

# **SWSI Phase 2 Technical Round Table**

## **Prioritize and Quantify Recreation and Environmental Needs**

The Statewide Water Supply Initiative (SWSI) Report developed a number of findings and recommendations. These findings and recommendations were reviewed by the Colorado Water Conservation Board (CWCB) and led to the adoption of two mission statements, which can be found in Section 11 of the Report. Based on the findings and recommendations, the CWCB mission statements, discussions with SWSI Basin Roundtables (BRTs) and stakeholders, and recommendations of the SWSI consulting team and CWCB staff, an initial set of priorities have been developed for further analysis. The purpose of SWSI Phase 2 is to further analyze, evaluate, and develop deeper consensus in four key areas. In order to do this, it is proposed that SWSI form Technical Roundtables (TRTs) to continue the dialogue in a facilitated meeting forum and conduct technical work around four key areas:

- Water Efficiency (Agricultural and Municipal & Industrial [M&I])
- Alternative Agricultural Transfers to Permanent Dry-up
- Prioritize and Quantify Recreation and Environment Needs
- Addressing the 20 Percent M&I Gap, Agricultural Shortages, and Environmental and Recreational Needs Including Development of Alternatives

It is recognized that significant overlap may occur between these topics/subject areas and that information exchange between TRTs should be facilitated and coordinated by the consulting team. The overall goal of SWSI Phase 2 is to develop reconnaissance level solutions to address the 20 percent M&I gap, agricultural shortages, and environmental and recreational enhancements. To the extent possible, multi-objective solutions will be sought/developed. In developing various solutions/alternatives, the final work product will help policymakers and stakeholders gain a deeper understanding of the relative role that water efficiency, agricultural transfers, and new water development can play in meeting future needs and the trade-offs associated with these solutions. These solutions can then be considered in the context of meeting human needs for water and providing for the needs of Colorado's natural environment and recreation.

The prioritizing environmental and recreational TRT differs from other SWSI work groups in that it is anticipated that the group will provide input on instream flows, a topic which the CWCB is provided unique and exclusive authority under Colorado law. It is therefore important that the TRT understand that it is not the goal of the TRT to look to modify the “base” instream flow program or the statutory process under which the program was established and has grown over subsequent years. Rather the TRT’s focus should be to look at this process as an opportunity to explore where and how ecological and recreational resources can be protected or improved and how to most effectively use the existing instream flow program in conjunction with new ideas and approaches.

### **1. Technical Roundtable Discussions**

It is anticipated that the technical roundtable will meet three to four times between September and May to further explore the opportunities and issues of the alternatives. Additional

questions for discussion have been categorized as institutional and political, technical, financial and legal/water rights. This list is not intended to be comprehensive and TRT members will be asked to expand upon these questions.

### Institutional and Political

- Can incentives be developed for entities to donate their water rights for instream or recreational uses?
- Should the CWCB Board have greater discretion in the protection of instream flows?
- Can an approach be developed and agreed upon between all water interests for setting goals and prioritizing areas for protection?
- How can an acceptable balance be achieved between competition for the same sources of water with existing uses such as agricultural and municipal and industrial?
- Can a prioritization scheme be developed where there is consideration of recreation and environmental needs, M&I needs, and agricultural needs?
- Do instream flows need to be permanent and what are the legal ramifications? Should CWCB be allowed to rescind ISF filings if they are found to impact other uses? Should someone be able to do a temporary dedication with the right to pull back the water during a drought?

### Technical

- What are a few most promising methods for calculating different instream flow regimes? Are there locations where these methods could be modeled to determine adequacy for meeting stated purposes and potential impacts on existing water rights and future water development potential?
- What are the elements of a prioritization methodology? What are the associated geographic tools to use?
- What are examples of projects that benefit multiple users that could serve as a model for the state?
- Are there potential enhancements to existing instream flow programs that could be developed?
- How can Conserve, Protect, Restore priorities be implemented and integrated into a prioritization process and how might that process interface with the instream flow program?

### Financial

- How can the CWCB Board's instream flow program be financed to provide for acquisition of senior water rights?

- What are sources of funding and payment for projects that enhance environment and recreation?
- Are there examples of payment mechanisms in the state that serve as a model?
- What have other western states done to address the acquisition and financing of instream flows?

### Legal/Water Rights

- What are the current conflicts in interpretation of existing RICD legislation?
- What are the potential impacts on senior and junior water rights holders if an environmental or recreation enhancement project is developed? What are the impacts on future uses of water?
- What are the potential impacts on timing and location of return flows if existing water rights are acquired and transferred for dedication for instream flow purposes?
- Does the water rights process need to be streamlined to implement the CWCB Boards acquisition program?

## **2. Background**

The purpose of the Prioritize and Quantify Environmental and Recreational Needs Technical Roundtable is to, where possible, fill gaps identified in the SWSI Report. Potential items to address include: prioritizing and characterizing important and sensitive areas, evaluating methods for quantifying environmental and recreational needs, and evaluation methods/alternatives to address needs.

Colorado was the third fastest growing state during the 1990s and this high growth rate is projected to continue. One of the primary factors for this growth rate is the quality of life in Colorado. In addition to the attractive climate, the natural environment of the Rocky Mountains and the wide array of recreational opportunities attract new residents and businesses. Recreational opportunities include skiing and snowboarding, golf, hunting, bicycling, camping, hiking, backpacking, reservoir-based recreation, stream and lake fishing, watchable wildlife, rafting and kayaking, boating, and water skiing. Many of these recreational activities are water-based (fishing, boating, rafting, kayaking, and water skiing) or rely on water to support the activity (turf watering for golf and snowmaking for skiing and snowboarding).

In addition to the recreational opportunities for residents, recreation and the natural environment support tourism, and is a major economic driver in many parts of the state. In many headwaters counties, recreation and tourism are the largest industries. As population growth continues, there will be increasing and competing demands for water. The new permanent residents and businesses will require water for their domestic uses, residential landscaping, urban recreation, and the associated municipal, commercial, and industrial uses that accompany population growth. These same residents will also seek water-based and other types of recreation in Colorado's natural environment.

### 3. Colorado Recreation Economy

Section 2 of the SWSI Report discusses the Colorado recreation economy and information on other economic sectors and their role to Colorado's overall economy. The following information on Colorado's recreational economy is taken from Section 2.2.3 of the SWSI Report.

Recreation and tourism activities are economically important in Colorado. According to the Colorado Office of State Planning and Budgeting Memorandum on the Economic Impact of Drought (2002), tourism spending injects \$8.5 billion into Colorado's economy and 8 percent of the work force is employed in recreation and tourism activities. Water-related activities, including winter sports, comprise a significant portion of the recreation attractions drawing tourists to Colorado. The most prevalent water-based activities are fishing, boating, and skiing. Water needs for recreation are generally non-consumptive and can be complementary to environmental water needs. One example is maintaining minimum instream flows to provide fish habitat and thereby benefiting recreational fishing.

Recreation and tourism expenditures are not compiled separately in federal government statistics. Various Colorado state agencies and public interest groups compile economic data on recreation and tourism. A significant portion of recreation and tourism expenditures are related to water. Some activities, such as boating and fishing, are totally dependent on water availability. Other activities, such as hunting, wildlife viewing, and camping, are impacted by water availability but not considered water-based recreation. Recreation and tourism expenditures are primarily contained within the services category of major industrial categories. The major subcategories within the services category are Hotels and Lodging, Eating and Drinking Places, Air Transportation, Automotive Rental and Leasing, Amusement and Recreation Services, and Retail Excluding Restaurants and Gas Stations.

#### Skiing

Between 1997 and 2003, skier visits (days) in Colorado have varied between 11,000,000 and 12,000,000 annually, according to Colorado Ski Country USA, the official recorder of ski statistics. The number of skier visits has not grown during these years, but has varied based upon economic and weather conditions. Colorado resorts use a relatively insignificant amount of water for snow making compared to Colorado's overall water consumption, but it can have a significant local environmental impact on high mountain streams near the ski resorts.

A published report on the economic impact of the skiing industry in Colorado was not found. The January 14, 2003 Snow Journal states that skiers spend \$1.7 billion in Colorado, which has an estimated economic impact of \$4.2 billion (the source of these statistics is not cited). An economic analysis of the Vermont ski industry estimated that the average per trip expenditure for ski visitors was \$876 in 1999. Based upon 11,000,000 skier days, the \$1.7 billion annual expenditure in Colorado would equal \$154.54 per skier day. Since ski trips are usually several days, the Colorado expenditure figure is consistent with the Vermont economic analysis.

#### Boating

Boat registration around Colorado has increased from 91,579 in 1996 to 104,880 in 2001. Boating in Colorado is centered in lakes and reservoirs where boats are used for fishing and water

skiing in addition to pleasure boating. It is difficult to estimate participation rates for lake boating because different government agencies maintain the different lakes. The impact of lake levels on boating has not been estimated, but low lake levels can be expected to hamper boating.

Visitor days to Colorado State Parks average over 11,000,000 per year. The Colorado Division of Parks and Outdoor Recreation (CDPOR) estimates that boating at the lakes and reservoirs at these state parks generates over \$375 million per year to the state economy. Boating at other public and private lakes and reservoirs is not included in this estimate (CDPOR 2004).

