# TOTAL MAXIMUM DAILY LOAD ASSESSMENT

## UPPER SOUTH PLATTE RIVER SEGMENT 4
## HALL VALLEY/HANDCART GULCH
## COPPER

## PARK COUNTY, COLORADO
## April 2008

## TMDL SUMMARY

| | |
|---|---|
| Waterbody Name/Segment Number | Mainstem of the North Fork of the South Platte River, including all tributaries, lakes, reservoirs and wetlands from the source to the confluence with the South Platte River, except for specific listings in Segments 1b, 5a, 5b, and 5c. / COSPUS04 |
| Pollutant/Condition Addressed | Copper (dissolved) |
| Affected Portion of Segments | Hall Valley area to Geneva Creek |
| Use Classification/Waterbody Designation | Aquatic Life Cold 1<br>Recreation 1a<br>Water Supply<br>Agriculture |
| Waterbody Antidegradation Designation | Reviewable |
| Water Quality Target | Attainment of water quality standards for Copper<br>Acute= $e^{0.9422[\ln(\text{hardness})]-1.7408}$<br>Chronic= $e^{0.8545[\ln(\text{hardness})]-1.7428}$ |
| TMDL Goal | Attainment of water quality standards |

## EXECUTIVE SUMMARY

Segment COSPUS04 has been identified as water-quality limited for dissolved copper on the 1998 303(d) List, as approved by the Colorado Water Quality Control Commission. This TMDL derives waste load allocations and load allocations for dissolved copper to demonstrate the load reduction necessary to attain the currently adopted standards.

## I. INTRODUCTION

Section 303(d) of the federal Clean Water Act requires states to identify water bodies or stream segments which are water quality limited. Water quality limited segments are those water bodies or stream segments which, for one or more assigned use classifications or standards, the classification or standard is not fully achieved. Once listed, the State is required to quantify the amount of a specific pollutant that a listed water body can assimilate without violating applicable water quality standards and to apportion that allowable quantity among the different pollutant sources. This maximum allowable pollutant quantity is referred to as the Total Maximum Daily Load (TMDL). The TMDL is comprised of the Load Allocation (LA) which is that portion of the pollutant load attributed to natural background or the nonpoint sources, the Waste Load Allocation (WLA) which is that portion of the pollutant load associated with point source discharges, and a Margin of Safety (MOS). The TMDL may also include an allocation reserved to accommodate future growth. The TMDL may be expressed as the sum of the LA, WLA and MOS (Equation 1)

Equation 1. $TMDL=WLA+LA+MOS$

Alternatively, a segment or pollutant may be removed from the list if the applicable standard is attained, if implementation of clean up activities via an alternate means will result in attainment of standards, if the original listing decision is shown to be in error, or if the standards have been changed as the result of a Use Attainability Analysis (UAA).

The goal of this TMDL document is to identify the reductions in metals loadings for dissolved copper necessary to attain the applicable water quality standards.

## II. BACKGROUND

The portion of the mainstem of the North Fork of the South Platte River and tributaries from the Hall Valley area to the confluence with Geneva Creek has been was identified by the Division as impaired on all of the 303(d) Lists since the first list was prepared in 1992. The 1992, 1994 and 1996 303(d) Lists identified segment 4 as partially supporting the Aquatic Life Use based on a nonpoint source assessment. Copper (Cu) and Manganese (Mn) were identified as the pollutants in non-attainment of the assigned Aquatic Life Use based on numeric standards. The 1998 303(d) List identified aluminum, cadmium, copper, iron and lead as causing the water quality impairment of the waterbody based on 1991 sampling. The 2002 303(d) List delisted the segment for cadmium, iron and lead since it was meeting those standards and removed the aluminum listing because there was not an assigned aluminum standard for the segment. The 2004 and 2006 303(d) Lists identify segment 4 as impaired or in non-attainment of the aquatic life use because of copper concentrations in exceedance of the assigned standards.

## III. SEGMENT DESCRIPTION

The headwaters of the North Fork of the South Platte River include the Hall Valley and Handcart Gulch watersheds that lie on the northwest edge of Park County in central Colorado. The Hall Valley/Handcart Gulch watershed covers approximately 11.2 square miles (CDPHE/HMWMD 2001) and is bounded by the Continental Divide on the north and west and the Hall Valley/Jefferson Creek watershed divide to the south. The Handcart Gulch watershed divide is to the north and east of the upper portion of Hall Valley. The two basins are identified in Figure 1. Map of Hall Valley / Handcart Gulch.

