HEALTHY RIVERS AND STREAMS
CITIZENS ADVISORY BOARD
530 E Main St, Plaza 1
Aspen, CO
August 16, 2012 - 4 p.m.

4:00	**Public Comment**	
4:05	**Board Comment**	
4:15	**Approval of Minutes** June 16, 2012 regular meeting July 9, 2012 special meeting	
4:20	**Roaring Fork Watershed Gaging Initiative**	Chelsea Congdon-Brundige – FORR Sharon Clarke - RFC Seth Mason –SK Mason Environmental
5:00	**Updates:** **1. Wild and Scenic** **2. Economic Study of the relationship between property values and the Roaring Fork River**	John Ely
5:15	**COBB Marketing and Communications**	
5:25	**Site visit to John Denver Kayak Park** (Board request from July 9, 2012 meeting)	

Upcoming 2012 regular meeting dates
Sept 20
Oct 18
Nov 15
Dec 20

HEALTHY RIVERS AND STREAMS CITIZENS ADVISORY BOARD
Meeting Minutes
June 21, 2012
Woody Creek, CO

Board members present: Ruthie Brown, Lisa Tasker, Bill Jochems, Rick Neiley and Andre Wille

Board members absent: Steve Hunter and Greg Poschman

Others present: John Ely and Lisa MacDonald

Public Comment –Steve Childs attended the meeting. He is running for county commissioner and is attending the various citizen board meetings to get an understanding of what each board does.

Board Comment – None

Approval of Minutes
Ms. Brown moved to approve the minutes of April 19, 2012. Mr. Neiley seconded the motion. The motion passed 5 to 0.

Briefing of Crystal River - America's Most Endangered Rivers for 2012
Bill Jochems briefed the Board on the event for naming of the Crystal River an endangered river in 2012 by American Rivers.

Roaring Fork Conservancy funding request Sharon Clarke - Roaring Fork Conservancy
The Board heard a funding request from Ms. Clarke for assistance on the Coal Creek Basin restoration project. The Conservancy was seeking $13,777 cash match for a road reclamation project in Coal Basin that would allow them to complete the pilot project this summer. The overall Coal Basin Restoration Project goal is to reduce sediment and total iron delivery to the Crystal River stream channel from Coal Basin; attenuate the Crystal River hydrograph; restore floodplain function at the Coal Creek/Crystal River confluence, including reducing the flood risk to the historic Town of Redstone; and improve overall riparian and instream habitat. The objective of the pilot project is to assess the benefits of several different techniques on a smaller-scale to determine the cost/benefit ratio of each different method for the planned landscape-scale restoration of Coal Basin.

Letter of Support - Ms. Clarke also asked the Board to approve and authorize the Chair to sign a letter of support that the Conservancy will use for grant funding by federal, state and local governmental entities, for-profit and non-profit entities, as well as individuals for projects and programs to restore the areas of Coal Basin and the Coal Creek/Crystal River Confluence.

Rio Grande Park Stormwater Improvements Funding Request
Stephen Ellsperman, April Long and Scott Chism - City of Aspen
The Board heard a funding request for $43,777 from the City of Aspen staff for a financial partnership on Phase 2 of the Rio Grande Stormwater Improvements Project. Specific elements that are being integrated for stormwater improvements include diverse wetlands, a sand infiltration system similar to a river 'bench', biofiltration swales, water quality finishing ponds, drop structures made of natural materials and a pre-sedimentation treatment vault. These stormwater practices will provide both water quality improvements with an enhanced park experience and also serve as a showcase of stormwater treatment options to be admired and replicated by other mountain resort communities.

Request for Proposal for the study of the relationship between the value of the residential real estate in Pitkin County and the Roaring Fork River

John Ely updated the Board on a request for proposals that was solicited for a study of the relationship between real estate values and the Roaring Fork River. The request language stated that Pitkin County was seeking qualified individuals or firms to conduct an economic analysis of the relationship between residential real estate values and the Roaring Fork River. The study will include research to support the relationship between healthy river systems and real estate values such as the following:

- Review the literature of previous economic impact studies of rivers in Pitkin County and describe the gap in these studies related to the real estate sector.
- Apply a statistically valid and accepted method for quantitatively assessing the relationship between the Roaring Fork River (and its major tributaries) and residential real estate values in Pitkin County
- Identify and test the influence of river flow related variables on residential real estate values
- Describe potential future diversions of native river flow from the Roaring Fork River headwaters

The Board deferred voting on the three funding requests until July 5, 2012 at which time it will hold a special telephonic meeting to further discuss the funding requests.

The Board authorized the Chair to sign an amended letter of support for the Roaring Fork Conservancy to include funding and support the Board has previously contributed.

Adjourn

Mr. Neiley moved to adjourn the meeting. Ms. Tasker seconded the motion. The motion passed 5 to 0.

The meeting adjourned at approximately at 6:45 p.m.

Approved:

Greg Poschman – Chairman
Healthy Rivers and Streams Board

Attest:

Lisa MacDonald

HEALTHY RIVERS AND STREAMS CITIZENS ADVISORY BOARD
Meeting Minutes
Special Telephonic Meeting
9:00 a.m.
July 09, 2012

Board members present:	Ruthie Brown, Lisa Tasker, Bill Jochems, Rick Neiley, Andre Wille Steve Hunter and Greg Poschman
Board members absent:	None
Others present:	John Ely, Lisa MacDonald, Sharon Clarke, April Long

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The Board met telephonically to vote on three funding requests it heard at its June 21, 2012 regular meeting.

Coal Creek Restoration funding request – The Roaring Fork Conservancy received a Colorado Water Conservation Board Watershed Restoration Grant for $39,579 for a road reclamation project in Coal Basin. They are requesting $13,277 cash match from the Pitkin County Rivers Board allowing them to complete the pilot project this summer.

Chairman Poschman moved to recommend to the BOCC an expenditure of $13,777 for the Coal Basin Road reclamation project. Mr. Wille seconded the motion. The motion passed 4 to 1 with Mr. Neiley abstaining.

Ms. Brown and Ms. Tasker joined the meeting.

Rio Grande Park Stormwater Improvements funding project - The City of Aspen is requesting a financial partnership with Pitkin County for its stormwater improvements project at the Rio Grande Park. The $43,000 financial partnership request for this project is based on some anticipated strain on the current budget from the necessary infrastructure costs associated with the pre-sedimentation treatment vault and proposed stormwater interpretation elements along the Mill Street/Central Drainage area.

Chairman Poschman moved to recommend to the BOCC an expenditure of $43,000 for the Rio Grande Park Stormwater Improvements Project. Mr. Neiley seconded the motion. The motion passed 7 to 0.

Study of the Relationship between Real Estate Values and the Roaring Fork River A request for proposals was solicited for a study of the relationship between real estate values and the Roaring Fork River. The request language stated that Pitkin County was seeking qualified individuals or firms to conduct an economic analysis of the relationship between residential real estate values and the Roaring Fork River.

Ms. Brown moved to recommend to the BOCC an expenditure of $85,000 for the study of the relationship between real estate values and the Roaring Fork River. Ms. Tasker seconded the motion. The motion passed 7 to 0.

Adjourn
The meeting adjourned at approximately at 10:23 a.m.

Approved: **Attest:**

Greg Poschman – Chairman
Healthy Rivers and Streams Board

Lisa MacDonald

FRIENDS OF RIVERS AND RENEWABLES
An Initiative of Public Counsel of the Rockies
In cooperation with
ROARING FORK CONSERVANCY

The Roaring Fork Watershed Gaging Initiative

Background

In April 2012, *Friends of Rivers and Renewables (FORR)* and *Roaring Fork Conservancy (RFC)* convened a collaborative **"Stream Gage Needs Workshop"**, the results of which have been compiled in a summary report which is incorporated as an Appendix in the attached proposal.[1] The opportunity to develop a smart grid of water flow and quality data monitoring stations in the watershed was enthusiastically endorsed by public agencies and private river conservation organizations, and has been a top priority for addressing water conservation goals.[2] By consensus of local and regional gaging and water resources experts, a Top Tier of eight reaches was developed at the workshop.

In June 2012, S.K. Mason Environmental analyzed the Top Tier for FORR and RFC and prepared the report, **"Site Recommendations for Stream Discharge Gaging on Top Tier Reaches in the Roaring Fork Watershed"** (revised August 2012).[3]

In July 2012, S.K. Mason Environmental performed manual stream sampling in one of the Top Tier reaches, the Roaring Fork River through Aspen. The purpose was to assess longitudinal flow variability during this extreme low flow year. This study included manual measurements of streamflow and temperature at eight locations in the upper Roaring Fork Watershed. Measurement locations bracketed all major tributaries to and diversions from the Roaring Fork River. Findings are summarized in the report "**Pilot Snapshot of Streamflow**."[4]

In August, 2012, Roaring Fork Conservancy, Friends of Rivers and Renewables, and S.K. Mason Environmental jointly prepared the attached proposal for a **"2012 Snapshot Assessment of Two Distressed Rivers"** which will inform a more refined design for stream gaging stations along these two reaches. This document (and its appendices) constitutes our proposal to Healthy Rivers and Streams and is attached. The total budget is $57,750 with a request of $21,475 from the Healthy Rivers and Streams Board in support of this component of the overall the Watershed Gaging Initiative.

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[1] This Workshop Summary report is **Attachment B of the proposal** and identifies the agency and expert participants and a Top Tier of Gaging Station locations and data needs developed by consensus at the April 20, 2012 Gaging Workshop.
[2] Gaging is listed as a top priority by Roaring Fork Conservancy in its recent "2011 Watershed Management Plan" and in its "Opportunities for Water Conservation" report dated February 20, 2012
[3] This Site Recommendations report is **Attachment C of the proposal** and includes for each of the eight identified Priority Reaches current information on precise locations, land ownership and access, data collection purposes, and projected installation and annual operating costs.
[4] See **Attachment D of the proposal.**

Friends of Rivers and Renewables will coordinate the development and submission of periodic reports and further requests to the Healthy Rivers and Streams Board for the installation and operation of the system of gages proposed for the Roaring Fork Watershed. The total budget for installation and operation is estimated to be $106,510. Friends of Rivers and Renewables would like to present a proposal to Healthy Rivers and Streams in September 2012 to partner with various private funders in funding this Watershed Gaging Initiative.

I. PROJECT VIABILITY

The requested funding will complete the proposed "Snapshot Assessment of Two Distressed Rivers" and will create the foundation on which a successful Roaring Fork Watershed Gaging Initiative will be finalized. Further funding will be required to install and operate the proposed Top Tier of gaging stations.

II. PUBLIC ACCESSIBILITY

The Roaring Fork River below the Salvation Ditch and through Aspen is highly visible, with nearly two-thirds of the adjacent lands in public ownership. There are riverside trails along much of its length, an adjacent outdoor art park, a memorial to John Denver, a municipal park, and city and county open space. Local traffic and trails also cross this stretch of the river in multiple locations. This same stretch of river is one of the Roaring Fork Watershed's most significant problem areas.

The Crystal River is the largest tributary to the Roaring Fork River, yet experiences severe low flows towards the end of most summers. The significant flow alterations that occur in the late summer/early fall are caused by in-basin diversions, are well-documented, and are highly visible where local road and trail crossings occur in multiple locations.

There are numerous locations along each of these reaches where landowners, agency staff or other interested public could observe the activities of this assessment. Bridges, foot/bike paths, and trail crossing provide locations for temporary signage to explain the activities and goals and objectives. RFC and FORR could employ websites and member "alerts" to advise members of planned gaging activities. FORR will work with local media to produce timely print articles describing ongoing gaging and assessment in this critical water year.

III. GOALS OF RIVER BOARD

The Roaring Fork Watershed Gaging Initiative is central to the principal River Board goal of maintaining and improving water quality and quantity within the Roaring Fork Watershed.

The applicant *Friends of Rivers and Renewables* (FORR) plans to develop and coordinate a long-term collaboration with the River Board, the Roaring Fork Conservancy, other non-profits, additional prospective grantmakers and funding sources, and appropriate state and federal water resource agencies. The purpose is to secure and augment stream flows through improved water conservation and management in order to improve the ecological health and riparian habitat of the Roaring Fork River and its principal tributaries. The Watershed Gaging Initiative offers a timely, cost-effective, efficient, state of the art real-time system of gages to better understand and manage critical water resources to maintain instream flows, and to satisfy agricultural and municipal irrigation requirements, in critical stream reaches in the Roaring Fork Watershed.

IV. PROSPECTS OF REPETITION OF PROJECT

This initial "Snapshot Assessment" focuses efforts on the Lower Crystal River and the Roaring Fork River through Aspen to:

1. Identify stream flow "pinch points" (both the precise location and the duration of low flow events); and
2. Refine site selection for stream gages necessary to improve administration of water rights and water quality monitoring.

These Snapshot Assessments are fully capable of repetition, and will be conducted in each reach each month during the period August –October 2012 (3 months) for a total of 6 studies. In general, this study approach can be adopted and replicated in other reaches to gather data on stream flows, diversions, return flows, etc. in other reaches as a basis for water conservation and improved management.

V. HISTORY OF REQUESTING PARTY:

Friends of Rivers and Renewables (FORR) is a new initiative of Public Counsel and is directed by Chelsea Congdon Brundige, a long-time water policy analyst for Environmental Defense and documentary filmmaker for First Light Films. (FORR) is committed to engaging and educating residents of the Roaring Fork Valley around the issues related to healthy river conservation and clean energy solutions. One of FORR's projects is a **Roaring Fork Watershed Gaging Initiative.**

In brief, FORR has assumed the role of catalyzing, organizing and coordinating public and private involvement in an effort to design and implement a basin-wide "smart grid" of stream gages. These gages will monitor flows and other indices of stream health in threatened or impaired reaches in the Roaring Fork watershed. Currently, the Roaring Fork watershed holds stream gages installed over several decades by different agencies to measure flows and diversions at critical locations in the watershed. A comprehensive

stream gaging network would provide continuous, well documented, well-archived, unbiased, and broad-based source of reliable water data that may be used for a variety of purposes including the assessment of the health of these ecosystems, a basis for evaluating potential new diversions and impacts, and opportunities for wise restoration or mitigation.

FORR will also coordinate the collection and distribution of real-time data from this network of gages so that it is available and useful to all interested parties through the Colorado Data Sharing Network or on USGS and other agency websites. By identifying technological approaches that are cost-effective and efficient in streamlining and integrating the collection of stream data, FORR hopes to demonstrate that accurate, useful and defensible stream data can be acquired within a reasonable timeframe and budget. At the same time, FORR hopes this collaborative planning process will generate broad public support for efforts to understand and improve the management of scarce water resources.

Public Counsel of the Rockies is a largely virtual public interest law firm focused on cutting edge issues of conservation, water and energy, and public justice.[5] It "balances the scales" by earmarking and leveraging grants and contributions so that the best professional talent, working at half-market, are empowered to pursue initiatives in these program areas.

VI. PARTICIPATION OF OTHER PARTIES

Roaring Fork Conservancy (RFC) is the premier regional water conservation organization in its namesake watershed. Its mission is "To inspire people to explore, value, and protect the Roaring Fork Watershed." Founded in 1996, RFC has a long and distinguished record of river conservation projects, including projects supported by Healthy Rivers & Streams funding. Recent RFC accomplishments include:

• Spearheading development of the multi-jurisdictional *Roaring Fork Watershed Plan* and the *State of the Roaring Fork Watershed Report 2008,* and serving as lead consultant on both projects;

• Organizing and facilitating a 2-day workshop that brought nearly 50 resource experts and stakeholders together to develop a strategy for the restoration of Coal Basin and the Coal Creek/Crystal River confluence area;

[5] Public Counsel was founded in 2000 and has enjoyed significant success in Colorado. Notable projects include reopening and preserving permanent 24/7 recreational road and trail access from Aspen to the nearby Hunter/Frying Pan Wilderness, with the assistance of former Colorado Supreme Court Justice Jean Dubofsky; protecting minimum stream flows in Snowmass Creek, with the assistance of Hydrosphere water engineer Lee Rozaklis; and former SCLDF regional director Lori Potter, Esq.; derailing a proposed new town mid-way between Glenwood Springs and Carbondale, with the assistance of Denver land use lawyer Gerald Dahl; blocking the proposed siting in downtown Carbondale of a 24/7 INS detention facility for immigrants captured by Western Slope "quick response teams", with the assistance of Aspen land use lawyer Tom Smith; and creating a moratorium on gas drilling near "ground zero" of the 1969 Rulison nuclear fracking blast site, with the assistance of Colorado lawyers Luke Danielson, Martha Tierney and Paul Zogg.

• Serving on the Colorado Basin Roundtable's Nonconsumptive Needs Assessment (NCNA) Subcommittee and providing the majority of the information used to establish the non-consumptive water needs for the Roaring Fork Watershed;
• Completing 19 scientific studies on water resource issues in the watershed;
• Reaching 45,700 students and 17,500 adults with hands-on, in-the-field education programs;
• Protecting 280 acres of riparian habitat *forever*; and
• Maintaining a user-friendly website and Facebook page, and issuing regular newsletters with information on critical and noteworthy watershed issues.

RFC will contract with *S.K.Mason Environmental* to carry out the "Snapshot Assessment." S.K. Mason Environmental offers technical expertise in hydrological data collection, remote data acquisition, GIS, water quality monitoring, stakeholder engagement and stream restoration planning for local governments and stakeholder groups working to improve their understanding of watershed sciences.

VII. PROPOSED PROJECT BUDGET

TASKS	COMPONENTS	TOTAL COST	REQUESTED AMOUNT	IN-KIND MATCH	CASH MATCH[1]
Stream Flow Gage Network					
	Project Coordination			$3,580	
	Workshop	$5,000		$2,580	$5,000
	Report and Revisions	$5,000		$2,080	$5,000
1. Synoptic Streamflow Assessment					
	Project Coordination and Oversight(landowner and partner contacts; working with consultants)	$7,500	$4,725	$2,775	
	Field Equipment (Acoustic Doppler Profiler)	$9,000			$9,000
	EcoFlight (3 flights)	$1,350	$1,350		
	Field Measurements (monthly for two reaches)	$6,000	$1,900		$4,100
	Project Reporting and Dissemination	$6,000	$4,000		$2,000
2.Field Measurements (bi-weekly) at Top Tier Sites through September					
	Equipment and Installation	$2,750	$2,750		
	Gaging and Reporting	$4,750	$4,750		

3. Refine Stream Flow Gage Locations		$1,200	$1,200		
4. Education and Outreach					
	Ditch Tours (2)	$2,000		$2,000	
	Public Dialogues (2)	$3,000		$3,000	
	Drought Public Awareness(including weekly local paper drought alerts)	$3,000		$3,000	
	3 presentations	$1,200	$800	$400	
TOTAL		**$57,750**	**$21,475**	**$19,415**	**$25,100**

[1]**Cash Match Sources**

CWCB is contributing $4,500 as a cash match for this project because they are very interested in the results

The Environment Foundation of Aspen Skiing Company contributed $4500 as a cash match for the acoustic doppler

RFC contributed $4500 as a cash match for the purchase of the acoustic doppler

The Walton Family Foundation contributed $10,000 as a cash match for spearheading and coordinating development of the gaging network

The Walton Family Foundation contributed $1,600 as a cash match for the first round of field measurements

Please note that the full Watershed Gaging Initiative will include the design, implementation and annual operation of 8 priority gaging stations in the watershed as part of an ultimate gaging "network." The total budget for installation and operation of the network is estimated to be $106,510. The estimated budget for this first phase of a "gaging network" is approximately $29,850. Significant funding partnerships are being developed with private and public donors. The applicants will prepare an Application for HRS to request funding for up to ½ of the cost of this gaging network in September and/or October 2012.

Funding for the "Snapshot Assessment" described in this proposal is requested solely from Healthy Rivers and Streams, with in-kind contributions and matching funds contributed by FORR, RFC, other donors, and our consultants.

VIII. ATTACHMENTS:

I. Funding Proposal for a **"2012 Snapshot Assessment of Two Distressed Rivers"** (August 16, 2012), including Appendices A-D.

II. **Curricula Vitae** for Gaging professional team:

Seth Mason and Bill Hoblitzell, S. K. Mason Environmental

Sharon Clarke, Roaring Fork Conservancy

Chelsea Congdon Brundige, Friends of Rivers and Renewables

2012 FUNDING REQUEST TO THE
PITKIN COUNTY HEALTHY RIVERS AND STREAMS PROGRAM
August 16, 2012

2012 Snapshot Assessment of Two Distressed Rivers:
Roaring Fork River through Aspen and the Lower Crystal River
As
Phase 1 of the Roaring Fork Watershed Gaging Initiative

CONTACT INFORMATION:

Contact Person: Chelsea Brundige, Director, Friends of Rivers and Renewables, an Initiative of Public Counsel of the Rockies
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EXECUTIVE SUMMARY

This project is Phase 1 of the Roaring Fork Watershed Gaging Initiative, is time sensitive, and will inform the effort of Friends of Rivers and Renewables (FORR) to coordinate and facilitate the design and implementation in the Fall of 2012 of a network of gages for the Roaring Fork Watershed. A collection of stream gages installed over several decades by different agencies to measure flows and diversions at critical locations exists in this watershed. Roaring Fork Conservancy (RFC), public agencies and other organizations have identified the need to review and assess the performance and value of existing gages in the watershed, to identify new stream monitoring needs and to create an intelligent, interactive and useful gaging network that will support immediate and long-term water rights administration and water management and conservation goals. In recent months, FORR and RFC worked to initiate a workshop and streamline the completion of two follow-up reports titled *Roaring Fork Watershed Stream Gage Needs Workshop (April 20, 2012, Aspen) Summary Report* (Appendix B) and *2012 Site Recommendations for Stream Discharge on Top Tier Reaches in the Roaring Fork Watershed* (Appendix C) detailing the gaging locations and infrastructure requirements needed to support stakeholder needs.

This proposed Snapshot Assessment will aid local water management in three areas: First, information is needed on the precise location and duration of low-flow events on the Roaring Fork River through Aspen and the Lower Crystal River, for which the summer and fall of 2012 presents an ideal opportunity. Information gathered during this assessment will support a water conservation program (not part of this current proposal), including a technical analysis of the feasibility and costs of various conservation measures applicable to local irrigation practices, which is essential for identifying realistic and effective conservation strategies for these stream reaches. Second, on-going manual measurements of streamflow and temperature at priority locations in the upper Roaring Fork Watershed will help to assess longitudinal flow variability in the Upper Roaring Fork River and create an approximate hydrograph for critical reaches during this record-setting drought year. Third, a refined evaluation of the stream flow gaging locations is required. Finally, with respect to public outreach and education, information gathered in this assessment will enable water right holders and water users to gain a better understanding of the connection between their water use and local and regional stream flows in these valued reaches. Water users must also know about the feasibility of water demand-management strategies as a means to address low flow concerns and be informed about the availability of guidance, and funding sources to achieve their objectives.

Importantly, this project addresses or informs many of the 2012 Roaring Fork Watershed Plan's Recommended Actions (*see* Appendix A). One of the Urgent Actions was to: *"Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate."* In 2012, Roaring Fork Conservancy (RFC) completed a year-long study entitled *Opportunities for Water Conservation: Realizing the Stream flow Benefits from Local Water Conservation Efforts*. The study investigated the legal feasibility of employing water conservation as a means to help meet local non-consumptive water demands. The study identified a number of potential strategies for enhancing local instream flows through individual water conservation efforts, such as short-term fallowing, deficit irrigation practices, and weather-based landscape irrigation controllers. Based on the study's recommendations, RFC partnered with Colorado Water Trust (CWT) on a program to solicit short-term instream flow donations to the Colorado Water Conservation Board during the current drought. RFC proposes to continue this initiative by partnering with other entities to develop more permanent water supplies to meet both non-consumptive and consumptive water demands in the Roaring Fork River through Aspen and in the Crystal River Basin.

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PROPOSAL NARRATIVE

Background and Rational:

Roaring Fork River through Aspen

The Roaring Fork River below the Salvation Ditch is highly visible, with nearly two-thirds of the adjacent lands in public ownership. There are riverside trails along much of its length, an adjacent outdoor art park, a memorial to John Denver, a municipal park, and open space. Local traffic also crosses this stretch of the river in multiple locations. This same stretch of river is also one of the Roaring Fork Watershed's most significant problem areas.

The hydrologic alteration assessment in the *State of the Roaring Fork Watershed Report 2008* (at Appendix 3.1.2) quantified flow alteration at the Roaring Fork near the Aspen Gage. Significant flow alteration was detected from May through August and in November. Flows in June and July were altered by more than 65 percent, reducing the annual probability of a small beneficial flood event from 45 percent to 3 percent. In addition to the loss of flushing flows, significant in-basin diversions reduce base flows in the almost three-mile stretch of the Roaring Fork River running through Aspen. Stream flows often fall below the Colorado Water Conservation Board's (CWCB) 32 cfs appropriated instream flow water right for this section of the Roaring Fork River. The river ran completely dry in 2002, runs below the decreed instream flow water right during the irrigation season even in average years, and even runs below 32 cfs in late September in wet years. The Roaring Fork River from the confluence with Hunter Creek to below the Brush Creek confluence is provisionally listed on the State's Section 303(D) list for impaired waters for aquatic life (CDPHE, 2012). Preliminary stream flow data collection on July 25th, 2012 measured a low flow of 4.7 cfs at the Mill Street Bridge with a corresponding water temperature of 64°F. The State Standard for water temperature is 68°F.

The 2011 Miller Ecological Consultants, Inc. report, *Final Report: Evaluation of River Health Roaring Fork River near Aspen, Colorado*, concluded that:

"The reach of the Roaring Fork River through the City of Aspen is significantly encroached upon as a result of urban development. Very little of the river's floodplain remains along the river corridor and upstream diversions, and man-made perturbations within the watershed have changed not only the hydrology of the system, but also a whole host of other functions and processes including the sediment transport characteristics of the river."

Other significant conclusions from this report include the following:

- Compared to other local sites, an *Ephemeroptera, Plecoptera,* and *Trichoptera* (EPT) macroinvertebrate index of seven at the Roaring Fork River downstream of Mill Street is low and indicates some type of degradation.

- Upstream diversions have the greatest impact on late summer base flows. In many years, late summer flows fall below the CWCB's junior instream flow water right of 32 cfs. Flows are often between 15-20 cfs at this time of year-which measurably reduces the amount of wetted area

available for macroinvertebrate production. There is approximately 20 percent less wetted habitat at 17 cfs than at 30 cfs.

- To maintain the current stream habitat conditions, peak flows greater than 350 cfs should occur every other year and peak flows greater than 1,000 cfs should occur approximately one out of every ten years. The ascending and descending limbs of the hydrograph should be maintained in the current shape without sharp increases or decreases in flow rise and fall rates. Habitat conditions would be improved by maintaining stream flows at 30 cfs or greater. Additional hydraulic and habitat simulations are recommended to refine the low flow recommendation.

Lower Crystal River

The Crystal River is the largest tributary to the Roaring Fork River, yet experiences severe low flows towards the end of most summers. The significant flow alterations that occur in the late summer/early fall are caused by in-basin diversions. The flow issues on the lower Crystal River are well-documented. According to a 2003 study conducted by Grand River Consulting for the West Divide Conservancy District and Colorado River Water Conservation District (*West Divide Project: Evaluation of Potential Water Demands Within the Crystal River Watershed*), 27 percent of years between 1955 and 2000 would have had an irrigation shortage under current water demands, in August at the confluence of the Crystal River and Roaring Fork Rivers. The study estimated that an irrigation shortage would have occurred in 22 percent of the years in September and 18 percent in October. In two-thirds of the years, flows would fall below the CWCB instream flow water right (100 cfs 5/1-9/30; 60cfs 10/1-4/30) in the month of August at the confluence of the Crystal and Roaring Fork Rivers. The study estimated that an instream flow shortage would have occurred in 75 percent of the years in September and 44 percent of the years in October. On July 30, 2012, the Crystal River at the Fish Hatchery measured 23 cfs, less than one quarter of the CWCB instream flow right. Citizen volunteer water temperature monitoring recorded a high of 71°F on July 24rd.

In 2008, the Colorado Basin Roundtable (CBRT) included the Crystal River in a list of water bodies in the region with environmental and recreational attributes “at risk.” Specifically, the CBRT identified reduced summer baseflows in the Crystal River as a threat to local water quality, geomorphic functioning (e.g., channel maintenance, sediment flushing), and riparian/aquatic ecological functioning. The CBRT listed “dry-year lease options” and “water use efficiencies” as potential solutions to the problem.

Goals and Objectives

Project Goal

Improve water availability for maintaining instream flows, and for satisfying agricultural and municipal irrigation requirements in two critical stream reaches in the Roaring Fork Watershed. These reaches are shown in the Roaring Fork Watershed Map on Figure 1.

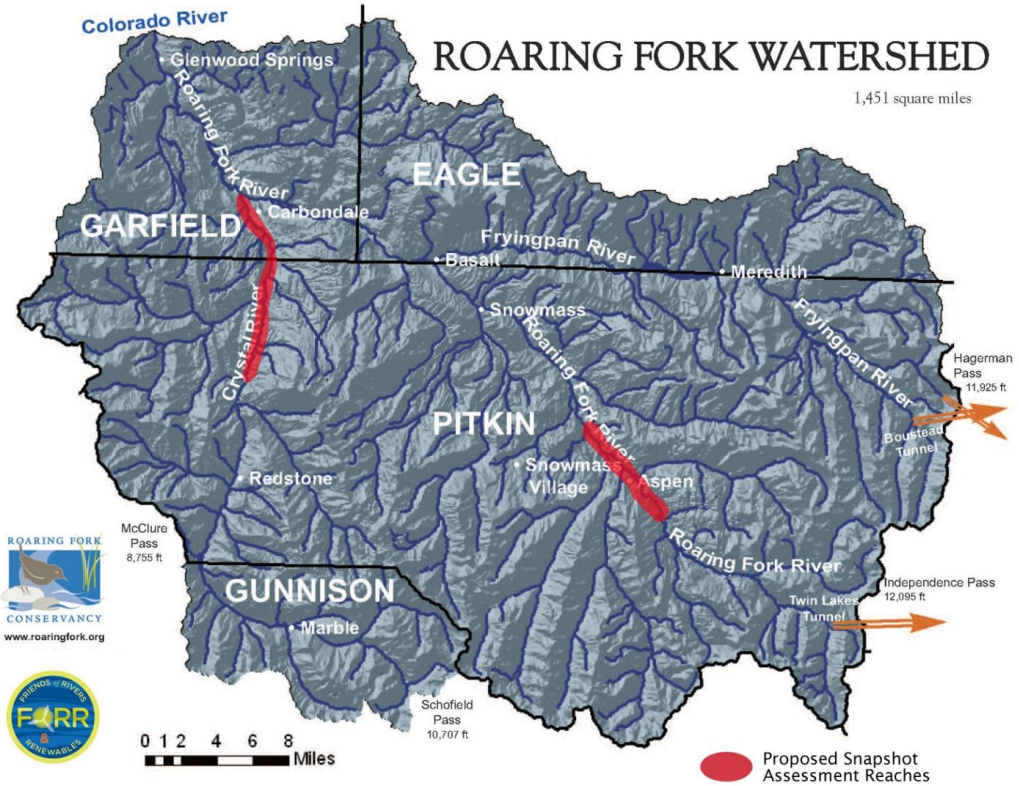


Figure 1. Roaring Fork Watershed Map and Targete Reaches.

Objectives

This project focuses efforts on the Lower Crystal River and the Roaring Fork River through Aspen and on identified top-tier stream gaging sites to:

1. Identify stream flow "pinch points" (both the precise location and the duration of low flow events),
2. Obtain stream flow data and refine site selection for proposed stream gages necessary to improve administration of water rights and water quality monitoring,

Information generated by the proposed project will provide a foundation for longer-term (1-3 years) efforts critical to understanding and conserving our valuable water resources. These include, but are not limited to the following:

- Develop a permanent network of water quantity and water quality monitoring stations in the Roaring Fork and Crystal River watersheds.
- Identify voluntary, market-based actions to improve water availability.
- Identify potential funding sources for projects/programs to support voluntary, market-based actions to improve water availability.
- Quantify flows needed to meet non-consumptive water and agricultural/municipal irrigation, and consumptive water needs.
- Work with willing water right holders to implement solutions to improving water availability.

Participants

Friends of Rivers and Renewables (FORR) and Roaring Fork Conservancy (RFC) (Project Co-Leads); Colorado Division of Water Resources; Colorado Water Conservation Board; Colorado Water Trust (CWT); EcoFlight; Pitkin County Health Rivers & Streams Citizens Advisory Board; S.K. Mason Environmental, LLC; water rights holders; and Western Rivers Institute.

Friends of Rivers and Renewables is a group of citizens working to engage and educate residents of the Roaring Fork Valley around the issues related to healthy rivers conservation and clean energy solutions. FORR's projects focus on:

- Science - coordinating a Roaring Fork watershed stream gaging initiative.
- Education – sponsoring open and lively FORR Dialogues at ACES and other venues about water and energy issues.
- Community – facilitating public stakeholder collaboratives to assess sustainable hydro opportunities in the watershed.

FORR seeks to promote the best clean energy solutions—those that protect our environment, use scarce financial resources wisely, and are supported by the community

Friends of Rivers and Renewables is a new initiative of Public Counsel and is directed by Chelsea Congdon Brundige, a long-time water policy analyst for the Environmental Defense Fund and documentary filmmaker for First Light Films. Public Counsel of the Rockies is a largely virtual public interest law firm focused on cutting edge issues of conservation, water and energy, and public justice. It "balances the scales" by earmarking and leveraging grants and contributions so that the best professional talent, working at half-market, are empowered to pursue initiatives in these program areas. Public Counsel is a nonprofit corporation with §501(c)(3) status, was founded in 2000, and has enjoyed significant success in Colorado.

Founded in 1996, Roaring Fork Conservancy (RFC) is the premier watershed conservation organization in the Roaring Fork Valley and one of the most respected watershed conservation organizations in Colorado. A nonprofit corporation with §501(c)(3) status, it is funded by individual donations, grants, program fees and special events. RFC regularly works with 8 staff members, 2 interns and 4 associates, as well as a strong network of partners (including local, regional, state and federal governments, private interests and universities) and individual volunteers. Recent RFC accomplishments include:

• Spearheading development of the multi-jurisdictional *Roaring Fork Watershed Plan* and the *State of the Roaring Fork Watershed Report 2008,* and serving as lead consultant on both projects;
• Organizing and facilitating a 2-day workshop that brought nearly 50 resource experts and stakeholders together to develop a strategy for the restoration of Coal Basin and the Coal Creek/Crystal River confluence area;
• Serving on the Colorado Basin Roundtable's Nonconsumptive Needs Assessment (NCNA) Subcommittee and providing the majority of the information used to establish the non-consumptive water needs for the Roaring Fork Watershed;
• Completing 19 scientific studies on water resource issues in the watershed;
• Reaching 45,700 students and 17,500 adults with hands-on, in-the-field education programs;
• Protecting 280 acres of riparian habitat *forever*; and
• Maintaining a user-friendly website and Facebook page, and issuing regular newsletters with information on critical and noteworthy watershed issues.

Implementation

Task 1 – Synoptic Streamflow Assessment

In the summer of 2012, a study was initiated by RFC and FORR and conducted by S.K. Mason Environmental, LLC to assess longitudinal flow variability in the Upper Roaring Fork River. This study included manual measurements of streamflow and temperature at eight locations in the upper Roaring Fork Watershed and was designed as a pilot study to inform the design and budget of the proposed synoptic streamflow assessment efforts proposed in this document. A report on this study and findings ***Pilot Snapshot of Streamflow*** is provided as an attachment (Appendix D) and will be available on FORR and RFC websites. A map and graph from the report are excerpted below.