River boating in Colorado is largely associated with river rafting and kayaking. These river boating activities have expanded rapidly during the past 10 years and are very reliant upon water availability. For example, according to the Colorado River Outfitters Association, the number of whitewater rafting user days jumped from 208,940 in 1988 to 523,587 in 2001. The 2002 drought was reported to have caused a 39 percent drop in whitewater rafting to 319,562 user days. The Colorado River Outfitters Association also states that the economic impact of whitewater rafting increased in nominal terms from \$75 million in 1993 to \$125 million in 2001. Using these figures, the economic impact equals \$391 per user day (Colorado River Outfitters 2003).

### Fishing

Fishing has the largest number of participants of any water-based sport. There were 915,000 participants in fishing in Colorado in 2001. Table 1 shows statistics from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, published by the U.S. Census Bureau (2001). Fishing occurs in Colorado's lakes, reservoirs, and streams.

Table 1 Colorado Fishing Statistics

	1991	1996	2001
Anglers in-state	778,000	830,000	915,000
Days in-state	6,284,000	8,232,000	9,267,000
State Resident Anglers	567,000	671,000	626,000

Source: 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

Table 2 lists expenditures in Colorado by United States residents for fishing in 2001, broken out by sub-categories.

Table 2 Fishing Expenditures in Colorado (Thousands of Dollars)

Revenue Source	Total Revenue
Food and Lodging	\$157,182
Transportation	\$102,845
Other Trip Costs	\$45,689
Fishing Equipment	\$75,412
Auxiliary Equipment	\$22,147
Special Equipment	\$199,673
<b>TOTAL</b>	<b>\$602,948</b>

Source: 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation

The expenditures per angler day average about \$65 (\$602,948,000 divided by 9,267,000 angler days) for food and lodging, transportation, other trip costs, and equipment.

### Recreation and Tourism Employment

Employment in recreation and tourism in Colorado accounts for about 8 percent of the state's total employment. Table 3 illustrates how recreation and tourism employment has increased in recent years. In this table, the 1997 and 1999 values for employment in all industries are interpolated.

**Table 3 Employment in Tourism vs. Employment in all Colorado Industries**

	1995	1997	1999	2000
Employment in Tourism		197,898	212,222	
Employment in all Industries	2,448,120	2,550,276*	2,652,432*	2,958,899
Tourism Percentage		7.8%	8.0%	

Source: Center for Business and Economic Consulting Inc. Tourism Jobs in Colorado, April 27, 2001. U.S. Bureau of Economic Analysis [www.bea.gov/bea/regional/reis/default.cfm#a](http://www.bea.gov/bea/regional/reis/default.cfm#a)

\*Denotes Interpolated Data

### Golfing

In 2002, the Colorado golf industry directly contributed over \$560 million into Colorado's economy as detailed in Table 4. Based on a survey conducted in 2003, Colorado had 264 golf courses, which is over half of the 466 total in the Mountain Region (Wyoming, Utah, and the northern half of both Arizona and New Mexico). The total acres of land invested in Colorado golf courses in 2002 was 35,600 acres, of which 19,837 were in irrigated turf grass. A notable trend in water resource management at golf courses is the use shift of some irrigation water from surface water to reclaimed wastewater. The use of reclaimed water is growing significantly. In 2002, 61 percent of irrigation water came from surface water while 10 percent was from reclaimed water. By 2002, surface water use had declined to 52 percent and reclaimed wastewater had increased to 20 percent (Davies et al. 2004).

**Table 4 Colorado Golf Course Revenues (2002) (Millions of Dollars)**

Revenue Source	Total Revenue
Green Fees	\$189.51
Golf Cart Rentals	\$47.82
Other Rentals	\$9.76
Driving Range	\$16.95
Pro Shop Merchandise	\$52.88
Food and Beverage	\$90.16
Dues/Initiations	\$134.81
Other	\$18.16
<b>TOTAL</b>	<b>\$560.06</b>

Source: Davies, S., P. Watson, D. Thilmany. 2004. Resource and Environmental Aspects of Golf in Colorado. Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, Colorado. April 2004-APR 04-01.

#### **4. Potential Approaches to Defining Environmental and Recreational Flow Enhancements**

Since its implementation in 1973, CWCB's Instream Flow Program has been successful filing water rights to protect the "minimum stream flows or natural lake levels or volumes necessary to preserve the natural environment to a reasonable degree." The recent addition by the State Legislature that granted the CWCB authority to secure instream flows that "preserve or *improve* the natural environment" provides an opportunity to further protect flows in Colorado's rivers and streams. A description of the CWCB instream flow program is attached at the end of this white paper in a paper titled "Colorado's Instream Flow Program: How it Works and Why It's Good for Colorado."

In addition, through the SWSI process, programs that go beyond CWCB's minimum flow requirements could be implemented where legally, technically, politically, and economically feasible. Recreational and environmental water needs are generally in-channel flow-based and non-consumptive. These uses have not traditionally been a major part of water planning. Today, much of the work done to address these flow-based needs is tied to agricultural or M&I projects, and much of it is done solely for mitigation of those project impacts. Roundtable and public participants in SWSI expressed significant interest in enhancing flows for recreational and environmental needs beyond legally mandated mitigation levels. Potential solutions were identified, such as RICDs, re-operation of existing facilities for flow enhancement, or dedicated or multi-use projects. For example, Elkhead Reservoir enlargement in the Yampa Basin will provide for water supply needs as well as a storage pool for releases for endangered species. Wolcott Reservoir in the Colorado Basin, if constructed, is intended to address endangered species needs through the 15-mile reach in the lower part of the Colorado River in Colorado in addition to fulfilling water supply needs. This is another example of a project that can serve multiple needs.

While flow enhancement for environmental and recreational uses was identified by many SWSI participants as being important, few Identified Projects and Processes, aside from river compact deliveries and the CWCB's instream flow program, directly addressing flow enhancements beyond statutory legal requirements. In support of future options with multi-benefit approaches, several groups provided input to SWSI as to how the state might consider developing a framework for setting goals for these flows. Environmental Defense, Trout Unlimited, and The Nature Conservancy (TNC) provided feedback and input on the subject, and suggested that this framework should include parameters such as seasonal variability, which could include occasional flood pulses, high flow periods, and steady base flows, as many aquatic ecosystems benefit from these flow conditions.

This section provides a synopsis of the input received from these groups as a possible starting point for defining environmental and recreational flow goals. Further discussion at the CWCB Board and through the Basin Roundtables or similar groups will be needed to effectively assess whether and how to proceed with incorporating some of these methods for use in Colorado. More specific environmental and recreational options or concepts that could be pursued, as brought forth through the Basin Roundtable process and public input, but that are not included on the list of Identified Projects and Processes, are provided in Section 10.

## Conserve, Protect, and Restore Approach

One concept for environmental and recreational flow management brought forth by environmental and recreational interest group representatives in SWSI was the "Conserve, Protect, and Restore" (CPR) approach.

The "Conserve" component is centered on keeping currently "healthy" (both in terms of quality and quantity) rivers healthy. This could include the following strategies:

- Acquisitions of interests in water to improve an existing environment via Senate Bill 02-156 authority
- New CWCB instream flow appropriations
- Interruptible water supply agreements
- Leases and other methods

Segments for consideration under the "Conserve" component could include Gold Medal fisheries, wild trout reaches, intact contiguous instream flow reaches, Great Outdoors Colorado Legacy reaches, TNC designated reaches, reaches in wilderness and national parks, and other known high-quality stream segments. By prioritizing these reaches, the gap between supply and demand could also be measured through ecologically sustainable water management, or other method(s) that fully protect flows, noting that in some cases there may be no gap.

The "Protect" component suggested by the interest groups includes keeping threatened but currently healthy reaches whole, or as close to whole as possible. In addition to the strategies indicated above for the "Conserve" segments, strategies could include integration of permit conditions (federal, state, or local) and agreements. Relevant segments could include any reach that might be affected by future water management actions (e.g., the Identified Projects and Processes or other future actions). The "gap" associated with protecting those identified reaches would then be the difference between current conditions and the minimum (or higher) flow necessary to maintain a functioning, healthy ecosystem.

The "Restore" component suggested by the interest group representatives revolves around restoration of dry, low-flow, or low-quality segments. Project reoperations and ditch lining are two possible strategies that could be employed, in addition to those listed for "Conserve" and "Protect." Possible candidate segments could include truncated instream flow reaches; reaches with endangered, threatened, or sensitive species; Dry Legacy reaches; or others from the Colorado Water Trust maps. Truncated instream flow reaches are those that do not connect habitat, such as portions between tributaries and mainstems, through which fish may not be able to move within a region. Two-factor instream flow reaches are those on which CWCB has used two of the normal three factors in determining minimum flows using the R2 Cross method, often resulting in lower flow criteria and often the result of a lack of water availability on the subject reach. The gap in the "Restore" segments could be considered to be the difference between current conditions and flow goals estimated from this approach, ecologically sustainable water management conditions, or other considerations.

It was noted that the "CPR" approach may differ for environmental versus recreational flow needs.

This approach could be integrated into the Identified Projects and Processes, Options for Alternatives, or as new stand-alone options, as each moves from concept toward implementation.

### Concepts for Estimating Environmental Flow Needs

Environmental and recreational interest groups suggested that in characterizing environmental water needs, a two-step approach could be implemented:

1. Identify and locate critical water-dependent species and natural systems.
2. Assess the environmental demands (or ecological flow needs) of those systems.

