Colorado Healthy Rivers Fund Grant 2009 - 2010
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FINAL REPORT

Project Sponsor:

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"to protect and restore…"

PROJECT DESCRIPTION AND BACKGROUND

In 2009, the Coal Creek Watershed Coalition (CCWC) was awarded funds from the Colorado Healthy Rivers Fund (CHRF) for four tasks:

Task 1. Groundwater Influences on Coal Creek:

Previous sampling in the Coal Creek Watershed has shown that Coal Creek is contaminated by metals and acidity from the Standard Mine on Elk Creek, a tributary of Coal Creek, as well as from a naturally occurring iron fen and gossan located just west of the Keystone Mine. Drainage from the Keystone Mine, which has been treated at the Mount Emmons treatment facility since 1981, also contributes metals to Coal Creek just downstream of Crested Butte's water supply intake.

To confirm historic sampling results and to locate any other inputs of metals and acidity to Coal Creek, a spatially detailed investigation of contaminant sources was performed by University of Colorado researchers in June 2006 and April 2007. The studies were conducted at high flow (June 2006) and during the period of snow melt in the watershed (April 2007) to complement companion studies conducted at low flow in September 2005.

In September of 2005, Dr. Joseph Ryan of University of Colorado-Boulder (CU-Boulder) conducted the first tracer study in the Coal Creek Watershed. The goal of the study was to characterize the influence of tributary and groundwater sources in the Watershed during low-flow conditions. Dr. Ryan returned again in June of 2006 and April 2007 to conduct similar studies during high-flow and time when early spring runoff occurs.

In 2007, Dr. Ryan was awarded another grant from the Outreach Committee at CU-Boulder to document where metals loading might be occurring during the spring runoff period. The study was completed in a timely manner but the limited funding available for the project was exhausted prior to the completion of the data analysis and generation of the final report. Funds from the CHRF were used to complete the data analysis and finalize the report.

Metal loading tracer-dilution tests on two reaches of Coal Creek allowed for the quantification of both surface and hyporheic flow and provided spatially detailed concentration and metal loading profiles for aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc along a 5.4 km reach of Coal Creek. For the June 2006 study, cadmium and zinc levels exceed acute aquatic life toxicity standards and aluminum, cadmium, copper, lead, and zinc levels exceeded chronic aquatic life toxicity standards. Drinking water supply standards were never exceeded. Most of the exceedances occurred downstream of Elk Creek and the iron gossan tributary. Water draining from the iron gossan near Keystone Mine was identified as the largest metal contributor in the watershed. It was a major source of aluminum, cadmium, copper, lead, manganese, and zinc to Coal Creek. Elk Creek, which carries metals from the Standard Mine drainage, was identified as a major source of cadmium, copper, lead, and zinc.

Splains Gulch was the major source of barium and chromium, which were present at concentrations that did not exceed any standards. The Mount Emmons treatment plant effluent was a minor or trace source of aluminum, copper, iron, lead, and manganese.

The April 2007 metal loading tracer dilution test was conducted on a 2.9 km reach of Coal

Creek stretching from just upstream of the iron fen to just downstream of the Keystone Mine property. Sample from Coal Creek and tributaries were analyzed for aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc. In this stream reach, chronic aquatic life toxicity standards were exceeded by aluminum, cadmium, copper, and zinc. Drinking water supply standards were not exceeded. The exceedances occurred downstream of the iron fen for aluminum, and downstream of the gossan for cadmium. Copper exceedances occurred downstream of the tributary carrying the Mount Emmons treatment plant effluent and drainage from the Keystone Mine property. Zinc exceedances occurred over the entire reach of the watershed encompassed in the study.

The Mount Emmons treatment plant effluent was a major or minor source for all of the metals exceeding the chronic aquatic life standards. The effluent was sampled at near its expected maximum flow rate. For cadmium, copper, and zinc, a Keystone Mine surface drainage that combined with the treatment plant effluent to form an unnamed tributary at stream distance 5.368 km (stream distance datum was the injection point of the September 2005 metal loading tracer test) was a major or minor source. A tributary draining the iron gossan and possibly the western portion of the Keystone Mine property was a minor source of aluminum and zinc. Other iron fen and gossan tributaries were trace sources for all of the metals. Excerpts from the 2006 and 2007 study are shown in the appendices as Tables 11 & 6 presenting loading summaries for the June 2006 and April 2007 studies, respectively. Final versions of the report have also been provided to the CHRF.