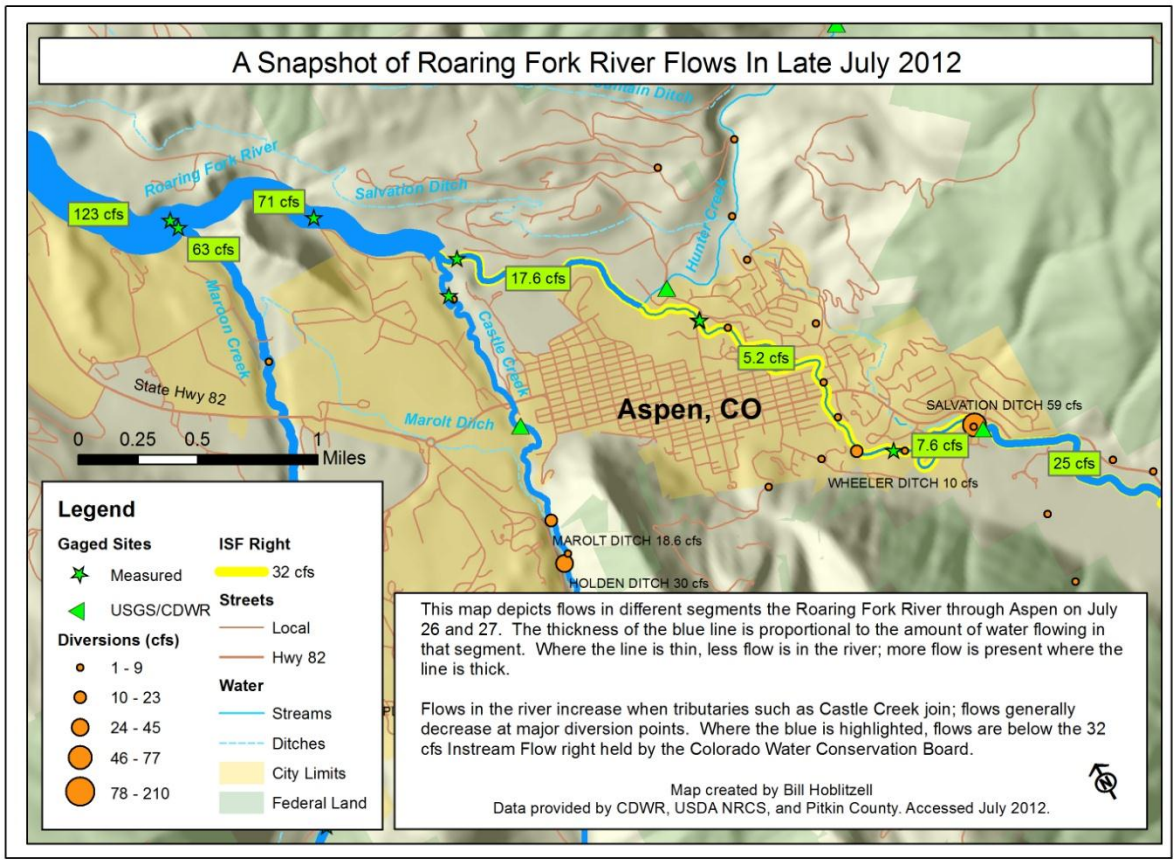


Figure 2. Snapshot Assessment of Roaring Fork River Flows in Late July.

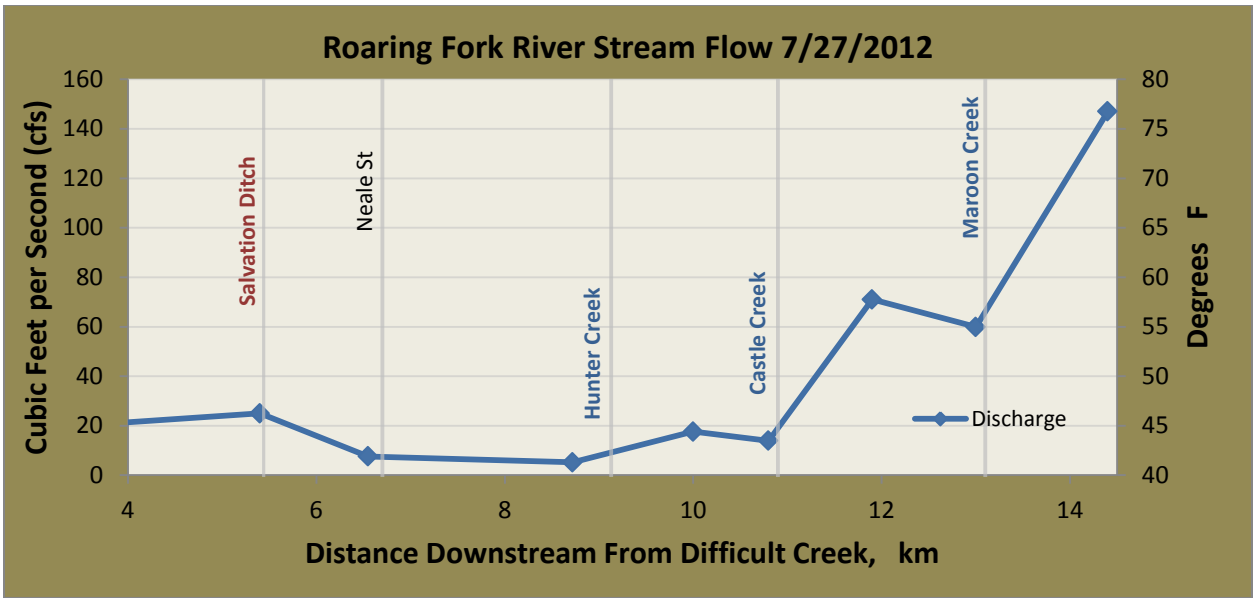


Figure 3. Longitudinal Profile of Flows on the Roaring Fork River below Difficult Creek.

This Synoptic Streamflow Assessment is designed to capture critical, site specific data on baseflows, temperature and other water quality parameters in the two most impaired river reaches in the Roaring Fork Watershed. Specifically, this Snapshot Assessment (or synoptic) will include the following steps or activities. First, project leads and technical consultants, working with the State Engineer's Office will identify diversions in the targeted areas, using the most recent Colorado Decision Support System (CDSS) GIS data, 1994 Resource Engineering water rights location map compiled for the Town of Carbondale, and the Roaring Fork diversion structures map available from the Pitkin County Attorney's Office. Project leads will contact major water rights holders and property owners to explain the goals of the project and to solicit and obtain permission to access affected properties for an evaluation of flows and existing diversion structures[1]. Consultants will then conduct repeated, synoptic stream flow and water quality (e.g., dissolved oxygen, temperature, specific conductance) measurements on targeted reaches: Roaring Fork through Aspen (Difficult Creek to Smith Way), and the Lower Crystal River (Sweet Jessup Canal to the confluence with the Roaring Fork River). **Synoptic sampling runs will be conducted monthly through October 31st**. Consultants and/or project leads will photograph all major diversion and channel structures. We will also work with EcoFlight to obtain concurrent imagery for the targeted areas.

Deliverables:

- Final report summarizing the methodology used to obtain data, indicating observation locations and timing. A table of the entire QA/QC'd dataset will be included as an appendix.
- Maps of observed stream segments utilizing symbology to indicate spatial and/or temporal changes in water quantity and quality. Map will indicate the locations of critical low-flow "pinch-points".
- Map showing major diversion structures and where appropriate the associated irrigated lands.
- Graphs depicting stream flow and temperature for these reaches.

[1] Diversion structure information obtained will be kept confidential and will only be provided to the corresponding water rights holders.

Timeline: Final Report, December 2012.

Task 2 – Bi-Weekly Streamflow Measurements at Top Tier Sites
In April of 2012, FORR and RFC hosted The Roaring Fork Watershed Stream Gage Needs Workshop. The *Workshop Summary Report* (Appendix B) generated by this event was used to facilitate and inform efforts to design a gaging network. Before a water quality and quantity data collection network can be implemented in the Roaring Fork Watershed, specific measurements should be taken. This task contemplates bi-weekly manual measurements of streamflow and temperature at eight locations that are proposed for permanent gaging under the Watershed Gaging Initiative (See Appendix C). These data measurements will be sufficient to support compilation of a hydrograph for this unprecedented low flow year, and will ensure that this invaluable data are collected while plans and funding for the permanent gaging network near completion. This task will produce data at all of the proposed stream gage locations, including locations that are not measured in Task 1. This effort will benefit the gaging network effort primarily by generating data that can be used for rating curve calibration when the complete gaging network is funded and built out. As an added benefit, this Task will elucidate just how low flows get this summer on reaches that are not currently described by USGS and CDWR gaging (e.g. Brush, Coal, and Maroon Creeks, and Roaring Fork River in Aspen).

- *Deliverables:* Final report summarizing the methodology used to obtain data, indicating observation locations and timing.
- A table of the entire QA/QC'd dataset.

Timeline: October 2012.

Task 3 – Refine Stream Flow Gage Locations
This task requires identification of exact locations along target reaches where channel-unit type (e.g. riffle, run, pool) and cross-sectional channel geometry are appropriate for stream discharge gaging. Site identification must also consider ease-of-access and communication network constraints. The report commissioned by RFC and FORR titled *2012 Site Recommendations for Stream Discharge on Top Tier reaches in the Roaring Fork Watershed* (Appendix C) details the gaging locations and infrastructure requirements needed to support stakeholder needs.

The information compiled in Tasks 1 and 2 will inform efforts to refine site-specific recommendations for infrastructure development and installation of monitoring equipment. Site recommendations will consider 1) any constraints imposed by the landscape or anticipated environmental conditions at each site, 2) the frequency of data collection needed to meet project goals for each site, and 3) the type of data access/publication required by the stakeholders. Importantly, final selection of gaging locations will support the data requirements for planned conservation measures intended to benefit instream flows and aid in the assessment of water quality status and trends. Depending on the findings from Task 1 and 2, recommendations for the location and installation of a system of stream discharge gages in Top Tier reaches may be finalized as the final (October) synoptic runs and stream flow assessments (Task 1 and 2) are completed, or thereafter.

Deliverable: Updated report (Appendix C).

Timeline: November 2012.

Task 4 - Education &Outreach

This record-breaking low flow year presents a crucial opportunity to increase public understanding of issues related to the maintenance of healthy rivers and streams, and public/private landowner engagement in issues of water resource conservation, mitigation in impaired river reaches, the importance of real-time gaging and monitoring in understanding and protecting water resources. This project will provide several key opportunities for enhancing public awareness and involvement in water conservation and management.

Deliverables:

- Greening Downtown: Aspen's Invisible Ditch Tour-August 8th. Carbondale Ditch Tour-September 5th.
- Hold a public dialog at ACES and 3rd Street Center to present "high points" of findings from assessments and the importance of conservation, market-based transfers and other mitigation measures.
- Publish, display, re-produce still and video images of Roaring Fork Watershed reaches under extreme low flow conditions with accompanying articles in local and regional papers and RFC, FORR, and Pitkin County Healthy Rivers and Streams Program websites.
- Publicize activities and findings associated with this scope of work in local papers, local and regional water workshops, panels, conferences such as:
    - Presentation or poster at the Upper Colorado River Basin Water conference, to be held in Grand Junction, CO on November 8-9, 2012. This year's theme is **"**How can communities that depend on Upper Colorado River Basin water resources prepare for the possibility of future water shortages?",
    - Roaring Fork Watershed Collaborative quarterly meetings, and
    - Colorado Basin Roundtable monthly meetings.

Timeline: Summer/fall 2012, winter 2013.

Seed Projects

Work products generated upon completion of the Tasks outlined above will inform future water conservation efforts in the Roaring Fork and Crystal River Watersheds. These future projects include:

1) Long-term Water Quantity and Quality Monitoring Network

A comprehensive stream-gaging network in the Crystal and Roaring Fork watersheds will provide hydrologic information needed to improve the use and management of the region's water resources. An integrated gaging network will provide a continuous, well-archived, unbiased, and broad-based source of water data that may be used for a variety of purposes including the assessment of the health of these ecosystems, a basis for evaluating potential new diversions and impacts, and opportunities for wise restoration or mitigation.

By introducing state-of-the-art technologies for real time river monitoring, local government agencies, elected leaders, conservation organizations, citizen advisory boards, and other concerned stakeholders will have information they need to better assess the health of our rivers and streams. With this knowledge will come the ability to manage and protect these resources far more effectively in the face of increasing and competing demands for water. Some of the specific goals for developing such a stream gaging network include:

- Enhancing legal and administrative accountability;
- Capturing critical water quality data and linking flows to quality;

- Identifying water conservation and instream flow protection opportunities (drought mitigation);
- Demonstrating cost-effective technologies for data collection that can provide alternatives to traditional gaging approaches and can be replicated in other locations;
- Identifying gaging priorities among different agencies, municipalities and utilities, and understanding where they overlap;
- Demonstrating the feasibility and efficiency of 3rd party agreements, e.g., a qualified hydrographer in the Roaring Fork Watershed employed by Pitkin County Rivers Board or Roaring Fork Conservancy to maintain a net of additional gages using USGS or other protocols and ensuring broad access to these data; and
- Demonstrating regional responsibility.

2) Irrigation Conservation Feasibility

This snapshot assessment would provide essential information needed to assess the feasibility of irrigation conservation (agricultural and municipal). The assessment would inform the practicability and effectiveness of various water conservation options for local irrigation practices. Assessing the feasibility of irrigation conservation would require working with willing water right holders/land and ditch owners, water commissioners and others to obtain additional information such as the age and functioning capacity of each diversion structure to learn what problems and mitigation have occurred; identify and fill in the existing gaps in technical engineering information necessary for adopting specific conservation measures, identify potential policy, operational, or physical improvements capable of improving water management, develop a process for evaluating and ranking the efficiency of existing diversion structures and their needs, and conduct a cost comparison of options on both a per irrigated acre of land and per acre-foot of conserved water basis. This information could be disseminated by holding a workshop for water right holders/ditch owners to discuss voluntary tools, physical solutions, and funding sources available to improve water availability for maintaining instream flows, and for satisfying agricultural and municipal irrigation requirements.

PROJECT BUDGET:

TASKS	COMPONENTS	TOTAL COST	REQUESTED AMOUNT	IN-KIND MATCH	CASH MATCH[1]
Stream Flow Gage Network					
	Project Coordination			$3,580	
	Workshop	$5,000		$2,580	$5,000
	Report and Revisions	$5,000		$2,080	$5,000
1. Synoptic Streamflow Assessment					
	Project Coordination and Oversight(landowner and partner contacts; working with consultants)	$7,500	$4,725	$2,775	
	Field Equipment (Acoustic Doppler Profiler)	$9,000			$9,000
	EcoFlight (3 flights)	$1,350	$1,350		
	Field Measurements (monthly for two reaches)	$6,000	$1,900		$4,100
	Project Reporting and Dissemination	$6,000	$4,000		$2,000
2.Field Measurements (bi-weekly) at Top Tier Sites through September					
	Equipment and Installation	$2,750	$2,750		
	Gaging and Reporting	$4,750	$4,750		
3. Refine Stream Flow Gage Locations		$1,200	$1,200		
4. Education and Outreach					
	Ditch Tours (2)	$2,000		$2,000	
	Public Dialogues (2)	$3,000		$3,000	
	Drought Public Awareness(including weekly local paper drought alerts)	$3,000		$3,000	
	3 presentations	$1,200	$800	$400	
TOTAL		**$57,750**	**$21,475**	**$19,415**	**$25,100**

[1]**Cash Match Sources**

CWCB is contributing $4,500 as a cash match for this project because they are very interested in the results

The Environment Foundation of Aspen Skiing Company contributed $4500 as a cash match for the acoustic doppler

RFC contributed $4500 as a cash match for the purchase of the acoustic doppler

The Walton Family Foundation contributed $10,000 as a cash match for spearheading and coordinating development of the gaging network

The Walton Family Foundation contributed $1,600 as a cash match for the first round of field measurements

The project budget for the 2102 Streamflow Assessment of Two Distressed Rivers summarizes the total costs to complete Tasks 1-4 outlined in this proposal, as well as several months of work by Friends of Rivers and Renewables, Roaring Fork Conservancy, S.K. Mason Environmental, LLC and others on the preliminary scoping, planning, design, and investigation of the Roaring Fork Watershed Gaging Initiative. To date, project partners have contributed directly or in-kind $44,515 of the total project cost of $ 57,750. This proposal seeks funding from Healthy Rivers and Streams Board in the amount of $21,475.

The Streamflow Assessment is a critical component in a larger Watershed Gaging Initiative to install and operate permanent, cost-effective, real-time gages at priority locations to improve information and understanding of flow and water quality conditions to support water conservation, mitigation of impaired river reaches, water management and planning. The cost for implementation and operation of the Top Tier priority gages in the watershed is approximately $106,510. FORR and project partners are developing a proposal for Healthy Rivers and Streams to participate in a public/private partnership to share in the funding of this effort.

Appendix A. Relevant Roaring Fork Watershed Plan Recommended Actions

(*Urgent Actions italicized and underlined*)

SURFACE WATER A1d. Create and maintain an adequate network of stream gages in the watershed.
SURFACE WATER A1f. Conduct site-specific studies of environmental and recreational flows needed for stream reaches that are currently significantly flow-altered or threatened by significant flow alteration. Include an analysis of how often these flows are not met.
SURFACE WATER B1b. Investigate why CWCB instream flows are not being met (*e.g.*, junior water rights, inadequate flow monitoring) and institute appropriate projects to remedy the problems identified (*e.g.*, acquire water rights, enhance stream gage network).
SURFACE WATER B1c. Increase the utilization of tools and funding available to improve instream flows.
SURFACE WATER B1d. Identify stream reaches where irrigation return flows and groundwater recharge provide late summer and fall flows and investigate opportunities to maintain these important sources of supplemental stream flows whenever possible.
SURFACE WATER B1e. Identify and pursue opportunities for improving natural and artificial water storage to improve low stream flows.
SURFACE WATER B1f. Investigate if water conservation translates to environmental benefits under Colorado water law. Pursue opportunities for water conservation, if appropriate.
SURFACE WATER D1a. Support and distribute films, videos, PowerPoint presentations, etc. illustrating local water conditions and issues.
SURFACE WATER D1d. Improve education/outreach on the connection between water availability and sustainability and land use planning and design strategies.
SURFACE WATER D1e. Improve education/outreach and opportunities for involvement in mitigating the effects of drought.
SURFACE WATER D1g. Increase awareness of water conservation techniques and the importance of conservation. Identify and implement the most strategic water conservation measures.
SURFACE WATER E1c. Create “shovel-ready” drought-mitigation projects that can be quickly implemented.
SURFACE WATER E1e. Investigate opportunities to temporarily loan water to streams using C.R.S. § 37-83-105. Discuss triggering criteria, such as low snowpack levels on specific spring dates, and draft agreements with critical water rights holders, the CDWR Division Engineer, and CWCB that can be quickly implemented when needed.
WATER QUALITY A1c. Undertake targeted water quality monitoring studies to investigate water quality issues identified through routine water quality monitoring, and to capture the impacts or benefits of developments, projects, or other activities.

Appendix B. Roaring Fork Watershed Stream Gage Needs Workshop (April 20, 2012) Summary Report.

Appendix C. Site Recommendations for Stream Discharge Gaging on Top Tier Priority Reaches in the Roaring Fork Watershed.

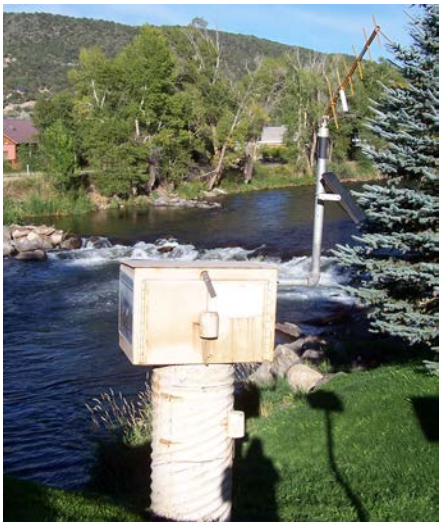
Appendix D. Pilot Snapshot of Streamflow. August, 2012

ROARING FORK WATERSHED STREAM GAGE NEEDS WORKSHOP

(April 20, 2012 Aspen)

SUMMARY REPORT

May 22, 2012



The Roaring Fork Watershed gaging initiative is a project of Friends of Rivers and Renewables (FORR). FORR is an initiative of Public Counsel of the Rockies and was formed to support continued community involvement in the development of regional smart water and clean energy projects. Please visit our website www.FORRaspen.com to learn more about all our emerging projects.

Table of Contents

NEXT STEPS

A draft report was provided to all participants in the April 20 meeting (identified in appendix 3), and other stakeholders. FORR requested that each recipient of the draft report review its contents (specifically notes pertaining to each priority reach) and provide any additional data to "fill in the blanks."

After comments were received and incorporated into this document, FORR and Roaring Fork Conservancy engaged technical experts to further analyze and refine stream gage placement, potential gage technology and data relay/transmission options for each location, including opportunities to co-locate additional data sensors to existing USGS, CDWR, CWCB and BOR gaging stations. They also assessed the potential cost (capital and maintenance) for proposed technologies.

During this same period, FORR worked to:

- Further investigate public and private funding opportunities,
- Evaluate examples of other gage networks in other watersheds, and
- Continue outreach to valley municipalities, water districts, and other interested stakeholders.

INTRODUCTION

Demands for water for municipal uses, irrigation, recreation (including snowmaking) and energy production put pressure on both the quantity and quality of water in the Roaring Fork watershed. These demands, coupled with growing population and climate change in the decades ahead, make it essential that we develop a comprehensive system of stream gages to inform the wise management and long-term conservation of local rivers and streams.

The Roaring Fork Watershed's operational and historic stream gages have been installed by different agencies for different purposes[1]. The oldest gage in the watershed, located on the lower Roaring Fork River, was installed in 1905. There is a need to review and assess the performance and value of existing gages, and identify new stream monitoring needs, to create an intelligent, interactive and useful gaging network that will support immediate and long-term water management and conservation goals. Federal and state agencies, local governments and conservation organizations in the Roaring Fork Watershed have expressed keen support for such an effort. Furthermore, the 2012 Roaring Fork Watershed Management Plan sponsored by the Ruedi Water and Power Authority and their lead consultant, Roaring Fork Conservancy, identified the creation and maintenance of an adequate network of stream gages in the watershed as a "high priority".[2]

A comprehensive stream gaging network provides hydrologic information needed to help define, use, and manage the region's water resources. An integrated gaging network provides a continuous, well documented, well-archived, unbiased, and broad-based source of reliable water data that may be used for a variety of purposes including the assessment of the health of these ecosystems, a basis for evaluating potential new diversions and impacts, and opportunities for wise restoration or mitigation. For more uses of stream flow data see Appendix 2.

Friends of Rivers and Renewables (FORR) has assumed the role of catalyzing, organizing and coordinating public and private involvement in an effort to design and implement a basin-wide system of stream gages. These gages will monitor flows and other indices of stream health in threatened or impaired reaches in the Roaring Fork Watershed. FORR will also coordinate the collection and distribution of real-time data

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[1] Appendix 1 is the current list of operational and historic gages in the Roaring Fork Watershed maintained by Roaring Fork Conservancy.

[2] The plan identified the following: Highest priorities for stream gages in the watershed are: (1) Castle and Maroon creeks, (2) the Lower Crystal River (year-round), (3) the Upper Roaring Fork, and (4) tributaries in the Upper Fryingpan. Second order and higher streams in the watershed with significant diversions and no active stream gage or no gage located below the major diversion structures include: Brush, Fourmile, Threemile, Cattle, Woody, Sopris, Capitol, Maroon, Owl, Landis and Thompson creeks. Several creeks with by-pass flows associated with the Fry-Ark Project are not gaged. Gages at Cattle, Fourmile, Maroon, Thompson, Castle Lime, Cunningham, Middle Cunningham, Mormon, Carter, Granite, Sawyer, and Lily Pad creeks are no longer operating.

from this network of gages so that it is available and useful to all interested parties through the Colorado Data Sharing Network or on USGS and other agency websites. By identifying technological approaches that are cost-effective and efficient in streamlining and integrating the collection of stream data, FORR hopes to demonstrate that accurate, useful and defensible stream flow data can be acquired within a reasonable timeframe and budget. At the same time, FORR hopes this collaborative planning process will generate broad public support for efforts to understand and improve the management of scarce water resources.

GOALS

By introducing state-of-the-art technologies for real time river monitoring, local government agencies, elected leaders, conservation organizations, citizen advisory boards, and other concerned stakeholders will have information they need to better assess the health of our rivers and streams. With this knowledge will come the ability to manage and protect these resources far more effectively in the face of increasing and competing demands for water.

Some of the specific **GOALS** for developing such a stream gaging network include:

1) enhancing legal and administrative accountability;

2) capturing critical water quality data and linking flows to quality;

3) identifying water conservation and instream flow protection opportunities (drought mitigation);

4) demonstrating cost-effective technologies for data collection that can provide alternatives to traditional gaging approaches and can be replicated in other locations;

5) identifying gaging priorities among different agencies, municipalities and utilities, and understanding where they overlap;

6) demonstrating the feasibility and efficiency of 3rd party agreements, e.g., a qualified hydrographer in the Roaring Fork Watershed employed by Pitkin County Rivers Board or Roaring Fork Conservancy to maintain a net of additional gages using USGS or other protocols and ensuring broad access to these data; and

7) demonstrating regional responsibility for monitoring and improving instream flows "in our own backyard."

BACKGROUND

On April 20, 2012 FORR convened experts from public agencies, private hydrology and consulting firms, and water management and conservation organizations to work together to identify the first tier of priority sites in the Roaring Fork Watershed (see Appendix 3 for a list of meeting participants).

Prior to this meeting FORR conducted individual meetings and/or phone consultations with meeting participants; relevant agencies, regional municipalities and water districts; and gaging and watershed experts to compile a broad list of 16 imperiled reaches in the Roaring Fork Watershed. See Appendix 4 for the complete list of pre-identified reaches.

A state-of-the-art watershed map was developed for the project, showing historic and existing gaging stations, land ownership, diversions, and responsibility for gage monitoring and maintenance. Using this map, the group discussed specific gaging needs and opportunities for the pre-identified reaches. The participants were asked to rank each reach in order of priority concern.

Based upon this ranking, FORR selected the eight highest ranked reaches to be the "first tier" of priority gages to be addressed. The purpose of this report is to provide further analysis of the stream gage development potential for these eight sites. Specifically, FORR will coordinate efforts of experts and stakeholders to understand:

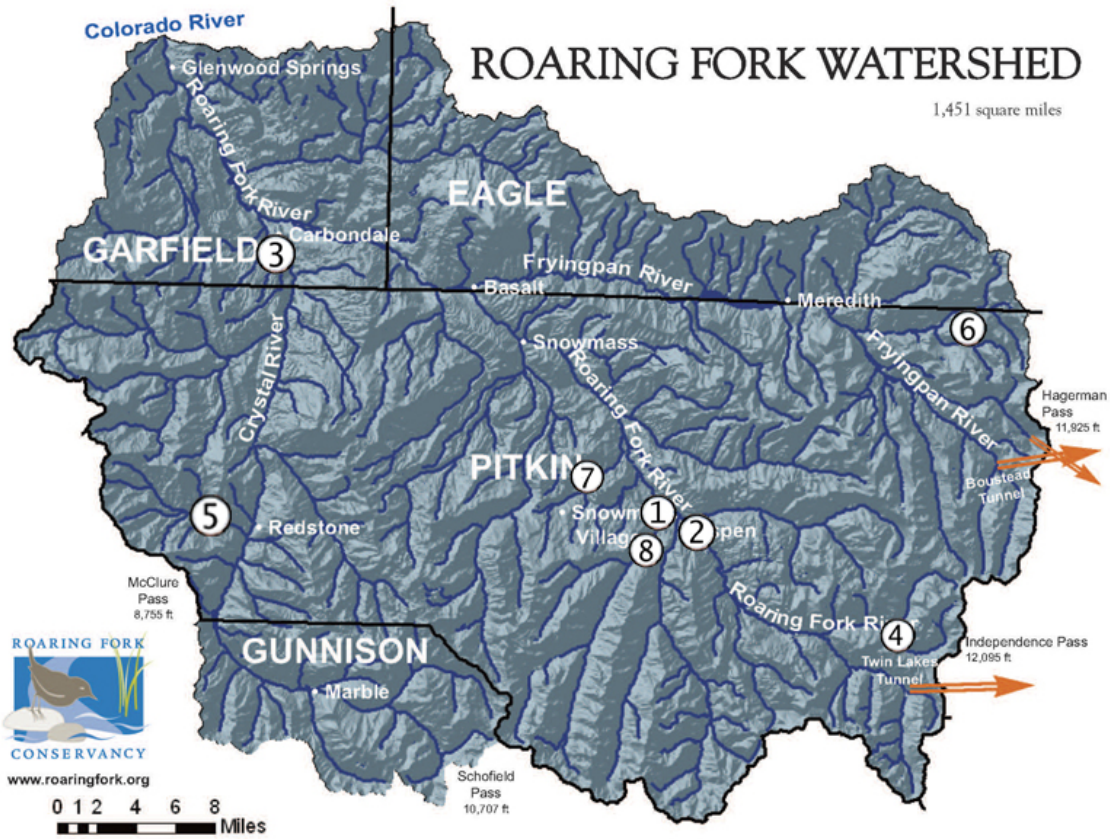
1) the data to be collected, as well as the timing and duration of monitoring, in each location based on potential uses of the data, e.g., water rights administration and accountability, water quality compliance, stream health, etc.,
2) technology options to accomplish data collection,
3) existing as well as potential funding sources for installation and maintenance of gages,
4) opportunities for public/private partnerships in implementing and funding this gaging net, and
5) data dissemination, including to water quality agencies such as Colorado Department of Public Health and the Environment and U.S. EPA if located on a State 303 (D) listed reach, and the Colorado River Water Conservation District.

FORR would like to thank all the individuals, agencies, and municipalities who contributed information and expert knowledge and to all the participants who were able to attend our April 20th meeting. A special thanks to Sharon Clarke and the Roaring Fork Conservancy for their expert involvement and enthusiasm throughout this project and in the preparation of this report.

This report will be distributed to all meeting attendees and interested stakeholders.

PRIORITY REACH DESCRIPTION

Assessment of Top Eight Priority Reaches[3]



1) Maroon Creek below Stapleton Ditch
2) Roaring Fork River near Aspen ("suite of gages")
3) Lower Crystal River (above fish hatchery)
4) Roaring Fork River near Lost Man
5) Coal Basin
6) Fryingpan-Arkansas Project Ungaged Bypass Flows
7) Brush Creek
8) Maroon Creek (below COA municipal diversion)

[3] See Appendix 4 for a complete listing of discussed stream reaches and meeting participants' priority ranking of those reaches.

Maroon Creek below Stapleton Ditch & Maroon Creek below COA municipal diversion

Middle Roaring Fork River Sub-watershed; Pitkin County

DESCRIPTION OF NEED:
Year round flow monitoring would allow the Colorado Division of Water Resources (CDWR) to administer a call placed by the Colorado Water Conservation Board (CWCB) to meet their instream flow (ISF) right. For this reason, stream flow gage technology must meet state standards. This site would also assist in the monitoring of the City of Aspen's (COA) municipal diversions.

DESCRIPTION OF REACH:
Pitkin County
From State of the Roaring Fork Watershed 2008:

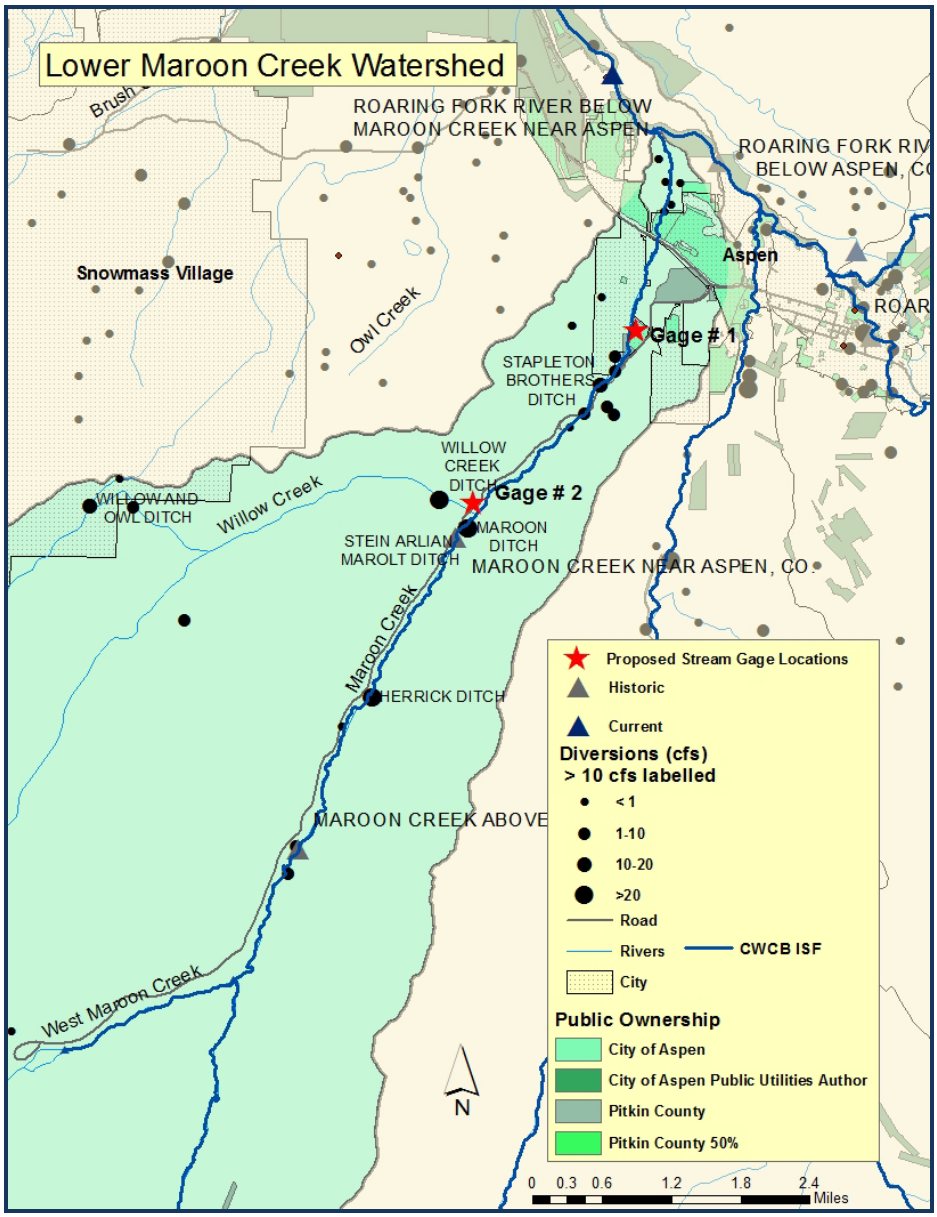
- Flows on Lower Maroon Creek (evaluated at lower historical gage site) has decreased 15-20 percent from October to April compared to pre-development flows.
- The greatest impacts on this reach are recreational activities/trails. Other contributors are weeds, development, and flow alteration.
- The riparian corridor is generally characterized as high quality.
- There is no heavily modified or severely degraded instream habitat. Of the sites surveyed, 14 percent was high quality, 49 percent slightly modified, and 31 percent moderately modified.
- There is no recent water quality data for Maroon Creek.
- Colorado Natural Heritage Program identified Lower Maroon-Castle Creek as a Potential Conservation Area and Maroon Creek was identified as a Conservation Area of Concern by Stream Health Initiative.
- The CWCB ISF right on Maroon Creek begins at the confluence of East and West Maroon Creeks and extends to the confluence with the Roaring Fork River. The ISF right was appropriated on January 14, 1976 for 14 cfs from Jan 1 to Dec 31.
- Maroon Creek had two historic USGS gages: Maroon Creek Near Aspen, CO.(9076000) that operated from 1/1/1911 to 5/31/1917 and Maroon Creek Above Aspen, CO. (9075700) that operated from 9/1/1969 to 9/30/1994 (locations are shown on the map). No gages are currently operating.