Key sources for information for water-dependent species and systems might include:

- CDOW
- Colorado Natural Heritage Program (CNHP)
- Colorado Water Trust
- TNC Ecoregional Plans
- Colorado River Endangered Fish Recovery Programs

It was also suggested that a model could be developed to determine environmental or instream needs of these communities by identifying integral components of the flow regime such as:

- Base flows
- Normal high flows
- Drought and flood conditions
- Interannual variability

### Approaches to Determining Environmental Flow Needs

TNC proposed the following components to serve as part of an initial method to quantify environmental water demands:

- A coarse statewide characterization
- A select set of pilot projects (two to five) at critical conservation sites
- An evaluation of specific environmental demand after preliminary identification of likely project locations through SWSI

TNC has offered its assistance, along with the Colorado Water Caucus, in data collection and characterization efforts, including gathering a team of experts in riparian and aquatic ecology to work with the CWCB and Basin Roundtable members. Trout Unlimited suggested that portions of the UPCO Study and other similar approaches be implemented to identify priority stream reaches within each basin that are used for recreational purposes. Table 5 provides a summary

of the methods and data sources suggested by these groups for determining environmental and recreational water needs.

Table 5 Summary of Suggestions for Determining Environmental and Recreational Needs

Suggested by	Environmental and Recreational Demand Component	Information	Source
Environmental Defense and Trout Unlimited	Determine restoration flow using methodology outlined in Covington and Hubert (2003) <sup>1</sup>	<ul style="list-style-type: none"> <li>■ Stream gage data</li> <li>■ Aerial photos</li> <li>■ Topographic info</li> </ul>	<ul style="list-style-type: none"> <li>■ USGS: <a href="http://waterdata/usgs.gov/co/nwis/rt">http://waterdata/usgs.gov/co/nwis/rt</a></li> <li>■ USGS and University of Colorado's Center for the Study of Earth from Space (CSSES)</li> <li>■ USGS topographic quadrangle maps</li> </ul>
TNC	Determine water-dependent species and ecosystems	—	<ul style="list-style-type: none"> <li>■ CDOW</li> <li>■ CNHP</li> <li>■ Colorado Water Trust, Documentation of Mapping of Critical Water-Dependent Natural Systems, prepared for CDOW, June 30, 2002</li> <li>■ TNC Ecoregional Plans</li> <li>■ Upper Colorado River Endangered Fish Recovery Program</li> </ul>
TNC	Determine environmental or instream needs of the systems	<ul style="list-style-type: none"> <li>■ Base flows</li> <li>■ Normal high flows</li> <li>■ Drought and flood conditions</li> <li>■ Interannual variability</li> </ul>	—
<i>Other information and relevant sources:</i>			
Trout Unlimited	—	<ul style="list-style-type: none"> <li>■ Instream flow and natural lake level water rights</li> </ul>	<ul style="list-style-type: none"> <li>■ <a href="http://cwcb.state.co.us/isf/Database">http://cwcb.state.co.us/isf/Database</a></li> </ul>
Trout Unlimited	—	<ul style="list-style-type: none"> <li>■ Recommendations for instream flow and lake level appropriations</li> </ul>	<ul style="list-style-type: none"> <li>■ CDOW</li> </ul>
Trout Unlimited	—	<ul style="list-style-type: none"> <li>■ Minimum and recommended optimum flow levels for popular kayaking and rafting stream reaches</li> </ul>	<ul style="list-style-type: none"> <li>■ American Whitewater Association: <a href="http://www.americanwhitewater.org/rivers/state/CO">http://www.americanwhitewater.org/rivers/state/CO</a></li> </ul>
<i>Additional reports to consider:</i>			
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ USFWS, PBO for the BOR's Operations and Depletions, Other Depletions and Funding and Implementation of Recovery Program Actions in UPCO, December 1999</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ USFWS, Recovery Implementation Program, Flow Recommendations to Benefit Endangered Fishes in the Colorado and Gunnison Rivers, Final Report, July 2003</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ Hydrosphere Consultants, Inc. Gunnison River - Aspinall Unit Temperature Study, Phase 1, Final Report, for the Endangered Species Recovery Program, March 2002</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ Roehm, G.W, USFWS, Mountain Prairie Region. A Draft Management Plan for Endangered Fishes in the Yampa River Basin and Environmental Assessment, Denver, 2003</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ USFWS, UPCO Endangered Fish Recovery Program, Summary of Section 7 Consultations</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ USFWS, 2002 Red Mesa Ward Reservoir Project Biological Opinion</li> </ul>
Trout Unlimited	—	—	<ul style="list-style-type: none"> <li>■ Annual Letter of Agreement Regarding Arkansas River Flows and Reservoir Releases for the Arkansas River Headwaters Recreation Area, from Executive Director Colorado DNR to the BOR and SECWCD</li> </ul>

Table 5 Summary of Suggestions for Determining Environmental and Recreational Needs

Suggested by	Environmental and Recreational Demand Component	Information	Source
Trout Unlimited	—	<ul style="list-style-type: none"> <li>Flow requirements for sustaining physical stream habitat and impacts that could result from altered flow regimes in various Metro Denver rivers</li> </ul>	<ul style="list-style-type: none"> <li>USACE, Metropolitan Denver Water Supply ES, 1988.</li> </ul>
Trout Unlimited	—	<ul style="list-style-type: none"> <li>1-day and 30-day, and 3-year low flows for stream reaches below wastewater treatment plant</li> </ul>	<ul style="list-style-type: none"> <li>Contact plant operators or Colorado Pollution Elimination Discharge Permits for each discharger</li> </ul>
Trout Unlimited	—	<ul style="list-style-type: none"> <li>Assessing instream flow needs for streams on National Forest System Lands</li> </ul>	<ul style="list-style-type: none"> <li>Various USFS EIS and Environmental Assessments - Ex: Arapahoe Basin Master Development Plan Final EIS, Prepared by the White River national Forest, Dillon Ranger District, September 1999</li> </ul>

<sup>1</sup> Covington, J. Scott, and Wayne A. Hubert (2003). Trout Population Responses to Restoration of Streamflows. Environmental Management, 31(1), 135-147.

## 5. Environmental and Recreational Options

Colorado's current and future environmental and recreational water needs bring a unique set of issues to water management. As highlighted in Section 6.1.3 of the SWSI Report, a number of new and innovative approaches to meeting environmental and recreational needs and moving from mitigation to enhancement were discussed through the course of SWSI and the Basin Roundtable Technical Meetings. However, to date, there is no single agreed upon approach or set of criteria, other than the CWCBC instream flow program, for prioritizing stream reaches for environmental and recreational enhancement or setting associated flow goals.

Section 6 of the SWSI Report also provided background on existing flow goals and key programs geared toward meeting environmental and recreational flows on major rivers and tributaries in each basin. Many of the identified flow goals do not have an associated Identified Project or Process to meet the goals, though some Identified Projects and Processes meet multiple goals that can include environmental and recreational benefits.

Looking ahead, SWSI sought to further identify approaches and possible new projects or management strategies – many of which are stand-alone, many of which could potentially be integrated into multi-beneficiary projects – that could be used to address environmental and recreational water needs. In this section, the key concepts guiding the development of future environmental and recreational "options" are discussed along with some potential statewide approaches to environmental and recreational flow enhancement. Section 10.3 of the SWSI Report presents a basin-by-basin discussion of specific M&I, agricultural, and environmental and recreational options that could be used to meet future needs.

## Overview of Environmental and Recreational Options

The primary objectives of the environmental and recreational options compiled and discussed in SWSI are to provide flow and/or habitat enhancement of surface water features – both streams and lakes. Specifically, environmental and recreational options may provide for enhancement of:

- Fish habitat
- Endangered species habitat
- Aquatic recreation
- Water quality
- Wetlands
- Riparian corridors

Some key characteristics and features of these types of options are:

1. Environmental and recreational options are not intended to merely provide mitigation of the impacts of other water supply projects. Mitigation of environmental impacts of new projects is required by law and is already a critical component of project planning. Mitigation is performed to offset potentially deleterious impacts of these projects. Environmental and recreational options, on the other hand, are meant to provide enhancement of resources. As an example, replacing wetlands impacted by a new water supply pipeline is considered environmental mitigation rather than an environmental and recreational option.
2. Environmental and recreational options may be stand-alone projects or may be integrated into other water supply projects (e.g., M&I or agricultural).
3. Environmental and recreational options are to be implemented consistent with state water law and interstate compacts.
4. Environmental and recreational options are subject to NEPA, CWA, ESA, and other applicable laws with respect to mitigating unintended adverse impacts of the options.

## Existing Statewide Environmental and Recreational Options

As noted in Section 6 of the SWSI Report, the CWCB has an existing program for appropriating, acquiring, and protecting instream flow water rights and natural lake levels. This stream and lake protection program is designed to "preserve and improve the natural environment to a reasonable degree." The CWCB appropriates minimum stream flows or natural surface water levels or volumes for natural lakes to preserve the natural environment to a reasonable degree. The CWCB is also authorized "to acquire, by grant, purchase, donation, bequest, devise, lease, exchange, or other contractual agreement, from or with any person, including any governmental entity, such water, water rights or interests in water in such amount as the Board determines is appropriate for stream flows or natural surface water levels or volumes for natural lakes to preserve or improve the natural environment to a reasonable degree." The CWCB protects these instream flow water rights both by obtaining terms and conditions in

water rights decrees filed by other water users and by monitoring stream flows and assisting the State and Division Engineers in administering the prior appropriation system so that the CWCB's instream flow water rights are not injured.

Additionally, the passage of Senate Bill 216 in 2001, which recognizes a new type of water right – RICDs – has provided a legal avenue for establishing recreational options.

The presence of endangered fish in basins across the state, as described in Sections 3 and 6 of the SWSI Report, influences current stream management in accordance with the ESA. Critical habitat designations have been applied to many reaches in the state with corresponding flow recommendations. While these recommendations are not legally binding, water users are making good faith efforts to meet the recommendations. In this way, the ESA has provided for the establishment of environmental options, albeit non- legally binding options.