FUTURE ACTIONS FOR TASK 1

The CCWC is using the data from the tracer study to help with the total maximum daily load (TMDL) development for Coal Creek. The CCWC supplied the State of Colorado Water Quality Control Division TMDL program with the two tracer study reports and a draft TMDL is expected prior to the end of 2010.

Due to the limited number of sampling locations used during the tracer study, only a limited understanding of groundwater influences of Coal Creek was gained. The purpose of the studies was primarily to determine loading from tributaries. Changes in loading between sampling sites without any surface tributary inputs was too small to attribute to anything but analytical error.

At the Keystone Mine property, contamination from historic mine workings and/or naturally mineralized stormwater affects downstream reaches of Coal Creek. Due to difficulties in differentiating between natural background mineralization and anthropogenic sources of mineralization, the CCWC has been unable to get the property owner or regulatory authorities to treat the mineralized stormwater. Further assessment of groundwater movement and mineralization is critical if this source of mineralization is to be addressed. The CCWC is beginning to pursue additional regulatory means of addressing this issue.

Task 2. Storm water, Magnesium Chloride, and Dust Deposition Assessment:

In 2009, the CCWC contracted with Bio-Environs and SGM Engineering, Inc., to conduct stormwater, magnesium chloride, and dust deposition assessments in Coal Creek. These two contractors and CCWC staff partnered to devise Best Management Practices (BMPs) to reduce chemical and sediment runoff from County Road 12 (Kebler Pass Road). Due to the complexity of the study and to funding limitations, dust deposition was not included in the study design, instead water quality would be used as the indicator for the study.

Steven Bogott, a Environmental Studies student at Western State College and an eight-week AmeriCorps Summer Associate for the CCWC, assisted in defining impacts to storm water runoff from sediment and magnesium chloride. Mr. Bogott collected and analyzed water samples and helped generate data summaries. Water quality samples were collected throughout the summer of 2009, prior to the implementation of BMPs. Intensified monitoring was also conducted during seasonal rainfall events.

Historic data and data from the 2009 study indicate chloride concentrations (Figure 1) are well below the ranges considered to be deleterious to aquatic life by the EPA (250 mg/L). However, there is limited research on supporting the use of these thresholds for aquatic life in Rocky Mountain watersheds. Lack of continuous water quality monitoring during this study allows for the possibility that chloride spikes during, or directly after, precipitation events or early spring snowmelt events that were not documented. Although chloride concentrations downstream of the Town of Crested Butte remain low overall, there is a trend for chloride concentrations at downstream locations in Coal Creek to be higher than upstream locations, indicating some chloride loading to Coal Creek occurs in downstream reaches. This study did not explore method for partitioning contributions from natural and anthropogenic sources. A copy of the final report for the 2009 study has been provided to the CHRF.

In 2009, the CCWC installed a series of rock check dams with sections of stilling basins and reinforced vegetative swales (Figure 2). In June of 2010, CCWC staff, contractors and volunteers removed sediment from the stilling basins rock check dams installed near mile-marker 30 on County Road 12. In all, over 4.9 tons of sediment were removed by this series of rock check dams captured during erosion periods between the fall of 2009 and June of 2010. For modeling purposes, theses estimates should only be used in areas with highly erosive slopes with less than 10% vegetative cover. Though funding from the CHRF is exhausted, additional studies and BMP implementation have continued in 2010 to help further protect the watershed.

FUTURE ACTIONS FOR TASK 2

Based on the findings from this study, the CCWC plans to collect additional field data to validate the chloride values seen in the watershed. Data was collected during baseline conditions (i.e., non-storm conditions) and during storm events and additional data will be gathered to augment the existing dataset and to expand on the effects of rainfall events.

The CCWC will also begin to document chloride in all seasons, including during the rising limb of the hydrograph seen typically in early spring. In May 2010, the CCWC collected eleven samples throughout the watershed during this period. The values shown in Figure 7 are well below the EPA standard of 250 mg/L. However, the CCWC has concerns that a national standard may not be protective for Coal Creek, and will explore options to determine toxicity for local organisms.