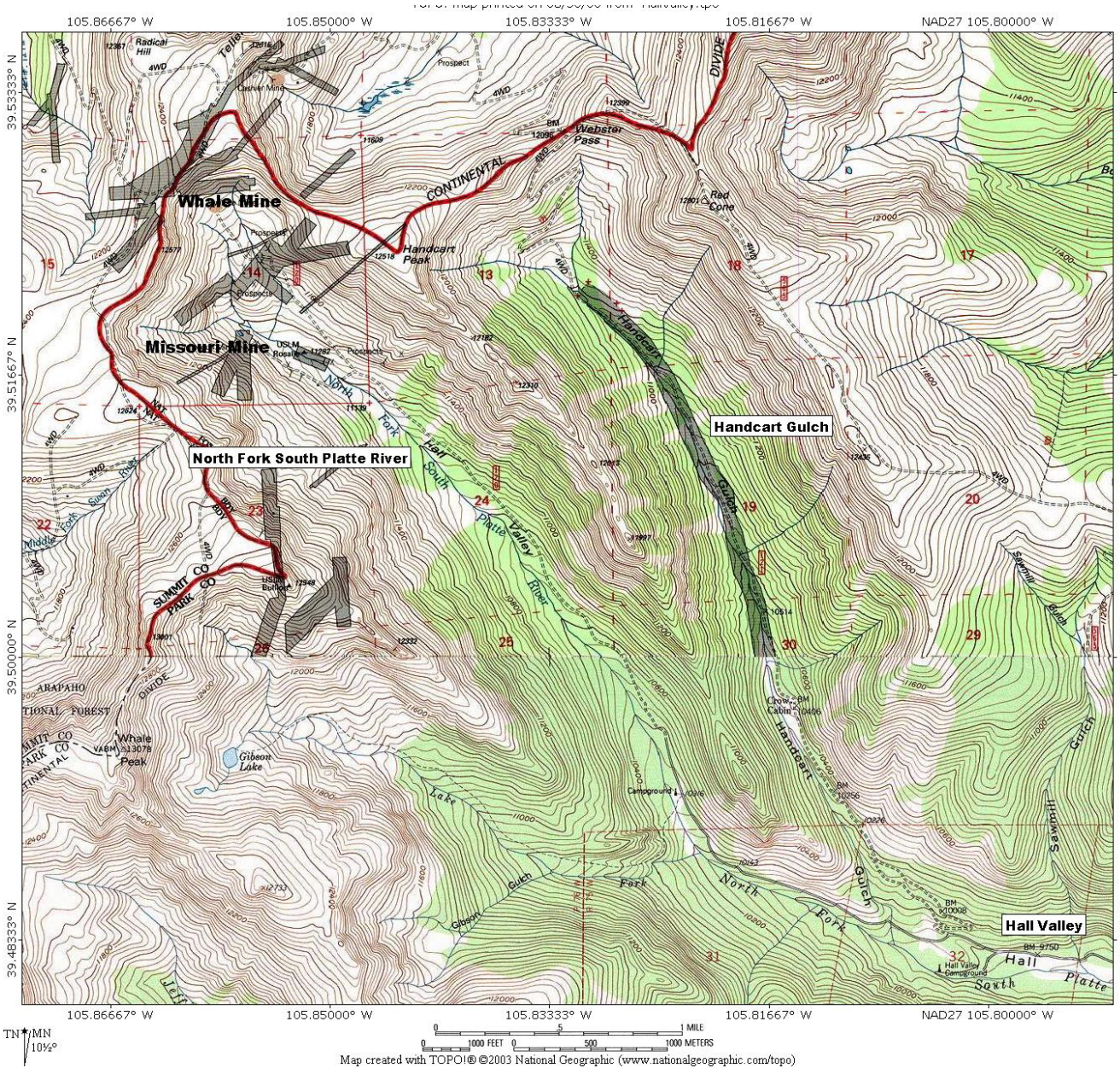



**Figure 1. Map of Hall Valley / Handcart Gulch**

The headwaters of the North Fork of the South Platte River including Hall Valley and Handcart Gulch are located in an area known as the Colorado mineral belt. The Colorado mineral belt is a geologic name for a region extending from near Durango in the southwestern part of the State to Boulder in the Front Range (Moran and Wentz, USGS, 1974).

Topography of Hall Valley and Handcart Gulch is extremely rugged. The headwaters of the valley and gulch are at approximately 12,600 feet above mean sea level (amsl) and are located near the Continental Divide to the west and north. The confluence of Handcart Gulch with the North Fork of the South Platte River is at approximately 9,846 feet amsl. The confluence is above the Hall Valley Campground in the Pike National Forest.

The Red Cone Peak area of which Hall Valley and Handcart Gulch are a portion of has been identified by the Colorado Geological Survey as an area with naturally-occurring acid rock drainage (ARD). Handcart Gulch is an unmined, naturally generated acidic stream from surface flow across and metal seeps from pyritically altered quartz monzonites of the Oligocene-age Montezuma stock (Struefert, CGS, 1997). Upstream of Handcard Gulch on the North Fork of the South Platte River, historic mining activities have affected surface water quality. The Montezuma stock straddles the Continental Divide in Park, Clear Creek and Summit Counties. Degraded water quality associated with the altered rocks affects stream basins on both sides of the Continental Divide (Neubert, CGS 2000).

## IV. HISTORY

The Hall Valley has a long history of mining. In the upper reaches of Hall Valley are two distinguishable mine workings. The Whale Mine load was discovered in 1869 and was the chief producer for the Hall Valley Silver-Lead Mining and Smelting Co. Ltd. located three miles down-valley of the mine. In 1883 the Whale Mine had four levels on the producing vein with a total development of 3,300 feet of shafts and adits. The mine was worked intermittently into the early 1920's. The Whale Mine was primarily worked for silver but also produced lead and copper (CDPHE/HMWMD, 2001).

The Missouri Mine is approximately ½ mile south of the Whale Mine. The mine was discovered in the late 1870's and was described in 1882 as one of the more prominent mines in Hall Gulch with 500 feet of tunnels. By the 1920's the mine had expanded to 2,100 feet of drifts on three separate levels. There are no production figures listed for the Missouri Mine after 1928 (CDPHE/HMWMD, 2001).

Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (CDPHE/HMWMD) prepared an Analytical Results Report (ARR) of the Hall Valley watershed including Handcart Gulch for the U.S. Environmental Protection Agency (EPA) in January 2001 following standard Site Inspection (SI) format under the Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA). Data for this report was collected in June 2000. Sampling included the waste rock dumps, surface water and sediment. Surface water sites are shown in Figure 2.

