Total Maximum Daily Load Assessment
Clear Creek
Clear Creek/Gilpin/Jefferson Counties, Colorado

Colorado Department of Publish Health and Environment
Water Quality Control Division

September, 2006

TMDL Summary	
Waterbody Description / WBID	Mainstem of Clear Creek, including all tributaries, lakes reservoirs and wetlands, from the I-70 bridge above Silver Plume to the Farmers Highline Canal diversion in Golden, except for North Fork Clear Creek (Segment 13b). / COSPCL02, COSPCL03a, COSPCL03b, COSPCL06, COSPCL09a, COSPCL09b, COSPCL11.
Pollutants Addressed	Dissolved Cadmium, Dissolved Copper, Dissolved Lead, and Dissolved Zinc
Relevant Portion of Segment (as applicable)	The mainstem of Clear Creek in Segments 2 and 11, mainstem South Clear Creek in Segment 3a, mainstem Leavenworth Creek 3b, Mad Creek in Segment 6, mainstem Fall River in Segment 9a, Trail Creek and all tributaries in Segment 9b.
Use Classifications / Designation	Segments 2, 3a, 6, 9a, 9b: Aquatic Life Cold 1, Recreation 1a, Water Supply, Agriculture / Reviewable Segment 3b: Aquatic Life Cold 2, Recreation 1a, Water Supply, Agriculture / Reviewable Segment 11: Aquatic Life Cold 1, Recreation 1a, Water Supply, Agriculture / Use Protected
Water Quality Targets (for dissolved fraction of metals)	

Segment 2	Chronic	Acute
Cu-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	200	TVS
Segment 3a	**Chronic**	**Acute**
Zn-D	TVS	TVS
Segment 3b	**Chronic**	**Acute**
Pb-D	TVS	TVS
Zn-D	TVS	TVS
Segment 6	**Chronic**	**Acute**
Zn-D	TVS	TVS
Segment 9a	**Chronic**	**Acute**
Cu-D	TVS	TVS
Segment 9b	**Chronic**	**Acute**
Cd-D/TR	TVS	TVS
Cu-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	200	TVS
Segment 11	**Chronic**	**Acute**
Cd-D	TVS	TVS
Pb-D	TVS	TVS
Zn-D	300	none

TMDL Goal	Attainment of Aquatic Life Classification

EXECUTIVE SUMMARY

The Clear Creek watershed is a medium size watershed that is a tributary to the South Platte River (Figure 1). The mainstem of Clear Creek from Silver Plume to the Farmers Highline Canal diversion in Golden, and several tributaries including South Clear Creek, Leavenworth Creek, Mad Creek, Fall River, and Trail Creek, appear on the Colorado 2006 303(d) list for excessive dissolved cadmium, copper, lead, and zinc (Table 1). These metals impair the Aquatic Life Cold 1 or 2 designation (dependant upon segment). The high concentration of metals is primarily the result of mining activity in the watershed since 1859 thru the present. A large portion of the Clear Creek watershed was placed on the National Priority List for clean up under Superfund in 1983 in response to concern about the high concentrations of heavy metals.

WBID	Segment Description	Portion	303(d) Listed Contaminants
COSPCL02	Mainstem of Clear Creek, I-70 bridge above Silver Plume to Argo Tunnel in Idaho Springs	mainstem	Cu, Pb, Zn
COSPCL03a	Mainstem of South Clear Creek	all	Zn
COSPCL03b	Leavenworth Creek	all	Pb, Zn
COSPCL06	West Clear Creek tributaries	Mad Creek	Zn
COSPCL09a	Fall River and tributaries	Fall River	Cu
COSPCL09b	Trail Creek and tributaries	all	Cd, Cu, Pb, Zn
COSPCL11	Mainstem Clear Creek, Argo Tunnel in Idaho Springs to Farmers Highline Canal Diversion in Golden	all	Cd, Pb, Zn

Table 1. Segments within the upper Clear Creek watershed that appear on the 2006 303(d) list of impaired waters for excessive heavy metals.

Reduction of metals in the upper Clear Creek watershed will be mainly through Superfund/CERCLA activities including the treatment of acid mine drainage from several large tunnels and contaminated groundwater, and by capping or removing numerous mining related rock piles and tailings within the watershed.

I. INTRODUCTION Section 303(d) of the federal Clean Water Act ("CWA") requires States to periodically submit to the U. S. Environmental Protection Agency ("EPA") a list of water bodies that are water quality impaired. Water quality limited segments are those water bodies that, for one or more assigned use classifications or standards, the classification or standard is not fully achieved. This list of water bodies is referred to as the "303(d) List". In Colorado, the agency responsible for developing the 303(d) List is the Water Quality Control Division ("WQCD"). The List is adopted by the Water Quality Control Commission ("WQCC") as Regulation No. 93. The WQCC adopted the current 303(d) List in March of 2006.

For water bodies and streams on the 303(d) list a Total Maximum Daily Load (TMDL) is used to determine the maximum amount of a contaminant that a water body may receive and still maintain water quality standards. The TMDL is the sum of the Waste Load Allocation (WLA) which is the contaminant load from point source discharges, Load Allocation (LA) which is the contaminant load attributed to natural background and/or non-point sources, and a Margin of Safety (MOS) (Equation 1).

(Equation 1) TMDL=WLA+LA+MOS

The main stem of Clear Creek watershed and several of its tributaries, are included in the 2006 303(d) list for exceeding aquatic life standards for cadmium, copper, lead, and zinc (WQCC, 2006) (Table 1). 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").

II. GEOGRAPHICAL EXTENT

The headwaters of mainstem Clear Creek are located at the continental divide (elevation 12,000-14,000 ft) near the Eisenhower/Johnson Tunnels and then follows I-70 east through the towns of Silver Plume, Georgetown, Lawson, Dumont, and Idaho Springs. At the junction I-70 and US 6, Clear Creek continues eastward along US 6 to Golden (elevation 5,500 ft). The headwaters of Clear Creek and its tributaries drain high mountain peaks, alpine tundra, and forested lands within Arapaho National Forest and the Mt. Evans Wilderness. The watershed also drains numerous abandoned and a few active mines that discharge water containing high levels of heavy metals. Within the mountain valleys, Clear Creek receives runoff from roads and urban areas from the I-70 corridor, Hwy 6, and Hwy 40, and effluent from several wastewater treatment plants and other permitted operations. There are four major tributaries, South Clear Creek, West Fork of Clear Creek, Fall River, Chicago Creek, North Fork Clear Creek, Beaver Brook/Soda Creek, and numerous minor tributaries including Trail Creek.

The tributaries of Clear Creek also listed on the 303(d) list include South Clear Creek, Leavenworth Creek, Mad Creek (tributary to West Clear Creek), Fall River, and Trail Creek. Leavenworth and South Clear Creek drain several high mountain lakes (13,000 ft) near Guanella Pass, and flow north to their confluence above Georgetown. The mouth of South Clear Creek is located in Georgetown. Nine mine tunnels are known to exist within the watershed of South Clear Creek, and six are known within the watershed of Leavenworth Creek (EPA 1990).

