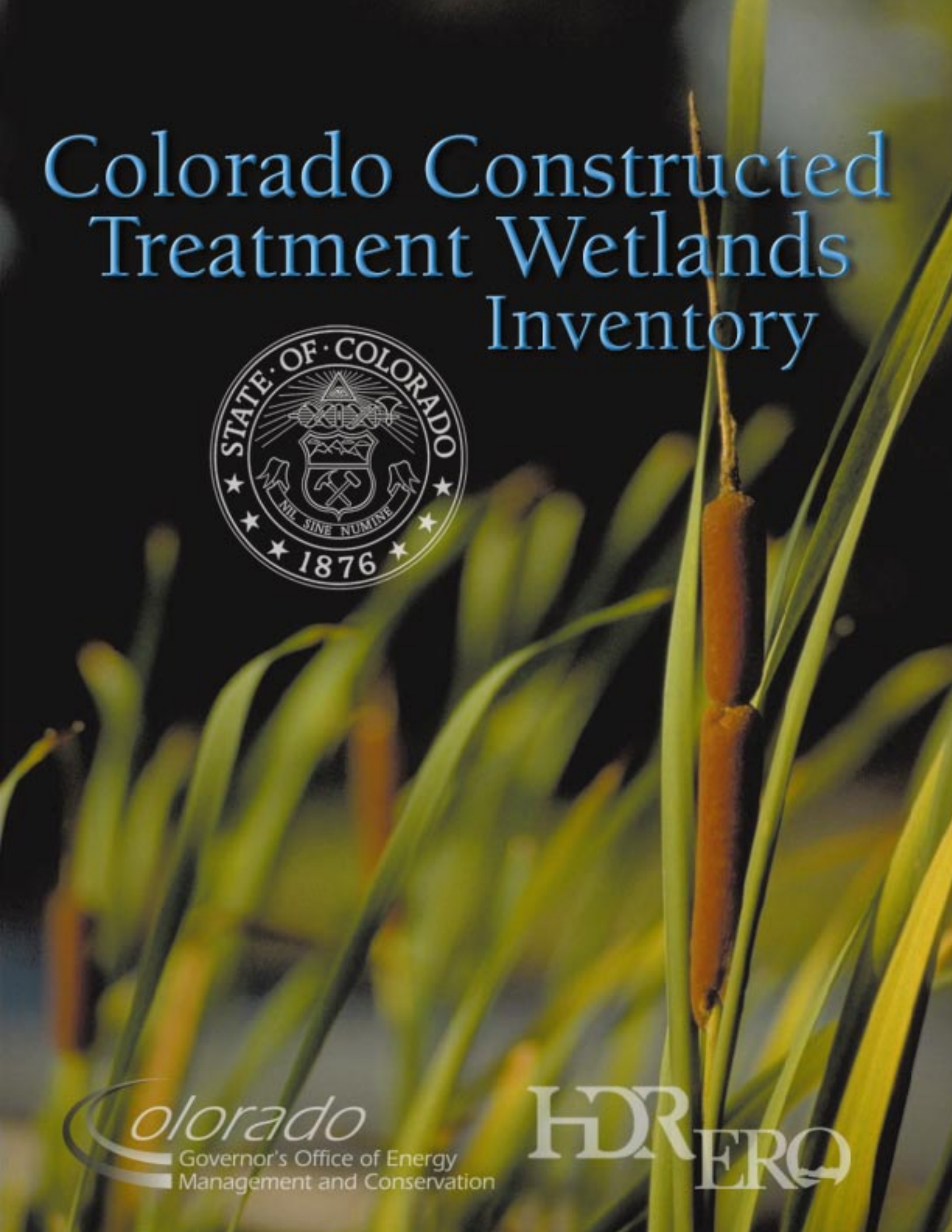
Colorado Constructed Treatment Wetlands Inventory



Colorado
Governor's Office of Energy Management and Conservation

HDR ERO

Letter from the Task Force Chair

The Colorado Constructed Treatment Wetlands Inventory project makes a significant contribution to knowledge about the design, construction, operation and energy efficiency of wetlands used to treat wastewater. Constructed wetlands are a very effective, low-cost, energy conserving wastewater treatment process. The importance of conserving energy, and the many other benefits of wetlands are outlined in the report.

It has been a pleasure and an enlightening experience working with the many wetlands experts serving on the Constructed Wetlands Task Force. The Task Force members offered guidance and counsel from many perspectives. Their input provided the framework for developing and implementing the useful and informative product described by this report. The Task Force members and their professional affiliations are listed below. As the facilitator for the Colorado Governor's Office of Energy Management and Conservation (OEMC), I would like to thank these dedicated professionals for sharing their expertise and time to make this project a success.

