# Coal Creek Watershed Protection Plan

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# Executive Summary

The Colorado Department of Public Health and Environment (CDPHE) has established nine minimum elements that need to be included in a watershed-based plan to address non-point source (NPS) pollution. The following elements are included in this report and are addressed as follows:

a. Pollution sources have been identified in section 3.0 that will need to be controlled to achieve the load reductions estimated in section 4.0 of this watershed-based plan (to achieve water quality standards), as discussed in item (b) immediately below. Sources that need to be controlled have been identified (mapped) in section 4.0 with estimates of the extent to which thev are present in the watershed (e.g., mining areas needing improved pollution prevention measures and sediment control).
b. NPS management measures (BMPs) are described in section 4.0 with reference to an implementation schedule in section 5.0 on how to achieve the pollutant load reductions estimated under paragraph (a) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification of the critical areas in which those measures will be needed to implemented;
c. Section 4.0 provides estimates on expected load reductions for these management measures and controls (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates are provided at the same level of as in item (a) above (e.g., the total load reduction expected for the Standard Mine);
d. Section 5.0 defines an information/education component that will be used to enhance public understanding of the project and encourage their participation in selecting, designing, and implementing the NPS management measures and point source controls that will be implemented.
e. A schedule for implementing the NPS management measures is identified in section 5.0 of this plan that is reasonably expeditious.
f. Section 6.0 describes interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented and a description of what will be done if the milestones are not being achieved;
g. Section 6.0 defines a set of criteria that can be used to determine whether loading reductions are being achieved and substantial progress is being made towards attaining water quality standards and, if not, what will be done if the milestones are not being achieved.
h. Section 6.0 focuses on a monitoring plan to evaluate the current water quality in the watershed, which can be implemented over the long-term to determine the effectiveness of the implementation efforts, measured against the milestones established under item (f) immediately above.
i. An estimate of the sources of technical and financial assistance needed is detailed in section 5.0 and includes components such as I&E, monitoring, O&M, reporting, and/or authorities that will be relied upon to implement this plan.

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# 1.0 Watershed Description and Setting

This section describes the study area, location, topography, climate, geology, vegetation, soils, water resources, hydrology, and land use in the Coal Creek Watershed. It contains information from previous reports on mining in the watershed as identified throughout this section. Figure 1.1, a map of the watershed including subwatershed delineation and numbering, is included as the inset map with this section.

## 1.1 STUDY AREA, SEGMENT 11 AND SEGMENT 12

The Colorado Department of Public Health and Environment (CDPHE) is required by the federal Clean Water Act to maintain a list of stream segments that do not meet water quality standards. This list is called the 303(d) List because of the section of the Clean Water Act that makes the requirement.

Two impaired stream segments in the Coal Creek Watershed are listed on Colorado's Section 303(d) list, which was adopted by the Water Quality Control Commission at Rulemaking Hearings on March 9, 2004. The segments are both listed as high priority segments:

1. Segment 11: Coal Creek from Elk Creek to the Crested Butte water supply intake, plus Elk Creek, impaired by cadmium (Cd), Lead (Pb), and Zinc (Zn), and
2. Segment 12: Coal Creek and tributaries from the Crested Butte water supply intake to Slate River, impaired by Zinc (Zn).

The watershed also includes segment 9, Coal Creek above Elk Creek including tributaries and Lake Irwin, which has not been listed as impaired water. Segments 9 and 11 are classified as "Aquatic Life Cold 1" with beneficial uses including agriculture and water supply for the Town of Crested Butte. Segment 12 falls in the same classification although it is not a water supply for the Town. Restoring segments 11 and 12 to their classified beneficial use has been the goal adopted by the Coal Creek Watershed Coalition for this project:

> *Restore the health of aquatic life and habitat, and protect other water uses in the Coal Creek watershed, which have been impaired due to metals and other pollutant loading from point and nonpoint sources (NPS).*

## 1.2 LOCATION AND TOPOGRAPHY

### 1.2.1 Location

The Coal Creek Watershed is located in Gunnison County, Colorado and is a tributary to the Slate, East, and Gunnison Rivers. The watershed lies in the Ruby-Anthracite Range of west central Colorado and provides some of the richest recreational opportunities in the state. The area is prized for its water-based recreation, including fishing, boating, and camping. Recreation constitutes the major contributor to the local economy of Crested Butte and Mt. Crested Butte.

### 1.2.2 Topography

Elevations in the watershed range from 8,800 feet MSL (mean sea level) at the eastern boundary in Crested Butte to a high of 13,000 feet MSL along the western boundary of the watershed, Ruby Range. The vegetation ranges from lush willow shrubs and scrub brush undergrowth in stream bottoms through aspen, fir, and spruce forests on mountain slopes to treeless alpine tundra vegetation on the ridge tops more than 12,800 feet MSL (URSOS, 1999).

## 1.3 CLIMATE

The average statewide precipitation in Colorado is about 20 inches, but that average is skewed because most of the precipitation falls as snow between November and March of each year. The mean annual precipitation in the watershed is 11.7 inches with a net annual precipitation, as calculated from precipitation and evapotranspiration data, of 3.7 inches (URSOS, 1999). The average annual snowfall in Crested Butte is 220 inches, while the top of Kebler Pass receives 500 inches annually (Adams, 2005).

## 1.4 GEOLOGY, VEGETATION AND SOILS

The watershed is defined by the following geologic formations (URSOS, 1999):

1. Ruby Range to the west on which occur a series of north trending Tertiary dikes;
2. Scarp Ridge to the north with early Tertiary Age sedimentary rocks of the Wasatch and Ohio Creek formations (State of Colorado, 1960);
3. Eastern boundary is covered by sedimentary rocks of the Upper Cretaceous Mesa Verde formation (USGS, 1979);

The Anthracite-Ruby range was the scene of middle and late Cenozoic epizonal plutonic activity with mineralized faults and fractures forming during the late Cenozoic tectonic activity (USGS, 1969). These mineralized structures consist of veins that have produced silver, zinc, lead, copper and gold ores (URSOS, 1999).

## 1.5 WATER RESOURCES AND HYDROLOGY

### 1.5.1 Water Resources

The primary municipal water source for the Town of Crested Butte is Coal Creek below Elk Creek. The diversion in Coal Creek is approximately 4.25 miles downstream of Irwin, 2.5 miles downstream of the Standard Mine, 50 feet upstream of the Keystone Mine outfall, and approximately 1 mile downstream of the water drainage from the Mt. Emmons Iron Fen (URSOS, 1999). At Wildcat Creek, a secondary intake exists to divert surface water as an emergency water source (Stantec, 2004).

The Town holds storage rights in Lake Irwin of 367.3 acre-feet with a junior right of 6-cfs. The water rights are intended to provide a water supply to the Town in the event that the natural flow in Coal Creek is insufficient or that a call by a senior right downstream affects the Town's diversion (Adams, 1992). During a site visit in 2004, an 18" flume had recently been installed on outlet from Lake Irwin to measure diverted water (Stantec, 2004). The water diverted from Lake Irwin by the Town of Crested Butte averages slightly less than 1 acre-foot per day over a one-year period (Adams, 1992), or an average of 0.5 cubic feet per second (cfs).

### 1.5.2 Hydrology

The majority of flow in Coal Creek and tributaries in the watershed is derived from snow melt. Historical flow data for the watershed is limited to USGS recorded flows from water years 1941 to 1946 and water years 2000 to 2003. Streamflow was recorded during these time periods at two locations: daily monitoring from 1941 to 1946 above the Crested Butte intake, and above the mouth of Coal Creek for monthly water quality samples from 2000 to 2003. A long-term USGS gaging station exists on the Slate River below the Coal Creek confluence, with mean annual streamflow given as 133 cubic feet per second (cfs) (USGS, 2005). A hydrograph of mean monthly streamflows for this station is provided in Figure 1.2 below.

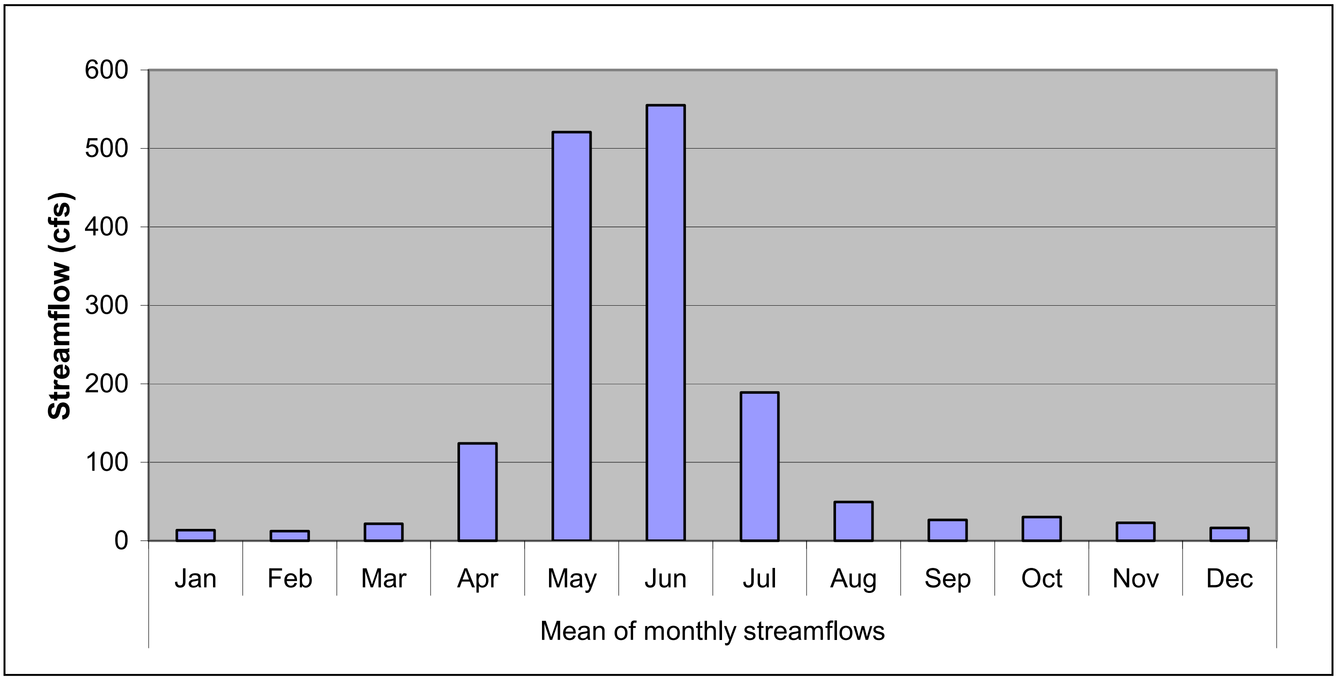



**Figure 1.2 Mean Monthly Streamflow at USGS Gaging Station on the Slate River**

The mean streamflow data in Figure 1.2 was calculated from 20 years of data including water years 1940 through 1950 and 1994 through 2004, and is typical of streams and rivers in Colorado. The peak of snowmelt in May and June of each year coincides with the highest streamflow rates, which for the Slate River are 521 and 555 cfs for monthly averages in May and June respectively. Streamflow outside of seasonal snow melt, or spring runoff, averaged less than 200 cfs for April and July and less than 50 cfs for other months. Although this hydrograph is for the Slate River, the same seasonal pattern would be expected for Coal Creek if sufficient flow data was available.

There are no extensive groundwater aquifers in the watershed although small to medium-sized isolated aquifers are presumed to be present in the coarser grained layers of the Wasatch and Ohio Creek formation (URSOS, 1999). Groundwater would also be expected in the alluvium and colluvium found in basins and stream valleys in the watershed such that a shallow unconfined aquifer is probable in the Lake Irwin area and along Coal Creek.

## 1.6 LAND USE

The Coal Creek Watershed includes a total area of 24.4 square miles or 15,600 acres. Much of the watershed is made up of U.S. Forest Service land. Pesticides and fertilizers are not currently used within the watershed although they could be used in the future by individual homeowners (RBD, 1994). Gunnison County Road 12 and other minor unpaved roads are located within the watershed including logging roads, although logging is not currently conducted.

The Coal Creek Watershed has a long history of mining. Successive periods of mining activity have occurred in the area inducing precious metals extraction, coal mining, and the mining of heavy metals. Mining first began in the Irwin silver district in 1874 when the land was still a part of the Ute Indian Reservation with silver mining activity ceasing by 1890 in this area except for the Forest Queen Mine (URSOS, 1999). Sporadic mining activity occurred between 1901 and 1974 with the three largest producing mines the Standard Mine, the Forest Queen Mine, and the Keystone mine (USGS, 1983; Thomas and Galey, 1982; New Mexico Geological Society, 1981). Two major molybdenum deposits were discovered in the 1970's in the Mount Emmons-Redwell Basin areas (Thomas and Galey, 1982). Neither has been developed.

Active mining in the Coal Creek watershed has ceased although there are several abandoned mine shafts and adits discharging water from underground workings into the surface water stream (URSOS, 1999). According to the URSOS site investigation in June 1999, the Standard Mine was discharging approximately 100-200 gallons per minute (gpm; 0.22-0.44 cfs) from the adit opening to Elk Creek.

Other land uses include residential housing at the Town of Irwin and the Town of Crested Butte. With a majority of the watershed U.S. Forest Service land, recreation is popular. Multiple-use trails for horseback riding, hiking, and mountain biking exist for summer recreation and forest roads are used for cross-country skiing, snowshoeing, and snowmobiling in the winter. Motorized vehicle traffic during summer months is high, especially along CR12. Off-road traffic (e.g. Jeeps and all-terrain vehicles (ATVs)) on forest service roads also occurs during summer months in the watershed.

## Figure 1.1 Coal Creek Watershed Map

Figure 1.1 is enclosed in the pocket following this page.

# 2.0 Existing Data

## 2.1 KNOWN AND POTENTIAL POLLUTANTS

Water quality may be described through observation of chemical, physical, and biological factors or processes. The known pollutants in the Coal Creek watershed are chemical constituents, namely metals associated with pollution from mining activity. The primary metals on concern in the watershed are lead, zinc, copper, manganese, nickel, iron and cadmium. These metals have been identified above stream standards, or water quality goals, for Coal Creek that protect aquatic life and the intended uses, which include recreation and water supply.

Water quality goals for the Coal Creek watershed are based on stream classifications set by the Colorado Water Quality Control Commission of the Colorado Department of Public Health and the Environment (CDPHE). The state's waters are divided into segments practical for classification. Each segment receives a classification that is made up of a use classification, numeric standards, and sometimes a narrative standard. For example, the stream segments in the Coal Creek watershed are classified as "Aquatic Life Cold", meaning waters that the waters "(1) are currently capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions."

Numeric standards specify the maximum values for particular pollutants. Generally, these numeric standards are the state's "table value standards", or TVS. The TVS may be adjusted on an exception basis for a particular stream segment by the Colorado Water Quality Control Commission after analysis of actual stream conditions and on actual and potential water uses. For example, the numeric standards for segment 12 of Coal Creek are the TVS except for chronic zinc, which is 598 $\mu$g/L (CDPHE, 2002).

## 2.2 SUMMARY OF AVAILABLE DATA

We have reviewed existing data from various sources including the following:

**Surface Water**

1. Analytical Results Report for Expanded Site Inspection, prepared for the USEPA by URS Operating Services in June 2000.
2. USGS Surface Water Sampling on Coal Creek at Mouth, water year 2000 to 2003
3. USGS Upper Gunnison River Watershed Data, Compiling Water Quality Data from the following agencies:
   - USEPA: U.S. Environmental Protection Agency
   - USFS: U.S. Forest Service
   - USGS: U.S. Geological Survey
   - CDPHE: Colorado Department of Public Health and Environment
4. USEPA STORET Database
5. CCWC Synoptic Sampling on Coal Creek and Elk Creek, August 2004.

6. Phelps-Dodge Water Quality Monitoring on Coal Creek and AMAX Discharge

**Sediments**

1. Analytical Results Report for Expanded Site Inspection, prepared for the USEPA by URS Operating Services in June 2000.
2. USGS Upper Gunnison River Watershed Data
3. USGS Surface Water and Sediment Sampling on Coal Creek, 1996-1998.

**Groundwater**

1. Analytical Results Report for Expanded Site Inspection, prepared for the USEPA by URS Operating Services in June 2000.

**Nutrients/Microbiological**

1. USGS Surface Water Sampling on Coal Creek at Mouth, water year 2000 to 2003

For these data sources, individual data sets were validated if the following criteria were identifiable:

- Date of sample collection;
- Location of sample collection
  - Identified in a stream segment for Coal Creek (Segment 9, 11 or 12), or
  - Identified in one of the delineated subwatersheds
- Organization that collected the sample
- Identifiable standard method or specific laboratory that was used for analysis
- Able to determine whether dissolved or total metals were analyzed
- Able to determine if preservation methods and holding times were met or used
- Detection limits used for analysis
- Some form of QA or QC, whether it be calibration of field equipment, duplicate, replicate, or blind samples, or spikes
- Field data from same sampling event (pH, temp, turbidity, DO, flow, etc.)

Where one or two of the criteria were not met, the data was included in a validated data set with notation that it did not meet all criteria. Where several of these criteria were not met, the data was considered available unverified data and not included in our database.

We assembled a database to query data by agency, location, date, and parameter type. Through this exercise were able to evaluate the quantity of available data, and ultimately identify data gaps. Table 2.1 displays the sampling frequency for each station according to the type of sampling that was conducted (synoptic or systematic).

Large data gaps exist for monitoring data in the Coal Creek watershed, as displayed in Table 2.1. Continuous monitoring, namely for cadmium and zinc, occurred only in Segment 12, and only for the AMAX discharge for the period of record. Samples at the mouth of Coal Creek are representative of the entire watershed and were collected by the USGS with at least one sample per quarter from water year 2000 to 2003. Synoptic, or one-event sampling, occurred in 1999 and 2004 for all three segments of Coal Creek. These sampling events were organized to identify metals loading in all reaches of Coal Creek and included the upper reaches of Coal Creek and Elk Creek to determine background metals concentrations. These stations were generally chosen based on known pollutant sources to Coal Creek.