From other sources:

- In a Roaring Fork Watershed Water Quality Monitoring Plan prepared by David Brown, USGS (2012), a new water quality and water quantity site was identified on Maroon Creek (39 10 42.03 N, 106 51 41.35 W) to document water quality before significant urbanization. The data would be used for concentrations, trends, and loads. He recommended field physical and chemical properties, E. coli bacteria, low level nutrients, discharge, major ions, trace elements, and selenium be measured 6 times/year. There was no collection of continuous parameters recommended.
- There are no River Watch water quality monitoring sites on Maroon Creek.

- In 2009, Pitkin County entered into an agreement with CWCB to place 4.3 cfs in trust to contribute to instream flows in Maroon Creek. (http://www.aspendailynews.com/section/home/137663).
- Educational opportunities may exist in adjacent open space areas, partnering with the City of Aspen or Pitkin County Open Space and Trails.
- The City of Aspen is working with Colorado Department of Parks and Wildlife to conduct stream monitoring. The upper proposed gage site is below the Maroon Creek intake and should be located at or near the current stream monitoring site.

POTENTIAL FUNDING SOURCES:
CWCB, City of Aspen, Aspen Skiing Company, private



Roaring Fork River near Aspen ("suite of gages")

Upper Roaring Fork Sub-watershed; Pitkin County

DESCRIPTION OF NEED:

Workshop participants supported the idea of a "suite of gages" throughout this reach that extends through Aspen to Smith Way. These gages would monitor water quantity and quality.

Year round flow monitoring would allow the CDWR to administer a call placed by the CWCB to meet their instream flow right. For this reason, stream flow gage technology must meet state standards.

Because of the high visibility of this area, this suite of gages is ideally suited to provide education about water quantity and quality.

This suite of gages would allow the City of Aspen to monitor the effectiveness of their aggressive stormwater management activities.

DESCRIPTION OF REACH:

From the State of the Roaring Fork Watershed 2008:

- The upper Roaring Fork River's hydrologic regime has been dramatically altered with an average of 37 percent of the sub-watershed's yield diverted to the East Slope annually.
- Below the Roaring Fork near Aspen stream gage the combined impact of the Independence Pass Transmountain Diversion System (IPTDS) and inbasin diversions (including the senior 1904 Salvation Ditch diversions and several smaller in-basin diversions) create low flows in the late summer and early fall.
- A CWCB ISF right on the Roaring Fork River extends from the confluence with Difficult Creek to the confluence with Maroon Creek. The ISF right was appropriated on January 14, 1976 for 32 cfs from Jan 1 to Dec 31. Downstream a CWCB ISF right on the Roaring Fork River extends from the confluence with Maroon Creek to the confluence with the Fryingpan River. The ISF right was appropriated on November 8, 1985 for 55 cfs from April 1 to Sept 30 and 30 cfs from Oct 1 to March 31.

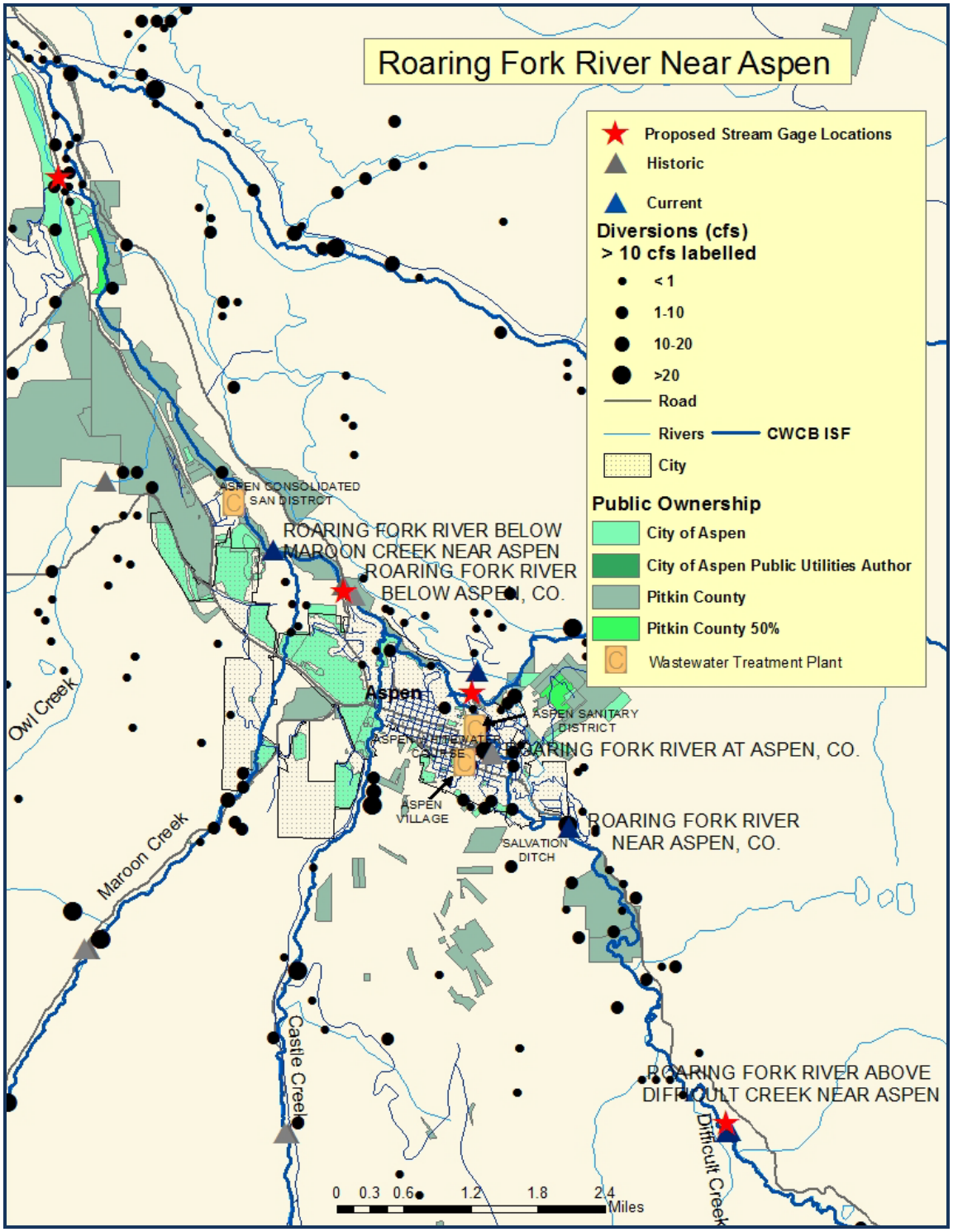
From other sources:

- The Roaring Fork River from the confluence with Hunter Creek to below the Brush Creek confluence is provisionally listed for aquatic life on the state's Section 303(D) list for impaired waters (CDPHE, 2012).
- In Roaring Fork Watershed Water Quality Monitoring Plan prepared by David Brown, USGS (2012) two water quality and stream gage sites were identified. One on the Roaring Fork River at Smith Way Road (39 15 31 N, 106 52 52.00 W; Below Aspen Metro Plaza) to evaluate urbanization and the upper portion of the Roaring Fork Watershed and also for regional assessment refinement. The data would be used for concentrations, trends, loads, water quantity, sediment loading, and surrogate development. He recommended field physical and chemical

properties, E. coli bacteria, low level nutrients, and discharge be measured 8/times year and major ions, trace elements, selenium, and suspended sediment be measured 6 times/year. The plan recommended installing a new streamflow gage that would collect continuous measurements of temperature, specific conductance, and sediment concentration. The other was located on the Roaring Fork above Difficult Creek at the USGS gage (09073300). The location is upstream of most human influences; and can be used to monitor the national forest and document water quality before significant urbanization. The data would be used for concentrations, trends, loads, and water quantity. He recommended field physical and chemical properties, E. coli bacteria, low level nutrients, discharge, major ions, trace elements, selenium, and discharge be measured 4 times/year. Continuous streamflow monitoring was recommended at this site.

- River Watch monitors water quality at three sites in this area: Roaring Fork River at Difficult Creek Campground (#769), at Mill Street Bridge (#770), and Slaughterhouse Bridge (#68). The first two are monitored 4 times a year and the last site is monitored every month. One gage is co-located with Site # 769 and proposed gages could be co-located with these monitoring sites.
- The closest operating stream gages are at the Roaring Fork River Near Aspen, CO above Aspen and the Salvation Ditch and the Roaring Fork River below Maroon Creek near Aspen. The location of these gages does not capture the lowest flow conditions seen in Aspen.
- RFC sampled Site # 68 and #770 for macroinvertebrates in the fall of 2011 and will partner with the City of Aspen's stormwater department to sample 4 sites in 2012.
- Educational opportunities may exist with the City of Aspen, Pitkin County and RFC.

POTENTIAL FUNDING SOURCES:
Pitkin County, Colorado River Water Conservation District, City of Aspen, Aspen Sanitation District.


Roaring Fork River Near Aspen
Proposed Stream Gage Locations
Historic
Current
Diversions (cfs)
> 10 cfs labelled
< 1
1-10
10-20
>20
Road
Rivers
CWCB ISF
City
Public Ownership
City of Aspen
City of Aspen Public Utilities Author
Pitkin County
Pitkin County 50%
Wastewater Treatment Plant
ASPEN CONSOLIDATED SAN DISTRCT
ROARING FORK RIVER BELOW MAROON CREEK NEAR ASPEN
ROARING FORK RIVER BELOW ASPEN, CO.
Aspen
ASPEN SANITARY DISTRICT
ROARING FORK RIVER AT ASPEN, CO.
ASPEN VILLAGE
SALVATION DITCH
ROARING FORK RIVER NEAR ASPEN, CO.
ROARING FORK RIVER ABOVE DIFFICULT CREEK NEAR ASPEN
Owl Creek
Maroon Creek
Castle Creek
Difficult Creek
0 0.3 0.6 1.2 1.8 2.4
Miles

Lower Crystal River

Crystal River Sub-watershed; Garfield County

DESCRIPTION OF NEED:
Water quality and quantity need to be monitored throughout the year in the Lower Crystal. Currently, water quantity is measured seasonally and water quality is measured year-round downstream of the stream flow gage. The collection of water quantity and quality data in the Lower Crystal needs to be coordinated to maximize the utility of these data.

DESCRIPTION OF REACH:
From State of the Roaring Fork Watershed 2008:

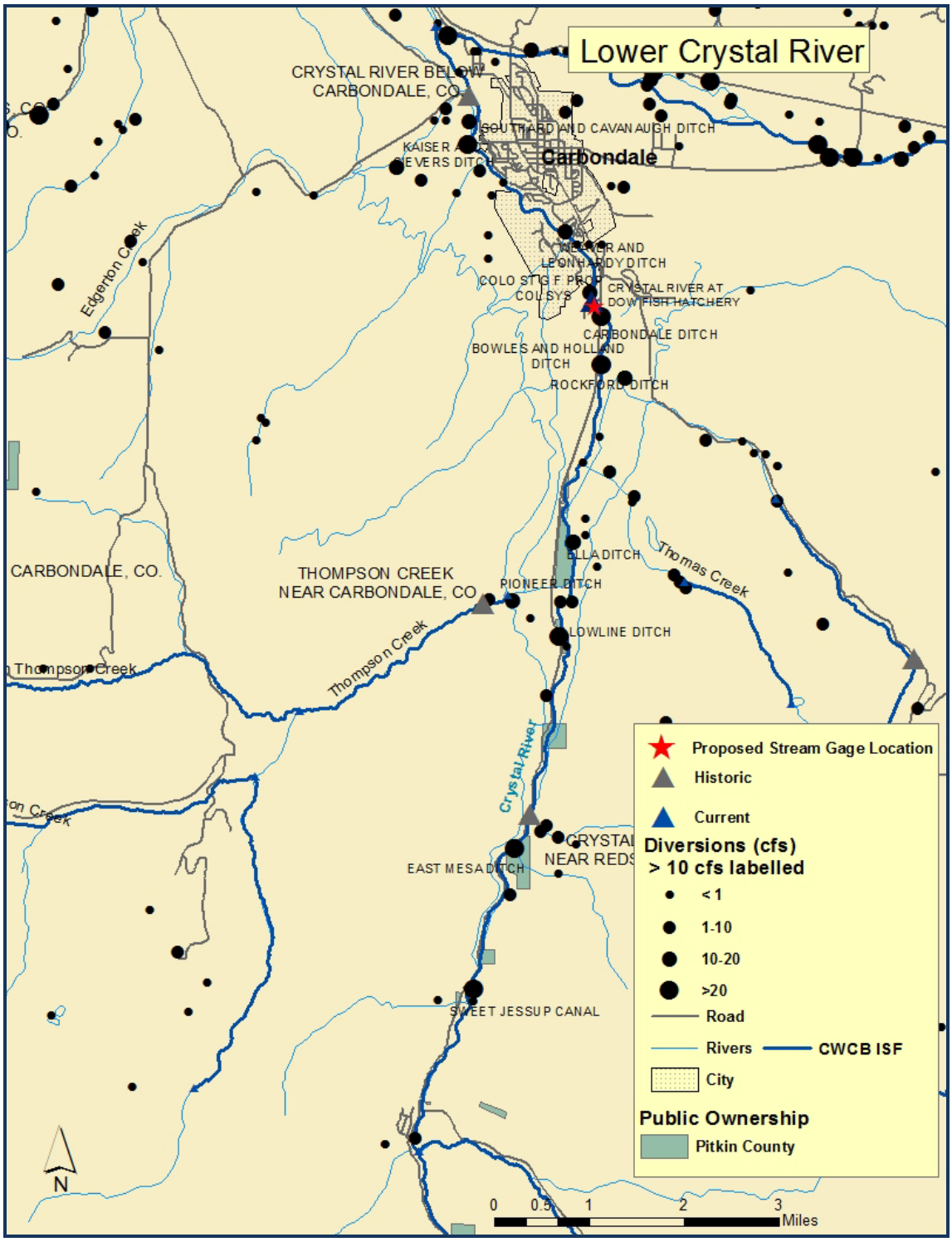
- Agricultural diversions decrease flow on the Crystal River in the late summer and fall.
- Grand River Consulting found there has been an irrigation shortage on the Crystal 27 percent of years from 1955 to 2000, with 22 percent of the years having shortages in September and 18 percent of the years having shortages in October.
- Grand River Consulting found instream flows below the CWCB ISF rights in 66 percent of years from 1955-2000. There were instream flow shortages in September 75 percent of those years and 44 percent of years in October.
- The stream gage was installed in 2006 by CDWR and CWCB. This gage allows the CWCB to better administer the lower Crystal River, including placing calls to meet CWCB ISF rights. The CWCB ISF right on the Lower Crystal River begins at Avalanche Creek and extends to the confluence with the Roaring Fork River. The ISF right was appropriated on May 1, 1975 for 100 cfs from May 1 to September 30 and 60 cfs from October 1 to April 30.

From other sources:

- In a Roaring Fork Watershed Water Quality Monitoring Plan prepared by David Brown, USGS (2012), a water quality and stream gage site was identified on the Lower Crystal River on CR 118. This site would be used to help identify potential agricultural influences on the Crystal River and refine the ability to bracket urban impacts. It would provide baseline information and integrate water quality impacts upstream of the Colorado Parks and Wildlife Fish Hatchery. The data would be used for concentrations, trends, loads, and water quantity. He recommended field physical and chemical properties, E. coli bacteria, low level nutrients, discharge, major ions, trace elements, and selenium be measured 4 times/year. Year round gaging was recommended.
- The current CDWR gage began operation in 2006 and operates seasonally (Apr-Sept). A USGS gage at the CRMS Bridge operated from 5/18/2000 to September 30, 2010.
- River Watch (Colorado Rocky Mountain School-CRMS) monitors water quality monthly at one site on the Lower Crystal River at the CRMS Bridge (#78). Another site at the Fish Hatchery (#75) was discontinued.
- RFC sampled Sites # 78 and #75 for macroinvertebrates in the fall of 2011 and is seeking a grant to resample these sites in 2012.

- Site # 78 is currently used as an educational River Watch site, with potential to further develop educational programs.

POTENTIAL FUNDING SOURCES:
Private, CWCB, CDWR, Town of Carbondale, Garfield County, CRMS

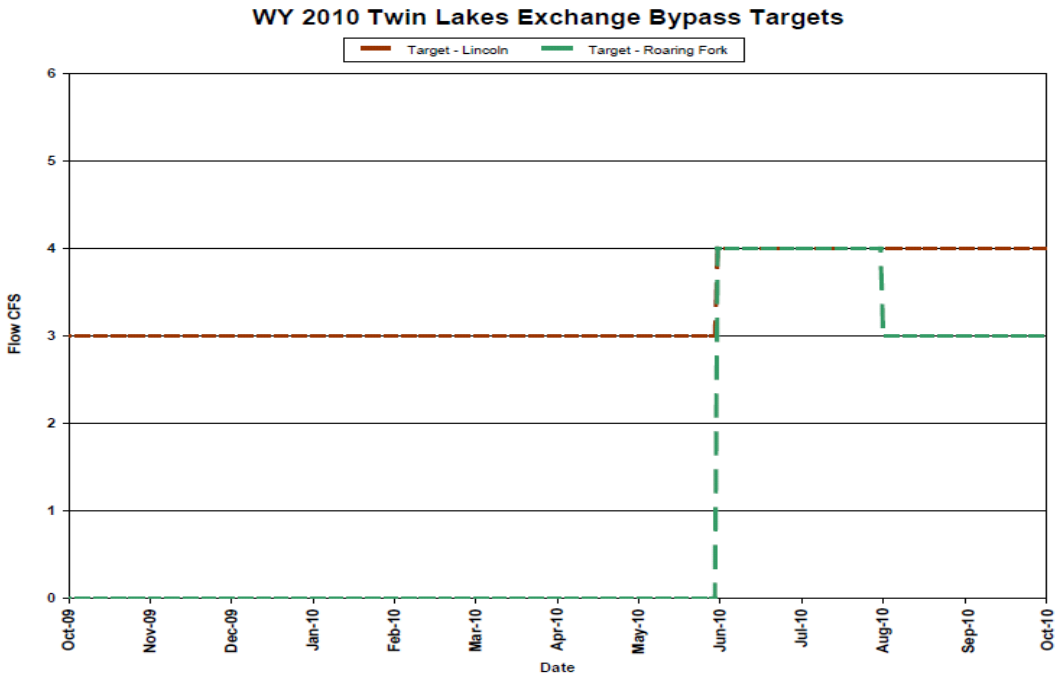


Roaring Fork River near Lost Man

Upper Roaring Fork Sub-watershed; Pitkin County

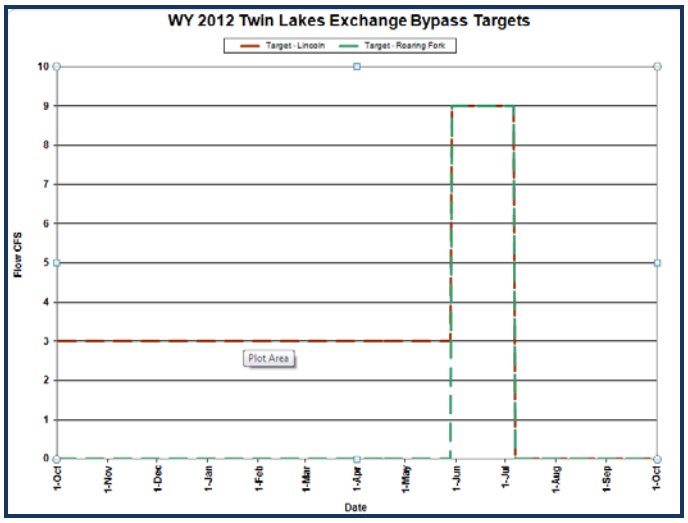
DESCRIPTION OF NEED:

The 3,000 acre foot Twin Lakes Exchange governs the need for a year-round stream gage in this section of the Roaring Fork. Currently, the bypass flows are set with input from the Colorado River Water Conservation District, Pitkin County, City of Aspen, USFS, Twin Lakes Reservoir and Canal Company, Colorado Springs Utilities, and RFC. The current bypass regime, shown below, allocated no bypass flows for the Roaring Fork River from Oct through June 10th. No water is bypassed to the Roaring Fork River for two reasons: 1) there is a limited amount of water available to allocate between the Upper Roaring Fork River and Lincoln Creek throughout the year and 2) there is no ability to measure bypass flows in the Upper Roaring Fork in the winter. An improved gage at this location or relocation of the gage closer to the diversion would be needed if the bypass flow regime called for a winter bypass flow to the Upper Roaring Fork River[4].



In 2012, a very dry year the bypass schedule was revised to reflect a lower projected bypass amount and an earlier projected Cameo Call. The following graph shows the proposed bypass amounts.

[4] There have been several field visits to this site to discuss needs/solutions. As a result, a V-notch weir was installed below the diversion structure on the Upper Roaring Fork to be able to accurately measure by-pass flows. Mark Henneberg, USGS, participated in these visits when he worked for BOR and may recall the specific ideas that were discussed.



However, the V-notch weir on the Upper Roaring Fork River that measures flow below the IPTDS is limited in capacity to 4-5 cfs. A new gage or measuring device in this area would allow bypassing equal amounts in the future. To reflect this limitation starting on May 29, 2012 Lincoln Creek started bypassing 13 cfs, and the Roaring Fork at Lost Man bypassed 3 cfs.

DESCRIPTION OF REACH:

From State of the Roaring Fork Watershed 2008:

- Riparian and instream habitat are generally high quality.
- This area has been identified as part of a Potential Conservation Area by CNHP.
- The upper Roaring Fork River has good water quality.

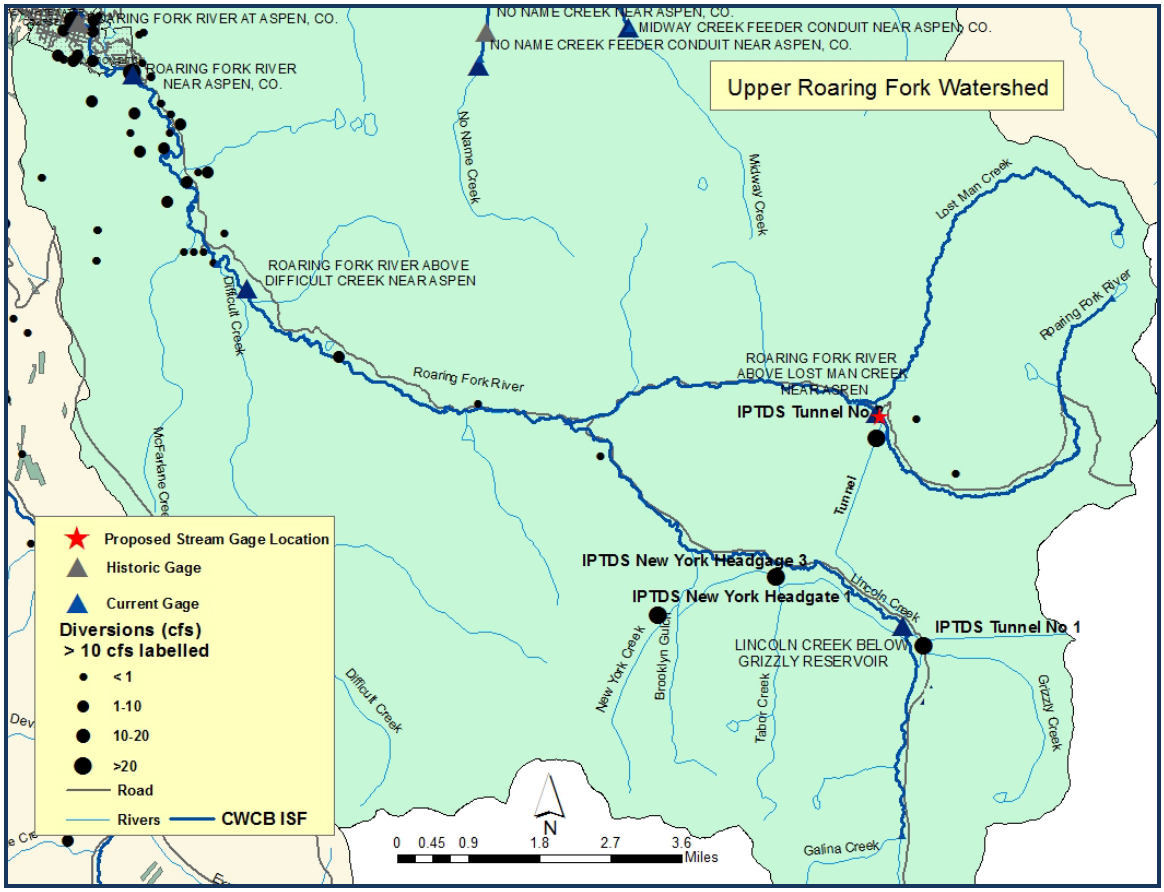
From other sources:

- The seasonal Roaring Fork River above Lost Man Creek near Aspen gage (May1-Oct 31) is operated by USGS and Bureau of Reclamation.
- The closest water quality monitoring is on the Roaring Fork River at Difficult Campground.
- This area is part of the Independence Pass Transmountain Diversion System (IPTDS)
- This site is within the White River National Forest and in a Wilderness Area.
- This gage is impacted by ice and the large boulder substrate makes accurate gage monitoring difficult icy conditions (See picture)
- A by-pass structure may be necessary for May - Oct.
- Winter access is difficult as it is only accessible via snowmobile/snowshoe.
- The USFS may be a good partner in maintaining and using information from this site.
- The CWCB ISF right on the Upper Roaring Fork River begins at the outlet of Independence Lake and extends to the confluence with Lincoln Creek. The ISF right was appropriated on January 14, 1976 for 10 cfs from Jan 1 to De3 31.

POTENTIAL FUNDING SOURCES:

Bureau of Reclamation

Roaring Fork above Lost Man Creek near Aspen stream flow gage (Oct, 2005). Ice and snow in the winter and the rocky substrate hinder accurate, year-round stream flow readings.



Coal Basin

Crystal River Sub-watershed; Pitkin County

DESCRIPTION OF NEED:
Water quality and quantity should be monitored in this basin. Both water quantity and quality data are needed to detect status and trends, plan and design restoration projects, and evaluate the effectiveness of restoration and reclamation projects in Coal Basin. This basin would also benefit from complementary weather and soil moisture monitoring capabilities. This highly altered basin could attract researchers interested in restoration projects.

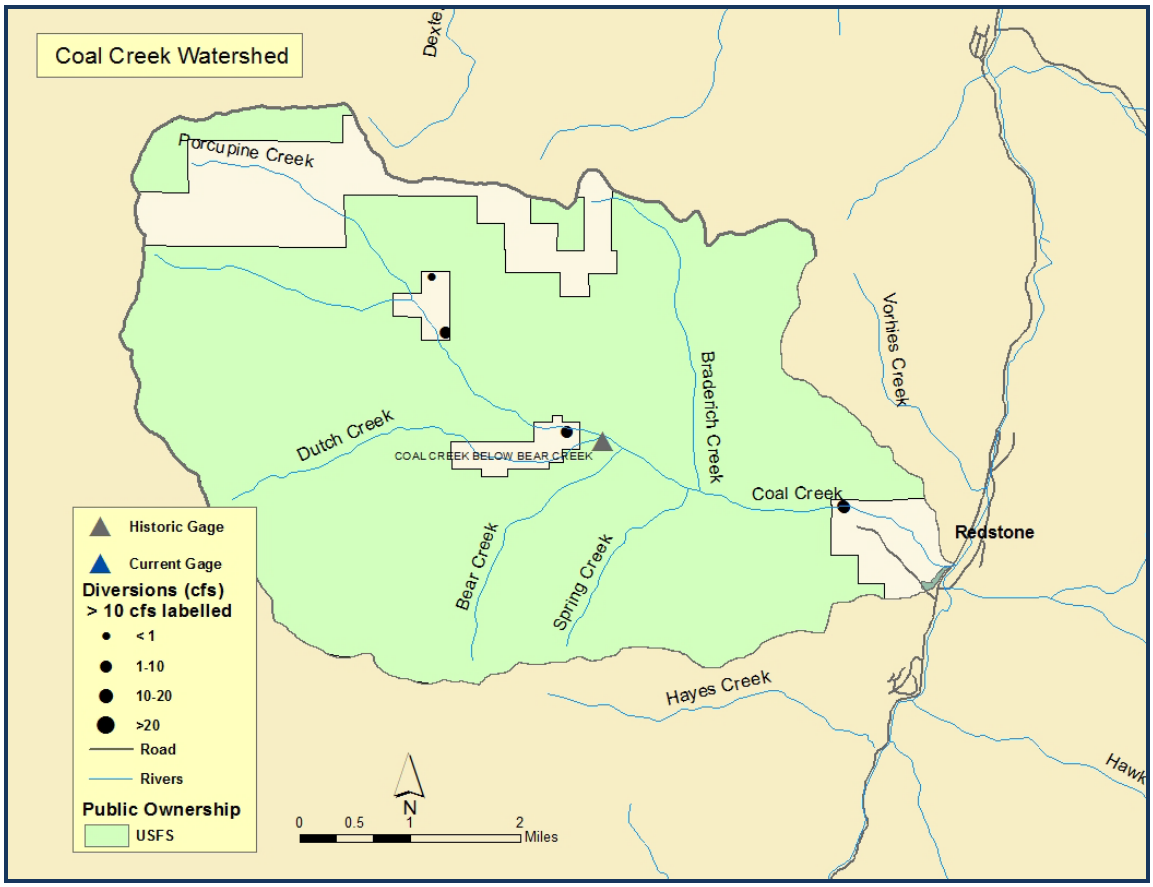
DESCRIPTION OF REACH:
From State of the Roaring Fork Watershed 2008:

- Coal Creek is a significant contributor to suspended solids in the Crystal River due to the unstable landscape and historical mining degradation.
- Coal Creek was on CPDHE's state list for total recoverable iron and on the monitoring and evaluating list for sediments.

From other sources:

- Coal Basin has a very "flashy" hydrograph and can move a large volume of large diameter bedload. Restoration/reclamation project are being planned to reduce sediment and attenuate the hydrograph.
- There are currently no gages in Coal Basin. The USGS has very limited historical flow data for this watershed. In 1981, they obtained flow data for Bear Creek at Coal Creek, Dutch Creek at Coal Creek, and Coal Creek below Bear Creek; flow data for the later site was obtained in 1985 as well.
- There is a current River Watch water quality monitoring site at the confluence of Coal Creek and Crystal River (#782). This site is monitored 4 times/year.
- RFC sampled Site # 782 for macroinvertebrates in the fall of 2011 and the USFS sampled four sites in Coal Basin. RFC is seeking funding to partner with them to resample these 4 sites in 2012.
- RFC is working with USFS on a 3 acre road reclamation restoration project on Dutch Creek in the fall of 2012.
- There are no CWCB ISF rights on Coal Creek.
- Coal Creek is accessible via Coal Creek Road. The road is not plowed in winter.

POTENTIAL FUNDING SOURCES:
State Water Supply Reserve Account, Pitkin County


Coal Creek Watershed
Porcupine Creek
Dutch Creek
COAL CREEK BELOW BEAR CREEK
Bradenich Creek
Vorhies Creek
Coal Creek
Redstone
Bear Creek
Spring Creek
Hayes Creek
Historic Gage
Current Gage
Diversions (cfs)
> 10 cfs labelled
< 1
1-10
10-20
>20
Road
Rivers
Public Ownership
USFS
N
0
0.5
1
2
Miles

Fryingpan Arkansas Project's Ungaged Bypass Flows (3)

Fryingpan Sub-watershed; Pitkin and Eagle Counties

DESCRIPTION OF NEED:
This gage is needed to monitor Fryingpan-Arkansas Project bypass flows in creeks with bypass flows and no gages.
1. Carter (priority) 2. Mormon (priority) 3. M. Cunningham

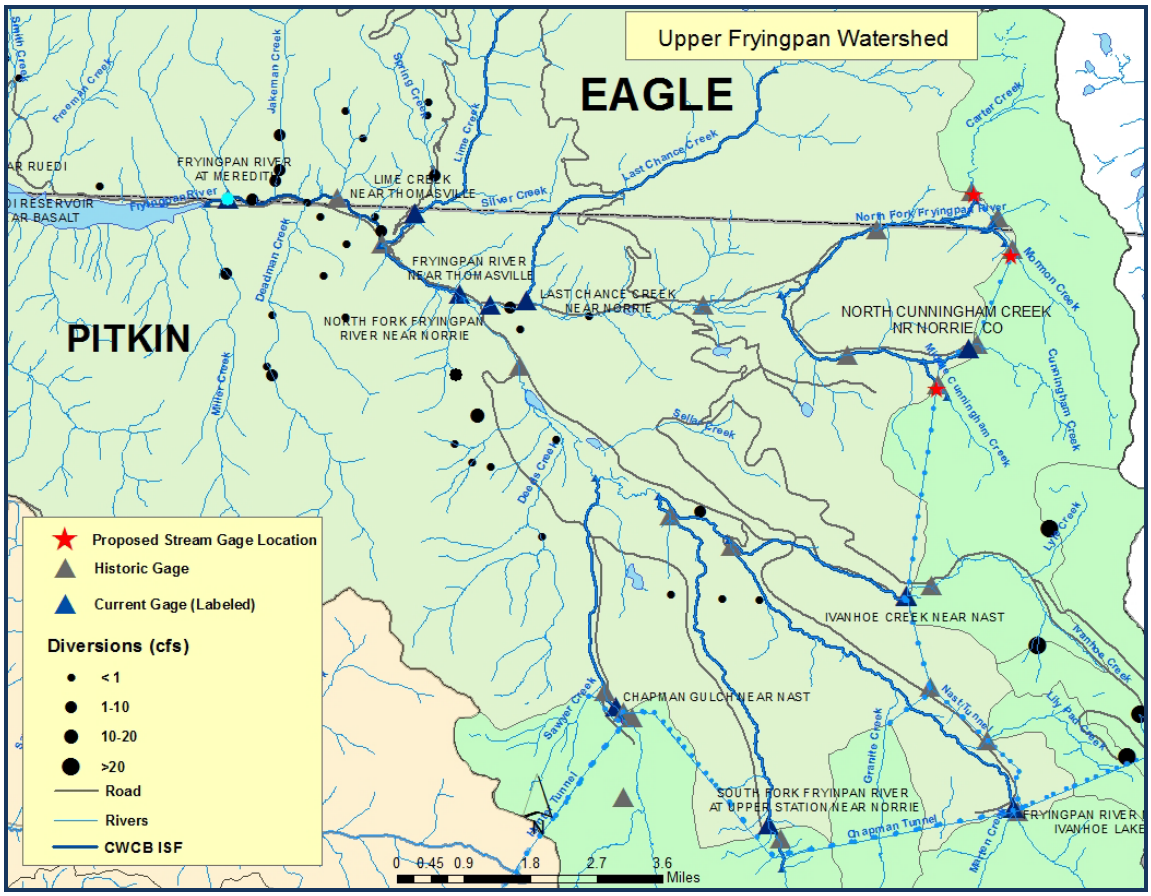
DESCRIPTION OF REACH:
From State of the Roaring Fork Watershed 2008:

- 41 percent of water is diverted from the Fryingpan River through the Fry-Ark Project Transmountain Diversion.
- The CWCB ISF right on Carter Creek begins at the headgate for the Fryingpan-Arkansas Project diversion and extends to the confluence with the North Fork Fryingpan River. The ISF right was appropriated on July 12, 1973 for 2 cfs from April 1 to Sept 30 and 1 cfs from Oct 1 to March 31.
- The CWCB ISF right on Mormon Creek begins at the headgate for the Fryingpan-Arkansas Project diversion and extends to the confluence with the North Fork Fryingpan River. The ISF right was appropriated on July 12, 1973 for 2 cfs from April 1 to Sept 30 and 1 cfs from Oct 1 to March 31.
- The CWCB ISF right on Middle Cunningham Creek begins at the headgate for the Fryingpan-Arkansas Project diversion and extends to the confluence with Cunningham Creek. The ISF right was appropriated on July 12, 1973 for 1 cfs from April 1 to Sept 30 and 0.5 cfs from Oct 1 to March 31.

