past fifty years, rubberized fabrics have come into use to reduce seepage where no structural reinforcement is needed. Fabric lining does not substantially modify the ditch; while it may have a visual impact, it is structurally minor and reversible.

Subtype: Flumes
*Flumes* carry water across ravines or depressions, at the grade of the ditch. *Bench flumes* carry water along a slope that is too steep or unstable for canal construction. Flume walls (whether of wood or especially of metal) provide less hydraulic friction than canal walls, so water flows faster and the cross-sectional area of the flume is typically about half that of the canal. The beginning and end of a flume thus involve changes in water velocity and canal section, resulting in turbulence. Flumes usually include some headworks and tail works, intended to avoid washouts at these points.

[120] See, for example, Silkensen, *Fanners' High Line,* 108.
[121] Davidson, "Grand River Ditch," 17-18.
[122] Early ditches in California included stone or clay tile linings; JRP Historical Consulting Services, *Water Conveyance Systems in California*. Small laterals in Colorado were sometimes lined in stone or wooden planks.
[123] Cultural resource inventory form 5GF.654 (Havemeyer-Willcox Canal); Silkensen, *Farmers' High Line*. 83; "Shooting Cement Lining in Ditches," *Irrigation Age* 30:7 (May 1915): 215-17.

Like other early canal structures, most flumes initially were built of wood. Early Hispano *Acequias* in New Mexico sometimes employed *canoas*, or hollow-log flumes. No examples are known in Colorado. Wooden flumes deteriorated quickly, in part because of wear by fast-moving water. Wooden trestles were vulnerable to fire. Iron and steel flumes, most commonly with semicircular section, began to replace them by the end of the nineteenth century; they still relied on wooden trestles. Larger systems sometimes used reinforced concrete flumes, standing on concrete supports.

Flumes could be among the most dramatic of all irrigation and water supply structures. The Hanging Flume on the Dolores ~~and San Mig~~uel Rivers was built in 1889-91 for a hydraulic placer mining operation. An eight-mile-long structure pinned to sheer canyon walls, it operated for only three years. In 1883 Frank E. Baker, a Fort Morgan contractor who specialized in wooden ditch structures, built a 2100-foot-long flume across Bijou Creek for the large (400 cubic feet per second) Fort Morgan Canal. In 1895 a flood washed it out and Baker rebuilt it. This one washed out in 1935, and was replaced by galvanized metal flume from the Hardesty Manufacturing Company in Denver. In 1949 part of this flume washed out and was replaced.[124]

Subtype: Laterals

*Laterals* refer to any water conduit distributing from the main ditch or canal. The term is thus elastic, depending on the scale of the system. Main laterals or branches from a large canal may be bigger than most main ditches. At the other end of the scale, the term "lateral" may refer to channels just inches wide, or to distribution pipes. The term lateral denotes function within a system rather than any absolute form or dimensions.

Ditch companies were generally responsible for the main ditch, and company responsibility ended at the lateral head gate (some complex systems might include company responsibility for main laterals as well). Laterals, even miles long and serving many users, were usually administered informally and were much less likely than the main ditch to be documented. Once water was delivered to a particular user, it needed to be brought to the fields and crops, or other points of use. Small channels called *field laterals* and *spreaders* distributed the water within a farm or ranch. The smallest field laterals brought the water to the tops of individual furrows for row crops, and spreaders were turned with a plow to carry water across a pasture for flood irrigation. These field spreaders may be replaced today with flexible perforated hoses.

Laterals may be lined before main ditches because of the comparative ease of working with concrete or other linings at a smaller scale. Poured-in-place or precast concrete lining was common in some areas by the first half of the twentieth century. Laterals in yards or urban areas might be stone- or plank-lined, probably less for hydraulic performance than for landscape tidiness.

Subtype: Pipes and Culverts

Nineteenth-century water *pipes*, and many large pipes into the twentieth century, were of wooden stave construction. Sheet metal pipes for water transport were one of the technological innovations of the California gold rush, and miners brought the technology to Colorado. By the end of the nineteenth century, corrugated piping was common, allowing pipes to support the weight of fill above them. Short

[124] Cultural resource inventory form 5MN.1840 (Hanging Flume), Office of Archaeology and Historic Preservation. Colorado Historical Society; Dille, *Irrigation in Morgan County*, 18-22.

lengths of pipe are common at lateral turnouts to run under a built-up embankment, protecting the main ditch from washouts. On the Sand Creek Lateral of Denver's High Line Canal, lateral turnouts all ran through vitrified clay pipes, ranging from 6 to 20 inches in diameter.[125]

Sheet metal and corrugated pipes carried gravity-flow water. When elevated they were called pipe flumes or "full-round" flumes. Small pipe flumes are common as crossings to carry a lateral over a ditch (not uncommon in areas where more than one ditch irrigated the same service area)..
Piping was also made of heavier iron and steel. As a flume, it could then support itself for longer spans between trestles. Heavy pipes (iron, steel, or wooden with steel reinforcement) could also carry water under pressure. Pressurized piping was necessary for siphons.

*Culverts* are covered channels, often with fill above. They are commonly used as crossings under roads or railroads. Sometimes culverts are employed to gain usable space above the ditch in urban areas or elsewhere where space is at a premium, or to protect a reach of ditch from foreign material that might fall in, to protect people or animals from falling in. Early culverts were most often stone retaining walls with stone or wooden covers. Later versions are either pipe culverts (concrete or corrugated metal) or concrete box culverts.