In addition, interstate compacts and decrees and senior water rights serve to ensure that river flows are maintained. For example, approximately 75 percent of the water in the Colorado River and its tributaries must flow out of the state pursuant to the compact.

#### Possible Future Statewide Environmental and Recreational Options

Statewide environmental and recreational options are those that are not specific to a stream reach or locality, and that could potentially be applicable in more than one part of the state. Possible statewide environmental options discussed in the Basin Roundtable Technical Meetings include:

- Sizing of new storage projects to include a dedicated "pool" for environmental instream flow management
- Acquiring by purchase or lease existing water rights to maintain higher instream flows for the environment
- Voluntary re-operation of existing projects to enhance environmental benefits without impacting yield
- Releasing reservoir water in a pattern that generally follows "natural" flow conditions; e.g., The Nature Conservancy paper (Richter 1997):
  - Releasing periodic high flows
  - Maintaining average monthly stream flows within  $\pm 1$  standard deviation of historical average monthly flows

Possible statewide recreational options discussed in the Basin Roundtable Technical Meetings include:

- New reservoir pool sizing to allow for recreational opportunities
- Developing minimum reservoir pool levels to maintain flatwater recreational appeal
- Voluntary flow management agreements

- Voluntary re-operation of existing projects to enhance recreational benefits without impacting yield
- Establishing new RICDs

The acquisition by purchase and transfer of existing water rights may be necessary for many of the options above. Leases and/or interruptible water supply agreements may also play a role. Water leases provide temporary water rights to users while interruptible water supply agreements refer to agreements whereby water supplies may be interrupted during water short years. Specific environmental and recreational options identified through the Basin Roundtable process are presented by basin in Section 10.3 of the SWSI Report.

CDOW has identified several "statewide" approaches that could be implemented to address environmental needs, as indicated in Table 6. This table also shows a conceptual strategy (the "Three-Species Conservation Strategy") that could be applied to Colorado's Western Slope basins.

Table 6 CDOW Statewide and Western Slope Water Management Options

Project	Description	CDOW Priority	State of Implementation
Three-Species Conservation Strategy	Five-State Conservation Agreement and Strategy document(s) for long-term conservation and protection of three native fish populations (bluehead sucker, roundtail chub, flannelmouth sucker)	High	Conservation Agreement between AZ, WY, UT, NM, and CO to be signed in spring 2004. Strategy document draft due Dec. 2004. La Plata and Mancos River roundtail chub broodstocks at Mumma Native Aquatic facility.
Water Quality	Continue to work through State's water quality rule-making procedures to improve standards and classifications for streams and water bodies. <ul style="list-style-type: none"> <li>■ Continue/ improve monitoring data collection, standardization, analyses, and posting;</li> <li>■ Continue advising watershed assemblies on water quality and wildlife issues.</li> </ul>	High	Ongoing Division of Wildlife participation in WQCC hearings and other local processes to ensure non-degradation and cooperation on wildlife issues.
Dynamic flows	Improve coordination and communication w/ water suppliers so that within operational, institutional, and hydrologic constraints, dynamic releases can be made to simulate natural flow conditions.	Medium	No substantive discussions have occurred to date. Successful implementation in other western river systems and Canada.
Return Flow Mitigation Project	Recognition of connectivity between irrigated agriculture and late-season baseflow and water temperatures. Ensure that changes to agricultural practices (e.g., sprinklers, or type-conversions) do not significantly impair or reduce these benefits.	Low to Medium	No discussions. Inventory of affected areas not compiled and anecdotal to date.
Western Slope: Three-Species Conservation Strategy	Five-State Conservation Agreement and Strategy document(s) for long-term conservation and protection of three native fish populations (bluehead sucker, roundtail chub, flannelmouth sucker) in Arizona, Wyoming, Utah, New Mexico, and Colorado.	High	Strategy document draft due Dec. 2004. La Plata and Mancos River roundtail chub broodstocks at Mumma Native Aquatic facility.

## WatSIT Summary and Nature Conservancy Instream Flow Analysis

The Water Supply Investigation Tool (WatSIT) is a screening level water allocation model designed to provide quantitative comparisons of water supply alternatives with respect to yields, storage requirements, and return flows. It is intended to be used as an initial step in a water supply alternatives analysis for a basin, sub-basin, water district, or individual user. The model can operate at monthly or annual timesteps for up to 100 years of simulated hydrologic record. Baseline available flows (user-input time series) can be supplemented with any combination of up to four available generic supply or demand management project alternatives: agricultural land transfer, reuse, consumptive use acquisition (non-agricultural), and conservation. WatSIT predicts reservoir storage and return flows as functions of baseline inflows, additional supply provided by project alternatives, and calculated demands. The model has proved to be particularly useful for quantifying firm yields associated with streamflow time series as functions of total reservoir storage and reservoir operating constraints.

A recent enhancement of WatSIT now provides the user with the ability to implement The Nature Conservancy's Range of Variability Approach (RVA) (Richter et al. 1997) to setting instream environmental flow targets in the context of water supply alternatives analysis. The user can investigate the impacts of these instream targets on reservoir firm yields, and/or conversely investigate the impacts of new reservoirs on maintaining instream flow criteria.

WatSIT calculates up to 18 of the 32 RVA metrics (Richter et al. 1997), as summarized in Table 7, for a given system based on a user-supplied "natural" flow time series. These flows can be calculated with existing water allocation models, like StateMod or ModSim, or they can be taken directly from appropriate historical measured USGS flow data. Those parameters not currently included in WatSIT are primarily daily values and thus not compatible with the model's monthly timestep. Future work may look to expand on the model's capacity in this regard.

Table 7 Summary of RVA Analysis in WatSIT (18 out of 32 parameters)

TNC RVA Parameter	Included in WatSIT	TNC RVA Parameter	Included in WatSIT
Mean Monthly Flow (1 - 12)	Y	Annual 3 Day Minima	N
Annual 1 Month Minima	Y	Annual 3 Day Maxima	N
Annual 1 Month Maxima	Y	Annual 7 Day Minima	N
Annual 3 Month Minima	Y	Annual 7 Day Maxima	N
Annual 3 Month Maxima	Y	No. of high pulses each year	N
Julian Month of Annual 1 Month Minima	Y	No. of low pulses each year	N
Julian Month of Annual 1 Month Maxima	Y	Mean duration of high pulses each year	N
Annual 1 Day Minima	N	Mean duration of low pulses each year	N
Annual 1 Day Maxima	N	Means on negative differences (consecutive days)	N
		Means on positive differences (consecutive days)	N

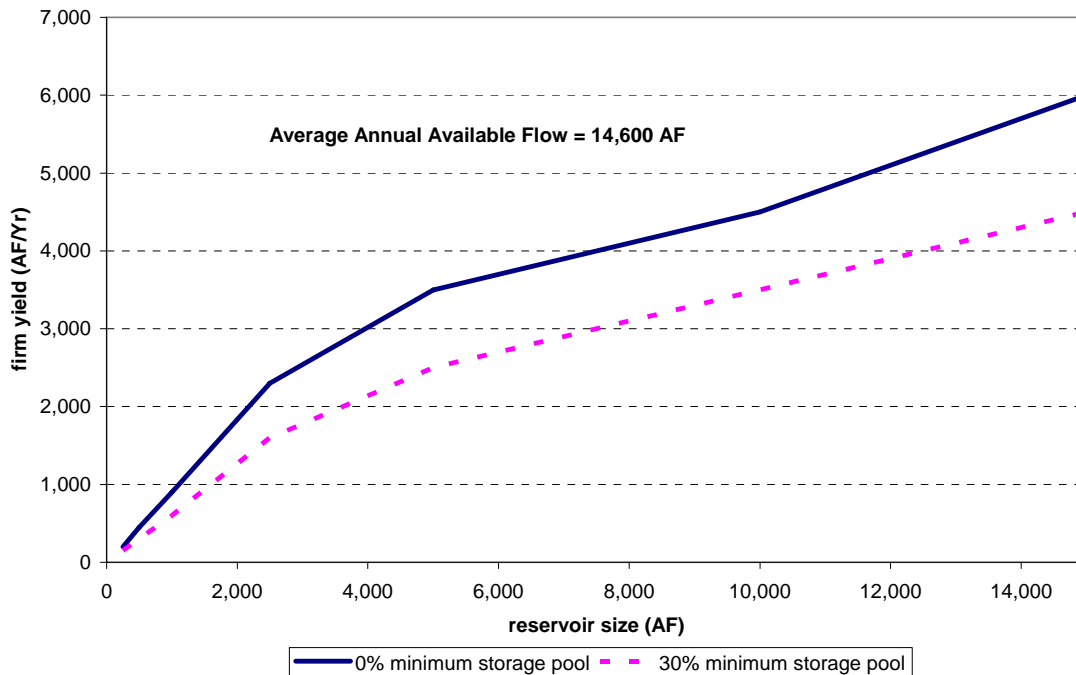
The calculated RVA metrics are then used in the model to set monthly reservoir release targets to maximize the amount of time instream flow criteria are met. The release targets subsequently constrain model yield calculations in the model. Significant outputs associated with these simulations include reservoir firm yields and rates of attainment of instream flow targets.

Numerical analyses were performed with the WatSIT model, described in Section 7 and Appendix F of the SWSI Report, to illustrate how an environmental option might be quantitatively incorporated into the planning of a new water supply project.