During 2010, additional best management practices (BMPs) have been implemented along Kebler Pass Road to reduce sediment and chloride transport to Coal Creek (Figures 3 – 6). These BMP will be assessed to determine sediment capture efficiency. The CCWC will continue to work with the Gunnison County Public Works Department to implement these BMPs and to follow efforts related to road maintenance practices in other parts of Colorado.

Due to concerns with the results from the TSS analyses performed in 2009, additional field data will be collected to develop an understanding of the sedimentation in the watershed. In 2010, the CCWC will switch to using Wollman pebble count methodology to document sedimentation and substrate size class distribution.

The CCWC will also attempt to secure additional funding for macroinvertebrate sampling to ensure the continuity of the data gathered.

Task 3. AmeriCorps/Office of Surface Mining VISTA Member:

The CCWC used funding from the CHRF to secure a Volunteer in Service to America (VISTA) member for the third and final year of support through the Western Hardrock Watershed Team (Team). The Team sponsored in part by the federal Office of Surface Mining (OSM) and State Division of Reclamation Mining and Safety (DRMS). The VISTA member, Amy Weinfurter, will work full-time with the CCWC for one year, expanding the organization's capacity by securing funds, coordinating volunteer efforts, and building the CCWC's presence and rapport in the local community. In 2009 and 2010, grant writing Amy assisted with led to $19,100 from the Colorado Watershed Restoration Program, $1,400 from the VISTA Program, $10,756 from the Colorado Healthy Rivers Fund, and $1,000 from the Community Foundation of the Gunnison Valley.

Amy also continues to recruit and train volunteers to help support the organization's missions and programs. Amy organized a volunteer training day in May 2010, and has organized multiple volunteer workdays in 2010.

FUTURE ACTIONS

The CCWC will continue to use the VISTA member to secure additional funding and help develop the capacity of the organization. The CCWC Board of Directors has set aside funding to help support the Director with part-time staff once Amy's term ends.

Task 4. Attendance at the Colorado Watershed Assembly Conference:

Funding from the CHRF was used to send two staff members (the director and second-year OSM/VISTA member) and one board member to the annual Colorado Watershed Assembly conference (Conference) in the fall of 2009. The Conference provided information and discussion on a broad range of topics, along with formal and informal networking sessions. The conference sessions included information on permitting, invasive species, outreach, and contaminant sources relevant to Colorado. The CCWC was able to network with potential funders, watershed groups, agency staff and academics.

FUTURE ACTIONS

The CCWC will look to use general funds or fundraise to continue to allow staff and board members to attend to the Conference on an annual basis.

APPENDIX A
FIGURES, TABLES AND PHOTOGRAPHS

Table 11. Total ("Tot") metal loading rates expressed as percentages of the cumulative total metal loading rate for Coal Creek as determined by Equation 8. Percentages between 12% and 33% are highlighted in italic font ("minor" sources); percentages greater than 33% are highlighted in bold font ("major" sources). Percentages of less than 0.1% are shown as blank entries.

Source / Tributary	Tot Al (%)	Tot Ba (%)	Tot Cd (%)	Tot Cr (%)	Tot Cu (%)	Tot Fe (%)	Tot Pb (%)	Tot Mn (%)	Tot Zn (%)
Splains Gulch-1.008	4.8	**33.9**		*20.0*	3.8	*21.5*		0.4	0.5
Elk Creek-1.425	0.5	3.9	4.5		*12.2*	3.0	**52.5**	2.1	4.2
UT-1.580		1.7			1.3	0.2			
UT-1.754	0.3	1.4			0.2	3.1		0.1	
UT-2.274	0.1	3.4		2.7	0.3	0.2			
UT-2.306		0.6		**37.0**		0.1	0.5		
UT-2.511	0.1	2.5		4.6	0.2	1.2		0.2	
UT-2.670, Evans Basin	0.4	5.5	0.2		0.8	1.8		0.1	0.8
UT-2.763	0.1	5.4		1.8	0.2	0.3			
UT-3.037	0.2	0.6			0.2	1.4	0.4	0.1	
UT-3.106	0.3	1.1			0.3	2.0	0.8	0.1	0.1
UT-3.212, iron fen	3.7	1.8	2.1		0.5	2.9	0.4	2.2	2.6
UT-3.378, iron fen	8.1	2.0	4.4		0.6	5.8	1.5	4.9	5.8
UT-3.594, iron fen	5.7	1.3	1.3		1.0	1.5	0.6	3.9	2.6
UT-3.835	1.9	5.9			0.6	7.6		0.3	0.1
UT-3.895, iron fen	0.9	0.5	0.5		0.1	0.3		0.7	0.9
UT-4.186, iron gossan	**55.9**	2.5	**81.9**		**52.1**	8.5	*32.0*	**64.4**	**76.5**
UT-4.482	1.0	1.7		1.5	0.1	2.8	0.2		
UT-4.521	5.9	9.6		2.6	0.9	*17.7*	0.4	0.3	0.1
UT-4.585	0.5	1.6		2.1	0.1	1.4			
UT-4.627	0.8	3.1		4.9	0.3	2.4			
UT-5.094	0.9	2.3	0.1	4.2	0.5	3.4	0.4	0.1	0.2
Mount Emmons tributary	5.9	2.8	4.6	5.6	*21.3*	8.4	9.0	*18.4*	4.1
UT-5.517	1.6	3.6	0.4	1.0	2.2	0.8	0.8	1.5	1.3
UT-5.766	0.2	0.7		1.0	0.1	1.0	0.1		
UT-5.885	0.3	0.7		10.9	0.1	0.6	0.3		