Mad Creek drains the high mountains of the continental divide (13,000 ft) near Berthoud Pass and then flows southeast to its confluence with the West Fork Clear Creek above the town of Empire. The mouth of West Fork Clear Creek is located at the junction of US 40 and I-70 where it flows into the mainstem. Several abandoned mines are known to exist in the Mad Creek watershed.

Fall River drains numerous high mountain lakes near the continental divide as well as St.

Mary's glacier and the town of Alice. Fall River flows southeast to its confluence with the mainstem between the towns of Dumont and Idaho Springs. Nineteen mine tunnels are known to exist within the watershed of Fall Creek.

The headwaters of Trail Creek are located south of the town of Lawson. Trail Creek then flows east to its confluence with the mainstem just downstream of Fall River. Twelve mine tunnels are known to exist within the small watershed of Trail Creek. The entire Clear Creek watershed lies within the USGS hydrologic unit code 10190004.

III. WATER QUALITY STANDARDS

The Colorado Basic Standards and Methodologies for Surface Water, Regulation 31 (5CCR 1002-31) identifies standards applicable to all surface waters statewide. The pollutants addressed in this assessment include dissolved species of cadmium, copper, lead, and zinc. The specific numeric standards assigned to the listed stream segments are contained in WQCC Regulation No. 38, the Classifications and Numeric Standards for the South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin.

Most of the relevant standards for the stream segments addressed in this document are Table Value Standards, which vary based on hardness. Because hardness fluctuates seasonally, standards are listed on a monthly basis using the average hardness for each month (data from Upper Clear Creek Watershed Association (UCCWA), and CDPHE). The highest hardness values and therefore more lenient standards occurred during low flow, which helped to offset the lack of dilution available at these times (Table 2). However, exceedance of the standard at low flow was common. Exceedances were also common on the rising limb of spring runoff when metal-laden water is displaced from shallow aquifers by snowmelt.

All of the stream segments addressed here are use classified as Aquatic Life Cold 1 (except Leavenworth Creek, segment COSPCL03b, which is Aquatic Life Cold 2), Recreation 1a, Water Supply, and Agriculture. In all cases the elevated levels of listed heavy metals exceed the aquatic life standards, while other uses are supported.

	Clear Cr. Silver Plume to Idaho Springs				South Clear Cr.		Leavenworth Cr.			Mad Cr.		Fall R.		Trail Cr.					Clear Cr. Idaho Springs to Golden			
	Segment 2				Segment 3a		Segment 3b			Segment 6		Segment 9a		Segment 9b					Segment 11			
Month	Hard. mg/L	Cu-D ug/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Zn-D ug/L	Hard. mg/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Zn-D ug/L	Hard. mg/L	Cu-D ug/L	Hard. mg/L	Cd-D ug/L	Cu-D ug/L	Pb-D ug/L	Zn-D ug/L	Hard. mg/L	Cd-D ug/L	Pb-D ug/L	Zn-D ug/L
Jan	105	9.3	2.7	200	55.5	72	287	1.4	76	13	4.2	40.7	4.2	140	2.9	11.9	3.6	157	103	2.3	2.6	300
Feb	112	9.9	2.9	200	55.8	72	293	1.5	79	16	4.5	44.6	4.5	147	3.0	12.5	3.8	164	107	2.4	2.7	300
Mar	107	9.5	2.7	200	55.2	71	296	1.5	78	27	3.2	29.4	3.2	160	3.2	13.4	4.2	176	117	2.5	3.0	300
Apr	102	9.1	2.6	200	54.7	71	275	1.5	78	19	4.4	43.5	4.4	136	2.8	11.7	3.5	153	101	2.3	2.6	300
May	58.6	5.7	1.4	200	39.6	54	116	0.9	53	13	2.9	27.0	2.9	101	2.3	9.1	2.6	119	94.0	2.1	2.4	300
Jun	34.3	3.6	0.8	200	30.0	43	4.7	0.6	37	7	2.0	17.2	2.0	59.2	1.5	5.7	1.4	76	26.7	0.8	0.6	300
Jul	36.6	3.8	0.8	200	33.9	47	27	0.7	45	8	1.8	15.7	1.8	82	1.9	7.6	2.0	100	36.1	1.1	0.8	300
Aug	49.0	4.9	1.2	200	39.6	54	116	0.9	54	9	2.1	18.1	2.1	94	2.1	8.5	2.4	112	49.8	1.3	1.2	300
Sep	55.2	5.4	1.3	200	44.6	60	169	1.0	60	12	2.2	19.1	2.2	115	2.5	10.1	2.9	133	59.3	1.5	1.4	300
Oct	61.4	5.9	1.5	200	49.6	65	205	1.2	66	12	2.3	20.2	2.3	120	2.6	10.5	3.1	138	74.0	1.8	1.8	300
Nov	79.7	7.4	2.0	200	52.3	68	247	1.3	69	12	3.1	28.5	3.1	130	2.7	11.2	3.3	148	90.3	2.1	2.3	300
Dec	98.0	8.8	2.5	200	55.1	71	273	1.4	73	12	3.8	36.8	3.8	140	2.9	11.9	3.6	157	108	2.4	2.7	300

Table 2. Average hardness and chronic stream standards for 303(d) listed segments of Clear Creek.

IV. PROBLEM IDENTIFICATION

There are relatively few permitted dischargers within the Clear Creek basin and four of the listed segments including South Clear Creek (Segment COSPCL03a), Leavenworth Creek (COSPCL03b), Mad Creek (COSPCL06), and Trail Creek (COSPCL09b) have no permitted dischargers within their watersheds (Table 3).

WBID	Dischargers	NPDES ID	SIC DESC	Design Capacity, mgd
COSPCL02	Central Clear Creek S.D.	COG588055	sewer systems	0.1
	Georgetown WWTP	CO0027961	sewer systems	0.058
	Georgetown, Town of	COG600624	amusement & recreation	N/A
	Silver Plume water imps.	COG072152	heavy construction	0.36
	Silver Plume, Town of	COG641113	water supply	N/A
COSPCL03a	N/A	N/A	N/A	N/A
COSPCL03b	N/A	N/A	N/A	N/A
COSPCL06	N/A	N/A	N/A	N/A
COSPCL09a	St. Mary's Glacier	COG380004	water supply	N/A
	St. Mary's Glacier W&SD	CO0023094	sewer systems	0.6
COSPCL09b	N/A	N/A	N/A	N/A
COSPCL 11	Albert Frei & Sons Inc	COG500268	construction sand/gravel	0.03
	Argo Tunnel Treatment Plant	COU000100	lead & zinc ores	N/A
	Idaho Springs, City of	COG641029	water supply	0.214
	Idaho Springs, Town of WWTP	COG650097	sewer systems	0.6

Table 3. Permitted dischargers in 303(d) listed streams segments of upper Clear Creek.