As an illustrative example, Figure 1 shows storage to yield curves for a hypothetical reservoir located on Leroux Creek in the Gunnison River Basin. Predicted yield versus storage values are a function of legally available flows for the site (as simulated by the Gunnison River Basin DSS, described in Section 7) and assumed monthly evaporation. Two curves are shown in this figure corresponding to:

**Alternative A** – A management alternative in which the reservoir is allowed to completely empty.

**Alternative B** – A management alternative in which a minimum pool volume of 30 percent of capacity is maintained as a recreational option.



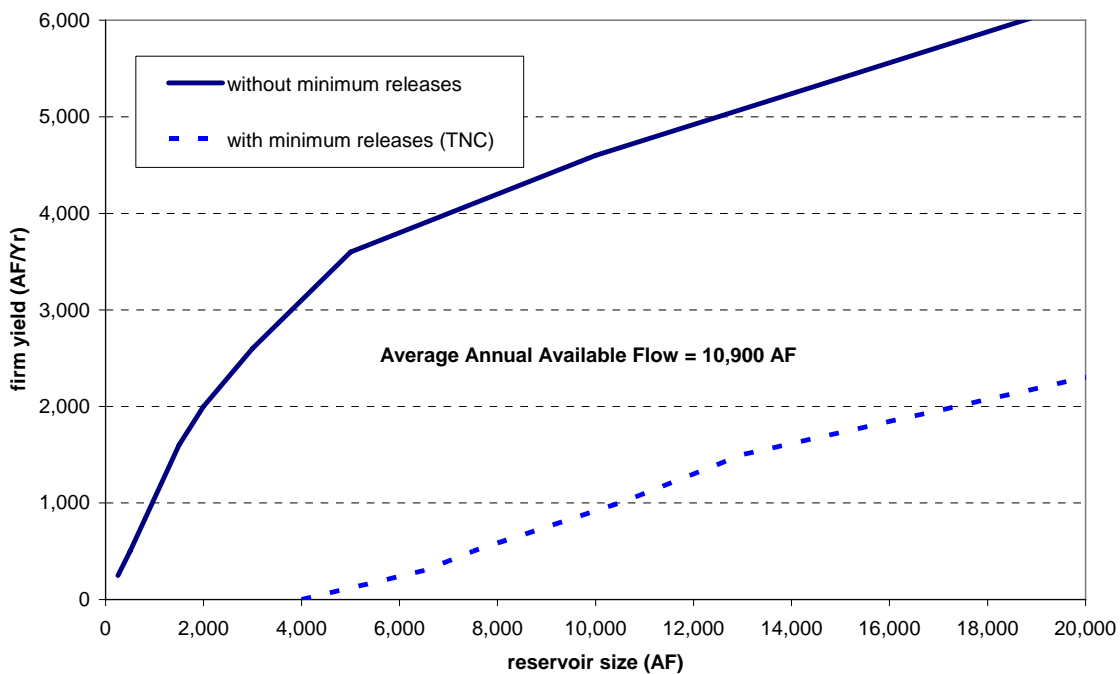
**Figure 1**  
*Example Storage to Yield Curve for Environmental and Recreational Options: Minimum Pool  
 Leroux Creek Reservoir - Gunnison River Basin: Agricultural Use*

The model simulations show that to achieve a firm yield of 4,000 AFY, for example, without minimum reservoir capacity considerations (Alternative A), approximately 8,000 AF of storage is required. Alternatively, for the same system but with a minimum permanent pool requirement of 30 percent (Alternative B), approximately 12,000 AF of storage is required. The additional storage requirement (4,000 AF) for Alternative B would allow for the capture and storage of a greater percentage of the legally available flows, which can then provide the minimum pool. The acquisition of additional water rights may be required for the implementation of Alternative B. Costing of the two reservoir options could then be performed and assessed relative to the recreational benefits gained from maintaining the minimum pool. This analysis assumes that reservoir releases for firm yield are taken out of the river at the reservoir and not released from the reservoir and carried downstream where the releases could help meet instream flow targets.

As a second example, Figure 2 shows model simulations for a hypothetical reservoir located on Little Bear Creek in the Yampa River basin. Predicted yield curves are again a function of legally available flows for the location, as predicted by the Yampa River basin CDSS. For this analysis, the two curves shown on the figure correspond to:

**Alternative A** - A management alternative in which no minimum release requirements are maintained.

**Alternative B** - A management alternative that follows the approach outlined by The Nature Conservancy in the paper "How much water does a river need?" This approach maintains average historical monthly flows, minus 1 standard deviation, downstream of the reservoir.



**Figure 2**  
*Example Storage to Yield Curve for Environmental and Recreational Options: Instream Flow Little Bear Creek Reservoir - Yampa River Basin: Agricultural Use*

Minimum release flow values for Alternative B were calculated using legally available flows captured by the reservoir. Model simulations show that, for the environmental Alternative B, significantly larger reservoirs are needed to provide the same firm yield when compared to the alternative without environmental considerations (A). For example, to provide 2,000 AF per year of firm yield, Alternative A requires approximately 2,000 AF of storage, while Alternative B requires approximately 17,000 to 18,000 AF of storage. It is possible for releases from the reservoir for downstream uses can serve a dual purpose and provide for the target environmental flows. This is a site specific issue and is determined by the location of the diversion from the reservoir for the water use. This analysis assumes that reservoir releases for firm yield are taken out of the river at the reservoir and not released from the reservoir and carried downstream where the releases could help meet instream flow targets.

Both sets of simulations show that these types of environmental and recreational alternatives are technically feasible with the proper planning. The simulations also show that the potential costs associated with environmental and recreational options may be significant. These costs might be monetary, such as those associated with larger storage requirements, or they might be in the form of yield reductions. While the benefits realized from environmental and recreational options are clear, to date, there is no clearly-accepted or widely implemented mechanism for investing in these types of flow enhancement projects.

Table 8 summarizes approaches to maintaining environmental integrity put forth by agencies. The objectives of the approach, key technical elements, and the potential applications are presented.

Table 8 Summary of Approaches to Maintaining Environmental Integrity in Statewide Water Supply Management

Approach Name	Organization	Approach Objectives	Key Technical Elements	Potential Applications	Data Needs/ Comments
<b>Identifying and Prioritizing Environmentally Sensitive or Impaired Areas:</b>					
Aquatic GAP	Colorado Division of Wildlife	<ul style="list-style-type: none"> <li>Preserve aquatic biodiversity through better identification of species, community types or representative ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>GIS tools to provide spatial data and mapping related to species habitat</li> <li>Hierarchical breakdown from large geographic units down to specific habitat types (8 levels)</li> <li>Tying species existence with mapped habitat types to locate sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Predict historical and current locations of native species</li> <li>Identification of rare habitat types</li> <li>Identification/prioritization of sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>GIS basemap coverages</li> <li>Biological data (fish surveys)</li> <li>Physical habitat data</li> <li>Water quality data?</li> <li>Land use data?</li> <li>Some of this data already in system?</li> </ul>
Environmental Monitoring and Assessment Program (EMAP)	EPA – Region 8	<ul style="list-style-type: none"> <li>Estimate current ecological status of streams</li> <li>Rank stressors that affect ecology of streams</li> <li>Establish relationships between stressors and ecological status</li> </ul>	<ul style="list-style-type: none"> <li>Comprehensive monitoring of physical, chemical, and biological characteristics</li> <li>At least 50 sites in each state</li> <li>Streams must be perennial and wadeable or boatable</li> <li>Ecology: fish, macroinvertebrates, periphyton</li> <li>Stressors: habitat, water quality, tissue contaminants, landuse</li> </ul>	<ul style="list-style-type: none"> <li>Identifying stressed streams and the source of that stress</li> <li>Guide water supply alternatives analysis with respect to impacts on ecology</li> <li>Identification/prioritization of sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Targeted for completion by Fall 2006?</li> <li>Is some of the data already available for Colorado?</li> </ul>
Freshwater Methodology	The Nature Conservancy	<ul style="list-style-type: none"> <li>Identify freshwater conservation targets (coarse filter) based on biodiversity</li> </ul>	<ul style="list-style-type: none"> <li>Classification of water bodies according to hierarchical system and physical factors (e.g. size, gradient, flow permanence, geology)</li> <li>Intended for GIS mapping</li> </ul>	<ul style="list-style-type: none"> <li>Identify/prioritize potential environmental conservation areas and water bodies to guide water supply alternatives analysis and management</li> </ul>	<ul style="list-style-type: none"> <li>Clearly depends on assumed link between physical characteristics and biodiversity</li> <li>No indication of what classifications have already been accomplished in CO</li> </ul>
Mapping Playa Lakes	Playa Lakes Joint Venture	<ul style="list-style-type: none"> <li>Map playa lakes that are critical to bird species</li> </ul>	<ul style="list-style-type: none"> <li>GIS</li> <li>Thermal imagery</li> <li>Precipitation data</li> <li>Infrared aerial photos</li> <li>Delineation of playas using this information</li> </ul>	<ul style="list-style-type: none"> <li>Identify/prioritize ecologically important playa maps in state to guide water management</li> </ul>	<ul style="list-style-type: none"> <li>How much mapping has already been done?</li> </ul>
NatCon	??	<ul style="list-style-type: none"> <li>Mapping of impairment and ecological sensitivity at multiple levels</li> </ul>	<ul style="list-style-type: none"> <li>Summaries of available data and information</li> </ul>	<ul style="list-style-type: none"> <li>Guide water supply alternatives analysis and management?</li> <li>Identify/prioritize sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Has the mapping already been done?</li> <li>Hard to tell what this is all about from the presentation</li> </ul>
Gold Medal Trout Fisheries	CDO	<ul style="list-style-type: none"> <li>Designation of waters with high quality habitat and the potential for trophy trout fishing</li> </ul>		<ul style="list-style-type: none"> <li>Identify/prioritize sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Readily available maps for quick reference</li> </ul>