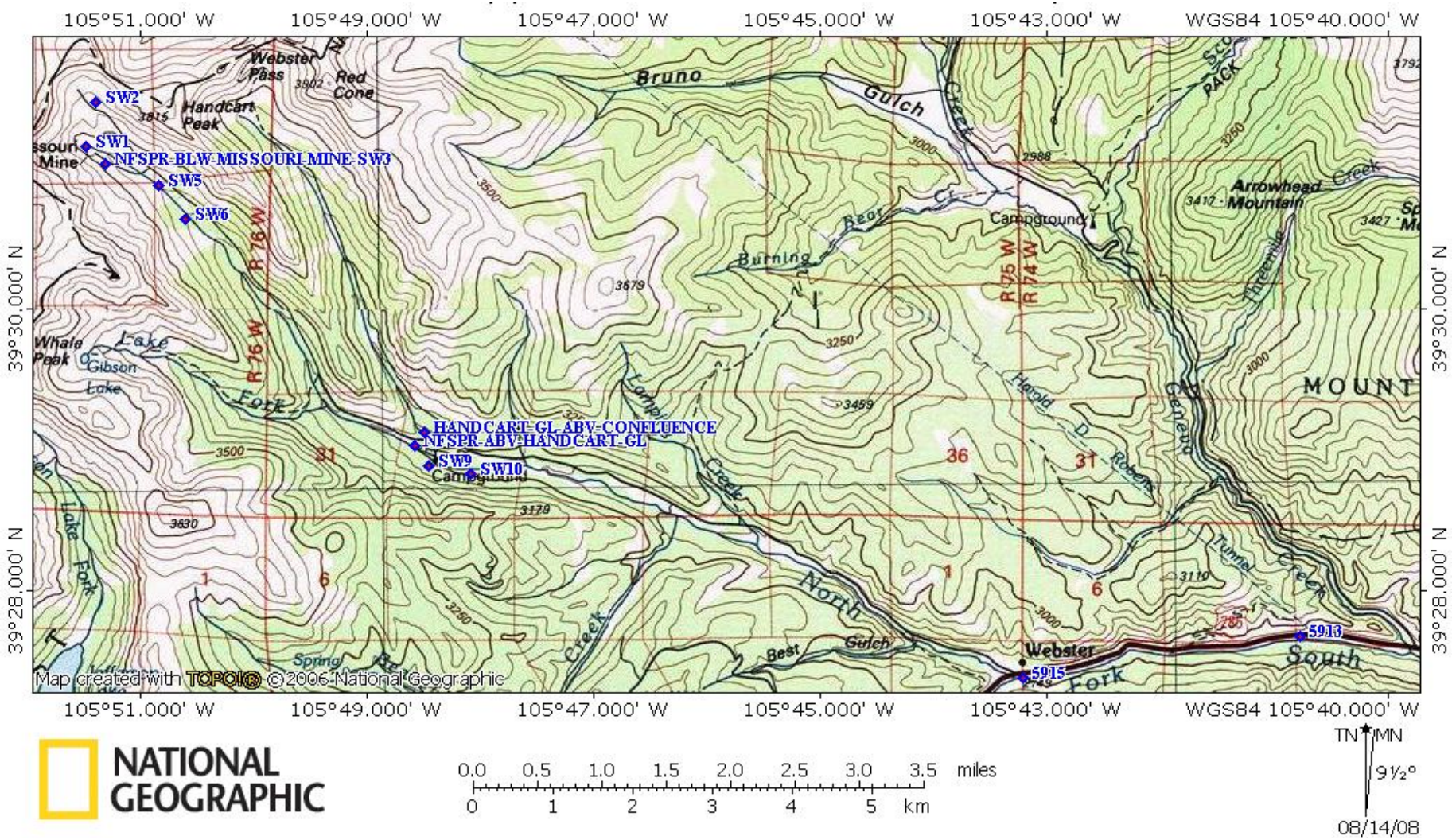



Figure 2. Surface water sampling sites from CDPHE HMWMD ARR.

Flow in Handcart Gulch is composed of low pH poor quality groundwater from numerous visible and subsurface seeps. Much of the rock in the gulch is stained red, yellow and brown as a result of the naturally-occurring ARD. Downstream of a number of seeps the stream channel is lined with ferricrete and abundant orange-red precipitate, and lesser amounts of grey-yellow precipitate (Neuburt, CGS, 2000). Handcart Gulch carries a considerable load of dissolved metals to the North Fork. Mass balance calculations based on sampling results indicate that Handcart Gulch is the predominant source of metals to the North Fork of the South Platte River (CDPHE/HMWMD, 2001).

The mainstem of the North Fork of the South Platte River (North Fork) begins to show aquatic life impairment below the Missouri Mine as it starts its flow through the Hall Valley area. Handcart Gulch confluences with the North Fork about half way down the valley. The Colorado Division of Wildlife reports fish populations in the North Fork of the South Platte River above the confluence with Handcart Gulch. Handcart Gulch and the North Fork of the South Platte River do not support a fishery below the confluence for an undetermined distance downstream. In the Hall Valley Watershed ARR it was noted that fish populations are present and fishing does occur in the North Fork of the South Platte River from the confluence of Geneva Creek to the confluence with the South Platte River (CDPHE/HMWMD, 2001). The confluence of Handcart Gulch with the North Fork of the South Platte River to the Geneva Creek confluence is approximately 8.5 miles.

## V. DISCHARGE PERMITS AND PROPERTY OWNERSHIP

There are currently no Colorado Discharge Permit System (CDPS) or National Permit Discharge Elimination System (NPDES) permits that discharge to the listed portions of segment COSPUS04. Land ownership in the area is mixed between Federal (USDA Forest Service) and private interests.

## VI. PROBLEM IDENTIFICATION

Copper is the pollutant of concern for this TMDL. The TMDL addresses a portion of Upper South Platte segment 4 (COSPUS04), which is the mainstem of the North Fork of the South Platte River, including all tributaries, lakes, reservoirs and wetlands from the source to the confluence with the South Platte river, except for specific listings in segments 1b, 5a, 5b, and 5c. The portion of concern is from the Hall Valley area to the confluence with Geneva Creek. The 303(d) lists rate the segment priority as “medium”. There are no permitted point sources in this watershed. The Division has not acted on this listing until 2008 because no significant anthropogenic point sources have been identified in the watershed that could be addressed through an NPDES or CDPS permit.

## VII. WATER QUALITY GOALS AND TARGETS

The water quality targets and goals for this TMDL are attainment of the current dissolved copper water quality standards, and attainment of the assigned aquatic life cold 1 use.

## VIII. WATER QUALITY STANDARDS

### Standards Framework

Waterbodies in Colorado are divided into discrete units or "segments". The Colorado *Basic Standards and Methodologies for Surface Water*, Regulation 31, discusses segmentation of waterbodies in terms of several broad considerations:

> *31.6(4)(b)…Segments may constitute a specified stretch of a river mainstem, a specific tributary, a specific lake or reservoir, or a generally defined grouping of waters within the basin (e.g., a specific mainstem segment and all tributaries flowing into that mainstem segment.*
>
> *(c) Segments shall generally be delineated according to the points at which the use, physical characteristics or water quality characteristics of a watercourse are determined to change significantly enough to require a change in use classifications and/or water quality standards*

As noted in paragraph 31.6(4)(c), the use or uses of surface waters are an important consideration with respect to segmentation. In Colorado there are four categories of beneficial use which are recognized. These include Aquatic Life Use, Recreational Use, Agricultural Use and Water Supply Use. A segment may be designated for any or all of these "Use Classifications":

> *31.6 Waters shall be classified for the present beneficial uses of the water, or the beneficial uses that may be reasonably expected in the future for which the water is suitable in its present condition or the beneficial uses for which it is to become suitable as a goal.*

Each assigned use is associated with a series of pollutant specific numeric standards. These pollutants may vary and are relevant to a given Classified Use. Numeric pollutant criteria are identified in sections 31.11 and 31.16 of the *Basic Standards and Methodologies for Surface Water.*

### Uses and Standards Addressed in this TMDL

The segment of the North Fork of the South Platte River addressed by this TMDL, COSPUS04, is classified for Aquatic Life (Cold 1), Water Supply, Agriculture, and Recreation (1a) Uses. The segment-specific numeric standards can be found in Regulation 38, Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin (WQCC, 2007b). The segment descriptions and associated standards are in Table 1 below.

The Table Value Standards (TVS) associated with the assigned Aquatic Life Use classification, are hardness based standards. Assessments for TVS metals are based on segment-specific mean hardness values. Based on data from WQCD monitoring stations, the dissolved chronic copper standard for COSPUS04 is 3.96 ug/L (TVS based on a mean total hardness value of 38.5 mg/L). Note that the acute Aquatic Life Use-based standard is based on sample-specific hardness and therefore is calculated for each discrete sampling event.