## Table 2.1 Data Gap Analysis

| Station ID | NAME | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Segment 9** | | | | | | | | | | | | | | | |
| Syn-06 | Coal Creek Above Elk Creek | | | | | | | | | | | | | | |
| RS-SW-01 | Coal Creek at Lake Irwin Outfall | | | | | | | | | | | | | | |
| RS-SW-07 | Coal Creek Above Elk Creek | | | | | | | | | | | | | | |
| RS-SW-03 | Coal Creek Below Kebler Pass | | | | | | | | | | | | | | |
| RS-SW-02 | Coal Creek Independence Basin | | | | | | | | | | | | | | |
| **Segment 11** | | | | | | | | | | | | | | | |
| Syn-07 | Coal Creek Below Elk Creek | | | | | | | | | | | | | | |
| AMAX CC 2A | Coal Creek Above Crested Butte Intake | | | | | | | | | | | | | | |
| Syn-10 | Above CB Intake Diversion | | | | | | | | | | | | | | |
| RS-SW-11 | Coal Creek at the Crested Butte Intake | | | | | | | | | | | | | | |
| RS-SW-10 | Coal Creek Below the Iron Bog | | | | | | | | | | | | | | |
| RS-SW-09 | Coal Creek Above the Iron Bog | | | | | | | | | | | | | | |
| RS-SW-08 | Coal Creek Below Elk Creek | | | | | | | | | | | | | | |
| Syn-05 | Bottom of Elk Creek Above Coal Ck | | | | | | | | | | | | | | |
| Syn-04 | Top of Elk Creek Below the Pond | | | | | | | | | | | | | | |
| Syn-03 | Top of Elk Creek Below the Pond | | | | | | | | | | | | | | |

| Station ID | NAME | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Segment 11** | | | | | | | | | | | | | | | |
| Syn-02 | Top of Elk Creek Below the Adits | | | | | | | | | | | | | | |
| Syn-01 | Top of Elk Creek Above All | | | | | | | | | | | | | | |
| AMAX EC-1 | Elk Creek Prior to Coal Creek | | | | | | | | | | | | | | |
| RS-SW-06 | Elk Creek Above Coal Creek | | | | | | | | | | | | | | |
| RS-SW-05 | Elk Creek Below the Standard Mine | | | | | | | | | | | | | | |
| RS-SW-04 | Elk Creek Background | | | | | | | | | | | | | | |
| Syn-09 | The Iron Fen | | | | | | | | | | | | | | |
| **Segment 12** | | | | | | | | | | | | | | | |
| Syn-11 | Below Emmons Dis & Town Intake | | | | | | | | | | | | | | |
| USGS Gaging | Coal Creek Above Mouth at Crested Butte, CO | | | | | | | | | | | | | | |
| Syn-15 | Coal Ck Above Slate River | | | | | | | | | | | | | | |
| RS-SW-13 | Coal Creek Below Keystone Outfall | | | | | | | | | | | | | | |
| AMAX KP-1 | Coal Creek at First Kebler Road Bridge | | | | | | | | | | | | | | |
| RS-SW-16 | Coal Creek Above the Slate River | | | | | | | | | | | | | | |
| RS-SW-15 | Coal Creek Below Wildcat Creek | | | | | | | | | | | | | | |
| AMAX Discharge | Mt. Emmons Discharge | | | | | | | | | | | | | | |

| | |
|---|---|
| | Synoptic (one event) sampling |
| | Systematic (greater than one sampling event) |

## 2.3 WATER QUALITY DATA

### 2.3.1 Surface Water Metals

Data analysis was done on water quality samples collected and analyzed within the past 14 years (1991-2005). Limiting the data to this range was necessary to provide a reliable data set based on the following:

1. Similar detection limits and reporting units for water quality parameters;
2. Similar watershed conditions. The start-up of the Mt. Emmons (AMAX) water treatment plant in July of 1981 changed both the hydrology and water quality of lower Coal Creek.

To increase the efficiency of the existing data review, a database was built to query water quality parameters by sample location and date. This ensured an accurate transfer of all water quality data from separate sources into one compiled dataset.

To review historical data from 1991-2004, the metals data was queried by segment of Coal Creek, sample location, parameter (dissolved or total), and sample date. With limited historical metals data, data analysis focused on the range of metals concentrations in each segment. A comparison of metals concentration to the identified stream standard was important in this exercise to determine the number of chronic stream standard exceedances that led to metals impairment. Attainment of chronic standards is based on the 85$^{th}$ percentile of the ranked data, and this type of statistical analysis could not be done on all data sets due to limited data points. On those data sets with sufficient data however, the 85$^{th}$ percentile was calculated for comparison to the chronic stream standard.

For the purposes of analyzing the data, a numerical value must be assigned to samples reported as non-detect. According to the definitions outlined for the CDPHE in determining compliance with chronic standards, all non-detects sample values were replaced with 0 to compute median and 85$^{th}$ percentile values.

A complete analysis of the water quality data for Coal Creek is presented in Appendix A. This analysis includes the number of total and dissolved metal samples for each parameter, the median, maximum, date of the maximum, 85$^{th}$ percentile, and number of exceedances for aquatic stream standards. Since a summary value was desired that is not strongly influenced by a few high concentrations, the median was preferable to the mean in the analysis. A summary of this data is shown in Table 2.2 with all reporting units in $\mu$g/L. For the 85$^{th}$ percentile data and aquatic stream standards by segment and parameters, see Appendix A.

### Table 2.2 Surface Water Metals Concentrations for Coal Creek

| Parameter | Fraction | Period | Sampling Frequency | Count | Median | Maximum | Exceedances Number | Exceedances % |
|---|---|---|---|---|---|---|---|---|
| **Segment 9: Coal Creek above Elk Creek including tributaries and Lake Irwin** | | | | | | | | |
| Aluminum | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 68.0 | 79.0 | N/A | N/A |
| | Total | '99-2004 | synoptic | 4 | 121 | 127 | N/A | N/A |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | 45.8 | 86.0 | N/A | N/A |
| | Total | 8/17/2004 | synoptic | 1 | - | 133 | N/A | N/A |
| Arsenic | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 3.60 | 5.50 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 3.60 | 5.70 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | ND | ND | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | ND | ND | 0 | 0% |
| Cadmium | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 0.040 | 0.130 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 0.007 | 0.024 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | ND | ND | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | ND | ND | 0 | 0% |
| Copper | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 0.750 | 2.00 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 0.860 | 1.02 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 1 | - | 8.57 | 1 | 100% |
| | Total | 8/17/2004 | synoptic | 1 | - | 9.89 | 1 | 100% |

| Parameter | Fraction | Period | Sampling Frequency | Count | Median | Maximum | Exceedances Number | Exceedances % |
|---|---|---|---|---|---|---|---|---|
| **Segment 9: Coal Creek above Elk Creek including tributaries and Lake Irwin** | | | | | | | | |
| Iron | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 86.0 | 130 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 147 | 173 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | - | 66.0 | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | - | 137 | 0 | 0% |
| Lead | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 0.162 | 0.400 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 0.352 | 0.448 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | - | 0.093 | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | - | 0.099 | 0 | 0% |
| Manganese | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 7.30 | 9.38 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 14.0 | 23.0 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | - | 1.53 | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | - | 3.25 | 0 | 0% |
| Zinc | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 5 | 7.40 | 26.0 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 3.65 | 4.50 | 0 | 0% |
| | **Wildcat Creek** | | | | | | | |
| | Dissolved | 6/22/1999 | synoptic | 2 | 3.65 | 5.30 | 0 | 0% |
| | Total | 8/17/2004 | synoptic | 1 | - | 1.20 | 0 | 0% |

N/A = Not available, ND = Non-detect, parameter was not detected above reporting limit by laboratory

| Parameter | Fraction | Period | Sampling Frequency | Count | Median | Maximum | Exceedances Number | Exceedances % |
|---|---|---|---|---|---|---|---|---|
| **Segment 11: Coal Creek from Elk Creek to the water supply intake, plus Elk Creek** | | | | | | | | |
| | **Coal Creek** | | | | | | | |
| | Dissolved | 1991-'94 | 1st - 3rd quarters | 10 | 115 | 310 | N/A | N/A |
| | | '99-2004 | synoptic | 6 | 79.5 | 107 | N/A | N/A |
| Aluminum | Total | '99-2004 | synoptic | 4 | 137 | 146 | N/A | N/A |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 54 | 1,500 | N/A | N/A |
| | Total | '99-2004 | synoptic | 2 | 182 | 235 | N/A | N/A |
| | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 6 | 1.80 | 3.50 | 0 | 0% |
| | Total | '99-2004 | synoptic | 4 | 2.10 | 2.40 | 0 | 0% |
| Arsenic | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 0.40 | 1.80 | 0 | 0% |
| | Total | '99-2004 | synoptic | 2 | 1.50 | 1.80 | 0 | 0% |
| | **Coal Creek** | | | | | | | |
| | Dissolved | 1988-'93 | 1st - 3rd quarters | 12 | 2.15 | 7.40 | 3 | 25% |
| | | '99-2004 | synoptic | 11 | 0.600 | 1.10 | 0 | 0% |
| Cadmium | Total | '99-2004 | synoptic | 5 | 0.665 | 0.822 | 0 | 0% |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 11.9 | 63.0 | 5 | 71% |
| | Total | '99-2004 | synoptic | 24 | 2.30 | 61.1 | 6 | 25% |
| | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 6 | 3.75 | 9.78 | 2 | 33% |
| | Total | '99-2004 | synoptic | 4 | 14.8 | 16.1 | 3 | 75% |
| Copper | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 41.0 | 170 | 6 | 86% |
| | Total | '99-2004 | synoptic | 3 | 14.8 | 335 | 3 | 100% |
| | **Coal Creek** | | | | | | | |
| | Dissolved | 1991-'94 | 1st - 3rd quarters | 10 | 110 | 580 | 0 | 0% |
| | | '99-2004 | synoptic | 6 | 76.0 | 130 | 0 | 0% |
| Iron | Total | '99-2004 | synoptic | 4 | 139 | 146 | 0 | 0% |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 8 | 64.5 | 450 | 0 | 0% |
| | Total | '99-2004 | synoptic | 2 | 222 | 319 | 0 | 0% |

| Parameter | Fraction | Period | Sampling Frequency | Count | Median | Maximum | Exceedances Number | Exceedances % |
|---|---|---|---|---|---|---|---|---|
| **Segment 11: Coal Creek from Elk Creek to the water supply intake, plus Elk Creek** | | | | | | | | |
| Lead | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 6 | 1.45 | 2.95 | 4 | 67% |
| | Total | '99-2004 | synoptic | 4 | 2.66 | 4.82 | 4 | 100% |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 32.0 | 230 | 6 | 86% |
| | Total | '99-2004 | synoptic | 2 | 291 | 563 | 2 | 100% |
| Manganese | **Coal Creek** | | | | | | | |
| | Dissolved | 1991-'98 | 1st - 3rd quarters | 16 | 126 | 540 | 0 | 0% |
| | | '99-2004 | synoptic | 6 | 23.0 | 41.0 | 0 | 0% |
| | Total | 1995-'98 | monthly | 32 | 115 | 570 | 0 | 0% |
| | | '99-2004 | synoptic | 4 | 29.0 | 33.0 | 0 | 0% |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 466 | 3,100 | 2 | 29% |
| | Total | '99-2004 | synoptic | 9 | 20 | 483 | 0 | 0% |
| Zinc | **Coal Creek** | | | | | | | |
| | Dissolved | 1988-'94 | 1st - 3rd quarters | 14 | 375 | 1,440 | 3 | 21% |
| | | '99-2004 | synoptic | 5 | 122 | 200 | 0 | 0% |
| | Total | 1995-'98 | monthly | 32 | 265 | 1,440 | 5 | 16% |
| | | '99-2004 | synoptic | 3 | 132 | 140 | 0 | 0% |
| | **Elk Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic | 7 | 1,940 | 12,000 | 5 | 71% |
| | Total | 1995-'96 | monthly | 22 | 405 | 840 | 4 | 18% |
| | | '99-2004 | synoptic | 2 | 1,355 | 1,990 | 2 | 100% |
| **Segment 12: Coal Creek and tributaries from the water supply intake to Slate River** | | | | | | | | |
| Aluminum | Dissolved | 1991-'94 | 1st - 3rd quarters | 10 | 70.0 | 270 | N/A | N/A |
| | | '99-2004 | synoptic/high flows | 18 | 55.0 | 240 | N/A | N/A |
| | Total | '99-2004 | synoptic | 3 | 171 | 172 | N/A | N/A |
| Arsenic | Dissolved | '99-2004 | synoptic/high flows | 6 | 1.05 | 1.60 | 0 | 0% |
| | Total | '99-2004 | synoptic | 3 | 1.40 | 1.95 | 0 | 0% |

| Parameter | Fraction | Period | Sampling Frequency | Count | Median | Maximum | Exceedances Number | Exceedances % |
|---|---|---|---|---|---|---|---|---|
| **Segment 12: Coal Creek and tributaries from the water supply intake to Slate River** | | | | | | | | |
| Cadmium | **Coal Creek** | | | | | | | |
| | Dissolved | 1988-'93 | 1st - 3rd quarters | 12 | 2.60 | 6.10 | 7 | 58% |
| | | '99-2004 | synoptic/high flows | 18 | 0.665 | 6.20 | 3 | 17% |
| | Total | '99-2004 | synoptic | 3 | 0.730 | 0.899 | 0 | 0% |
| | **AMAX Discharge** | | | | | | | |
| | Total | 2003-'04 | monthly | 21 | 0.700 | 0.900 | 0 | 0% |
| Copper | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic/high flows | 18 | 2.40 | 17.0 | 4 | 22% |
| | Total | '99-2004 | synoptic | 3 | 14.1 | 18.4 | 2 | 67% |
| | **AMAX Discharge** | | | | | | | |
| | Total | 2003-'04 | monthly | 21 | 2.50 | 4.00 | 0 | 0% |
| Iron | Dissolved | 1991-'94 | 1st - 3rd quarters | 10 | 130 | 1,250 | 1 | 10% |
| | | '99-2004 | synoptic/high flows | 18 | 35.0 | 82.0 | 0 | 0% |
| | Total | '99-2004 | synoptic | 3 | 166 | 168 | 0 | 0% |
| Lead | **Coal Creek** | | | | | | | |
| | Dissolved | '99-2004 | synoptic/high flows | 15 | 1.00 | 2.00 | 0 | 0% |
| | Total | '99-2004 | synoptic | 3 | 2.10 | 2.58 | 1 | 33% |
| | **AMAX Discharge** | | | | | | | |
| | Total | 2003-'04 | monthly | 21 | ND | ND | 0 | 0% |
| Manganese | Dissolved | 1991-'94 | 1st - 3rd quarters | 10 | 210 | 750 | 0 | 0% |
| | | '99-2004 | synoptic/high flows | 18 | 37.1 | 598 | 0 | 0% |
| | Total | 1995-'98 | monthly | 23 | 200 | 750 | 0 | 0% |
| | | '99-2004 | synoptic | 3 | 46.0 | 53.0 | 0 | 0% |
| Zinc | **Coal Creek** | | | | | | | |
| | Dissolved | 1988-'94 | 1st - 3rd quarters | 14 | 440 | 1,200 | 5 | 36% |
| | | '99-2004 | synoptic/high flows | 18 | 120 | 1,120 | 2 | 11% |
| | Total | 1995-'98 | monthly | 29 | 220 | 1,150 | 3 | 10% |
| | | '99-2004 | synoptic | 3 | 153 | 156 | 0 | 0% |
| | **AMAX Discharge** | | | | | | | |
| | Total | 2003-'04 | monthly | 21 | 20.0 | 40.0 | 0 | 0% |

Reviewing metals data for segments 9, 11, and 12, the following observations can be made:

- Seasonal water quality is only available for aluminum, cadmium, iron, manganese and zinc in segments 11 and 12;
- Synoptic sampling in the main steam of segment 9 Coal Creek did not identify exceedances of aquatic stream standards during the review period, yet only 9 samples were collected between 1991 and 2004;
- Exceedances were the highest (% of total samples) for cadmium, copper, lead and zinc in segments 11 and 12;
- Elk Creek (seg. 11) had exceedances of aquatic stream standards for cadmium, copper, lead, manganese, and zinc;
- Wildcat Creek (seg. 9) had exceedances of aquatic stream standards for copper;
- The maximum concentrations of cadmium, copper, lead, and zinc in Elk Creek were 10-fold greater than those in Coal Creek in segment 11;
- Exceedances of aquatic standards in Elk Creek were at least 70% for dissolved cadmium, copper, lead and zinc based on seven distinct samples;

Reviewing Tables 2.1 and 2.2, it is apparent that major data gaps exist which limits comparison of water quality across segments 9, 11, and 12. Synoptic samples collected in 6/1999 and 8/2004 can be compared to determine major sources of metals pollution in the watershed. This synoptic water quality sampling occurred during various flow regimes, high flow in June and low flow in August, and can narrow the search for pollution sources to particular sub-watersheds. Doing such a comparison would yield the conclusion that the Elk Creek sub-watershed is the source of metals that exceed stream standards for segments 11 and 12 of Coal Creek. The basis for this is that cadmium, copper, lead and zinc concentrations in Elk Creek are 10-fold greater than Coal Creek in segment 11 and exceed stream standards for at least 70% of samples. This generalization would identify Elk Creek as the major source of metals loading to Coal Creek; however, this is based on synoptic sampling events without monitoring metals on a seasonal or annual basis. Without more definitive data on seasonal water quality in all segments of Coal Creek, it is difficult to quantify the metals loading from Elk Creek compared to other nonpoint or point source loads in the watershed.