**Table 8 Summary of Approaches to Maintaining Environmental Integrity in Statewide Water Supply Management**

Approach Name	Organization	Approach Objectives	Key Technical Elements	Potential Applications	Data Needs/Comments
Threatened and Endangered Species Critical Habitat	Federal and State authorities	<ul style="list-style-type: none"> <li>■ Designation of waters critical to the survival of T&amp;E species</li> </ul>		<ul style="list-style-type: none"> <li>■ Identify/prioritize sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>■ Readily available maps for quick reference</li> </ul>
USEPA 303(d) list for water quality impairment	USEPA	<ul style="list-style-type: none"> <li>■ Designation of impaired surface waters with respect to water quality parameters</li> </ul>		<ul style="list-style-type: none"> <li>■ Identify/prioritize sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>■ Depending on the listed parameter, impairment may or may not be sensitive to dewatering</li> <li>■ 303(d) list mapping readily available</li> </ul>
National and State Forests, Parks, and Wildlife areas				<ul style="list-style-type: none"> <li>■ Identify/prioritize sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>■ Readily available maps for quick reference</li> </ul>
<b>Quantification – Environmental Flows and Impacts on or from Supply Alternatives:</b>					
Approach Name	Organization	Approach Objectives	Key Technical Elements	Potential Applications	Data Needs/Comments
R2CROSS	CWCB	<ul style="list-style-type: none"> <li>■ Establish minimum instream flow criteria to meet environmental needs</li> </ul>	<ul style="list-style-type: none"> <li>■ Hydraulic survey at a single representative riffle cross-section</li> <li>■ Assumes riffles are the limiting habitat type during low-flow</li> <li>■ Reach-specific biological and water quality data collection to define hydraulic (depth, velocity, bankfull %) minimum criteria</li> <li>■ R2CROSS model to generate hydraulics for a range of flow regimes (or something like HEC-RAS)</li> </ul>	<ul style="list-style-type: none"> <li>■ Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>■ Not all streams of interest have already established criteria</li> <li>■ Level of protection afforded by the method has been debated</li> <li>■ Doesn't account for variability in hydrology, just minimum flow for habitat</li> <li>■ Relatively easy to apply to a large number of streams</li> <li>■ Does require site-specific data collection</li> </ul>
UpCo Study Minimum Flow Criteria		<ul style="list-style-type: none"> <li>■ Establish minimum and optimum instream flow criteria to meet environmental and recreational needs</li> </ul>	<ul style="list-style-type: none"> <li>■ Interviews with local commercial fishermen</li> <li>■ Interviews with CDOW</li> <li>■ PHABSIM simulations</li> </ul>	<ul style="list-style-type: none"> <li>■ Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>■ Criteria proposed for selected streams in Grand and Summit Counties (?)</li> <li>■ Look like only slightly more stringent than CWCB instream flows?</li> <li>■ Also includes a few general guidelines for instream flow maintenance</li> </ul>

**Table 8 Summary of Approaches to Maintaining Environmental Integrity in Statewide Water Supply Management**

Approach Name	Organization	Approach Objectives	Key Technical Elements	Potential Applications	Data Needs/Comments
Threatened and Endangered Species Critical Habitat Flow Recommendations	USFWS	<ul style="list-style-type: none"> <li>Instream flow recommendations to support T&amp;E species</li> </ul>	<ul style="list-style-type: none"> <li>For Colorado and Gunnison Rivers</li> <li>peak and baseflow recommendations based on historical flow analysis</li> </ul>	<ul style="list-style-type: none"> <li>Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>Recommended flows are readily available</li> </ul>
Ecologically Sustainable Water Management	The Nature Conservancy	<ul style="list-style-type: none"> <li>Maintain ecological integrity in waterways while meeting water demands</li> </ul>	<ul style="list-style-type: none"> <li>RVA (Range of Variability Approach);</li> <li>statistical analyses of historical stream flows;</li> <li>Defining and meeting metrics (33) associated with "natural" streamflows</li> <li>Assessing human impacts river hydrologies (modeling)</li> </ul>	<ul style="list-style-type: none"> <li>Guiding reservoir operations</li> <li>Guiding river flow management</li> </ul>	<ul style="list-style-type: none"> <li>Approach relies heavily on historical data availability and being able to define "natural conditions"</li> </ul>
Tennant Method	Tennant (1976)	<ul style="list-style-type: none"> <li>Establish minimum instream flow criteria to meet environmental needs</li> </ul>	<ul style="list-style-type: none"> <li>Based on the assumption that aquatic habitat conditions are directly tied to the proportion of mean annual flow in a reach</li> <li>Generally a seasonal analysis</li> <li>Minimum flow set based on proportion of mean annual flow (proportions set in original methodology)</li> </ul>	<ul style="list-style-type: none"> <li>Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>Originally developed for Rocky Mountain region</li> <li>Requires historical gaged unregulated flows</li> <li>Easy to apply but less site-specific and probably less defensible</li> </ul>
Wetted Perimeter		<ul style="list-style-type: none"> <li>Establish minimum instream flow criteria to meet environmental needs</li> </ul>	<ul style="list-style-type: none"> <li>Based on establishing a relationship between wetted perimeter and flow for representative riffles</li> <li>Site-specific cross-section surveying</li> <li>Instream flows set based on breakpoint in wetted perimeter vs. flow curve</li> </ul>	<ul style="list-style-type: none"> <li>Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>Requires site-specific data collection</li> <li>Similar to R2CROSS in underlying assumptions and rationale</li> <li>Best-suited to alluvial channels</li> <li>Not well-suited to disturbed or modified channels</li> </ul>
Covington and Hubert: Trout Reponse to Restoration of Stream Flows	USGS	<ul style="list-style-type: none"> <li>Assess the impacts of flow reductions or restoration on trout</li> </ul>	<ul style="list-style-type: none"> <li>Relies heavily on other published empirical models to establish relationship between flows, habitat, and trout</li> <li>Aerial photos and topographic maps, rather than intensive field surveys, to characterize habitat</li> <li>Historical flow data to characterize natural flows</li> </ul>	<ul style="list-style-type: none"> <li>Analyze potential relative impacts on trout from a specific water supply alternative</li> </ul>	<ul style="list-style-type: none"> <li>Where do we get the appropriate empirical models?</li> <li>TNC approach is more generalized, this tries to take it a step further (actually predicting biomass)</li> </ul>

**Table 8 Summary of Approaches to Maintaining Environmental Integrity in Statewide Water Supply Management**

Approach Name	Organization	Approach Objectives	Key Technical Elements	Potential Applications	Data Needs/ Comments
PHABSIM	USGS	<ul style="list-style-type: none"> <li>■ Analyze effects of altered flow regimes on aquatic life habitat</li> <li>■ Establish instream flow criteria (not necessarily just minimum flow)</li> </ul>	<ul style="list-style-type: none"> <li>■ Brings hydrology, hydraulics, and biology together as an aquatic habitat model (flow -&gt; hydraulics -&gt; habitat)</li> <li>■ Estimates changes in physical habitat (e.g. weighted usable area) as a function of flow</li> <li>■ Often part of applying the Instream Flow Incremental Methodology (IFIM)</li> <li>■ Analysis is dependent on selection of target species and habitat suitability curves (HSC) for that species</li> <li>■ HSC's may require data collection and certainly require consensus building prior to PHABSIM simulation</li> <li>■ HSC's may be taken from literature or other studies if appropriate and agreed upon</li> </ul>	<ul style="list-style-type: none"> <li>■ Guide water supply alternatives analysis</li> </ul>	<ul style="list-style-type: none"> <li>■ Likely a significant effort to apply the model but the only one of the options that tries to directly quantify habitat impacts and is species-specific</li> </ul>

# COLORADO'S INSTREAM FLOW PROGRAM – HOW IT WORKS AND WHY IT'S GOOD FOR COLORADO

Dan Merriman<sup>1</sup>, Anne M. Janicki<sup>2</sup>

## COLORADO'S INSTREAM FLOW PROGRAM

### History

In the early 1970's, the environment was at the forefront of the nation's agenda and Colorado's focus was no different. Colorado mountain streams were being tapped to meet urban water needs, and federal minimum bypass flow requirements at diversion structures were not protected from diversion past the point of release. In 1973, the Colorado legislature recognized the need to "correlate the activities of mankind with some reasonable preservation of the natural environment" and passed Senate Bill 97 creating the State's Instream Flow Program. This program, one of the first of its kind, vested the Colorado Water Conservation Board (CWCB) with exclusive authority to protect streamflow through a reach of stream rather than just at a point, and to protect levels in natural lakes. Until this law was passed, all appropriations of water in Colorado were required to divert water from its natural course in the stream. SB 97 removed the diversion requirement for the CWCB and allowed the Board to appropriate water "instream".

In Colorado, diversion and use of water is governed by the Prior Appropriation Doctrine, and to be enforceable, water rights must be assigned priorities and decreed by the Water Court. Sometimes referred to as "first in time, first in right", the Doctrine awards priorities to water rights based on dates of appropriation. Better priorities are assigned to early claims for water from a stream than to those rights with later claims. With the exception of instream flow or natural lake level claims by the CWCB, all water rights claimed in Colorado must demonstrate that water has been diverted, or otherwise captured, possessed or controlled and applied to a beneficial use in order to be awarded a decree by the Water Court. An instream flow or natural lake level water right is unique in the system. These rights are "in-channel" or "in-lake" appropriations of water made exclusively by the CWCB for a specific lake or reach of stream for the purpose of preserving the natural environment. Once decreed by the water court, these water rights are assigned a priority, just as any other water right claim, and administered within the State's water right priority system.