| Table 1. Water quality standards for Upper South Platte River segment 4 (COSPUS04). | | | | | |
|---|---|---|---|---|---|
| Stream Segment Description | Classification | Physical and Biological | INORGANICS mg/l | METALS ug/l | |
| 4. Mainstem of the North Fork of the South Platte River, including all tributaries, lakes, reservoirs and wetlands from the source to the confluence with the South Platte River, except for specific listings in Segments 1b, 5a, 5b, and 5c. | Agriculture<br>Aq Life Cold 1<br>Recreation 1a<br>Water Supply | E.Coli=126/100ml<br>F.Coli=200/100ml<br>D.O.=6.0mg/l<br>D.O.(sp)=7.0mg/l<br>pH=6.5-9.0 | B=0.75<br>Cl=250<br>Cl2(ac)=0.019<br>Cl2(ch)=0.011<br>CN=0.005<br>NH3(ac)=TVS<br>NH3(ch)=0.02<br>NO2=0.05<br>NO3=10<br>S=0.002<br>SO4=WS | Ag(ac)=TVS<br>Ag(chtr)=TVS<br>As(ch)=100(Trec)<br>Cd(actr)=TVS<br>Cd(ch)=TVS<br>CrIII(ac)=TVS<br>CrIII(ch)=TVS<br>CrVI(ac)=TVS<br>CrVI(ch)=TVS<br>Cu(ac)=TVS<br>Cu(ch)=TVS<br>Fe(ch)=WS(Dis)<br>Fe(ch)=1000(Trec) | Hg(ch)=0.01(Tot)<br>Mn(ac)=TVS<br>Mn(ch)=WS(Dis)<br>Mn(ch)=TVS<br>Ni(ac)=TVS<br>Ni(ch)=TVS<br>Pb(ac)=TVS<br>Pb(ch)=TVS<br>Se(ac)=TVS<br>Se(ch)=TVS<br>Zn(ac)=TVS<br>Zn(ch)=TVS |

## IX. AMBIENT WATER QUALITY

Two sources of data are used to assess water quality for the listed segment. The Water Quality Control Division (Division) collected water samples from the listed portion of COSPUS04 on the North Fork South Platte River (North Fork) at two sites from 1997-2003 (WQCD 5913 N.F. SOUTH PLATTE ABOVE ROBERTS TUNNEL and WQCD 5915 N.F. SOUTH PLATTE at WEBSTER). These sites are located at the lower end of the listed portion of COSPUS04 (see Figure 2). The second source of data is from CDPHE Hazardous Materials and Waste Management Division (HMWMD). Assessment of available data documents non-attainment of both acute and chronic Aquatic Life Use-based copper standards. All other assigned Aquatic Life Use-based standards, as well as all assigned Water Supply, Recreation, and Agriculture Use-based standards are attained.

The 303(d) listing was based on data from the two Division sites. These data demonstrate exceedance of the Aquatic Life Use-based dissolved copper standards for the listed portion of the segment. According to the Division's assessment methodology, data from different sites within the same segment are pooled in the following manner. Means are calculated from results for samples taken on the same date or sampling event. These sampling event means are then used to calculate the relevant statistic ($85^{th}$ percentile for metals, or mean for hardness). For the purpose of this TMDL report, the data were examined separately for each of the sites as well as combined. Table 2 illustrates the ambient water quality at each of the sites. Although the distance between these sites is not great, the results in the table indicate that dissolved copper attenuates with distance downstream.

Table 2. 1997-2003 water quality data summary for WQCD North fork South Platte River sites below Handcart Gulch

| Site | n | Avg. Hardness, mg/L | Cu TVS, chronic, ug/L | Cu-Diss, Observed ug/L |
|---|---|---|---|---|
| WQCD #5915 | 33 | 37.8 | 3.91 | 28.2 |
| WQCD #5913 | 34 | 39.0 | 3.99 | 20 |
| 5913 & 5915 | 34 | 38.5 | 3.96 | 23.5 |

The data for the Division sites were examined for seasonal differences. The results are shown in Table 3. Data from the segment was assessed on a monthly basis. The results in Table 3 show that while the dissolved copper concentrations are diluted during the high water (snowmelt) period of April through August, the chronic standard typically is exceeded, except during June and July. Although the dissolved copper is diluted at higher flows, the hardness also is diluted, which results in more stringent copper TVS during this time. The 85$^{th}$ percentile was used to calculate ambient concentrations of dissolved copper.

Table 3. Monthly ambient water quality data for North Fork South Platte River sites below Handcart Gulch.

| | n | Hardness | Cu TVS-chronic ug/L | Cu Diss Observed ug/L |
|---|---|---|---|---|
| Jan | 5 | 44 | 4.44 | 27 |
| Feb | 1 | 42 | 4.27 | 20 |
| Mar | 3 | 43 | 4.35 | 16 |
| Apr | 2 | 40 | 4.09 | 7 |
| May | 2 | 34 | 3.56 | 8 |
| Jun | 4 | 23 | 2.55 | 2 |
| Jul | 2 | 31 | 3.29 | 2 |
| Aug | 2 | 30 | 3.2 | 5 |
| Sep | 4 | 40 | 4.09 | 20 |
| Oct | 2 | 42 | 4.27 | 21 |
| Nov | 4 | 44 | 4.44 | 19 |
| Dec | 3 | 46 | 4.61 | 24 |

As stated in Section VIII, the acute Aquatic Life Use-based standard is based on sample-specific hardness and therefore is calculated for each discrete sampling event. For assessment for acute standards, sampling event means were calculated for hardness and dissolved copper. The acute standards were exceeded for twenty-five out of thirty-four sampling events. Table 4 presents the results of this assessment.

Table 4. North Fork South Platte River Dissolved Copper Acute Standards and Exceedances.