Academia—**Maurice Albertson**
American Water Works Association—**Clare Haas Claveau**
Colorado Department of Agriculture—**Jim Miller**
Colorado Department of Natural Resources—**Kent Holsinger**
Colorado Department of Public Health and Environment—**Cary Pilon**
Colorado Water Congress—**Ralph Curtis**
Land Developer—**Todd Alexander/Tom Hoyt**
National Audubon Society—**Susan Kirkpatrick**
Natural Resources Conservation Service—**Terri Skadeland**
Treatment Plant Supervisor—**Todd Harris**
US Environmental Protection Agency—**Gene Reetz**
US Army Corps of Engineers—**Tim Carey**
US Geological Survey/US Bureau of Reclamation—**Joan Thullen/Rick Roline**
Water Environment Federation—**Dale Butler**

The cooperation of the management and operators of the constructed wetland facilities inventoried during this project made it possible to collect the information presented in this report. Analyses of these data will lead to improved design and operation of constructed wetlands in Colorado, and other cold regions of the United States, as well as other parts of the world. The operators have shown considerable ingenuity in adapting facilities to their environment and this operational information will be invaluable to present and future constructed wetlands operators. Although individual facility participants are not listed in this letter, their contributions were vital to the success of this project. We sincerely thank everyone for their help and ideas.

I commend Ed Lewis and Rob Pearson with the OEMC for their guidance and leadership in managing and coordinating this successful project. Rick Grice, Director of OEMC, is to be commended for recognizing the potential for constructed treatment wetlands and the need to collect basic information about their operation and design in Colorado.

The professional approach used to collect the information and prepare this report by HDR Engineering, Inc. and ERO Resources must be acknowledged. Margaret Medellin with HDR; and Liz Payson and Andy Cole with ERO, established an effective working relationship with wetlands management and operating personnel. Their professional approach made it possible to obtain design and operating information that will be extremely useful to the public.

I have thoroughly enjoyed working with all of the people involved in this project, and look forward to the next phase; construction of a demonstration project suited to Colorado.

Sincerely,

E. Joe Middlebrooks, P.E., Ph.D., D.E.E.
Task Force Chair

New Horizons

Wastewater treatment professionals have long recognized the cleansing abilities of wetland systems. However, there are limited data available about these systems. Pioneers in this industry designed wetland systems based on ingenuity and limited performance data. Because these professionals had such foresight, there are many operating constructed treatment wetlands and data are now available from which wetland designers can learn. In 1999, the OEMC recognized the need to collect and disseminate this data and embarked on a Phase I program to evaluate and document constructed treatment wetland features and performance in Colorado. The OEMC's timely implementation of Phase I will help all future builders of constructed treatment wetlands in Colorado and other parts of the country.

OEMC began this effort by selecting experts from various groups involved with wetlands and wetlands issues. These individuals comprise the OEMC Wetlands Task Force. The Task Force provided expertise and advice to guide the project and establish the requirements for evaluating wetland data.

In Search Of Excellence—A New Perspective

To implement the program, the OEMC requested proposals from qualified firms to locate, catalog and document the efficiency of Colorado's constructed treatment wetlands. From that request, the Task Force and OEMC selected the team of HDR Engineering, Inc. and ERO Resources. The HDR/ERO team was chosen based on their ability to evaluate wetlands from both an engineering and biological perspective. Including both engineers and biologists in the inventory allowed a comprehensive review of the wetland treatment systems—from engineering details to habitat value. The team collected data to assess design features, energy savings, flora and fauna biodiversity, general operational problems, and lessons learned. From this inventory a database that is compatible with the North American Treatment Wetland Database (NADB) was created.

A Vision For The Future

The OEMC plans to develop a demonstration project that incorporates the most effective features of all the wetlands evaluated. The project will require a partnership between the OEMC, an engineering consultant, a community wishing to build a wastewater treatment facility using wetlands, and potentially the Department of Energy, US Environmental Protection Agency (EPA) or other interested parties. Ideally, the wetlands project will incorporate energy savings and efficiency, improved water quality for stream or river discharge, high-value wildlife habitat, and walking trails for wildlife viewing. The demonstration project will consider general quality-of-life issues such as buffers between developments or communities to address "smart growth" issues and acquisition of open space. This project will likely begin in the early summer of 2001.