### 2.3.2 Ground Water Metals

The Town of Crested Butte does not have any municipal groundwater wells although several private wells are used for domestic water supply in the watershed. URS Operating Services (URSOS, 1999) collected two groundwater samples during an expanded site investigation of water quality in the watershed. A background water sample was taken from an artesian well 0.5 miles east of Kebler Pass and one docmestic well for the residence located at 1060 County Road 12. This well was believed to be the domestic use well closest to the potential sources of mining contamination (URSOS, 1999). The analytical test results on these two wells determined that the groundwater well down gradient of the mining district source areas was more mineralized than the background well. URSOS (1999) noted that the elevated concentrations could not be attributed to a specific source but rather may be the result of groundwater exposed to naturally occurring regional mineralization. Contaminant levels in the domestic use well were not above primary or secondary drinking water maximum contaminant levels (MCLs). With this being the only groundwater data for the watershed, it will be advantageous to sample domestic supply water wells as part of the watershed sampling plan to determine if mining source areas contribute to contamination of the ground water supply.

### 2.3.3 Sediment Metals

Sediment sampling was completed by URS Operating Services during synoptic sampling of the entire watershed in June 1999 and by the USGS at the mouth of Coal Creek in September 1996. Synoptic sampling by URSOS included sediment sampling at all surface water sampling locations identified in the map with analysis for total metals in the sediments. The USGS tested for total metals in the sediment but with different detection limits as the URSOS sediment analysis, a reliable comparison cannot be done between the two data sets. Results for both sampling events are displayed in Figures 2.1 and 2.2 which display spatial graphs for cadmium, copper, iron and zinc in Coal Creek, metals that were found at levels greater than or equal to three times background levels. Table 2.3 references the rationale used by URSOS (1999) for each sampling location and can be used for evaluating potential pollutant sources in the figures.

**Table 2.3 Sediment Sampling Sites in Coal Creek by URSOS (1999)**

| Sample Sites | Description | Rationale |
|---|---|---|
| RS-SE-02 | From Coal Creek downstream tributary from Independence Basin | To assess the influence of potential sources in Independence Basin on targets along Coal Creek |
| RS-SE-03 | From Coal Creek in wetlands just downstream from the Little Frank Area | To assess the influence of potential sources at the Little Frank area on targets along Coal Creek |
| RS-SE-07 | From Coal Creek between the confluences of Splains Gulch and Elk Creek | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |
| RS-SE-08 | From Elk Creek just below the confluence of Elk Creek with Coal Creek | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |
| RS-SE-09 | From Coal Creek in wetlands prior to the the Mount Emmons Iron Bog/Fen | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |
| RS-SE-10 | From Coal Creek in wetlands below the Mount Emmons Iron Bog/Fen and before the Keystone Mine outfall | To assess the influence of sources on the wetlands and fishery targets along Coal Creek. |
| RS-SE-11 | From the Keystone Mine outfall just before confluence with Coal Creek | To characterize surface water of the permitted outfall |
| RS-SE-13 | From Coal Creek just below the Keystone Mine outfall | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |
| RS-SE-15 | From Coal Creek just below the confluence of Wildcat Creek and Coal Creek | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |
| RS-SE-16 | From Coal Creek just before the confluence with the Slate River | To assess the influence of sources on the wetlands and fishery targets along Coal Creek |

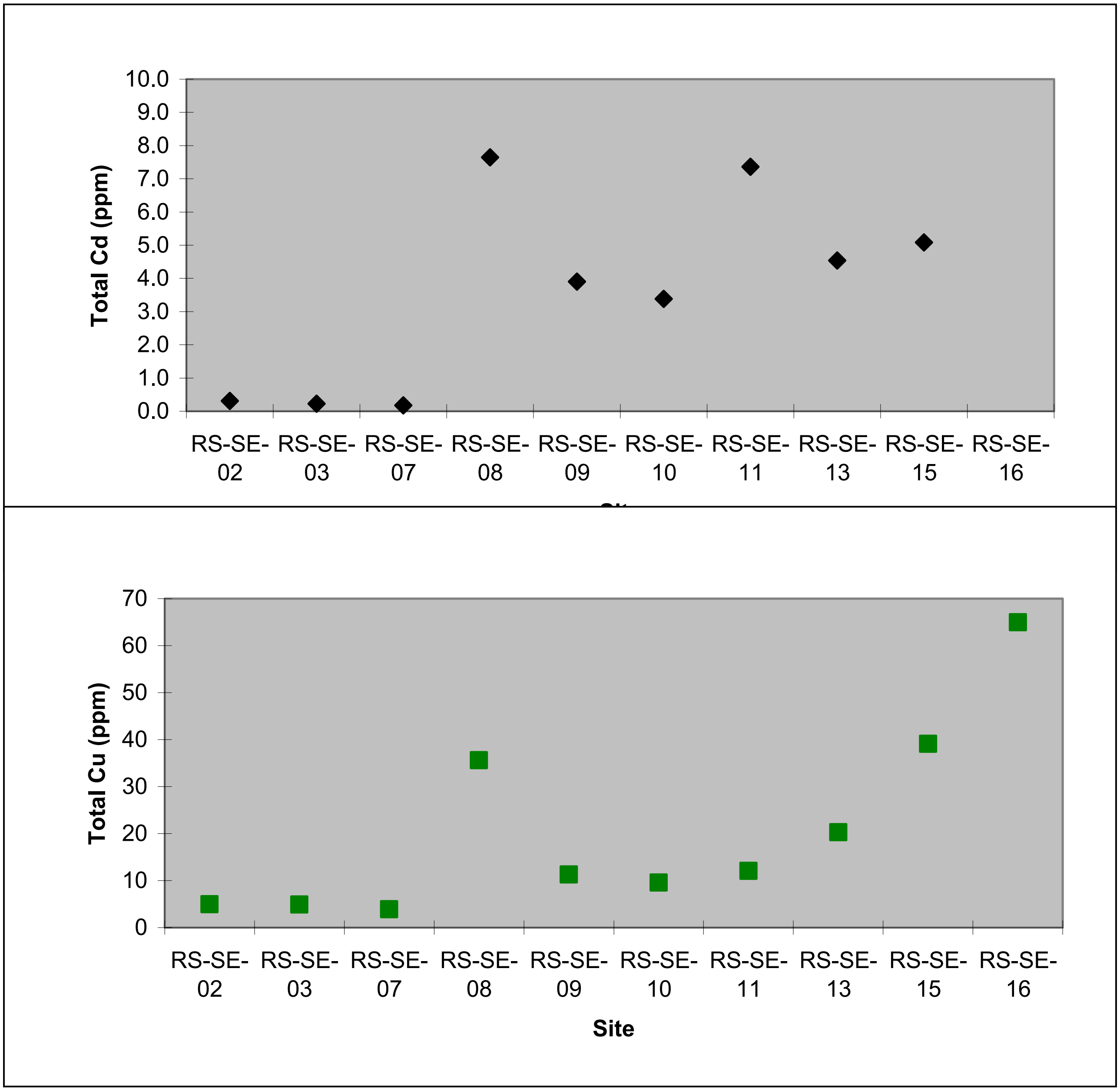



**Figure 2.1 Total Cadmium (Cd) and Copper (Cu) levels in Coal Creek Sediments as a function of Sample Location (URSOS, 1999)**

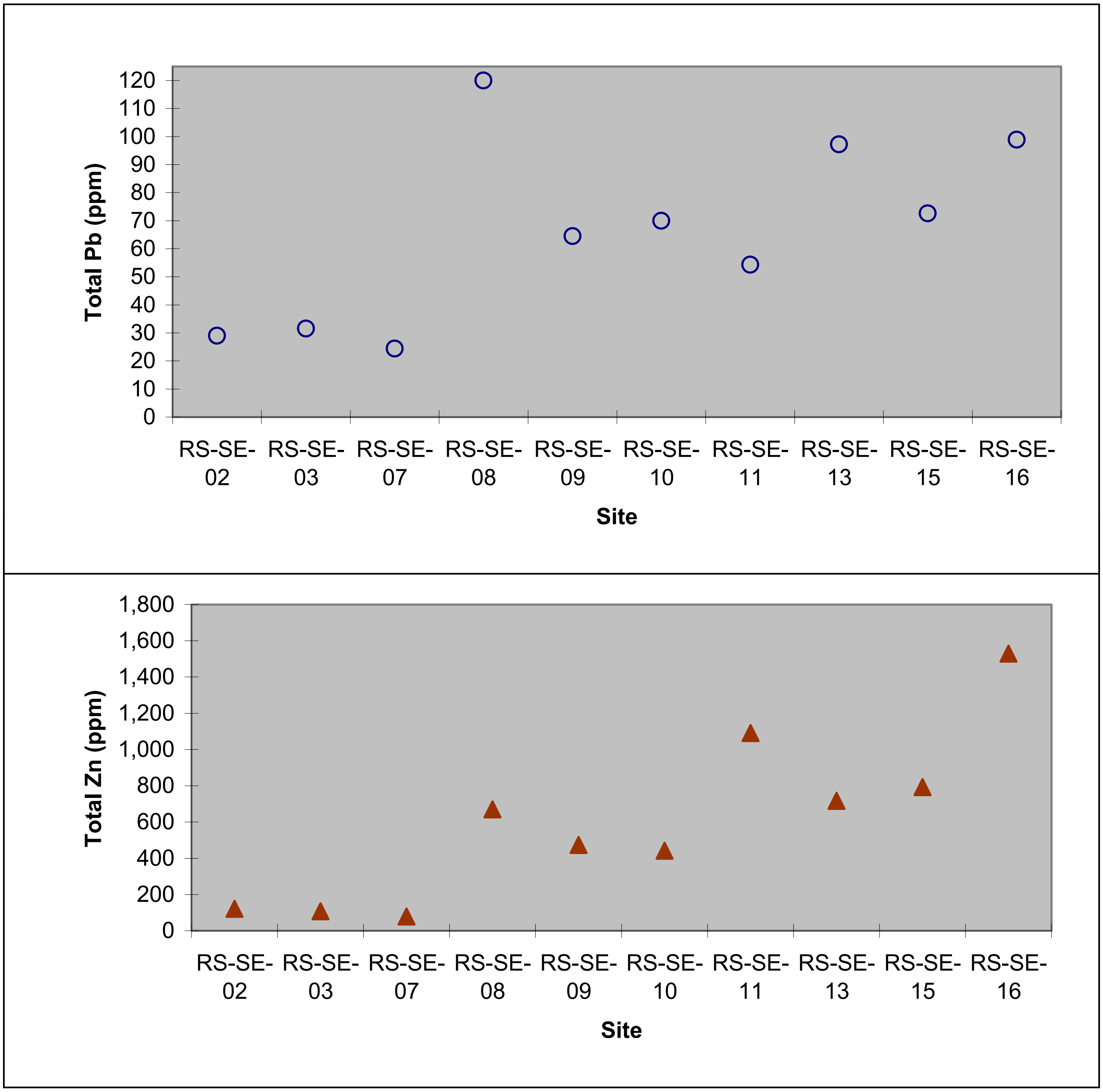



**Figure 2.2 Total Lead (Pb) and Zinc (Zn) levels in Coal Creek Sediments as a function of Sample Location (URSOS, 1999)**

Reviewing sediment data for figures 2.1 and 2.2, the following observations can be made:

- Total cadmium concentrations spike at sample locations below Elk Creek (RS-SE-08) and on the Mt. Emmons Outfall before confluence with Coal Creek (RS-SE-11);
- Total copper concentrations spike at the sample location below Elk Creek (RS-SE-08) and increase in the lower reaches of Coal Creek to a maximum

concentration at the last sampling location before the confluence with the Slate River (RS-SE-16);

- Total lead concentrations are highest below Elk Creek (RS-SE-08) and increase in the lower reaches of Coal Creek after the Mt. Emmons Outfall (RS-SE-13) and at the lowest sampling location (RS-SE-16);
- Total zinc concentrations spike at sample locations below Elk Creek (RS-SE-08) and below the Mt. Emmons Outfall before confluence with Coal Creek (RS-SE-11) and increase in the lower reaches of Coal Creek to a maximum concentration at the lowest sampling location (RS-SE-16).

These observations are important in assessing sediment transport from mining source areas into Coal Creek. Comparing sediment metals concentrations from the upper to lower reaches of Coal Creek, cadmium, copper, and zinc concentrations spike after Elk Creek and reach a maximum at the lowest sampling location, below Crested Butte and before the confluence of Coal Creek with the Slate River. Lead levels follow the same pattern although the maximum sediment lead level is after Elk Creek.

The lowest sampling location is approximately 7.5 miles downstream from confluence with Elk Creek and had elevated metal concentrations in sediment samples that were significantly greater than background levels for certain metals. To determine the relative contamination of sediments in the lower reaches of Coal Creek, synoptic sediment data was compared between background levels at Independence Basin (RS-SE-02) and levels at the mouth of Coal Creek (RS-SE-16). Table 2.4 displays the concentrations of metals (in ppm) for samples collected during sampling in June of 1999 (URSOS, 1999). It should be noted that there was not fine- to medium-grain sediment at the Lake Irwin sampling location so the background sample for Coal Creek was collected below the Irwin town site (URSOS, 1999). The sample was derived in flat bottom land with a scrub-shrub wetland and would be influenced by drainage from Independence Basin. For the comparison, the increase in metals concentrations was calculated with non-detect values in the background samples set equal to the detection limit for the specified parameter.

**Table 2.4 Comparisons of Metals Concentrations for Sediments at Background Soils and the Mouth of Coal Creek**

| Parameter | Sample Location | | increase | Parameter | Sample Location | | increase |
|---|---|---|---|---|---|---|---|
| | Background | At Mouth | | | Background | At Mouth | |
| Aluminum | 9280 | 8600 | - | Manganese | 1270 | 2180 | **911** |
| Antimony | 0.17 | 0.21 | 1.0 | Mercury | 0.01 | 0.06 | 1.1 |
| Arsenic | 99.6 | 46.7 | - | Molybdenum | 0.71 | 1.08 | 1.4 |
| Barium | 96 | 117 | **22** | Nickel | 3.8 | 8.2 | 5.4 |
| Beryllium | 0.35 | 0.97 | 1.6 | Potassium | 1100 | 950 | - |
| Cadmium | 0.31 | 10.3 | **11** | Selenium | ND | ND | ND |
| Calcium | 2490 | 2530 | 41 | Silver | 1.3 | 1.54 | 1.2 |
| Chromium | 2.3 | 4.6 | 3.3 | Sodium | 76 | 79 | 4.0 |
| Cobalt | 5.67 | 12.1 | 7.4 | Thallium | 0.14 | 0.3 | 1.2 |
| Copper | 5 | 65 | **61** | Vanadium | 10.5 | 13.4 | 3.9 |
| Iron | 18500 | 16900 | - | Zinc | 121 | 1530 | **1,410** |
| Lead | 29 | 98.9 | **71** | Cyanide | 1.3 | ND | ND |
| Magnesium | 3200 | 2160 | - | ND | Not Detected above Laboratory RL | | |

Barium, cadmium, copper, lead, manganese, and zinc all exhibit at least a 10-fold increase in sediment levels between the background and lowest reach of Coal Creek. These were the same metals (with the exception of barium and manganese) that exceeded aquatic stream standards in segments 11 and 12 of Coal Creek. This conclusion is expected although the extent that these sediments contribute to aqueous concentrations cannot be quantified based on the current dataset. The potential for sediment-bound metals to increase aqueous metals concentrations may influence the effectiveness of best management practices upstream in the watershed.

### 2.3.4 Surface Water Nutrients

Nitrogen and phosphorus are important nutrients in the aquatic food chain since they are a key element for growth in organisms. Some nitrogen containing compounds, such as nitrates, nitrites, and namely un-ionized ammonia, however are toxic to fish and other aquatic organisms at elevated levels. Phosphorus is typically the limiting nutrient that is necessary for growth of plants and algae in freshwaters although high concentrations of phosphorus can promote excessive growth of algae. High concentrations of phosphorus and nitrogen in surface waters are a concern since excessive growth of algae and aquatic plants can cause oxygen depletion and fish kills.

The CDPHE has set stream standards in Coal Creek for nitrogen containing compounds and phosphorus to protect aquatic life in all segments. The USGS monitored these nutrients levels in lower Coal Creek during quarterly sampling between water year 2000 and 2003. Results for the monitoring are presented in Table 2.5.

**Table 2.5 Summary of Nutrient Water Quality Data for USGS Station on Coal Creek**

| Parameter | Units | Count | Median | Maximum | Exceedances Number | Exceedances % | Comments |
|---|---|---|---|---|---|---|---|
| **Segment 12: Coal Creek and tributaries from the water supply intake to Slate River** | | | | | | | |
| Ammonia | mg/L | 18 | 0 | 0.01 | N/A | N/A | Parameter LRL = 0.015 |
| Nitrite | mg/L | 18 | 0 | <0.002 | 0 | 0% | Parameter LRL = 0.002 |
| Nitrite plus Nitrate | mg/L | 18 | 0.046 | 0.494 | 0 | 0% | Parameter LRL = 0.022 |
| Orthophosphate | mg/L | 18 | 0 | <0.007 | N/A | N/A | Parameter LRL = 0.007 |
| Total Phosphorus | mg/L | 18 | 0.005 | 0.021 | 0 | 0% | Parameter LRL = 0.004 |
| LRL | Laboratory Reporting Level | | | | | | |

Data in Table 2.5 shows that nutrients are not a concern in lower Coal Creek based on 18 samples collected by the USGS at the mouth of Coal Creek. Many of the parameters were not detected above the LRL, a value that is equal to twice the method detection level and controls false-negative error. False negative error is when nondetection is reported for a sample that had a concentration above the method detection limit.