From other sources:

- Current stream gaging sites are located on the Fryingpan River at Meredith (CDWR, NWS), Fryingpan River near Ivanhoe Lake (CDWR, BOR), South Fork Fryingpan River at Upper Station near Norrie (CDWR, BOR), Fryingpan River near Ruedi (USGS), Rocky Fork Creek near Meredith (CDWR, BOR), Chapman Gulch near Nast (CDWR, BOR) Ivanhoe Creek near Nast (BOR), Fryingpan River near Thomasville (CDRW), Ruedi Reservoir near Basalt (USGS, BOR), Lime Creek near Thomasville (USGS, BOR), Last Chance Creek near Norrie (USGS/BOR), North Fork Fryingpan near Norrie (CDWR), Busk-Ivanhoe Tunnel (CDWR),and Charles H. Boustead Tunnel (CDWR, BOR)
- Three River Watch sites are located in the Fryingpan. One above Ruedi Reservoir: Meredith (#776); and two below the reservoir: Baetis Bridge (#733), and Upper Basalt Bridge (#73). The first two are monitored 4 times/ year and the last one is monitored monthly.

POTENTIAL FUNDING SOURCES:
Bureau of Reclamation, USFS


Upper Fryingpan Watershed
EAGLE
PITKIN
FRYINGPAN RIVER AT MEREDITH
LIME CREEK NEAR THOMASVILLE
FRYINGPAN RIVER NEAR THOMASVILLE
LAST CHANCE CREEK NEAR NORRIE
NORTH FORK FRYINGPAN RIVER NEAR NORRIE
NORTH CUNNINGHAM CREEK NR NORRIE, CO
IVANHOE CREEK NEAR NAST
CHAPMAN GULCH NEAR NAST
SOUTH FORK FRYINPAN RIVER AT UPPER STATION NEAR NORRIE
Proposed Stream Gage Location
Historic Gage
Current Gage (Labeled)
Diversions (cfs)
< 1
1-10
10-20
>20
Road
Rivers
CWCB ISF
0 0.45 0.9 1.8 2.7 3.6
Miles

Brush Creek

Upper Middle Roaring Fork Sub-watershed; Pitkin County

DESCRIPTION OF NEED:
There is a need for stream flow monitoring on Brush Creek. Continuous versus periodic flow monitoring to monitor water quantity still needs to be discussed with the Town of Snowmass Village and the Snowmass Water and Sanitation District. These flow data would also be used to interpret water quality data. The need for continuous recording of water quality data also needs to be discussed.

DESCRIPTION OF REACH:
From State of the Roaring Fork Watershed 2008:

- There are frequent observations on Brush Creek exceeding state pH standards.
- Elevated phosphorus levels have been detected in Brush Creek.
- 38 percent of Brush Creek instream habitat is impacted by development and weeds.
- The riparian habitat on the right bank of Brush Creek is severely degraded over 27 percent of its length. 42 percent of the left bank is severely degraded.
- There are no CWCB ISF rights on Brush Creek.

From 2007 Brush Creek Water Quality Study:

- Although all pH levels did not exceed state standards in this study, there is a supposition that past pH elevation are coincidental with low flows. Testing of this hypothesis requires a stream gage.
- An established relationship between pH and flows could point towards a need to establish a CWCB instream flow right.
- There is a marked spike in nitrate levels between the Snowmass Chapel River Watch site (#889) and above Roundabout River Watch site (#887). The golf course is a potential source of pollutants between these sites.
- Although there were no state standards for phosphate, Brush Creek levels are consistently high, and increase from the Snowmass Chapel River Watch site (#889) to the Y (above Roundabout River Watch site-#887) in 3 of 4 sites sampled.

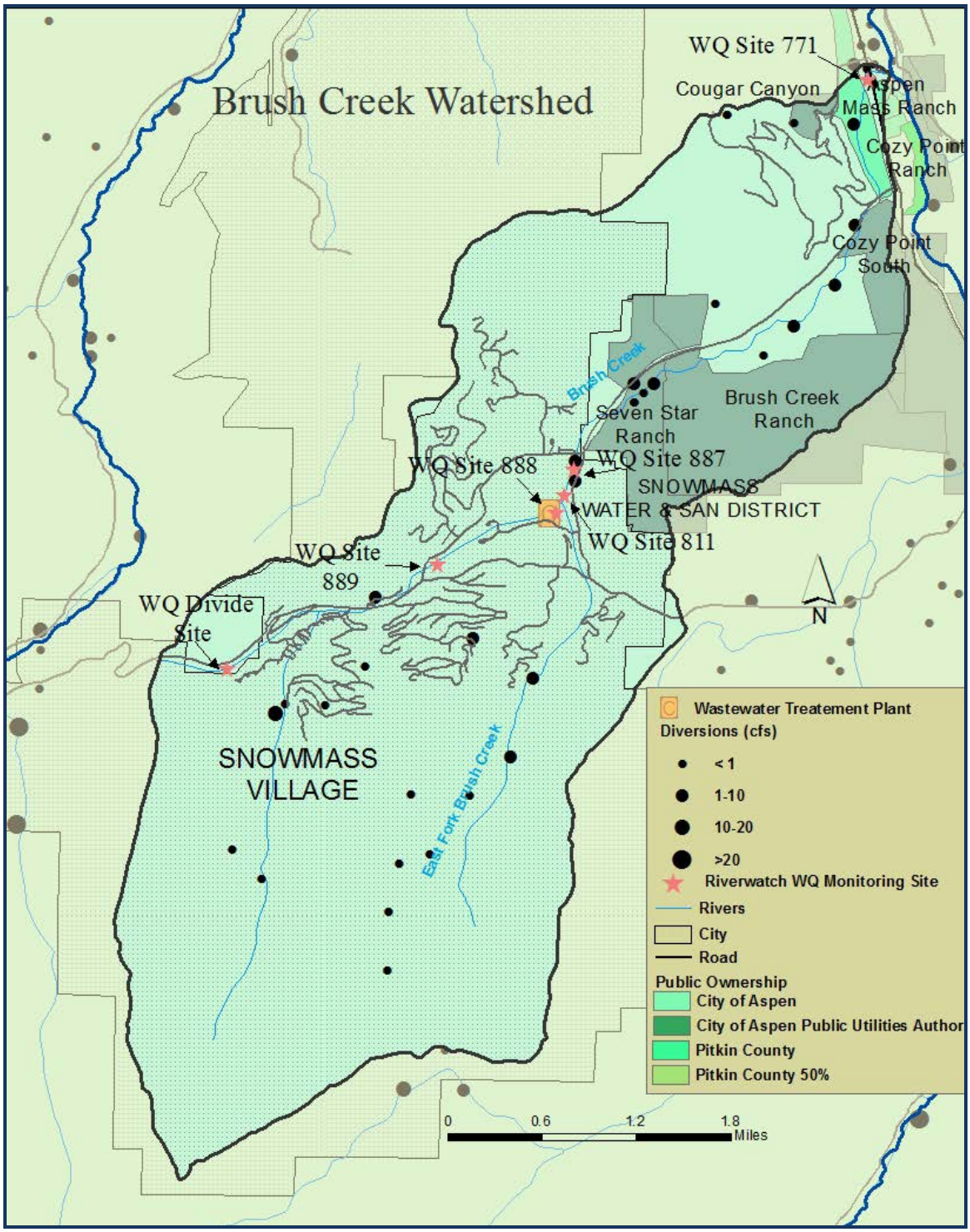
From other sources:

- There are no stream gages on Brush Creek and no historic gages.
- In a Roaring Fork Watershed Water Quality Monitoring Plan prepared by David Brown, USGS (2012) a new water quantity and water quality site was identified on Brush Creek (39 14 50.72 N, 106 53 12.67 W) to integrate urban impacts from Snowmass Village. The data would be used for concentrations, trends, and loads. He recommended field physical and chemical properties, E. coli bacteria, low level nutrients, and discharge be measured 8 times/year and major ions, trace elements, and selenium be measured 6 times/year. There was no collection of continuous parameters recommended.

- There are five active River Watch Sites on Brush Creek: Snowmass Chapel (#889), Clubhouse Drive Bridge (#888), below Snowmass Village and Snowmass Wastewater Treatment Plant (#811), above Roundabout (#887), and at the Highway 82 Bridge (#771). The last site is monitored by a RFC volunteer six times a year and the other four sites are monitored by RFC twice a year. A site on Upper Brush Creek (Divide Site) has historical data, but is no longer monitored. This site was used for the Brush Creek Study.
- Brush Creek is provisionally listed for aquatic life on the state's Section 303(D) list for impaired waters (CDPHE, 2012).
- Golf course pollutants are a potential concern on Brush Creek.
- A review of total phosphorus (TP) data for Brush Creek[5] below Snowmass Village River Watch Site near the junction of Brush Creek and Highline Roads, downstream of the Snowmass Village Wastewater Treatment Facility (2 samples per year from 2008- 2011) shows significant exceedances of the new interim values occurring every winter during low flow. One exceedance was 0.139 mg/L, just above the interim value, but the other three were well above, averaging 1.3 mg/L. In contrast, every high flow sample had TP results below the interim value. When these yearly results are used to calculate an annual median, the median still exceeds the interim value in three of the four years.
- The Snowmass Water and Sanitation District is considering monitoring water quality, macroinvertebrates, and stream flow at 4 sites above and below the Waste Water Treatment Plant as a targeted study to determine the source of water quality issues in the watershed. This would hopefully lead to solutions.
- RFC sampled Site # 887 for macroinvertebrates in the fall of 2011 and will partner with Snowmass Water and Sanitation District to sample 4 sites in 2012.

POTENTIAL FUNDING SOURCES:
Town of Snowmass Village and Snowmass Water and Sanitation District

[5] In March, 2012 Colorado Water Quality Control Commission provided preliminary approval of the new Nutrient Control Regulation 85 and changes to Regulation 31, Basic Standard. These regulations will set total phosphorus (TP) and total inorganic nitrogen (TIN) for the largest wastewater dischargers and set phosphorus and nitrogen interim values for rivers and streams. Interim value for total phosphorus in rivers and streams (0.11 mg/L).


Brush Creek Watershed
WQ Site 771
Cougar Canyon
Aspen
Mass Ranch
Cozy Point Ranch
Cozy Point South
Brush Creek
Seven Star Ranch
Brush Creek Ranch
WQ Site 888
WQ Site 887
SNOWMASS
WATER & SAN DISTRICT
WQ Site 811
WQ Site 889
WQ Divide Site
N
SNOWMASS VILLAGE
East Fork Brush Creek
Wastewater Treatement Plant
Diversions (cfs)
< 1
1-10
10-20
>20
Riverwatch WQ Monitoring Site
Rivers
City
Road
Public Ownership
City of Aspen
City of Aspen Public Utilities Author
Pitkin County
Pitkin County 50%
0
0.6
1.2
1.8
Miles

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APPENDIX 1: List of Current and Historic Gages in the RF Watershed

SITE NUMBER	STATION NAME	CURRENT OPERATOR	DATE OPERATION BEGAN	SEASONAL
9081600	CRYSTAL RIVER ABOVE AVALANCHE CREEK NEAR REDSTONE	USGS	10/1/1955	Year-round
	CRYSTAL RIVER AT DOW FISH HATCHERY AB CARBONDALE	CDWR	?? 2006	April-Sept
9078500	NORTH FORK FRYINGPAN RIVER NEAR NORRIE	CDWR	10/1/1910	
9080100	FRYINGPAN RIVER AT MEREDITH	CDWR/NWS	10/1/1910	
9077500	BUSK-IVANHOE TUNNEL	CDWR	10/1/1947	
9077200	FRYING PAN RIVER NEAR IVANHOE LAKE	CDWR/BOR	10/1/1963	Year-round
9077900	SOUTH FORK FRYINGPAN RIVER AT UPPER STATION NEAR NORRIE	CDWR/BOR??	10/1/1963	
9080400	FRYINGPAN RIVER NEAR RUEDI	USGS	10/1/1964	Year-round
9080300	ROCKY FORK CREEK NEAR MEREDITH, CO.	CDWR/BOR	10/1/1968	
9077160	CHARLES H. BOUSTEAD TUNNEL	CDWR/BOR	10/1/1971	
9077945	CHAPMAN GULCH NEAR NAST	CDWR/BOR	10/1/1972	
9077610	IVANHOE CREEK NEAR NAST	BOR	10/1/1975	
9078600	FRYINGPAN RIVER NEAR THOMASVILLE	CDWR	10/1/1975	Year-round
9080190	RUEDI RESERVOIR NEAR BASALT	USGS/BOR		Year-round
9081000	ROARING FORK RIVER NEAR EMMA	USGS	3/12/1998	Year-round
9085000	ROARING FORK RIVER AT GLENWOOD SPRINGS	USGS	4/1/1906	Year-round
	SNOWMASS CREEK (391930107592001)	CDWR		
	ROARING FORK RIVER BELOW MAROON CREEK NEAR ASPEN	CDWR	10/1/1988	Year-round
	ROARING FORK RIVER AB FRYINGPAN RIVER NR BASALT	CDWR	10/1/2006	April-Sept
9073000	TWIN LAKES TUNNEL	CDWR	10/1/1934	
9074000	HUNTER CREEK NEAR ASPEN	USGS	6/1/1950	Year-round
9074500	HUNTER CREEK AT ASPEN, CO	USGS/BOR	9/16/2009	Year-round
9073400	ROARING FORK RIVER NEAR ASPEN	USGS	10/1/1964	Year-round
9075400	CASTLE CREEK AT ASPEN, CO	USGS/SOS	5/15/2012	Year-round
9073300	ROARING FORK RIVER ABOVE DIFFICULT CREEK NEAR ASPEN	USGS/BOR	10/1/1979	Year-round
9072550	ROARING FORK RIVER ABOVE LOST MAN CREEK NEAR ASPEN	USGS/BOR	10/1/1980	May 1- Oct 31
9073005	LINCOLN CREEK BELOW GRIZZLY RESERVOIR NEAR ASPEN	USGS/BOR	10/1/1980	Year-round
9079450	LIME CREEK NEAR THOMASVILLE	USGS/BOR	4/10/2009	April-Sept
9078475	LAST CHANCE CREEK NEAR NORRIE	USGS/BOR	4/10/2009	April-Sept
9078141	NORTH CUNNINGHAM CREEK CONDUIT BYPASS NR NORRIE,CO	USGS/BOR	4/11/2009	April-Sept
9073721	HUNTER CREEK CONDUIT BYPASS NEAR ASPEN,CO	USGS/BOR	4/9/2009	April-Sept
9073720	HUNTER CREEK FEEDER CONDUIT NEAR ASPEN, CO.	USGS/BOR	5/20/1980	April-Sept
9073891	NONAME CONDUIT BYPASS NEAR	USGS/BOR	4/8/2009	April-Sept

	ASPEN, CO			
9073890	NO NAME CREEK FEEDER CONDUIT NEAR ASPEN, CO.	USGS/BOR	5/18/1980	April-Sept
9073791	MIDWAY CREEK CONDUIT BYPASS NEAR ASPEN, CO	USGS/BOR	4/9/2009	April-Sept
9073790	MIDWAY CREEK FEEDER CONDUIT NEAR ASPEN, CO.	USGS/BOR	5/6/1980	April-Sept
HISTORIC		**HISTORIC OPERATOR**		
9075000	CASTLE CREEK NEAR ASPEN, CO.		10/1/1911	
9074800	CASTLE CREEK ABOVE ASPEN, CO.		9/1/1969	
9084000	CATTLE CREEK NEAR CARBONDALE, CO.	USGS	10/1/1950	
9081500	CRYSTAL RIVER AT MARBLE, CO.		11/1/1910	
9083800	CRYSTAL RIVER BELOW CARBONDALE, CO.	USGS	5/18/2000	
9082500	CRYSTAL RIVER NEAR REDSTONE, CO.	USGS	10/1/1935	
9083000	THOMPSON CREEK NEAR CARBONDALE	USGS	10/1/1950	
9081550	CRYSTAL RIVER AT PLACITA, CO.		10/1/1959	
9082880	NORTH THOMPSON CREEK NEAR CARBONDALE, CO.	USGS	10/1/1963	
9083700	PRINCE CREEK NEAR CARBONDALE, CO.	USGS	10/1/1963	
	THOMPSON CREEK FEEDER DITCH NEAR HAYSTACK, CO	CDWR		
9078000	FRYINGPAN RIVER AT NORRIE, CO.	USGS	10/1/1910	
9080000	FRYINGPAN RIVER AT THOMASVILLE, CO.	USGS	3/1/1915	
9079500	LIME CREEK AT THOMASVILLE, CO.	USGS	6/1/1950	
9079000	LIME CREEK AT TROUTVILLE, CO.	USGS	6/1/1950	
9080200	FRYINGPAN RIVER AT RUEDI, CO.	USGS	10/1/1959	
9078140	CUNNINGHAM CREEK NEAR NORRIE, CO.	USGS	10/1/1963	
9077400	FRYING PAN RIVER NEAR IVANHOE LAKE*	USGS	10/1/1963	
9077200	FRYINGPAN RIVER NEAR NORRIE, CO.	USGS	10/1/1963	
9077600	IVANHOE CREEK NEAR NORRIE, CO.	USGS	10/1/1963	
9078900	LIME CREEK NEAR TROUTVILLE, CO.	USGS	10/1/1963	
9078100	NF FRYINGPAN R AB CUNNINGHAM C, NR NORRIE, CO.	USGS	10/1/1963	
9078300	NF FRYINGPAN R BL CUNNINGHAM C, NR NORRIE, CO.	USGS	10/1/1963	
9077800	SOUTH FORK FRYINGPAN RIVER AT UPPER STATION NEAR NORRIE*	USGS	10/1/1963	
9077900	SOUTH FORK FRYINGPAN RIVER NEAR NORRIE, CO.	USGS	10/1/1963	
9077950	CHAPMAN GULCH NEAR NORRIE, CO.	USGS	10/1/1966	
9077940	CHAPMAN GULCH FEEDER CANAL NEAR NORRIE, CO.	USGS	10/1/1971	
9077150	FRYINGPAN RIVER FEEDER CANAL NEAR NORRIE, CO.	USGS	10/1/1971	
9077960	SAWYER CREEK FEEDER CANAL NEAR NORRIE, CO.	USGS	10/1/1971	
9077750	SF FRYINGPAN RIVER FEEDER	USGS	10/1/1971	

	CANAL NEAR NORRIE, CO.			
9077250	LILY PAD CREEK FEEDER CANAL NEAR NORRIE, CO.	USGS	10/1/1973	
9077605	IVANHOE CREEK FEEDER CANAL NEAR NAST, CO.	USGS	10/1/1975	
9078140	CUNNINGHAM CREEK FEEDER CANAL NEAR NORRIE, CO.	USGS	6/1/1979	
9078150	MIDDLE CUNNINGHAM CREEK FEEDER CANAL NR.	USGS	6/1/1979	
9078050	MORMON CREEK FEEDER CANAL NEAR NORRIE, CO.	USGS	6/1/1979	
9078060	CARTER CREEK FEEDER CANAL NEAR NORRIE, CO.	USGS	4/27/1981	
9078040	NF FRYINGPAN RIVER FEEDER CANAL NEAR NORRIE, CO.	USGS	4/30/1981	
9077300	GRANITE CREEK FEEDER CONDUIT NEAR NORRIE,CO.	USGS	5/5/1981	
	CHAPMAN CONTROL HOUSE			
	MEREDITH (CLIMATOLOGICAL)			
	MIDDLE CUNNINGHAM CREEK FEEDER CANAL NR.			
	MORMON CONTROL HOUSE			
9080300	ROCKY FORK CREEK NEAR MEREDITH	USGS	10/1/1968	
9080800	WEST SOPRIS CREEK NEAR BASALT, CO.	USGS	10/1/1963	
9084500	FOURMILE CREEK NEAR CARBONDALE, CO.	USGS	10/1/1941	
9084600	FOURMILE CREEK NEAR GLENWOOD SPRINGS, CO.	USGS	10/1/1957	
	PORTER THREEMILE DITCH AT THREEMILE PASS			
9076000	MAROON CREEK NEAR ASPEN, CO.	USGS	1/1/1911	
9075700	MAROON CREEK ABOVE ASPEN, CO.	USGS	9/1/1969	
9075500	ROARING FORK RIVER BELOW ASPEN, CO.	USGS	10/1/1913	
9076520	OWL CREEK NEAR ASPEN, CO.	USGS	10/1/1974	
9073500	ROARING FORK RIVER AT ASPEN, CO.	USGS	10/1/1910	
9073700	HUNTER CREEK ABOVE MIDWAY CREEK, NEAR ASPEN, CO.	USGS	10/1/1964	
9073900	NO NAME CREEK NEAR ASPEN, CO.	USGS	10/1/1970	
9073800	MIDWAY CREEK NEAR ASPEN, CO.	USGS/BOR	10/1/1970	
	COAL CREEK	USGS	1981; 1985	
	* still in operation-with new operator			

APPENDIX 2: List of Stream Flow Data Uses

Environmental Studies

- Non-point source pollution
- Channel morphology evolution
- Sediment studies
- Wetlands ecology
- Tidal gate studies
- Vegetation studies
- Wildlife studies
- Fish studies
- Benthic studies
- Instream flow analysis
- Aquatic habitat studies
- Wild & Scenic determination

Hydraulic Design

- Roadways
- Bridges and culverts
- Dams, spillways and reservoirs
- Channel modifications
- Flood-plain development
- Hydraulic modeling
- Urban beautification
- Navigable rivers for travel

Reservoir Management

- Routine operations
- Flood suppression
- Droughts
- Hydropower operation
- Scheduling bridge and dam inspections/repairs

Statistical Analysis

- Flood frequency
- Low flow frequency
- Flow duration
- Storage requirements
- Areal studies
- Safe yield analysis

Water Management

- Water supply, public and private
- Waste disposal
- Water use
- Irrigation
- Emergency flood alert
- Water diversion permits
- Compliance with instream flow requirements
- Tide monitoring

Urban Studies

- Storm run-off
- Flood inundation
- Zoning and design regulations
- Pollution studies
- Scenic and wildlife suitability assessments

Water Quality

- Assimilative capacity
- Cumulative impacts assessment
- Baseline conditions
- Long-term trends
- Point-source impacts
- Interstate pollution transport
- Surface water – ground water relationships
- Salinity studies
- Dissolved oxygen studies
- Vegetation studies
- Nutrient loading studies
- Recreation suitability
- Regulatory monitoring

Recreation

- Canoeing activities
- Scenic river tour operations
- Sport fishing
- Competition rowing, swimming, water-skiing ...
- Pleasure boating

This list was taken from: Recommendations for a stream gaging network in Rhode Island. Prepared by the DEM-WRB Streamflow Committee. April 2004.

APPENDIX 3: Participant Contact Information

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APPENDIX 4: Priority Ranking Sheet

Priority Reach Name	Region	Total
1) Maroon Creek @ Stapleton Ditch	Middle Roaring Fork	39
2) RF above Castle Creek (in Aspen)	Upper Roaring Fork	36
3) Lower Crystal (above fish hatchery)	Lower Roaring Fork	36
4) RF near Lost Man	Upper Roaring Fork	23
5) Coal Creek	Lower Roaring Fork	22
6) (4) FP Bypasses	Frying Pan	19
7) Brush Creek	Middle Roaring Fork	18
**) Castle Creek	Middle Roaring Fork	18
8) Maroon Creek (below diversions)	Middle Roaring Fork	17
9) Cattle Creek	Lower Roaring Fork	14
10) (3) Hunter Creek (at no name, midway and hunter creek diversions)	Upper Roaring Fork	13
11) Thompson Creek	Lower Roaring Fork	13
12) FP Deferred area	Frying Pan	11
13) Four Mile	Lower Roaring Fork	8
14) Capitol Creek	Middle Roaring Fork	6
15) Woody Creek (lower)	Middle Roaring Fork	5

Notes:
After reviewing notes from participants' rating sheets, a few numbers were updated from what was originally displayed at the library. These changes did not affect the order of priority reaches.

**One of the pre-identified reaches was on Castle Creek below the return flow of the City of Aspen's proposed Castle Creek Energy Center. On April 26, a local non-profit, Saving Our Streams, arranged for the installment of USGS stream gage in that reach. Therefore, although it received a high priority ranking, Castle Creek will not be further considered in this report. See Appendix 5 for a map of the gaging site and more details.

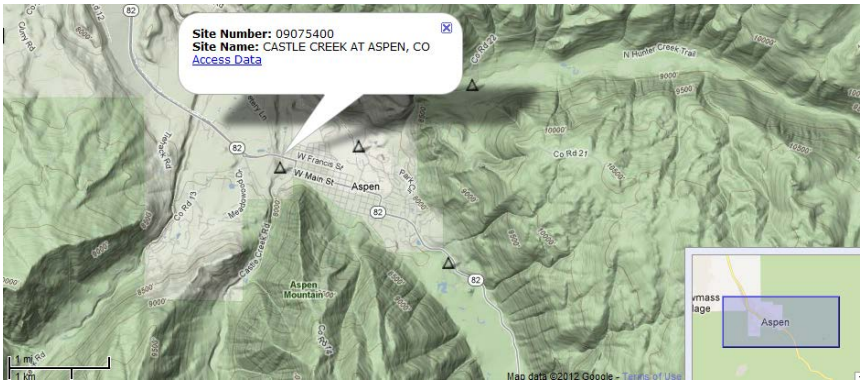
APPENDIX 5: Update on New Castle Creek Gage

USGS 09075400 Castle Creek at Aspen, CO

Installed: April 26, 2012

USGS gage web resource: http://waterdata.usgs.gov/co/nwis

Station operated by the U.S. Geological Survey (Grand Junction Western Colorado Office) in cooperation with Saving Our Streams. Continuous temperature data are collected at this gage location.



APPENDIX 6: Monitoring Network Cost Estimate

Monitoring Network Cost Estimate, S.K. Mason Environmental

S.K.Mason Environmental

S.K.Mason Environmental, LLC
856 Colorado Avenue
Carbondale, CO 81623

MEMORANDUM

Date: April 17, 2012

To: Sharon Clark, Roaring Fork Conservancy

From: Seth Mason, S.K.Mason Environmental, LLC

Subject: Aspen Area Stream Discharge Monitoring Network – Cost Estimate

Dear Sharon,

I am pleased to provide this cost estimate for the Roaring Fork Conservancy and the Upper Roaring Fork Watershed stakeholder group interested in the installation, operation, and maintenance of several stream discharge gauging stations. I've done my best to provide estimates for several gauging scenarios, each fulfilling a different data-use need.

The following is a preliminary estimate only; intended to aid the group in discussions that continue to refine the project goals and scope. Thus, this document comes along with the following terms and conditions:

1. This is an unofficial, nonbinding document for the purpose of communicating approximate pricing options for installation, operation and maintenance of gauging stations in the Upper Roaring Fork Watershed.

2. Infrastructure costs for gauging stations may change (in some cases, significantly) depending on access constraints and telemetry network requirements unique to individual sites.

3. Equipment prices provided by the vendor are subject to change at any time without notice and do not include sales tax, shipping, or insurance.

4. Operation and Maintenance costs are largely a function of site-access and may change following final selection of gauging locations.

Each of the scenarios described below assumes that gauging stations are located on a stream that can be waded at all times of the year. Larger, faster flowing streams that preclude wading will require use of additional equipment for the creation of rating curves. This will add approximately $1,000 to the cost associated with the Hach FH90 Velocity Flow Meter System listed below.

Telephone: 970.903.7561 | Email: seth@skmason-envi.com | Web: www.skmason-envi.com 1

Scenario 1

Description: Periodic point-measurements of stream discharge collected and referenced against a staff gauge installed in the streambed. A velocity flow meter is used to create a rating curve (stream stage vs. stream discharge) for each site. Calibrated staff gauges allow discharge to be approximated by visiting a given site and manually recording the water height on the gauge. This scenario is best suited to

Infrastructure:

First Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge	$45.00
Hach FH950	Velocity Flow Meter System	$5,300.00
	Subtotal:	**$5,345.00**
Each Additional Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge	$45.00
	Subtotal:	**$45.00**

Setup and Installation:

- Approximate one-time cost per site: $250.00
- Actual cost will be a function of site access characteristics.

Operation and Maintenance:

- Approximate cost per site, per visit: $200.00
- Actual cost may vary due to site access characteristics.

Data Management:

- Approximate cost per site per year: $300.00
- Includes QAQC of data and archiving in an existing database
- Development of a custom database will incur additional costs

Scenario 2

Description: Periodic point-measurements of stream discharge collected and referenced against water depth readings collected by an automated data collection system. A velocity flow meter is used to create a rating curve (stream stage vs. stream discharge) for each site. Calibrated stations approximate discharge in real-time, but stored data must be collected manually by visiting each site at regular intervals. This scenario is best suited for use-cases that require data be collected at a fine time interval but do not depend on access to data in real-time.

Infrastructure: Estimate includes the cost of instrumentation necessary for completing discharge measurements necessary to satisfy the scenario, but does not include material costs associated with mounting and housing the equipment in the field. Many different methods/materials are available to accomplish this task. Material selection and subsequent cost estimation should, thus, follow gauging site selection and identification of access restrictions and the existence of previously installed infrastructure.

First Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci. CR200	Datalogger	$450.00
CS-450-L	Pressure Transducer	$695.00
10-Watt PV Panel	Solar Panel	$50.00
12 V 12 AH Gell Cell	Battery	$35.00
Hach FH950	Velocity Flow Meter System	$4,300.00
	Subtotal:	**$5,575.00**
Each Additional Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci. CR200	Datalogger	$450.00
CS-450-L	Pressure Transducer	$695.00
10-Watt PV Panel	Solar Panel	$50.00
12 V 12 AH Gell Cell	Battery	$35.00
	Subtotal:	**$1,275.00**

Note: Pressure transducer may be swapped with one of the instruments listed below

Item	**Description**	**Price**
Campbell Sci. CS470	OTT CBS Compact Bubbler	$3,220.00
Campbell Sci. SR50A-L	Sonic Ranging Sensor	$1,050.00

Setup and Installation:

- Approximate cost per site: $800.00
- Actual cost may vary due to site access characteristics.

Operation and Maintenance:

- Approximate annual cost per site: $1,500.00
- Actual cost will be a function of site access characteristics.
- Includes (12) annual site visits for data download, rating-curve calibration, and instrument cleaning, as well as as-needed on-site troubleshooting.

Data Management:

- Approximate cost per site per year: $2,000.00
- Includes QAQC of data and archiving in an existing database
- Creation of a custom database would incur additional costs

Scenario 3

Description: Periodic point-measurements of stream discharge collected and referenced against water depth readings collected by an automated data collection system. A velocity flow meter is used to create a rating curve (stream stage vs. stream discharge) for each site. Calibrated stations approximate discharge in real-time. A radio telemetry system transmits real-time data to a base station where provisional data can be viewed in real-time. This scenario is best suited for those sites in a gauging network that are located near existing communication infrastructure (e.g. lower reaches of Castle and Maroon).

Infrastructure: Estimate includes the cost of instrumentation necessary for completing discharge measurements necessary to satisfy the scenario, but does not include material costs associated with mounting and housing the equipment in the field. Many different methods/materials are available to accomplish this task. Material selection and subsequent cost estimation should, thus, follow gauging site selection and identification of access restrictions and the existence of previously installed infrastructure.

An unknown number of repeater stations will likely need to be installed in order to ensure clear and consistent communication between gauging stations and a base station. Determination of the appropriate number of repeater stations will require a line-of-sight terrain analysis following final site selection. The cost estimate below assumes one repeater is needed per gauging station.

First Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci. CR206X	Datalogger w/ 915-MHz Radio	$685.00
900 MHz 9dBd Yagi	Antenna	$195.00
Radio Telemetry Repeater Station	CR206X, PV Panel, antenna, battery	$1,660.00
CS-450-L	Pressure Transducer	$695.00
10-Watt PV Panel	Solar Panel	$50.00
12 V 12 AH Gel Cell	Battery	$35.00
Hach FH950	Velocity Flow Meter System	$5,300.00
	Subtotal:	**$8,665.00**

Each Additional Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci. CR206X	Datalogger w/ 915-MHz Radio	$685.00
Radio Telemetry Repeater Station	CR206X, PV Panel, antenna, battery	$1,660.00
CS-450-L	Pressure Transducer	$695.00
10-Watt PV Panel	Solar Panel	$50.00
12 V 12 AH Gel Cell	Battery	$35.00
	Subtotal:	**$3,170.00**

Note: Pressure transducer may be swapped with one of the instruments listed below

Item	Description	Price
Campbell Sci. CS470	OTT CBS Compact Bubbler	$3,220.00
Campbell Sci. SR50A-L	Sonic Ranging Sensor	$1,050.00

Setup and Installation:

- Approximate cost per site: $1,500.00
- Actual cost may vary due to site access characteristics.

Operation and Maintenance:

- Approximate annual cost per site: $2,000.00
- Actual cost will be a function of site access characteristics.
- Includes (12) annual site visits for rating-curve calibration and instrument cleaning, as well as as-needed on-site troubleshooting.

Data Management:

- Approximate cost per site per year: $2000.00
- Includes QAQC of data and archiving in an existing database
- Development of a custom database will incur additional costs

Scenario 4

Description: Periodic point-measurements of stream discharge collected and referenced against water depth readings collected by an automated data collection system. A velocity flow meter is used to create a rating curve (stream stage vs. stream discharge) for each site. Calibrated stations approximate discharge in real-time. A satellite telemetry system periodically transmits data to a base station. This scenario relies on the GOES satellite system, the use of which requires USGS sponsorship. This scenario is best suited for remote gauging locations where development of a radio telemetry system is cost prohibitive. This may be the best solution for obtaining real-time data from the upper reaches of Hunter Creek.

Infrastructure: Estimate includes the cost of instrumentation necessary for completing discharge measurements necessary to satisfy the scenario, but does not include material costs associated with mounting and housing the equipment in the field. Many different methods/materials are available to accomplish this task. Material selection and subsequent cost estimation should, thus, follow gauging site selection and identification of access restrictions and the existence of previously installed infrastructure.

First Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci.DPC200	Datalogger w/ GOES Satellite System	$4,500.00
CS-450-L	Pressure Transducer	$695.00
Hach FH950	Velocity Flow Meter System	$5,300.00
	Subtotal:	**$10,540.00**
Each Additional Station		
Item	**Description**	**Price**
Style A Stream Gauge	Staff Gauge (Optional)	$45.00
Campbell Sci.DPC200	Datalogger w/ GOES Satellite System	$4,500.00
CS-450-L	Pressure Transducer	$695.00
	Subtotal:	**$5,240.00**

Note: Pressure transducer may be swapped with one of the instruments listed below

Item	**Description**	**Price**
Campbell Sci. CS470	OTT CBS Compact Bubbler	$3,220.00
Campbell Sci. SR50A-L	Sonic Ranging Sensor	$1,050.00

Setup and Installation:

- Approximate cost per site: $1,800.00
- Actual cost may vary due to site access characteristics.

Operation and Maintenance:

- Approximate annual cost per site: $2,000.00
- Actual cost will be a function of site access characteristics.
- Includes (12) annual site visits for rating-curve calibration and instrument cleaning, as well as as-needed on-site troubleshooting.

Data Management:

- Approximate cost per site per year: $2,000.00
- Includes QAQC of data and archiving in an existing database
- Development of a custom database will incur additional costs

These cost estimates are based on the premise that no equipment is currently available for use in the development of gauging stations and for subsequent creation of rating curves. Additionally, in composing this estimate I developed each scenario independently of the others. Therefore, some cost savings will be realized if multiple scenarios are simultaneously used in the development of the gauging network. Specifically, the "Hach FH950" listed in each cost estimate can be shared between sites and/or scenarios. Only one of these velocity flow meters is actually needed for the entire gauging network. If a velocity flow meter is currently available for use (as Sam suggested at the meeting last week), the cost for each gauging scenario will drop accordingly.