Table 6. Total ("Tot") and dissolved ("Diss") metal loading rates expressed as percentages of the cumulative total metal loading rate for Coal Creek as determined by Equation 7. Percentages between 12% and 33% are highlighted in italic font ("minor" sources); percentages greater than 33% are highlighted in bold font ("major" sources). Percentages of less than 0.1% are shown as blank entries. Percentages are shown in grey for the three sources that combine to form the tributary UT-5.368. The cumulative total loading rate is shown on the final line of the table.

Source / Tributary	Tot Al (%)	Tot As (%)	Tot Ba (%)	Tot Cd (%)	Tot Cr (%)	Tot Cu (%)	Tot Fe (%)	Tot Pb (%)	Tot Mn (%)	Tot Ni (%)	Tot Zn (%)
UT-3.146	2.6	6.1	2.7		*14.5*	0.2	4.0	3.4		1.2	0.2
UT-3.212 1st iron fen	4.1	2.4	7.1	2.9	*16.5*	0.3	3.6	2.4	1.4	5.5	4.0
UT-3.378 2nd iron fen	4.9	0.5	3.4	4.1	5.9	0.2	4.5	0.6	2.1	4.9	5.3
UT-3.595 3rd iron fen	2.1	0.7	1.3	0.9	1.2	0.1	0.5	0.3	1.0	1.7	1.6
UT-3.895 1st iron gossan	0.6	1.2	0.9	0.2	1.5		1.0	0.3	0.1	0.3	0.3
UT-4.027	5.1	0.4	1.4	7.9	0.9	0.5	0.6	2.4	1.7	6.4	7.1
UT-4.186 2nd iron gossan	11.4	1.0	1.6	*23.8*	2.1	4.3	1.3	3.3	*15.0*	*17.1*	*24.4*
UT-4.406 west Keystone Mine	0.4	0.2	0.1	1.5	0.2	0.6		0.1	1.1	1.2	1.6
UT-4.584 west Keystone Mine	0.1		0.1	0.2	0.1				0.4	0.4	0.4
UT-4.733 west Keystone Mine	2.8	0.9	2.2	4.1	1.0	2.0		0.4	*18.5*	8.0	5.0
UT-5.368 combined tributary	**58.9**	**74.2**	**65.4**	**54.4**	**37.7**	**91.1**	**72.9**	**83.5**	**58.5**	**51.5**	**49.6**
treatment plant effluent	**41.3**	*19.5*	*17.2*	**33.3**	*19.4*	**39.0**	*24.5*	10.6	**50.5**	**40.6**	*31.0*
roadside ditch	2.5	5.5	6.6	0.5	1.6	0.1	4.3	0.5	0.9	1.0	0.7
Keystone Mine drainage	*15.1*	**49.2**	**41.6**	*20.7*	*16.7*	**52.0**	**44.1**	**72.3**	7.1	9.9	*17.9*
UT-5.613 east Keystone Mine	0.8	2.7	2.7	0.1	6.1	0.3	1.9	1.4		1.1	0.4
UT-5.827 east Keystone Mine	0.6	3.6	1.8		4.0	0.1	1.7	0.6		0.2	
UT-5.930 east Keystone Mine	5.6	6.2	9.1		8.3	0.2	8.1	1.4	0.1	0.6	0.1
Cumulative total load (kg d-1)	**68.1**	**0.02**	**0.52**	**0.22**	**0.01**	**0.88**	**17.7**	**0.17**	**29.5**	**0.15**	**36.1**