The monitoring does not assess nutrient levels in higher reaches of the watershed. The Town of Irwin has permitted individual sewage disposal systems (ISDS) for sanitary wastes from residential homes, an area that is approximately 8.25 miles upstream of the USGS sampling location. The ISDS represent the highest probability of nutrient loading to Coal Creek in the watershed, although other unidentified sources may exist. To determine the impact of the ISDS in the watershed, nutrient levels should be monitored at locations representative of drainage from Irwin and other areas with a high density of ISDS in the watershed.

## 2.4 PHYSICAL DATA

Physical data recorded for Coal Creek included stream flow, water temperature, conductivity (i.e. specific conductance, SC), dissolved oxygen (DO), pH, and hardness. These parameters were monitored sporadically throughout the water quality review period with the most comprehensive record of physical data at the USGS gaging station at the mouth of Coal Creek (USGS #385224106590100). Physical water quality data is included in Appendix A of this report with a summary of physical water quality for monitoring at the USGS station presented in Table 2.6.

**Table 2.6 Summary of Physical Water Quality Data for USGS Station on Coal Creek**

| Value | Flow cfs | DO mg/L | SC uS/cm | pH S.U. | Temperature degrees C |
|---|---|---|---|---|---|
| Minimum | 0.6 | 7.1 | 62 | 6.80 | 0.1 |
| Maximum | 94 | 10.3 | 365 | 8.20 | 16.3 |
| Mean | 21 | 9.2 | 199 | 7.72 | 5.1 |
| Stream std. | N/A | 7.0 | N/A | 6.5 - 9.0 | N/A |
| N/A | Not Applicable | | | | |

The water quality at the mouth of Coal Creek meets stream standards identified by the CDPHE for segment 12. Two DO standards exist for all segments of Coal Creek; the primary standard is 6.0 mg/L while a secondary standard of 7.0 mg/L was assigned by the CDPHE based on DO levels necessary for fish spawning (listed in Table 2.6). A DO level of 7.1 mg/L was recorded at the USGS gaging station on August 5, 2002 and is typical of late summer DO levels recorded in the three year USGS monitoring record; however, this is not a fish spawning period in the creek. With further monitoring of physical water quality in Coal Creek, including field measurement of flow, DO, SC, and water temperature during sampling events, water quality can be trended for seasonal and spatial comparison in the watershed. Such trending may identify patterns for contaminant source areas in the watershed (e.g. lower pH in acidic mine drainage) such that routine monitoring of physical water quality could identify other contaminant sources and/or progress after implementation of BMPs.

## 2.5 BIOLOGICAL DATA

### 2.5.1 Microbiological Data

Since it is difficult to monitor all pathogenic organisms in surface water, microbiological monitoring typically focuses on indicator organisms to compare the presence or absence

of contamination in water. Microbiologists have used the traditional coliform group of bacteria as indicator organisms with fecal coliform most commonly tested for in polluted water. *Escherichia coli* (*E.coli*) has also been used as an indicator organism for fecal contamination since it is highly present in the human intestine.
Microbiological data was collected by the USGS during quarterly sampling between water year 2000 and 2003 and focused on *E. coli* monitoring. The CDPHE has set chronic stream standards in Coal Creek for *E. coli* not to exceed 126 colonies per 100 mL in all stream segments. A summary of the USGS data is provided in Table 2.7.

**Table 2.7 Summary of Microbiological Data for USGS Station on Coal Creek**

| Value | E. Coli #/100mL |
|---|---|
| Samples | 17 |
| Maximum | 19 |
| Geo. Mean | 2 |
| Stream std. | 126 |
| Exceedances | 0 |

The geometric mean is used for comparison of *E. coli* data to the stream standard set by the CDPHE in Table 2.7. With no exceedances of the stream standard in the three-year sampling period, fecal contamination was not identified as a concern by the USGS in the lower reaches of Coal Creek (USGS, 2003). Without long-range monitoring results for all segments of Coal Creek, however, it is difficult to quantify whether fecal contamination is lower than the stream standard for the entire watershed. As with nutrient monitoring, fecal contamination should be monitored at locations representative of drainage from Irwin and other areas with a high density of ISDS in the watershed.

### 2.5.2 Biological Data

Verifiable biological data could not be located for Coal Creek for the review period of 1991 through 2004.

## 2.6 ADDITIONAL DATA NEEDS

Large data gaps exist for monitoring data in the Coal Creek watershed, as identified in Table 2.1. This report includes a water quality and monitoring plan that will identify parameters to be monitored and their sampling frequency to confirm the contribution from each source area. A priority of this sampling plan will be monitoring baseline or background water quality data to determine the contribution of natural sources to pollutant levels in Coal Creek as compared to known source areas.

# 3.0 Known and Potential Pollution Sources

Pollutants could enter Coal Creek from two main classes of inputs. Point sources are the readily identifiable inputs where waste is discharged to the receiving waters from a pipe or drain. Non-point sources of pollution refer to those inputs that occur over a wide area and are associated with particular land uses, as opposed to individual point source discharges. Both point and non-point sources will be discussed for segments 9, 11 and 12 of Coal Creek in this chapter. Figure 3.1, a map of the watershed including known pollution source areas, is included as the inset map with this section.

## 3.1 POTENTIAL POLLUTION SOURCES IN SEGMENT 9 DRAINAGES

Segment 9 drainages include sub-watersheds S5, N7 and N8 as identified on the watershed mapping. These drainages have varied land uses including mining, residential areas with sewage/septic systems, and recreation.

Sub-watershed N8 drains into Lake Irwin with a trans-basin diversion into upper Coal Creek to augment water supply for the Town of Crested Butte. The Town owns storage rights in Lake Irwin and can divert this water right unless a call by a senior right requires them to close the Coal Creek outlet. This has happened previously during irrigation season (May 1 through September 15) such that drainage from sub-watershed N8 did not flow into Coal Creek. This could conceivably happen each year during irrigation season especially during drought years when flows are lower.

### 3.1.1 Point Sources

No known point sources exist in these sub-watersheds. The Irwin Lodge previously held a discharge permit for a sewage treatment system, but the treatment plant is no longer in operation with plans for replacement with a new system.

### 3.1.2 Non-Point Sources

3.1.2.1 Roadways
County Road 12 (CR12) follows Coal Creek from the Town of Crested Butte through the southern border of sub-watersheds N1 to N7 and the northern and western border of S5. CR12 is part of the West Elk Scenic Loop, which is popular with motorists during summer and fall months. The County of Gunnison maintains the roadway that is paved with chip and seal for the first two miles west of the Town of Crested Butte boundary. After the first two miles, the road is unpaved. Magnesium chloride ($MgCl_2$) is used during heavy traffic periods to suppress dust on the unpaved upper six miles of the road. Several culverts also exist to transfer surface drainage north of CR12 to Coal Creek, potentially impacting stream stability around the culvert discharge during high runoff events.

A 300-acre parcel exists south of the Irwin townsite along CR 12 and Coal Creek that is a potential non-point source of sediment. The area was privately owned at one point with plans for residential development leading to logging activity and clearing for access roads. The Crested Butte Land Trust recently purchased the property although erosion from disturbed lands in the parcel has the potential to impact water quality.

Stakeholders in this project have planned a stream visual assessment protocol (SVAP) during the summer of 2005 to identify the erosion potential on sections of CR12 in the watershed. Based on stakeholder discussions during the development of this report, CR12 will be listed as a potential source of non-point source pollution for all segments of Coal Creek. Without observations from the SVAP, however, the significance of the pollution cannot be determined.

Gunnison County is currently upgrading the Old Kebler Pass road to a multiple-use path for pedestrians and bikes. At this point, enough information is not known on the path to determine its potential as a source of pollution.

#### 3.1.2.2 Sewage Systems

A year-round lodge exists west of Lake Irwin, the Irwin Lodge, which is used primarily for summer and winter outdoor recreation. The current lodge owners are renovating the lodge with plans for a new underground sewage treatment system. The Town of Irwin has individual septic systems with approximately 15 structures currently in use. Most residents of Irwin do not live on a year-round basis but are present during summer of each year. These septic systems, in addition to the proposed Lodge sewage system, are considered potential non-point sources for nutrient and bacterial contamination in the watershed should they fail.

#### 3.1.2.3 Mining

The presence of mines, prospects, and/or mineralized occurrences that belong to one deposit-type or a group of genetically related deposit-types in a geographic area is termed a mineralized area (MA; USGS, 2000). The Coal Creek watershed is within the Ruby MA that includes the Mining Districts of Irwin, Ruby, Mt. Emmons, and Redwell Basin. Mining activity in the watershed occurred in the Ruby Mining District, with the first recorded activity in 1874 (URSOS, 1999). During the 1900's, attempts were made to work the silver-rich base-metal veins of the region, with the Mt. Emmons/Keystone, Micawber (Standard), and Daisy mines beginning operations around 1950 (USGS, 2000). These base-metal veins were mined until 1969, after which molybdenum exploration became the main activity.

Mining activity in sub-watersheds N7 and N8 is around the Irwin townsite in N7, with named mines for this area shown in Figure 3.2.

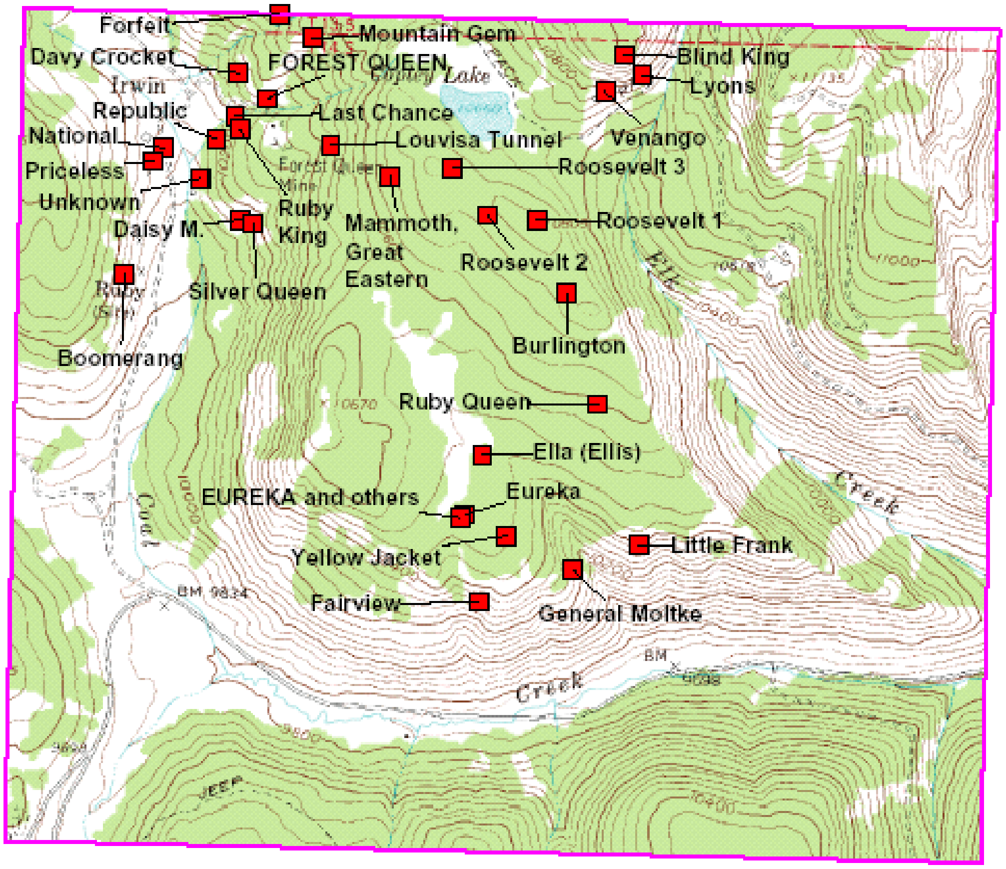



**Figure 3.2 Mapping of Mining Activity in the Segment 9 Drainages of Coal Creek (from USGS, 2000)**

The largest mine in segment 9 drainage is the Forest Queen mine, although the area contains 30 other named mines and several unnamed areas of mining activity. Mined ore material included silver and lead with waste pile rocks in the vicinity of the mines. URSOS characterized mining activity in segment 9 drainages during their site investigation in June 1999, with specific data provided in Table 3.1.

**Table 3.1 Data for Mining Activity in Segment 9 Drainages (from URSOS, 1999) [1]**

| Property or Mine | Sub-watershed | Location | Volume of Mine Waste Rock | Impoundments | Mine Water Discharges |
|---|---|---|---|---|---|
| Forest Queen Mine | N7 | Upper Coal Creek, east bank, east of Irwin | 1,200 $yd^3$ in three large dumps west of shaft | None | None: estimated flow of >15 gpm in bottom of shaft |
| Unnamed adits and prospect pits | N7 | Robinson Basin, source of Lake Irwin | Unknown | Unknown | Unknown |
| Jawcracker | N7 | Independence Basin | 60 $yd^3$ | None | None |
| Little Frank Area | N7 | South of Irwin, Northeast of Coal Creek | 30 $yd^3$ | None | None |
| Unnamed Mines | N7 | Lower Streches of Elk Creek | 50 $yd^3$ | None | None |
| Unnamed Mines | N7 | Lower Streches of Elk Creek | 385 $yd^3$ | Unknown | Yes. No volume given |
| Irwin #1 | N8 | Robinson Basin, source of Lake Irwin | Unknown | Unknown | Unknown |

The mines in the area do not have any referenced treatment systems to reduce metals pollution in drainage or seepage from waste rock piles. The waste piles and abandoned mines therefore have the potential to be a significant non-point source of metals' contamination in the watershed.

3.1.2.4 Recreation

Recreation activity in the segment 9 drainages is seasonal with snowshoeing, skiing and snowmobiling during the winter and hiking, fishing, camping, biking and four-wheeling during the summer. The U.S. Forest Service prohibits camping in the Irwin townsite and throughout the watershed except for developed campsites. Lake Irwin is a popular recreation area with parking and camping facilities for convenient access to recreation trails. The Irwin Campground has standard vault-type toilets. Motorized vehicle access to these areas could also contribute to oil and grease pollution of these drainages as well, as has been observed for Lake Irwin before the U.S. Forest Service banned permitted snowmobilers from riding on the frozen lake surface (Stantec, 2004). Private snowmobilers still ride on the frozen lake because it is flat. Snowmobile activity occurs in other areas surrounding the Lake and in sub-watersheds S5 and N8.

Recreational activities have the potential to increase bacterial contamination from human activity and sediment transport into segment 9 drainages from unpaved parking areas and roadways. Based on these activities, recreation is considered a potential non-point source of pollution to segment 9 of Coal Creek but has not been shown to be significant based on the limited water quality data available (see section 2).

[1] This table does not reference all named mines listed in Figure 3.1, from the USGS, since data for these mines was not provided in the URSOS report. A site investigation would be necessary to collect more data.

Table 3.2 summarizes non-point source areas for segment 9 drainages in Coal Creek by characterizing each sub-watershed. To qualitatively evaluate the potential for human activities and land uses to contaminate Coal Creek, shading is used in the matrix as follows:

- Black indicates the activity is present and *may be* a significant source;
- Grey indicates the activity is present and not a significant source;
- White indicates the activity is not present.

**Table 3.2 Potential Source Areas of Pollution in Segment 9 Drainages to Coal Creek**

| Name | Subwatersheds | Area | Land Uses | | | |
|---|---|---|---|---|---|---|
| | | acres | Roads | Sewage | Mining | Outdoor Recreation |
| S5 | Splains Drainage | 2,427 | | | | |
| N7 | Independence Drainage | 1,941 | | | | |
| N8** | Lake Irwin Drainage | 2,451 | | | | |
| **Segment 9 Drainage** | | **6,818** | | | | |
| ** Seasonal contribution from May 1 to Sept. 15 | | | | | | |

## 3.2 POTENTIAL POLLUTION SOURCES IN SEGMENT 11 DRAINAGES

Segment 11 drainages include sub-watersheds S4, N5 and N6 as identified on the watershed mapping. These drainages have varied land uses including mining in N5 and N6 and outdoor recreation in all sub-watersheds.

### 3.2.1 Point Sources

No known point sources exist in these sub-watersheds. Acidic mine drainage from the Standard Mine adits, or tunnels, is considered a non-point source of pollution since it occurs over a large area and is not specific to the mine tailings pond.

### 3.2.2 Non-Point Sources

3.2.2.1 Roadways
Same risk as identified for CR12 in section 3.1.

3.2.2.2 Sewage
No known septic systems exist in segment 11 drainages.

3.2.2.3 Mining
Two major areas of mining activity exist in segment 11 drainages: the Standard Mine in N6 and the Mt. Emmons/Keystone mine in N5. The mines were two of three largest producing mines in the Ruby Mining District with the Keystone Mine ranked third in silver production in Colorado for several years between 1955 and 1964 (USGS, 1987). The

mines are both currently inactive although mine-related structures remain including waste rock piles and mill tailings.
The Standard Mine is within the boundaries of the Gunnison National Forest at the headwaters of Elk Creek, which flows southeast to Coal Creek in sub-watershed N5. The main years of production at the mine were from 1951 to 1966 with zinc, lead, silver, gold, and copper mined from subsurface tunnels or adits. Numerous mine related structures remain at the mine site including a concrete service pad, a gutted house, a trestle with rails, ore bins, a corrugated metal shed and several adits that are intact and accessible (SAIC, 2002). The main portal accesses a total of about 8,400 feet of drifts on six operating levels (Ellis, 1983) with the main portal at an elevation of 11,000 feet MSL and the highest portal at 11,500 feet MSL. Photographs from the site visit to the Standard Mine area are provided in Appendix B of this report.

The main mine area encompasses five acres with 55,800 cubic yards of waste rock estimated on the ground surface outside of the adits and at the dumping sites at the end of the rail tracks (SAIC, 2002). Elk Creek flows through one of the smaller waste rock piles and there is evidence of erosion and seepage from all the waste rock piles. Below the mill site and adjacent to Elk Creek is a tailings pond that is approximately a half-acre in size (SAIC, 2004). A non-structural tailings dam exists that has a notch on the southern side to permit overflow from the tailing pond into Elk Creek. Seepage from the foot of the tailings dam has been observed with drainage flowing into Elk Creek (Stantec, 2004). Based on the potential for total and dissolved metals to enter Elk Creek, the Standard Mine Site is considered a significant non-point pollution source to segment 11 of Coal Creek.