Water—A Limited Resource

"When the well's dry, we know the worth of water"—*Benjamin Franklin*

Earth is often referred to as the water planet because more than 70% of the earth's surface is covered with water. Since this resource is seemingly abundant it is easily taken for granted. This apparent abundance is deceptive, as only 3% of the earth's water is fresh, and two-thirds of that is trapped in glaciers and icecaps. So the issue that must be dealt with is not water supply, but water quality. With a limited amount of fresh water and an increasing global population,wise management of water supplies is essential. It is important for societies to recognize the value of protecting the quality of this limited and valuable resource.

Wetlands provide a natural cleansing process for Town of Ouray.

A Natural Treatment Alternative

Natural purification barriers: Wetlands are natural water purification barriers. Because of land development practices during the last few decades, many natural wetlands have been dewatered. This reduction in wetland area has resulted in larger amounts of pollutants entering water bodies. A shift towards wetland area protection has occurred in recent years as the cleansing capabilities of wetlands have been recognized.

Natural cleansing process: The cleansing processes identified in natural wetlands can be mimicked in constructed treatment wetlands. Constructed treatment wetlands are designed to maximize the natural abilities of wetlands to remove pollutants from a variety of wastewater sources. This study focuses on the use of constructed wetlands for the treatment of municipal wastewater.

Constructed wetlands are a viable treatment alternative for many reasons. Treatment wetlands remove solids, oxygen depleting pollutants, and lower bacterial and viral levels. Unlike traditional treatment methods, wetlands offer many ancillary benefits. These benefits, including wildlife habitat, and aesthetic and educational values, were evaluated as was the wetland's ability to successfully meet its treatment goals.

Identifying Constructed Treatment Wetlands In Colorado

Phase I of the Colorado Constructed Treatment Wetlands Inventory was a reconnaissance effort to locate wetlands in Colorado used to treat point source pollutants. The project team performed a literature review, pursued leads provided by the OEMC and Task Force, and used local community knowledge to identify appropriate wetland sites. From a preliminary list of constructed treatment wetlands, the Task Force developed a final list to include in this study. The criteria used to determine whether a site would be included on the final list are as follows:

- Constructed wetland must be treating a point source.
- Data must be available in order to assess the wetland's wastewater treatment efficiency.

Twenty sites met both of the above criteria. While examples of other types of wetlands are included in the study, most of them were not included in the more rigorous analysis, since this project focused on municipal treatment wetlands.

Evaluating Colorado's Existing Constructed Treatment Wetlands

The HDR/ERO team considered both engineering and biological parameters in their wetland evaluations. The team made site visits to the selected wetlands and used a Site Data Sheet (SDS) to provide a consistent method to evaluate each site. The evaluation process allowed for an independent review of both the engineering and biological aspects. The inventory provided a 'snapshot' of how the wetland was performing on the date of the site visit. Water quality records and historical information were gathered during an interview with a wetland contact person; as well as from Colorado Department of Public Health and Environment (CDPHE) permit files.

Pitkin County subsurface flow wetland in the midst of Aspen trees.

Updating The National Database With Information On Colorado Wetlands

In the early 1990's the US EPA sponsored the creation of a database containing design and performance information about constructed treatment wetlands. This information is used to develop design guidelines and to chronicle the successes and failures of wetland systems. Prior to the Colorado Constructed Treatment Wetland Inventory project, only one Colorado wetland system was included in the database. A primary goal of this study was to collect data on Colorado's treatment wetlands for entry into the National Database. The team developed the SDS with this goal in mind and designed a database compatible with the National Database to store this information.

'Lessons Learned' From Those Involved With Existing Wetlands

Wastewater treatment using constructed wetlands involves different processes than conventional treatment methods. Operators, designers, and local officials must approach the implementation and operation of constructed wetlands with an understanding of the natural treatment processes involved. Information collected from existing Colorado treatment wetlands details the challenges of designing and operating these systems and chronicles the innovative solutions developed to meet them. The ultimate goal of this project is to disseminate information regarding the use, design, operation, and performance of constructed treatment wetlands. This will assist future wetland designers and operators to learn from the past experience of others.

Ridgway State Park uses a treatment wetland as a water feature.

Who's Who In Constructed Treatment Wetlands In Colorado

Over the course of this project, the HDR/ERO team developed a contact list. This list is provided in the report to facilitate communication between those with knowledge about these systems and those interested in learning more.