Since 1973, Colorado has passed additional legislation to clarify and strengthen the program. In addition to the authorities granted for new appropriations of water rights, the legislature clarified the CWCB's authority to acquire existing, decreed senior water rights on a voluntary basis from willing owners for instream flow uses. This authority allows the CWCB to improve the natural environment by adding water to streams or restoring native flows. Most recently, the legislature clarified the CWCB's authority to accept temporary loans or leases of water for instream flows or natural lakes.

Since 1973, Colorado has appropriated instream flow water rights covering over 8,500 miles of stream and 486 natural lakes. This protection represents approximately 30% of the perennial stream miles in the state. In addition, the CWCB has completed 21 water acquisition transactions, including acquisitions to protect critical habitat for endangered species on the Yampa River, to improve the natural environment of the Blue River downstream from Dillon Reservoir, and to restore native flows to a degraded stream system near Silverton, Colorado.

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## Key Program Areas

Colorado's Instream Flow Program is comprised of three key program areas – **New Appropriations**, **Water Acquisitions** and **Water Rights Protection**. These key program areas represent the CWCB's "toolbox" for preserving or improving Colorado's water-dependent natural environment.

### *New Appropriations*

New appropriations are new, junior water rights claimed by the CWCB to preserve the natural environment. New appropriations are considered by the CWCB each year and are filed annually with the Water Court for adjudication.

### *Water Acquisitions*

Under this program area, the CWCB can acquire "water, water rights or interests in water" to preserve or improve the natural environment, and can acquire by a variety of contractual arrangements including purchase, bequest, donation, devise, lease, exchange, or any other contractual arrangement. Water acquisitions allow the CWCB to obtain water rights with a more senior priority date than the CWCB could obtain with a new junior instream flow appropriation. As a result, the CWCB is able to obtain more senior priorities for water to preserve or improve the natural environment.

Water acquisitions are considered by the CWCB on an "as-offered" basis. The CWCB cannot acquire water rights by eminent domain, or force an individual to convey a water right to CWCB for instream flow purposes. All water acquisitions are voluntary transactions proposed by a water right owner.

### *Water Rights Protection*

Once decreed, it is important to monitor stream flows to ensure the instream flow water rights obtained by CWCB are being fully met, and to protect those rights from potential injury that may result from subsequent claims for water from the same stream system. The CWCB provides **Physical Protection** for decreed instream flow rights by installing stream gages and monitoring stream flow on critical reaches of stream, and seeking administration by placing "calls" for rights entitled to receive water. The CWCB provides **Legal Protection** for instream flow or natural lake level water rights by reviewing other water right applications for potential injury to its rights. If a potential injury is identified, the CWCB files a Statement of Opposition with the Water Court, and seeks protective terms and conditions in that decree. If the CWCB is unable to reach a stipulated settlement, the CWCB may pursue litigation.

### *Support Services*

Administration of the Instream Flow Program requires technical and professional support from a team of experts. CWCB staff provides engineering expertise to assist with water availability and consumptive use analyses. These experts perform complex water resource engineering to support water right applications and evaluate potential injury to instream flow and natural lake level water rights. Additionally, CWCB engineers and scientists may provide expert testimony in the event water cases are litigated.

The CWCB staff also relies on various technical tools to assess instream flow needs, and to evaluate other water right applications. The Colorado Decision Support System houses a library of tools including GIS maps, hydrologic, climatologic and water use data, water right databases, and predictive models. These tools are developed and maintained by the CWCB and are essential to program development and administration.

CWCB also relies on outside expertise to develop and protect instream flow water rights, with the Colorado Division of Wildlife (CDOW) as an integral partner in this effort. The statutes require the CWCB to determine that a natural environment exists in order to appropriate or acquire water for an instream flow right. Additionally, the

CWCB must determine the minimum amount of water required to preserve the natural environment to a reasonable degree. CWCB relies upon CDOW scientists to provide the biological information needed to make the statutory determinations.

## **How the Program Works**

### *New Appropriation Process*

The process for appropriating a new instream flow or natural lake level begins with the CWCB's request for recommendations. Each February, staff hosts an Instream Flow Workshop where requests for streams and lakes to be protected are solicited. Any person, including any governmental entity, can submit recommendations. Recommendations must be submitted in writing and with specificity. All recommendations are compiled in the Instream Flow Work Plan and prioritized by staff based on resource value, data requirements and other criteria. Priority streams and lakes are added to the Candidate Stream List for immediate processing.

Once field work is collected for the candidate streams and lakes, the data is analyzed and the instream flow amount is quantified using R2Cross or other standard methodologies. Colorado adapted the R2Cross methodology from a cross-section model used by Region 2 of the Forest Service; hence the name. The R2Cross model stages streamflow at a cross-section location using Manning's equation, and calculates key hydraulic parameters necessary for fish passage, egg incubation and food production. The R2Cross model is a cost-effective tool that provides consistent, reproducible results, and is easy to use. The model has been upheld by Colorado's Water Courts and is used by other agencies and states for quantifying instream flow needs. The model was also recently adopted by the Montana Water Trust for use in evaluating needs for project streams<sup>3</sup>.

Most instream flow water rights are based on the presence of a cold water fishery as an indicator of healthy natural environment. Numerous models have been developed to quantify the flow requirements for fish, and those models have been upheld in court challenges. However, Colorado's Instream Flow Program is not limited to protecting coldwater fisheries. The CWCB has appropriated and acquired water for non-fishery purposes. On Gageby Creek in southeastern Colorado, the CWCB's appropriation was based upon maintaining wetlands for waterfowl habitat. On the Arikaree River in northeastern Colorado and the Mexican Cut Ponds near Crested Butte, water was appropriated to protect unique species of frogs and salamanders. The CWCB has also appropriated water to protect unique hydrologic and geologic features (Hanging Lake) and acquired water to maintain critical habitat for endangered native, warm water fish (Yampa and Colorado River). The challenge in securing water for non-fishery purposes is identifying a scientifically reproducible and acceptable method for quantifying flow needs.

Once flow needs are quantified, the statutes require that the CWCB determine whether water is available to meet those requirements. The intent of the water availability requirement is to ensure that water is legally and physically available to meet the modeled flow recommendations. To estimate hydrology, CWCB staff relies on existing gage records or standard methods or models for determining flow for ungaged basins in Colorado. Staff relies heavily on the resources and technical tools available through the U.S.G.S. and the Colorado Decision Support System.

Recommendations that meet the statutory tests of 1) presence of a natural environment and 2) water available to preserve the natural environment are presented to the CWCB for appropriation. Colorado water rights are adjudicated by the Water Court on an annual basis; therefore, new instream flow or natural lake water rights are junior to existing decreed water rights. For that reason, new instream flow appropriations can not affect or impact existing uses on a given stream, so long as those senior rights are used for their decreed purposes.

### *Water Acquisitions*

CWCB can acquire water released from storage reservoirs, direct diversions, interests in water owned in a ditch or reservoir, water pumped from wells, or other water, water rights or interests in water

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<sup>3</sup> Montana Water Trust web site, <http://www.montanawatertrust.org/>

to preserve the natural environment to a reasonable degree. The CWCB does not need to hold title to the water, but can lease or contract for water using a variety of legal mechanisms including "purchase, bequest, devise, lease, exchange, or other contractual agreement". The water acquisition process is different from the process for new appropriations since each water acquisition is a voluntary proposal initiated by a water right owner.

The process typically begins with a request for consideration of an acquisition proposal. Once a proposal is received, CWCB staff will evaluate the water or water right proposed for acquisition. Additional engineering analyses may be required to determine historic consumptive use or return flow issues. The CWCB determines the amount of water required to preserve or improve the natural environment to a reasonable degree, and decides whether to combine the acquired water with any existing instream flow water right currently decreed for the stream. A draft acquisition agreement is prepared between CWCB and the proponent and presented to the CWCB for consideration. If the CWCB accepts the proposal, a change of water right application is filed with the Water Court seeking adjudication of the use for instream flow purposes. Adjudicated acquisitions are monitored and protected according to the terms of the acquisition agreement and Water Court decree.

#### *Protection*

The CWCB has a very active program to protect instream flow and natural lake level water rights, and staff relies on the latest technologies to accomplish this job. Legal protection of instream flow or natural lake level water rights requires review of every water right application filed in the state. CWCB staff utilizes GIS mapping tools to locate each claim and to evaluate the potential for injury. Staff may also consult water right databases or other electronic information to understand historic patterns of use. If a potential injury to instream flow water rights is identified, a Statement of Opposition is filed with the Water Court, and staff works with the applicants to develop terms and conditions to protect the instream flow or natural lake level water rights from injury.

Monitoring actual streamflow conditions is equally important in the protection of instream flow rights. Over the years, staff has worked with the U.S.G.S. and the State Engineer's Office to develop a system of satellite linked stream gages on streams throughout the state. Real-time streamflow data is transmitted via satellite to the Denver office, and is readily accessible through the Internet. CWCB staff has also developed a low flow alert system to notify staff by email and cell phone if stream flow drops below decreed amounts on critical reaches of stream. In the event a low flow condition is identified, CWCB staff will contact the Division Engineer to determine whether the instream flow right is in-priority and entitled to receive water. If so, CWCB staff will place a "call" for water, and junior rights diverting out-of-priority may be curtailed to satisfy the "call" for water.