Subtype: Pumps and Water Wheels, Sprinkler Systems
The great majority of Colorado ditches and canals are gravity systems. Exceptions included the Price Ditch in the early 1890s and the Stub Ditch in 1903, which pumped water from the Grand Valley Canal system in Grand Junction, and two other ditches pumped from the south side of the Colorado River in 1910. Pumps became fairly common in the mid-twentieth century for short rises to water lands above ditch. Before that time they were rare, in part because of the difficulty and cost of applying large amounts of power.[126]

One solution was the *current wheel*, using the flow of water in the canal itself as a power source. The most spectacular example was John Wellington's Wheel, constructed in 1894 near Grand Junction, lifting water 25 feet above the Grand Valley Canal to a 160-acre orchard. Using an ancient technology, the canal turned a water wheel which lifted water to a flume that brought it to the orchard ditch. Current wheels were also reported on the South Platte River. The Sharrard Park Pumping Station on the Havemeyer-Willcox Canal used a 50-foot drop on the Havemeyer Ditch to pump some of the water to two smaller ditches, 75 and 200 feet above the ditch. It operated for only a month in 1912 (the pumphouse was demolished in 1980 for the construction of Interstate 70).[127]

Pumps were also used to lift water to tanks or reservoirs from which it could be delivered through sprinklers. Sprinkler delivery could be accomplished without pumping where lands were sufficiently below ditch. Such systems generally included at least a small regulating reservoir below ditch to maintain uninterrupted supply and pressure.

Irrigation pumping from groundwater is beyond the scope of this historic context. The first irrigation wells were shallow and steam-powered. Irrigation wells increased tenfold from 1929 to 1959, first

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[125] HAER CO-43-A: 18.
[126] Simonds, "Grand Valley Project"; King, *Colorado Engineering Context*, 10-15.
[127] Davidson, "Grand River Ditch," 24-26; King, *Colorado Engineering Context*. 10; Cultural resource inventory form 5GF.654 (Havemeyer- Willcox Canal).

through rural electrification and then through the advent of center-pivot irrigation systems in 1952.[128] It would be worthwhile to prepare an additional historic context to identify historic resources related to this practice.

Subtype: Siphons

*Siphons* are closed conduits (pipes or culverts) that carry water under pressure, allowing it to dip below ditch grade. The *invert* is the vertical difference between elevations at the ends and at the low point. Long siphons (sometimes with a deep invert as well) avoided or replaced trestles to cross ravines or depressions, or circuitous ditch routes to go around them. These siphons are pressurized pipes, usually of steel, sometimes steel-banded wooden stave or reinforced concrete. Shorter siphons became common at railroad crossings, and at road crossings as highway grades became more controlled. Siphons could also cross streams, substituting for a flume and reducing the risk of flood damage. The High Line Canal was built in 1880-83 with wood-stave siphons under creeks. Farmers High Line installed a wooden siphon at Ralston Creek in 1899, and added an additional 46-inch siphon pipe in 1902. The company installed another siphon under the Union Pacific Railroad tracks around 1911.[129] Many stream crossings have a shallow invert and are built as pressurized concrete box culverts.

Subtype: Tunnels and Rock Cuts

Small *tunnels* and *rock cuts* could substitute for flumes where construction was difficult. Larger tunnels were built as parts of major engineered systems, particularly for inter-basin transfers. The Gunnison Tunnel on the Uncompahgre project is one example, the Moffat Tunnel Pioneer Bore in the Denver Water system is another. Colorado's hard-rock mining tradition may make water-supply tunnels more prevalent here than they would otherwise be. Water tunnels originated mainly from miners and mining technology. Handy Ditch in Berthoud includes a tunnel constructed in 1883 by miners who had worked in the Sunshine Mining District. On Boulder's Silver Lake Ditch, the availability in the 1930s of an out-of-work miner allowed the ditch owners to replace a troublesome 1888 wooden flume with a short tunnel.[130] Tunnels could be simple unlined rock or earth, timber cribbed, concrete lined, or mortared stone. Rock Cuts are discernable as artificial open cuts through rock where water is directed to flow.

Subtype: Weir

A *weir* is a type of dam where water is meant to flow over the top of the structure. A weir is meant to raise the level of a watercourse to ensure gravity flow through turnouts to fields or other destinations, to create a pond, to collect sediment, or slow the flow of water. Weirs can vary from a temporary stack of brush, cobblestone or gravel, framed lumber, mortared stone, concrete, or collapsible steel.

**Protective and Cleaning Features**

Subtype: Sand traps

*Sand traps*, sometimes called "stilling basins," allowed water velocity to slow down enough for suspended particles to settle, at a place where it was convenient to remove them. The sand trap would typically be incorporated into the headworks where a gate at the bottom of the trap could be opened to flush (or "sand out") the sediment, rather than removing it mechanically. A waste gate back to the

[128] Steinel, *History of Agriculture in Colorado;* Dille, *Irrigation in Morgan County.*
[129] HAER CO-43: 8; Silkensen, *Farmers' High Line*, 79-81.
[130] Cultural resource inventory forms 5LR.1710.1 (Handy Ditch) and 5BL.3813 (Silver Lake Ditch), Office of Archaeology and Historic Preservation, Colorado Historical Society.

stream, a hundred yards to a mile or more from the headgate, might serve a similar purpose, allowing a periodic flushing of sand and gravel that had settled, making the ditch itself a sand trap that was at least partially self-cleaning. Other traps might be installed at stream crossings to flush sediments that entered the ditch later. Sand traps sometimes played a role in protecting water quality, when the "sand" included mine tailings or street runoff.[131]

Subtype: Debris Grates

*Debris grates* were often incorporated into headworks, sometimes sized for whole trees and cow carcasses rather than anything smaller. Smaller ones were often hinged to permit cleaning without having to step into the ditch. Debris grates are also common at siphon and culvert intakes.