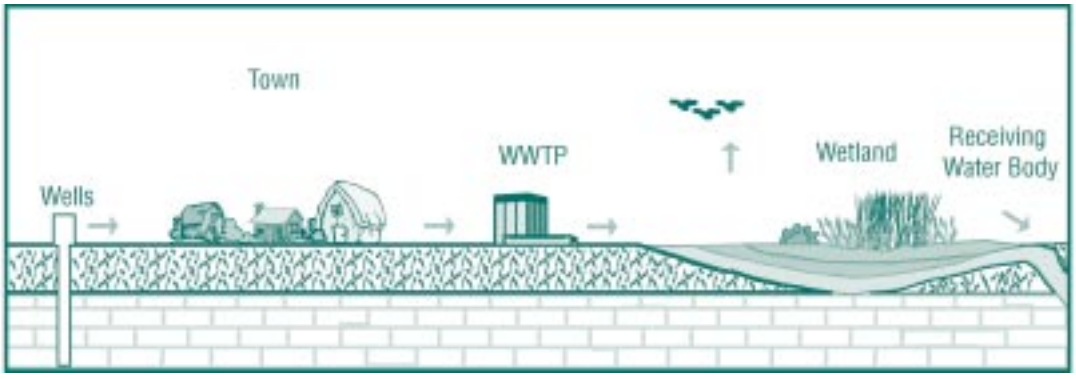
The Colorado Constructed Treatment Wetlands Inventory report documents experiences with Colorado's constructed treatment wetlands. A description of individual sites is discussed in the report and general observations from the project are presented. The OEMC, Task Force and HDR/ERO team hope this document will serve as a resource for those interested in using constructed wetlands as an effective and low energy method of treating wastewater.

What Is A Constructed Treatment Wetland?

In a wetland, microorganisms that are naturally present in wastewater are provided with an ideal habitat and readily available organic material as a food source. As these microorganisms feed, they breakdown pollutants into basic components which are harmless to the environment. In addition, solids such as trash and silt, are removed as the water moves through the quiescent zones of the wetland.

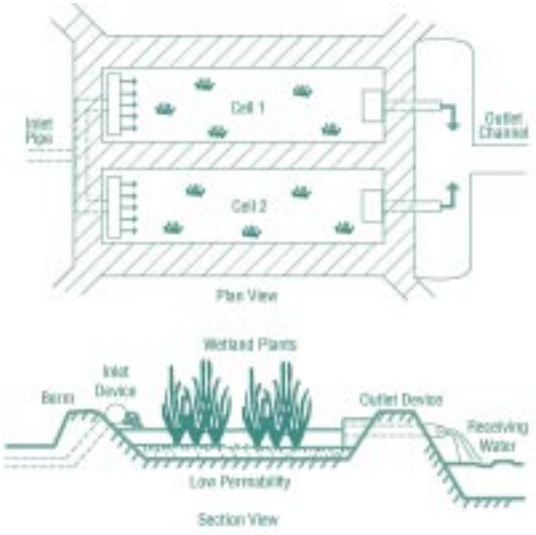
A constructed treatment wetland is a bio-engineered system that provides optimum conditions for natural cleansing processes to take place. Constructed treatment wetlands are used to treat widely varying sources of wastewater:

Location of Wetland within Watershed

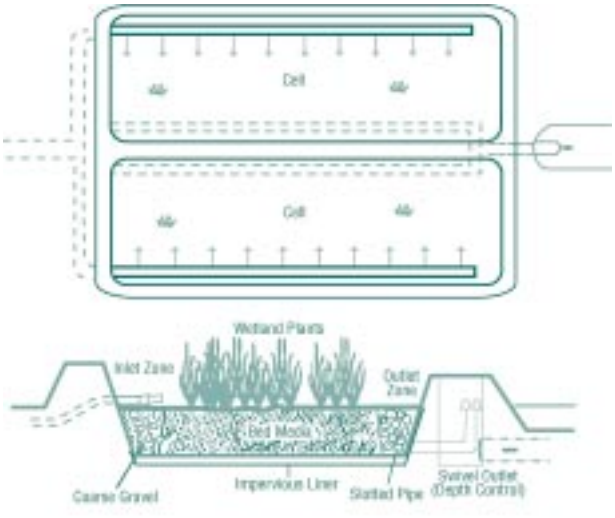


Wetlands can be constructed to purify water before it enters the receiving water body.

Free Water Surface Wetland



Subsurface Wetland



Two general types of wetlands are typically constructed for water treatment: free water surface flow (FWS) and subsurface flow (SS) wetlands. In a FWS wetland, water is generally introduced above the ground surface and flows through the wetlands at depths ranging from 6 to 12 inches. In a SS wetland, water is introduced into a gravel medium through a perforated pipe or other underground dispersal system. SS wetlands may contain up to 4 feet of gravel, and the water surface elevation is maintained just below the top surface of the gravel.