The Mt. Emmons/Keystone mine spans two sub-watersheds in this study with tailings piles and mine workings located in sub-watershed N5 and the point source discharge from the a treatment plant in sub-watershed N4. A water treatment facility was placed on-line in July 1981 to treat acidic mine drainage from the Mt. Emmons/Keystone mines. Drainage from mine waste sources has been engineered to flow into retaining ponds on the mine property. A collections system exists below the tailings ponds to collect drainage and pump back into the water treatment plant. The water treatment facility utilizes pH adjustment, clarification, and sand filtration to remove dissolved and total metals before discharge to segment 12 of Coal Creek. The potential for non-point source drainage from these mine sites into segment 11 exists although it is not considered significant due to remediation activities.

In addition to the Standard and Mt. Emmons/Keystone mine, waste rock from other mining activity exist in segment 11 drainages that have the potential to impact water quality. URSOS characterized mining activity in segment 11 drainages during their site investigation in June 1999, with specific data provided in Table 3.3.

**Table 3.3 Data for Mining Activity in Segment 11 Drainages (from URSOS, 1999)**

| Property or Mine | Sub-watershed | Location | Volume of Mine Waste Rock | Impoundments | Mine Water Discharges |
|---|---|---|---|---|---|
| Standard | N6 | Upper Elk Creek | 55,800 $yd^3$ in several dump piles. Elk Creek is eroding these piles. | Smaller: 120 ft diameter, 8 ft deep; Larger: 300 ft. diameter, 15 ft deep | 200 gpm from main shaft in spring, 10 gpm from main shaft in fall |
| Unnamed Mines | N6 | Upper Elk Creek Basin | 75 $yd^3$ | None | None |
| Unnamed Mines | N6 | Northeast flank of Upper Elk Creek Basin | Minimal | None | None |
| Bonanza King and Number Seven | N6 | Upper Elk Creek Basin | 600 $yd^3$ | None | 10 gpm in spring |
| Mt. Emmons / Keystone Mine | N5 | North Side of Coal Creek in Evans Basin | Waste rock is located topographically above capped impoundments | Four capped and vegetated tailings impoundments | Up to 1200 gpm of treated water discharged to Coal Creek |
| Unnamed Adits | N5 | Northwest of Keystone Tunnel | Approximately 300 to 400 $yd^3$ | Unknown | Possible |

With waste rock piles associated with mining activity other than the Standard and Mt. Emmons/Keystone mines, quantifying specific sources of metals pollution in segment 11 may be difficult without a more finite characterization of waste rock volumes and mine water discharges. However, it can be stated that mining activity is present in segment 11 drainages and is a significant source of non-point source pollution to Coal Creek.

#### 3.2.2.4 Iron Fen

An area with soils characterized by high iron content is located just west of the Mt. Emmons/Keystone Mine in sub-watershed N5 (referred to in the report at the Iron Fen). The Iron Fen is approximately two acres in size with an estimated water depth of 18 to 24 inches (URSOS, 1999). A rust colored material lines the bottom of the fen and appears to be colloidal iron precipitate, under which lies black organic material (URSOS, 1999). Flow out of the Iron Fen is to the southwest towards Coal Creek and based on URSOS sampling in June 1999 contains ferrous ($Fe^{2+}$) iron and other metals. The metals concentrations in the Iron Fen were generally higher than surface water but lower than those found in mine water discharges (URSOS, 1999).

A fire burned in the area in the early 1980's and little vegetation has since grown back. Mining claims still exist for the Iron Fen despite the unique properties of this natural feature and its designation as a Colorado Natural Area in 1980. The Iron Fen is potentially a significant natural contamination source to segment 11 of Coal Creek considering the elevated metals concentrations and potential for mining activity.

#### 3.2.2.5 Recreation

Recreation activity in the segment 11 drainages is not as heavy as in segment 9. However, the extensive network of forest roads in segment 11 sub-watersheds present opportunities for off-road motorized traffic. Forest roads in sub-watershed S4 allow vehicular access to Wildcat Creek. A restricted access gate exists on Forest Road 732 that serves as access points to both the Standard and Mt. Emmons/Keystone mining areas. There is an un-maintained road up and over Gunsight Pass where motorized vehicles sometimes gain access to the Standard Mine area. URSOS (1999) noted ATV tracks in the vicinity of the tailings pond in June of 1999. Currently, access controls are not sufficient to minimize public access. Human activity in the mine areas has the potential to increase metal and sediment transport into Elk Creek. Based on this, recreation is potentially a significant non-point source of pollution in sub-watershed N6 and a minor source in N5 and S4.

Table 3.4 summarizes non-point source areas for segment 11 drainages in Coal Creek by characterizing each sub-watershed according to criteria discussed in section 3.1.

**Table 3.4 Potential Source Areas of Pollution in Segment 11 Drainages to Coal Creek**

| **Name** | **Subwatersheds** | **Area** | **Land Uses** | | | |
|---|---|---|---|---|---|---|
| | | acres | Roads | Sewage | Mining | Outdoor Recreation |
| S4 | S4 | 1,366 | | | | |
| N5 | Evans Drainage | 1,741 | | | | |
| N6 | Elk Cr. Drainage | 1,014 | | | | |
| **Segment 11 Drainage** | | **4,121** | | | | |

## 3.3 POTENTIAL POLLUTION SOURCES IN SEGMENT 12 DRAINAGES

Segment 12 drainages include sub-watersheds S1, S2, S3, N1, N2, N3 and N4 as identified on the watershed mapping. These drainages have varied land uses including mining in N4 and S2, septic systems in S1, and outdoor recreation in all sub-watersheds.

### 3.3.1 Point Sources

As discussed in section 3.2, the Mt. Emmons/Keystone Mine water treatment facility discharges into segment 12 of Coal Creek. The discharge enters the north side of Coal Creek on the south side of CR12, 50 feet downstream from the Town of Crested Butte municipal intake. For this evaluation, the discharge will be considered drainage from sub-watershed N4 although a majority of the mining activity was present in N5. As a requirement for the Colorado Discharge Permit System (CDPS), monthly water quality samples are collected and analyzed for physical water quality and metals concentrations. A summary of water quality data is provided in section 2 for the Mt. Emmons/Keystone point discharge.

### 3.3.2 Non-Point Sources

3.3.2.1 Roadways
Same risk as identified for CR12 in section 3.1 with additional unpaved roadways in the Trapper's crossing subdivision. The subdivision is 3500 acres and spans subwatershed S1, S2, S3, N1, N2 and N3. Erosion and runoff from subdivision roads have the potential to impact water quality in the lower reaches of Coal Creek.

3.3.2.2 Sewage Systems
Trapper's Crossing subdivision has residential homes served by individual septic systems. The buildout capacity of the subdivision is 100 homes, all of which would be served by separate systems. Should these systems fail, the potential exists for bacterial and nutrient contamination to reach Coal Creek.

The Town of Crested Butte owns and operates a wastewater treatment system that collects and treats sewage from Crested Butte, including residences and businesses in the Town limits. The wastewater plant discharges to the Slate River east of Town and outside of the Coal Creek watershed.

3.3.2.3 Mining
Known mining activity in segment 12 drainages is limited to sub-watershed S2. Unnamed mine workings are located northwest of Green Lake at the source of Wildcat Creek. URSOS did not report specifics on the volume of waste rock or mine water discharges during their site investigation.

A gravel pit operated by Gunnison County exists in subwatershed N5. The County does not hold a discharge permit for the gravel pit. As such, the gravel pit is not considered a significant point source of pollution to Coal Creek.

3.3.2.4 Recreation
As with other segments of Coal Creek, recreation is popular in segment 12 drainages. Forest Roads and trails exist in all sub-watersheds increasing human activity, especially along major drainages such as Wildcat Creek. During the winter, CR12 is closed just west of the entrance road to the Mt. Emmons/Keystone Mine (FR 732) with motorized vehicle parking (including snowmobiles) at the gate. Parking in this area has the potential to increase oil and grease pollution to Coal Creek from sub-watershed N3. Other recreational activities, namely during the summer, have the potential to increase erosion and sediment transport for drainages to Coal Creek. Trapper's Crossing subdivision roads are located to the north and south of Coal Creek. Recreation activities are present throughout segment 12 drainages, although they are not considered a significant non-point pollution source to segment 12 of Coal Creek.
Table 3.5 summarizes non-point source areas for segment 12 drainages in Coal Creek by characterizing each sub-watershed according to criteria discussed in section 3.1.

**Table 3.5 Potential Source Areas of Pollution in Segment 12 Drainages to Coal Creek**

| Name | Subwatersheds | Area | Land Uses | | | |
|---|---|---|---|---|---|---|
| | | acres | Roads | Sewage | Mining | Outdoor Recreation |
| S1 | Gibson Drainage | 1,332 | | | | |
| S2 | Wildcat Drainage | 1,332 | | | | |
| S3 | S3 | 121 | | | | |
| N1 | N1 | 232 | | | | |
| N2 | Coon Drainage | 768 | | | | |
| N3 | N3 | 115 | | | | |
| N4 | Red Lady Drainage | 753 | | | | |
| **Segment 12 Drainage** | | **4,653** | | | | |

## 3.4 SUMMARY OF POTENTIAL POLLUTANT AREAS

To summarize potential pollutant source areas, Table 3.6 combines pollutant data for all segments of Coal Creek. Significant pollutant source areas include N5, N6, N7 and S2 for mining and N6 for recreational activity. Non-point source pollution from roadways and sewage systems could be present in the watershed, although the available water quality data reviewed in section 2 did not show exceedances for biological or physical parameters. Section 2 did identify metals exceedances for segments 11 and 12 of Coal Creek, specifically cadmium, copper, lead and zinc. As such, efforts to reduce metals loading to Coal Creek will focus on mining source areas listed in Table 3.6 as 'significant'.

## Table 3.6 Potential Source Areas for Coal Creek

| Name | Subwatersheds | Area | Land Uses | | | |
|---|---|---|---|---|---|---|
| | | acres | Roads | Sewage | Mining | Outdoor Recreation |
| **Segment 9** | | | | | | |
| S5 | Splains Drainage | 2,427 | | | | |
| N7 | Independence Drainage | 1,941 | | | | |
| N8** | Lake Irwin Drainage | 2,451 | | | | |
| **Segment 11** | | | | | | |
| S4 | S4 | 1,366 | | | | |
| N5 | Evans Drainage | 1,741 | | | | |
| N6 | Elk Cr. Drainage | 1,014 | | | | |
| **Segment 12** | | | | | | |
| S1 | Gibson Drainage | 1,332 | | | | |
| S2 | Wildcat Drainage | 1,332 | | | | |
| S3 | S3 | 121 | | | | |
| N1 | N1 | 232 | | | | |
| N2 | Coon Drainage | 768 | | | | |
| N3 | N3 | 115 | | | | |
| N4 | Red Lady Drainage | 753 | | | | |
| ** Seasonal contribution from May 1 to Sept. 15 | | | | | | |

**Figure 3.1 Known and Potential Pollution Source Areas Map**

Figure 3.1 is enclosed in the pocket following this page.

# 4.0 Identified Management Measures, Potential Load Reductions and Costs

## 4.1 STREAM STANDARDS

The water quality data reviewed in Section 2.0 was compared to the CDPHE water quality standards for segments 9, 11 and 12 of Coal Creek. Generally, these numeric standards are the state's "table value standards", or TVS. The TVS are based on an empirical relationship with hardness values, and may vary spatially throughout the watershed. The Colorado Water Quality Control Commission may adjust the TVS on an exception basis for a particular stream segment after analysis of actual stream conditions and on actual and potential water uses. Temporary modifications and qualifiers for segments 11 and 12 of Coal Creek are compared to acute TVS standards in Table 4.1. The acute TVS standards were calculated based on water quality data collected during the CCWC's sampling in August 2004 *during low flows*. Since insufficient hardness data exists to perform a regression analysis, the hardness values for samples collected at the end of each segment were used. Since the samples were grab samples, acute values were assumed more representative than chronic standards for comparison to metals values reported.

**Table 4.1 Stream Standards for Segments 11 and 12 (CDPHE, 2002)**

| Segment | Metal | TVS* ug/L | Modification ug/L | Expiration Date |
|---|---|---|---|---|
| 9 | Cadmium | 1.4 | - | |
| | Copper | 5.0 | - | |
| | Lead | 20 | - | |
| | Zinc | 48 | - | |
| 11 | Cadmium | 2.0 | 3.5 | 12/31/2006 |
| | Copper | 6.9 | - | |
| | Lead | 30 | - | |
| | Zinc | 64 | 661 | 12/31/2006 |
| 12 | Cadmium | 3.9 | - | |
| | Copper | 12 | - | |
| | Lead | 59 | - | |
| | Zinc | 109 | 598 | 12/31/2006 |

Acute numbers adopted as stream standards, such as those in Table 4.1, are not to be exceeded once every three years on average (CDPHE, 2002). As an overall objective for this project, the CCWC has identified a goal of restoring water quality to ambient or aquatic life standards for Coal Creek and its tributaries (CCWC, 2005). Aquatic life standards are considered to be acute TVS standards listed in Table 4.1, and for the purpose of calculating metals load reductions needed in the watershed, will be used as water quality objectives for the remainder of this report.

## 4.2 METALS LOADING TO COAL CREEK

Section 2 identified that cadmium, copper, lead, and zinc levels exceeded chronic stream standards in segments 11 and 12 during high flow periods or spring runoff. To correlate metals load to metal concentration data, stream flow data is needed for water quality sampling events. A large percentage of the water quality data reviewed in Section 2 does not have corresponding flow data. This section will review methods to estimate flows and project metals loads from source areas identified from Section 3. To establish management measures for contributing source areas, necessary load reductions will be calculated and compared with appropriate pollution control measures.

### 4.2.1 Flow Estimates for Segments 11 and 12

Seasonal metals load calculations are possible when water quality sampling and flow data are both available for four or more consecutive quarters. Quarterly water quality sampling occurred from 1995 to 1997 at stations AMAX CC2A (segment 11) and AMAX KP-1 (segment 12), and from 1995 to 1996 at AMAX EC-1 (Elk Creek). However, quantitative flow data was not collected during these water quality sampling events. Therefore, indirect methods were used to extrapolate flow volumes above and below the Crested Butte municipal intake.
Two commonly used methods to estimate stream flow were reviewed:

1. Historical hydrograph where historical flow data is trended to develop a hydrograph which can be used to estimate flows;
2. Contributing watershed approach where delineated watershed areas are used to estimate contributing flows from each sub-watershed or drainage;

Both methods are recognized as reliable when sufficient data exists. Reviewing historical flow data for the Coal Creek and Slate River watersheds, reliable data was only available for gaging stations on Coal Creek and the Slate River from 1941 to 1946. Daily mean streamflow was recorded at USGS station #09111000 on Coal Creek and at USGS station #09111500 from 10/1/1941 to 9/30/1946. The Coal Creek station was located 1,000 feet downstream of the Elk Creek confluence while the Slate River station was located a half-mile east of Crested Butte and two-thirds mile downstream of the Coal Creek confluence. The Slate River station has been identified by the USGS for long-term water quality and streamflow gaging. Daily mean streamflow data was available for this station from 1995 through 1997, the period when flow data is desired for segments 11 and 12. With historical hydrograph data and estimates on contributing watershed drainage available from GIS mapping, a parallel-watershed analysis was completed using a hybrid of both methods.

The parallel-watershed analysis used historical daily mean streamflow to develop a hydrograph for Coal Creek and the Slate River below Coal Creek. The contributing drainage for each station was then used to calculate a hydrograph for the Coal Creek station based on the Slate River hydrograph. The contributing drainage to these stations was 8.65 square miles for Coal Creek and 68.9 square miles for the Slate River. The parallel-watershed analysis compared 1,826 data points and returned a Pearson correlation of 0.95 ($r^2$ = 0.91 or 91%) between the actual and estimated flow for the Coal Creek station. This correlation states that flow can be estimated for Coal Creek using the parallel-watershed model with a variance error of 9%, a level that is acceptable since the calculated data was to be used to compare metals loads for segment 11 relative to 12. Figure 4.1 shows a snapshot of this analysis, with estimated flows compared with actual flows measured on Coal Creek below Elk Creek for 20 days in October 1941.