Subtype: Waste Gates or Overflows

*Waste gates* were frequently incorporated in headworks to flush sediment. At stream crossings, they might also serve as an *overflow* to shed excess water, ditch builders early learned that excess could be as disastrous as shortage of water. Washouts were hazardous to the ditch and to life and property below it. An influx of runoff water could completely fill whole reaches of ditch with sediment. Historic patterns of runoff to ditches have increased insidiously in volume and velocity and decreased in wholesomeness, with the paving of roads and development of additional impervious surfaces. Waste spillways have been part of good ditch design from the earliest times, but they have also been added frequently in retrofits.

Subtype: Drop Structures

Ditch gradient much greater than the norm of one to five feet per mile greatly increases erosion. Where topography requires that flow move to a lower elevation, well-engineered ditches concentrate the elevation change in a vertical or near-vertical *drop*, or a sloped *chute*, where a structure can absorb the energy of the falling water. Some drop structures are retrofits after early maintenance experience revealed which reaches of ditch were prone to erosion. These modifications might take place during the period of significance.

Nineteenth-century drop structures, like most early ditch structures, were built of wood. Drops took the hardest wear and tear of any ditch structures, with a useful life even shorter than the 15-20 year span for flumes and headgates. For example, the Golden Canal in an 1872 extension descended Semper Hill in Westminster in an unlined channel. Some time during the next few years, according to irrigation historian Greg Silkensen, the company built:

> a series of weirs and wooden flumes hundreds of feet long to convey irrigation water down the hill. A year after Farmers' High Line purchased the Golden Canal in 1886, the company rebuilt the existing 750-foot wooden chute .... [A]fter the 1898 irrigation season the weirs and chutes once again needed repairs. In 1911 after high water from a series of storms washed out a number of the canal's checks and weirs, Farmers' High Line slowly replaced the remaining wooden structures with concrete.[132]

[131] See photos in 'Historic Canals on the Bureau of Reclamation's Uncompahgre Project," Official Determination of Eligibility (1983). Farmers High Line installed a discharge weir in 1918 to flush tailings from the first mile of the canal. Silkensen, *Farmers' High Line*, 90.
[132] Silkensen, *Farmers' High Line*. 81.

The wooden structures were not completely replaced until the completion in 1920 of a concrete chute. It was still in use in 2000. For smaller drops, Farmers High Line had begun replacing wooden drops with concrete around 1900. The Grand Valley Canal's "Great Drop" was built of wood, later replaced by concrete.[133] It is unlikely that any wooden drops over fifty years old survive unless as ruins on unused stretches of ditch.

Subtype: Overchutes

*Overchutes* carry drainage water over the ditch channel. They are less common than culverts beneath the ditch. Their use depends on the relationship of the ditch to the surrounding topography.[134]

### Water Storage

Reservoirs (and dams) are covered in the *Colorado Engineering Context*.[135] This section considers their relation to ditch and canal systems.

Subtype: Reservoirs

Within a ditch system, reservoirs may be either below ditch-storing water between the headgate and the user — or above ditch, releasing water to the stream to be taken out at the ditch headgate. Below-ditch reservoirs range from farm ponds to large artificial lakes. Reservoirs are as old as ditches and canals in Colorado. They were part of Mesa Verde's water system, and the first in historic times was constructed in Jefferson County in 1859.[136]

Above-ditch reservoirs became feasible once there was a working system of water rights administration to ensure that water released to the stream would not be taken out somewhere along the way to its intended users. The first substantial high-altitude reservoir was Chambers Lake, begun in 1882 on the upper Poudre River.[137]

Within the area that became Rocky Mountain National Park, the United States Forest Service approved 19 dams before the park was established in 1915. Only five were eventually built. The first was Lawn Lake, approved in 1903 and completed 1911 by the Farmers Ditch and Reservoir Company in Loveland. Lawn Lake Dam burst in 1982. Two others, begun in the same decade, became part of Longmont's municipal supply system in the 1930s.[138]

High-altitude reservoirs were particularly suitable for municipal supply because they captured water before it had much chance to pick up impurities. They also minimized losses to evaporation.

### Control and Measurement Features

Control of water flow is essential for its use. Control and measurement are essential for sharing water among multiple users, whether on a single ditch, or along the length of a whole river.

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[133] Silkensen, *Fanners' High Line*, 34,82-83; Davidson, "Grand River Ditch," 3 (photo page 9).
[134] JRP Historical Consulting Services, *Water Conveyance Systems in California*, 80.
[135] King, *Colorado Engineering Context*, 1-9.
[136] On Coal Creek. McKinnon, *A Hundred Years of Irrigation in Colorado*, 37.
[137] McKinnon, *A Hundred Years of Irrigation in Colorado*, 37.
[138] Rocky Mountain National Park Multiple Resource Nomination, 34-36.