Much of the heavy metal loading throughout the Clear Creek basin is the result of natural geologic conditions and historic mining activities. The upper Clear Creek watershed has experienced widespread mining activity throughout the basin beginning in 1859, and one large mining operation (Climax Henderson) presently operates within the watershed of West Fork Clear Creek. However, most mining tunnels, waste rock piles, and mine tailings have long been abandoned, and these mining features are a significant source of heavy metals within the upper Clear Creek watershed.

Historically, three large tunnels on the mainstem discharged water of low pH, and high metal concentration into the mainstem of Clear Creek: Burleigh Tunnel (Silver Plume), Big Five Tunnel (Idaho Springs), and Argo Tunnel (Idaho Springs). These three tunnels accounted for a large portion of the copper and zinc load in Clear Creek especially during low flow, but the flows from Big Five and Argo tunnels are now treated at the Argo WTP. In addition to the three large tunnels in the watershed, over 200 smaller mining tunnels have been identified by the EPA, and there are at least 800 abandoned mines within the affected portions of the watershed (EPA OU4 ROD 2004).

In addition to mining, Clear Creek receives runoff and gravel from roads and road construction (primarily I-70, US 6, and US 40), urban drainage from numerous small towns, and treated effluent from permitted dischargers including municipal wastewater treatment plants and water supply systems.

Within the last year discharges from the Big Five Tunnel and Virginia Canyon have been piped to the Argo WTP, which will further improve water quality in the mainstem below Idaho Springs (COSPCL11). A wetland remediation site was constructed for the Burleigh Tunnel near Silver Plume, but has since been abandoned and no further remedial action has been planned. Remediation has not been planned for any of the mining features in the watersheds of South Clear Creek (COSPCL03a), Leavenworth Creek (COSPCL03b), Mad Creek (COSPCL06), Fall Creek (COSPCL09a), or Trail Creek (COSPCL09b). Without remedial action of abandoned mine features in these watersheds improvement in water quality will not occur.

The high metals concentrations within 303(d) listed segments of the upper Clear Creek basin exceed the standards to protect aquatic life. Biological studies over the last 15 years by the CDOW and U.S. Environmental Protection Agency ("EPA") concluded that cadmium, copper, and zinc threaten trout and macroinvertebrates. Lead also reached toxic levels in parts of the upper Clear Creek watershed.

V. WATER QUALITY GOALS

The water quality goal for 303(d) listed segments of Clear Creek is attainment of the Aquatic Life Cold 1 or 2 classifications. Reduction of metal loads will also improve the quality of municipal drinking water supplies for residents in the Clear Creek basin.

In the case of the mainstem (Segments COSPCL02 and COSPCL11), it is not known to what extent treating the discharges of the Big Five Tunnel and Virginia Canyon will have to reduce metal loads since treatment of those flows has been very recent. Continued monitoring at UCCWA and CDPHE sites on the mainstem will determine the effect of treating those discharges.

To mitigate the problematic metals loading into the upper Clear Creek watershed there are ongoing CERCLA cleanup activities associated with the Clear Creek/Central City Superfund site (COD980717557). Four Operable Units (OU) of the Clear Creek/Central City Superfund Site exit within the watershed. Operable Units 1 and 2 sought to passively treat the discharges and remediate the waste piles from the Big Five and Argo sites as well as three other sites on the North Fork of Clear Creek, but the goals of OU's 1 and 2 have been modified or superceded by OU's 3 and 4. Operable Unit 3 brought about the completion of the Argo WTP (April 1998) that is used to treat metal-laden water from the Argo Tunnel, and recently, water from Virginia Canyon and the Big Five Tunnel as well. A passive treatment system was attempted at the Burleigh Tunnel site, but the project was later abandoned, thus Burleigh discharges remain untreated. Mine tailings/rock piles at the McClelland Tunnel have been remediated, but the discharges remain untreated, and the Rockford Tunnel has not been remediated in any way. There are over 800 abandoned mines (both discharging and non-discharging) within the upper Clear Creek watershed. Relatively small contributions of metals come from ambient loading of the undisturbed surrounding watershed, such as the Mount Evans Wilderness Area.

VI. INSTREAM CONDITIONS

Hydrology

The hydrograph of Clear Creek and its tributaries are typical of high mountain streams, with low flows occurring in the late fall to early spring followed by a large increase in flow, usually in May, due to snowmelt that tails off through the summer (Figure 2, Table 4).

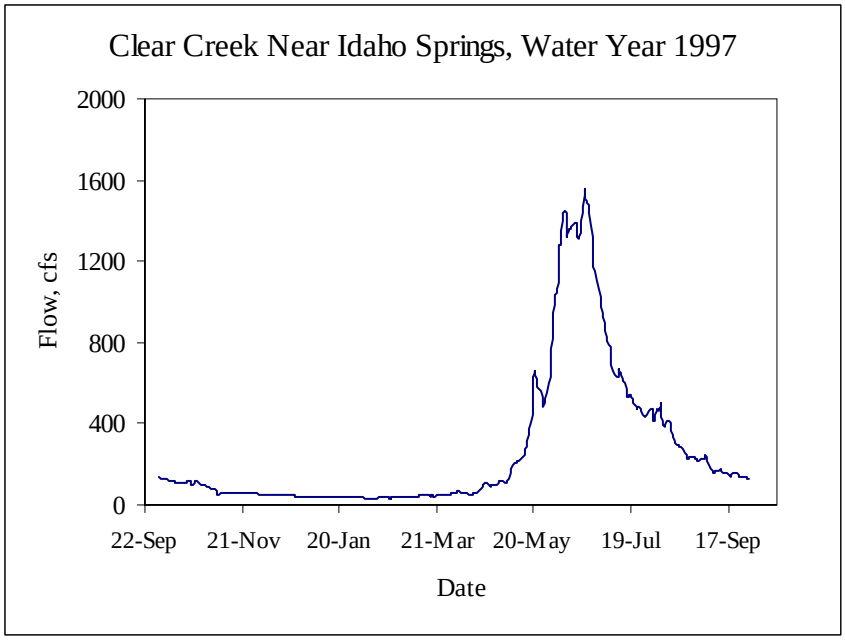

Figure 2. Hydrograph of Clear Creek near Idaho Springs, USGS gage 6718300.

The smaller tributaries show the same pattern, but tend to show greater influences to summer rain events. There are three minor trans-basin diversions into the watershed, the Vidler Tunnel, Gumlick Tunnel, and the Berthoud Ditch that have no known effect on metal concentrations in the upper Clear Creek watershed.