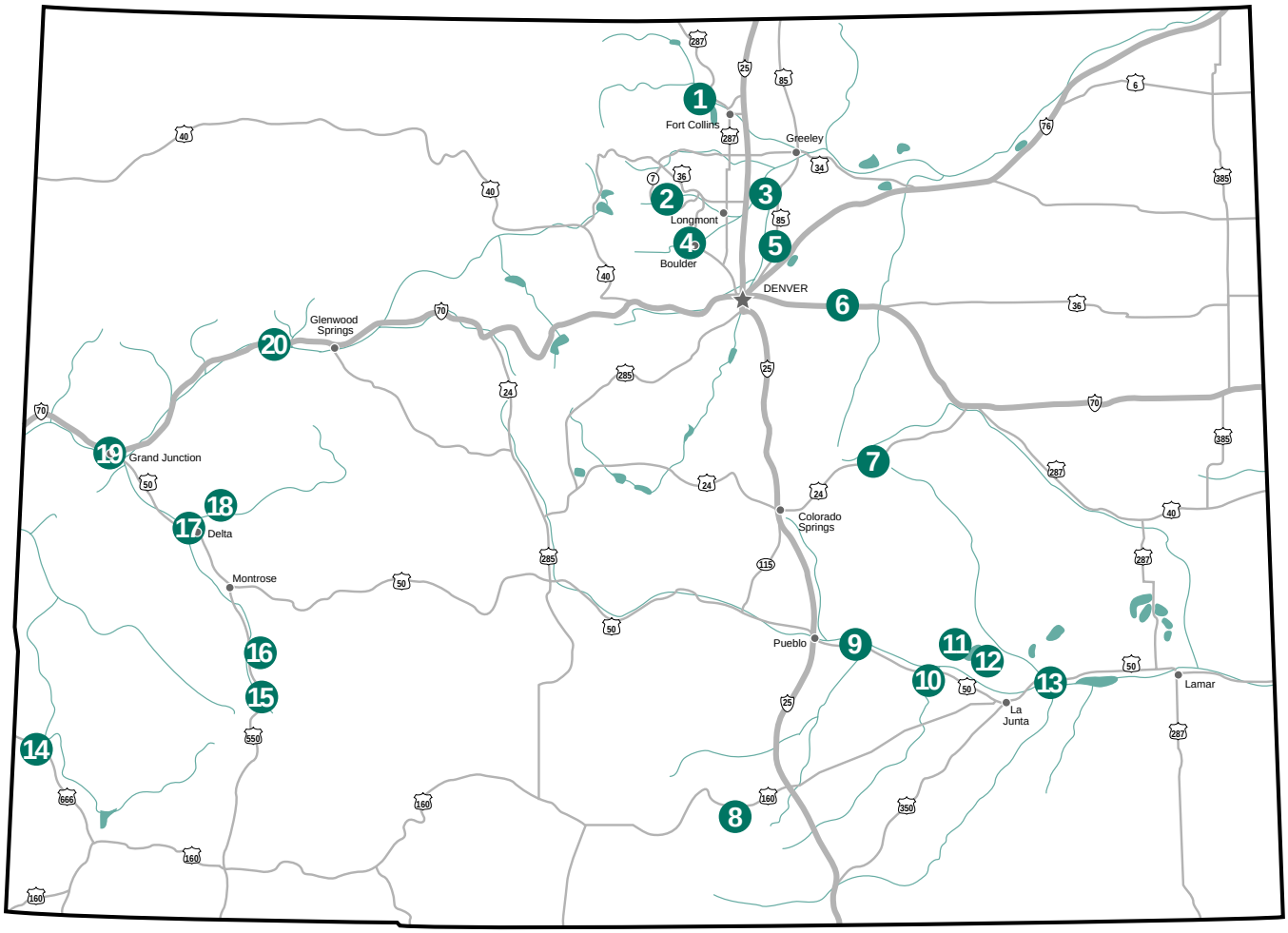
What Are The Benefits Of Using Constructed Treatment Wetlands?

Silt wetlands contribute to this scenic view of the Rocky Mountains.