Please do not hesitate to contact me if you have any questions or are in need of any clarification. I look forward to ongoing collaboration with the Roaring Fork Conservancy on this and other projects.

Site Recommendations for Stream Discharge Gaging on Top Tier Priority Reaches in the Roaring Fork Watershed

Prepared for

Roaring Fork Conservancy

and

Friends of Rivers and Renewables

In conjunction with

Roaring Fork Watershed Stream Gage Needs Workshop

June 29, 2012

Prepared by:

Seth Mason and Bill Hoblitzell
SK Mason Environmental, LLC
856 Colorado Avenue
Carbondale, CO 81623
(970) 903-7561

Terms and Conditions of This Document:

1. This is an unofficial, nonbinding document for the purpose of communicating approximate pricing and product options for installation, operation and maintenance of a gaging network in the Upper Roaring Fork and Crystal River watersheds.

2. Equipment prices provided by the vendor are subject to change at any time without notice and do not include sales tax, shipping, or insurance.

3. All pricing options assume that the stakeholders will own all stream gaging equipment outright.

4. Operation and maintenance plans provided by S.K.Mason Environmental, LLC do not include replacement, repair, or calibration costs incurred due to sensor drift, equipment loss or damage resulting from environmental conditions or normal wear-and-tear.

5. Cost estimates for operation and maintenance plans rely on access to stakeholder-owned stream discharge measurement device(s) that can be used to measure streamflow at each of the identified gaging locations (e.g. Sontek FlowTracker ® and/or Sontek RiverSurveyor®).

Table of Contents

1.0 Introduction

1.1 Purpose and Scope

Friends of Rivers and Renewables (FORR) recently identified a need for a comprehensive stream gaging[1] system in the Roaring Fork Watershed to inform multiple stakeholders involved in natural resource management decisions with timely, unified, and scientifically defensible stream flow data. This need was also classified as a priority in the Roaring Fork Conservancy's (RFC) 2011 Watershed Management Plan. In April 2012, FORR and RFC held a collaborative Stream Gage Needs Workshop, the results of which have been compiled in a Draft Summary Report for free distribution to all interested parties (generally referred to here as the *Workshop Summary*). Participants at the Workshop identified 7 specific development goals for a proposed gaging network, and selected 8 stream reaches in the watershed as top-ranked priorities for gaging. These reaches are termed *first tier priorities*.

The purpose of this report is to explain the need for an expanded network, recommend physical locations for stream gages on each first tier reach, and provide a brief analysis of the strengths or notable weaknesses for a particular site. Alternative options for a given site are discussed where appropriate. Site recommendations are driven by a combination of technical and non-technical factors, and follow USGS-based guidelines for gaging locations. Technical factors include the existence of stream channel morphology amenable to gaging discharge, and locations favorable to wireless communications network needs. Non-technical factors include site accessibility, land ownership, and stakeholder criteria as specified in the Workshop Summary and other communications.

Why an expanded monitoring network in the Roaring Fork?

As stated in the Summary, the goal of a state-of-the-art, technology-driven river monitoring network is to provide timely assessments of river health to natural resource decision makers. This information would be used to manage and protect these natural resources more effectively in the face of increasing and competing demands for water. The purpose of an enhanced gaging network goes beyond the existing gage networks run by federal and state agencies. It is not aimed solely at further scientific characterization of the Roaring Fork in terms of water flows, annual yields, flood prediction, or water rights administration. It is targeted to more fully address specific questions of water quality and quantity related to numerous and sometimes-competing in-basin stakeholder interests in the Roaring Fork watershed. As the Workshop Summary explains, these may include increased administrative accountability, long term regional ecosystem assessment, linking flows to water quality, and mitigation of drought effects to aquatic ecosystems by identifying potential opportunities for water conservation and instream flow protection. The Roaring Fork's social and geographic context is representative of numerous

[1] The USGS-preferred spelling of *gage* is adopted throughout, rather than the also-common *gauge.*

watersheds in the intermountain west. An extensive gaging system with a focus on stream function in addition to traditional water administration can help identify and answer questions concerning ecosystem health and resiliency in the face of increasing pressures from land use change and climate change; important questions faced by many communities across the western US.

A special opportunity exists in the Roaring Fork because of the extensive social capital and strong technical capacity of the region's citizenry. This opportunity, which may not be possible elsewhere, arises in the intersection of vibrant conservation groups, engaged local governments, and invested federal and state agencies. Developing a locally operated smart gage network to actively address stakeholder interests in the greater watershed can help create a model for better stream management that can be duplicated and exported, one that strives to sustainably meet human needs while maintaining sufficient flows to promote stream function and integrity.

In this context, Water Year 2012 is an important year. While the weak snowpack and low runoff may simply be a dry outlier in the range of hydrologic conditions for the southern Rockies, some view 2012 as a glimpse of what the 'new normal' might become for precipitation and stream flow trends in the region. In a report to Congress and the President, the US Global Change Research Program (2009) forecasts decreased annual average snowpack and runoff in the southern Rockies, more precipitation falling as rain with quicker runoff, and increased irregularity to timing, frequency and magnitude of precipitation. The comprehensive federal report also forecasts large increases in wildfire size and frequency which will significantly affect montane watersheds via large-scale land-cover change. Global climate models cannot always be easily down-scaled to apply to the complex topography of the state, and some models are equivocal about whether precipitation will increase or decrease locally in some of Colorado's mountain regions. Many parties are working on finer resolution climate modeling for localized regions to resolve these questions (Ray et al 2008).

The governor's office has produced a Climate Action Plan (2007) identifying likely effects which include earlier thaw and snowmelt, and lower late-summer and fall stream flows. As such effects manifest, they will affect agriculture, fisheries, riparian communities, current and future hydropower potential, and forest health. Paleo-climate study has recently shown a range of drought and wet periods larger than what is in our current weather and streamflow record (Ray et al 2008). Regardless of current issues and disparate views surrounding anthropogenic climate change, this fact alone warrants closer scrutiny of water management, including current and future policies targeted towards drought resiliency and mitigation.

If Water Year 2012 reflects conditions more likely to be experienced in the future, an important question is whether the current water management institutions are adequately equipped to deal with them and find the appropriate balance between human use and ecosystem health. Recognizing the strong cultural and economic ties between residents in the Roaring Fork watershed and their rivers, this is an important issue to proactively confront. If water managers

wish to seek an appropriate balance, they will require the necessary tools, policy instruments, and legal frameworks to carry out this important work while still respecting local customs, state water laws, and federal water compacts.

In the past, the ability to characterize watersheds operated on a fairly coarse resolution. For example, the Colorado River basin as whole is managed for water supply between the states using very large and blunt tools: a system of large reservoirs and dams from source to sea which are operated on a yearly water budget, using information from stream gages on a few trunk-scale rivers. Our institutional framework to govern and manage actual processes within a watershed similarly operates on a variety of scales, from the multi-state Colorado River Compact down to the local ditch boss or water commissioner. Currently, the ability exists to characterize flows and other processes in small watersheds at fine resolutions on very short timescales. One question at hand is whether available policy instruments and legal frameworks for flow management function at a scale that matches the scale of available technical information. Specifically: can our water management institutions react and make resource decisions concurrent with the improved speed and accuracy at which we can now observe changes in the watershed? If institutional actions can be matched to technical capacity in scale and time, water management actions might be optimally utilized and fine-tuned to meet consumptive human needs while potentially employing 'system slack' in agricultural, urban, and industrial water use in a manner which maximizes ecological benefits and maintains river systems that are stable, diverse, and resilient.

The following example may help ground these ideas in a real-world situation. A hypothetical rapid-onset water quality issue affecting ecosystem health, such as critical low flows or high pollutant concentrations, is identified in real time by an extensive water quality and quantity monitoring network. This situation, which threatens degradation of stream health and function, is subsequently paired with an appropriate and quickly-implementable policy response instrument, such as a short-term water lease of a few days or week in duration that would increase stream flow and provide dilution. Perhaps a local irrigator repeatedly makes use of a windows provided by a strong midsummer monsoon to temporarily decrease diversion at his ditch headgate, without facing potential future legal repercussions on his water rights such as claims of abandonment or diminishment.

These are the types of questions and solutions that a smart monitoring network can help address, provided that the parties both interested-in and responsible for water systems management are willing to invest in the necessary physical and legal foundations. Given the strong capacity of human communities and institutional resources in the Roaring Fork watershed, it could be a vital proving ground for a 21st century water management paradigm that moves beyond the last century's pitched conflicts of human need versus stream health, and instead chooses both, or 'all of the above'.

1.2 Stream Channel Requirements for Gage Sites

In order to obtain accurate, repeatable, and easily measurable discharge information, a gage site on a stream channel should be judged on several characteristics (USGS 1983):

- The channel should be relatively straight for some distance above and below the site
- Discharge must be confined to a single channel at all flows
- The bed is geomorphically stable and unchanging (i.e. not subject to frequent scour or fill, stable banks, stable channel type),
- Banks are relatively free of vegetation
- Channel type allows for accurate gage readings even during low-flow conditions
- Accessibility needs for installation, maintenance, and wireless communication are met

Often an ideal site for a gage consists of a pool coupled with a run. A run is a segment of stream with non-turbulent flow over a relatively flat stream bottom. Runs often occur where a steepened riffle section transitions into a flatter pool section. The run provides a location to collect discharge measurements, and the nearby pool provides a suitably calm area for the placement of a staff gage or sensor to measure water depth. Meeting all criteria at every site can prove difficult, and requires careful judgment to maximize a given site's advantages while minimizing its shortcomings. The Roaring Fork Watershed comprises some of the most mountainous terrain in the United States; the steep and rocky nature of its waterways and the high variability in annual environmental conditions can pose special problems for siting and operating stream gages.

Stream gages function by relating physically measured discharge values to a corresponding height or depth of water at a specific stream location using what is known as a stage-rating curve. Discharge measurement at a given river depth, or stage, is the product of a stream channel's cross-sectional area and its average velocity. By measuring discharge at a given site over a variety of flows states, a rating curve (a mathematical function describing the relationship between depth and discharge) is established. Subsequent to the creation of a rating curve, discharge may be calculated by observing only water depth at the gaging location. Because the cross sectional geometry of a stream is subject to change over time (especially in steep mountain streams) it is necessary to periodically return to a given gaging location for calibration of the rating curve. An in-depth explanation of these methods is beyond the scope of this report. Interested parties may wish to review a hydrologic text such as *Physical Hydrology* (Hornberger et al, 1998) for a full treatment.

1.3 First Tier Priority Reaches

The Workshop Summary identifies the following reaches as Top Tier Priority Reaches:

1) Maroon Creek below the Stapleton Ditch
2) Roaring Fork above Castle Creek (Suite of gages in Aspen)
3) Lower Crystal River
4) Roaring Fork River near Lost Man Creek (upper Roaring Fork headwaters)
5) Coal Creek Sub-basin
6) Fryingpan-Arkansas Project Bypasses (Carter, Mormon, and M. Cunningham Creeks)
7) Brush Creek in Snowmass
8) Maroon Creek (below the City of Aspen municipal diversion)

How the reaches were chosen:

Reaches for gauging were determined by consensus in the Roaring Fork Watershed Stream Gage Needs Workshop in April 2012. Prior to the workshop, FORR conducted preliminary investigations with public and private entities including federal agencies, local county and city governments, and watershed experts, to develop a list of 16 imperiled reaches. The Workshop was subsequently attended by 'experts from public agencies, private hydrology and consulting firms, and water management and conservation organizations'. Based on their collective judgment and collaborative discussion, 8 reaches were selected from the original 16 to become First Tier Priorities, meaning that immediate attention for installation and operation of new gauges would be focused at these locations (Stream Gage Needs Workshop Report 2012).

In each of these reaches, one or more gaging stations meet stakeholder needs regarding water resource management decisions. The remainder of this report provides details on proposed gage locations, and alternatives to gage installation where appropriate. Reaches are presented in parallel order to the Workshop Summary. Accompanying maps and images are intended as aids to understand gage site locations relative to other landmarks; they are not intended as definitive statements of final site selection or property ownership lines.

1.4 Structure of this document

This body of this report strives simultaneously to 1) recommend an ideal gaging option based on identified stakeholder needs in the Workshop Summary and 2) provide a clear road map for any party to proceed with gage installation at a given site. Each site begins with a *Description of Need* which is adapted directly from the Workshop Summary. Site recommendations include both a physical location discovered through field work to be suitable for gage installation based on the criteria listed in Section 1.2 and specifications for the infrastructure required at each site to meet stakeholder needs. Stream gaging station development possibilities cover a wide spectrum, ranging from the very simple (a staff gage and periodic manual flow measurements) to the complex (USGS-type real-time stage sensor with satellite uplink and web publishing). Infrastructure recommendations here are made based on the stakeholder needs for each priority reach as communicated by the stakeholders to S.K.Mason Environmental, LLC.

2.0 Gaging Recommendations for Priority Reaches

2.1 Maroon Creek at the Stapleton Ditch

Description of Need:

Lower Maroon Creek, from Willow Creek to the confluence with the Roaring Fork River, has experienced varying pressures from flow alteration, urbanization, and recreational activities. The stream corridor is generally undeveloped with good riparian habitat. Areas on lower Maroon and Castle Creeks have been identified as having unique conservation potential. Flow alteration may currently be the most significant impacting pressure on the creek. A 1976 ISF right of 14 cfs year round exists from the confluence of East and West Maroon Creeks to the Roaring Fork. The Stapleton Brothers Ditch diverts water to areas on the west side of the Roaring Fork valley near the land now occupied by the Pitkin County Airport. In 2009, Pitkin County donated 4.3 cfs of the water it owns in the Stapleton Ditch to the CWCB for instream flows. This action was initially challenged by Basalt Water Conservancy District and Starwood Metropolitan District, in part because no way existed to measure or administer the water right in the river at that location. The Stapleton Ditch is a significant diversion between the existing hydroelectric plant return flow and the Roaring Fork. Flows in this reach cannot currently be measured for ISF administration, or to link flows to quality for scientific assessments, a gage here would fulfill this need.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Site:
Below Stapleton Ditch Diversion

Location:
N 39^{0}11’10” W 106^{0}41’15”

Access:
The site may be accessed by foot via Maroon Creek Trail from the Aspen Rec Center parking lot on Maroon Creek Road, or from Tiehack Road.

Looking downstream from the Stapleton diversion

Permission and Land Ownership:
Land ownership in the creek corridor by the footpath on river-left and right banks up to the Rec Center is Aspen Highlands Open Space. Installation would need approval with City of Aspen and Pitkin County. City of Aspen Parks and Open Space, Brian Flynn (970) 429-2035, Pitkin

County Public Works Director Brian Pettet (970) 920-5392. A US ACE Nationwide Permit 5 (for scientific measuring devices) may be required for structures along watercourses. US Army Corps of Engineers Grand Junction (970) 243-1199.

Discussion:
Immediately below the Stapleton Ditch lies a channel-run section of Maroon Creek approximately 30 meters long. The right bank is steep and moderately vegetated, with some small exposures of bedrock. The Stapleton Ditch road makes up the left bank, 1-2 meters above the creek. Maroon Creek is well-confined in this section with a bed of cobble to boulder-sized substrate. Two alternative sites exist in this area: one approximately 30m downstream of the diversion point, and a second just below the Maroon Creek Trail Footbridge. The left bank is steep and loose, the right may easily be accessed by walking downstream from the footbridge. Finding an ideal channel-run on lower Maroon Creek is difficult because of the constant gradient of the streambed. Most sections near the ditch and footbridge are suitable but not perfect. Rocky substrate and turbulence may hinder some measurements at the lowest flows at any site on this reach. Further downstream the valley widens and the creek is prone to meandering and multiple channels in a wider floodplain.

Supporting Infrastructure:
The infrastructure to meet stakeholder needs for Maroon Creek at Stapleton Ditch includes a real-time streamflow measurement gage and telemetry system for transmitting collected data from the site. Specifically, a sensor for measuring stream depth must be installed in the stream channel. In order for data produced by the station to be considered by the Colorado Department of Water Resources (CDWR), the accuracy and precision of the water depth sensor must comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). Depth measurements at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients.

The site characteristics and CDWR's need to view data in near real-time dictate that data be transmitted from the site using satellite telemetry. The station will transmit data over the GOES satellite system. Data transmission and collection will follow National Environmental Satellite, Data, and Information Service (NESDIS) protocols and will require the development of an MOU between a city government, county government, or non-profit entity and the NESDIS.

Estimated Cost: **See Section 3.1**

Installation
Installation and initial setup of the gaging station and telemetry network requires design and assembly of electrical components, programming the datalogger to collect stage measurements at

a selected time interval, securely installing the gaging station on the stream bank, and setting up the GEOS telemetry system to enable transmission of data from the site and subsequent aggregation of data on a client network or machine.

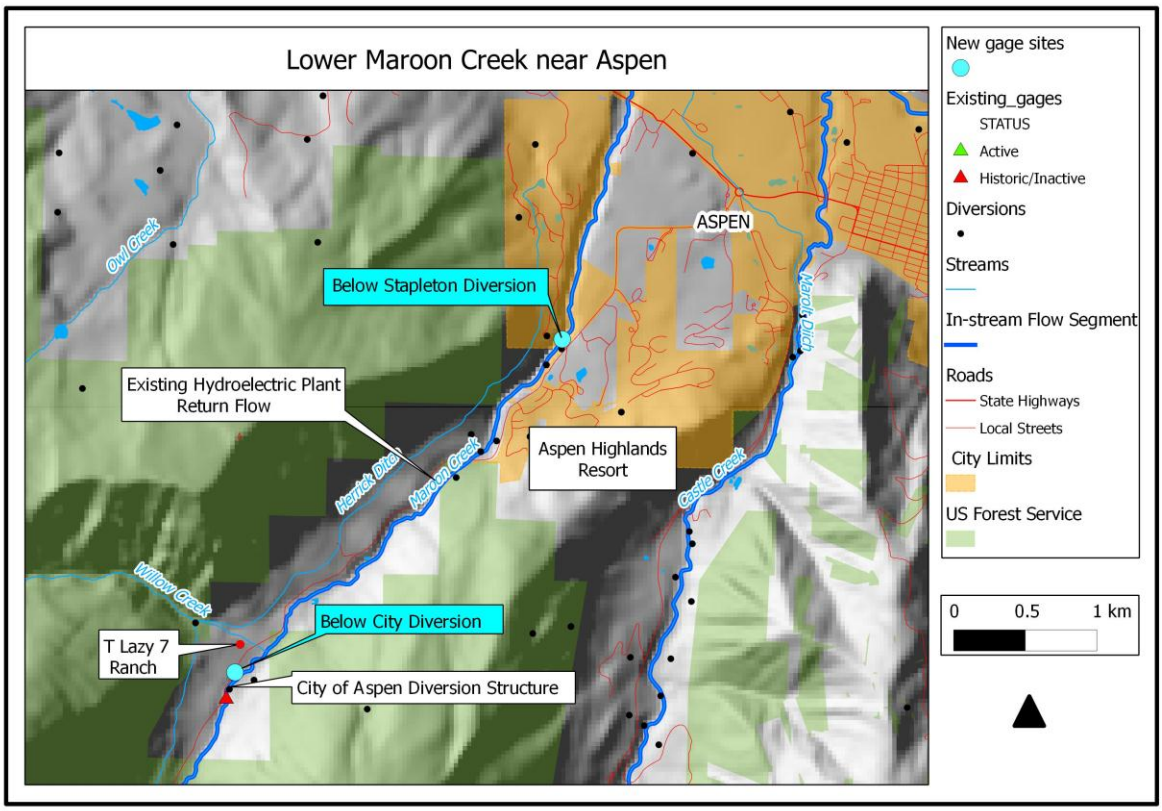
Estimated Cost: **$ 2,500.00**

Operation and Maintenance

The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger, sensor, or telemetry network. A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. The gaging station must be leveled by a licensed surveyor each year for the first three years following installation and periodically thereafter following the methods outlined in USGS Techniques and Methods Report 3-A19 (Turnipseed and Sauer, 2010). This station will be operated year-round.

Estimated Cost: **$ 3,000.00**

Location Map:



2.2 Lower Crystal River

Description of Need

Extending the operational capacity of the existing CDPW hatchery gage fulfills a number of stakeholder interests. A May-Sept ISF right of 100 cfs and an Oct-Apr ISF right of 60 cfs were established in 1975. Those flows are not met in a majority of years. The most significant diversions upstream are for agriculture, which has experienced an irrigation shortage in many years. The current CDPW gauge operates in summer to early fall in order to best characterize the reach most exposed to low flows. This site is also a River Watch monitoring site and was suggested by USGS as a water quality monitoring site to best describe agricultural influences upstream and bracket the effects of urbanization downstream to the confluence with the Roaring Fork. Paired year-round flow data adds an important component to water quality monitoring.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Site:
Colorado Parks and Wildlife Fish Hatchery

Location:
N 39^{0}22’38” W 107^{0}12’16”

Access:
County Road 118 bridge, 1.9 miles on the right from the Carbondale stoplight on Rt. 113.

Seasonal Gage site at CPW Fish Hatchery

Permission and Land Ownership:
Colorado Parks and Wildlife administers the fish hatchery, and the bridge easement may require Pitkin County permission. Crystal River Hatchery, John Riger (970) 963-2665. For access to easements near the county road bridge, contact Pitkin County Public Works Director Brian Pettet (970) 920-5392.

Discussion:
This is the site of a current gage administered by the Colorado Division of Water Resources. It is well-placed to capture flows on the most dewatered section of the Crystal—below several large diversions but above significant irrigation return flows. In spring of 2012, USGS removed all remaining infrastructure at the lower site near CRMS campus (USGS Crystal River below Carbondale). That site is co-located with macroinvertebrate sampling sites monitored by River

Watch and CRMS; due to the significant return flows above CRMS it does not characterize the most dewatered section of the lower Crystal in the same way as the fish hatchery site. The site is seasonally active from April to September.

As an alternative to the recommended infrastructure below, stakeholders may desire to re-enter discussion and negotiation with CDWR regarding year-round operation of the existing hatchery gage. Correspondence with CDWR places the approximate average cost for year-round gage operation at similar near-by sites as $9000 per year. Actual costs vary based on factors including stream channel stability control, data publishing needs, and winter operation costs. The Crystal River Hatchery site is low in the watershed, where the stream is wider and less steep, it is likely that channel stability is good at the site, and icing issues would be less frequent than higher elevation sites and smaller streams. However, whether CDWR will take on additional gages should not be assumed a certainty. CDWR currently faces an administrative workload beyond existing employee capacity. The agency retains discretion to accept or decline new gage work based on decisions by local Division 5 staff , who must determine themselves whether a new gage materially benefits water administration needs. CDWR operates the hatchery gage from May to September specifically to capture low flow summer conditions on the lower Crystal. An earlier effort by CWCB to secure local cooperators for annual gage O/M did not succeed. Focus at the sight now is to monitor low flows and maintain an accurate low-end ratings curve for CWCB ISF administration. For a fuller treatment of CDWR considerations for shared gage operation, please refer to **Section 4.** Section 4 further discusses CDWR and USGS criteria for constructing and cost-sharing of new gage work.

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for the Lower Crystal River includes a real-time streamflow measurement gage and the possible addition of several real-time water quality sensors. Specifically, a sensor for measuring stream depth must be installed in the stream channel. The accuracy and precision of the water depth sensor should comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). It is also possible to install pH, temperature, turbidity, or specific conductance sensors alongside the depth sensor. Depth measurements (and any additional parameters) at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients. Data will be stored on the datalogger and must be manually downloaded periodically.

Estimated Cost: **See Section 3.2**

Installation
Installation and initial setup of the gaging station requires design and assembly of electrical components, programming the datalogger to collect stage measurements (and any other selected

parameters) at a selected time interval, and securely installing the gaging station on the stream bank.

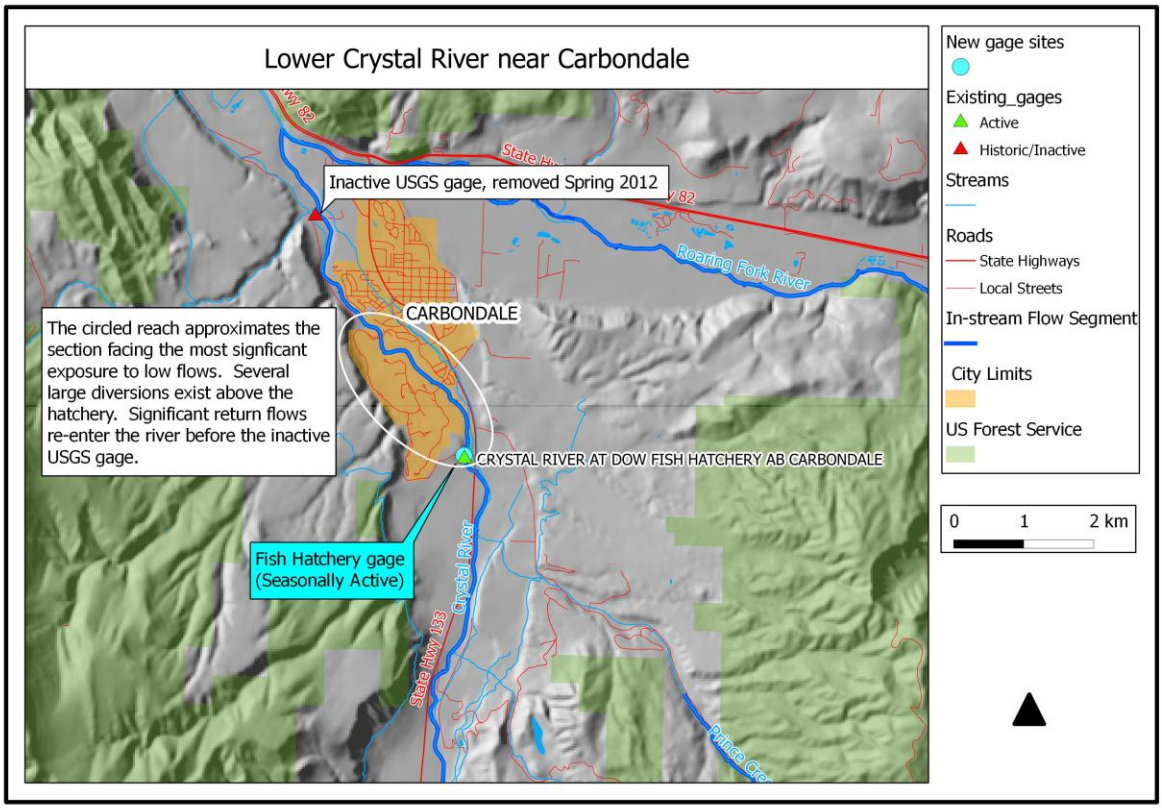
Estimated Cost: (single sensor): **$ 800.00**

Operation and Maintenance

The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger and sensor(s). A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. The gaging station does **not** need to be leveled following USGS standards as this data will not be used by CDWR, but will instead be used in assessments of water quality. This station will be operated seasonally to correspond with the months of the year that streamflow data is not captured by the CDWR gage co-located at this site.

Estimated Cost: (single sensor): **$ 800.00**

Location Map:



2.3 Brush Creek

Description of Need:

Brush Creek features several water quality issues including intermittent exceedances of state pH standards, high potassium levels, and high nutrients. Brush Creek is provisionally listed on the 2012 303(d) list of impaired waters. Pressures include low flows, urban and golf course stormwater runoff, and local geologic and soil conditions. USGS has identified Brush Creek as a useful site for evaluating water quality and quantity in relation to urbanization. Snowmass Water and Sanitation District is interested in water quality monitoring, and River Watch has several monitoring sites. Paired flow data adds an important component to water quality monitoring. A targeted water quality study may better illuminate potential pollutant sources within the watershed.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Site:
Intersection of Brush Creek Rd and Highline Rd

Location:
N 39^{0}13'31" W 106^{0}55'15"

Access:
Brush Creek Road in Snowmass Village.

Permissions and Land Ownership:
This site may be accessed through permission with the Town of Snowmass Village. Contact: Kit Hamby, Snowmass Water and Sanitation Manager (970) 923-2056.

Culvert below roundabout at Brush Creek and Highline Rds

Discussion:
This site is below the confluence of both forks of Brush Creek. From a water quality standpoint it captures the combined effects of both the Water Treatment Plant effluent and the Snowmass Club Golf Course. The WTP has a SCADA system with real time monitoring of effluent volume, allowing for separation of WTP and natural load sources of water quality parameters. Brush Creek in the vicinity of Snowmass resort development is a fairly complicated 'plumbed system' with many diversion and return points upstream. This site is likely the best located to address water quality issues identified in the Workshop Summary and correspondence with stakeholders. An alternate location for the gage idenitified by Snowmass Water exists approximately 200 meters upstream at a small concrete box constriction in the stream.

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for Brush Creek includes a real-time streamflow measurement gage, pH sensor, and specific conductivity sensor. All three sensors must be installed in the stream channel. The accuracy and precision of the water depth sensor should comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). Depth, pH, and specific conductance measurements at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients. Data will be stored on the datalogger and must be manually downloaded periodically.

Estimated Cost: **See Section 3.3**

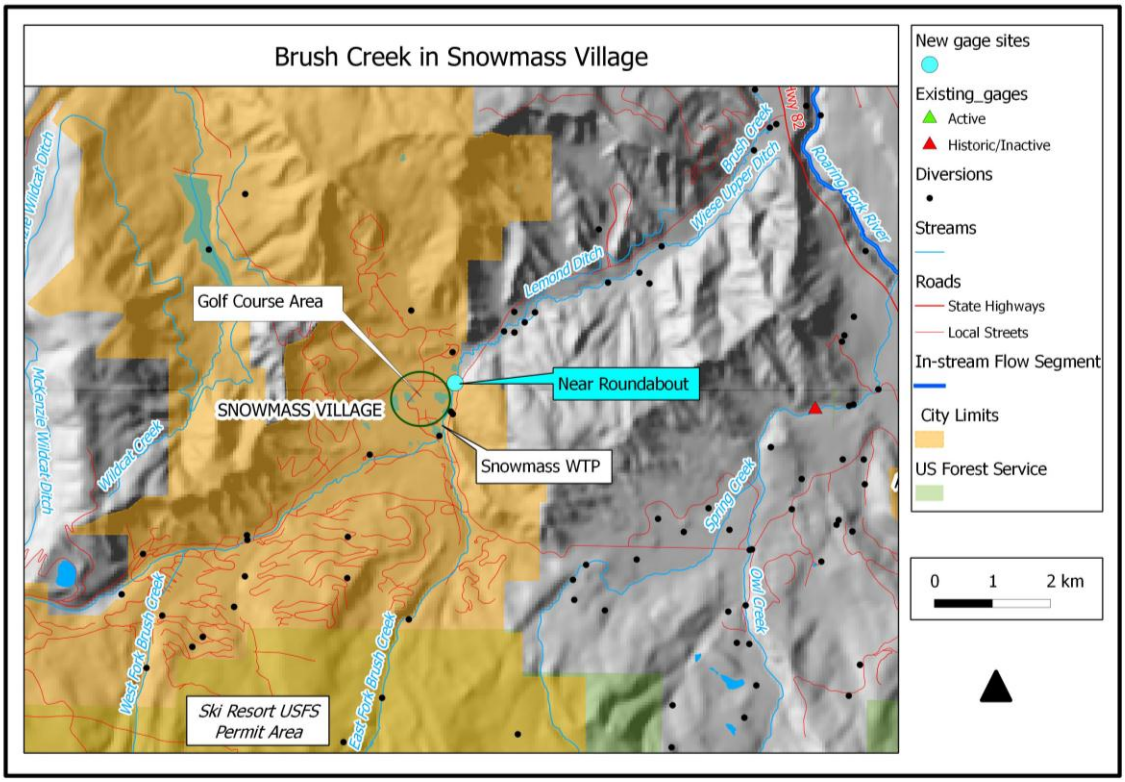
Installation
Installation and initial setup of the gaging station requires design and assembly of electrical components, programming the datalogger to collect stage, pH, and specific conductance measurements at a selected time interval, and securely installing the gaging station on the stream bank.

Estimated Cost: **$ 1200.00**

Operation and Maintenance
The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger and sensors. A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. The gaging station does **not** need to be leveled following USGS standards as this data will not be used by CDWR, but will instead be used in assessments of water quality. This station will be operated year-round.

Estimated Cost: **$ 2000.00**

Location Map:



2.4 Roaring Fork at Lost Man Creek

Description of Need:

Flows in the upper Roaring Fork (and Lincoln Creek as well) are governed by bypasses from the Independence Pass Transmountain Diversion System. This system, which utilizes the Twin Lakes Tunnel, is owned and operated by the Twin Lakes Reservoir and Canal Company (TLRCC), located in Pueblo, CO. The Twin Lakes Exchange Agreement allows for 3000 af/y to enter the upper Roaring Fork. For context, if that amount were equally released over the year it annualizes to approximately 4.1 cfs constant flow. Because flow can only be monitored in summer, no flows are scheduled from October to June. Any change to current bypass regimes desired by stakeholders would require to the ability to conduct year-round gaging.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Site:
Below Independence Pass Transmountain Diversion System

Location:
N 39^{0}07'01" W 106^{0}37'12"

Access:
Park at the a pull-off on the switchback on Rt 82 Independence pass road where the diversion ditch goes under the road and walk approximately 0.25 miles down the ditch road (right side of ditch) until reaching the diversion structure. Or park at the Lost Man Campground, walk off-trail towards the Roaring Fork, then follow it upstream (no trail) to reach the diversion structure.

This V-notch weir is the current USGS-run gage setup on the upper Roaring Fork at Lost Man. Only able to measure flows below 5 cfs, it does not operate in the winter due to icing.

Permissions and Land Ownership:
This area is USFS administered land, White River National Forest Aspen-Sopris Ranger District Office in Aspen (970) 925-3445. Diversion structures are owned by the Twin Lakes Reservoir and Canal Company, Ordway Colorado. Contact: Scott Campbell (719) 267-4411.

Discussion:
A V-notch weir structure operated by USGS is currently in place to monitor bypass flows into the upper Roaring Fork. Flows are controlled by the Twin Lakes Reservoir and Canal Company (TLRCC) which owns Independence Pass Transmountain Diversion System (IDPTS). TLRCC owns rights to more water from the headwaters than it currently diverts. Bypass flows are provided by TLRCC pursuant to the Twin Lakes Exchange, in which 'foregone diversions' to Twin Lakes from the upper Roaring Fork are repaid to TLRCC via water from diversions above Ruedi in the upper Fryingpan tributaries. Another inactive USGS gage exists a few hundred meters downstream near Lost Man campground. The weir can monitor flows up to approximately 6.8 cfs seasonally from May to October. During the winter months, the site is inaccessible and subject to extreme environmental conditions due to its high altitude location. Summer flows greater than the total tunnel diversion capacity and bypass weir exit over a concrete spillway and are unmeasured.

Streambed morphology downstream at the inactive gage provides no preferred natural channel sites for discharge measurement, and is subject to the same harsh environmental conditions and freezing problems as the active weir site. Current bypass flows at the weir are designed specifically to meet the 3000 af/yr agreement, the Twin Lakes Exchange. This is administered with various federal and local agencies with the TLRCC through joint flows to both the upper Roaring Fork, and its tributary Lincoln Creek. Correspondence with TLRCC staff indicates the current flow division was originally set up to address a fisheries concern in Lincoln Creek.