	Clear Cr. Silver Plume to Idaho Spgs	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr. Idaho Spgs to Golden
Gage #	6718300	6714600	6714800		6717000		6719505
Month	COSPCL02	COSPCL03a	COSPCL03b	COSPCL06	COSPCL09a	COSPCL09b	COSPCL011
Jan	40	4.5	2.2	N/A	4.0	N/A	49
Feb	37	3.9	1.9	N/A	3.0	N/A	46
Mar	43	6.3	1.8	N/A	4.0	N/A	50
Apr	66	6.5	2.6	N/A	7.0	N/A	81
May	258	11	12	N/A	38	N/A	307
Jun	705	62	47	N/A	70	N/A	682
Jul	418	48	28	N/A	35	N/A	364
Aug	196	24	12	N/A	28	N/A	167
Sep	140	16	7.9	N/A	11.5	N/A	125
Oct	103	9	5.8	N/A	8.0	N/A	91
Nov	64	6.3	3.8	N/A	6.0	N/A	69
Dec	47	5.5	2.7	N/A	4.3	N/A	55

Table 4. Monthly median flows (cfs), for 303(d) listed stream segments in the upper Clear Creek watershed.

Ambient Water Quality Data

To identify exceedances of the chronic water-quality standard the average concentration of metals was calculated using the most current available data from UCCWA and in some cases data was supplemented by CDPHE (Tables 5 & 6). Exceedances of the standard and percent reductions needed to meet the standard for 303(d) listed segments of Clear Creek are listed in Tables 7 and 8.

WBID	Period of Record	n	Location	Source
COSPCL02	4/03-2/06	22	Clear Cr. above Chicago Cr	UCCWA
COSPCL03a	2/94-10/05	89	South Clear Cr. above Leavenworth Cr.	UCCWA
COSPCL03b	5/99-10/05	48	Leavenworth Cr. near mouth	UCCWA
COSPCL06	9/02-10/03	13	Mad Cr. at US 40	CDPHE
COSPCL09a	2/94-10/05	93	Fall R. near mouth	UCCWA
COSPCL09b	1/03-12/05	23	Trail Cr. near mouth	UCCWA/CDPHE
COSPCL11	2/95-12/05	95	Clear Cr. at Golden	UCCWA

Table 5. Sources of water-quality data for 303(d) listed stream segments in the upper Clear Creek basin.

In Segment COSPCL02 (mainstem, Silver Plume to Idaho Springs), the concentration of copper was highest during the low flow months, and exceedances of the standard occurred during the low flow months January-April, early runoff in May and June, and in October (Tables 6-8). Exceedance of the copper standard in May and June is probably related to the lower hardness values during those months (Table 9). The average lead concentration did not exceed the standard in COSPCL02 at any time of year (Tables 6-8). Zinc exceeded the standard during low flow at the beginning of the year, but was not a problem once spring runoff began in May through December (Tables 6-8).

In Segment COSPCL03a (South Clear Creek), zinc exceeded the standard in all months except February-April when concentrations of lead were lowest, and hardness was relatively high (Tables 6-9). The highest concentration of zinc was observed in May and coincided with low hardness, which compounded the problem (Tables 6 & 9).

	Clear Cr. Silver Plume to Idaho Springs			South Clear Cr.	Leavenworth Cr.		Mad Cr.	Fall R.	Trail Cr.				Clear Cr. Idaho Springs to Golden		
	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
	Cu-D	Pb-D	Zn-D	Zn-D	Pb-D	Zn-D	Zn-D	Cu-D	Cd-D	Cu-D	Pb-D	Zn-D	Cd-D	Pb-D	Zn-D
Month	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Jan	9.56	0.09	251	79.4	1.01	203	29	1.95	3.40	120	4.0	890	1.05	0.27	341
Feb	12.25	0	303	67.6	1.11	202	22	1.77	2.73	144	3.5	1050	0.87	0.53	331
Mar	10.93	0	277	61.2	1.31	196	30	2.35	2.90	11.0	0	740	0.81	2.85	277
Apr	9.61	0	251	54.8	1.50	190	50	2.92	6.96	143	6.4	1515	0.75	5.17	222
May	6.11	0.32	91.8	126	1.68	171	25	15.2	6.04	185	7.3	1215	1.03	0.39	250
Jun	3.73	0.42	71.8	94.1	1.08	115	0	8.97	2.85	53.4	3.0	604	0.28	0.29	111
Jul	1.20	0.12	58.1	66.6	0.72	110	0	2.10	2.86	44.2	0.5	798	0.19	0.21	76.7
Aug	1.87	0.12	83.2	69.4	0.94	133	0	1.84	2.98	38.1	0.2	662	0.51	0.11	125
Sep	4.11	0.30	97.9	74.0	1.06	159	6.5	1.43	3.40	56.0	3.5	820	0.51	0.06	161
Oct	6.35	0.48	113	78.6	1.19	185	31	1.02	4.05	86.5	9.5	900	0.52	0.02	197
Nov	6.61	0.34	155	84.8	1.05	195	66	1.57	3.10	67.0	2.0	750	0.88	0.01	274
Dec	6.87	0.19	198	91.1	0.91	205	22	2.12	3.76	142	4.8	780	1.24	0.01	352

Table 6. Ambient concentrations of metals in the 303(d) listed segments of the upper Clear Creek basin.

	Clear Cr. Silver Plume to Idaho	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr. Idaho Springs to Golden

Springs

	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
Month	Cu-D	Pb-D	Zn-D	Zn-D	Pb-D	Zn-D	Zn-D	Cu-D	Cd-D	Cu-D	Pb-D	Zn-D	Cd-D	Pb-D	Zn-D
Jan	X	O	X	X	O	X	X	O	X	X	X	X	O	O	X
Feb	X	O	X	O	O	X	O	O	O	X	O	X	O	O	X
Mar	X	O	X	O	O	X	O	O	O	O	O	X	O	O	O
Apr	X	O	X	O	X	X	X	O	X	X	X	X	O	X	O
May	X	O	O	X	X	X	X	X	X	X	X	X	O	O	O
Jun	X	O	O	X	X	X	O	X	X	X	X	X	O	O	O
Jul	O	O	O	X	X	X	O	X	X	X	O	X	O	O	O
Aug	O	O	O	X	X	X	O	O	X	X	O	X	O	O	O
Sep	O	O	O	X	X	X	O	O	X	X	X	X	O	O	O
Oct	X	O	O	X	X	X	X	O	X	X	X	X	O	O	O
Nov	O	O	O	X	O	X	X	O	X	X	O	X	O	O	O
Dec	O	O	O	X	O	X	X	O	X	X	X	X	O	O	X

Table 7. Exceedances of the standard for 303(d) listed stream segments in the upper Clear Creek basin. “X” indicates the standard is exceeded.