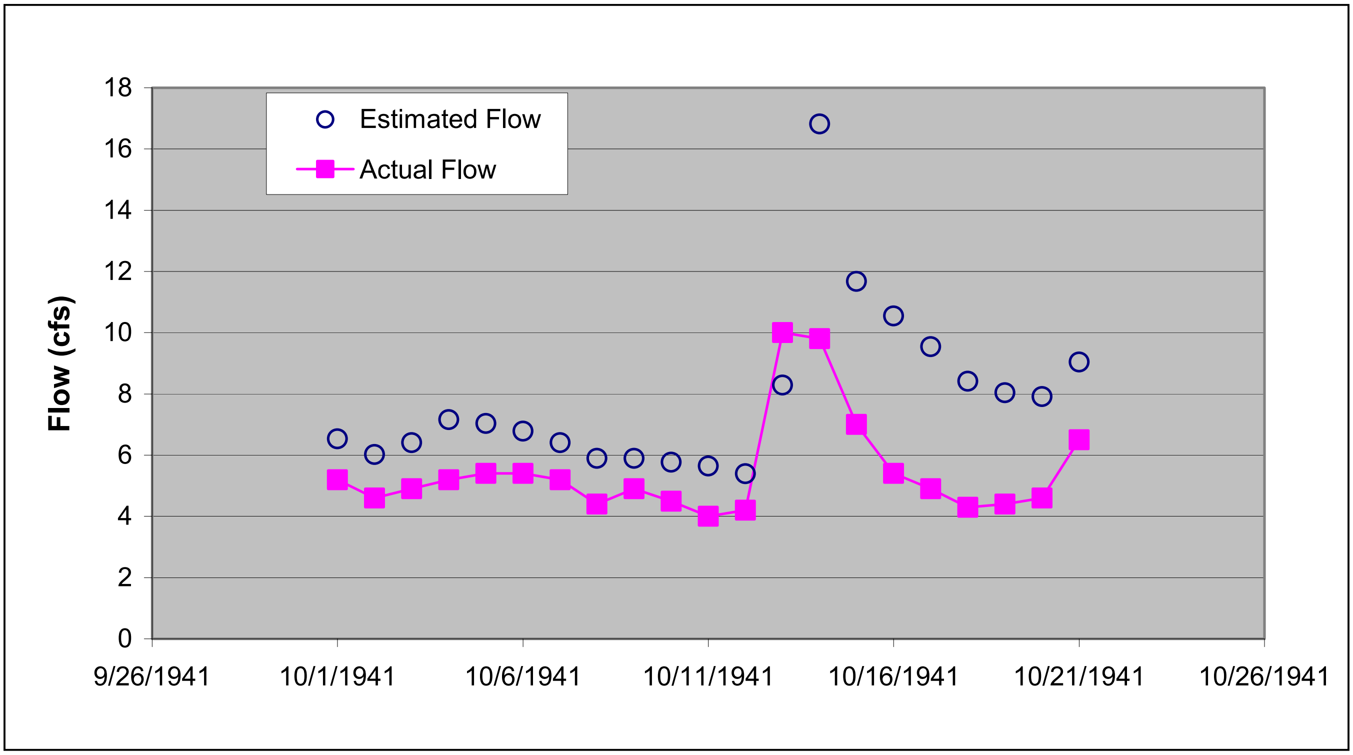



**Figure 4.1 Snapshot Comparison of Estimated and Actual Flow for Coal Creek after Elk Creek confluence**

### 4.2.2 Zinc Loading in Segments 11 and 12

Zinc loading for segments 11 and 12 of Coal Creek was calculated by multiplying zinc concentration by flow data for each sampling event. Figure 4.2 compares zinc loading between segment 11 and 12 by trending zinc loads for stations AMAX CC2A (seg. 11) and AMAX KP-1 (seg. 12). Figure 4.3 displays zinc loading in segment 11 for Elk Creek (AMAX EC-1) and Coal Creek 2.25 miles downstream of Elk Creek (AMAX CC2A). It should be noted that it was necessary to graph the zinc loads in log scale (y-axis) to fit the minimum and maximum data.

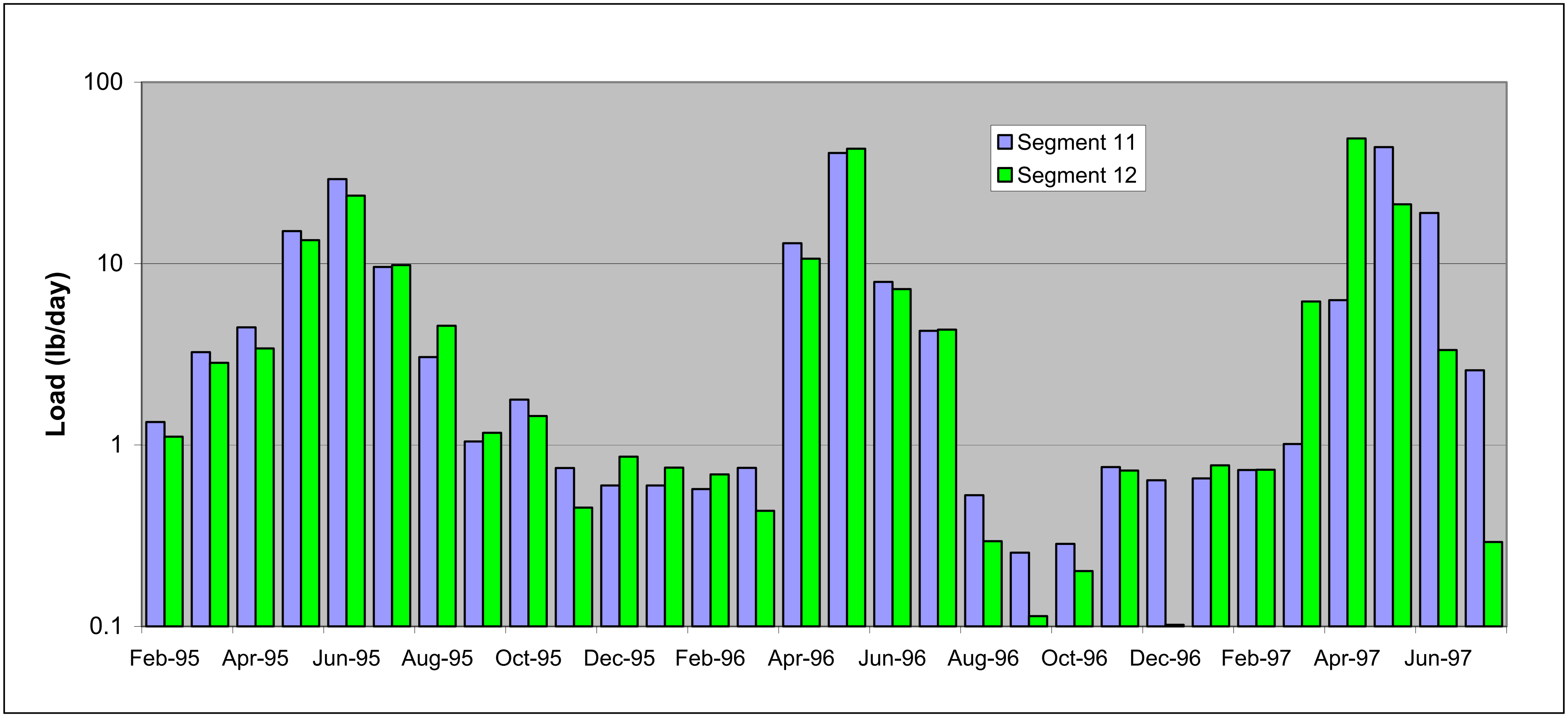



**Figure 4.2 Zinc Load in Segments 11 and 12 of Coal Creek based on Monitoring from 2/1995 to 8/1997**

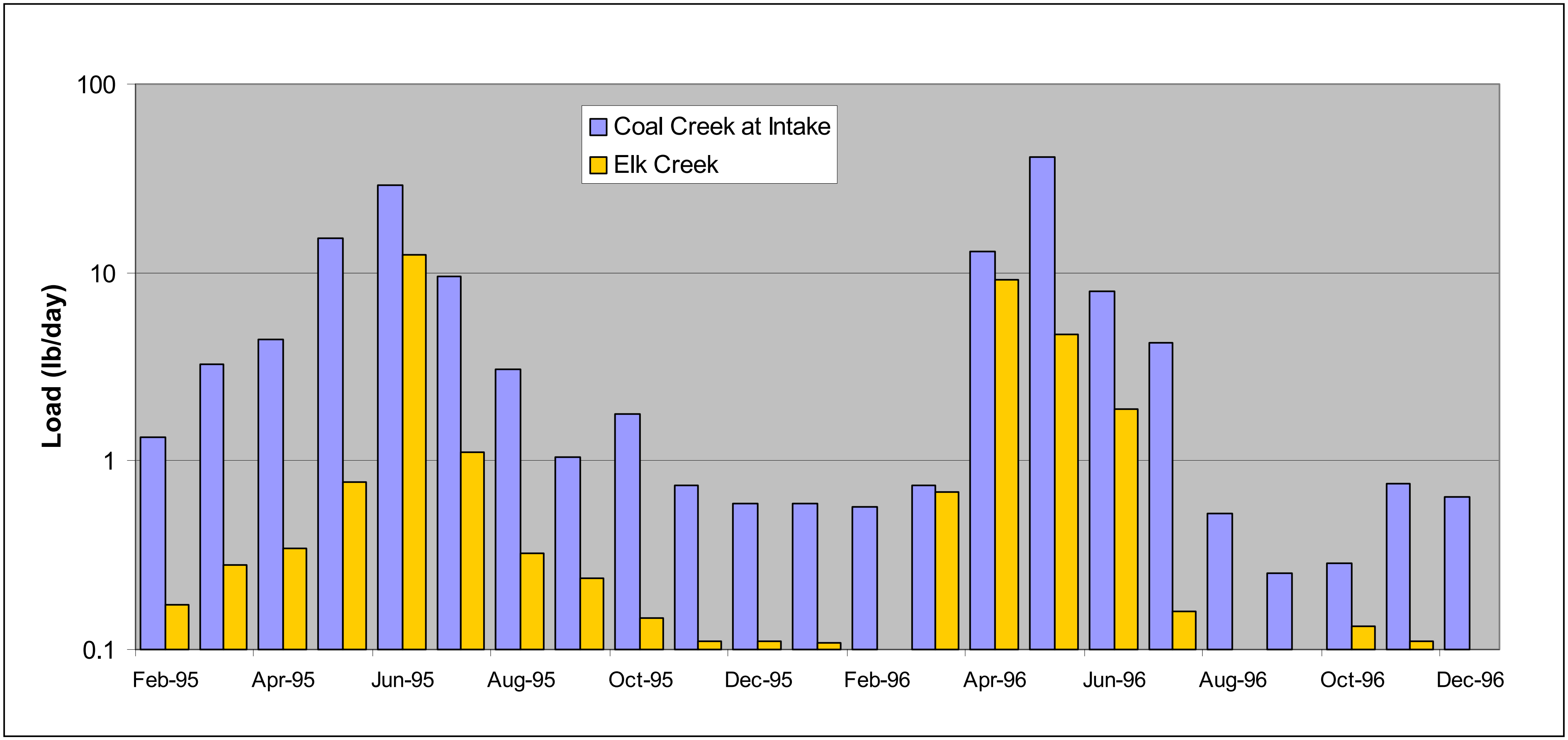



**Figure 4.3 Zinc Load in Segments 11 of Coal Creek based on Monitoring from 2/1995 to 8/1997**

Observations from Figures 4.1, 4.2 and 4.3 include:

1. Calculated flows for Coal Creek overestimated actual flows recorded, with overestimates greater at higher actual stream flows;
2. Using monthly water quality sampling and estimating flow for these sampling events allowed for calculation and comparison of seasonal zinc loads in Coal Creek;
3. Zinc loading is greatest during spring runoff (May-June) of each year with zinc loads exceeding 10 lb/day (based on one sample per month);
4. Zinc loading is generally below 1 lb/day from September through March;
5. The month of April and July through August are transition months when loading is generally between 1 and 10 lb/day;
6. Zinc loading in Segment 11 generally exceeds Segment 12 based on samples collected above the Crested Butte Intake and at the first Kebler Road Bridge;
7. Elk Creek zinc loads appear to be less than Coal Creek loads in Segment 11 and do not exceed 1 lb/day except for spring runoff periods based on 1995-'96 data sets;
8. Current flows and zinc loading in Elk Creek do not appear to be the only source of zinc loading to Coal Creek before the Crested Butte intake.

Reviewing water quality data for segments 11 and 12 in Appendix A, other metal concentrations are elevated during spring runoff such that the same trend are observed for known contaminants identified in Section 2.3 including cadmium, copper, and lead. As such, zinc loading will be used as the 'model' metal in the remainder of this chapter with the assumption that other metals exhibit similar characteristics.

## 4.3 NEEDED LOAD REDUCTIONS

### 4.3.1 Needed Load Reductions for Segments 11 and 12

To determine the necessary load reductions, dissolved zinc concentrations were compared to acute TVS stream standards in segments 11 and 12. For those concentrations that exceeded stream standards, a percentage reduction was calculated to lower the concentration below stream standards. This percentage reduction in concentration was correlated to zinc loading (lb/day) so that comparisons could be made between segment 11 and 12. With different stream standards in segment 11 and 12, calculated load reductions had to be compared on a load basis instead of concentration basis. Table 4.2 displays the needed reductions in zinc loading to meet stream standards for segments 11 and 12. Data compiled for the table is from synoptic samples collected during high flows (URSOS, 1999) and low flows (CCWC, 2004) when hardness values were reported to calculate acute TVS standards.

**Table 4.2 Needed Zinc Load Reductions for main stem of Coal Creek[2]**

| Season | Segment | Zinc | Zinc Std. | Zinc Load* | Reduction needed | |
|---|---|---|---|---|---|---|
| | | ug/L | ug/L | lb/day | % | lb/day |
| High Flow | 9 | 6 | 30 | 0.257 | 0% | 0.00 |
| | 11 | 122 | 32 | 6.83 | 74% | 5.04 |
| | 12 | 125 | 39 | 2.80 | 69% | 1.93 |
| | **TOTAL** | | | **9.89** | **70%** | **6.97** |
| Low Flow | 9 | 12 | 49 | 0.032 | 0% | 0.000 |
| | 11 | 200 | 65 | 0.777 | 68% | 0.548 |
| | 12 | 140 | 157 | 0.000 | 0% | 0.000 |
| | **TOTAL** | | | **0.809** | **68%** | **0.548** |

* Zinc load is calculated as composite increase to Coal Creek from Lake Irwin to the Slate River

Based on the synoptic data sets, zinc load reductions are needed in segment 11 and 12 during high flow periods and in segment 11 during low flows. Load reductions are not needed for segment 9. These conclusions were reached based on water quality monitoring data for three sample areas that coincided for the two data sets and where acute TVS stream standards could be calculated:

1. At the end of segment 9 before Elk Creek;
2. Before the Crested Butte Municipal Intake on segment 11;
3. Below the Mt. Emmons/Keystone Mine discharge on segment 12.

Based on synoptic zinc loading data, achieving a 74% metals load reduction in segment 11 would meet stream standards in segments 11 during high and low flows. For segment 12, 16%* of the zinc load in segment 12 would need to be removed during high flows to achieve stream standards (*difference of segment 11 and 12 zinc loads divided by segment 12 zinc load). This particular data set shows that load reductions of 7 lb/day during high flows and 0.55 lb/day during low flows would be needed to achieve aquatic stream standards for the *main stem of Coal Creek*. Load reductions for tributaries to Coal Creek, such as Elk Creek, could require high load reductions to achieve acute aquatic life stream standards. As the project progresses with additional data, adjustments to needed load reductions may be necessary.

### 4.3.2 Source Area Contributions in Segments 11 and 12

To identify management measures, the percentage contribution of known contaminant source areas in segments 11 and 12 must be established. The source area contributions will be compared to the needed metals load reduction to determine the best management measures for meeting the goals of this project.
Synoptic sampling during June 1999 represents the most comprehensive spatial testing of water quality in segments 11 and 12 of Coal Creek. Samples were collected above and below major drainages with water quality and quantity (flow) data available for most samples. Due to data gaps in stream flow data, however, actual zinc loads could not be calculated for all water quality sample locations. Estimates on stream flow were needed

[2] Zinc standards calculated for Table 4.2 are based on hardness values reported for samples collected in each segment and may differ from those TVS standards reported in Table 4.1

to delineate pollutant source areas for Coal Creek. Assuming that the contributing watershed analysis can be used to generate stream flows for these water quality samples, flows were calculated for June 22-24, 1999 when field sampling was completed.
From actual and calculated zinc loads, increases in zinc loading were calculated based on spatial sampling along Coal Creek. Figure 4.4 displays this data in a pie chart. Percent contributions were calculated for samples collected from the Lake Irwin outfall to above the Slate River confluence. These contributions were based on the percent each sample location contributed to the cumulative zinc load to Coal Creek (total = 9 lb /day).