Communication with current USGS employee and former BOR staff Mark Henneberg identified previously discussed possible technical solutions. These included a snow-shed and heating unit at the bypass to measure winter flows, and the possibility for a larger weir to measure larger flows during the summer. Any new installation or change to current facilities would need to be fully self-sufficient in terms of operation and maintenance during winter months. Traversing the closed Independence Pass road from December to May not only requires long snowmobile travel on an un-maintained (non-groomed) route, it also entails crossing several large avalanche paths which add a difficult risk-management component to site visits. For these reasons, changes to the set up were previously identified as cost-prohibitive or infeasible. Informal communication with the TLRCC indicates that company is not opposed to changes in operation schedules that still fall within the 3000 af/yr agreement, and that a winter-operating diversion structure is technically feasible. However, it is important to note that TLRCC is not currently legally obligated to make such changes to release schedules, and the Twin Lakes Exchange could also be subject to revision in the future. Currently, excess flows are spilled over the diversion spillway and are not measured by the weir or counted in the 3000 af/yr bypass regime. An alternative weir design might be installed to measure flows over 6.8 cfs, but would lose measurement resolution during low flow. According to Mark Henneberg, accurate low-flow

measurement for the 3000 af/yr exchange agreement is the primary reason for the type and size of the current weir.

Construction of a new gage in this area is problematic for the reasons listed previously. The most cost-effective option for procuring year-round streamflow data from this reach is likely the extension of the months of operation of the current USGS gage. This would require the development of a new cooperators agreement between the USGS, TLRCC, and stakeholders. Please refer to **Section 4.4** for a better understanding of how USGS determines potential cost-match schedules and ranks funding priorities for new gage sites. Further discussion of stakeholder interests and realistic agency options is warranted before proceeding.

2.5 Roaring Fork in City of Aspen

Description of Need:

In the downtown area of Aspen, the Roaring Fork River faces some of its most significant challenges. These include a severely altered hydrologic regime and high levels of development with the concurrent urban runoff issues and alteration to in-stream and riparian habitat. Multiple stakeholder interests occur on this reach, although meeting them all at one site may be difficult.

Flows: Nearly 40% of the average annual flow is diverted in the headwaters through the Independence Pass Transmountain Diversion System, additional significant diversions occur at the upstream limits of town in the Salvation Ditch, and to a lesser extent, the Wheeler Ditch. In 2002, this reach nearly ran dry. A 1976 ISF right of 32 cfs exists between Difficult Creek and the confluence with Maroon Creek, however this right is junior to the significant diversions listed above. Existing USGS and CDWR gages are located above the Salvation Ditch and below Maroon Creek; neither captures flows in the most dewatered reach and neither provides information that might be used by CWCB regarding ISF rights.

Water Quality: This reach is provisionally 303(d) listed in the state's Clean Water Act reporting for impaired aquatic life.
River Watch currently monitors 3 sites between Difficult Creek Campground and Cemetery Lane Bridge. USGS has recommended water quality monitoring sites above and below the city to better characterize urbanization effects and fine-tune regional assessments of watersheds. Paired flow data adds an important component to water quality monitoring. In recent years, the city of Aspen has invested in innovative approaches to stormwater management which include treatment wetlands for primary city outflows at several downtown locations. Water quality monitoring for the stormwater program can benefit from paired flow data above and below the outflows.

Education: Any gage site in the downtown reach will potentially feature high visibility for public outreach. Interpretive signing paired with the gage site may provide a living classroom for lay-public communication concerning water usage in Colorado, conservation, water policy, and fisheries/ecosystem function and health. ACES conducts extensive environmental programs, and the Hallam Lake campus is very close by; the proximity of the Rio Grande multiuse trail and important public spaces like the John Denver Sanctuary and the Aspen Art Center also draw large volumes of pedestrian

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

An existing gage upstream of town administered by USGS and the one below Maroon Creek administered by CDWR may be used in conjunction with any new sites to fully address stakeholder interests. The total number of gages through this reach will likely be determined by the combination of cost feasibility and prioritization of stakeholder goals as determined by

FORR, RFC, and others. All sites utilize right-of-ways near bridges and parks, installation would need county or city approval respectively. The high pedestrian traffic in these areas may warrant more-secure installation housing than other locations to prevent incidental equipment damage or vandalism.

Site 1:
Mill Street Bridge (Jenny Adair, John Denver Sanctuary)

Location:
N 39^{0}11'38.7" W 106^{0}49'02.2"

Access:
The site under the bridge may be accessed from Mill St by parking at the Aspen Art Museum.

Permissions and Land Ownership:
This site and the two alternatives are situated in city parks. Contact: Brian Flynn, City of Aspen Parks Department, (970) 429-2035. Additionally, a US ACE Nationwide Permit 5 (for scientific measuring devices) may be required for structures along watercourses. Contact: US Army Corps of Engineers Grand Junction (970) 243-1199.

Discussion:
This site was picked from three similar sites in the vicinity (including the Jenny Adair wetlands and the John Denver Sanctuary). All three sites satisfy the same requirements and should be viewed as interchangeable in a final decision. Other possible sites are located at the Neale St Bridge and the Rt. 82 Bridge. The reach through town faces significant exposure to dewatering and the attendant problems for aquatic life during low flows. The Roaring Fork in this area is provisionally 303(d)-listed as impaired due to aquatic life. Multiple stakeholder interests on this reach include monitoring ISF rights, understanding how flow relates to aquatic macroinvertebrate impairment, and background water quality for city stormwater assessment. One of the city's primary stormwater treatment outflows is at the Jenny Adair Wetlands, just downstream of the gaging location. Gages are sited in downtown pedestrian parks and in close proximity to the Aspen Center for Environmental Studies Hallam Lake campus, adding potential for an education/outreach component.

Roaring Fork River at Mill St

Roaring Fork at John Denver Sanctuary

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for the Roaring Fork at Mill Street Bridge includes a real-time streamflow measurement gage and telemetry system for transmitting collected data from the site. Specifically, a sensor for measuring stream depth must be installed in the stream channel. In order for data produced by the station to be considered by the Colorado Department of Water Resources (CDWR), the accuracy and precision of the water depth sensor must comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). Depth measurements at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients.

Site characteristics and CDWR's need to view data in near real-time dictate that data would be transmitted from the site using a telemetry system. Two alternative communication systems are possible: a 900 MHz radio telemetry system or the GOES satellite system. If the 900 MHz alternative is selected, data transmission and collection will follow the Federal Communications Commission (FCC) protocols for radio transmissions. If the GOES alternative is selected, data transmission and collection will follow National Environmental Satellite, Data, and Information Service (NESDIS) protocols and will require the development of an MOU between a city government, county government, or non-profit entity and the NESDIS. The 900 MHz system presents a considerable cost savings, but will require placement and maintenance of a receiving base station within the City of Aspen. This base station will consist of a datalogger and an omni-directional radio antenna and must to be connected to a computer hosting the necessary data aggregation software. See **Sections 3.4.1 and 3.4.2** for a full description of equipment and cost differences between a GOES and 900 MHz systems.

Estimated Cost: **See Sections 3.4.1 and 3.4.2**

Installation
Installation and initial setup of the gaging station and telemetry network requires design and assembly of electrical components, programming the datalogger to collect stage measurements at a selected time interval, securely installing the gaging station on the stream bank, and setting up the selected telemetry system to enable of transmission of data from the site and subsequent aggregation of data on a client network or machine.

Estimated Cost: (single sensor): **$ 2,500.00**

Operation and Maintenance
The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger, sensor, or telemetry network. A stage-discharge rating curve developed on the site over a range of flow stages and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. Calibration of the rating curve during peak flows will likely require the use of a floating platform. A licensed surveyor must level the gaging station each year for the first three years following installation and periodically thereafter following the methods outlined in USGS Techniques and Methods Report 3-A19 (Turnipseed and Sauer, 2010). This station will be operated year-round.

Estimated Cost: (single sensor): **$ 4,000.00**

Site 2:
Cemetery Lane at Henry Stein Park

Location:
N 39^{0}12’39.08” W 106^{0}50’22.53”

Access:
The site may be accessed from Cemetery Lane by crossing to the north side of the river and parking at Henry Stein Park. The gage site is on the upstream end of the park under the bridges.


Roaring Fork River at Henry Stein Park

Permissions and Land Ownership:
This site is located in Henry Stein Park. This park is owned by the Aspen Valley Land Trust and maintained by City of Aspen Parks. Installation of any structures on Cemetery Lane Bridge itself would also need to be approval with the City and County. A US ACE Nationwide Permit 5 (for scientific measuring devices) may be required for structures along watercourses. Contacts: City

of Aspen Streets, Jerry Nye (970) 920-5133; City of Aspen Parks, Bryan Flynn (970) 429-2035; County Public Works Director, Bryan Pettet (970) 920-5392; US Army Corps of Engineers Grand Junction (970) 243-1199.

Discussion:
This is an easily accessible site with good channel morphology under the bridges for discharge measurements. The park is a mixture of public property that should be amenable to gage infrastructure placement since both the County and City are considered interested stakeholders. The Rio Grande trail is a county right-of-way, the bridges are also a public right-of-way, and Henry Stein Park is run by the city and owned by the Aspen Valley Land Trust. This site sits approximately at the downstream city limit, and serves as a good catch point for water quality parameters potentially influenced by Aspen. It is also an existing macroinvertebrate monitoring site. Cemetery Lane is below the confluence of Castle Creek but above Maroon Creek. Above Castle Creek is the potentially most-de-watered section of the Roaring Fork. The difference between flows measured here and flows on the newly-installed Castle Creek gage should provide additional cross-validation to flows at any new gage on the Roaring Fork upstream of Castle Creek.

Supporting Infrastructure:
The infrastructure to meet stakeholder needs for the Roaring Fork at Cemetery Lane includes a real-time streamflow measurement gage and the possible addition of several real-time water quality sensors. Specifically, a sensor for measuring stream depth must be installed in the stream channel. The accuracy and precision of the water depth sensor should comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). It is also possible to install pH, turbidity, or specific conductance sensors alongside the depth sensor. Depth measurements (and any additional parameters) at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients. Data will be stored on the datalogger and must be manually downloaded periodically.

Estimated Cost: **See Section 3.5**

Installation
Installation and initial setup of the gaging station requires design and assembly of electrical components, programming the datalogger to collect stage measurements (and any other selected parameters) at a selected time interval, and securely installing the gaging station on the stream bank.

Estimated Cost: (single sensor): **$ 1000.00**

Operation and Maintenance
The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger and sensor(s). A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. Calibration of the rating curve during peak flows will likely require the use of a floating platform. The gaging station does **not** need to be leveled following USGS standards as this data will not be used by CDWR, but will instead be used in assessments of water quality. This station will be operated year-round

Estimated Cost: (single sensor): **$ 2500.00**

Site 3:
Smith Way Road Bridge

Location:
N 39^{0}15'31" W 106^{0}52'56"

Access:
The site may be accessed via Smith Hill Way from Hwy 82. Access to this site would need to be managed through an agreement permitting the installation and maintenance of gaging equipment on the Pitkin County's right-of-way.


Smith Way Road Bridge and pedestrian bridge

Permissions and Land Ownership:
This site is located near Jaffee Park, which is administered by Pitkin County Open Space and Trails. Installation of any structures County Land in the park or along the Rio Grande Trail easement would require approval through the County. County Public Works Director, Bryan Pettet (970) 920-5392. Installation on the bridge may also require an agreement with CDOT. A US ACE Nationwide Permit 5 (for scientific measuring devices) may be required for structures along watercourses. Contact: US Army Corps of Engineers Grand Junction (970) 243-1199.

Discussion:
Immediately below the Smith Hill Way Bridge lies a channel run section of the Roaring Fork River. Rip-rap material on both banks provides excellent channel stability at this site. The bridge provides a platform for gage calibration during high flows. This location lies sufficiently

downstream from the city of Aspen and most major points of diversion to capture the cumulative effects of urbanization and consumptive water use on water quantity and quality.

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for the Roaring Fork at Smith Hill Way includes a real-time streamflow measurement gage and the possible addition of several real-time water quality sensors. Specifically, a sensor for measuring stream depth must be installed in the stream channel. The accuracy and precision of the water depth sensor should comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). It is also possible to install pH, turbidity, or specific conductance sensors alongside the depth sensor. Depth measurements (and any additional parameters) at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients. Data will be stored on the datalogger and must be manually downloaded periodically.

Estimated Cost: **See Section 3.6**

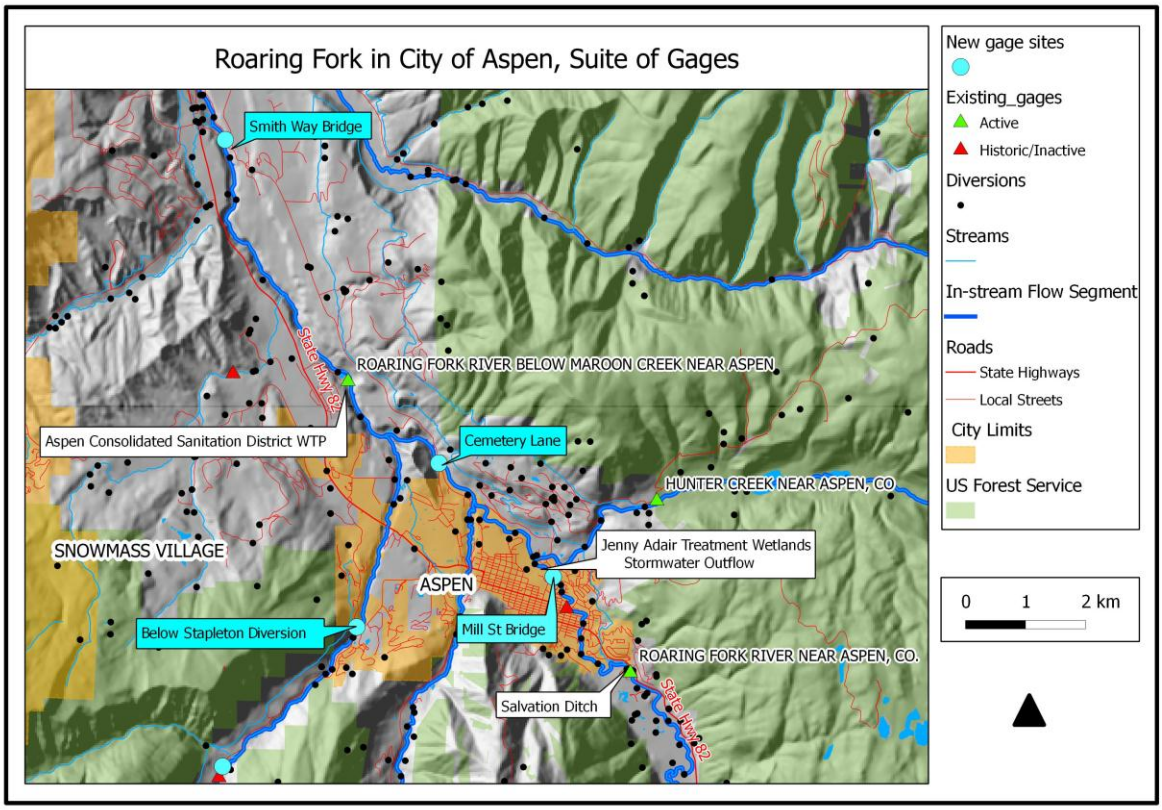
Installation
Installation and initial setup of the gaging station requires design and assembly of electrical components, programming the datalogger to collect stage measurements (and any other selected parameters) at a selected time interval, and securely installing the gaging station on the stream bank.

Estimated Cost: (single sensor): **$ 1000.00**

Operation and Maintenance
The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger and sensor(s). A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. Calibration of the rating curve during peak flows will likely require the use of a floating platform. The gaging station does **not** need to be leveled following USGS standards as this data will not be used by CDWR for ISF rights, but will instead be used in assessments of water quality. This station will be operated year-round

Estimated Cost: (single sensor): **$ 2500.00**

Location Map:



2.6 Coal Creek Sub-basin

Description of Need:

> Coal Basin is the former site of large scale coal mining operations which have left a watershed of unstable hillslopes with high erosive potential. During significant precipitation events, Coal Creek regularly discharges a large sediment influx to the Crystal River at Redstone, potentially impairing the stream system. A number of short and long term restoration projects are planned or currently underway in Coal Basin involving USFS, the Roaring Fork Conservancy, Colorado DRMS, and others. Ongoing monitoring and assessment will be a vital component. One key aspect of these projects includes constructing a sediment budget for Coal Creek, which requires accurate flow data at the mouth of the basin.
>
> (Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Coal Creek drains a large tributary basin to the Crystal River near the town of Redstone. RFC and other partners have multiple project interests in the area including water quality monitoring and assessment, mine lands reclamation, and channel restoration at the confluence with the Crystal. The high sediment volume, steepness, and instability of mine lands in the basin contribute to stream channel instability, adding difficulty to gage siting. In the event that property ownership clarification prohibits the first site, two alternative sites are identified here within 1 km of the Forest Service property boundary.

Permissions and Land Ownership:

By establishing any prospective site on USFS land, private property ownership issues may be avoided. All Coal Creek restoration and research currently conducted by RFC is in collaboration with USFS, which should be assumed as willing a cooperator for installation. Contact: White River National Forest Aspen-Sopris Ranger District Office in Aspen (970) 925-3445.

Site:
National Forest Boundary

Location:
N 39^{0}11’25.7” W 107^{0}15’42.5”

Access:
Via Coal Creek Road. The location resides on river right, 30m above the culvert at the National Forest Boundary. Access to this site on river right would need to be granted by the property owner. Due to the close proximity to the National Forest boundary, a survey may be necessary to determine exact property lines.


Coal Creek at the USFS boundary

Discussion:
A short run section located 30m upstream of the culvert on Coal Creek provides an ideal location for characterizing the meteorology, hydrological behavior and the water quality of the Coal Creek watershed. The proposed gaging location is situated along a narrow and deep section of the creek, improving the likelihood of continuous data collection during low-flow periods. The channel appears relatively stable throughout this reach and large boulder along the stream banks will allow instrumentation to be installed in such a way that it should be protected from debris moving down the channel during high flows. Instrumentation may be installed well above the floodplain at this site due to steep stream banks and flashy hydrography.

Alternate Site #1:

Location:
N 39^{0}11’24.4” W 107^{0}15’43.6”

Access:
Via Coal Creek Rd.

Discussion:
The proposed gaging location resides on river left, adjacent to a shallow and relatively stable run. It is located


Alternate Site 1 on Coal Creek

approximately 200m upstream from the Forest boundary. A large boulder on river right that extends into the stream provides protection from downstream debris movement. Installation of equipment on the top of the boulder will prevent it from being inundated during high flow events. The channel is relatively wide and shallow, which may make low flow measurements challenging**.**

Alternate Site #2:

Location:
N 39^{0}11’22.3” W 107^{0}16’03.2”

Access:
Via Coal Creek Rd.


Alternate Site 2 on Coal Creek

Discussion:
The proposed gaging location resides on river left, adjacent to shallow and relatively stable run. It is located approximately 600m upstream from the Forest boundary. A terrace on river left provides a satisfactory location for gaging equipment that will be protected from inundation during all but extremely high flow events. The channel here is relatively wide and shallow, which may make consistent gaging during low flows challenging.

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for Coal Creek includes a real-time streamflow measurement gage, pH sensor, turbidity/ total suspended solids (TSS) sensor, and specific conductivity sensor. All sensors must be installed in the stream channel. The accuracy and precision of the water depth sensor should comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). Depth, pH, turbidity, TSS, and specific conductance measurements at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients. Data will be stored on the datalogger and must be manually downloaded periodically.

Estimated Cost: **See Section 3.7**

Installation

Installation and initial setup of the gaging station requires design and assembly of electrical components, programming the datalogger to collect stage, pH, turbidity, TSS, and specific conductance measurements at a selected time interval, and securely installing the gaging station on the stream bank.

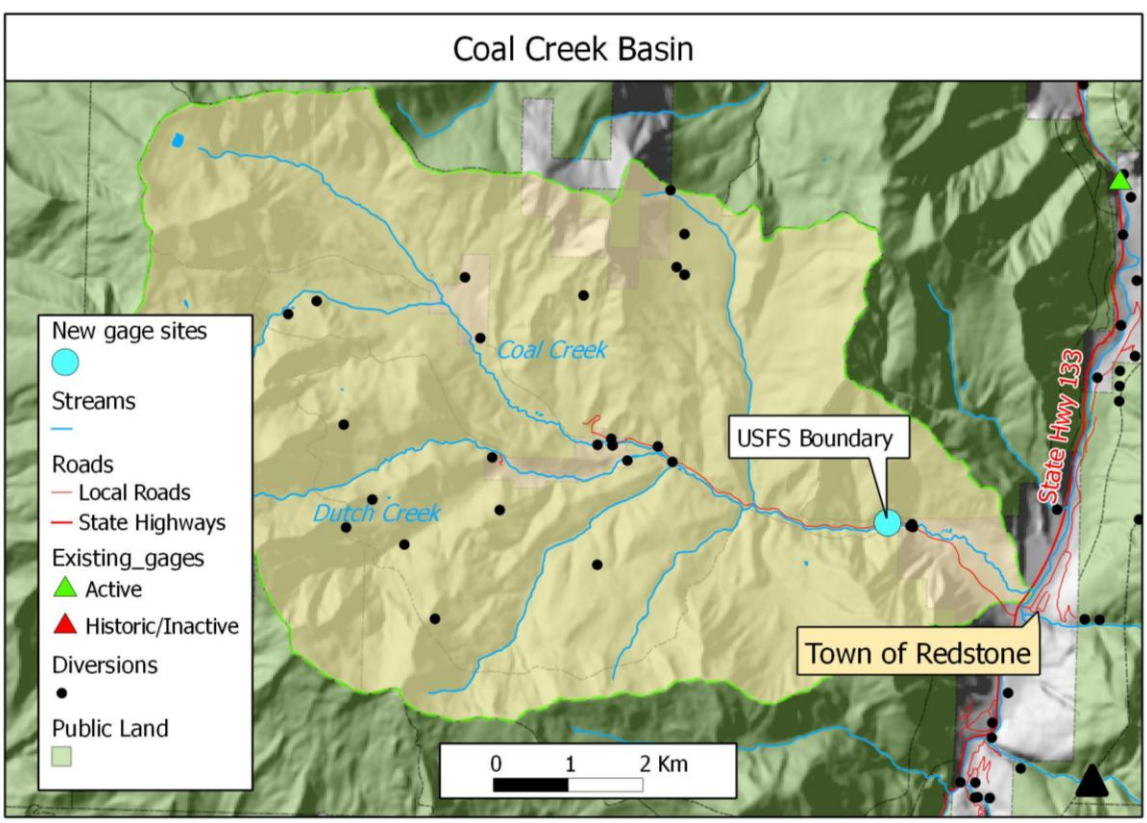
Estimated Cost: **$ 1500.00**

Operation and Maintenance

The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger and sensors. A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. The gaging station does **not** need to be leveled following USGS standards as this data will not be used by CDWR for ISF rights, but will instead be used in assessments of water quality. This station will be operated year-round.

Estimated Cost: **$ 4000.00**

Location Map:



2.7 Fryingpan-Arkansas Project bypass flows

Description of Need

These three tributaries to the Fryingpan River all have diversion structures for the Bureau of Reclamation's Fry-Ark project. ISF rights appropriated in 1973 exist on each stream, varying from 0.5 cfs to 2 cfs seasonally. No gages exist on the tributaries to monitor ISFs, however, the BOR can monitor bypass flows in weirs at each diversion structure. CDWR monitors this watershed at sites further downstream on the North Fork of the Fryingpan near Norrie for the purpose of administering water agreements between west slope parties and the Fry-Ark project. If BOR data and CDWR gages downstream are considered insufficient by stakeholders for flow monitoring of these tributaries, new gages would be required on each. See discussion below.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Discussion:

In the Workshop Summary, the stakeholders identify the need to monitor flows in the upper Fryingpan watershed above Ruedi Reservoir in un-gaged streams subject to trans-mountain diversions. The three streams specified in the Workshop Summary are Carter (priority), Mormon (priority), and Middle Cunningham. In each of these, a CWCB ISF right ranging from 0.5 cfs to 2 cfs was established in 1973.

The Workshop Summary states that each of the aforementioned reaches is currently un-gaged. However, at each diversion intake in the Fryingpan-Arkansas project (the trans-mountain diversion project affecting these three streams), the Bureau of Reclamation monitors various parameters including bypass flows using its own system. This data is publicly available in real time (15 minute instantaneous values) and daily-averaged increments at the BOR's Hydromet web portal (http://www.usbr.gov/gp/hydromet/station_list_by_state.cfm). The data may be viewed at the web address http://www.usbr.gov/gp/hydromet/dayfile_colorado.cfm by selecting the respective links for Carter, Mormon, and Middle Cunningham. The parameter of interest in the real-time link is 'Q', which represents the total bypass flow in cubic feet per second. For daily-averaged data, the bypass flow parameter is 'QD'. Only the most recent 24-hour values for the current calendar day are published online. For a longer period of record or archived data, a special request to BOR or the site webmaster may be necessary (gpwebmaster@usbr.gov).

CDWR believes the current infrastructure in the Fryingpan watershed is adequate to meet administrative needs regarding Ruedi Reservoir, local ISF rights, and trans-basin compact decrees. Installation of 3 new gages in Fry-ark diversion tributaries will face the same difficulties of infrastructure maintenance and access risk-management for year-round maintenance as the Roaring Fork at Lost Man: extreme environmental conditions and icing, lack of winter access, and channel morphology that makes gage calibration difficult. If BOR data-sharing or

stakeholder-shared operational QA/QC oversight at Carter, Mormon, and Cunningham Creeks are desired goals, along with possible alteration of bypass flow schedules (i.e. even if an ISF right cannot be fully met, can the creek at least be 'kept a little wet'?), these goals may be better pursued administratively within existing decree frameworks rather than allocating resources to infrastructure that the two key parties controlling flow, CDWR and BOR, may not be willing or legally able to recognize and use. If new gages are absolutely desired, then a more focused engagement with BOR and CDWR on goals, uses, and sites is recommended.

2.8 Maroon Creek at City of Aspen diversion

Description of Need

Lower Maroon Creek, from Willow Creek to the confluence with the Roaring Fork River, experiences varying pressures from flow alteration, urbanization, and recreational activities. The stream corridor is generally intact and features high quality riparian habitat, and areas on lower Maroon and Castle Creeks have been identified as having unique conservation potential. Flow alteration may currently be the most significant impacting pressure on the creek. A 1976 ISF right of 14 cfs year round exists from the confluence of East and West Maroon Creeks to the Roaring Fork. Maroon Creek Ditch, owned by the City of Aspen, has existing water rights for municipal uses, including up to 27 cfs for hydropower use in the proposed Castle Creek project, and diverts a significant portion of stream flow during lower flow periods.

(Adapted directly from *Stream Gage Needs Workshop Report 2012*)

Site:
Below city diversion intake

Location:
N 39^{0}10'42" W 106^{0}51'42"

Access: Maroon Creek Road, T Lazy 7 property

Permissions and Land Ownership:
The large majority of Maroon Creek below the city diversion and extending downstream to the Stapleton Brothers diversion is privately owned land with small home sites. The T Lazy 7 Ranch also comprises a significant parcel immediately downstream-of and surrounding the diversion. In informal communication, the T Lazy 7 owner has indicated he would decline permission for access or installation of stream gages on the property. City of Aspen maintains an easement around the diversion structure, this may provide one potential avenue for access, but discussion is ongoing. Contact: City of Aspen, Dave Hornbacher, Director of Utilities and Environmental Initiatives (970) 429-1983.

Discussion:
This site presents unique circumstances that may need further exploration to determine an appropriate stream gaging option. The City of Aspen municipal intake diverts a significant amount of water from Maroon Creek just upstream of the T Lazy 7 ranch. Water flows to the existing city hydroelectric generating plant and returns to the creek a few hundred meters above the bridge on Maroon Creek Rd near Aspen Highlands Resort. Between the diversion and return flow, the creek sometimes faces exposure to very low-flow conditions. A 1976 ISF right of 14 cfs exists from the confluence of East and West Maroon Creeks to the Roaring Fork River.

Nearly the entire reach from the city diversion to the bridge on Maroon Creek Road lies on private land. A small wedge of USFS ownership near the T Lazy 7 Ranch was investigated, but the stream channel morphology on that reach is steep with braids and divided flow, yielding no desirable gage location on the public right-of-way. The other publicly accessible site is at the Maroon Creek Rd Bridge just past Aspen Highlands Resort, but this site is below the hydroelectric return flow and does not monitor the potentially most de-watered sections of stream. A reach immediately downstream of the city diversion (on the ranch property) crossed by a small footbridge presents suitable channel morphology for gaging. However, in personal phone communication, the land owner has indicated unwillingness to allow a gage to be sited on T Lazy 7 property.

The City of Aspen maintains some monitoring capability on the diversion intake; potentially including bypass flows to Maroon Creek. A dialogue regarding the timing and accessibility of this data is currently underway. If the city intake data is permissible to the CDWR for administrative oversight, it may obviate the need for an additional gage at the site unless 3rd-party verification of city diversions is a specific stakeholder interest. In that case, further engagement of T-Lazy-7 landowners or other downstream landowners in the reach above the hydroelectric return flow will be necessary. The majority of the creek below T Lazy 7 lies well below and distant from Maroon Creek Road, with poor access and generally unsuitable stream channel morphology.

City of Aspen currently takes manual flow measurements 3 times per week in low flow conditions within their easement below the diversion structure to correlate with their system readings and monitor flow conditions. S.K.Mason Environmental questioned the city regarding interest in joint stakeholder management of a permanent gage just downstream of the diversion on the city easement. Due to the questions concerning the legal, administrative, and cost aspects of this option, as well as the political nature of current events regarding diversions in Maroon and Castle Creeks, definitive resolutions to gaging at this site are not yet available.

Potential gage site at Footbridge below city diversion structure, access is currently prohibited.

City of Aspen diversion structure on Maroon Creek

Supporting Infrastructure:
The infrastructure necessary to meet stakeholder needs for Maroon Creek at the City of Aspen Diversion includes a real-time streamflow measurement gage and telemetry system for transmitting collected data from the site. Specifically, a sensor for measuring stream depth must be installed in the stream channel. In order for data produced by the station to be considered by the Colorado Department of Water Resources (CDWR), the accuracy and precision of the water depth sensor must comply with the standards outlined in the USGS Techniques and Methods Report 3-A7 (Sauer and Turnipseed, 2010). Depth measurements at the site will be collected in real-time (e.g. every 15 minutes) by a Campbell Scientific controller/datalogger. The datalogger will be programmed to calculate stream discharge from stage measurement using the best-fit rating curve coefficients.

The site characteristics and CDWR's need to view data in near real-time dictate that data be transmitted from the site using satellite telemetry. The station will transmit data over the GOES satellite system. Data transmission and collection will follow National Environmental Satellite, Data, and Information Service (NESDIS) protocols and will require the development of an MOU between a city government, county government, or non-profit entity and the NESDIS.

Estimated Cost: **See Section 3.8**

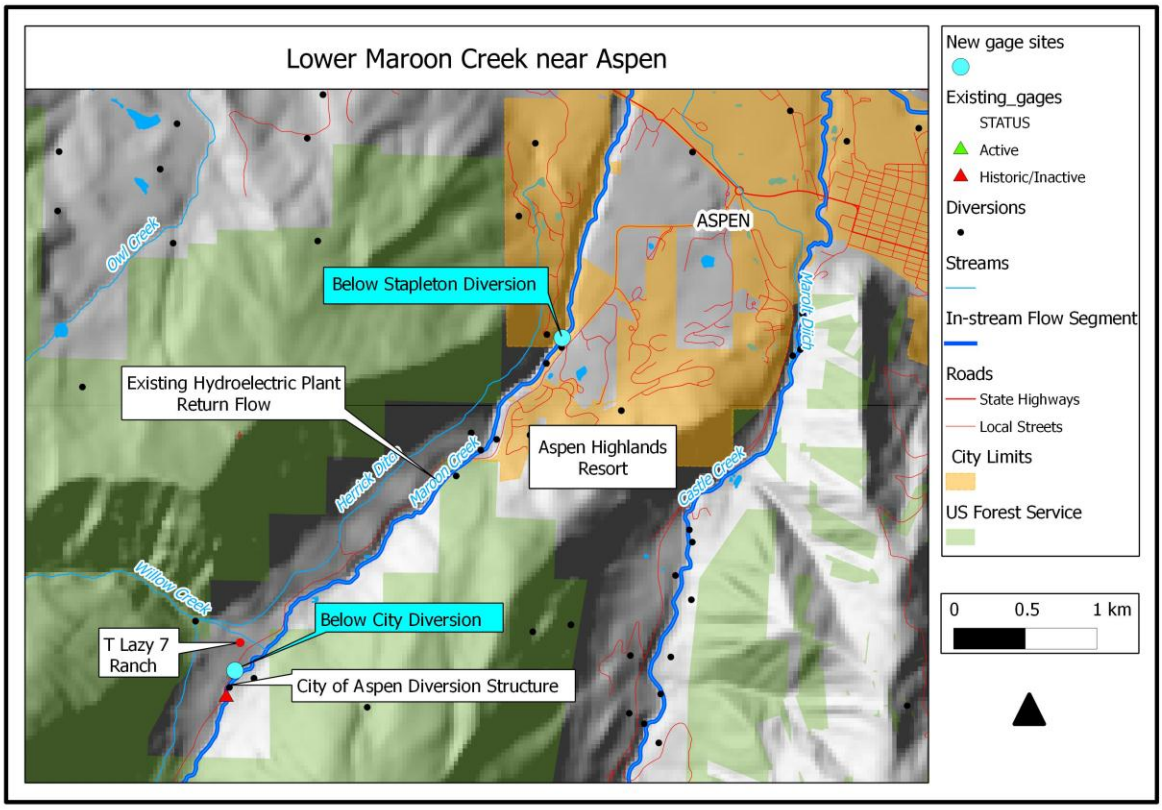
Installation
Installation and initial setup of the gaging station and telemetry network requires design and assembly of electrical components, programming the datalogger to collect stage measurements at a selected time interval, securely installing the gaging station on the stream bank, and setting up the GEOS telemetry system to enable of transmission of data from the site and subsequent aggregation of data on a client network or machine.

Estimated Cost: **$ 2,500.00**

Operation and Maintenance
The operation and maintenance of this station requires periodic site visits for instrument cleaning, rating curve calibration and as-needed troubleshooting of the datalogger, sensor, or telemetry network. A stage-discharge rating curve developed on the site over a range of flow states and following methods outlined in the USGS Techniques and Methods Report 3-A8 must be used to relate stream depth measurements to stream discharge. The gaging station must be leveled by a licensed surveyor each year for the first three years following installation and periodically thereafter following the methods outlined in USGS Techniques and Methods Report 3-A19 (Turnipseed and Sauer, 2010). This station will be operated year-round.

Estimated Cost: **$ 3,000.00**

Location Map:



2.9 Data Management

Management of data produced by gaging stations must be tailored to the particular needs and data collection/communication platform ultimately selected by the stakeholders for each location. An example: for a gaging station installed to monitor in-stream flow rights and relying on GEOS satellite telemetry, data must be retrieved from a NESDIS downlink station and published in a manner to make it useful to the Water Commissioner for the administration of water rights. This will require development of software designed to retrieve data at a fixed time interval and subsequently display it in graph and numerical form on a website. Furthermore, data must pass through quality assurance and quality control procedures in a timely manner following collection. Options for permanent data storage include storage in raw data files, archival in an existing database, or archival in a custom-built database, the selection of which will incur widely varying costs. Contrast this scenario with a gage installed to inform local decision making processes about stormwater management or non-point source pollution. If such a gage is not part of a telemetry system, it may be sufficient to periodically download data from the gage and store it as appended, raw data files. The level of QAQC procedures that this data must pass through will largely follow the requirements of the particular study or assessment that the data is used for.

Determination of data management costs is thus beyond the scope of this report and will require further guidance from the stakeholder group. Important considerations for the development of a Data Management Plan include, but are not limited to, the following:

- Who owns the data?
- Who is responsible for storage and backup of the data?
- What level of data quality (raw data files vs. QAQC'd data sets) is required?
- What level of data control (restricted user access vs. publicly accessible) is required?
- How will requests for data be handled?
- What sort of metadata needs to be managed with the data?
- How should data/metadata be formatted?