By mimicking the natural cleansing processes that take place in wetlands, constructed treatment wetlands can purify wastewater and provide the following ancillary benefits:

- **Minimize Energy Consumption.** Typically a constructed wetland has no supplemental energy requirements. The type of pretreatment used will determine the entire energy consumption of the treatment system.
- **Minimize Chemical Requirements.** A wetland treatment system uses minimal chemicals. Before treated wastewater is released it must meet certain regulatory requirements, such as those detailed in the Clean Water Act. All the wetlands inventoried had the capability of providing some form of disinfection to the treated wastewater; however, many of the wetlands inventoried treated the wastewater to a high enough level that further disinfection was unnecessary.
- **Provide Habitat for Wildlife.** Wetland vegetation provides food sources and habitat for birds, mammals, and amphibians. Over 20% of the animals listed on the Endangered Species List use wetlands for either habitat or as a food source. Constructed wetlands provide an additional habitat for many species.
- **Educate.** Wastewater treatment wetlands offer educational opportunities for local schoolchildren and interested adults. Treatment wetlands are ideal settings to view wildlife, discuss wastewater treatment processes, and educate the public about the importance of wetlands in the environment.
- **Add Aesthetic Value.** Constructed treatment wetlands are an attractive addition to the community. In contrast to conventional treatment systems, these wetlands provide aesthetic benefits and do not detract from the scenic beauty of many remote areas. The Colorado inventory identified constructed treatment wetlands that were along trails, used as water features, and as parts of scenic vistas.

Constructed Treatment Wetlands Inventoried



1 Rocky Mountain Shambhala Center

2 Highlands Presbyterian Camp

3 Platteville

4 Valmont Power Plant

5 Brighton

6 Bennett

7 Calhan

8 La Veta

9 Avondale

10 Manzanola

11 Crowley County Correctional Facility

12 City of Crowley

13 Las Animas

14 Dove Creek

15 Ouray

16 Ridgway State Park

17 Delta

18 Horizon Nursing Home

19 Island Acres State Park

20 Silt

Featured Colorado Constructed Treatment Wetlands

	COUNTY	WETLAND TYPE	AVG FLOW (MGD)	AVG BOD IN (mg/L)	AVG BOD OUT (mg/L)	AVG TSS IN (mg/L)	AVG TSS OUT (mg/L)	AVG pH	WASTEWATER SOURCE	YEAR BUILT	SITE VISIT
Avondale	Pueblo	FWS	0.1	184.27	26.62	164.27	39.03	7.99	Municipal	1996	Y
Benedictine Monastery Cloister	Aspen/Pitkin	SS	NA	NA	NA	NA	NA	NA	Residential	1998	N
Bennett	Adams	FWS	0.08	284.96	20	328.64	47.04	7.81	Municipal	1998	Y
Brighton	Adams	SS	0.02	184.02	11.6	166.21	20.25	8.6	Municipal	1998	Y
Buena Vista	Buena Vista	SS	NA	NA	NA	NA	NA	NA	Residential	NA	N
Calhan	El Paso	FWS/SS	0.06	245.43	10.67	241.09	7.17	7.78	Municipal	1997	Y
Chalk Cliffs Lodge B&B	Chaffee	SS	NA	NA	NA	NA	NA	NA	Residential	1998	N
Cheyenne Mtn Zoo Tiger Exhibit	El Paso	SS	NA	NA	NA	NA	NA	NA	Small Exotic	1996	N
City of Crowley	Crowley	FWS	0.14	207.52	19.96	502.84	16	7.5	Municipal/Prison	1994	Y
Clear Creek Residence	Clear Creek	SS	NA	NA	NA	NA	NA	NA	Residential	1994	N
Coors Field	Denver	SS	NA	NA	NA	NA	NA	NA	Stormwater	NA	Y
Crowley County Correctional Facility	Crowley	FWS	0.11	278.18	13.2	333.25	14.58	8.42	Prison	1998	Y
Delta	Delta	FWS	0.03	248.86	14.52	113.1	41.98	6.84	Prison	1997	Y
Dove Creek	Dolores	FWS	0.05	258.31	38.09	338.48	71.7	7.86	Municipal	1999	Y
Fishing Cabin	Garfield	SS	NA	NA	NA	NA	NA	NA	Residential	1996	N
Grand County Cabin Court	Grand	SS	NA	NA	NA	NA	NA	NA	B&B	NA	N
Green Gulch	Denver	FWS	NA	NA	NA	NA	NA	NA	Stormwater	NA	Y
Highlands Presbyterian Camp	Boulder	SS	NA	NA	NA	NA	NA	NA	Seasonal	NA	Y
Horizon	Delta	FWS	NA	NA	NA	NA	NA	NA	Nursing Home	NA	Y
Island Acres	Mesa	FWS	NA	NA	NA	NA	NA	NA	Park	NA	Y
Jefferson County Residence	Jefferson	SS	NA	NA	NA	NA	NA	NA	Residential	1994	N
Larimer Residence	Larimer	SS	NA	NA	NA	NA	NA	NA	Residential	1992	N
La Veta	Huerfano	FWS	0.07	216.62	19.97	245.12	25.8	7.92	Municipal	1993	Y
Las Animas	Bent	SS	0.61	200.65	24.18	236.8	44.07	8.01	Municipal	1998	Y
Manzanola	Otero	FWS	0.06	193.1	28.34	143.94	49.42	8.09	Municipal	1996	Y
Mt Elbert Lodge	Twin Lakes	SS	NA	NA	NA	NA	NA	NA	B&B	1994	Y
Ocean Journey	Denver	FWS	NA	NA	NA	NA	NA	NA	Small Exotic	1999	Y
Oberon Middle School	Jefferson	FWS	NA	NA	NA	NA	NA	NA	Stormwater	1998	Y
Ouray	Ouray	FWS	0.21	95.8	3.98	138.7	6.52	7.23	Municipal	1992	Y
Park County Residence	Park	SS	NA	NA	NA	NA	NA	NA	Residential	1994	N
Pitkin County Residence	Pitkin	SS	NA	NA	NA	NA	NA	NA	Residential	1998	N
Platteville	Weld	FWS	0.13	271.78	25.64	270.92	26.69	7.48	Municipal	1993	Y
Ridgway	Ouray	FWS	NA	NA	NA	NA	NA	NA	Park	NA	Y
Shambhala Center	Larimer	SS	NA	NA	NA	NA	NA	NA	Seasonal	NA	Y
Shop Creek	Arapahoe	FWS	NA	NA	NA	NA	NA	NA	Stormwater	1992	Y
Silt	Garfield	FWS	0.12	229.25	30.26	202.28	26.52	7.61	Municipal	1992	Y
Summit County Residence	Summit	SS	NA	NA	NA	NA	NA	NA	Residential	1997	N
Teller Residence	Teller	SS	NA	NA	NA	NA	NA	NA	Residential	1995	N
Telluride	Telluride	FWS	NA	NA	NA	NA	NA	NA	Stormwater	1999	Y
Valmont	Boulder	SS	NA	NA	NA	NA	NA	NA	Office Buildings	NA	Y
Wildcat Ranch	Pitken	SS	NA	NA	NA	NA	NA	NA	Residential	1996	Y