| station | date | hardness | Cu acute std | Cu amb | Exceedance? |
|---|---|---|---|---|---|
| WQCD 5913 and 5915 | 11/18/1997 | 43.0 | 6.07 | 21.00 | 1 |
| WQCD 5913 and 5915 | 12/9/1997 | 41.0 | 5.80 | 23.50 | 1 |
| WQCD 5913 and 5915 | 12/29/1997 | 56.0 | 7.78 | 20.50 | 1 |
| WQCD 5913 and 5915 | 1/13/1998 | 42.5 | 6.00 | 24.50 | 1 |
| WQCD 5913 and 5915 | 1/29/1998 | 43.5 | 6.13 | 27.50 | 1 |
| WQCD 5913 and 5915 | 3/23/1998 | 41.5 | 5.87 | 8.00 | 1 |
| WQCD 5913 and 5915 | 4/21/1998 | 42.0 | 5.93 | 5.05 | 0 |
| WQCD 5913 and 5915 | 5/21/1998 | 28.0 | 4.05 | 8.25 | 1 |
| WQCD 5913 and 5915 | 6/23/1998 | 23.0 | 3.37 | 3.30 | 0 |
| WQCD 5913 and 5915 | 7/21/1998 | 31.0 | 4.46 | 2.00 | 0 |
| WQCD 5913 and 5915 | 8/6/1998 | 31.5 | 4.53 | 5.50 | 1 |
| WQCD 5913 and 5915 | 9/24/1998 | 38.5 | 5.47 | 21.50 | 1 |
| WQCD 5913 and 5915 | 11/19/1998 | 43.5 | 6.13 | 10.50 | 1 |
| WQCD 5913 and 5915 | 1/12/1999 | 42.0 | 5.93 | 20.00 | 1 |
| WQCD 5913 and 5915 | 2/10/1999 | 42.0 | 5.93 | 19.50 | 1 |
| WQCD 5913 and 5915 | 3/24/1999 | 37.0 | 5.27 | 7.50 | 1 |
| WQCD 5913 and 5915 | 4/21/1999 | 37.5 | 5.33 | 7.00 | 1 |
| WQCD 5913 and 5915 | 6/2/1999 | 22.0 | 3.23 | 0.00 | 0 |
| WQCD 5913 and 5915 | 6/24/1999 | 20.5 | 3.02 | 0.00 | 0 |
| WQCD 5913 and 5915 | 8/9/1999 | 29.0 | 4.19 | 3.00 | 0 |
| WQCD 5913 and 5915 | 9/20/1999 | 35.0 | 5.00 | 18.50 | 1 |
| WQCD 5913 and 5915 | 10/25/1999 | 34.0 | 4.86 | 22.50 | 1 |
| WQCD 5913 and 5915 | 11/22/1999 | 40.0 | 5.67 | 15.50 | 1 |
| WQCD 5913 and 5915 | 12/15/1999 | 40.0 | 5.67 | 23.50 | 1 |
| WQCD 5913 and 5915 | 1/24/2000 | 42.0 | 5.93 | 26.00 | 1 |
| WQCD 5913 and 5915 | 9/12/2002 | 46.5 | 6.53 | 14.50 | 1 |
| WQCD 5913 and 5915 | 10/8/2002 | 50.0 | 6.99 | 11.00 | 1 |
| WQCD 5913 and 5915 | 11/18/2002 | 49.0 | 6.86 | 14.50 | 1 |
| WQCD 5913 and 5915 | 1/21/2003 | 50.5 | 7.06 | 26.50 | 1 |
| WQCD 5913 and 5915 | 3/10/2003 | 49.5 | 6.93 | 19.00 | 1 |
| WQCD 5913 and 5915 | 5/13/2003 | 40.0 | 5.67 | 5.50 | 0 |
| WQCD 5913 and 5915 | 6/18/2003 | 25.5 | 3.71 | 0.00 | 0 |
| WQCD 5913 and 5915 | 7/14/2003 | 31.0 | 4.46 | 0.00 | 0 |
| WQCD 5913 and 5915 | 9/9/2003 | 40.0 | 5.67 | 18.00 | 1 |
| Sampling Event Total | | | n= 34 | | 25 |

The Hazardous Materials and Waste Management Division (HMWMD) of CDPHE collected surface water samples in June 2000, and submitted an ARR in 2001. Samples were collected from Hall Valley and Handcart Gulch, which are the upper reaches of the listed portion of segment COSPUS04. Sampling in the upper reaches of the segment is difficult due to snowpack and ice cover at these elevations. Access to surface waters is limited to an abbreviated summer season.

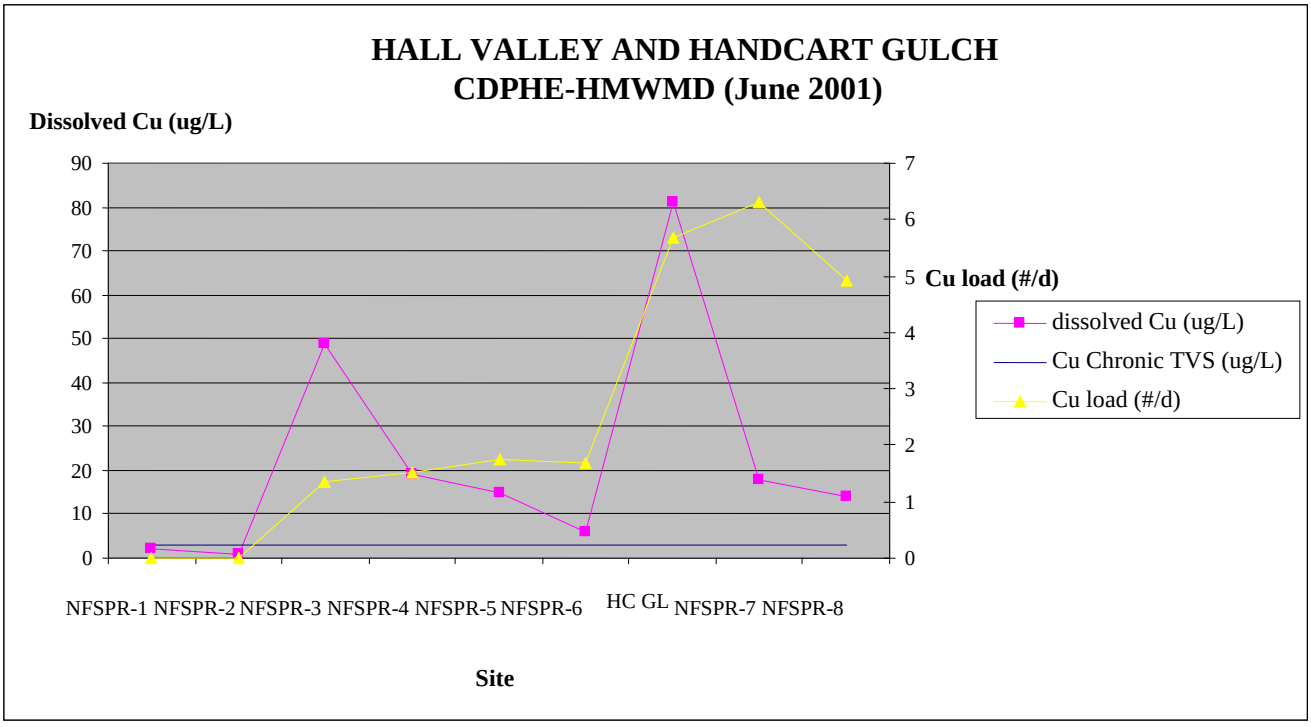
Although these data represent only one sampling event, some important observations of the watershed may be made. These data demonstrate exceedances of the chronic and acute copper standards (Table 5) and bracket the sources of copper. The main source of copper in the North Fork upstream from Handcart Gulch is from the Missouri Mine. The two sites upstream from the Missouri Mine do not exceed the standards for dissolved copper. The levels of dissolved copper are elevated in the North Fork below the Missouri Mine and remain elevated above both chronic and acute Table Value

Standards in the stream from below the Missouri Mine to the confluence with Handcart Gulch and below the confluence. Although dissolved copper concentrations attenuate prior to the confluence, they still exceed stream standards above Handcart Gulch (Figure 3). Dissolved copper concentrations in the North Fork downstream of Handcart Gulch increase again upon receipt of flow from Handcart Gulch (CDPHE/HMWMD 2001).