Subtype: Turnouts or Lateral Headgates

*Lateral headgates* range from little gates off the ditch, to complex structures that divide the main ditch among several major channels. They differ from ditch headworks in that the incoming flow is normally controlled, so they do not need to be armored against flooding and debris. The simplest durable lateral turnout is a wooden control box: flow is started or stopped by a plank sliding in a wooden track. The box holds the track in place and keeps the water from flowing directly against the earthen bank and washing it out. Variants may add a simple mechanism such as a lever to lift the gate. Such wooden boxes were used in Colorado's first ditches, and they are still being built today. They are not particularly durable but they are easy to construct and cost little.

Simple wooden gates could vary the flow, but the results had to be judged by eye. Many early innovations in control boxes aimed to add some means of measurement. An early version was the "Max Clark water box" developed by J. Max Clark, a member of the Union Colony. They were widely used by the 1880s, but were not particularly accurate.

While wooden gates were being refined, their short lifespan led to increasing popularity of more durable materials. One alternative was manufactured patent iron and steel gates, common by the 1890s. Hardesty Manufacturing Company of Denver was one major supplier. Manufactured gates in the twentieth century were usually set in concrete headwalls, though earlier construction was often stone, which continued to be used. Steel gates often fed a pipe that extended beyond the ditch embankment.

*Junction Boxes or "Hydrants"*

As some lateral systems moved into underground pipes, "hydrant" junction boxes made controls accessible to people above the ground. One example, promoted by the Colorado Agricultural Experiment Station, was the Azusa Hydrant.[139] Concrete junction boxes also became common for small surface laterals.

Subtype: Field Control (non-structural)

The smallest ditches — field spreaders — also required control of water flow, but not necessarily with fixed structures. The simplest, most ancient means of control was to move earth with a shovel, opening a channel here and closing one there. Sandbags worked the same way, and once filled were less work to move from one channel to another. Another alternative was a plank or piece of sheet metal pushed or pounded into the earthen channel. A *tappoon* was a canvas flap, attached to a rod, which served as a movable gate in field spreaders, damming water so that it would overflow the spreader banks and flood a section of field.

Subtype: Water Measuring Devices

Most early attempts at water measurement involved efforts to calibrate lateral turnouts and other gates. These tended to be unreliable. Hydraulic variables made actual flow vary not in linear relationship to the gate openings, and the gates left uncontrolled variables that made their absolute measurements dependant upon installation and therefore not consistent from one site to another. William E. Pabor described the problem in 1883: "The grade, the size of the orifice through which the water flows, the depth and breadth of the channel, all affect the result, more or less."[140] More accurate measurement of flow required a measurement structure separate from the control gate.

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[139] Colorado Agricultural Experiment Station *Bulletin 207* (1915): 14.
[140] Pabor, *Colorado as an Agricultural State*, 47.

One common device was the *Cipoletti weir,* a measured opening across the flow of the ditch. Cipoletti weirs required calibration by temporarily installing a measuring device to determine actual ditch flow. The weir would then lose accuracy as sediment or other factors changed the channel.

The *Parshall flume* was developed by Professor Ralph Parshall of Colorado State Agricultural College (now Colorado State University). Parshall refined the design over the decades from the 1920s to the 1940s. The flume's throat (intake) and afterbay remove the hydraulic variables so that, properly constructed and installed, it is pre- calibrated to give a true flow measurement at a range of volumes. It is also self-cleaning. Parshall flumes may be installed at a variety of scales. They may be constructed of wood, sheet metal, or concrete.

*Recording Structures*
Measurements that required human observation could only be checked from time to time. Locking a gate in position was one more-or-less reliable means of ensuring that a measurement held steady, but it was dangerous to lock a headgate in an open position. By the 1880s, "clock-work" (spring-driven) and electric "registers" or "continuous self-recording gauges" were available to make a record of water level on a rotating spool of paper (these devices were developed first for use at stream gauging stations).

Water commissioners gradually required that such gauges be installed at ditch headgates. They were located in a recording house, usually not a building but a small shed or a cylindrical metal structure 2 feet to 3 feet in diameter and 4 feet to 6 feet tall.[141]

**Associated Properties**

Subtype: Camps and Buildings

*Construction Camps*
Major canals shared with railroads the process of construction by large crews, often immigrants, and large collections of draft animals. Some were built from a single encampment that moved along as the right-of-way progressed. The Boulder and White Rock Ditch, for example, was built in 1874 with 35 men and 42 horses in an "encampment after the style of railroad grading," and during construction an observer reported it "now the busiest point in the county."[142] Other well-capitalized ditches used multiple camps to work on different sections simultaneously. Grand River Ditch in Mesa County, for example, was under construction in 1883 with 17 grading camps, including 110 teams of horses and 150 men, spread over 20 miles of ditch.[143]

Grand Ditch, in present-day Rocky Mountain National Park, was under construction on and off from the 1890s to the 1930s, with new camps built as late as 1938 because of its remote location. Some ditch camps remain only as archaeological sites. Others, including several of the Grand Ditch camps, include

141 Colorado State Engineer, *Second Biennial Report*, 1883-1884 (Denver, 1884),7; State Engineer, *Biennial Report, 1889-90*, 18.
142 Unidentified news clipping, Feb. 13, 1874, Carnegie Library.
143 Davidson, "Grand River Ditch," 12.