Source / Tributary	Diss Al (%)	Diss As (%)	Diss Ba (%)	Diss Cd (%)	Diss Cr (%)	Diss Cu (%)	Diss Fe (%)	Diss Pb (%)	Diss Mn (%)	Diss Ni (%)	Diss Zn (%)
UT-3.146	0.4	*14.5*	3.3		*31.8*	0.3	7.2	5.6		2.1	0.2
UT-3.212 1st iron fen	6.2	5.4	*14.0*	2.9	6.9	0.4	0.7	0.6	1.6	6.3	4.5
UT-3.378 2nd iron fen	8.5	1.6	6.1	4.3	7.9	0.3	**33.4**	3.5	2.2	5.4	5.7
UT-3.595 3rd iron fen	3.2	0.7	2.2	0.8	2.5	0.2	0.1	0.5	1.0	1.8	1.5
UT-3.895 1st iron gossan	0.1	1.1	0.6	0.2	0.6		0.1		0.1	0.2	0.2
UT-4.027	8.6	1.4	2.5	7.6	2.5	0.6	2.7	*15.8*	1.8	6.3	7.0
UT-4.186 2nd iron gossan	*19.4*	5.0	3.1	*23.6*	3.2	5.7	9.1	*23.6*	*15.2*	*16.8*	*23.7*
UT-4.406 west Keystone Mine	0.6	0.5	0.2	1.4	0.2	0.8		0.8	1.1	1.2	1.5
UT-4.584 west Keystone Mine	0.1	0.2	0.1	0.2	0.1				0.4	0.4	0.4
UT-4.733 west Keystone Mine	4.7	2.8	4.0	3.9	1.7	2.5	0.2	1.9	*18.8*	7.7	4.6
UT-5.368 combined tributary	**47.5**	**36.0**	**51.4**	**54.9**	*25.4*	**88.7**	*31.8*	**43.9**	**57.8**	**50.3**	**50.2**
treatment plant effluent	**42.4**	*25.5*	*16.9*	**33.4**	*13.0*	**37.2**	*13.8*	2.8	**50.0**	**40.2**	*31.7*
roadside ditch	0.6	2.0	3.2	0.5	1.3				0.9	0.9	0.7
Keystone Mine drainage	4.5	8.6	31.3	*21.0*	11.1	**51.4**	*18.0*	**41.1**	6.9	9.2	*17.9*
UT-5.613 east Keystone Mine	0.1	7.5	4.0	0.1	5.2	0.4	2.0	1.7		1.0	0.4
UT-5.827 east Keystone Mine	0.2	10.7	2.0		8.8	0.1	5.6	0.9		0.2	0.1
UT-5.930 east Keystone Mine	0.3	*12.7*	6.3		3.1	0.2	7.2	1.2		0.4	0.1
Cumulative total load (kg d-1)	**40.0**	**0.003**	**0.29**	**0.23**	**0.006**	**0.69**	**2.21**	**0.016**	**29.2**	**0.16**	**37.3**