Clear Cr. Silver Plume to Idaho	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr. Idaho Springs to Golden

Springs

	Segment 2			Segment 3a	Segment 3b		Segment 6	Segment 9a	Segment 9b				Segment 11		
Month	Cu-D	Pb-D	Zn-D	Zn-D	Pb-D	Zn-D	Zn-D	Cu-D	Cd-D	Cu-D	Pb-D	Zn-D	Cd-D	Pb-D	Zn-D
Jan	2%	-	20%	10%	-	63%	28%	-	16%	90%	10%	82%	-	-	12%
Feb	19%	-	34%	-	-	61%	-	-	-	91%	-	84%	-	-	9%
Mar	13%	-	28%	-	-	60%	-	-	-	-	-	76%	-	-	-
Apr	6%	-	20%	-	3%	59%	42%	-	60%	92%	45%	90%	-	51%	-
May	7%	-	-	57%	48%	69%	16%	81%	63%	95%	65%	90%	-	-	-
Jun	4%	-	-	55%	49%	68%	-	78%	47%	89%	52%	87%	-	-	-
Jul	-	-	-	29%	0%	59%	-	12%	32%	83%	-	87%	-	-	-
Aug	-	-	-	22%	2%	59%	-	-	28%	78%	-	83%	-	-	-
Sep	-	-	-	19%	2%	62%	-	-	27%	82%	16%	84%	-	-	-
Oct	7%	-	-	17%	1%	64%	36%	-	37%	88%	68%	85%	-	-	-
Nov	-	-	-	20%	-	64%	70%	-	12%	83%	-	80%	-	-	-
Dec	-	-	-	22%	-	64%	11%	-	24%	92%	24%	80%	-	-	15%

Table 8. Percent reduction in concentration/load to meet the chronic water quality standards for 303(d) listed stream segments of the upper Clear Creek basin.

	Clear Cr. Silver Plume to Idaho Springs	South Clear Cr.	Leavenworth Cr.	Mad Cr.	Fall R.	Trail Cr.	Clear Cr. Idaho Springs to Golden
	Segment 2	Segment 3a	Segment 3b	Segment 6	Segment 9a	Segment 9b	Segment 11
Month	Hard., mg/L	Hard., mg/L	Hard., mg/L	Hard, mg/L	Hard., mg/L	Hard., mg/L	Hard., mg/L
Jan	105	55.5	287	13	40.7	140	103
Feb	112	55.8	293	16	44.6	147	107
Mar	107	55.2	296	27	29.4	160	117
Apr	102	54.7	275	19	43.5	136	101
May	58.6	39.6	116	13	27.0	101	94.0
Jun	34.3	30.0	4.7	7.0	17.2	59.2	26.7
Jul	36.6	33.9	27	8	15.7	82	36.1
Aug	49.0	39.6	116	9	18.1	94	49.8
Sep	55.2	44.6	169	12	19.1	115	59.3
Oct	61.4	49.6	205	12	20.2	120	74.0
Nov	79.7	52.3	247	12	28.5	130	90.3
Dec	98.0	55.1	273	12	36.8	140	108

Table 9. Hardness concentrations for 303(d) listed stream segments in the upper Clear Creek basin.

In Segment COSPCL03b (Leavenworth Creek), lead exceeded the standard April-October. The concentration of lead was highest in April and May, and hardness values were low when lead exceedances occurred in June-October (Tables 6-9). Zinc exceeded the standard in all months (Table 7 & 8). Zinc concentrations were slightly lower June-September, and these months also had extremely low hardness values (Table 6 & 9).

In Segment COSPCL06 (Mad Creek), zinc exceeded the standard October-January, and in April and May (Tables 7 & 8). Elevated concentrations of zinc were observed October-May (Table 6). Hardness values were extremely low in Mad Creek throughout the year, but were slightly higher in February and March, which suggests that hardness may have been protective during those months when flows are typically low (although no flow data was available for Mad Creek) (Table 9).

In Segment COSPCL09a (Fall River), copper exceeded the standard May-July (Table 7 & 8). Copper concentrations were very high in May and June, and hardness values were very low during these months (Table 6 & 9).

In Segment COSPCL09b (Trail Creek), cadmium exceeded the standard in all months except February and March when high hardness values were protective (Tables 6-8). Copper exceeded the standard in all months except March, which had high hardness and an uncharacteristically low concentration of copper (Tables 6-9). Lead exceeded the standard in all months except February-March, July-August, and November (Tables 7 & 8). The high hardness in February and March, and low concentration of lead in March was protective in those months

(Tables 6-9). In July, August, and November the average lead concentration was low (Table 6). The highest concentration of lead was observed in May (Table 6). It is not know why copper and lead were so much lower in March compared to other months, although the paucity of data on Trail Creek may be partly to blame as only one sample was collected in the month of March for the period of record. Zinc exceeded the standard at all times of the year, and the highest concentrations and exceedances were observed in April and May (Tables 6 & 8).

In Segment COSPCL11 (mainstem, Idaho Springs to Golden), cadmium did not exceed the standard at any time of the year (Tables 7 & 8). Lead exceeded the standard in April when the highest average concentration of lead was observed due to one sample with abnormally high lead concentration (Table 6-9). Zinc exceeded the standard December-February when the highest average zinc concentrations were observed (Tables 6-8).

The Argo Tunnel, and recently flows and ground water from the Big Five Tunnel and Virginia Canyon are being treated at the Argo WTP, but flows from the Burleigh Tunnel, McClelland Tunnel, and Rockford Tunnel still contribute loads to Segment 2, with zinc loads from the Burleigh Tunnel being particularly high.

	Jun-89			Sep-89		
	Cu-D	Pb-D	Zn-D	Cu-D	Pb-D	Zn-D
Tunnels	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Rockford	0.092	0.001	0.486	0.068	0.000	0.273
McClelland	0.031	0.001	1.093	0.003	0.000	0.490
Burleigh	0.002	0.003	11.4	0.000	0.002	19.5

Table 10. Average load from largest untreated tunnels discharging into Segment 2 (Silver Plume to Idaho Springs). Loads derived from two EPA sampling dates in 6/89 and 9/89.

VII. SOURCES, TECHNICAL ANALYSIS, AND TMDL LOAD ALLOCATIONS

The vast majority of the metal loads into Clear Creek are from historic and present day mining activities. The metals loads to Clear Creek vary along the length of the stream, and correspondingly so do the ambient concentrations of metals. Additionally there are 11 permitted discharges within the upper Clear Creek watershed (Table 3).

For most of the stream segments the highest metal loads occurred in May or June, when flows were highest, and in some cases, concentrations were high as well (Tables 6, 11-20). Exceedance of the standard is likely to occur in during low flow when there is less dilution available, or in spring when snowmelt infiltrates shallow aquifers displacing metal-laden water stored within the aquifer to adjacent streams, but it should be noted that exceedances of the standards occurred at all times of the year (Tables 7 & 8).

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

The TMDL was calculated using the median monthly flow from the nearest gage to a segment and the existing stream standard. Metal loads from dischargers were calculated using the design capacity for flow, and assuming the concentration in the effluent is equal to the standard. Modeled discharges were then given waste load allocations (WLA) and load allocations (LA) were calculated by subtracting the WLA from the TMDL. Where the ambient stream load is higher than the TMDL a load reduction was calculated.