### **WHY THE INSTREAM FLOW PROGRAM IS GOOD FOR COLORADO**

#### Colorado Has a Strong Track Record of Protecting Stream Flows and Natural Lake Levels

Colorado is a leader in instream flow protection, having established one of the first programs among the western states, and it remains one of the most active programs. Colorado has been appropriating, acquiring and protecting water in streams and natural lakes for over 32 years, and has committed significant staff and financial resources to the program. The program currently maintains a staff of six permanent positions, and sponsors an active internship program.

A recent study by Trout Unlimited <sup>4</sup> viewed Colorado's Instream Flow Program this way:

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<sup>4</sup> "Liquid Assets: Protecting and Restoring the West's Rivers and Wetlands through Environmental Water Transactions", Steven Malloch for Trout Unlimited, March 2005

"In water law, Colorado has a reputation for doing things a bit differently than other states – for instance its water court system requires the use of more lawyers and water engineers than any other state. With instream flows, Colorado maintains its reputation, requiring very careful scrutiny of water rights used to protect the environment. This approach creates additional costs and hurdles for environmental water transactions, but results in rights that are well defined, secure and defensible." <sup>4</sup> (page 52)

"Assuming that environmental rights are defended and enforced once established, rights are more secure because of the Colorado water system. Unlike many western states, Colorado water rights are essentially fully adjudicated. Information about water rights and use is easy to find and rely upon compared to most states. It is comparatively easy to know about new appropriations or changes to existing rights that may affect an instream right." <sup>4</sup> (page 56)

Another recently completed study comparing instream flow programs in western states found that Colorado has "perfected more permanent water rights than any other [western] state; in fact, more than most other [western] states combined." <sup>5</sup> Colorado has established instream flow rights on over 8,500 miles of stream and 486 natural lakes in the state, and continues to provide instream flow protection to approximately 40 new stream segments each year.

#### Instream Flow and Natural Lake Level Rights Provide Legal Protection for the Natural Environment

Balancing human needs with the needs of the environment can be a difficult task; providing legal protection for environmental needs can be even more daunting. Rather than creating a "super" right, or mandating bypass flows, Colorado's system of integrating instream flow and natural lake level water rights into the state's water right allocation system places these water rights on an even plane with traditional, consumptive water uses. Instream flow and natural lake rights are permanent, fully adjudicated water rights and are administered as any other water right in the state, consistent with Colorado's Prior Appropriation Doctrine.

Instream flow and natural lake rights in Colorado provide legal protection for the natural environment by awarding them status as permanent, fully adjudicated water rights. These rights protect flow through a reach of stream, not just at a bypass point, and have legal standing in Water Court to protect against injury at any point within that instream flow reach.

#### New Appropriations Preserve Existing Stream Conditions

Under state water law, adjudicated water rights are entitled to stream conditions as they existed at the time of appropriation. Junior priority instream flow water rights cannot affect operation of any senior decreed water rights. However, if a change of water right is sought for the senior water right, CWCB has standing in Water Court, just as any other water right owner, to ensure stream conditions are not altered to the detriment of decreed instream flow water rights. This fundamental premise forms the basis for CWCB to file Statements of Opposition to potentially injurious change of water right applications, and to require protective terms and conditions in the applicant's decree. The CWCB has successfully negotiated terms and conditions to insure its instream flow water rights are protected in over 99% of the cases it enters; thereby allowing the water right change to proceed and the stream to be protected.

#### Water Acquisitions Provide a Mechanism for Improving or Restoring Flows

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<sup>5</sup> "Decades Down the Road: An Analysis of Instream Flow Programs in Colorado and the Western United States, prepared by Sasha Charney for the Colorado Water Conservation Board, July 2005.  
<http://www.cwcb.state.co.us/isf/Programs/WesternISF.htm>

Recent statutory changes have allowed the CWCB to acquire water to IMPROVE the natural environment. This expanded authority for water acquisitions allows the CWCB to work with willing owners to restore flows to degraded stream systems.

In 2001, CWCB was contacted by the San Juan Resources Conservation and Development Council with an acquisition proposal directed at restoration of a drainage impacted by mine runoff. In the North Mineral Creek drainage northwest of Silverton, a leaky, trans-basin diversion ditch was seeping into old mine workings and exacerbating water quality problems. In addition to the seepage problem, the ditch also diverted up to 15 c.f.s. of native flow into another water basin. Local conservation groups secured a grant to purchase the trans-basin water right, and conveyed the right, through a donation agreement, to the CWCB for instream flow use. The CWCB accepted the donation, and designated the use of the acquired right to improve the natural environment, thereby restoring native flows to the watershed. The old ditch alignment has been reclaimed, and the ditch no longer traverses the mine workings. The result has been increased streamflows and improved water quality.

Without the water acquisition process, it would have been difficult to restore and protect the natural environment. A new instream flow appropriation preserves existing conditions, and may have been difficult to obtain as a result of the degraded natural environment. Water acquisitions provide a key mechanism for improving the natural environment and for river restoration efforts.

### **Water Acquisitions Provide a Mechanism for Temporary or Emergency Instream Flows**

During the drought of 2002, many streams experienced record low flows and stream fisheries were stressed to the point of loss. Many water users also found themselves short of the water needed to meet decreed uses, and wished to dedicate water to the stream to sustain the fisheries. At the time, current statutes required any change in use, including temporary instream flow use, to be approved by the Water Court. Any water added to a stream to sustain a fishery without first obtaining a decree for that use was not protectable by CWCB, and was subject to diversion by other downstream water rights. Although the Instream Flow Program did provide for water acquisitions through lease arrangements, the existing process required Water Court approval, and could not be completed quickly enough to meet the urgent need.

As a result of the drought, the legislature recognized the need to streamline the water right loan process, and passed legislation allowing temporary loans of water to CWCB for instream flow use without the need to seek judicial approval. As a result of legislative foresight, the current process now provides for timely, administrative review by the State Engineer, and temporary loans of water for instream flows can be completed in a timely manner.

### **Program Provides a Mechanism for Identifying and Prioritizing Environmental Needs**

In February of each year, CWCB staff hosts an Instream Flow Workshop to solicit recommendations for instream flow or natural lake appropriations. Any person, including any governmental entity, can recommend streams or lakes for protection, and invitations to the workshop are extended to over 100 interested parties, including federal, state and local representatives and members of the public at large. Recommended streams or lakes are added to the Instream Flow Work Plan list and included on GIS maps. As recommendations are prioritized, they are added to the Candidate Stream List, and processed for the CWCB's consideration. In this manner, high resource value or high risk streams or lakes are identified and prioritized for immediate consideration.

### **Program Provides an Opportunity for Federal Agencies and Conservation Groups to Accomplish Streamflow Protection Goals in a Manner Consistent with State Law**

Colorado is one of the few western states that limits the appropriation and acquisition of instream flow or natural lake water rights to a single state agency. While that exclusive authority may strike some as being overly restrictive, in fact, the process for proposing streams and lakes for consideration is, by design, quite inclusive. The statutes require the CWCB to request recommendations for stream and lake protection from the CDOW, the Colorado Division of Parks and Outdoor Recreation, the U.S. Department of Agriculture, and the U.S. Department

of Interior. Also, the Instream Flow Rules allow other interested parties to recommend streams and lakes for protection. After reviewing data and other information for the recommended streams and lakes, the CWCB makes the required statutory determinations and seeks to obtain permanent, fully adjudicated instream flow or natural lake level water rights.

By working through the Instream Flow Program, federal agencies can achieve streamflow protection goals on federal lands in a manner consistent with Colorado's system of prior appropriation and state water laws, and potentially avoid the need for costly litigation. In fact, the State has recently entered into MOUs with the U.S. Forest Service (April 2004) and the U.S. Bureau of Land Management (September 2005) committing to work together on streamflow protection efforts on federal lands, hopefully eliminating the need for federal bypass flow requirements. Instream flow water rights can provide protection for a reach of stream and are administrable under Colorado water law; whereas, federally-imposed bypass flow requirements may only be available in the stream at the point of bypass, are not administrable under Colorado water law, and cannot protect flows from diversion by other water users downstream.

Similarly, conservation groups or members of the public interested in environmental preservation and restoration are invited to recommend streams and lakes for protection through the annual ISF Work Plan process. In 2003, the Colorado Water Trust, a private non-profit conservation group, presented a water acquisition proposal to CWCB to preserve and improve the natural environment of the Blue River downstream from Dillon Reservoir. That segment of the Blue River, designated a Gold Medal Fishery by the CDOW, had been identified as a "water short" stream. The Colorado Water Trust purchased an existing irrigation water right from a willing seller, and donated the water right to the CWCB for use to improve the natural environment of the Blue River. In that manner, the Water Trust was able to achieve its goals by restoring flows to the Blue River, and the water right donation to CWCB comports with state law, integrates the water right into Colorado's water right administration system, and provides an opportunity for CWCB to monitor and protect the donated right.

## **CONCLUSION**

Colorado has a strong, active Instream Flow Program that provides legal protection for the natural environment. The program is inclusive, and benefits Colorado by providing an opportunity to preserve existing stream conditions or to restore native flows and improve the natural environment in a manner consistent with state law. The CWCB has been appropriating, acquiring and protecting water in streams and natural lakes for over 32 years, and will continue to carry out its mission to preserve, improve, and protect Colorado's natural environment for present and future generations.