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3.0 Equipment Costs

3.1 Section Overview

This section provides detailed equipment specifications for gaging sites identified in **Section 2**. Infrastructure requirements are made based on the stakeholder needs for each priority reach as communicated to S.K.Mason Environmental, LLC. Gaging locations are presented in an order paralleling that laid out in the Workshop Summary Report. The goal here is to provide a complete 'shopping list' for instrumentation needs at each site.

Summary of Infrastructure and Operation Needs:

Priority Reach	**Stakeholder Needs**	**Recommended Set-up**	**Equip Cost*** (w/o optional sensors)	**Install**	**Annual O/M**
Maroon Ck blw Stapleton	ISF	Real-time w/ GOES satellite telemetry	$6,610	$2,500	$3,000
Lower Crystal	ISF, WQ link to flows	Real-time, periodic manual download, WQ sensors	$2,900	$800	$800
Brush Creek	WQ	Real-time, periodic manual download, WQ sensors	$5,124	$1,200	$2000
RF City of Aspen Mill St Area	ISF, WQ, Stormwater Assessment	Real-time w/ GOES satellite telemetry	$6,470 [Satellite] $4,486 [900 MHz]	$2,500	$4,000
RF City of Aspen Cemetery Lane	WQ, Stormwater Assessment	Real time, periodic manual download	$2,900	$1,000	$2,500
RF City of Aspen Smith Way Road	WQ	Real time, periodic manual download	$2,900	$1,000	$2,500
RF at Lost Man Ck	ISF	*See Section 2.4*	--	--	--
Coal Creek	Hyrologic regime, WQ, sediment transport	Real time, periodic download, WQ sensors	$7,196	$1,500	$4,000
Fryingpan Tributaries	ISF	*See Section 2.7*	--	--	--
Maroon Ck blw City Diversion	ISF	Real-time w/ GOES satellite telemetry	$6,610	$2,500	$3,000

* Does not include tax or shipping charges

3.1 Maroon Creek at Stapleton Ditch

Item	Description	Each	Quantity	Cost
DCP200-MM	GOES Data Collection Platform (Mast Mounting)	$4,560.00	1	$4,560.00
	(1) 25316 GOES Yagi antenna			
	(1) 10873 9-Pin Female to 9-pin Male serial cable, 6 ft			
	(1) 7623 3/4" IPS aluminum pipe for mounting GPS antenna			
	(1) BP24 24-Ahr Sealed Rechargeable Battery			
	(1) SC12 Serial Cable			
	(1) 18134 Transmitter Support Software			
	(1) CR295X GOES Datalogger			
	(1) 4905 Desiccant			
	(1) 1113 Flat-bladed screwdriver			
	(1) COAXNTN-L GOES Antenna Cable			
	(1) 6186 External Battery Cable			
	(1) CM220 Right Angle Mounting Kit			
	(1) 18133 Power Cable, 2 ft (includes one 18889 Fuse)			
	(2) 2376 Cable Tie Mounts			
	(1) 17992 GPS Antenna 3.3 V, 30 dB			
	(1) 8125 Flat-bladed screwdriver			
	(1) SP20 20 W solar panel			
	(1) TX320 HDR GOES Satellite Transmitter			
	(1) 18017-L GPS Antenna Cable			
	(1) ENC16/18 Environmental Enclosure			
	(1) 7363 Enclosure supply kit			
	(1) CH100 Regulator			
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Style A Stream Gage	Staff Gage	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$6,610.00**

3.2 Lower Crystal River

Item	Description	Each	Quantity	Cost
CR200	Datalogger	$450.00	1	$450.00
SPM010P-D	Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
RBC4	PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SG-4	SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
ENC 10/12	Weather resistant 10x12in enclosure	$200.00	1	$200.00
ENC 10/12-MM	Tripod mast mounting	$60.00	1	$60.00
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Style A Stream Gage	Staff Gage	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$2,899.95**

Optional Water Quality Sensors

Item	Description	Each	Quantity	Cost
CS526	pH sensor w/ 50ft cable	$852.50	1	$852.50
CS547A-50	Water conductivity probe w/ 50ft cable	$382.00	1	$382.00
OBS-3+ -TB -21308	Titanium turbidity sensor w/ 15m cable	$1,530.00	1	$1,530.00

3.3 Brush Creek

Item	Description	Each	Quantity	Cost
CR1000	Measurement and control datalogger	$1,440.00	1	$1,440.00
CS547A	Water conductivity probe	$345.00	1	$345.00
CS547A--L	ft cable per sensor	$0.74	50	$37.00
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
CS526	pH sensor	$815.00	1	$815.00
CS526-L	ft cable per sensor	$0.75	50	$37.50
ENC 10/12	Weather resistant 10x12in enclosure	$200.00	1	$200.00
ENC 10/12-MM	Tripod mast mounting	$60.00	1	$60.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
SPM010P-D	Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
RBC4	PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SG-4	SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
Style A Stream Gage	Staff Gage (Optional)	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$5,124.45**

3.4 Roaring Fork in City of Aspen: Mill Street Bridge

3.4.1 Mill Street Bridge (GEOS Communication System)

Description	Each	Quantity	Cost
GOES Data Collection Platform (Mast Mounting)	$4,560.00	1	$4,560.00
(1) 25316 GOES Yagi antenna			
(1) 10873 9-Pin Female to 9-pin Male serial cable, 6 ft			
(1) 7623 3/4" IPS aluminum pipe for mounting GPS antenna			
(1) BP24 24-Ahr Sealed Rechargeable Battery			
(1) SC12 Serial Cable			
(1) 18134 Transmitter Support Software			
(1) CR295X GOES Datalogger			
(1) 4905 Desiccant			
(1) 1113 Flat-bladed screwdriver			
(1) COAXNTN-L GOES Antenna Cable			
(1) 6186 External Battery Cable			
(1) CM220 Right Angle Mounting Kit			
(1) 18133 Power Cable, 2 ft (includes one 18889 Fuse)			
(2) 2376 Cable Tie Mounts			
(1) 17992 GPS Antenna 3.3 V, 30 dB			
(1) 8125 Flat-bladed screwdriver			
(1) SP20 20 W solar panel			
(1) TX320 HDR GOES Satellite Transmitter			
(1) 18017-L GPS Antenna Cable			
(1) ENC16/18 Environmental Enclosure			
(1) 7363 Enclosure supply kit			
(1) CH100 Regulator			
Keller America Acculevel pressure transducer	$710.00	1	$710.00
ft cable per sensor	$1.62	50	$81.00
Datalogger support software	$599.00	1	$599.00
Stainless steel tripod	$425.00	1	$425.00
Staff Gage	$45.00	1	$45.00
Miscellaneous mounting hardware	$50.00	1	$50.00
Does not include tax or shipping charges	**Total**		**$6,470.00**

3.4.2 Mill Street Bridge (900 MHz Communication System)

Description	Each	Quantity	Cost
Datalogger w/ 915-MHz Radio	$685.00	2	$1,370.00
900 MHz 9dBd Yagi Antenna w/ mounting	$195.00	1	$195.00
900 MHz 3dBd Omni Antenna w/ mounting	$210.00	1	$210.00
Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
ft cable per antenna	$2.04	20	$40.80
Surge supressor kit	$110.00	2	$220.00
Weather resistant 10x12in enclosure	$200.00	1	$200.00
Tripod mast mounting	$60.00	1	$60.00
Keller America Acculevel pressure transducer	$710.00	1	$710.00
ft cable per sensor	$1.62	50	$81.00
Datalogger support software	$599.00	1	$599.00
10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Staff Gage	$45.00	1	$45.00
Miscellaneous mounting hardware	$50.00	1	$50.00
Does not include tax or shipping charges	**Total**		**$4,485.75**

Optional Water Quality Sensors

Description	Each	Quantity	Cost
pH sensor w/ 50ft cable	$852.50	1	$852.50
Water conductivity probe w/ 50ft cable	$382.00	1	$382.00
Titanium turbidity sensor w/ 15m cable	$1,530.00	1	$1,530.00

3.5 Roaring Fork in City of Aspen: Cemetery Lane at Henry Stein Park

Item	Description	Each	Quantity	Cost
CR200	Datalogger	$450.00	1	$450.00
SPM010P-D	Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
RBC4	PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SG-4	SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
ENC 10/12	Weather resistant 10x12in enclosure	$200.00	1	$200.00
ENC 10/12-MM	Tripod mast mounting	$60.00	1	$60.00
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Style A Stream Gage	Staff Gage	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$2,899.95**

Optional Water Quality Sensors

Item	Description	Each	Quantity	Cost
CS526	pH sensor w/ 50ft cable	$852.50	1	$852.50
CS547A-50	Water conductivity probe w/ 50ft cable	$382.00	1	$382.00
OBS-3+ -TB -21308	Titanium turbidity sensor w/ 15m cable	$1,530.00	1	$1,530.00

3.6 Roaring Fork in City of Aspen: Smith Way Bridge

Item	Description	Each	Quantity	Cost
CR200	Datalogger	$450.00	1	$450.00
SPM010P-D	Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
RBC4	PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SG-4	SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
ENC 10/12	Weather resistant 10x12in enclosure	$200.00	1	$200.00
ENC 10/12-MM	Tripod mast mounting	$60.00	1	$60.00
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Style A Stream Gage	Staff Gage	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$2,899.95**

Optional Water Quality Sensors

Item	Description	Each	Quantity	Cost
CS526	pH sensor w/ 50ft cable	$852.50	1	$852.50
CS547A-50	Water conductivity probe w/ 50ft cable	$382.00	1	$382.00
OBS-3+ -TB -21308	Titanium turbidity sensor w/ 15m cable	$1,530.00	1	$1,530.00

3.7 Coal Creek

Item	Description	Each	Quantity	Cost
CR1000	Measurement and control datalogger	$1,440.00	1	$1,440.00
TE525WS	Texas Electronics Tipping Bucket Rain Gage (0.01in)	$385.00	1	$385.00
TE525WS--L	ft cable per sensor	$0.45	6	$2.70
TE525WS--CM300	23in mounting pol w/ cap	$56.00	1	$56.00
CS547A	Water conductivity probe	$345.00	1	$345.00
CS547A--L	ft cable per sensor	$0.74	50	$37.00
OBS-3+	Turbidity sensor	$990.00	1	$990.00
OBS-3+ -TB	Titanium sensor body	$150.00	1	$150.00
OBS-3+ -21308	OBS300 15m cable	$390.00	1	$390.00
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
CS526	pH sensor	$815.00	1	$815.00
CS526-L	ft cable per sensor	$0.75	50	$37.50
ENC 10/12	Weather resistant 10x12in enclosure	$200.00	1	$200.00
ENC 10/12-MM	Tripod mast mounting	$60.00	1	$60.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
CM206	Sensor crossarm w/ one CM2120 mounting kit, 6ft	$98.00	1	$98.00
SPM010P-D	Solartech 10-Watt 12-Volt ES polycrystalline PV solar panel	$69.95	1	$69.95
RBC4	PowerStar AGM 12V 12AH sealed battery	$35.00	1	$35.00
SG-4	SunGuard 4.5-amp 12-Volt solar charge controller regulator	$35.00	1	$35.00
Style A Stream Gage	Staff Gage (Optional)	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$7,196.15**

3.8 Maroon Creek at City of Aspen Diversion

Item	Description	Each	Quantity	Cost
DCP200-MM	GOES Data Collection Platform (Mast Mounting)	$4,560.00	1	$4,560.00
	(1) 25316 GOES Yagi antenna			
	(1) 10873 9-Pin Female to 9-pin Male serial cable, 6 ft			
	(1) 7623 3/4" IPS aluminum pipe for mounting GPS antenna			
	(1) BP24 24-Ahr Sealed Rechargeable Battery			
	(1) SC12 Serial Cable			
	(1) 18134 Transmitter Support Software			
	(1) CR295X GOES Datalogger			
	(1) 4905 Desiccant			
	(1) 1113 Flat-bladed screwdriver			
	(1) COAXNTN-L GOES Antenna Cable			
	(1) 6186 External Battery Cable			
	(1) CM220 Right Angle Mounting Kit			
	(1) 18133 Power Cable, 2 ft (includes one 18889 Fuse)			
	(2) 2376 Cable Tie Mounts			
	(1) 17992 GPS Antenna 3.3 V, 30 dB			
	(1) 8125 Flat-bladed screwdriver			
	(1) SP20 20 W solar panel			
	(1) TX320 HDR GOES Satellite Transmitter			
	(1) 18017-L GPS Antenna Cable			
	(1) ENC16/18 Environmental Enclosure			
	(1) 7363 Enclosure supply kit			
	(1) CH100 Regulator			
CS460	Keller America Acculevel pressure transducer	$710.00	1	$710.00
CS460-L	ft cable per sensor	$1.62	50	$81.00
LoggerNet	Datalogger support software	$599.00	1	$599.00
UT10	10ftTower with adjustable mast, base and grounding kit	$565.00	1	$565.00
Style A Stream Gage	Staff Gage	$45.00	1	$45.00
MISC	Miscellaneous mounting hardware	$50.00	1	$50.00
Total	**Does not include tax or shipping charges**	**Total**		**$6,610.00**

4.0 CDWR and USGS Streamflow Monitoring

4.1 Section Overview

This section is intended to clarify the procedures by which the CDWR and USGS—the two entities responsible for the vast majority of surface water quantity and quality data collection in the State of Colorado--conduct real-time stream gaging.

4.2 CDWR Requirements for Locally Operated Gaging Stations

In Colorado, water rights are administered by the State Engineer's Office in the Colorado Division of Water Resources (CDWR). To administer In-stream Flow rights, which are held only by the Colorado Water Conservation Board (CWCB), the Division of Water Resources maintains its own network of gages, as well as relying upon those managed federally by USGS or other cooperators. CDWR gage sites are operated and maintained based on standards and protocols laid out by USGS. Data produced by gage sites that are operated by parties other than CDWR or USGS may be used for ISF-rights actions, however these sites must operate to the same standards and protocols as the state and federal sites in order to provide legally actionable flow information.

Colorado Division of Water Resources adopts protocols established by USGS regarding technical aspects of gage installation and maintenance. These protocols are laid out in the USGS Techniques and Methods Reports 3-A7, 3-A8, 3-A19. In brief, some of the essential criteria that must be met for real time water administration follow:

- Gage height measurement accuracy of 0.01 ft.
- Height collected every 15 minutes and transmitted hourly to the web for processing, discharge computation, and visual display.
- Levels run annually at all new gages and every 2-3 years at established sites to confirm stability of the primary reference gage against nearby benchmarks.
- Data telemetry on the State's satellite system must adhere to CDWR equipment requirements and methods. Data from other providers such as USGS, NCWCD may be posted via website link with disclaimer.
- Gages with man-made controls must be developed and maintained accurate to within +/-5% to +/-8%; maintaining rating accuracy means regular discharge measurements throughout the expected range in stage using standard discharge measurement methods and equipment accurate to within +/-5% accuracy
- Gages with natural controls and channel controls ratings must be developed and maintained accurate to within +/-5% to +/-8%; maintaining rating accuracy

means regular discharge measurements throughout the expected range in stage using standard discharge measurement methods and equipment accurate to within +/-5% accuracy

- For data to be useful to CDWR for real-time water administration, near real-time (hourly) data telemetry and processing are necessary. Some administration decisions are made using daily average flows

CWCB may install or use data from temporary gages or gages that do not meet the above standards. This data will be used for the purposes of studying river reaches for potential ISF filing. If a filing is made, CWCB may then choose to work with CDWR or USGS and local cooperators to fund a permanent gage at the location.

As mentioned in **Section 2.2, CDWR may not consent to stakeholder requests to develop new gages** due to an administrative workload beyond existing employee capacity. The agency retains discretion to accept or decline new gage work based on decisions by local Division 5 staff, who must determine whether a new gage or change in existing gage operation materially benefits water administration needs. In those cases where CDWR does consent to stakeholder requests for monitoring, the Division charges third parties approximately $9000 for yearly operation. This amount should be understood as a starting point that is subject to changes as a function of many site-specific factors.

4.3 USGS Streamflow Monitoring

The USGS installs and manages many streamflow gages throughout Colorado. These gages may be funded solely by the USGS, or may be jointly funded by local stakeholder groups. In cases where local groups request gage installation and management, USGS will endeavor to determine the need for the gage and will subsequently designate it with a priority rating and a corresponding match rate. The funding match USGS provides helps offset the cost of gaging stations on a site-by-site basis.

USGS match rates for streamflow gages vary depending on a variety of factors. For a given site, a criteria point system is used to determine a rank: high, medium, low, or very low. Match rates for each rank vary over time from one fiscal year to the next, depending on the availability of funds in the Cooperative Water Program, and the funds are limited. In any given year, there is no guarantee that the USGS will be able to provide matching funds, regardless of gaging station's rank.

Rank match rates for cooperatively funded stream gages in Colorado:

Points	Rank	USGS match (FY12)	Cooperator match (FY12)
>7	High	43.5%	56.5%
4-7	Medium	36.5%	63.5%
2-3	Low	10%	90%
0-1	Very Low	0%	100%

The prioritization schema developed to aid in determining match rates is summarized below:

Goal 1--Quantify Streamflow in Major Colorado Watersheds

3 points--Gages on major rivers (North Platte, South Platte, Arkansas, Rio Grande, San Juan, Animas, Dolores, Gunnison, Colorado, White, and Yampa) that have a > 20% change in annual flow from downstream gage(s). Gages are selected by beginning with state-line gage and moving upstream until flow is less than 5% of the flow at the gage that has the largest average annual flow on that river.
2 points--Gages on tributaries to major rivers: 1) Up to three gages on very large tributaries (tributary flow is > 20% of the flow at the gage that has the largest average annual mainstem flow); 2) Up to two gages on large tributaries (tributary flow is > 20% of the mainstem flow upstream from the tributary); or 3) One gage on medium tributaries (tributary flow is > 10 % of the mainstem flow upstream from the tributary).
1 point--One gage on small tributaries (tributary flow is > 5% of the mainstem flow upstream from the tributary).
0 points--All other gages**.**

Goal 2--Support Colorado Flood and Water-Supply Forecasting

3 points--Gage is an NWS, COE, USBR, State, or local flood forecast gage**.**
2 points--Gage is an NRCS or NWS water-supply forecast gage**.**
1 point--Gage is a State or local water-supply forecast gage**.**
0 points--All other gages.

Goal 3--Support Colorado Water Administration and Management

3 points--Gage is a National Streamflow Information Program (NSIP) 'Compact or Border' gage or is needed to administer water to meet interstate compact requirements.
2 points--Gage is critical for water administration or is a key gage for water administration within a water division.
1 point--Gage is used for water administration or is important for water administration within a water district.
0 points--All other gages.

Goal 4--Support Streamflow Gages for Determination of Trends in Flow

3 points--Gage is an NSIP 'Sentinel' gage (monitors streamflow in response to changes in climate, land use, and water use in largely unregulated basins), or is one of up to 3 gages per major river basin, and no more than one gage per tributary to a major river, that has < 5% of the gaged flow in annual diversions into or out of the stream, and has > 25 years of record.
2 points--Gage has > 50 years of record, regardless of diversions.
1 point--Gage has > 25 years of record, regardless of diversions.
0 points--All other gages.

Goal 5--Support Water-Quality Networks in Colorado

3 points--Gage is an active site in a USGS National water-quality network or the USGS Idealized Statewide Surface Water-Quality Network (see attached description of concepts for this network).
2 points--Gage is an active site in a long-term water-quality network operated by USGS in Colorado or an inactive site in the USGS Idealized Statewide Surface Water-Quality Network.
1 point—Gage is an active site in a long-term state or local water-quality network operated by others.
0 points--All other gages.

Pilot Synoptic Assessment of the Roaring Fork River near Aspen, Colorado

A Snapshot of Low Flows in 2012

August 12, 2012

Prepared for Friends of Rivers and Renewables and the Roaring Fork Conservancy

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A Snapshot of a Distressed River: The Roaring Fork River in Aspen, Colorado

On July 25 - 27 of this year, Friends of Rivers and Renewables and the Roaring Fork Conservancy completed a pilot synoptic flow assessment on a reach of the Roaring Fork River through Aspen. The following Overview covers several aspects of this work, including:

- What information it can provide
- Why a synoptic snapshot was done on the Roaring Fork this year
- How can this information be best communicated to non-experts

What is synoptic sampling and what information can it provide?

Synoptic sampling provides a moment-in-time snapshot of a watershed segment by taking many samples from different locations on a single stream in a short time period. This effectively creates an overall picture of the system. The practice is employed often in water chemistry studies, for example, to understand dissolved metal loading to a stream in a mining-affected area, or nutrient loading in agricultural-influenced streams. Overall, the goal is to link changes in water quality to specific locations on the land, such as a point source input and non-point source. Point sources are easily identifiable, discrete contributions of a pollutant to a waterway, such as an industrial outflow pipe, or a draining mine tunnel. A tributary stream adding large volumes of muddy water to a river would also be considered a point source; in this case the pollutant would be sediment. Non-point sources are generally dispersed geographic locations, such as agricultural fields or a large area of one particular land-use type such as logging.

Instead of looking at where and how particular pollution sources alter stream water quality, the goal of a synoptic discharge study is to understand how various diversions, return flows, and tributaries, affect the actual discharge of a stream on a longitudinal (upstream-to-downstream) profile. The resulting information should communicate how human 'plumbing' of a natural stream system can locally affect the flows, and by extension, the health of local aquatic communities of fish and macroinvertebrates. In this setting, the information also provides strong confirmation for identification of gauge sites that best-characterize where low flows and instream flow rights (ISF) could optimally be measured.

Why was this assessment done?

The Roaring Fork River faces numerous pressures including loss of flow from trans-basin and local diversions, loss of riparian habitat and floodplain due to development and urbanization, and potentially impaired water quality from a variety of sources. One of the most significant issues faced in the upper portion of the river is low flows. Nearly 40% of flow in the upper basin is diverted east into the Independence Pass Transmountain Diversion System to augment supplies for Front Range user each year (Clarke et al 2008). Once the river reaches the City of Aspen, additional significant diversions occur to meet the needs of municipal users and irrigators.

This year is notable for drought, with a particularly weak snowpack and runoff which has resulted in very low flows by mid-summer. Impacts from regional and local diversions are especially visible to people, and increasingly stressful to stream health in aquatic species like fish and macroinvertebrates. By conducting this pilot assessment, the portions of the river which are most vulnerable to low flow impacts can be identified and highlighted to the public. It is hoped that this can provide motivation and focus to continue working towards innovative conservation and resource management solutions for the waterways of the Roaring Fork Watershed. Solutions which both meet the needs of human communities yet still ample provide water in our streams to maintain healthy and resilient river systems, with the many economic and social benefits that such systems clearly provide.

Limitations and assumptions for synoptic sampling

In a practical sense, the number of samples is limited by the transactional costs of travel to different sites and the actual time required taking a sample. Performing a synoptic sample for chemistry can occur relatively quickly in mountain watersheds because grab sampling requires only a little time at each site. In a synoptic flow study, the creation of a snapshot of discharge throughout a reach is limited by the time it takes to perform each discharge measurement, which can be upwards of one to two hours, and the amount of personnel available to perform the measurements. Information gained from synoptic sampling is useful under the assumption that it is a snapshot of a temporarily static and unchanging system, a frozen moment in time. As the total time to collect flow measurements increases, this assumption becomes less and less valid and the information gained begins to lose some value in terms of accurately describing the stream system. At different times of year in the Rockies, this assumption of unchanging flows during sampling may be more or less justifiable.

Streamflow in Colorado's mountain rivers exhibits a snowmelt-driven hydrology. Rivers experience large peaks in May and June when the snowpack is melting, taper throughout the summer, and experience low flows in the fall and winter. Most people living near mountain streams are familiar with this yearly cycle. Many are also familiar with the daily rise and fall of streams during the spring snowmelt as intense diurnal heating of the snowpack alternates with cooler nights. Later in the summer, once the North American Monsoon weather pattern establishes in the southern Rockies, streamflows may show short-term increases due to heavy localized rainfall. Some streams can even show a small decrease in flow during daytime hours due evapotranspiration of nearby plant communities on the banks. The assumption of static and unchanging flows that underlies synoptic sampling would be hard to support during the diurnal fluctuations of water in spring, or during a round of heavy afternoon thunderstorms in the summer. Generally, late summer and fall flows during stable weather should be good times for a synoptic discharge effort.

Site Selection

The two reaches of interest in this effort were the Roaring Fork River through the City of Aspen from Difficult Creek to the Airport Business Park, and Maroon Creek from the Forest Service Boundary to the confluence with the Roaring Fork. Sample sites for flow measurements in each stream were picked specifically to bracket significant inflows and outflows. Which inflows and diversions were considered important was based on local knowledge and expert judgment of parties familiar with the two sections.

Significant inflows to the Roaring Fork River on the reach between Difficult Creek and the Airport Business Park are generally tributary creeks, although a few irrigation return-flows may increase flow in a measureable amount. The main inflows include Hunter Creek, Castle Creek, and Maroon Creek. Headgate diversions into municipal and irrigation ditch systems are the main outflows in this area. Such diversions can date back over a century to Aspen's origin during mining boom times, and may be only a few cfs, to well over 50cfs. The main outflows identified starting above town are the Salvation Ditch, with a decreed absolute rate of 59 cfs; and the Wheeler Ditch, with a right of 10 cfs. The situation on Maroon Creek is similar in structure. Significant inflows include Willow Creek, as well as the return-flow canal of the existing Maroon Creek hydroelectric plant. Significant outflows included the Maroon Ditch, which diverts for two water rights totaling around 90 cfs; and the Stapleton Brothers Ditch, with rights up to 16 cfs.

It is important to note that these numbers are the Absolute Rate (in cfs) listed by the Colorado Department of Water Resources through their web portal for a particular diversion, they do not reflect the actual amount of water being diverted at the time of this effort, or any other private agreements regarding a particular water right and diversion amounts. In reality, most of these diversions were likely not diverting maximum allowable amounts during sampling due to temporal constraints on the water right, and constraints from actual available stream flows in July of 2012. The numbers are useful primarily to understand the relative size and importance of different diversion structures on the study reaches.

Other natural processes may be responsible for changes in discharge on a particular reach. In particular, groundwater processes in which water moves towards or away from the surface channel may occur throughout the area. A reach of stream on which surface flow is moving out of the channel and into the surrounding groundwater is known as a *losing reach.* These often occur in mountain streams segments where the valley and flood plain is wider and geologically comprised of highly porous gravels and sand called alluvium. Conversely, where groundwater is exiting the subsurface and adding to stream flow with no visible surface source, the segment is called a *gaining reach*. These may occur where a valley constricts or due to an underlying geologic structure such as a fault or aquifer that is cut across by the stream channel. While portions of the Roaring Fork and Maroon Creek are likely both losing and gaining reaches, these contributions to stream discharge are assumed to be negligible here.

Measuring Flow

Discharge information was collected at a total of 9 sites on the Roaring Fork. Of those sites, 6 were manually collected and 3 were provided by existing USGS gages. On Maroon Creek, 6 sites were measured. Discharge from two sites on Hunter Creek and one on Castle Creek was available from existing USGS and CDWR gages; an additional measurement was collected above the mouth of Castle Creek. From these sites, a discharge measurement could be supplied both above and below the major inflows and outflows listed above.

Discharge was measured using the velocity-area method outlined in USGS Techniques and Methods 3-A8 (Turnipseed and Sauer 2010) with a handheld Sontek Flowtracker Acoustic Doppler Velocimeter provided by the Roaring Fork Conservancy. Many site selections on the steep and rocky reaches of the

Roaring Fork and Maroon Creek were only fair-to-good, which increased potential error for each measurement. Measuring discharge using the velocity-area method is based on several assumptions including uniform flow in a downstream direction at a regular-shaped ideal cross section. The swift and turbulent nature of mountain streams created by steep slope and large boulders can push the boundaries of these assumptions. Even with these difficulties, discharge measurements can still provide reasonable estimates of flow, provided that the instrument and method's error and limitations are well understood.

No thunderstorms of large significance were noted in the area on the dates of sampling, including the Maroon Creek, Castle Creek, and Hunter Creek subwatersheds. In prior conversations with local water administrators, it was felt that water right calls were not actively going on and off locally, most significant water rights with seniority in the area would be actively diverting, and the diversion levels would not be subject to short term changes at the headgates. This supported the assumption of static or nearly-static flow conditions during the sample period.

For each site, a distance downstream from the topmost site (Difficult Creek on the Roaring Fork, and the USFS Boundary on Maroon Creek) is listed. This estimate was determined using Google Earth © by tracing a line down the center of each river on the satellite photograph when zoomed in to a virtual elevation of less than 2500m above the surface. The Elevation Profile tool in the software was then used to trace the path and record a downstream distance in meters for sample sites and inflows/outflows. Distances are rounded to the nearest 10 meters.

Data Summary

The accompanying data spreadsheet records the flows measured at each site. The site code is the 8 letter site name entered into the Flowtracker instrument. For each site a brief description is included that identifies more fully where on the reach the measurement occurred. The UTM coordinates were measured using either a handheld Delorme PN60 GPS unit, or via aerial images in Google Earth©. Temperature measurements are made by the Flowtracker and averaged for each site. The remaining attributes for each site are statistics calculated by the Flowtracker software that describe various sources of error, and measured channel geometry. A full description is not warranted here, but they may be used to assess aspects of the quality of the discharge measurement at a particular site.

Roaring Fork flows varied from a low of 5 cfs near Mill St where a large portion of the flow entering town has been diverted, to a high of 147 cfs below the combined outputs of Castle and Maroon Creek. Maroon Creek flowed at 52 cfs at the Forest Boundary, declined to 19 cfs between the Maroon Ditch and the hydrolelectric return canal, and reached a maximum of 63 cfs at its mouth. For measured flows at all sites, see Table 1 below.

Stream	Desc	Discharge, cfs	Distance from Site 0
Roaring Fork	Above Difficult Creek	11	0
Roaring Fork	Above Salvation Ditch on Stillwater Road	25	5.4
Roaring Fork	Aspen Club below Salvation and above Wheeler ditches	7.6	6.55
Roaring Fork	Mill St Bridge	5.2	8.72
Roaring Fork	At footbridge to Music Tent and Aspen Institute	18	10
Roaring Fork	Above Castle Creek Confluence	14	10.8
Roaring Fork	At Stein Park	71	11.9
Roaring Fork	Above Maroon Creek confluence (below Slaughterhouse Rapid)	60	13
Roaring Fork	Below Maroon Creek and Aspen WTP	147	14.4
Maroon Creek	USFS Boundary	52	0
Maroon Creek	Above hydroelectric return canal	19	3.08
Maroon Creek	Bridge on MC Road past Highlands	50	3.4
Maroon Creek	Above Stapleton Ditch	57	4.6
Maroon Creek	Below Stapleton Ditch	56	4.88
Maroon Creek	Mouth	63	8.12
Castle Creek	Above Power Plant Rd	30	
Castle Creek	Mouth	38	
Hunter Creek	Above most diversions in red canyon section	18	
Hunter Creek	Just above confluence with Roaring Fork	3.0	

Table 1 Flows measured July 25-27 on the Roaring Fork and select tributaries

How will this information be communicated?

To aid in visual interpretation and communication of results to non-experts, flow information was incorporated to a GIS for map creation. The study reaches were broken into segments based on locations of inflows and outflows, and discharge values measured at discrete sites were assigned to the entire segment. An important assumption was made here: when two segments of the river differ in discharge, that difference is assumed to come *entirely* from an inflow or outflow. Essentially, any large changes in discharge are credited either to one of the large tributary inflows previously mentioned, or one of the significant diversion outflows. Other processes such as groundwater inflows and outflows that either increase or decrease flow may certainly be occurring on a particular segment. For example, where no major tributaries or diversions are present on a stream segment, and differences in discharge are observed, these differences might be reasonably attributed to unmapped tributaries and diversions, groundwater influences, and the range of error inherent in taking discharge measurements in steep rocky streams. In general, these processes are likely minor compared to the amounts of water added or lost from major tributaries and ditches.

The accompanying map depicts the Roaring Fork study reach. Existing USGS and CDWR gages are marked and labeled. Major diversions of 10 cfs or more are labeled with their absolute decreed rate in cfs. Again, this is the legal right, not the rate that was actually being diverted during the synoptic sample. The width of the blue streamline is proportional to the measured flow in that segment. For

example, downstream of the confluence with Maroon Creek, the Roaring Fork River had 147 cfs and the line depicted is very thick. Where the river was measured at only 5 cfs through the downtown area, the line depicting the stream is proportionally very thin. The *only* streams for which this proportional representation is used are the Roaring Fork, Maroon Creek, and Castle Creek. These are the streams for which actual gaged or USGS discharge information was available. Additionally, the figure below shows how discharge varied with downstream distance. This is referred to as a *longitudinal profile*.

For both study reaches, an Instream Flow right (ISF) exists. It is 32 cfs for the Roaring Fork, and 14 cfs for Maroon Creek. The ISF is depicted by a yellow line proportional in thickness to the amount of the right. Where the measured streamflow was less than the ISF, the line is clearly visible. The downtown reach is one example: here the river was flowing at 5 cfs between the Salvation/Wheeler ditch diversions and hunter creek, while the ISF is for 14 cfs. Because the ISF program began in 1973, these rights are often junior to others and do not guarantee a minimum flow for a given reach.