Letter from the OEMC Director

Wetlands are not only a natural way to clean wastewater—they are energy efficient, help clean the air, provide wildlife habitat, constitute highly valued open space, and are aesthetically preferable to conventional wastewater treatment methods. The use of wetlands to treat wastewater is a win/win strategy for the environment and the public.

The city officials, design engineers, and operators we encountered in this study are pioneers who have had the courage to try alternative methods in search of more efficient and more economical solutions. It is our hope that this study will allow engineers, public officials, and operators contemplating the use of wetlands to learn from their successes and stumbling blocks.

In Phase II of this program, the OEMC and the Task Force will put new knowledge to work in a demonstration project that will serve as a model for others and a test for refinements in the treatment of wastewater with wetlands.

I wish to extend my thanks to HDR Engineering, Inc. for the effort and quality they put into this study. I also wish to thank the task force members, particularly Joe Middlebrooks, whose direction and gravitas have given it its value, and to Jack O'Connor who brought the concept of the value of wetlands as a wastewater treatment system to the attention of this office.

Rick Grice, *Director*

Governor's Office of
Energy Management and Conservation

For further information or a copy of the report, please contact:

Governor's Office of Energy Management and Conservation

Mr. Rob Pearson, *Program Manager*
225 E. 16th Avenue, Suite 650
Denver, CO 80203
Phone: (303) 894-2383
Fax: (303) 894-2388
e-mail: Rob.Pearson@state.co.us
www.state.co.us/oemc

The Governor's Office of Energy Management and Conservation (OEMC) is Colorado's lead state agency on energy efficiency issues. The OEMC has grown from an agency created to respond to the energy crisis of the 1970s to one that now supports cost-effective programs, grants and partnerships that benefit Colorado's economic and natural environment. OEMC's programs touch virtually every citizen of Colorado in meaningful ways. The agency's primary objective is to serve the people of Colorado through education, technical and financial assistance.

HDR Engineering, Inc.