The highest copper loading to Segment COSPCL02 (Silver Plume to Idaho Springs) comes from the West Fork Clear Creek (Table 11). In the lower portion of Segment COSPCL02, Fall River and Chicago Creek carry high copper loads May-July. Although no flow data are available for Trail Creek it is reasonable to assume from the extremely high concentrations of copper observed year-round that loads are high from that tributary as well (Table 6). The highest lead and zinc loading to Segment 2 occurs between South Clear Creek and the West Fork Clear Creek, although the South Fork Clear Creek and West Fork Clear Creek are still significant sources of zinc (Tables 12 & 13). Lead and zinc loads are probably significant from Trail Creek as well (Table 6). The Burleigh Tunnel contributes a significant zinc load the mainstem as well and CERCLA has decided not to take any further action to remediate that site (Table 10). The five permitted facilities on Segment COSPCL02 contribute only a small percentage of the total metals load to the stream, and can easily meet TVS metals limits protective of the aquatic life use.

The highest zinc loads in South Clear Creek (Segment COSPCL03a) occurred in June when flows are highest (Table 14), but no data are available to further determine the upstream sources of zinc. The highest lead and zinc loads in Leavenworth Creek (Segment COSPCL03b) also occurred in June (Table 15 & 16), but again no data are available to further track the upstream sources of these metals. Loads could not be determined for Mad Creek (Segment 6) or Trail Creek (Segment COSPCL09b) because no flow data were available for those sites. Copper loads were highest in the Fall River (Segment COSPCL09a) in May and June (Table 17). The St. Mary's Glacier Water and Sanitation District have a discharge permit on the Fall River, but contribute a relatively small load of copper to Fall River (Tables 3 &17). No data were available to further trace the upstream sources of copper in Fall River.

The highest cadmium loads occurred in May in the mainstem from Idaho Springs to

Golden (Segment COSPCL11), but cadmium loads never exceeded the TMDL (Table 18). The North Fork of Clear Creek contributes a significant portion of the cadmium load to the mainstem although loads are somewhat diluted by the time they reach Golden at the end of COSPCL 11 (Table 18). Four dischargers have permits in COSPCL11, and the Argo WTP has the highest effluent limits but consistently discharges well below their allowable limit (Table 18).

In Segment COSPCL11, the highest loads of lead occurred in April, which was the only month when lead exceeded the standard (one abnormally high lead sample was taken 4/5/1994) (Table 19). The Argo WTP has the highest allowable effluent limit and if it discharged at its maximum allowable limit would cause the stream to exceed the standard. However, the Argo WTP consistently discharges well below its lead limit.

In Segment COSPCL11, the highest zinc loads occurred in May, although the standard was exceeded during low flow (December-February) when there is less dilution (Table 20). North Fork Clear Creek contributes a significant zinc load to the mainstem, but dilution from other sources reduces the loads by the time the mainstem reaches Golden (Table 20). The permitted dischargers contribute a very small portion of the overall lead load in the mainstem.

Margin of Safety

An explicit margin of safety was not included in this assessment. There is an overall implicit margin of safety with regards to this assessment due to the calculation of monthly TMDLs. Monthly TMDLs reflect the extreme hydrograph of the Clear Creek Basin, and adequately reflect the current water quality situation. There is also an uncertainty with the ultimate CERCLA cleanup results, and an impending water quality standards triennial review, that are part of an implicit margin of safety.

	Copper																
						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 2, lbs/day							
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	Sliver Plume Water Imps	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.	Upstream Clear Cr.	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Chicago Cr.
Jan	2.02	0.028	1.99	2.06	0.05	0.019	0.0001	0.003	0.005	0.03	0.01	0.00	0.05	0.30	0.17	0.04	0.01
Feb	1.97	0.028	1.95	2.45	0.47	0.019	0.0001	0.003	0.005	0.03	0.02	0.00	0.03	0.36	0.16	0.03	0.00
Mar	2.20	0.028	2.17	2.54	0.34	0.019	0.0001	0.003	0.005	0.16	0.03	0.00	0.04	0.34	0.17	0.05	0.00
Apr	3.23	0.028	3.20	3.42	0.19	0.019	0.0001	0.003	0.005	0.29	0.03	0.00	0.05	0.32	0.18	0.11	0.00
May	7.94	0.028	7.91	8.51	0.57	0.019	0.0001	0.003	0.005	0.62	0.19	0.30	0.94	4.7	3.31	3.12	0.10
Jun	13.7	0.028	13.6	14.2	0.55	0.019	0.0001	0.003	0.005	1.34	0.57	0.69	1.57	3.63	3.5	3.37	0.13
Jul	8.55	0.028	8.53	2.71	0	0.019	0.0001	0.003	0.005	0.20	0.32	0.11	0.20	0.93	1.58	0.40	0.01
Aug	5.15	0.028	5.13	1.98	0	0.019	0.0001	0.003	0.005	0.14	0.05	0.06	0.08	0.32	0.71	0.28	0.03
Sep	4.07	0.028	4.05	3.11	0	0.019	0.0001	0.003	0.005	0.14	0.07	0.04	0.10	0.35	0.46	0.09	0.02
Oct	3.28	0.028	3.25	3.53	0.25	0.019	0.0001	0.003	0.005	0.14	0.06	0.03	0.12	0.38	0.21	0.04	0.01
Nov	2.55	0.028	2.52	2.28	0	0.019	0.0001	0.003	0.005	0.08	0.03	0.01	0.10	0.31	0.20	0.05	0.01
Dec	2.23	0.028	2.21	1.74	0	0.019	0.0001	0.003	0.005	0.03	0.01	0.00	0.07	0.23	0.18	0.05	0.02

Table 11. Copper total maximum daily load, waste load allocation, and load allocations for Segment COSPCL02 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved copper, waste loads are given for potentially dissolved copper.