remnant cabins or ruins. Some buildings continued in use, such as the La Poudre Pass Barn, built in 1892 or 1893 for the construction of Grand Ditch, and demolished in 1986.[144]

*Houses and Maintenance Buildings*

Before automobiles, the length of even a medium-sized ditch could be the better part of a day's travel. Ditch companies sometimes provided houses for ditch riders, particularly on remote parts of a system. There is no evidence that ditch riders' houses differ in type or arrangement from other contemporary modest housing. Their origin and siting make them potential associated properties. A variant with specific siting is the headgate operator's house. Ditch companies also built and used other buildings-tool houses, barns and garages, shops.[145]

*Administration Buildings*

Ditch offices do not necessarily differ from other contemporary administration buildings. They are the one irrigation and water supply-associated property that may be located in no particular proximity to the ditch system itself, but rather in town. The Bureau of Reclamation's Uncompahgre Project headquarters in Montrose, constructed in 1905, is listed on the National Register.

Subtype: Borrow Pits and Quarries

Canals are large engineering works, comparable to railroads and highways, and even small ditches could involve a great deal of earthmoving, especially when they crossed uneven terrain. Borrow pits provided earthen fill for ditch projects, and quarries provided stone for constructed features such as retaining walls. The McGraw Ranch ditch system in Rocky Mountain National Park includes an apparent borrow pit.[146]

Subtype: Power Stations and Mills

Power could be taken from a drop on the main ditch or as a lateral dropping from the ditch back to the stream. Early grist mills were water powered and often took their water supply from an irrigation ditch. Examples include the Rough and Ready Mill in Littleton and the Yount Mill in Boulder. At the Hayden Ranch outside Leadville, a water wheel on a lateral operated a sawmill and hay baler. The Grand Junction system was designed in the early 1880s for water-powered industry — it included large drops to give high head. Joseph King's *Colorado Engineering Context* describes the technology of water wheels and turbines.[147]

Later systems pursued the same general arrangements for the purpose of hydroelectric power. Reclamation projects such as the Colorado-Big Thompson were engineered for multiple purposes, including hydroelectric generation.

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[144] Rocky Mountain National Park Multiple Resource Nomination, 8-10; Cultural resource inventory form 5GA.301.7 (Grand River Ditch Camp 7), Office of Archaeology and Historic Preservation, Colorado Historical Society.

[145] Farmer's High Line built a four-room house at the headgate in Golden for the head gate operator in 1926, built a new one in 1967, purchased a tool house near Standley Lake in 1912 and constructed a garage in 1916; Silkensen, *Fanners' High Line*. 83.

[146] Cultural resource inventory form 5LR.1131.26 (McGraw Ranch Ditch System), Office of Archaeology and Historic Preservation, Colorado Historical Society.

[147] King, *Colorado Engineering Context*. 38-44.

Subtype: Bridges

Bridges are typically part of a road or railroad system (and those systems provide the historical context for these structures).[148] Ditch and canal crossings generally did not need to be designed with capacity for the high flows of floods, and therefore bridges are lower and openings narrower, and culverts more likely to be employed than on a natural stream of comparable size. Pedestrian bridges are relatively common because they can be small and close to the water with little chance of washing out. Some bridges are functionally part of the ditch system: for example access road crossings, or pedestrian bridges for access to control structures.

Subtype: Retaining Walls

Walls may be in the ditch, retaining the sides of the ditch; or outside the ditch to retain the ditch bank or to retain sides of cuts above the ditch. Walls may be of stone, log (Grand Ditch), or concrete.

Subtype: Access Roads

Access roads are usually on the below-ditch bank (for access to lateral gates, which are located on this side, and to monitor for leaks and maintenance, mainly on this side). Occasionally they are on the uphill side for some local reason. Sometimes they are omitted, where nearby roads provide access, or topography or development make a road infeasible.

Subtype: Communication Lines

Farmers High Line Canal, in Jefferson County, in 1902 installed its own telephone service along the ditch, mostly strung along fence posts, in use until 1912.[149] Telephone lines may be an associated property along ditch access roads and rights-of- way, but integrity of the resource may be an issue if those communication lines have continued use and have therefore altered drastically over time.

Subtype: Drains (*Desagues*)

Complete ditch systems include *drains* for removing excess water from irrigated lands (in Hispano systems, *desaugues)*. Water pooling and evaporating produces salinization, the most long-term irremediable hazard of irrigated agriculture. Drains are ditches, typically less finished than supply ditches, and depending on topography they are sometimes deeper. Drains do not require control structures but simply provide channels leading toward a natural drainage. Drains were also employed in hydraulic mining operations.[150]

Subtype: Site Landscape and Vegetation

Ditch managers have been of two minds about vegetation. For the most part they try to minimize vegetation, especially phreatophytes, or water-consuming species such as willows. But they also frequently encourage or tolerate mature cottonwoods and other trees, as shade for livestock and people. The cultural landscape functions of ditches were not limited to urban street trees. Benjamin Eaton transplanted 45,000 cottonwoods along the Larimer and Weld Canal and the laterals under it.[151] In agricultural settings, irrigation made possible large orchards. In general, the three types of

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[148] For more specific information on bridge types, please reference: Clayton B. Fraser, *Highway Bridges in Colorado*, National Register of Historic Places Multiple Property Documentation Form (Denver, CO: Colorado Historical Society, 2000).