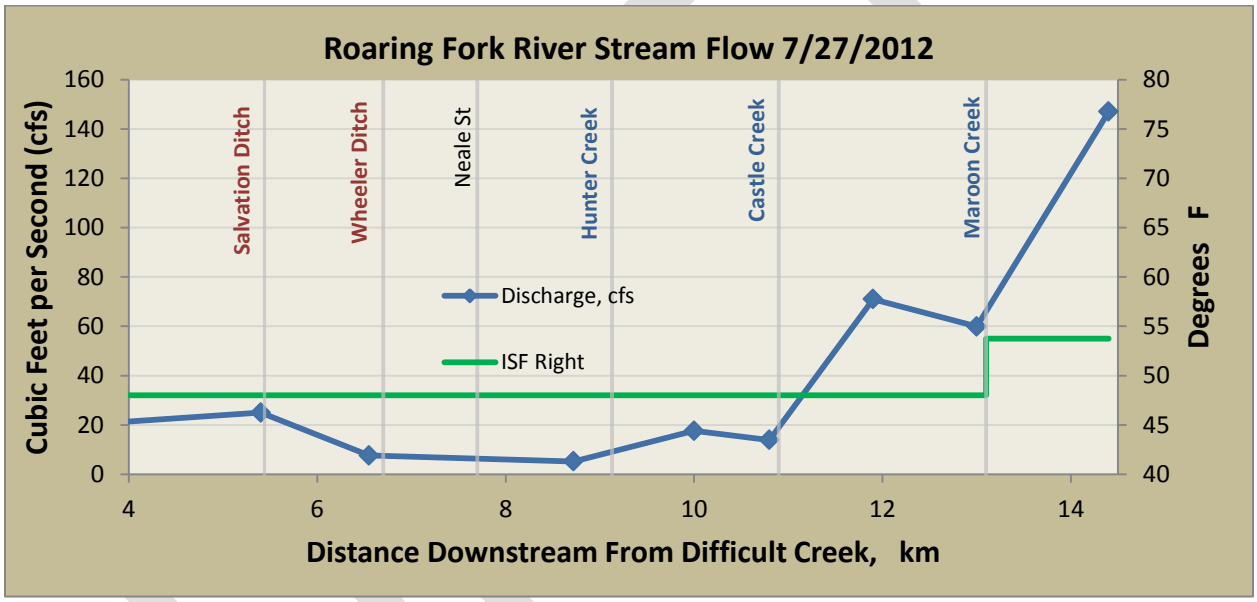
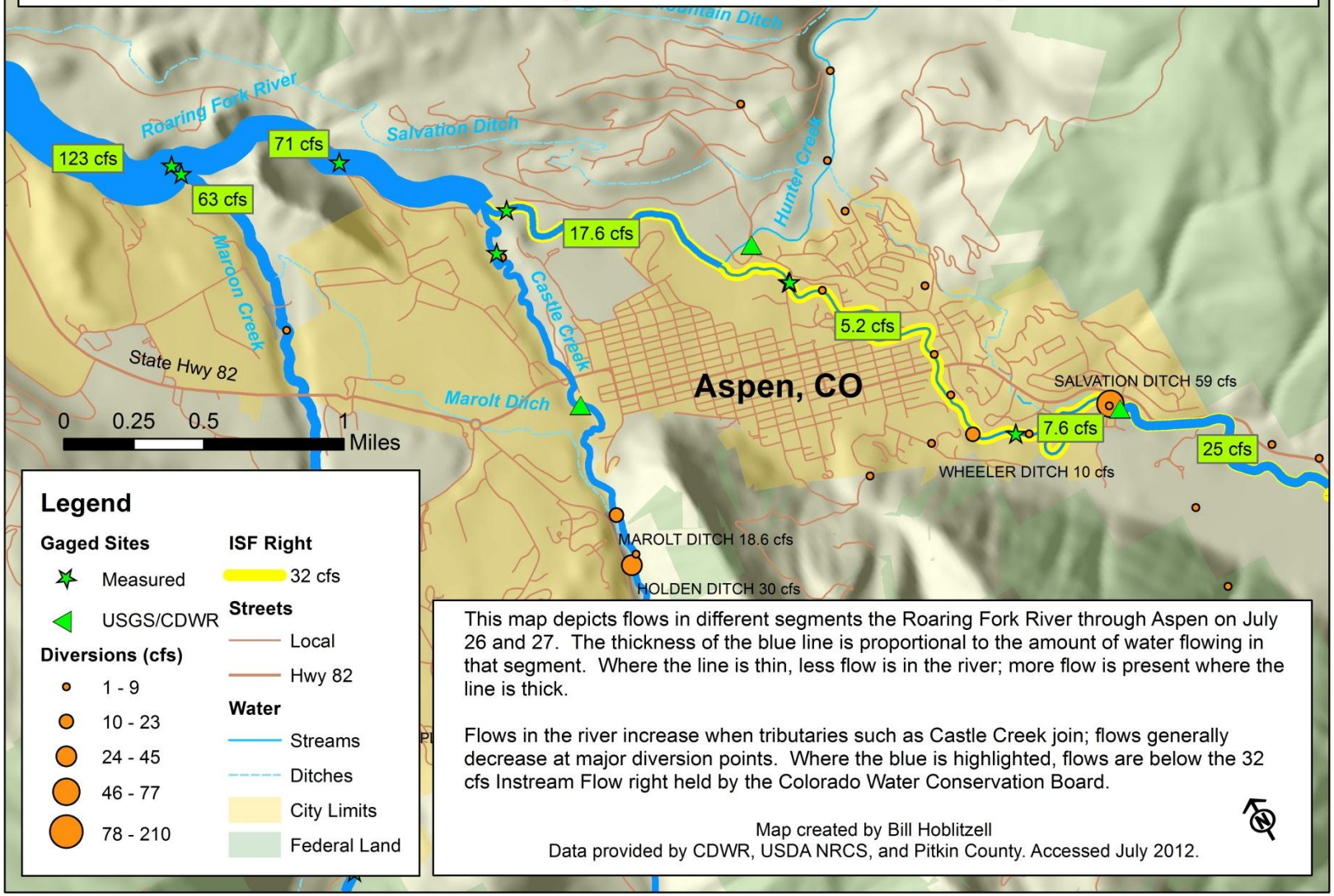


Figure 1 Longitudinal Profile of flows on the Roaring Fork starting below Difficult Creek

A Snapshot of Roaring Fork River Flows In Late July 2012



This map depicts flows in different segments the Roaring Fork River through Aspen on July 26 and 27. The thickness of the blue line is proportional to the amount of water flowing in that segment. Where the line is thin, less flow is in the river; more flow is present where the line is thick.

Flows in the river increase when tributaries such as Castle Creek join; flows generally decrease at major diversion points. Where the blue is highlighted, flows are below the 32 cfs Instream Flow right held by the Colorado Water Conservation Board.

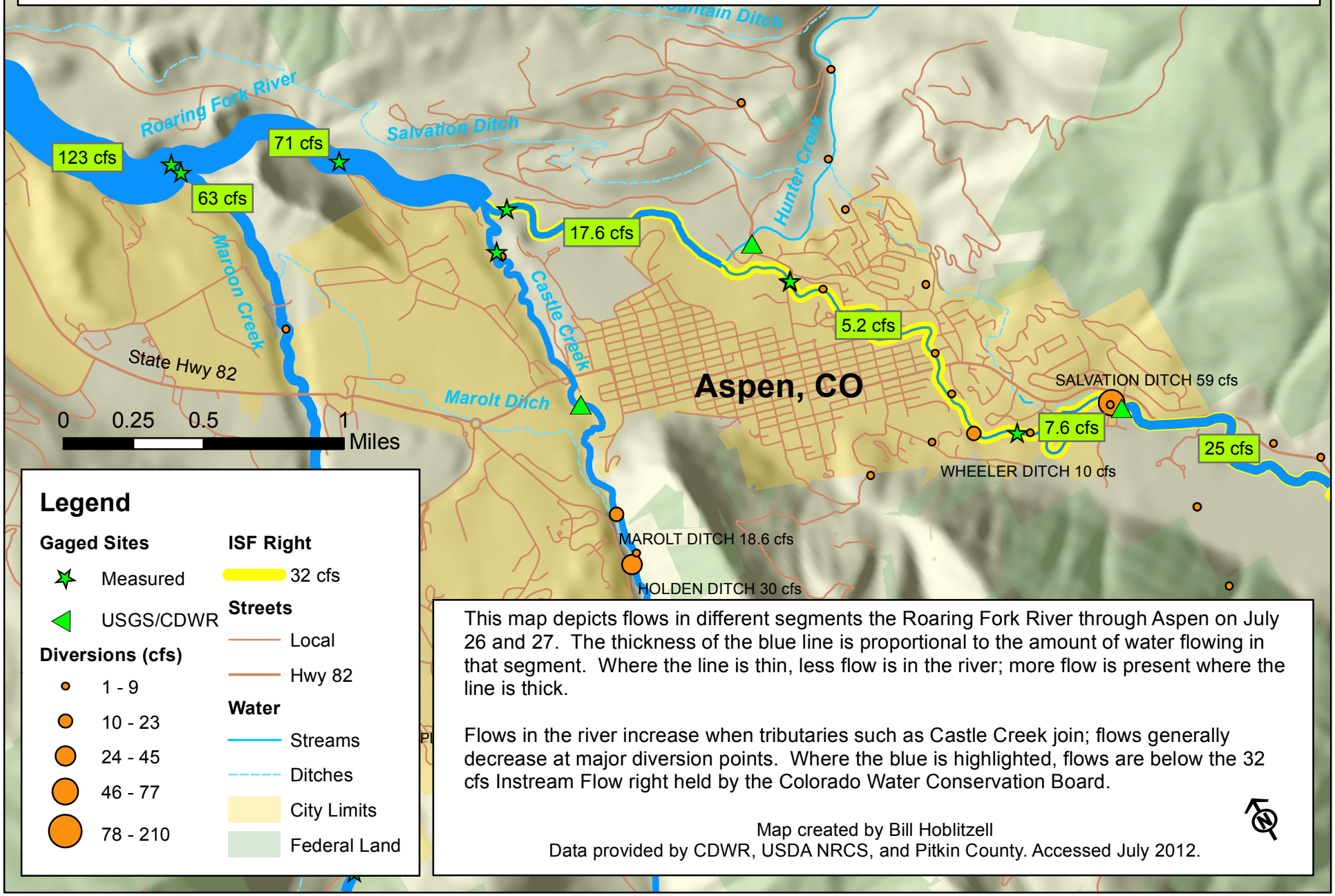
Map created by Bill Hoblitzell
Data provided by CDWR, USDA NRCS, and Pitkin County. Accessed July 2012.

References:

Clarke, S., K. Crandall, J. Emerick, M. Fuller, J. Katzenberger, D. Malone, M. Masone, A. Slap, and J. Thomas. 2008. State of the Roaring Fork Watershed Report 2008. Sponsor: Ruedi Water and Power Authority. Lead Consultant: Roaring Fork Conservancy. http://www.roaringfork.org/watershedplan.

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. (Also available at http://pubs.usgs.gov/tm/tm3-a8/.)

A Snapshot of Roaring Fork River Flows In Late July 2012



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Map created by Bill Hoblitzell
Data provided by CDWR, USDA NRCS, and Pitkin County. Accessed July 2012.

Seth Mason, M.S.
Principle, S.K.Mason Environmental, LLC
Email: seth@skmason-envi.com
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Seth Mason provides a breadth of environmental data services and guidance in watershed monitoring and evaluation.

Summary

Seth's approach to environmental consulting reflects professional experience gained in both academia and the private sector. He brings a broad technical expertise and a firm commitment to scientific problem solving, whether engaged in field data collection or complex quantitative analysis. Seth aims to provide clients with high-quality data tools and interpretations to aid in development of public policy and watershed-scale natural resource use solutions. As populations in western states continue to boom, anthropogenic impacts on natural ecosystems are likely to increase in both frequency and magnitude. The continued development of water and land resources and the growth of human populations in many watersheds leave many local governments and stakeholder groups seeking to improve their understanding of interactions between human and natural environments and subsequent affects on watershed hydrology, ecology, and biogeochemistry. Seth provides a breadth of environmental data services to help elucidate such interactions and to assist local organizations and municipalities implement strategies that maintain high levels of environmental quality and provide for long-term stewardship of our local places.

Seth commands a diverse technical skill set, strong leadership, interpersonal, and communication skills, and a broad knowledge base for considering the multi-faceted nature of natural resource management issues. He is practiced and effective at engaging stakeholders and presenting technical material to diverse audiences in a variety of formats. He is also adept at working independently or collaboratively to implement various phases of natural resource project management, including: problem identification, environmental data collection and management; quantitative data analysis; synthesis of results; and technical reporting. Seth has twice been recognized by the American Water Resources Association, Montana Section for excellence in his presentation of technical material.

Seth's recent projects include: data management, liaison, and software development activities in support of a multi-year National Science Foundation funded effort to develop a state-of-the-art cyber-infrastructure for the collation and management of environmental data, and the development and execution of a multi-phase research project investigating the effect of large-scale stream restoration activities on groundwater-surface water exchange. Seth currently serves on the Board of Directors of Eagle Mine Ltd., a non-profit established to monitor the Superfund cleanup efforts at the Eagle Mine Site near Red Cliff, Colorado.

Education

M.S. in Land Resources and Environmental Sciences, Montana State University
Focus: Groundwater/Surface Water Interactions, Solute Transport, Stream Restoration
Thesis: Hydrologic response to channel reconfiguration on Silver Bow Creek: Science to inform the restoration process

Bachelor of Arts and Sciences, University of Colorado-Boulder
Major: Environmental Studies
Emphasis: Environmental Sciences Water Track

Technical Skills

Field Equipment Proficiencies

Solar array and battery bank setup
Meteorological tower set-up
Radio telemetry communication systems
Familiar equipment setup and usage:
- Campbell Scientific CR1000, CR10X, and CR10 dataloggers
- Campbell Scientific water quality and meteorological probes (assorted)
- Hach Hydrolab multiprobes
- YSI multiprobes
- Turner 10-AU and Cyclops fluorometers
- RDI Acoustic Doppler Current Profilers
- Survey-grade GPS equipment
- Mapping-grade GPS equipment

Methodological Proficiencies

Stream discharge measurements (ADCP, dilution gauging, velocity-area techniques)
Solute transport characterization
Synoptic stream temperature gauging
Stream metabolism assessment
Hydrological modeling
Geostatistical analysis
Bathymetric mapping

Programming and Computing Proficiencies

Python
ArcGIS
Matlab
Excel
R
Loggernet, CR-Basic, and Edlog (Campbell Scientific)

Selected Project Experience

Eagle River Watershed Monitoring and Assessment Program. *Program Coordinator.* Coordinated monitoring and assessment activities, provided data interpretation and technical assistance to stakeholders, identified data gaps, and suggested actions to remedy perceived impairments. Specific activities included: compilation of annual reports assessing current water quality conditions and changes in the trajectory of those conditions; organization and coordination of watershed-wide data collection maximize spatio-temporal efficiency of those efforts; engagement of stakeholders and the general public to support community-wide understanding of water quality issues; provision of technical assistance to program partners; identification, coordination and support of a common data repository for archiving and sharing water quality data; and development of a long-term water quality monitoring plan. 2011-Current.

NSF-EPSCoR Track II, VOEIS, MT. *Research Associate/Data Manager.* Managed and maintained water resource and environmental field experiment data in support of empirical and modeling analysis. Duties included: development of a database to collate and monitor data collected via research projects; implementation of an information system for data management and publishing;

administration of individual/group meetings to harvest data from individuals and archives; developed protocols for dealing with streaming time series data; provided user training for the Virtual Observatory and Ecological Informatics System (VOEIS). 2011-Current.

Silver Bow Creek Monitoring Project, MT. *Co-Principle Investigator, Project Manager, Graduate Research Associate.* Developed, secured funding for, and executed a multi-phase research project focused changes in stream hydrologic and ecological processes resulting from large-scale restoration activities that altered the structure of the streambed on a federal Superfund site. Compiled technical reports for state and federal agencies. Presented research findings to diverse audiences with varying levels of technical expertise. Submitted findings for publication in a respected academic journal. 2008-2010.

FLOWSED/POWERSED, CO. *Hydrologist Field Technician*. Gathered and compiled bedload and suspended load sediment transport field data. Assisted in initial analysis of data for development of the FLOWSED and POWERSED sediment transport models. 2005.

MSU Sustainability, MT. *Campus Sustainability Advisory Council Advisor.* Assisted in development of institutional structures to facilitate, guide, and implement sustainable initiatives on the Montana State University Campus. Assisted in organization of community events, hosted/led meetings and discussions, edited, compiled and posted relevant content on a web-based public information clearinghouse. 2008.

Publications and Presentations

Mason, S.J.K., B.L. McGlynn, and G.C. Poole. 2012. Hydrologic response to channel reconfiguration on Silver Bow Creek, Montana. Journal of Hydrology 438-439: 125-136. DOI: 10.1016/j.jhydrol.2012.03.010.

Mason, S.J.K., Cleveland, S., Izurieta, C., Llovet, P., Poole, G.C. (2012) The Virtual Observatory and Ecological Informatics System (VOEIS): Using RESTful architecture and an extensible data model to provide a unique data management solution. Spring Runoff Conference (April 3-4, Logan, UT).

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2010). Hydrologic behavior in restored streambeds: Does function follow form? Montana Section AWRA Conference (October 14-15, 2010).

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2010). Assessing hydrologic response to channel reconfiguration. NABS/ASLO Annual Conference (June 6-12, 2010).

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2010). Assessing hydrologic response to channel reconfiguration. RRNW Annual Symposium (February 1-4, 2010).

Mason, S.J.K., B.L. McGlynn, and G.C. Poole, (2009). Assessing groundwater-surface water interactions before and after stream channel reconstruction: science to inform the restoration process, Silver Bow Creek, Montana. Montana Section AWRA Conference (October 1-2, 2009).

Employment History

9/11-Present **Owner/Principal**, *S.K.Mason Environmental, LLC, Carbondale, CO*

3/11-Present **Research Associate/Data Manager**, *Montana State University, Bozeman, MT*
Managed and maintained water resource and environmental field experiment data in support of empirical and modeling analysis.

9/07-11/10 **Co-Principle Investigator and Graduate Research Assistant**, *Montana State University, Bozeman, MT*
Managed a multi-phase research project focused changes in stream hydrologic and ecological processes resulting from large-scale restoration activities.

5/05-8/05 **Hydrologist Field Technician**, *Wildland Hydrology, Pagosa Springs, CO.*
Gathered and compiled hydrological field data. Assisted with data analysis.

Additional Leadership Experience

1/12-Present **Leadership Committee Member**, *Colorado Water Quality Monitoring Council*

1/12-Present **Technical Advisory Committee Member**, *Colorado Water Quality Monitoring Council*

10/11-Present **Sports and Competition Committee Member**, *International Rafting Federation*

5/10-Present **Treasurer,** *United States Rafting Association, Minturn, CO*
Managed fundraising activities and sponsorship funds. Wrote grants for procurement of funds to support general operations. Interacted with a board of directors, president, vice-president, and secretary to develop both long-term organizational strategies and individual events.

4/07-Present **Member**, *U.S.A. Men's Whitewater Raft Racing Team*

8/07-05/08 **Graduate Teaching Assistant**, *Montana State University, Bozeman*.
Led and/or assisted with classroom lectures, answered questions from students, led study sessions, graded student work, and managed class grade sheets for courses in Soil Resources, Holistic Management, and Soil Remediation.

6/06-08/10 **Guide Instructor/Trip Leader**, *Lakota Guides, Vail, CO.*
Supervised 1-6 guides on multi-boat trips. Worked independently in a high-stress, high-risk environment on single boat trips. Guided clients on class III-V whitewater trips on the Eagle, Arkansas, and Colorado rivers. Instructed raft guides in various aspects of whitewater rafting safety including: interpersonal communication, risk management, conflict management, river hydraulics, hazard recognition/avoidance, emergency protocols, and whitewater swimming.

CV: Bill Hoblitzell **bill@skmason-envi.com (970) 471-6216**

Synopsis

Bill's interest is in developing and supporting collaborative solutions to environmental problems by utilizing sound science and science-communication to provide high quality information for natural resource management decision makers. He has a strong knowledge base in hydrology, stream ecology, and environmental policy; with proficiencies in aquatic geochemistry, and spatial data collection and presentation. Bill is familiar with multidisciplinary aspects of watershed science including field methodologies in physical hydrology, chemical and biological water quality sampling and monitoring, and geospatial data collection and analysis. His goal is to apply this diverse skill set to help implement effective and innovative management of water resources in mountain communities.

Experience

Environmental and Conservation

Present	**Hydrology technician, GIS technician**, S.K.Mason Environmental, Carbondale CO
Present	**Interim Volunteer and Outreach Coordinator,** Eagle River Watershed Council, Avon CO
2011	**Water quality intern,** Coal Creek Watershed Coalition, Crested Butte CO

Teaching

2010	**Graduate Teaching Assistanceship**, Northern Arizona University, Flagstaff AZ
2008	**K-6 Place-based science educator**, Montana Outdoor Science School, Bozeman MT

Outdoor, Leadership

2006-10	**Operations manager, Lead guide trainer**, Lakota River Guides, Vail and Granite, CO
2007-8	**Emergency medical education trainer**, **Avalanche forecasting and mitigation**
	Technical rescue trainer, Moonlight Basin Ski Patrol, Big Sky MT

Education

In progress, expected completion in December 2012:

M.S. Environmental Sciences and Policy, Northern Arizona University
Program focus: Watershed sciences, science-policy communication
Thesis: A spatial characterization of dissolved metal load sources to the Dolores River from legacy hardrock mining activities in Rico, Colorado

Graduate Certificate in GIS, Northern Arizona University

2002 **B.A**. Environmental Science, Hydrology and Geology concentration, University of Virginia
B.A. Economics, University of Virginia,

Awards Wyss Scholar for the American West, 2011

Technology ArcGIS, QuantamGIS, MS suite (Excel, Word, Powerpoint)

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PROFESSIONAL FIELDS
Regional Geography, Water Resources, Geographic Information Systems (GIS)

EMPLOYMENT
Roaring Fork Conservancy, Basalt, CO, Director Land and Water Conservation (1/2012-present), Water Resource Specialist (5/2004-2012)

- Spearheading implementation of the *Roaring Fork Watershed Plan*, including
  - Overseeing a major restoration project in Coal Basin, and
  - Working to implement water conservation recommendations from Roaring Fork Conservancy's recently published *Opportunities for Water Conservation* report.
- Collaboration and coordination with local, state and federal government agencies, stakeholders, to pursue approaches for achieving sustainable stream flows, healthy water quality, and riparian and instream habitat,
- Writing and coordinating national, state, and local grants to fund research and application projects in the Roaring Fork Watershed, and
- Participation in outreach and development activities of the Conservancy.

Forest Science Dept., Oregon State University, Corvallis, OR, Senior Faculty Research Assistant (6/97 – 9/2004)
- Coordinated and conducted Geographic and GIS analyses for the aquatic component of the Coastal Landscape Analysis and Modeling Study (CLAMS).
- Member of the Oregon Plan for Salmon and Watersheds Monitoring Team. Co-author Riparian Assessment Framework Document.
- Initiated and led the Forestry Community's GIS/Remote Sensing (RS) group, consisting of members from OSU Forestry Department; PNW Research Station; Forest and Rangeland Ecosystem Science Center, Biological Resources Division, USGS; and Oregon Department of Fish and Wildlife.

Forest Science Dept., Oregon State University, Corvallis, OR, Faculty Research Assistant (90 - 6/97).
- Defined landscape-level ecological regions for anadromous fish habitat for watersheds in the Blue Mountains, Columbia Plateau, and Coast Range ecoregions.
- Developed and maintained a database of historical stream physical habitat from the 1940's for the Columbia Basin.
- Analyzed spatial and temporal patterns of anadromous fish habitat in the Columbia Basin and Coast Range, OR using Arc/Info.

- Identified critical watersheds in Oregon with the Watershed Classification Committee, Oregon Chapter of the American Fisheries Society.

NSI Technology Services Corp. (contractor to Environmental Protection Agency), Corvallis, OR, Senior Scientist (87-90), Scientist (85-87), Associate Scientist (83-85).

- Determined ecoregions of Oregon for the Oregon Department of Environmental Quality.
- Aided in the design of a sampling framework for selecting lakes and streams to assess status and trends in water quality.
- Mapped historic changes in land use/land cover which may be related to alkalinity of surface waters.

The Wilderness Society, Seattle, WA, Consultant (89-90).

- Produced maps showing the extent of old growth at several points in time for the Olympic National Forest.

Environmental Remote Sensing Applications Laboratory (ERSAL), Oregon State University, Corvallis, OR, Graduate Research Assistant (82-83), State classified, lab technician (81-82).

- Developed statistical analysis procedures for the study of the relationship between spectral classes and elk utilization of different habitats as documented by observation.
- Interpreted and mapped filbert orchards from color infrared aerial photography.
- Estimated burned acreage using aerial surveys, photo interpretation, and field surveys.

SELECTED PUBLICATIONS AND REPORTS

Clarke, S. M. Fuller, and R. Sullivan. 2012. Roaring Fork Watershed Plan. Sponsor: Ruedi Water and Power Authority. Lead Consultant: Roaring Fork Conservancy.

Clarke, S., K. Crandall, J. Emerick, M. Fuller, J. Katzenberger, D. Malone, M. Masone, A. Slap, and J. Thomas. 2008. State of the Roaring Fork Watershed Report 2008. Sponsor: Ruedi Water and Power Authority. Lead Consultant: Roaring Fork Conservancy.

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implications for conservation. Ecological Applications 17 (1): 66-80.

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McIntosh, Bruce A., James R. Sedell, Russell F. Thurow, Sharon E. Clarke, and Gweynn L. Chandler. 2000. Historical changes in stream habitats in the Columbia River basin. Ecological Applications 10(5) 1478-1496.

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Resume for
CHELSEA CONGDON BRUNDIGE

CHELSEA CONGDON BRUNDIGE is director of *Friends of Rivers and Renewables,* an initiative of ***Public Counsel of the Rockies*** in Aspen, Colorado. She is a writer and producer with ***First Light Films***, an independent film and television company based in Snowmass, Colorado. She is chair of the Water Committee of the Snowmass–Capitol Creek Caucus working to protect biologically-sustainable flows in Snowmass Creek.

From 1986 to 2000 Chelsea worked as a professional in the field of environmental conservation, with the ***Natural Heritage Institute*** in Sausalito, California, and more recently as a senior water resource specialist with the ***Environmental Defense Fund*** in California and Colorado. Her work focused primarily on finding cost-effective, equitable and environmentally sound ways to improve the management of western water resources in the Colorado, Sacramento and San Joaquin River basins, the San Francisco Bay/delta, and the Colorado River delta in Mexico. Chelsea was the project director and principal researcher for Environmental Defense Fund's report *"A Delta Once More: Restoring Riparian and Wetland Habitat in the Colorado River Delta"* (June 1999).

Chelsea graduated from **Yale University** in 1982, magna cum laude. She earned a M.A. from the Energy and Resources Group at the **University of California in Berkeley** in 1989. Chelsea currently serves on the Board of *Western Resources Advocates*, a non-profit environmental law and policy organization with strategic programs focusing on water, energy and land in the West.

Chelsea served as a member of the *National Academy of Sciences Committee on the Future of Irrigation* from 1994 to 1996. She also served on the Advisory Board for the *Rocky Mountain Office of the Environmental Defense Fund*, the Board of the *Aspen Valley Land Trust*, the Advisory Board of the *Trust for Public Land*, the President of *COMPASS*, an organization supporting progressive education in Colorado's Roaring Fork Valley.

Chelsea was born and raised in Denver, Colorado and now lives in Old Snowmass, Colorado with her husband James, and two children, Tashi and Miles.

August 2012

AGENDA ITEM SUMMARY

August 16, 2012

TO: River Board

FROM: Lisa MacDonald

SUBJECT: COBB Marketing and Communications

Information: We have been approached by a marketing firm out of Grand Junction who is interested in partnering with Pitkin County to help craft strategic and targeted messaging regarding education efforts to various public entities (ag/business/residential/energy development/etc.) for linking water conservation to a healthy economy. They have worked with other agencies on water conservation initiatives, including DRIP 5-2-1, Ute Water, and the Colorado River District.

They are interested in opening a dialogue with the county for partnership.

Requested Board Action: Informational only.

Attachments: Letter from COBB
Samples of campaigns

Marketing & Communications
DO WHAT WORKS

521 ROOD AVENUE
GRAND JUNCTION, CO 81501

Mr. John Ely
County Attorney, Pitkin County
530 E. Main Street
3rd Floor
Aspen, CO 81611

Dear Mr. Ely,

Living and working in western Colorado, I understand the importance of water as a life-giving resource and as an asset in supporting various industries that provide economic sustainability. It is with great interest that COBB & Associates wishes to partner with Pitkin County to help craft strategic and targeted messaging regarding education efforts to various public and entities (agriculture/business/residential/energy development/etc.) for linking water conservation to a healthy economy.

Our firm has worked with other agencies on water conservation initiatives, including DRIP 5-2-1, Ute Water, and the Colorado River District. COBB has the experience and knowledge to help Pitkin County Healthy Rivers and Streams develop a successful public awareness campaign.

Following are some thoughts for discussion and how we would approach your specific needs for this project. I hope we can meet to start a dialogue on moving forward.

Respectfully submitted,

Sonya

Sonya Foster, Account Executive
COBB & Associates, inc.
Marketing & Communications

521 Rood Avenue, Grand Junction, Colorado 81501

970.257.6813 | Direct line
Sonya@LCAA.com | email

521 ROOD AVENUE
GRAND JUNCTION, CO 81501

Assessment

As confirmed in the *Water and It's Relationship* to *Six Headwaters Counties in Colorado* report by Coley/Forrest, Inc., December of 2011, there is a direct correlation of Western Colorado's water supply to our local and state economies. Noting that tourism jobs comprise of nearly 50% of Pitkin County's jobs and agriculture is 48% of the private-sector land use, it is in everyone's best interest to support a water conservation initiative, or face the alternative of economic repression, decreasing property values, and deteriorating quality of life.

What is your desired result?

When working with the Grand Valley Drought Information Response Project (DRIP), they had one end goal in mind... to still have water running in the canals at the end of the irrigation season. This nonprofit collaborative group was established to heighten awareness around the seriousness of drought, and develop plans to conserve western Colorado's precious and endangered water supply. After the campaign launched, DRIP noticed an increase in website traffic and a revived appreciation for drought awareness. Not only was their main goal attained, but it also yielded more return flow than they originally hoped for.

Set the stage

Because Pitkin County's economic foundation relies so heavily on tourism, your audiences will need to be defined to provide the most benefit for your budget and to leverage messaging. Who are your heaviest users? Are there incentives the County is willing to provide to help reduce consumption and build ongoing awareness?

In addition, are there opportunities for Pitkin County to leverage your budget with other county stakeholders (i.e., environmental nonprofits, city governments, municipalities, private sector businesses)?

Message objective & strategy

Your story concept should reflect relevancy to each of your target markets and accomplish the immediate task of reassurance in the presence of change. Additionally, when considering messaging needs that could potentially range from commitment themes, to environment crisis management situations, a clear understanding of what the effects are if conservation is not a countywide community effort should be the bedrock on which advanced understanding is built.

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Campaign

With target audiences, targeted core messaging, and any additional stakeholder partners in place, the campaign development and timelines are crucial to successful execution. Specific message distribution would be the task of focused planning, however general concepts can set a framework for discussions.

Internal campaigns
Without a doubt, the biggest internal asset local businesses possess in terms of message distribution is its own employee base. Internal messaging campaigns would serve to put that base on the same set of community talking points, extend and encourage civic participation, encourage community dialog, and give a deep and genuine voice to that business.

Traditional media
Traditional print methods can be effective in generating broad general awareness, and should be used to drive online methods. The reach and frequency of traditional print, coupled with strategic targeting and adding a mix of other media such as outdoor, would greatly increase the effectiveness of traditional channels. Earned media (public relation stories and editorial opportunities) would also significantly increase the effectiveness of traditional medias.

Online methods
Use of a blog-type website and social channels should be incorporated the campaign and would most likely represent the best return from relatively low cost methods of message distribution. Once content has been created, its online distribution can be accomplished through the company's own internal resources and with the help of local civic and business partners.

Direct community outreach
Outreach presentations to community, civic and governmental groups provide synergy and momentum. Incorporating the strategic messaging identified previously, and directing presentation materials to create understanding and anchor that messaging, is the primary directive of dialing these opportunities in to your new objective.

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Results tracking

Tracking methods should be established in advance in order to improve the ongoing effectiveness of planning. Simple and inexpensive methods can be established to set benchmarks and gain insights.

Go forward

Budget setting and strategic planning will mark the beginning for permitting results-driven, targeted messaging, copywriting and campaign development, and execution.

Thank you

...for this opportunity to present our firm as your ideal marketing partner. We look forward to more detailed discussions and the opportunity to dial planning in to meet your needs and vision.

About us

We are the largest, most experienced marketing and advertising firm in the region, managing over $3 million in annual marketing budgets. COBB recently earned seventeen state, national and international excellence awards and is consistently rising in ColoradoBiz Magazines rankings for Top 250 Privately Owned Companies and Top 100 Women Owned Businesses.

A second-generation Colorado business based in Grand Junction, many of our clients have been with us, and grown with us, from the time we opened our doors. We present this as a strong testimony to our ability to create effective marketing solutions and happy clients. Since 1970 COBB has been synonymous with the region's best-known brands and most successful companies.

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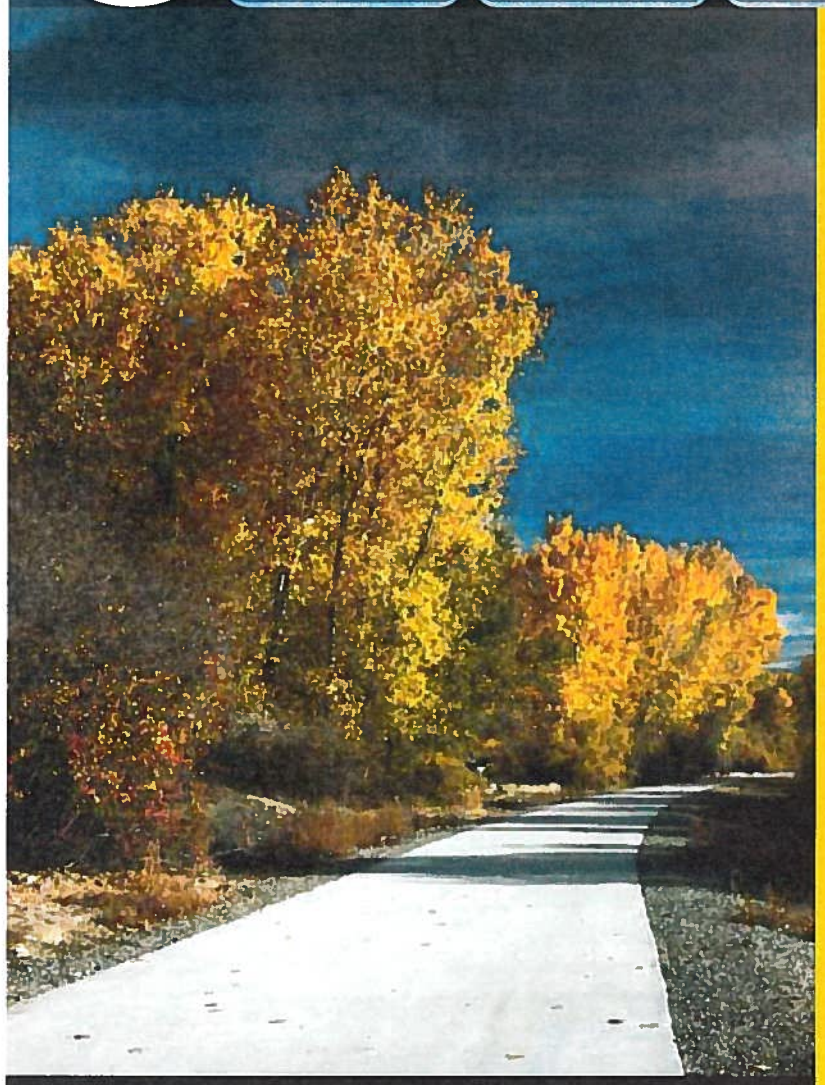
A sampling of our clients

- Cities of Grand Junction, Fruita and Palisade
- Colorado Riverfront Commission
- Delta Economic Development Council
- DRIP 5-2-1
- Eagle County Tourism
- Fruita Tourism
- Gateway Canyons Resorts and Air Tours
- Grand Junction, Fruita and Palisade Chambers of Commerce
- Grand Junction Economic Partnership (current board member)
- Grand Junction Region Airport Authority
- Grand Valley Irrigation District
- Montrose economic Development Council
- Region 9 Economic Development Council
- Western Slope Colorado Oil & Gas Association
- WPX Energy

COLORADO RIVERFRONT COMMISSION

NEWS | EVENTS | TRAILS | DONATIONS | ADOPT-A-TRAIL | CONTACT US | LINKS



A view of the fall colors along the Riverfront Trail.
– photo taken October 2005

NEWS ITEM.
Cdhapf gaupg giopg sjklf kl;;jk hjfghggh;ghjagio gehgpg a hhgh nalpgh fjlpa nejfp b erno[g bna hiofpghfodadfbnoadbn dbnd;bn bndlpbno bhnoei[hnoe[neto[hne njpdg bnetupgh ne; ne geo bhe nbjoa *click to continue to link...*

UPCOMING EVENT.
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UPCOMING EVENT.
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A Word from...
Jacob Jackson, botanist at the Grand Junction Butterfly Museum.
click to continue to link...

While Walking the Trail...
Steve Johnson tells us what kind of wildlife to keep an eye out for on the trail.
click to continue to link...

Future Developments...
Melinda Stewart fills us in on the next steps of the Riverfront's progress.
click to continue to link...

Examine your flowcharts.

DRIP
DROUGHT RESPONSE INFORMATION PROJECT
EVERY DROP MATTERS

Here in the Grand Valley, water is one of our most precious resources.
We need water to keep our Valley and our economy growing.

Smart water use means a better future for everyone.

For more information, please visit the Drought Response Information Project website at:

www.thedripwebsite.com

Conserve water?

Brilliant idea.

Here in the Grand Valley, water is one of our most precious resources.
We need water to keep our Valley and our economy growing.

Smart water use means a better future for everyone.

For more information, please visit the Drought Response Information Project website at:

www.thedripwebsite.com

DRIP
DROUGHT RESPONSE INFORMATION PROJECT
EVERY DROP MATTERS