Table 5. HMWMD samples from North Fork South Platte River.

| **Location Description** | **Flow** (cfs) | **Hardness** | **Acute Cu TVS** (ug/L) | **Chronic Cu TVS** (ug/L) | **Copper Observed** (ug/L) |
|---|---|---|---|---|---|
| Background N.F. So. Platte (SW1) | 1.50 | 18.60 | 2.76 | 2.78 | 2 |
| N.F. So. Platte Below Whale Mine (SW2) | 1.07 | 30.74 | 4.42 | 2.78 | 1.0 U |
| N.F. So. Platte Below MO. Mine (SW3) | 5.12 | 28.31 | 4.09 | 2.78 | 49 |
| N.F. So. Platte Below Whale and Mo. Mines (SW5) | 14.70 | 26.74 | 3.88 | 2.78 | 19 |
| N.F. So. Platte 0.8 mi Below Whale and Mo. Mines (SW6) | 21.70 | 24.08 | 3.51 | 2.78 | 15 |
| Handcart Gulch abv Confluence | 13.00 | 24.66 | 3.59 | 2.78 | 81 |
| N.F. So. Platte Above Handcart Gl | 52.38 | 25.15 | 3.66 | 2.78 | 6 |
| N.F. S. Platte River300' Below H.C. Gulch (SW9) | 65.00 | 25.55 | 3.72 | 2.78 | 18 |
| N.F. S. Platte River at Hall Valley Cmpgrnd (SW10) | 65.00 | 24.89 | 3.63 | 2.78 | 14 |

Figure 3. Dissolved copper concentrations and associated loads for Hall Valley and Handcart Gulch.



## X. SOURCE ANALYSIS

### Point Sources

There are no NPDES or CDPS permitted point source discharges in the Hall Valley watershed. The majority of the Hall Valley area is owned by the U.S. Forest Service as part of the Pike National Forest, therefore it is unlikely that any new discharges will occur in the next twenty years. Topographical maps from the USGS show several mining features in the basin at high elevation.

The geology of the Hall Valley watershed is highly mineralized. The area has a history of mining. Exposure to natural geologic features, as well as mining features, to runoff leaches metals such as copper into surface waters. The mines identified for this report were the Whale Mine and the Missouri Mine. Ownership of these mines is not clearly established.

### Non-Point and Natural Sources

Natural geologic features in Handcart Gulch, including exposed rock and seeps, contribute to the copper loading in the watershed. As stated in section IV, Handcart Gulch is composed of low pH poor quality groundwater from numerous visible and subsurface seeps. Much of the rock in the gulch is stained red, yellow and brown as a result of the naturally-occurring ARD. Downstream of a number of seeps the stream channel is lined with ferricrete and abundant orange-red precipitate, and lesser amounts of grey-yellow precipitate (Neuburt, CGS, 2000).

The headwaters of the Handcart Gulch are in hydrothermally altered geologic terrain associated with the Montezuma Stock. This type of geologic terrain produces acid rock drainage (ARD) which results in naturally occurring degradation of waters by the contact of the ARD with oxidizing sulphide minerals. This ARD is the source of copper and other metals in Handcart Gulch.

## XI. TECHNICAL ANALYSIS

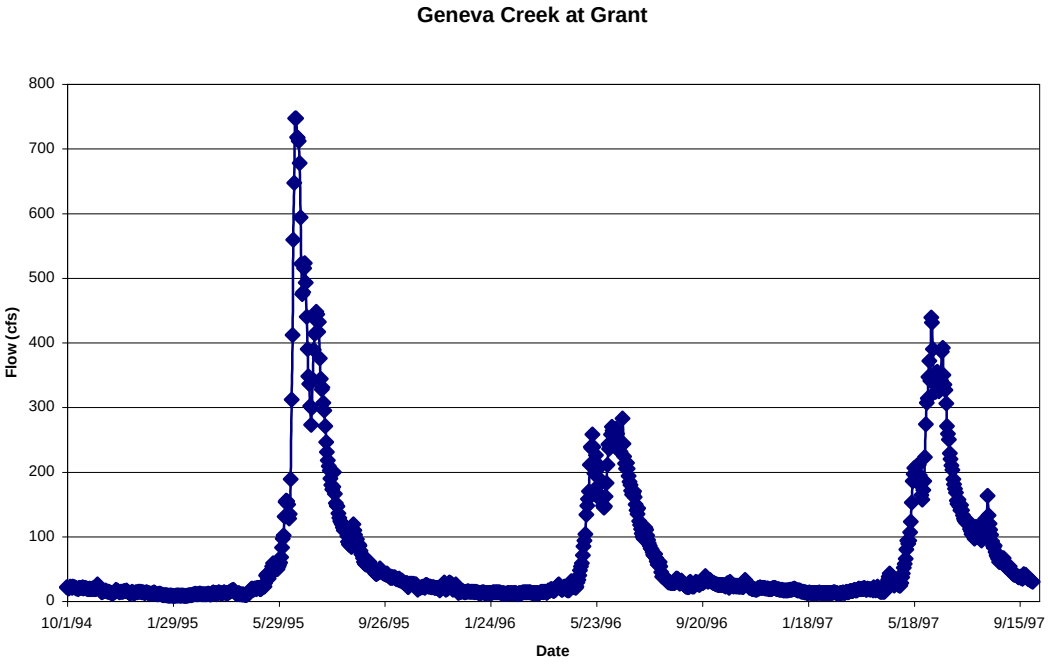
### Hydrology

The tributaries in Hall Valley area express the hydrologic characteristics of a high-altitude, snowmelt-dominated stream, with peak runoff occurring in June. The U.S. Geological Survey operated a hydrologic gage on Geneva Creek near the town of Grant from water-years 1994 through 1997. This gage reasonably approximates the hydrology patterns in the tributaries of the North Fork South Platte River. The drainage area at the USGS gage for Geneva Creek is 74.6 square miles, and the gage is at 8,760 feet above sea level. Table 6 and Figure 4 show the hydrologic characteristics of Geneva Creek.

Table 6: Hydrologic characteristics of Geneva Creek (USGS gage #06705500).

| Month | Mean Flow (cfs) | 25th Percentile Flow (cfs) | Median Flow (cfs) | 75th Percentile (cfs) |
|---|---|---|---|---|
| Jan | 12.1 | 11.0 | 12.0 | 13.0 |
| Feb | 10.8 | 9.6 | 12.0 | 12.0 |
| Mar | 13.6 | 12.0 | 13.0 | 15.0 |
| Apr | 18.2 | 14.0 | 17.0 | 22.0 |
| May | 101.4 | 35.5 | 65.0 | 174.5 |
| Jun | 315.2 | 211.5 | 267.5 | 374.5 |
| Jul | 183.8 | 107.0 | 148.0 | 223.5 |
| Aug | 77.1 | 36.5 | 82.0 | 109.5 |
| Sep | 38.5 | 29.0 | 38.5 | 45.0 |
| Oct | 24.8 | 20.0 | 24.0 | 27.0 |
| Nov | 19.1 | 16.8 | 20.0 | 21.0 |
| Dec | 16.5 | 14.0 | 16.0 | 18.0 |