[149] Silkensen, *Farmers' High Line*, 78 n. 3.

[150] JRP Historical Consulting Services, *Water Conveyance Systems in California*, 48.

[151] Allison, "The Founding and Early Y ears of Eaton."

landscapes associated with water conveyance systems are urban, agricultural, and mining. As ditches and canals made possible the settlement or production surrounding them, the landscape setting became dependent on the irrigation routes.

Subtype: Ditching Machinery
Ditchers, dredges, fresnoes, if located in association with a ditch system, are potential associated *structures* or *objects*.

**National Register of Historic Places Registration Requirements**
Ditches and canals, as linear resources, are best understood as parts of functional systems. For even the simplest farm ditch, the system includes a source of water, a means of diversion, a conduit — the ditch itself — for carrying the water, and a means of controlling the flow, which may be a shovel in the farmer's hand. The system also includes a use for which the water is delivered. That use — the farm or ranch — is part of a larger system, whether a subsistence community or an agricultural market.

The value of a systems approach in understanding ditches increases with the complexity of the system. Most major canals after the pioneer period relied upon water storage in reservoirs. The reservoir might be distant from the canal itself, at a high altitude for example; the canal cannot function and cannot be understood without it. The natural stream serves as a conduit in such a system. Water rights law and administration is an essential part of this system; a high-altitude reservoir would be constructed only with confidence that waters released into the stream may be withdrawn downstream at the canal headgate. Law and administration are intangible, but they have tangible expressions in measuring and recording devices on the ditch and gauging stations in the stream. Most areas of extensive irrigation now function as complex systems in which direct-flow and stored water are traded up and down the stream to get water to the right place at the right time for use. Almost all of Colorado's surface water is delivered by gravity (irrigable land is referred to as "below ditch"), and water traders must end up with water that is physically above their point of use. Systems have evolved toward versatility in this respect; thus the several "high line" canals capable of delivering water to any of the earlier ditches below them.

Significance, for the purpose of National Register of Historic Places eligibility, should be evaluated with respect to the complete resource. That generally means the whole ditch or canal; it may mean a section of a canal if it has a distinct historical origin and identity (for example, the Upper and Lower Platte and Beaver Ditches in Morgan County). The surveyor should consider the significance of the whole resource. Significance should be evaluated with respect to at least a rudimentary historic context of a larger system. Survey projects that will include multiple ditches in a particular area should begin with such a context. The definition and scale of the system may be flexible depending upon the nature and function of the resources being studied. A consideration of significance for a small pioneer ditch in an isolated valley may look only at the farms that it served. A canal in the lower South Platte or Arkansas Valley should provide some understanding of its relationship to the history and function of the great Bureau of Reclamation plumbing systems that supply those regions.

When a section of a larger system is being considered with the context of a larger cultural landscape (such as a lateral or a ditch that allowed for agricultural development on a farmstead), the component should be evaluated within a larger context — either the ditch system of which they are a part or a larger land use context such as the fields that they watered.[152] A lateral system need not be functioning or capable of functioning but should retain sufficient integrity to convey its function. Survival of some control structures is helpful in this regard but not essential. In a rural or urban district eligible for other reasons, even fragmentary traces of a lateral system may convey information about earlier landscape relationships and functions, and thus may be contributing features.

Resource Classification

A ditch channel itself is a *structure*. It may be a single complex structure many miles long, including a headgate, lateral turnouts, embankments and an access drive. Some parts of the system, such as a diversion dam, tunnels, major siphons or flumes (but not minor components such as lateral gates or a recording shed), may be of sufficient magnitude that they can be classified as separate structures in their own right. A ditch may be treated as a *district* if it includes multiple resources as components, or if it includes additional component landscapes such as farm fields or ditch camps.[153]

Significance Criteria

*Criterion A.*

The property types for ditch and canal systems are most often eligible under Criterion A for Agriculture, Community Planning and Development, Conservation, Ethnic Heritage: Hispano, Ethnic Heritage: Native American, Exploration/Settlement, and Politics/Government. These categories could apply to the ditch or canal system individually or the significance of a ditch or canal system within a larger cultural landscape.

Water is essential to life in semi-arid Colorado, and the development of water resources is central to the story of human habitation within the region. Ditches and canals were the most important factors in the development of Colorado's agriculture. Water supply was also a prerequisite for urban development. Many primarily agricultural systems also provided water for urban irrigation or municipal supply, for industrial power or process, or for hydroelectric generation, any of which, evaluated in context, may constitute a basis for significance under Criterion A.

*Criterion B.*

Ditch and canal systems are often large and complex parts of their communities, involving many people in many ways — as advocates, promoters, land developers, ditch company officers or managers, for example. Individuals served as leaders or organizers for political, economic and legal actions, sometimes with significance far beyond any individual ditch. As such, these systems are rarely eligible under Criterion B. Where such an individual is historically significant, a ditch or canal system's significance under criterion B will depend upon the strength of the person's association with the resource, and whether other resources better embody the association with the portions of the person's life or work that are historically important. Some examples of individuals important in Colorado (or

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152 One such approach might be to define all of the resources as part of a Rural Historic Landscape. Linda Flint McClelland, J. Timothy Keller, Genevieve Keller, Robert Z. Melnick, *National Register Bulletin 30: Guidelines for Identifying and Documenting Rural Historic Landscapes* (Washington, DC: National Park Service, 1999).