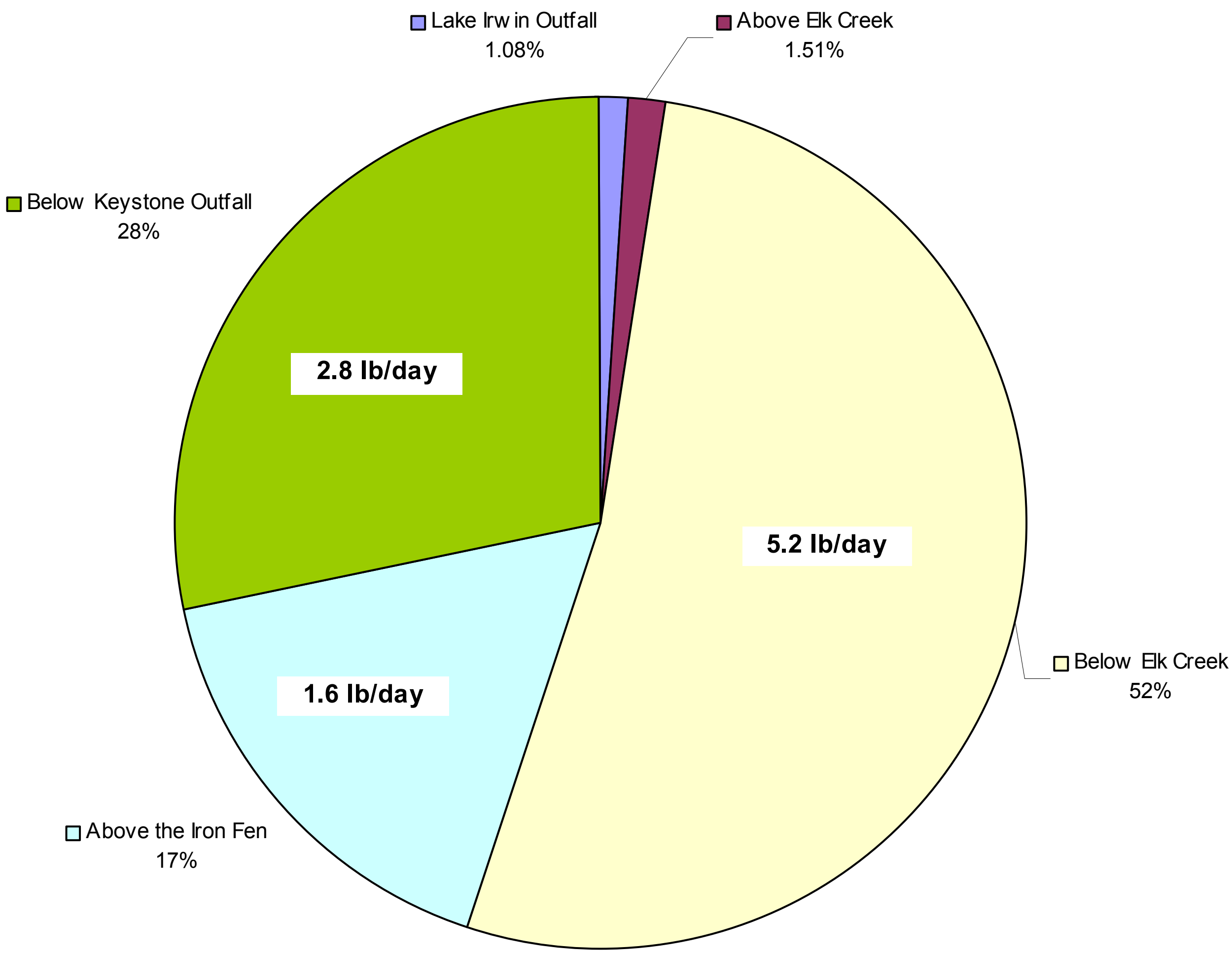



**Figure 4.3 Percent Contribution from Pollutant Source Areas to main stem of Coal Creek in June 1999 (URSOS, 1999)**

Figure 4.4 shows that three significant zinc loadings occur to Coal Creek:
1. 52% enters below Elk Creek or 5.2 lb/day during high flows;
2. 17% enters below Elk Creek and above the Iron Fen or 1.6 lb/day;
3. 28% enters below the Mt. Emmons/Keystone Mine outfall, or 2.8 lb/day;

It cannot be assumed that the composite 28% zinc load below the Mt. Emmons/Keystone Mine is solely from the Mine outfall since the sample was collected below the drainage prior to Coal Creek and not at the end-of-pipe from the water treatment plant. Phelps-Dodge is the owner of the Mt. Emmons / Keystone Mine water treatment plant (WTP) at the time of this study. Data collected by Phelps-Dodge, as a requirement of their CDPS permit, provided both zinc concentration and flow data for monthly sampling in 1999. Although the CDPS sampling date in June 1999 did not coincide with URSOS sampling, a review of monthly grab sample analyses for the WTP effluent revealed a maximum zinc load of 0.06 lb/day. This load is 2% of the 2.8 lb zinc/day increase calculated for the sample taken by URSOS below the Mine outfall. Without more definitive data, other pollutant source areas in sub-watershed N4 appear to contribute considerable zinc loads to Coal Creek.

Clearly, the largest zinc load occurs after Elk Creek based on synoptic sampling. The two zinc loads between the Elk Creek confluence and before the Iron Fen comprise 5.2 lb zinc/day and 1.6 lb zinc/day. With no major pollutant sources identified in Section 3.0 between Elk Creek and the Iron Fen, it will be assumed for this report that both zinc loads are from Elk Creek. As such, the combined 6.8 lb/day load is 69% of the 9.9 lb/day total load for Coal Creek. With Elk Creek accounting for 6.8 lb/day of high flow zinc loading to Coal Creek, it would seem logical to focus management measures on the Standard Mine site to achieve the 7.0 lb/day reduction goal identified for segments 11 and 12 in Table 4.2.

However, estimates need to be made on what zinc load reductions could be attained by meeting stream standards in upper Elk Creek as compared to other pollutant source areas. The Elk Creek drainage is only 1,014 acres (6.5% of watershed) with variable stream flows (and metals loading) between high and low flow periods. To evaluate potential load reductions, zinc concentrations were compared to chronic stream standards for

i. High flow conditions based on URSOS sampling in June 1999, and
ii. Low flow conditions based on the CCWC sampling in August 2004.

By determining load reductions needed for high and low flows, management practices can be tailored to achieve stream standards year-round throughout the watershed. Table 4.3 displays needed zinc load reductions from pollutant areas that exceed aquatic stream standards in Coal Creek, including tributaries and wetlands. It should be restated that the data used for calculating the load reductions is based on synoptic data, during high and low flows, from distinct sample locations on drainages in the watershed. Other drainages or wetlands in the watershed may exceed stream standards, but were not sampled during these sampling events.

**Table 4.3 Needed Zinc Load Reductions from Pollutant Source Areas**

| Season | Segment | Source Area | Zinc | Zinc Std. | Zinc Load | Reduction | |
|---|---|---|---|---|---|---|---|
| | | | ug/L | ug/L | lb/day | % | lb/day |
| High Flow | 11 | Standard Mine | 1,940 | 32 | 6.83 | 98% | 6.72 |
| | 11 | Iron Fen | 4,910 | 45 | 0.059 | 99% | 0.058 |
| | 12 | Below Keystone Outfall | 611 | 392 | 2.80 | 36% | 1.00 |
| | | TOTAL | | | **9.69** | **80%** | **7.78** |
| Low Flow | 11 | Standard Mine | 11,000 | 160 | 0.777 | 99% | 0.766 |
| | 11 | Iron Fen | 3300 | 60 | 0.004 | 98% | 0.003 |
| | 12 | Below Keystone Outfall | 140 | 350 | 0.000 | 0% | 0.00 |
| | | TOTAL | | | **0.781** | **99%** | **0.769** |

Comparing data from Table 4.2 with the inventory of needed zinc load reductions in Table 4.3, the 7.0 lb/day load reduction needed in Coal Creek during high flows can be achieved *only* if reductions occur from the Standard Mine site and below the Mt. Emmons/Keystone Mine drainage. The zinc load from the Iron Fen is negligible compared to these loads and has been considered a natural background source by the CCWC. To meet the low flow reduction goal of 0.55 lb/day in Coal Creek (Table 4.2), load reductions solely from the Standard Mine site could be necessary. To achieve reduction goals using management measures at the Standard Mine, a 98% reduction in zinc loading is needed during high flow periods while a 99% reduction is needed during low flow periods. This approach assumes that all drainages in the upper Elk Creek watershed are subject to acute aquatic stream standards and are targets for needed load reductions.

## 4.4 MANAGEMENT STRATEGIES

### 4.4.1 Previous Studies

Management strategies for the Standard Mine Site have been analyzed by SAIC in their Engineering Evaluation/Cost Analysis (2002). A comparative analysis was completed on five alternatives:

1. Adit and Shaft Closure: restrict access to the mine adits and shaft workings by backfilling and sealing mine shafts;
2. Excavate, Consolidate, Dispose in On-site Cell: excavate all of the waste rock and mill tailings and then place in an engineered cell;
3. Excavate, Consolidate, Dispose of Majority of Tailings to On-site Cell: excavate only a portion of the waste rock and mill tailings located in close proximity to Elk Creek and then place the material in an engineered cell;
4. Treat Acidic Discharge using Bioreactor System: passively treat acidic mine drainage by plugging the main adit and treating discharge water with a bioreactor system;
5. Excavate and Dispose Off-site: excavate mill tailings and waste rock and place the materials in a permitted off-site facility

Each of these alternatives was evaluated in the report on the basis of effectiveness, implementability, and cost.

### 4.4.2 Standard Mine Source Areas

Management strategies for the Standard Mine will need to focus on minimizing acidic mine drainage from entering Elk Creek. With load reductions from the mine needed during high and low flows (see Table 4.3) and the disturbed mining area encompassing five acres, general strategies will be discussed. The intent is that these strategies would be implemented where acidic mine drainage would be managed to meet the necessary load reductions during high and low flows.
There are several major sources of metals from the mine site. Three of these areas were tested during high flows with the URSOS site investigation with samples collected for:

1. Background levels for Elk Creek above historical mining activity;
2. Elk Creek below upper level adits noted as levels 2 through 5;
3. Drainage from the main mine adit described as Level 1;
4. Tailings pond below the mill site;
5. Elk Creek below the tailings pond and mine site;

The CCWC collected low flow samples in August 2004 for areas #1, #4 and #5 along with a sample in Elk Creek below #2 and #3. Based on observed and estimated flows from these areas during these site investigations, zinc loads were calculated from metals data. Figure 4.4 displays the contributing zinc load from these areas for high and low flows.

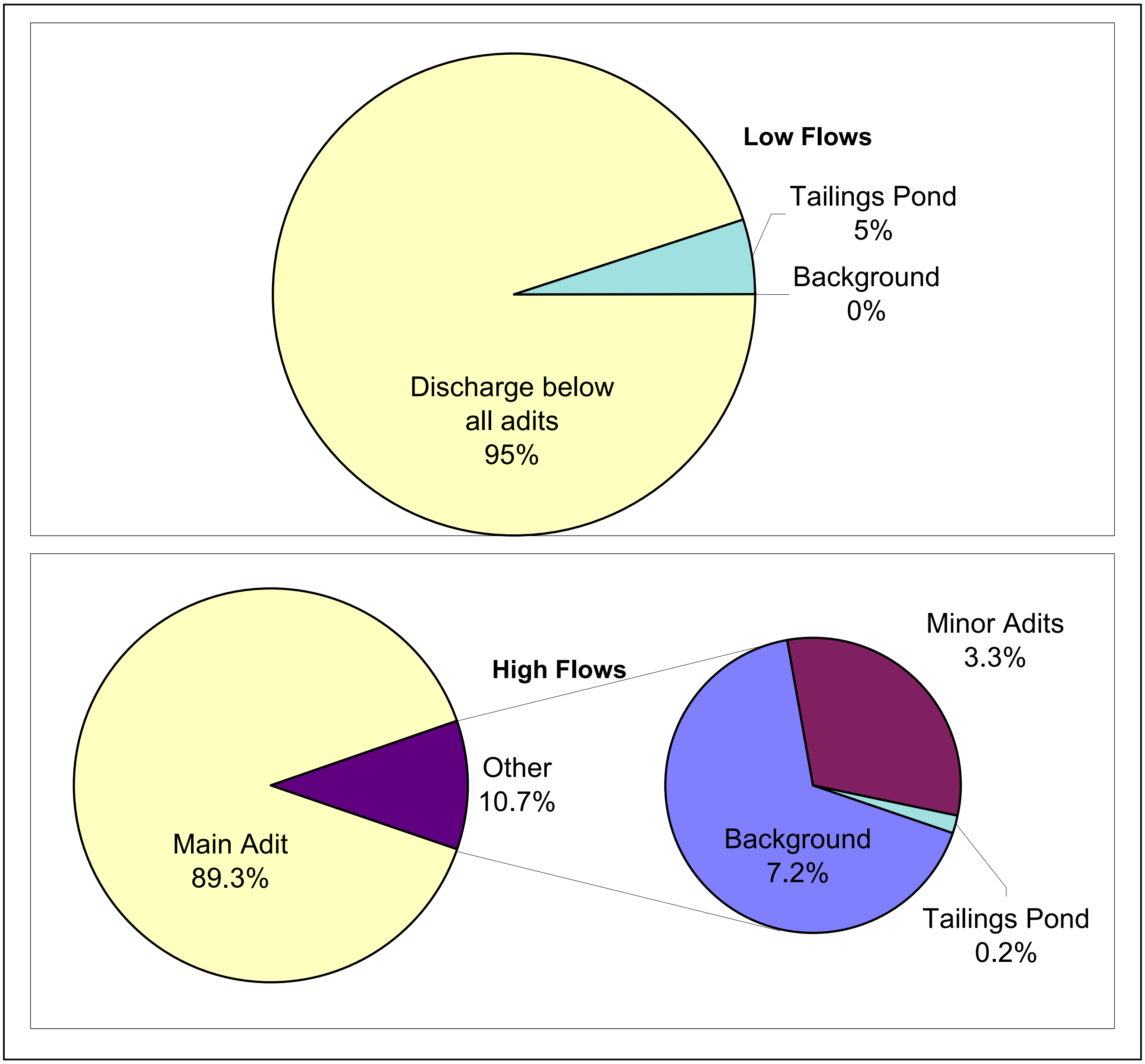



**Figure 4.4 Percent Contribution of Source Areas to Zinc Loading at Standard Mine for low flow (upper) and high flow (lower) data sets**

The largest zinc load from the mine is from the main adit, or Level 1 adit, at the mine site. During high flows, 90% of the zinc load originates from the Level 1 adit. Of the remaining 10%, 7% of the zinc load is from background sources above historical mining activity (natural sources). For low flows, the zinc load from the minor adits and Level 1 adits could not be differentiated. However, 95% of the zinc load originates before the tailings pond with the majority of this load assumed to be from the main adit. Assuming that seepage from the pond occurs at 0.5-1 gpm (Stantec 2004), this seepage would compromise the other 5% of zinc loading from the mine site based on available data. No zinc loads are observed from natural sources upstream of Standard Mine.

### 4.4.3 Management Strategies for Standard Mine

To achieve stream standards in all segments of Coal Creek, load reductions were established in Table 4.3. With a majority of these load reductions needed at the Standard Mine area, the proposed management measures for the mine will focus on achieving metals load reductions needed to achieve the water quality goals for segment 11 of Coal Creek. This conservative approach allows the project coordinator, the CCWC, to decide how to appropriate technical and fiscal resources identified later in this report.

Management measures for the Standard Mine site should achieve a metals load reduction of 6.72 lb/day during high flows (March through June) and 0.77 lb/day during lower flow period (see Table 4.3). The variability of flows through the site and in Elk Creek precludes using one management measure to achieve these reductions but rather using a toolbox approach. The measures will need to include both source controls and treatment controls to achieve the load reductions necessary throughout the year. Source controls focus on reducing the generation, release concentration, conveyance or transport of pollutants to Elk Creek. This pollution prevention concept is generally accepted as being the most effective and cost-efficient method of improving water quality. Source controls can be further defined as structural and non-structural measures as defined in Figure 4.5. Treatment controls reduce the concentration or mass of pollutants discharged from a source. Treatment controls can include active treatment, passive treatment, or a combination of passive and active technologies.

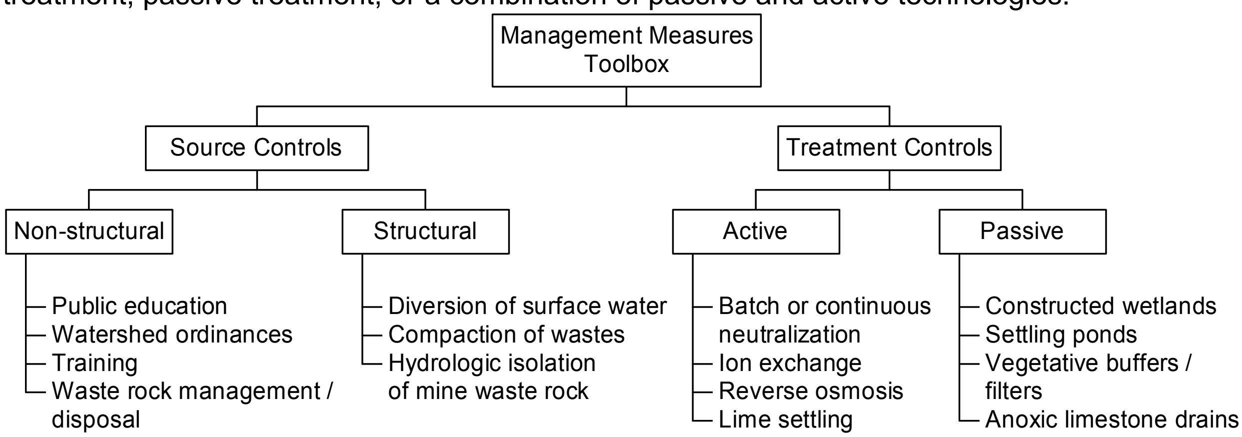



**Figure 4.5 Management Measure Technologies and Programs**

The control measures in Figure 4.5 were reviewed against their demonstrated effectiveness and implementability for the Standard Mine site. The management measures will be discussed in two groups; (1) active treatment measures to meet aquatic stream standards in Elk Creek, and (2) passive treatment and source control measures to achieve load reductions from the site using non-point source strategies.

4.4.3.1 Active Treatment

Management measures to achieve greater than a 90% reduction of metals loading from the Standard Mine site are limited, and would need to focus on the capture and all acidic mine drainage. Advanced treatment of this drainage would be required either on-site, or via direct piping to the existing Mt. Emmons/Keystone Mine water treatment plant (WTP). To achieve the required load reductions using on-site treatment, a combination of active treatment controls listed in Table 4.5 would likely be necessary. To transfer the acidic mine drainage to the Mt. Emmons/Keystone Mine WTP, a separate study would be needed to assess the feasibility of a transfer pipeline and impact to the WTP.

4.4.3.2 Passive Treatment and Source Control

For non-point source (NPS) strategies, the following physical management measures are recommended for the Standard Mine site, with priority for implementation given to drainage from the main adit.

**Table 4.4 Non-point Source Management Measures for Standard Mine Site**

| Type | Management Measure | Purpose |
|---|---|---|
| **Source** | Provide ditches to divert low surface flows around tailings areas | Reduce the exposure of tailings to stormwater/snowmelt runoff |
| **Source / Treatment** | Design and Construct off-line detention pond for Elk Creek, low flow detention | Construct pond capacity for low flows to establish residence time and increase sedimentation for decrease of metals loading |
| **Source** | Provide ditches/pipes to divert low surface flows around areas | Reduce the exposure of tailings and mineralized areas to minimize contact with surface water runoff |
| **Treatment** | Design and Construct wetlands (grade and revegetate 2 acres) | Construct wetlands to improve pollutant removal process through filtration |

Without more definitive data on the site, it is difficult to discuss which of these management measures, or combination of, could achieve load reductions goals for the watershed. Full-scale monitoring at the Standard Mine site would provide useful information on the load reductions needed and better define a strategy for management measures. As such, each of the NPS management measures listed in Table 4.4 for the Standard Mine site are recommended to meet the load reductions necessary.