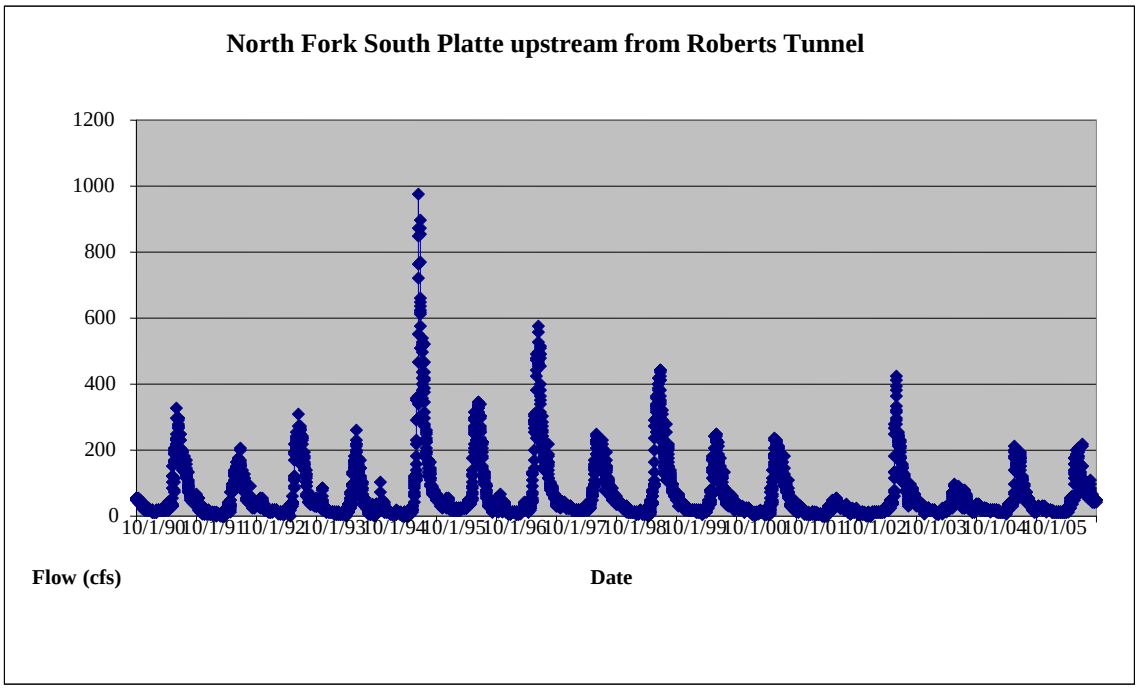
Figure 4: Hydrologic characteristics of Geneva Creek (USGS gage #06705500).



The Colorado Division of Water Resources operates gages on the North Fork South Platte River at Grant (PLAGRACO) and Roberts Tunnel at East Portal Near Grant (ROBTUNCO). The PLAGRACO gage is downstream from Geneva Creek and ROBTUNCO. Data from the three gages (North Fork South Platte River at Grant, Roberts Tunnel, and Geneva Creek) were used to estimate the discharge in the North Fork South Platte River upstream from Roberts Tunnel.

Discharge estimates were calculated as follows: The ROBTUNCO gage measurements were subtracted from the PLAGRACO gage measurements. The results represent the flows from the east side of the Divide. The results were regressed with the Geneva Creek gage measurements to calculate the proportion of the Geneva Creek flow in the PLAGRACO flow, and by subtraction, the portion of the PLAGRACO flow from the North Fork South Platte River. The resulting equation was $y=0.7342x$ ($r^2=0.9936$). Therefore, estimate of the portion of the PLAGRACO flow from the North Fork South Platte River is 0.2658. Figure 5 illustrates the hydrologic patterns in the North Fork South Platte River upstream from Roberts Tunnel.

Figure 5: Hydrologic characteristics of North Fork South Platte River (modeled)



DFlow was used to calculate chronic (30E3) low flows for the segment. These are biologically based low flows and are intended to measure the actual occurrence of low flow events with respect to both the duration and frequency (i.e., the number of days aquatic life is subjected to flows below a certain level within a period of several years). Although the extreme value analytical techniques used to calculate hydrologically-based design flows have been used extensively in the field of hydrology and in state water quality standards, these methods do not capture the cumulative nature of effects of low flow events because they only consider the most extreme low flow in any given year. By considering all low flow events within a year, the biologically-based design flow method accounts for the cumulative nature of the biological effects related to low flow events. Chronic low flows (30E3) refer to 30-day low flow periods which occur once in three years. The chronic low flows for the North Fork South Platte River upstream from Roberts Tunnel are presented in Table 7.

Table 7: Hydrologic characteristics of North Fork South Platte River upstream from Roberts Tunnel (modeled).

| Month | Median Flow (cfs) | 30E3 Chronic Low Flow (cfs) |
|---|---|---|
| Jan | 19 | 2 |
| Feb | 36 | 1 |
| Mar | 40 | 1 |
| Apr | 42 | 1 |
| May | 29 | 2 |
| Jun | 88 | 7 |
| Jul | 100 | 3 |
| Aug | 43 | 2 |
| Sep | 20 | 2 |
| Oct | 15 | 2 |
| Nov | 15 | 2 |
| Dec | 15 | 2 |

**Total Maximum Daily Loads (TMDL)**

A TMDL is comprised of the Load Allocation (LA), which is that portion of the pollutant load attributed to natural background or the nonpoint sources, the Waste Load Allocation (WLA), which is that portion of the pollutant load associated with point source discharges, and a Margin of Safety (MOS). The TMDL may also include an allocation reserved to accommodate future growth. The TMDL may be expressed as the sum of the LA, WLA and MOS.

$$TMDL = WLA + LA + MOS$$

TMDL = Sum of Waste Load Allocations + Sum of Load Allocations + Margin of Safety

## Waste Load Allocations (WLA)

There are no permitted dischargers within the geographic scope of the TMDL. There are two legacy mining operations within the upper portion of the North Fork South Platte mainstem portion of the affected watershed. Copper loading from these sources is included in the waste load allocation for this TMDL. Contributions from Missouri Mine and possibly the Whale Mine represent an unpermitted WLA.

## Load Allocations (LA)

All other sources that were examined are considered nonpoint sources and therefore are accountable to load allocations. Such sources of copper loading are treated as nonpoint sources and/or background. Copper loading from Handcart Gulch is expressed in the Load Allocation (LA) of the TMDL.

## Margin of Safety (MOS)

According to the Federal Clean Water Act, TMDLs require a margin of safety (MOS) component that accounts for the uncertainty about the relationship between the pollutant loads and the receiving waterbody. The margin of safety may be explicit (a separate value in the TMDL) or implicit (included in factors determining the TMDL). The MOS used in this TMDL analysis is implicit and resides in the conservative assumptions utilized in the calculations. The conservative assumptions used in the analysis include the use of the 85th percentile of the data in establishing ambient conditions. Mean hardness was used in calculation of hardness based TVS and represents a conservative element. Finally, the TMDL is based on stream low flow (30-day chronic low flows) which is considerably lower than flows recorded during low-flow conditions. Using low flow to calculate the TMDLs tends to overestimate the loading reductions.