	Lead																
						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 2, lbs/day							
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	Sliver Plume Water Imps	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.	Upstream Clear Cr.	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Chicago Cr.
Jan	0.57	0.006	0.57	0.02	0	0.004	0.000	0.001	0.001	0.00	0.00	0.01	0.01	0.001	0.00	0.00	0.00
Feb	0.57	0.006	0.56	0.00	0	0.004	0.000	0.001	0.001	0.00	0.00	0.01	0.01	0.000	0.00	0.00	0.00
Mar	0.63	0.006	0.62	0.00	0	0.004	0.000	0.001	0.001	0.47	0.00	0.01	0.01	0.001	0.00	0.00	0.01
Apr	0.91	0.006	0.91	0.00	0	0.004	0.000	0.001	0.001	0.93	0.00	0.02	0.00	0.001	0.00	0.00	0.02
May	1.95	0.006	1.94	0.44	0	0.004	0.000	0.001	0.001	0.07	0.05	0.11	0.49	0.000	0.48	0.00	0.01
Jun	2.93	0.006	2.92	1.59	0	0.004	0.000	0.001	0.001	0.05	0.22	0.27	0.84	0.000	0.64	0.00	0.00
Jul	1.87	0.006	1.87	0.26	0	0.004	0.000	0.001	0.001	0.05	0.09	0.11	0.92	0.008	0.66	0.00	0.00
Aug	1.22	0.006	1.21	0.12	0	0.004	0.000	0.001	0.001	0.02	0.03	0.06	0.19	0.002	0.21	0.00	0.00
Sep	0.99	0.006	0.98	0.23	0	0.004	0.000	0.001	0.001	0.02	0.02	0.05	0.11	0.001	0.14	0.00	0.00
Oct	0.82	0.006	0.81	0.27	0	0.004	0.000	0.001	0.001	0.02	0.01	0.04	0.04	0.000	0.07	0.00	0.00
Nov	0.68	0.006	0.67	0.12	0	0.004	0.000	0.001	0.001	0.01	0.01	0.02	0.02	0.001	0.04	0.00	0.00
Dec	0.62	0.006	0.62	0.05	0	0.004	0.000	0.001	0.001	0.00	0.00	0.01	0.00	0.002	0.00	0.00	0.00

Table 12. Lead total maximum daily load, waste load allocation, and load allocations for Segment COSPCL02 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead.

	Zinc																
						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 2, lbs/day							
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	Sliver Plume Water Imps	Town of Silver Plume	George-town WWTP	Central Clear Cr. S.D.	Upstream Clear Cr.	South Clear Cr.	Leaven-worth Cr.	Clear Cr. Abv West Fork	West Clear Cr.	Clear Cr. @ Lawson	Fall R.	Chicago Cr.
Jan	43.2	0.868	42.3	54.1	10.9	0.601	0.0027	0.097	0.167	0.80	1.93	2.36	26.76	3.28	26.8	0.73	0.13
Feb	40.0	0.868	39.1	60.5	20.6	0.601	0.0027	0.097	0.167	0.48	1.42	2.08	22.92	3.08	25.2	0.65	0.07
Mar	46.4	0.868	45.6	64.4	17.9	0.601	0.0027	0.097	0.167	1.73	2.08	1.91	25.54	3.10	26.3	0.81	0.10
Apr	71.3	0.868	70.4	89.6	18.3	0.601	0.0027	0.097	0.167	2.98	1.92	2.66	28.16	3.11	27.4	1.30	0.14
May	279	0.868	278	128	0	0.601	0.0027	0.097	0.167	5.46	7.47	11.1	135.4	50.0	131	13.5	1.68
Jun	761	0.868	760	273	0	0.601	0.0027	0.097	0.167	26.0	31.5	29.2	187.6	48	188	4.72	3.20
Jul	451	0.868	451	131	0	0.601	0.0027	0.097	0.167	8.95	17.3	16.6	112.7	18.8	84	1.47	0.60
Aug	212	0.868	211	88.1	0	0.601	0.0027	0.097	0.167	6.95	8.99	8.64	61.01	15.48	51.7	1.96	0.32
Sep	151	0.868	150	74.0	0	0.601	0.0027	0.097	0.167	4.44	6.39	6.79	47.61	10.06	40.1	0.75	0.24
Oct	111	0.868	110	62.6	0	0.601	0.0027	0.097	0.167	1.92	3.82	5.79	34.22	4.64	28.6	0.49	0.16
Nov	69.1	0.868	68.3	53.7	0	0.601	0.0027	0.097	0.167	1.52	2.89	4.00	32.41	4.05	28.5	0.63	0.18
Dec	50.8	0.868	49.9	50.3	0	0.601	0.0027	0.097	0.167	1.12	2.71	2.98	30.60	3.47	28.4	0.63	0.19

Table 13. Zinc total maximum daily load, waste load allocation, and load allocations for Segment COSPCL02 (mainstem Silver Plume to Idaho Springs). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc.

	Zinc				
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day
Jan	1.74	0	1.74	1.93	0.19
Feb	1.52	0	1.52	1.42	0
Mar	2.43	0	2.43	2.08	0
Apr	2.49	0	2.49	1.92	0
May	3.20	0	3.20	7.47	4.27
Jun	14.3	0	14.3	31.5	17.2
Jul	12.2	0	12.2	17.3	5.01
Aug	6.98	0	6.98	8.99	2.01
Sep	5.15	0	5.15	6.39	1.24
Oct	3.17	0	3.17	3.82	0.65
Nov	2.32	0	2.32	2.89	0.57
Dec	2.12	0	2.12	2.71	0.59

Table 14. Zinc total maximum daily load, waste load allocation, and load allocations for Segment COSPCL03a (South Clear Creek). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc.

	Lead				
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day
Jan	0.02	0	0.02	0.01	0
Feb	0.02	0	0.02	0.01	0
Mar	0.01	0	0.01	0.01	0
Apr	0.02	0	0.02	0.02	0.001
May	0.06	0	0.06	0.11	0.052
Jun	0.14	0	0.14	0.27	0.134
Jul	0.11	0	0.11	0.11	0.000
Aug	0.06	0	0.06	0.06	0.002
Sep	0.04	0	0.04	0.05	0.001
Oct	0.04	0	0.04	0.04	0
Nov	0.03	0	0.03	0.02	0
Dec	0.02	0	0.02	0.01	0

Table 15. Lead total maximum daily load, waste load allocation, and load allocations for Segment COSPCL03b (Leavenworth Creek). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead.

	Zinc				
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day
Jan	0.88	0	0.88	2.36	1.48
Feb	0.81	0	0.81	2.08	1.27
Mar	0.76	0	0.76	1.91	1.14
Apr	1.09	0	1.09	2.66	1.57
May	3.40	0	3.40	11.1	7.68
Jun	9.33	0	9.33	29.2	19.9
Jul	6.84	0	6.84	16.6	9.80
Aug	3.52	0	3.52	8.64	5.11
Sep	2.56	0	2.56	6.79	4.22
Oct	2.06	0	2.06	5.79	3.73
Nov	1.42	0	1.42	4.00	2.57
Dec	1.07	0	1.07	2.98	1.92

Table 16. Zinc total maximum daily load, waste load allocation, and load allocations for Segment COSPCL03b (Leavenworth Creek). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc.

	Copper					
						WLA, lbs/day
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	St Mary's Glacier W&SD
Jan	0.09	0.015	0.07	0.04	0	0.015
Feb	0.07	0.015	0.06	0.03	0	0.015
Mar	0.07	0.015	0.05	0.05	0	0.015
Apr	0.17	0.015	0.15	0.11	0	0.015
May	0.60	0.015	0.59	3.12	2.52	0.015
Jun	0.75	0.015	0.73	3.37	2.62	0.015
Jul	0.35	0.015	0.33	0.40	0.05	0.015
Aug	0.31	0.015	0.30	0.28	0	0.015
Sep	0.14	0.015	0.12	0.09	0	0.015
Oct	0.10	0.015	0.08	0.04	0	0.015
Nov	0.10	0.015	0.08	0.05	0	0.015
Dec	0.09	0.015	0.07	0.05	0	0.015

Table 17. Copper total maximum daily load, waste load allocation, and load allocations for Segment COSPCL09a (Fall River). Stream loads are given for dissolved copper, waste loads are given for potentially dissolved copper.