153 "Linear Resources: Beware the Snake in the Grass,'" *The Camera and Clipboard* (Nov. 2002, Colorado Office of Archaeology and Historic Preservation): 6-7.

nationally) irrigation history include Benjamin Eaton, T. C. Henry, Elwood Mead, J. Max Clark, Ralph Parshall, E. S. Nettleton, William E. Pabor, David Boyd, and James Duff.

*Criterion C.*
Ditch and canal systems may be eligible under Criterion C in the areas of Architecture, Engineering, or Landscape Architecture. Ditches may be eligible as an important example or as a rare remaining example of an important type of construction (for example mining diversions or an Anasazi check dam). They may be eligible as well-preserved and characteristic examples of a type that is not rare (for example pioneer ditches or commercial canals). They may be eligible for departures from a type that demonstrate formal evolution, or that demonstrate adaptation to the circumstances of a particular function or place.

*Criterion D.*
Traces of ditches from early or underrepresented periods of Colorado's history may be eligible under Criterion D for its information potential. For example, Native American irrigation systems, early Hispano ditches, placer mining ditches, ditches from trading posts or pioneer-era homesteads all may yield information from periods and settlement types that are otherwise undocumented. Associated properties, for example ditch construction camps, may yield important information about historical groups such as immigrant labor populations or early federal construction activities. Later water conveyance systems may also yield information unavailable elsewhere — ditch laterals, for example, whose location and arrangement is seldom documented, may provide information on the historic arrangement of agricultural lands, irrigation methods, and changing crop cultivation patterns. Remnant lateral turnout gates, where the laterals themselves have disappeared, may be the only evidence of previous development patterns.

Period of Significance
The period of significance is important because it becomes a standard for determining which changes are to be treated as part of the evolution of the historic resource and which are to be treated as alterations that may contribute to a loss of integrity. The period of significance must bear a logical relationship with the significance criteria under which the ditch or canal system is eligible. Eligibility under Criterion A should be reflected in a period of significance corresponding to the historic events, or broad historical patterns, from which the system's significance derives. Under Criterion B, the period of significance should reflect the dates of association with the important individual. If a ditch or canal system is eligible under Criterion C for its design or engineering, the period of significance will ordinarily be the period of construction. It may include the dates of later alterations if they are significant in their own right.

Level of Significance
Depending on the size, purpose, and impact of any given ditch or canal system, the level of significance can vary. A simple system might be best addressed at the local level of significance. More extensive systems might be better addressed on a state or possibly national level of significance, depending on the type of impact or precedent those systems had. Researchers must complete a comparative analysis of similar systems in the state in order to determine if a resource is at the state level of significance, and a comparative analysis of similar systems in the nation to determine if a property is nationally significant. Preferably these comparisons would be to properties that are already established at either a state or national level of significance, but when there is no precedent for a particular type of

ditch or canal system, then the state or national level of significance must also be supported by a strong contextual argument in the statement of significance.

### Integrity

Properties may meet registration requirements if they possess sufficient character and integrity to retain their sense of time and place from their period of significance during the historic period of ditch or canal construction or usage. If the property lacks the significant distinguishing features from its period of significance, no matter how just and well intentioned those renovations may be, the property no longer possesses integrity for that period of significance.

*Location*
The ditch or canal system should remain on the original alignment from its period of significance. It is rare for a significant length of ditch or canal to be re-routed. Alignment changes for short lengths of ditch are more common: a ditch may have washed out and been re-excavated farther into a hillside; a highway crossing may have reconfigured a channel; headworks may have been rebuilt with new diversion points; leak-prone or meandering sections may have been cut off by the use of heavy excavating machinery. Such minor realignments do not ordinarily compromise the integrity of the whole resource. Any changes to location must be judged in relation to the ditch or canal system's overall significance and the period of that significance.

*Design*
Design may refer to the engineering or technology of specific components, or the arrangement of the system as a whole. Where the ditch or canal is significant for its design or engineering, the characteristic qualities or features of that design should remain evident. Integrity of design may be evaluated at the scale of individual ditch or canal components, if that is where significance resides, or at the scale of the whole system. At the system scale, replacement of components may not diminish integrity if they are replaced in kind, the system functions in the same way, and its function remains evident. A systems approach, applied at the scale of the single ditch, can help keep clear the relative importance of component features when assessing integrity.

*Setting*
In urbanizing areas, open agricultural settings may have changed dramatically. Integrity does not require that the entire historic landscape remain, but rather that the features defining the ditch's significance are not rendered imperceptible by changes in the setting. Changes in a ditch's setting will not be fatal to integrity unless a contemporary from the period of significance would be unable to recognize the ditch. A well-preserved setting may contribute to integrity. Consider what the setting relationships were during the period of significance: some ditches passed through urban areas or non-irrigated areas with no integral relationship to the ditch. Setting may be relevant at various scales; it may consist of the ditch corridor itself, particularly where the ditch was historically vegetated and thus the character of the corridor was linear and self-contained.