## TMDL FOR DISSOLVED COPPER

The TMDL for dissolved copper is based on the data collected by the Water Quality Control Division of CDPHE and is presented in Table 8. These data were collected from the lower reach of the listed portion of the segment on the mainstem of the North Fork South Platte River below the source area. The TMDL is calculated using low flows while the ambient or observed loads are calculated using median stream flows. Proposed copper reductions are conservative and overestimate the reductions necessary to attain chronic standards. However, basing the TMDLs on low flows addresses the acute copper exceedances, as well as the chronic copper exceedances.

Table 8: Total Maximum Daily Load for COSPUS04, (WQCD 5913 and 3515)

| Month | Hardness CaC03 (mg/l) | Cu TVS (ug/l) | Ambient Cu (ug/l ) | Flow (cfs) Median | Flow (cfs) Low | Ambient Cu Load (lbs/day) | Cu TMDL (lbs/day) | Load Reduction (lbs/day) | Percent Load Reduction |
|---|---|---|---|---|---|---|---|---|---|
| Jan | 44 | 4.44 | 27 | 19 | 2 | 2.76 | 0.04 | 2.72 | 99% |
| Feb | 42 | 4.27 | 20 | 36 | 1 | 3.75 | 0.03 | 3.72 | 99% |
| Mar | 43 | 4.35 | 16 | 40 | 1 | 3.39 | 0.03 | 3.36 | 99% |
| Apr | 40 | 4.09 | 7 | 42 | 1 | 1.52 | 0.03 | 1.49 | 98% |
| May | 34 | 3.56 | 8 | 29 | 2 | 1.24 | 0.03 | 1.20 | 97% |
| Jun | 23 | 2.55 | 2 | 88 | 7 | 0.86 | 0.09 | 0.77 | 89% |
| Jul | 31 | 3.29 | 2 | 100 | 3 | 0.92 | 0.06 | 0.86 | 93% |
| Aug | 30 | 3.20 | 5 | 43 | 2 | 1.19 | 0.03 | 1.15 | 97% |
| Sept | 40 | 4.09 | 20 | 20 | 2 | 2.18 | 0.04 | 2.13 | 98% |
| Oct | 42 | 4.27 | 21 | 15 | 2 | 1.67 | 0.04 | 1.63 | 98% |
| Nov | 44 | 4.44 | 19 | 15 | 2 | 1.54 | 0.04 | 1.50 | 98% |
| Dec | 46 | 4.61 | 24 | 15 | 2 | 1.87 | 0.04 | 1.83 | 98% |

Results available from the single sampling event by HMWMD from 2000 provide information on sources of dissolved copper. As discussed in section IX Ambient Water Quality, the main sources of copper are from the Missouri Mine and Handcart Gulch. The Missouri Mine is the main source of dissolved copper to the North Fork South Platte River upstream from Handcart Gulch. The dissolved copper loading from Handcart Gulch is much larger than the Missouri Mine loading (Table 9). This is due both to higher flows and higher copper concentrations. Handcart Gulch contributes approximately 80% of the dissolved copper load to the North Fork.

Table 9: Dissolved Copper Loads from sources in Hall Valley area

| Site | Hardness CaC03 (mg/l) | Ambient Cu (ug/l) | Cu TVS Std (ug/l ) | Flow (cfs) | Observed Cu Load (lbs/day) | Percent Load Reduction |
|---|---|---|---|---|---|---|
| North Fork SPR below Missouri Mine | 28.3 | 49 | 3.1 | 5.1 | 1.4 | 94% |
| Handcart Gulch above confluence | 24 | 81 | 2.65 | 13 | 5.7 | 97% |

The Missouri Mine is considered an unpermitted point source, and as such, would receive a waste load allocation (WLA). Handcart Gulch is considered a natural load and would be assigned a load allocation (LA). As a result, the TMDL from Table 8 could be split with 80% as LA and 20% as WLA.

To test for attainment of acute copper standards, observed copper concentrations for individual samples were reduced by the calculated monthly load reduction percentages and compared to the sample specific acute copper standards. If these load reductions were attained, no exceedances of the acute standard would be observed.

## XII. RESTORATION PLANNING AND IMPLEMENTATION PROCESS

The Division plans only limited monitoring from this area. The area is owned by the U.S. Forest Service and private interests. Currently there are no plans by parties to develop the area through additional recreation development, logging or mining that may expose additional rock to precipitation and weathering. The area has not been mined for over 75 years and is not expected to be explored or mined in the next 20 years.

The Hazardous Materials and Waste Management Division of CDPHE prepared an Analytical Results Report of the Hall Valley watershed. In response, the EPA is not expected to pursue any remedial activities designed to improve water in the valley.

Natural attenuation mechanisms have and continue to remediate effects from the naturally-occurring acid rock drainage in the basin. Natural attenuation mechanisms such as precipitation help to ameliorate water quality by removing metals from solution. Analyses of new and old precipitate show that trace metals are incorporated and remain immobile (Meyer, CGS, 1997).

The Division is considering a proposal to modify the aquatic life standards for the Hall Valley / Handcart Gulch segment to reflect the ambient conditions in the basin. During the Regulation 38, Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin hearing in 2009 the Water Quality Control Commission will consider alternate acute and chronic standards adjusted to reflect ambient water conditions of the upper basin affected by ARD.

## XIII. PUBLIC INVOLVEMENT

The portion of COSPUS04 North Fork South Platte River from Hall Valley to Geneva Creek was included on the 1998 303(d) list of impaired waters in Colorado based upon water quality data. The development of the 303(d) list is a public process involving solicitation from the public, of candidate waterbodies, formation of a technical review committee comprised of representatives of both the public and private sector, and a public hearing before the Colorado Water Quality Control Commission. Public notice is provided concerning both the solicitation of impaired waterbodies and the public hearing.

The TMDL itself is subject to an independent public process. The TMDL report was made available for public review and comment during a 30 day public notice period in April, 2008.

## XV. REFERENCES

*Combined Assessment Analytical Results Report, Hall Valley, Park County, Colorado,* CDPHE, Hazardous Materials and Waste Management Division, January 10, 2001.

Meyer, Wendy A.; Streufert, Randall K.; Williamson, Mark A.; *A Comparison of Natural Acid Rock Drainage Occurrences in Colorado,* Colorado Geological Survey, 1997?.

Moran, Robert E. and Wentz, Dennis A.; *Effects of Metal-Mine Drainage on Water Quality in Selected Areas of Colorado, 1972-73*; USGS, 1974.

Neubert, John, *Naturally Degraded Surface Water Associated with Hydrothermally Altered Terrane in Colorado,* Colorado Geological Survey, 2000.

*Regulation 38, Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smokey Hill River Basin, amended effective January 20, 2005.*

*USFS-Abandoned Mined Land Inventory Project, South Platte Ranger District, Summary Report,* USDA/USFS, January 4, 1993.