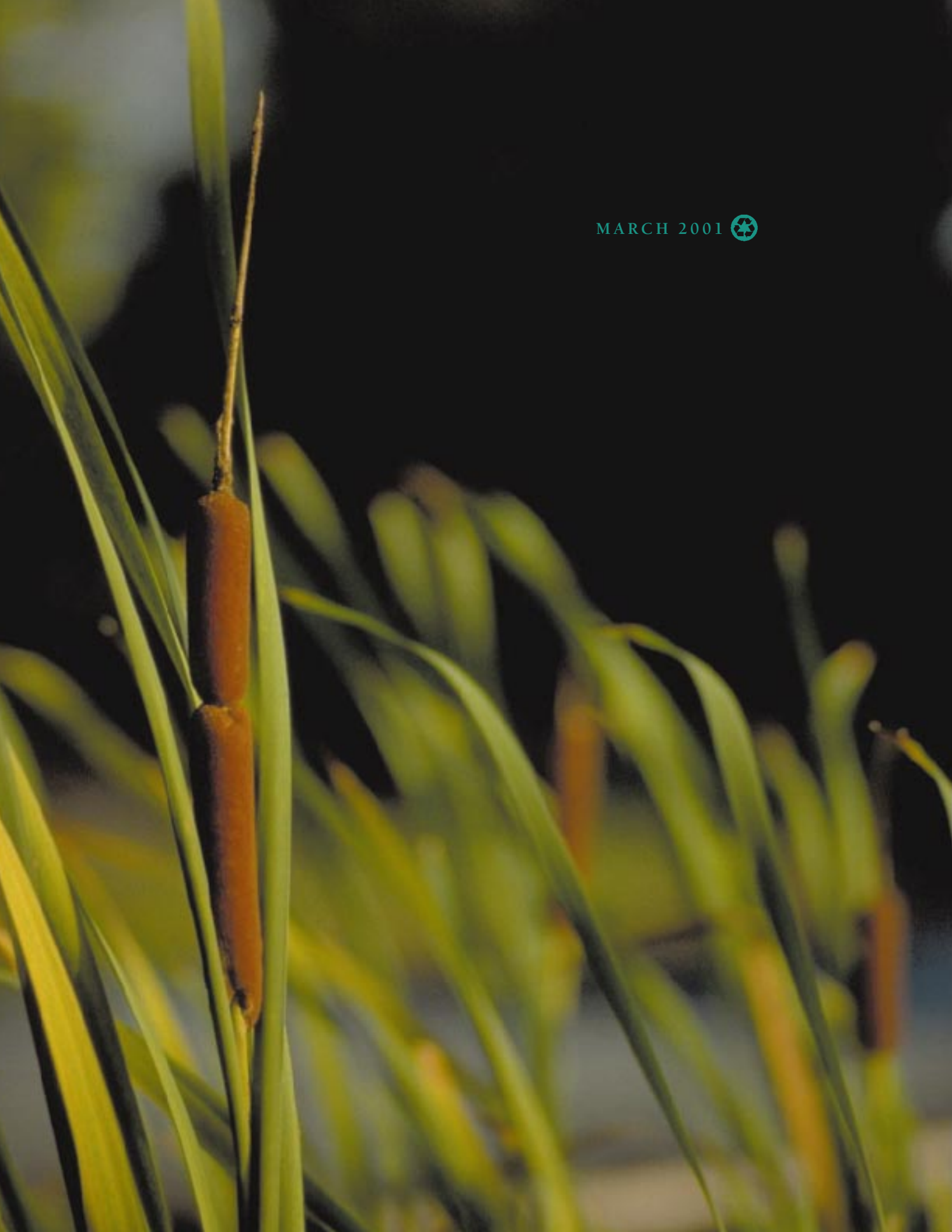
Ms. Margaret Medellin, *Project Engineer*
303 East 17th Avenue, Suite 300
Denver, CO 80203
Phone: (303) 764-1520
Fax: (303) 860-7139
e-mail: mmedelli@hdrinc.com
www.hdrinc.com

The operating companies of HDR bring their clients a wide range of services. HDR Engineering, Inc. offers engineering solutions in the areas of environmental and resource management, transportation and water. Building on HDR's established traditional services of planning, design, environmental and construction services, HDR also provides consulting and alternative delivery services such as design–build. These services offer innovative approaches and solutions that ensure client's needs are met. HDR Engineering, Inc. is a full service engineering firm with 3000 employee–owners and more than 50 offices nation-wide.

ERO Resources Corp.

Ms. Liz Payson, *Project Biologist*
1842 Clarkson Street
Denver, CO 80218
Phone: (303) 830-1188
Fax: (303) 830-1199
e-mail: lpayson@eroresources.com

ERO Resources is a team of scientists, planners, and engineers with diverse backgrounds and a shared interest in environmental issues. ERO's expertise in science and planning provides an approach to the environment that balances development with natural resources protection. With offices in Denver and Boise, ERO strives for a close working relationship with their clients. ERO listens closely to their clients' needs and expectations, and develops solutions for accomplishing project goals within an environmental framework. ERO provides services in natural resource investigations, environmental impact assessment and permitting, water resources, hazardous waste investigations, open lands planning and management and recreation and visual resource planning.


MARCH 2001