### 4.4.4 Other Mining Activity

Table 4.3 identified source areas for which load reductions should occur if the CCWC decides to broaden management strategies outside the Standard Mine. With mining activity throughout the watershed, approaches identified for mining activity in Table 4.4 are applicable to all mined areas throughout the watershed. For example, copper exceedances were found in Wildcat Creek during synoptic testing in 1999 and 2004 (see Table 2.2). Mining activity in upper Wildcat Creek could be the source area contributing to these exceedances, although the synoptic sample locations chosen cannot narrow the source to this area. Natural mineralization could also be the source. In addition, mining activity in subwatershed N4 could be contributing to the increase in metals loading below the Mt. Emmons/Keystone Mine outfall; without further data, quantification of the source and pathway (surface or ground water) for this load increase cannot be done.

Further water quality monitoring and is needed to determine specific areas of mining activity that impair water quality in the Coal Creek watershed. Monitoring water quality and biological health of Coal Creek, including tributaries, is further discussed in Section 6.0. A watershed mapping study, particularly full-scale mine identification, could provide useful information on where mining activity exists and the contribution to surface water in the watershed. The effort could map the sources by Geographic Information Systems (GIS) coordinates and increase awareness of where and when mine drainages reach Coal Creek. The intent is that these efforts would hone in on appropriate management strategies where acidic mine drainage needs to be controlled to help achieve stream standards.

### 4.4.5 Management Strategies for Other Areas

#### 4.4.5.1 Iron Fen

The Iron Fen was listed in Section 3 as a potential contamination source considering the elevated metals concentrations and potential for mining activity. Mining claims still exist for the Iron Fen despite the unique properties of this natural feature and its designation as a Colorado Natural Area in 1980. Working to preserve this area is important to the CCWC since mining activity could disturb the unique properties of the Iron Fen.

Water quality testing confirmed that the Iron Fen exceeds aquatic stream standards and could potentially increase metals loading to Coal Creek. Management measures for the Iron Fen are difficult to quantify since the area is revered as a unique natural feature and has been designated as a Colorado Natural Area. However, a fire burned through the area in the early 1980's and little vegetation has since grown back. Runoff from this area flows across CR 12 through culverts and discharges into Coal Creek. If the CCWC pursues a strategy to control metals loading from these areas, management measures should focus on seeding revegetation and vegetative buffer strips below the Iron Fen but above Coal Creek.

#### 4.4.5.2 Other Pollutant Source Areas

Recreational activities in the watershed have the potential to impair water quality in Coal Creek, especially in the vicinity of Lake Irwin and in sub-watershed N6 with public access to the Standard Mine site. Public education is key to address these activities, especially when considering the watershed's remoteness. Public education efforts should promote a clear identification and understanding of water quality issues, including practices that residents can implement to reduce pollutants to surface waters. With tourism a major part of the Town's economy, the public education program should extend to visitors. A good way to educate visitors and residents is to produce a brochure that clearly identifies how activities in the watershed impact water quality in Coal Creek. Appropriate signage at trailheads, parking areas, and along CR12 is a useful method of educating residents and visitors alike that the watershed upstream of Town is a public water supply. It may be difficult to prevent vandalism or damage to signs in highly visible areas; however, resident volunteers could check and maintain signs.

4.4.5.3 Roadways

Stakeholders in this project have planned a stream visual assessment protocol (SVAP) during the summer of 2005 to identify the erosion potential on sections of CR12 in the watershed. Based on stakeholder discussions during the development of this report, CR12 will be listed as a potential source of non-point source pollution for all segments of Coal Creek. Based on the findings from the SVAP, the following physical management measures could be beneficial in reducing erosion for CR12 and other forest access roads.

**Table 4.5 Management Measures for Roadways**

| *Management Measure* | *Purpose* |
|---|---|
| Evaluate roadways, proximity to drainages and improvements | Identify erosion problems and transport of sediment |
| Fill slope and revegetate to fix gully erosion at identified locations | Repair erosion problems to minimize sediment loading to Creek |
| Evaluate minimum dirt roadway width requirements | Require minimum roadway widths to minimize impacts of runoff |
| Evaluate current maintenance requirements | Evaluate routine roadway maintenance to minimize impacts of runoff |

To achieve the CCWC long-term goal of minimizing roadway erosion and sediment transport, a combination of these measures could be necessary.

4.4.5.4 Construction Site Management

The Town of Crested Butte, in conjunction with Gunnison County, should require construction site management for all sites within the watershed. Construction sites should have erosion and sediment control management practices designed and implemented. An erosion control plan should be prepared that details practices that will be used to reduce the pollutants in stormwater discharges from construction sites. The erosion control plan should be submitted to the Town for review and approval. The contents of the erosion control plan could consist of the following information:

1. Estimates of total area of the site and total area to be disturbed by excavation, grading or other activities;
2. General location map with drainage patterns and approximate slopes after major grading activities;
3. Areas of soil disturbance and areas of no disturbance;
4. Location of best management practices to control erosion and sediment transport from the site; and
5. Locations of where stormwater is discharged into surface waters and name of the surface water receiving the discharge.

Each submitted plan should include a description of appropriate controls and measures that will be implemented during construction activities to reduce the transport of sediment offsite. Controls include, but are not limited to, the following:

- Vegetative buffers
- Silt Fence

- Ditches, berms and swales
- Sediment basins and/or sediment traps
- Geotexiles
- Stepped check dams
- Pipe slope drains
- Or other equivalent control

Each plan should also include a description of appropriate controls and measures that will be implemented during construction activities to reduce the transport of pollutants offsite from the following activities:

- Waste Disposal
- Off-site tracking
- Septic, Waste and Sanitary Sewer Disposal
- Construction Material Storage

Only stormwater discharges from the construction site should be allowed. Discharges of material other than stormwater would require a national pollutant discharge elimination system permit (NPDES) from the CDPHE.

# 5.0 Watershed Implementation Strategy

## 5.1 GOALS AND OBJECTIVES

A wide variety of management strategies were evaluated against the water quality goals and objectives outlined in Section 1. Based on the assessment of management measures in section 4.0 to meet these objectives, this section will define a 5-year implementation plan.

## 5.2 TECHNICAL ASSISTANCE NEEDS

Review of the historical water quality for the Coal Creek watershed has revealed that stream standards are not being achieved nor are all protected current designated uses being met. Identification of all necessary management measures to achieve the reference water quality goals will require considerably more investigation and evaluation.

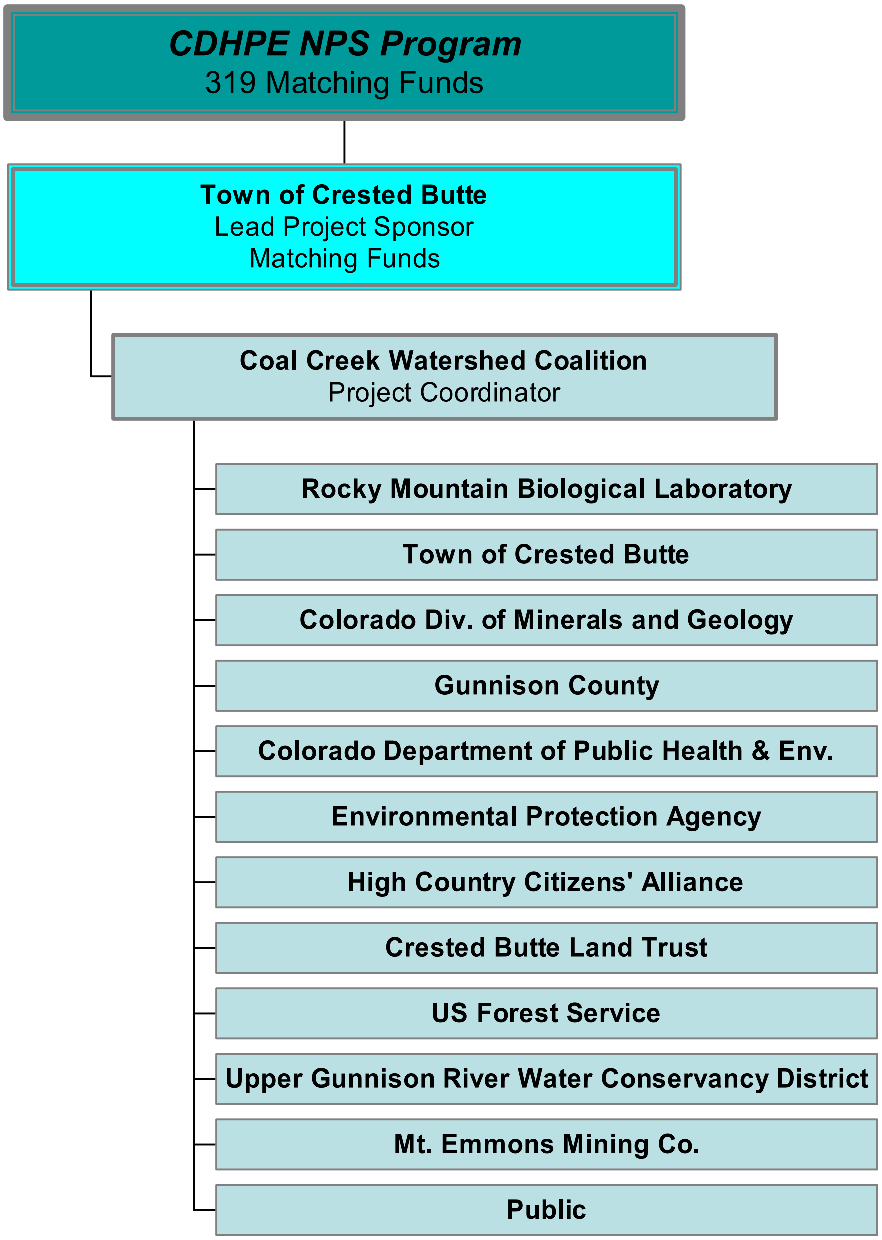
As a first phase for the implementation plan, the Town of Crested Butte and CCWC are completing additional water quality monitoring in the watershed. The framework for this sampling and monitoring plan is outlined in section 6.0 of this report. The water quality monitoring may require the services of an outside consultant to coordinate sampling events and sample analyses. At a minimum, a technical consultant should be present at the first round of sampling to train and ensure monitoring efforts follow the prescribed QA/QC procedures provided in section 6.0. As the monitoring effort progresses, this lead technical consultant may train individual team leaders to coordinate future sampling events and evaluate the effectiveness of the monitoring plan. The CCWC will ultimately be responsible for monitoring the long-term effectiveness of the sampling plan and establishing modifications as needed. The watershed coordinator position shown in the implementation plan (Table 5.1) would be a logical person to track and implement modifications to the sampling plan.

## 5.3 FUNDING NEEDS

The anticipated financial resources to address water quality improvements in the Coal Creek Watershed exceed the Town of Crested Butte's budget; therefore the Town must pursue additional funding sources to implement water quality management strategies and to construct, operate, and maintain BMPs. This section discusses a number of potential funding sources for implement a water quality management program in the Coal Creek Watershed.

There are significant opportunities to work collaboratively with various local governmental agencies, nonprofit organizations, and businesses to fund the 5-year plan. Those groups with special interests in achieving the objectives for this plan have formed the Coal Creek Watershed Coalition (CCWC), with stakeholders in the CCWC listed in Figure 5.1. The involvement of the CCWC partners in the implementation of this plan may provide immediate funding opportunities and reveal longer-term opportunities as the watershed plan progresses.

**Figure 5.1 Coal Creek Watershed Coalition (CCWC) Stakeholders**




The funding needs of the Watershed Plan include nonstructural managemenent approaches and capital construction dollars (hard costs), as well as funding for administration and studies (soft costs). These costs have been estimated in Table 5.1 at the end of this section and are phased over the 5-year plan. Both hard and soft costs were discussed with CCWC members at a committee meeting (CCWC, 2005), with a preliminary assessment of the potential funding needs. Within the range of possible outcomes of other actions (e.g. Superfund listing for Standard Mine), the most likely outcome involves a combination of local government actions and state/federal construction projects. On balance, it seems that each party in Figure 5.1 benefits from maintaining Coal Creek's water quality and has a role in generating revenue or providing services to support programs that reduce the actual pollution loads in the watershed.

## 5.4 INFORMATION AND PUBLIC EDUCATION

The CCWC will use two forms of public outreach to keep the community involved and informed of the watershed improvement efforts: notification and education. The first form of public outreach, a simple notification function, will be a media-based effort, which could be implemented through print, radio, or other public advertisement channels. This communications effort will explain who, what, why, where, and how the CCWC watershed improvements are being implemented. The stakeholders and residents of the watershed would be the target audience for the notification effort.

A second level of effort will be directed toward the interested and engaged stakeholders that come forward as a result of the first notification effort. This public education component will be more detailed, and will utilize more formal means of education, such as workshops, brochures, forums, field trips, and interactive programs such as including volunteers as resources to implement CCWC goals.

Collectively, these two forms of public outreach will allow for the public to be both informed and involved in the important goals of the CCWC efforts to restore and maintain Coal Creek water quality to the highest standards needed to maintain the beneficial uses of the watershed.

## 5.5 CRITERIA FOR SUCCESS

Successful restoration and maintenance of water quality standards in the Coal Creek watershed can be measured by both qualitative and quantitative criteria. Both quantitative and qualitative success will be needed to determine the overall success of the CCWC efforts at restoration and maintenance of the Coal Creek watershed. Qualitative criteria would document and measure program elements as they are implemented. The programs and tasks of the implementation plan can be measured for each of the discrete steps of planning, funding, initiation, completion, and repetition as needed. Those programs that are not implemented would be qualified as unsuccessful. Those programs that are fully funded and completed would be qualified as successfully implemented. The watershed coordinator position shown in the implementation plan (Table 5.1) would be a logical person to track and report on progress using qualitative criteria.

Quantitative criteria for program success would include scientific measures of results from the programs and efforts in the implementation plan. Most simplistic would be the physical and chemical and biological measures of water quality as determined from the results of watershed monitoring. Trends, attainment of water quality standards, avoidance of violations or exceedances, improvement of biological diversity, and species distribution throughout the watershed can be numerically and graphically measured and presented. The watershed coordinator position shown in the implementation plan would be the logical person to track and report on the results of the program to bring about quantitative improvement and ultimate success in attaining and maintaining water quality standards throughout the Coal Creek watershed.

The five-year schedule shown on the implementation plan is a reasonable period of time to expect incremental and meaningful improvement for both qualitative and quantitative measures of watershed conditions. There should be increased aquatic diversity as measured by number of species at some monitoring stations with improved water quality, as well as improved density of aquatic organisms at these stations. It is also possible that aquatic biota at some stations is not currently repressed by water quality, and no changes to aquatic biota populations would be anticipated at these stations.

## 5.6 IMPLEMENTATION PLAN

A five-year implementation plan is presented in Table 5.1 on the following page. The plan is phased with watershed planning efforts (e.g. studies, water quality monitoring) scheduled for implementation at the front end of the 5-year plan. Based on the results of these front-end studies, it is anticipated that construction activities would follow. The plan includes a line item under mining/metal sources for an active treatment plant reducing the metal load from the Standard Mine site. This will require considerably more capital and O&M money than other non-point source pollution strategies, but is considered necessary to meet aquatic life stream standards in upper Elk Creek. Within the range of possible outcomes for other watershed actions (e.g. Superfund listing), the most likely implementation plan will include a combination of non-point source and point source strategies to incrementally reduce pollutant loads.
In cooperation with project stakeholders, the Town of Crested Butte and CCWC should implement a management plan that will address prioritization, planning, and implementation of the recommendations provided. The plan should track progress and measure benefits on the opportunities, using criteria discussed in section 5.5 and the Implementation Plan shown on the table provided below.

**Table 5.1 Coal Creek Watershed Implementation Plan**

Table 5.1 is enclosed as a foldout table following this page.

# 6.0 MONITORING

## 6.1 INTERIM MILESTONES

Successful restoration and maintenance of water quality standards in the Coal Creek watershed can be measured by both qualitative and quantitative criteria as identified in section 5.5. Interim milestones for qualitative and quantitative criteria are described below.

### 6.1.1 Qualitative Criteria

Qualitative criteria were identified in section 5.5 of this report for documenting progress with implementation of table 5.1. Another method of documenting qualitative progress is comparing the Stream Visual Assessment Protocol (SVAP) completed at the onset of the plan and the SVAP completed after 5-years. The final SVAP could document the changes in those areas identified for improvement through the initial SVAP. Milestones to document progress should be established by the CCWC after the initial SVAP, and could include objectives for visual water quality and wildlife habitat.

### 6.1.2 Quantitative Criteria

Trends, attainment of water quality standards, avoidance of violations or exceedances, improvement of biological diversity, and species distribution throughout the watershed can be numerically and graphically measured and presented.

6.1.2.1 Metals Concentrations

There should be a reduction in metals loading from mining areas to receiving water bodies, as measured by a decrease in metals concentrations and improved water quality. Metrics by which to measure this include

I. Attainment of temporary modified stream standards in all reaches of the watershed year round; and
II. Attainment of aquatic life, or TVS, stream standards for all reaches of the watershed on a seasonal basis; and
III. Attainment of aquatic life stream standards year-round throughout the watershed.

The step-wise progression through tiers I to III will allow the CCWC to measure quantitative progress in achieving their water quality objectives for the watershed.

6.1.2.2 Biological Indices

There should be increased aquatic diversity as measured by number of species at some monitoring stations with improved water quality, as well as improved density of aquatic organisms at these stations. It is also possible that aquatic biota at some stations is not currently repressed by water quality, and no changes to aquatic biota populations would be anticipated at these stations.

## 6.2 LONG TERM MONITORING PLAN

A sampling and analysis plan is included with this report under separate cover. Refer to the plan for a long-term monitoring schedule.

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