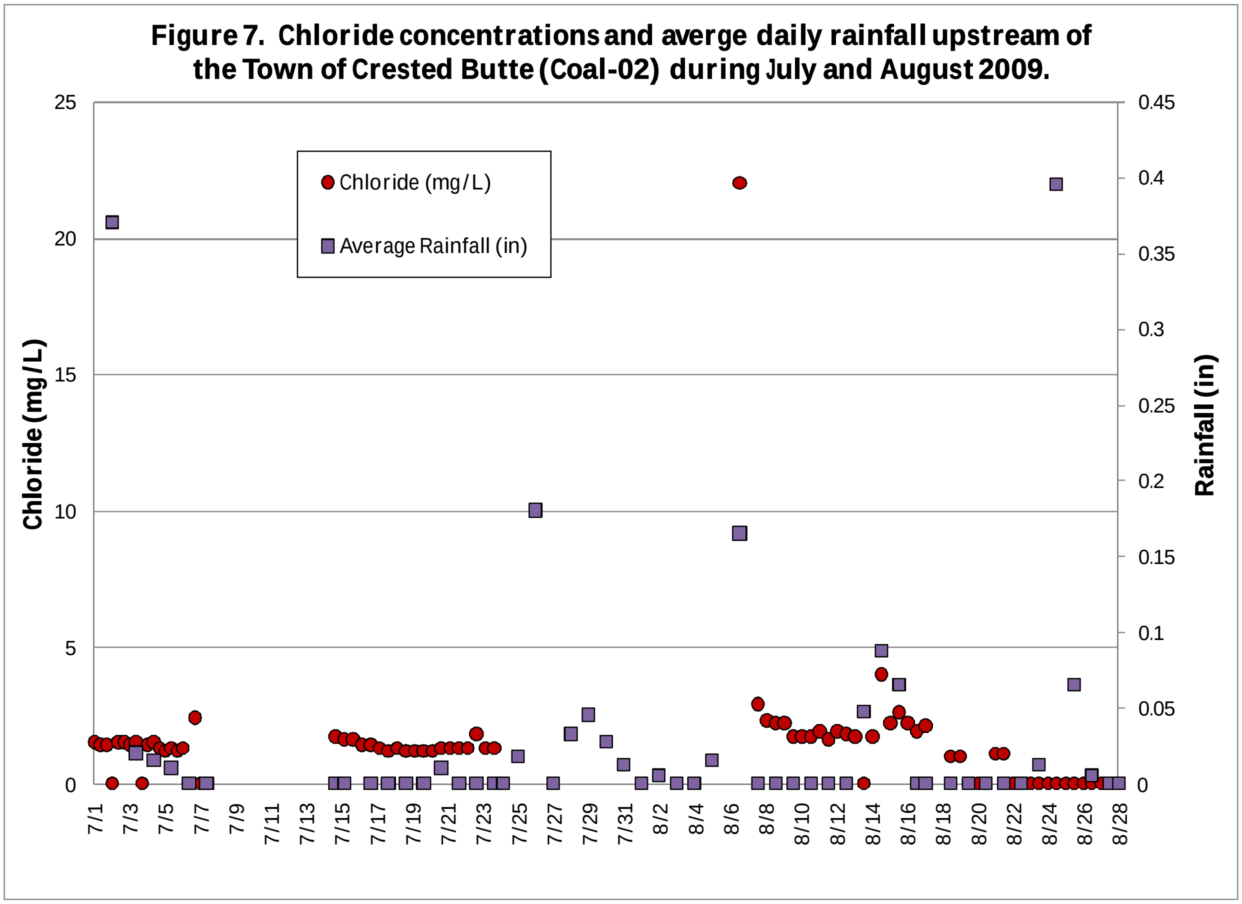
Figure 7. Chloride concentrations and averge daily rainfall upstream of the Town of Crested Butte (Coal-02) during July and August 2009.
Chloride (mg/L)
Average Rainfall (in)
Rainfall (in)
0
5
10
15
20
25
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
7/1
7/3
7/5
7/7
7/9
7/11
7/13
7/15
7/17
7/19
7/21
7/23
7/25
7/27
7/29
7/31
8/2
8/4
8/6
8/8
8/10
8/12
8/14
8/16
8/18
8/20
8/22
8/24
8/26
8/28

Figure 2 - Erosion control mats being installed in the Coal Creek Watershed near Crested Butte, Colorado, in 2009.

Figure 3- A rock check dam with an upstream stilling basin and downstream reinforced vegetative swale near Crested Butte, Colorado. A larger cap rock was installed to complete the check dam.

Figure 4 – Erosion control mats and "s-fence" being installed to address erosion on slopes in the Coal Creek Watershed, near Crested Butte, Colorado.

Figure 5 - "Grate guard" filters used to capture stormwater contaminants on Elk Ave in Crested Butte, Colorado.

Figure 6 - "Ditch guard" check dams used to reduce roadside runoff on Kebler Pass Road near Crested Butte, Colorado.

Figure 7. Chloride values in the Coal Creek Watershed on May 18, 2010 during baseline conditions.