*Materials*
Earthen channels ought to remain primarily earthen. Lining of sections in order to correct leaks, or as part of highway crossings or other short sections, do not adversely impact integrity. Clay lining in particular has no effect on the integrity of an earthen channel. Wooden structures of all kinds were

subject to such rapid wear and deterioration in the ditch that they were essentially temporary, typically replaced every 15 to 20 years. The absence of original wooden structures cannot be fatal to integrity, and the survival of any wooden ditch structure more than fifty years old, especially in functioning condition, is highly unusual. However, there is the possibility of replacement of materials in kind as part of regular maintenance. The gradual replacement over time of wooden by more permanent structures is characteristic of the evolution of almost all ditches. Concrete lining of whole ditches was practiced as early as the turn of the twentieth century, and concrete and steel structures of all kinds were common by the 1910s and 1920s. In short, the mere presence of metal gates or concrete lining does not necessarily undermine the integrity of a ditch system, and instead it might convey a critical aspect of development during the historic period of significance for the system.

*Workmanship*
Workmanship may be exhibited in the maintenance of traditional earthen channels, or the craft of rock cuts or the formwork of concrete structures. For vernacular construction, workmanship does not require that quality be exceptional, but rather that the characteristic methods and quality of the type should be evident.

*Feeling*
Flowing water in an arid environment is evocative. The sight and sound of water, and our awareness that it is on its way to be useful, may help a ditch express its essential significance, and thus retain integrity in the face of other changes. The lack of flowing water does not mean that a ditch, canal, or other associated feature has lost integrity of feeling. Most active ditches are dry for periods each year. Ditches or portions of ditches that no longer carry water may retain integrity if enough remains of their physical fabric to convey their function and significance. Non-operating ditches may be subject to losses through natural erosion or human development, but may also retain original features unmolested by periodic replacement.

*Association*
The integrity of setting, location, design, workmanship, materials, and feeling of a ditch or canal system help to establish the integrity of association. The resource must be able to convey its associations with its period of significance and historic function. When determining eligibility under Criterion B, the resource must still convey its association with that significant individual.

## GEOGRAPHICAL DATA

The State of Colorado.

## SUMMARY OF IDENTIFICATION AND EVALUATION METHODS

The multiple property listing of irrigation and water supply ditches and canals in Colorado is based upon a historical context study conducted from 2001 to 2005 by Professor Michael Holleran, with the assistance of Dr. Manish Chalana, Kris Christensen, and Michael Hinke, of the Colorado Center for Preservation Research, University of Colorado at Denver and Health Sciences Center. The context study was conducted for the Office of Archaeology and Historic Preservation of the Colorado Historical Society (OAHP, the Colorado SHPO), with support from the Colorado State Historical Fund. The context draws upon Professor Holleran's earlier surveys of several Colorado ditches, also supported by the State Historical Fund.

Because these resources are extraordinarily numerous and widespread, this project did not attempt to record or field survey them, nor did it attempt primary archival research on individual ditches. Much of the research drew upon two data sources: the Colorado Department of Water Resources (DWR) and the OAHP.

The DWR maintains databases from the State Engineer's Office, including water appropriations and water delivery structures. These were used to help define the universe of potential ditch and canal resources. The structures database lists approximately 22,858 ditches and canals. This includes all for which any water right filing has ever been made – practically every one in operation today, and also abandoned ditches where they operated long enough to have encountered the system of water rights adjudication (beginning in 1881). Abandoned ditches may still remain as potential historic or archaeological properties. An unknown number were abandoned before entering the adjudication system, so the DWR tally understates the potential number of resources. The appropriations database includes more than 70,000 water right records associated with ditches. Dr. Chalana sorted the water rights records to find the earliest attached to each structure. This serves as a reasonable proxy for the beginning of construction, though the period of significance may depend upon other factors as well. Approximately 17,500 Colorado ditches have appropriation dates before 1950.

The OAHP's database includes all properties that have been surveyed to date as cultural resources. The database was used for an overview of previous surveys and eligibility determinations. A file search in 2001 showed 3389 water-related records. These were sorted to select those that appeared to be ditch- or canal-related based on keywords (ditch, canal, lateral, flume, headgate, irrigation), leaving 1539 records. Duplication was eliminated (resurveys or multiple sections of the same resource) to arrive at a list of 1007 unique properties surveyed so far. The historical context is based upon Joseph E. King's *Colorado Engineering Context* (Denver: Colorado Historical Society, 1984). Ditches and canals have been constructed in every region of Colorado, in every period of its history, so the context draws upon all the OAHP regional historical contexts (including *Colorado Urbanization*). The DWR database includes quarter-sections of each ditch's point of diversion, so that Dr. Chalana was able to link the whole database to GIS and the statewide development of water diversions could be mapped with respect to both time and space. This spatial analysis supplemented a review of the secondary historical literature. Most of water history is logically organized by major drainage basins (which also correspond with DWR's water divisions), though some property types (Reclamation projects, municipal water systems, mining diversions) may cross basin boundaries. The context also presents themes such as water law and administration that cut across the different regions and ditch types, and that may bear on the significance of particular properties.

Property types – Anasazi irrigation systems, Hispano *Acequias*, mining diversions, pioneer ditches, colony ditch systems, commercial canals, state, federal, and municipal water systems – are defined by their role in larger functional and cultural systems. They are arranged in the rough chronological order in which they emerged. These types did not supersede one another but formed layers in an increasingly complex structure. Registration requirements recognize the variety of these systems and of the ways that they may exhibit significance. Registration requirements also recognize the scales at which a ditch may exhibit significance, from local to national.

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