	Cadmium										
						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.61	0.038	0.57	0.28	0	0.025	0.0005	0.003	0.009	0.38	0.09
Feb	0.58	0.038	0.55	0.22	0	0.025	0.0005	0.003	0.009	0.31	0.07
Mar	0.68	0.038	0.64	0.22	0	0.025	0.0005	0.003	0.009	0.40	0.13
Apr	0.99	0.038	0.95	0.33	0	0.025	0.0005	0.003	0.009	0.49	0.18
May	3.55	0.038	3.51	1.70	0	0.025	0.0005	0.003	0.009	1.97	1.37
Jun	3.09	0.038	3.05	1.05	0	0.025	0.0005	0.003	0.009	1.7	0.92
Jul	2.06	0.038	2.03	0.36	0	0.025	0.0005	0.003	0.009	0.69	0.19
Aug	1.21	0.038	1.17	0.46	0	0.025	0.0005	0.003	0.009	0.82	0.57
Sep	1.03	0.038	0.99	0.35	0	0.025	0.0005	0.003	0.009	0.63	0.36
Oct	0.88	0.038	0.84	0.25	0	0.025	0.0005	0.003	0.009	0.44	0.14
Nov	0.78	0.038	0.74	0.33	0	0.025	0.0005	0.003	0.009	0.45	0.13
Dec	0.70	0.038	0.66	0.37	0	0.025	0.0005	0.003	0.009	0.45	0.11

Table 18. Cadmium total maximum daily load, waste load allocation, and load allocations for Segment COSPCL11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved cadmium, waste loads are given for potentially dissolved cadmium.

	Lead										
						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
Month	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	0.69	4.014	-3.32	0.07	0	4.0	0.0005	0.004	0.01	0.14	0
Feb	0.67	4.014	-3.34	0.13	0	4.0	0.0005	0.004	0.01	0.15	0
Mar	0.80	4.014	-3.21	0.77	0	4.0	0.0005	0.004	0.01	0.09	0.003
Apr	1.12	4.014	-2.90	2.26	1.14	4.0	0.0005	0.004	0.01	0.03	0.007
May	3.90	4.014	-0.12	0.65	0	4.0	0.0005	0.004	0.01	0.61	0.216
Jun	2.13	4.014	-1.88	1.05	0	4.0	0.0005	0.004	0.01	0.97	0.208
Jul	1.61	4.014	-2.40	0.40	0	4.0	0.0005	0.004	0.01	1.25	0.062
Aug	1.06	4.014	-2.96	0.10	0	4.0	0.0005	0.004	0.01	0.16	0
Sep	0.96	4.014	-3.06	0.04	0	4.0	0.0005	0.004	0.01	0.10	0
Oct	0.89	4.014	-3.12	0.01	0	4.0	0.0005	0.004	0.01	0.05	0
Nov	0.84	4.014	-3.18	0.01	0	4.0	0.0005	0.004	0.01	0.09	0
Dec	0.81	4.014	-3.20	0.00	0	4.0	0.0005	0.004	0.01	0.13	0

Table 19. Lead total maximum daily load, waste load allocation, and load allocations for Segment COSPCL11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved lead, waste loads are given for potentially dissolved lead.

Month	Zinc

						WLA, lbs/day				Current Load in Mainstem and Tribs of Segment 11, lbs/day	
	TMDL, lbs/day	Total WLA, lbs/day	Total LA, lbs/day	Ave. Stream Load, lbs/day	Reduction to Meet TMDL, lbs/day	ARGO WWTP	Albert Frei & Sons Inc	Idaho Springs Water Supply	Idaho Spring WWTP	Clear Cr. @ Kermits (junction I-70 & Hwy 6)	N. Fork Clear Cr.
Jan	79.4	4.01	75.4	90	11.0	1.9	0.075	0.54	1.50	107	24.7
Feb	74.5	4.01	70.5	82.3	7.8	1.9	0.075	0.54	1.50	88.0	19.5
Mar	81.0	4.01	77.0	74.7	0	1.9	0.075	0.54	1.50	107	32.4
Apr	131	4.01	127	97	0	1.9	0.075	0.54	1.50	126	45.3
May	497	4.01	493	414	0	1.9	0.075	0.54	1.50	544	265
Jun	1104	4.01	1100	408	0	1.9	0.075	0.54	1.50	613	194
Jul	590	4.01	586	151	0	1.9	0.075	0.54	1.50	318	48.6
Aug	271	4.01	267	113	0	1.9	0.075	0.54	1.50	251	106
Sep	203	4.01	198	109	0	1.9	0.075	0.54	1.50	201	71.5
Oct	147	4.01	143	97	0	1.9	0.075	0.54	1.50	152	37.2
Nov	112	4.01	108	102	0	1.9	0.075	0.54	1.50	139	33.5
Dec	89.1	4.01	85.1	104	15.4	1.9	0.075	0.54	1.50	126	29.8

Table 20. Zinc total maximum daily load, waste load allocation, and load allocations for Segment COSPCL11 (mainstem Idaho Springs to Golden). Stream loads are given for dissolved zinc, waste loads are given for potentially dissolved zinc.

VII. Public Involvement

There has been a strong public participation in protecting and enhancing the water quality of the Clear Creek Basin since the early 1980's. Many organizations have been extensively involved including, the Upper Clear Creek Watershed Association (UCCWA), Colorado Department of Public Health and Environment Hazardous Materials and Waste Management, and Water Quality Control Divisions, Environmental Protection Agency, Colorado Division of Wildlife, Colorado Division of Minerals and Geology and numerous downstream entities that are involved in the Clear Creek Watershed Forum. The public has openly participated in the UCCWA since the early 1990's and held public monthly meetings since that time. The UCCWA and other entities have and will continue to participate is WQCC hearings on water quality classifications and standards in the basin. The public has also participated in EPA/Hazardous Materials Division Technical Advisory Groups and Watershed Advisor Groups evaluating mine cleanup alternatives in the basin. This public participation will continue in the future, as new remediation options are investigated. The flow and chemistry data used in this TMDL was collected at USGS flow gauges, and by UCCWA in monthly sampling events, special EPA sampling events, CDOW sampling events, routine WQCD sampling, and sampling conducted by other private entities.

IX. Works Cited

US EPA. 2004. Clear Creek/Central City Superfund Site - Operable Unit 4: Final Remedial Investigative Report.

WQCC 2006: Colorado Department of Public Health and Environment, Water Quality Control Commission, 2006, 303(d) List of Impaired Waters, 2006.